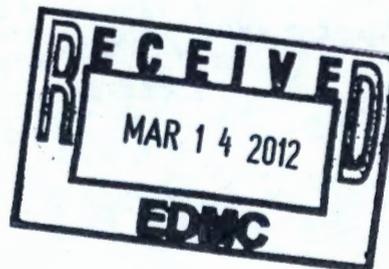


1212467

BHI-01231

Rev. 0

105-C Reactor Interim Safe Storage Project Final Report



*Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration*

Submitted by; Bechtel Hanford, Inc.

100-BC-1

151515

TRADEMARK DISCLAIMER

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 or its contractors or subcontractors.

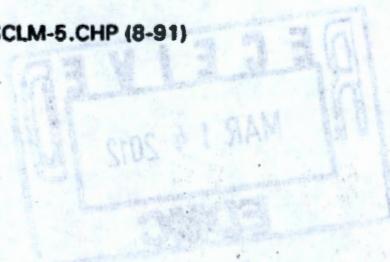
This report has been reproduced from the best available copy. Available in paper copy and microfiche.

Available to the U.S. Department of Energy
and its contractors from
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831
(615) 576-8401

Available to the public from the U.S. Department of
Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650

Printed in the United States of America

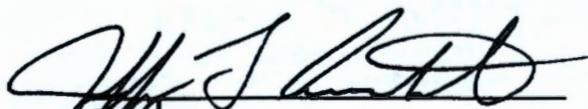
DISCLM-5.CHP (8-91)



APPROVAL PAGE

Title: 105-C Reactor Interim Safety Storage project Final Report

Approval: J. F. Armatrout, Bechtel Hanford, Inc.
Task Lead


Signature

12/1/98
Date

T. E. Logan, Bechtel Hanford, Inc.
Project Manager


Signature

12/1/98
Date

The approval signatures on this page indicate that this document has been authorized for information release to the public through appropriate channels. No other forms or signatures are required to document this information release.

BHI-01231
Rev. 0

105-C Reactor Interim Safe Storage Project Final Report

Author

C. A. Palmquist
Bechtel Hanford, Inc.

Date Published

December 1998

CONTENTS

| | | |
|-------|---|----|
| 1.0 | SCOPE | 1 |
| 2.0 | FACILITY DESCRIPTION AND CONDITIONS..... | 1 |
| 2.1 | HISTORY..... | 1 |
| 2.2 | FACILITY DESCRIPTION..... | 3 |
| 2.3 | DECOMMISSIONING DECISIONS | 3 |
| 3.0 | CHARACTERIZATION | 7 |
| 4.0 | PROJECT ACTIVITIES | 7 |
| 4.1 | ENGINEERING AND PERMITS | 7 |
| 4.2 | MOBILIZATION | 9 |
| 4.3 | READINESS ASSESSMENTS | 9 |
| 4.4 | HAZARDOUS MATERIAL REMOVAL..... | 10 |
| 4.4.1 | Asbestos (Excluding Transite) | 10 |
| 4.4.2 | Transite (Cement Asbestos Board) | 10 |
| 4.4.3 | Lead..... | 10 |
| 4.4.4 | Mercury | 11 |
| 4.4.5 | Polychlorinated Biphenyls | 11 |
| 4.5 | EQUIPMENT REMOVAL | 11 |
| 4.6 | DEMOLITION OF ABOVE-GRADE STRUCTURES | 13 |
| 4.7 | UTILITY AND DRAIN ISOLATION | 17 |
| 4.7.1 | Electrical System..... | 17 |
| 4.7.2 | Water Systems..... | 17 |
| 4.7.3 | Equipment and Floor Drains | 17 |
| 4.8 | SAFE STORAGE ENCLOSURE DEMOLITION | 17 |
| 4.9 | BELOW-GRADE VERIFICATION SURVEYING AND SAMPLING | 19 |
| 4.10 | BELOW-GRADE DEMOLITION | 21 |
| 4.11 | FUEL STORAGE BASIN DEMOLITION AND TRANSFER PIT REMOVAL | 21 |
| 4.12 | INTERFACE AT THE 190-C TO 105-C WATER TUNNELS | 26 |
| 4.13 | SITE RESTORATION..... | 26 |
| 4.14 | INTERFACE WITH REMEDIAL ACTION..... | 26 |
| 4.15 | INTERFACE WITH SURVEILLANCE AND MAINTENANCE | 26 |
| 4.16 | DEMOBILIZATION | 30 |
| 5.0 | COST AND SCHEDULE | 30 |
| 5.1 | SCHEDULE | 30 |
| 5.2 | COST..... | 31 |
| 6.0 | RECYCLED MATERIAL AND WASTE DISPOSAL..... | 31 |
| 6.1 | RECYCLING AND WASTE MINIMIZATION..... | 31 |
| 6.2 | WASTE DISPOSAL..... | 32 |
| 7.0 | OCCUPATIONAL EXPOSURES | 32 |
| 7.1 | PERSONNEL INJURIES | 32 |
| 7.2 | PERSONNEL RADIOLOGICAL EXPOSURES..... | 32 |

| | | |
|------|--|-----|
| 8.0 | SAFE STORAGE ENCLOSURE.. | .33 |
| 8.1 | ROOF | 33 |
| 8.2 | ELECTRICAL SYSTEM..... | 34 |
| 8.3 | REMOTE MONITORING SYSTEM..... | 34 |
| 8.4 | VENTILATION | 34 |
| 8.5 | SECURITY | 35 |
| 9.0 | INNOVATIVE TECHNOLOGY DEMONSTRATION | .35 |
| 9.1 | OVERVIEW AND OBJECTIVES | .35 |
| 9.2 | LARGE SCALE TECHNOLOGY DEMONSTRATION AND DEPLOYMENT PROJECT PURPOSE | .36 |
| 9.3 | TECHNOLOGY DEMONSTRATION RESULTS..... | 37 |
| 10.0 | LESSONS LEARNED AND RECOMMENDATIONS..... | 38 |
| 11.0 | DRAWINGS | 38 |
| 11.1 | STRUCTURAL..... | 38 |
| 11.2 | ELECTRICAL | 39 |
| 11.3 | INSTRUMENTATION..... | .39 |
| 11.4 | MECHANICAL | .39 |
| 12.0 | REFERENCES.. | .40 |

FIGURES

| | | |
|-----|--|-----|
| 1. | Hanford Site Map | 2 |
| 2. | Floor Plan Layout at Ground Level..... | 4 |
| 3. | Pre-1996 Aerial Photo (Looking East)..... | 5 |
| 4. | Ground-Level Photo (Looking Southwest) | 6 |
| 5. | Aerial Photo Showing Fan Supply Room Demolition Completion | 14 |
| 6. | Aerial Photo Showing Control Room Demolition in Progress | 15 |
| 7. | Photo Showing Outer Rod Room Demolition in Progress..... | 16 |
| 8. | Aerial Photo Showing Upper Reactor Roof Demolition in Progress | 18 |
| 9. | Photo Showing Upper Reactor Roof Demolition in Progress.. | .20 |
| 10. | Photo Showing Below-Grade Structure Roof Demolition..... | .22 |
| 11. | 1985 Photo of Transfer Pit Protective Cover..... | .23 |
| 12. | Old Photo Showing the FSB Wood Planking and Monorail System | 24 |
| 13. | Photo of FSB Below-Grade Demolition in Progress | 25 |
| 14. | Photo of FSB Transfer Pit Monolith Lift | 27 |
| 15. | Aerial Photo of Completed SSE (Looking Northeast) | .28 |
| 16. | Aerial Photo of Completed SSE (Looking North) | 29 |

ACRONYMS AND ABBREVIATIONS

| | |
|---------|--|
| ACM | asbestos-containing material |
| ALARA | as low as reasonably achievable |
| ARARs | applicable or relevant and appropriate requirements |
| ASA | auditable safety analysis |
| CERCLA | <i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i> |
| CVP | cleanup verification package |
| D&D | decontamination and decommissioning |
| DDFA | decontamination and decommissioning focus area |
| DOE | U.S. Department of Energy |
| DOE-HQ | U.S. Department of Energy-Headquarters |
| DOH | Washington State Department of Health |
| DQA | data quality assessment |
| DQO | data quality objective |
| EE/CA | engineering evaluation and cost analysis |
| EPA | U.S. Environmental Protection Agency |
| ERC | Environmental Restoration Contractor |
| ERDF | Environmental Restoration Disposal Facility |
| Ecology | Washington State Department of Ecology |
| FHC | final hazard classification |
| FIG | field implementation guide |
| FSB | fuel storage basin |
| FY | Fiscal Year |
| HCR | horizontal control rod |
| IRA | independent readiness assessment |
| ISS | interim safe storage |
| LSDDP | large scale technology demonstration and deployment project |
| MEF | metal examination facility |
| MITUS | Mobile Integrated Temporary Utility System |
| MOC | management of change |
| MTCA | <i>Model Toxics Control Act</i> |
| NOC | Notice of Construction |
| PCBs | polychlorinated biphenyls |
| PFWR | Plant Forces Work Review |
| PLC | programmable logic controller |
| PNOV | Preliminary Notice of Violation |
| RCT | radiological control technician |
| RESRAD | Residual Radioactivity Dose Model |
| RL | U.S. Department of Energy, Richland Operations Office |

ACRONYMS AND ABBREVIATIONS (continued)

| | |
|----------------------------|---|
| ROD | Record of Decision |
| S&M | surveillance and maintenance |
| SAP | sampling and analysis plan |
| SSE | safe storage enclosure |
| Tri-Party Agreement | <i>Hanford Federal Facility Agreement and Consent Order</i> |
| UNI | United Nuclear Industries, Inc. |
| USQ | unreviewed safety question |
| VAC | volt-alternating current |
| VSR | vertical safety rod |

METRIC CONVERSION CHART

The following conversion chart is provided to the reader as a tool to aid in conversion.

| In To Metric Units | | | Out of Metric Units | | |
|----------------------|---|-----------------|----------------------|------------------------------------|---------------|
| <i>If You Know</i> | <i>Multiply By</i> | <i>To Get</i> | <i>If You Know</i> | <i>Multiply By</i> | <i>To Get</i> |
| Length | | | Length | | |
| inches | 25.4 | millimeters | millimeters | 0.039 | inches |
| inches | 2.54 | centimeters | centimeters | 0.394 | inches |
| feet | 0.3048 | meters | meters | 3.281 | feet |
| yards | 0.914 | meters | meters | 1.094 | yards |
| miles | 1.609 | kilometers | kilometers | 0.621 | miles |
| Area | | | Area | | |
| sq. inches | 6.452 | sq. centimeters | sq. centimeters | 0.155 | sq. inches |
| sq. feet | 0.093 | sq. meters | sq. meters | 10.76 | sq. feet |
| sq. yards | .0836 | sq. meters | sq. meters | 1.196 | sq. yards |
| sq. miles | 2.6 | sq. kilometers | sq. kilometers | 0.4 | sq. miles |
| acres | 0.405 | hectares | hectares | 2.47 | acres |
| Mass (weight) | | | Mass (weight) | | |
| ounces | 28.35 | grams | grams | 0.035 | ounces |
| pounds | 0.454 | kilograms | kilograms | 2.205 | pounds |
| ton | 0.907 | metric ton | metric ton | 1.102 | ton |
| Volume | | | Volume | | |
| teaspoons | 5 | millimeters | millimeters | 0.033 | fluid ounces |
| tablespoons | 15 | millimeters | liters | 2.1 | pints |
| fluid ounces | 30 | millimeters | liters | 1.057 | quarts |
| cups | 0.24 | liters | liters | 0.264 | gallons |
| pints | 0.47 | liters | cubic meters | 35.315 | cubic feet |
| quarts | 0.95 | liters | cubic meters | 1.308 | cubic yards |
| gallons | 3.8 | liters | | | |
| cubic feet | 0.028 | cubic meters | | | |
| cubic yards | 0.765 | cubic meters | | | |
| Temperature | | | Temperature | | |
| Fahrenheit | subtract 32, then multiply by 5/9 | Celsius | Celsius | multiply by 9/5, then add 32 | Fahrenheit |

1.0 SCOPE

The following information documents the decontamination and decommissioning (D&D) of the **105-C** Reactor Facility and the placement of the reactor core into interim safe storage (**ISS**). The D&D of the facility included characterization, engineering, removal of hazardous and radiologically contaminated materials, equipment removal, decontamination, demolition of the structure, and restoration of the site. The **ISS** work also included the construction of the safe storage enclosure (**SSE**), which required the installation of a new roofing system, power and lighting, a remote monitoring system, and ventilation components.

2.0 FACILITY DESCRIPTION AND CONDITIONS

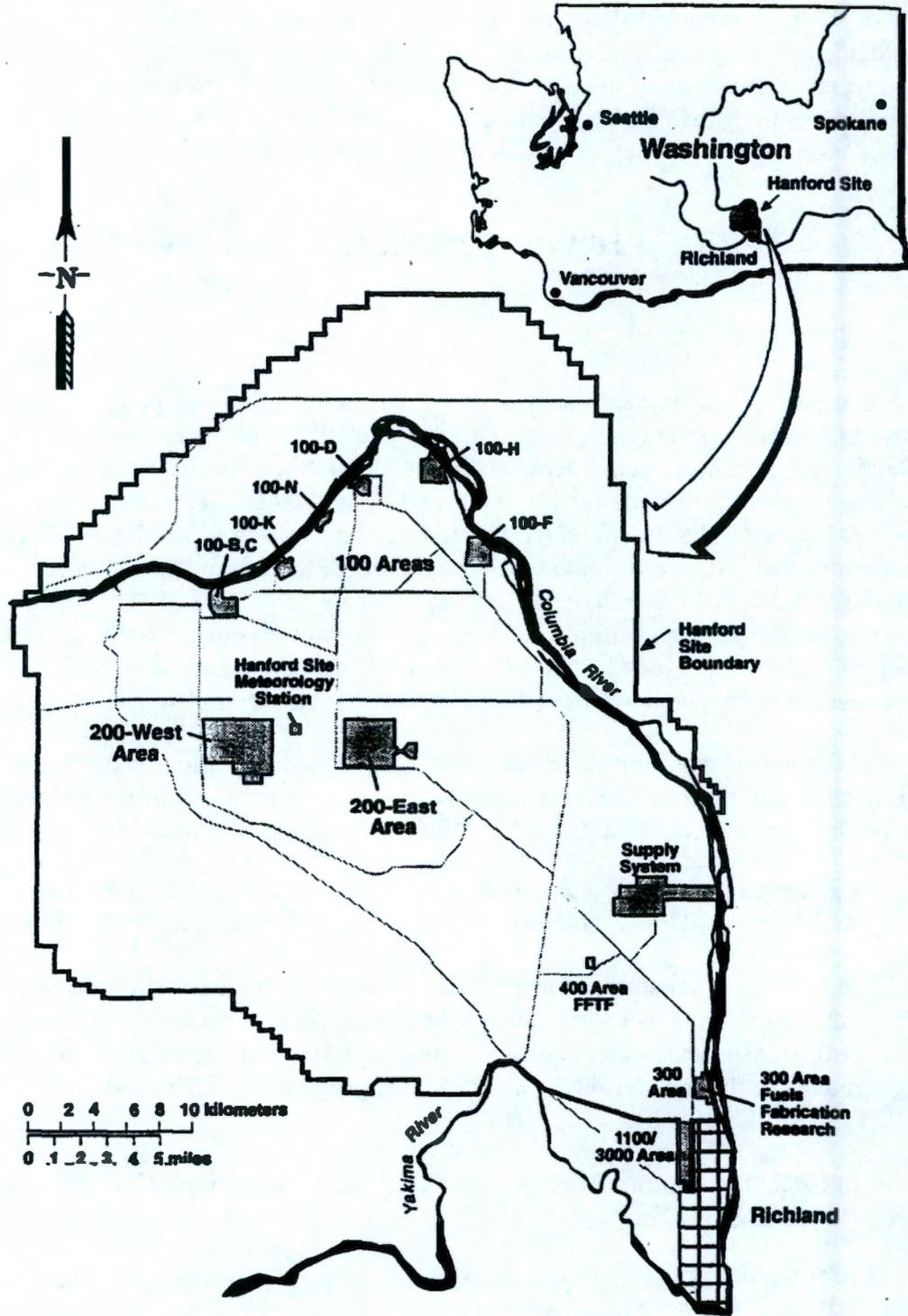
2.1 HISTORY

In **1942**, the U.S. Government commissioned the Hanford Site for the production of plutonium for use in weapons production. Between **1942** and **1955**, eight water-cooled, graphite-moderated production reactors were constructed along the Columbia River in the **100** Areas of the Hanford Site. The Hanford C Reactor facility is located in the **100-B/C** Area of the Hanford Site, as shown in Figure 1. The design of the **105-C** Reactor was started in March **1951**, and construction was initiated on June **6, 1951**. Initial startup of the **105-C** Reactor was achieved on November **18, 1952**, **17** months after ground breaking had occurred. The design of the facility was based on the earlier Hanford Site reactors, and drawings of the older facilities were modified to form the design drawings for the **105-C** Reactor. The *Summary of 100-B/C Reactor Operations and Resultant Wastes* (**WHC 1993**) provides a complete history of the C Reactor.

The **105-C** Reactor was shut down on April **25, 1969**. Deactivation of the reactor was completed in early **1971** (**DUN 197 1** provides the radiological status report). In the years following deactivation, several significant cleanup efforts were completed at the C Reactor complex:

- On September **13, 1983**, the C Reactor exhaust stack (**116-C**) was demolished, as described in a United Nuclear Industries, Inc. (**UNI**) project report (**UNI 1986a**).
- In **1985**, the fuel storage basin (**FSB**), metal examination facility (**MEF**) basin, and all other adjoining basins were cleaned of sediment and the basin surfaces were stabilized with an asphalt emulsion to approximately **8 ft** above the basin floor. The sediment was moved to the transfer pit (which is **5 ft** deeper than the **FSB**) and capped with a plywood cover (**UNI 1986b**).
- In **1988**, demolition work was completed on the adjoining **117-C** Exhaust Filter Building (**WHC 1989**).
- In **1996**, the **187-C** high tanks were explosively demolished, and all **360** tons of steel was salvaged. In **1997**, the associated foundations and valve pits leading to the tanks were demolished (**BHI 1998g**).

Figure 1. Hanford Site Map.



E9602004

2.2 FACILITY DESCRIPTION

The 105-C Building is 106 m by 93 m by 30 m in height (346 ft by 305 ft by 98 ft). The lower levels of the building and the central portions surrounding the reactor are constructed of reinforced concrete. A floor plan layout at ground level is shown in Figure 2. The massive reinforced-concrete walls surrounding the reactor are 0.9- to 1.5-m thick (3 ft to 5 ft). The upper portion of the building and many of the at-grade ancillary rooms are steel-framed, enclosed with corrugated asbestos cement (**transite**). The roof is constructed of badly deteriorated poured-in-place gypsum, with felt paper and gravel roofing serving as the waterproof membrane. A pre-1996 aerial photo looking east is shown in Figure 3. A ground-level photo looking southwest (toward outer rod room and the rod rack) is shown in Figure 4.

2.3 DECOMMISSIONING DECISIONS

Since deactivation, the 105-C Reactor has been in a condition of minimum surveillance and maintenance (S&M) and significant deterioration has occurred, particularly in the roof sections over the fan room and work area. Permanent decommissioning alternatives for the Hanford Site production reactors were assessed *in the Final Environmental Impact Statement, Decommissioning of the Eight Surplus Production Reactors at the Hanford Site* (DOE 1992). A Record of Decision (ROD) was issued by the U.S. Department of Energy (DOE) (58 FR 48509). The ROD states that the preferred alternative is to place the reactors into a safe storage condition for up to 75 years. After ISS, the reactors would be transported in one piece to a specially prepared burial facility in the 200 West Area of the Hanford Site.

The plan for the ISS of the C-Reactor includes removing all portions of the reactor facility outside of the reactor block shield walls. The areas to be removed included the FSB, MEF, outer rod room, control room, electrical room, switchgear room, lunch room, office space, fan supply and exhaust rooms, sample rooms, ready room, lift station, upper reactor framing and roofing, and other miscellaneous rooms and tunnels. The remaining portion of the reactor facility (the areas inside the concrete shield walls) is called the SSE and is discussed in depth in Section 8.0.

The planning process for the 105-C ISS Project was conducted jointly between the U.S. Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and the U.S. Department of Energy, Richland Operations Office (RL). The up-front planning for the project allowed waste disposal to the Environmental Restoration Disposal Facility (ERDF) and streamlined the process for releasing DOE real property. The working relationships between DOE, EPA, and Ecology were greatly strengthened through open communication and cooperation for developing solutions to streamline the D&D planning process. The 105-C ISS Project was the first D&D job implementing the process for conducting decommissioning under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)* at the Hanford Site (which is a joint strategy between EPA and DOE). Additionally, *the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)* (Ecology et al. 1994) was revised to reflect the planning process employed by the 105-C ISS Project, including milestones for 105-C and the following reactors.

Figure 2. Floor Plan Layout at Ground Level.

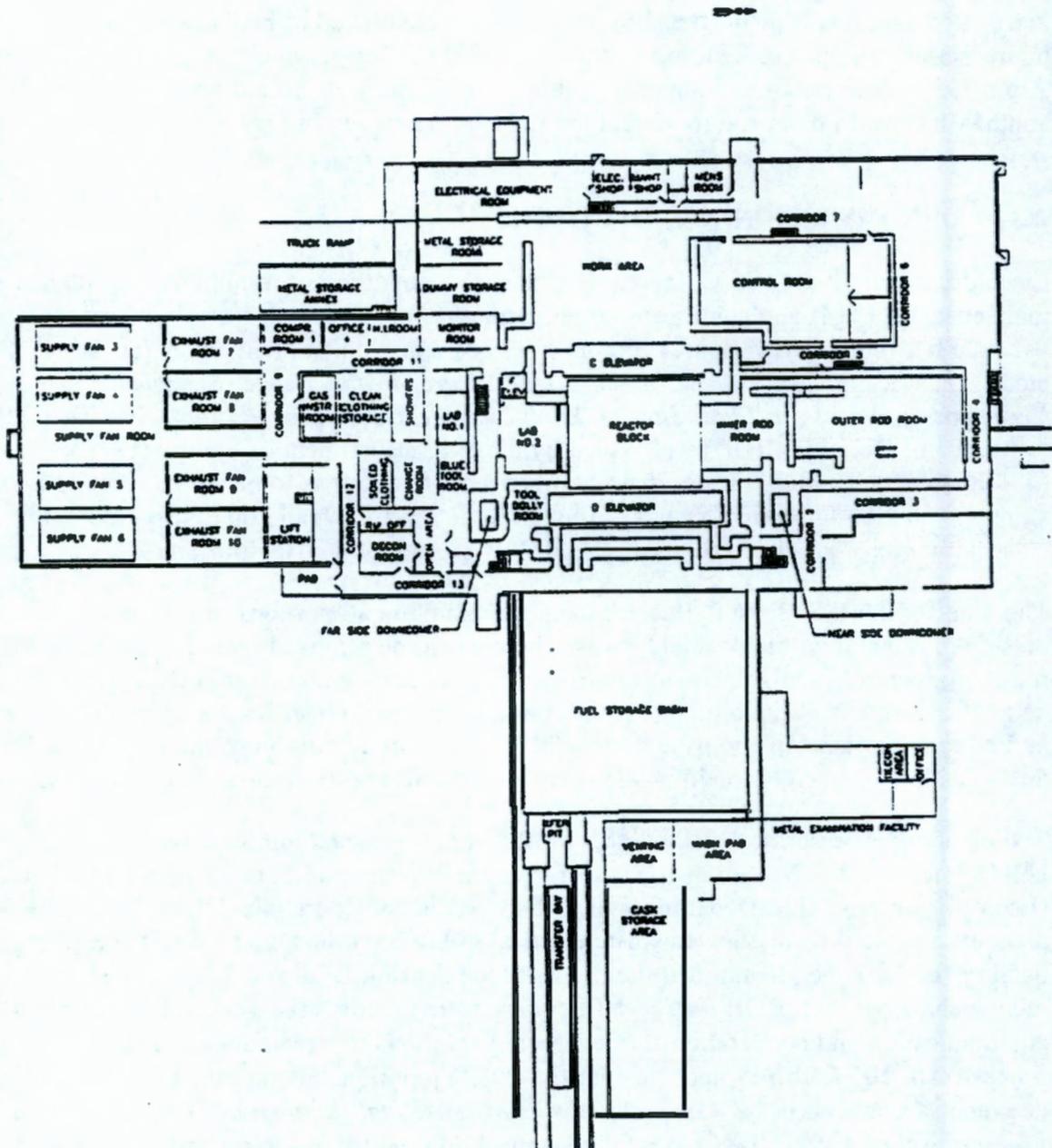


Figure 3. Pre-1996 Aerial Photo (Looking East).



Figure 4. Ground-Level Photo (Looking Southwest).



3.0 CHARACTERIZATION

Fiscal year (FY) 1994 activities included developing a characterization plan (CEES 1994a), characterizing the facility, completing sample and data analysis, and completing the characterization report. Characterization tasks included radiological surveys and sampling for hazardous and radiological contaminants. The characterization results are provided in CEES 1994b.

In FY 1997, the characterization plan and report was amended and reissued as DOE-RL 1997a and DOE-RL 1997b, respectively.

4.0 PROJECT ACTIVITIES

The D&D activities were conducted in accordance with the activities discussed in BHI 1997a.

4.1 ENGINEERING AND PERMITS

An engineering evaluation and cost analysis (EE/CA) was prepared to present results for final disposition for the 105-C Reactor waste and for five other facilities (DOE-RI 1996b). The EE/CA evaluated four alternatives for this removal action:

- No action
- Continued S&M
- D&D and disposal at the ERDF
- D&D and disposal at other Hanford Site facilities.

Based on overall effectiveness, implementability, and cost, the EE/CA states that the recommended removal alternative is to decontaminate, demolish, and dispose of the associated waste at the ERDF (for those wastes meeting the ERDF waste acceptance criteria). The EE/CA received a 30-day public comment and review period. An action memorandum (EPA 1997) provided approval for the EE/CA proposed removal action, subject to approval of additional waste streams not covered by the 105-C characterization report (DOE-RL 1997b) or waste streams not going to the ERDF. Approval for the additional waste streams was subsequently provided but will not be documented herein. The action memorandum also specifies the applicable or relevant and appropriate requirements (ARARs) with which the 105-C ISS Project D&D work must comply (EPA 1997).

Prior to the ISS Project, the 105-C Reactor was under the control of the S&M Projects group. The control of the building was temporarily assigned to D&D Projects to perform the ISS work. This change of control was accomplished by a memorandum of understanding (BHI 1996f).

A biological review (BHI 1996a) and a cultural resources review (BHI 1996b) were performed prior to mobilization at the 105-C Reactor site.

Plant Forces Work Reviews (**PFWRs**) were performed on the entire scope of work required to bring the C Reactor into its final state of **ISS**. The **PFWRs** are documented in **BHI 1996c** and **BHI 1996d**.

The final hazard classification (**FHC**) and auditable safety analysis (**ASA**) for the **105-C ISS** Project (**BHI 1996e**) summarizes the inventories of radioactive and hazardous materials present within the **105-C** Reactor. The **ASA/FHC** also documents the operations associated with the **ISS** Project, which includes decontamination, demolition, and construction of the **SSE**. This document also identifies accident scenarios, performs bounding evaluation of the consequences of the potentially significant accident scenario, and establishes a hazard classification based on the bounding consequence evaluation. The result of the evaluation is that the **FHC** for the **105-C ISS** Project is "Radiological."

The **ASA/FHC** also establishes safety functions and controls. Two special controls were established to ensure that conditions assumed in the **FHC** analysis are maintained:

- Any additions to the inventory of radioactive or hazardous materials in the facility shall be promptly analyzed to determine the impact on the hazard category and safety of the facility.
- Any activity that could selectively concentrate or remove **fissile** material from the transfer pit sediment shall be evaluated prior to initiation of the activity.

Based on the above controls and commitments, four conditions arose during the course of the project that required evaluation. The first two evaluations were unreviewed safety question (**USQ**) determinations. However, half way through the project, procedure revisions required that **USQs** are only for "Nuclear" facilities. Since the **105-C ISS** Project is classified as "Radiological," the two initial **USQs** could have been management of change (**MOC**). The two later evaluations were handled as **MOCs**. Briefly, the **USQs/MOCs** were performed for the following:

| Number | Reference | Description |
|----------------------------|------------------|---|
| USQD 0105C-US-N0001 | BHI 1997e | Discovery of increased concentrations of radionuclides in transfer pit sediments |
| USQD 0105C-US-N0002 | BHI 1997f | Monolith removal of the transfer pit sediments |
| MOC-98-0024 | BHI 1998e | Demolition plan for transfer pit walls above the transfer pit monoliths |
| MOC-98-0030 | BHI 1998f | Increase of lift height of transfer pit monoliths |

The D&D process has the potential to generate radioactive air emissions. Prior to initiating work, a Notice of Construction (**NOC**) (**DOE-RI 1996a**) was prepared for submittal to EPA and

the State of Washington Department of Health (DOH). Approval of the NOC was received from DOH (DOH 1996) and EPA (EPA 1996) prior to starting work.

4.2 MOBILIZATION

Mobilization activities in support of asbestos removal were initiated on October 1, 1996 (beginning of FY 1997). Initial activities consisted of setting up the engineering, field support, radiological control technician (RCT) and lunch trailers, and the associated electrical and phone systems. Parking areas were graded and **graveled** for the workers. Finally, two temporary septic holding tanks and a restroom trailer were installed after the permits were received. This completed mobilization activities outside the reactor fence.

Inside the fence, **MODEC** trailers and water trailers were set up for the asbestos workers and numerous trailers were set up for D&D equipment and supplies. The final step in mobilization was to set up a temporary power and lighting system to replace the inadequate, non-as-built, unsafe power and lighting inside the leaking building. The Mobile Integrated Temporary Utility System (**MITUS**) technology demonstration (see Section 9.0) was very efficiently and safely used to provide power and lighting throughout the course of the **ISS** Project. The **MITUS** technology used a trailer-mounted transformer and distribution panel that stepped down the incoming voltage from **13.8 kV** to **480 V**. International orange cable was used to feed **480 V** power to individual kiosks throughout the facility. Selected kiosks then had the capability to step down the voltage to **240 V** and **120 V**. Lighting strings from each kiosk were then used to provide lighting. In addition to the power and lighting provided, each kiosk had a three-position paging system, emergency lights in case of power loss, and an alarm system. The alarm system would not only alert everyone in the building, but would also signal the central monitoring station outside the building. The central monitoring station could identify the exact kiosk where the alarm was sounded.

After the **MITUS** technology was functional, the entire old power and lighting system was disconnected. Electrical isolation was ensured by removing the main transformer. Additional zero-energy checks were made to ensure that an alternate electrical feed was not coming into the building from another source. Subsequently, all personnel were notified that the only power in the building was in orange or orange-marked cords (this streamlined electrical demolition throughout the course of the **ISS** Project).

4.3 READINESS ASSESSMENTS

The project manager determined that independent readiness assessments (**IRAs**) were to be conducted prior to initiating work at four stages of the **ISS** Project. The primary objectives of the assessments were to determine if (1) the project was ready to begin from an administrative standpoint, (2) all the required resources were available, and (3) all work activities would be accomplished safely. Briefly, the assessments were performed on the following areas:

| <u>IRA Number</u> | <u>Reference</u> | <u>Description</u> |
|--------------------|------------------|-----------------------------------|
| 105C-ISS / FY97-01 | BHI 1997b | Non-intrusive asbestos removal |
| 105C-ISS / FY97-02 | BHI 1997c | Radiological asbestos removal |
| 105C-ISS / FY97-03 | BHI 1997d | General housekeeping |
| BHI-RA-98-00005 | BHI 1998d | Removal of the fuel transfer pits |

The assessments concluded that the project was ready to proceed as scheduled, pending completion of specified **pre-start** and post-start construction punchlist items.

4.4 HAZARDOUS MATERIAL REMOVAL

The scope of the demolition project included removing and properly disposing of flammable and hazardous materials (e.g., oils, grease, asbestos-containing material [ACM], mercury, lead, and **polychlorinated biphenyls [PCBs]**). All of this material was removed inside and outside the **SSE**, with the exception of non-removable lead (as discussed below). All of the removed material was typically removed prior to heavy equipment demolition, with the exception of the lead joints in bell and spigot piping, and a few heavy pieces of lead encased equipment (which was carefully removed during the demolition).

4.4.1 Asbestos (Excluding Transite)

Asbestos monitoring was performed in support of asbestos-removal activities. Removal work activities included the use of glovebags, a cut-and-wrap technique, and negative-pressure enclosures. Applicable areas were sprayed with lock-down after the asbestos work. An asbestos clearance sampling and inspection program was implemented to release each area from asbestos concerns following the asbestos abatement in each area. Approximately **6,600 ft³** of asbestos insulation was removed.

4.4.2 Transite (Cement Asbestos Board)

The exterior walls were constructed of double **transite** panels (exterior and interior). There were also double **transite** panels in most of the interior rooms. Approximately **500 tons** of **transite** were removed. Many panels were radiologically released and were disposed of **offsite**. Radiologically contaminated **transite** was shipped to the **ERDF** for disposal.

4.4.3 Lead

Lead-based paint was originally used throughout the facility but was determined to be below regulatory limits. The majority of lead encountered during D&D was in the form of bricks; however, lead was encountered in additional forms:

- Bricks
- Sheet material

- Small lead balls
- Lead poured around piping and p-traps
- Poured into interior cavities of equipment (e.g., turrets)
- Lead joints from bell and spigot drain piping
- Light bulbs.

Appendix G of **UNI 1987** provided a list of the lead inventory at the **105-C** Reactor. The **ISS** Project could not remove the items listed below:

- Inside the reactor block (**160,000 lbs**)
- Rear shielding door (**26,000 lbs**)
- Experimental room 2 shielding door (**500 lbs**).

Appendix G of **UNI 1987** provided a very under-estimated inventory of lead for the facility. In addition to the above documented items, there are three lead items that the **ISS** Project has identified as components that are not practical to remove. The locations and estimated weights are as follows:

- Upper viewing room **60,000 lbs** (sandwiched around steel framing)
- Horizontal control rod shielding **19,000 lbs** (attached to the rod rack)
- Experimental room 1 table **4,000 lbs** (unsafe to carry downstairs).

UNI 1987 inventoried only **105** tons of lead. During D&D, **70** tons of lead was removed from the reactor building, and **133** tons of lead is inventoried above for a total quantity of **203** tons (twice the original estimate or five times the original estimate if the skewing weight of the reactor block is ignored). Approximately **40** tons of the **70** tons removed was recycled.

4.4.4 Mercury

Mercury was found in numerous switches, manometers and instruments. Approximately one gallon of mercury was collected and was recycled.

4.4.5 Polychlorinated Biphenyls

No regulated quantities of **PCBs** were found in any of the grease or oil. The main transformer was the property of the Hanford Utility Group, so they handled the disposal. Light ballasts were the only **PCB** waste stream requiring **105-C ISS** Project disposal

4.5 EQUIPMENT REMOVAL

Some of the major equipment removed during the **ISS** Project included the following:

| Description | Location |
|--|---------------|
| 45 vertical safety rod (VSR) drives | Upper reactor |
| VSR drive crane | Upper reactor |

| Description | Location |
|---|-------------------------------|
| Ball 3X elevator and delivery system | Upper reactor |
| Rear face elevator drive equipment and counterweights | Upper reactor |
| Front face elevator drive equipment and counterweights | Upper reactor |
| Horizontal control rods (HCR) drives and cooling equipment | Outer rod room |
| HCR drive shafts | Inner rod room |
| Fuel examination equipment | Metal examination facility |
| Control room equipment | Control room |
| Leak detection turrets | Sample rooms |
| Fan equipment | Fan supply and exhaust rooms |
| Fuel loading equipment | Metal storage room |
| 3 pumps | Lift station |
| 2 ion exchangers | Transfer bay |
| Heat exchanger | Transfer bay |
| Cask crane | Transfer bay |
| Compressor | Compressor room |
| Vacuum receiver | Vacuum system room |
| Gas piping | Gas tunnel 13 |
| Water supply piping | North and south water tunnels |
| F elevator (personnel) | All levels |
| Electrical equipment | Upper electrical room |
| Switchgear equipment | Switchgear room. |

The reactor block itself was disturbed as little as possible.

- During deactivation, the **15 HCRs** and the **45 VSRs** were placed in the “full-in” position into the reactor (**WHC 1993**). The **ISS** Project did not touch the rods, but their drive shafts and cables were disconnected and removed.
- Also during deactivation, all **2,004** process tubes were emptied and a “plastic noodle” was placed through the tube to verify that the tube was empty (**WHC 1993**). The **ISS** project did not remove any process tube caps on the front or rear face.
- The Ball **3X** system had the balls removed after deactivation. The Ball **3X** system was left intact because there are **90** pathways into the reactor (**45** in the top and **45** in the

bottom of the reactor block), but it was necessary to remove the Ball 3X elevator that extended above the top of the reactor. The elevator was disconnected directly above the top of the inner rod room, and all upper components were removed and disposed. A sheet metal cover was placed over the top of the elevator to provide isolation.

- Concrete pourbacks (18-in. thick) were placed in the gas tunnel in line with the remainder of the SSE shield wall. Thus, the gas tunnel piping was severed inside of this pourback, and the pipes were foamed to close the openings.

4.6 DEMOLITION OF ABOVE-GRADE STRUCTURES

After the hazardous materials and isolations were performed (as discussed in Sections 4.4 and 4.5), the above grade structures were ready for demolition. Demolition was performed based on whether the areas were relatively radiologically "clean" or contaminated.

Many areas of the reactor (e.g., fan supply room, office spaces, control room, and electrical rooms) had very little radiological contamination. For these areas, surveys were performed and local contamination was removed. These areas were then ready for clean demolition and the resulting waste could be recycled or sent **offsite** for disposal (e.g., the gypsum roofs were sent to municipal landfills). Figure 5 shows the completed demolition of the fan supply room. Figure 6 shows demolition on the control room in progress.

For contaminated areas of the building, it was not cost effective or safe to decontaminate entirely. The major portion of the loose contamination was removed and a fixative was applied as required. Figure 7 shows demolition in progress on the outer rod room.

The building structure was demolished using excavator-mounted hydraulic shears and a hoe-ram. The debris was segregated for disposal or salvage.

The original footprint area of the reactor building was $5,528 \text{ m}^2$ ($59,500 \text{ ft}^2$). The final footprint area of the SSE is $1,059 \text{ m}^2$ ($11,400 \text{ ft}^2$). Thus, the footprint area of the reactor was reduced by 81%. The footprint area is strictly the at-grade area and does not include the square footage of any above-grade rooms (e.g., sample rooms, ready room, upper electrical room, or exhaust plenums) or below-grade rooms/tunnels to avoid confusion.

The front and rear face elevators were shimmed in place (steel shims placed between the elevator frame and the concrete walls) so the elevator floor could serve as a working platform to access the front and rear faces of the reactor block. The rear face elevator is part of the path for performing surveillance.

The roofs to the north and south water tunnels, gas tunnel, vacuum system room, and the compressor room were removed prior to performing the surveys and sampling discussed in Section 4.9. The piping and equipment in these areas was also removed. This was required due to the extreme congestion and unsafe conditions in the tunnels and the high background in the gas tunnel, vacuum system room, and the compressor room. After the piping, equipment, and debris were removed, these areas were available for the surveying and sampling (as discussed in Section 4.9).

Figure 5. Aerial Photo Showing Fan Supply Room Demolition Completion.



Figure 6. Aerial Photo Showing Control Room Demolition in Progress.



Figure 7. Photo Showing Outer Rod Room Demolition in Progress.



4.7 UTILITY AND DRAIN ISOLATION

4.7.1 Electrical System

The power supply to the entire reactor complex was disconnected in the early stages of the ISS Project. The Hanford Utility Group disconnected the main feed and removed the transformer that had been feeding the building. Temporary power and lighting needs during the project were provided by the MITUS technology, which is one of the technologies demonstrated during the project. MITUS also provided a paging system, emergency lighting, and an alarm system. Figures 5 and 6 show the MITUS trailer and the central monitoring station.

4.7.2 Water Systems

All Hanford Site water supply lines have been isolated to the 105-C Reactor SSE. The two fire hydrants inside the C Reactor fence are still active.

4.7.3 Equipment and Floor Drains

All operations at the 105-C Reactor have been shutdown for many years, and the liquids have been flushed and drained to the extent possible as part of the shutdown and deactivation process. Liquid pipe checks have been performed at low points of the piping systems to ensure that no liquids remain. Contaminated piping systems (e.g., the gas piping and process effluent piping) remaining in the facility have been sealed as part of the SSE modifications.

Floors were drained to either the lift station or the **pluto** crib. Floor drains were checked for liquid and mercury, and the floor drains have been sealed to provide isolation. There were no sanitary sewers inside the SSE. The lift station has been demolished, and the **pluto** crib (located outside the reactor building) will be demolished during remedial action.

4.8 SAFE STORAGE ENCLOSURE DEMOLITION

Demolition work on the reactor complex was divided between plant forces and the SSE subcontractor per the requirements of BHI 1996c and 1996d. The SSE subcontractor performed the structural demolition on the portions of the reactor complex inside the SSE concrete shield walls. This structure was mainly composed of several levels of steel framing with **transite** siding (see Figure 8). The SSE subcontractor was also required to remove any large equipment required to place the reactor block into its final SSE configuration. Thus, all the upper reactor equipment listed in Section 4.5 and the F elevator were removed by the SSE subcontractor.

After the elevators were shimmed into place by plant forces (see Section 4.6), the chains, cables, upper drive units, and synchronizing shafts were disconnected and removed. The rear face elevator (D elevator) counterweights were removed and recycled. It was not safe to remove the front face elevator (C elevator) counterweights, so the weights were lowered to the bottom of their shafts (to the water tunnel floor).

Figure 8. Aerial Photo Showing Upper Reactor Roof Demolition in Progress.



Since much of the demolition work by the **SSE** subcontractor was performed directly above the reactor, the top and front face of the reactor had to be protected from falling debris. This was accomplished by building a wood barrier over the entire set of **45 VSRs** and ball hoppers. Scaffolding was built-up to within a few feet of each floor and planking installed to serve as a working platform for demolition and served as additional protection for the reactor (see Figure 9).

4.9 BELOW-GRADE VERIFICATION SURVEYING AND SAMPLING

The goal of the data quality objective (**DQO**) process is to establish the sampling and analysis design strategy to support decontamination and closeout decisions. The historical information for the **105-C** Reactor explains the mechanism by which the below-grade structures and the underlying soils were contaminated, what contamination can be documented, which constituents are eliminated from further consideration, and which constituents are the subject of the sampling and analysis design. This process along with the closeout criteria and procedures is documented in the **DQO** summary report (**BHI 1998a**).

Using the **DQO** summary report as the basis, a sampling and analysis plan (**SAP**) (**DOE-RL 1997c**) was developed to present the rationale and strategies for the sampling, field measurements, and analyses of the below-grade concrete and soil. The regulators (i.e., EPA and Ecology) were instrumental in helping **RL** and the Environmental Restoration Contractor (**ERC**) team develop the **SAP**. The significant aspects of the **SAP** include the following:

- Sampling the concrete and underlying soil of the fuel storage basin as the Phase I step in a graded approach to validate and, as necessary, to refine the **SAP** assumptions
- Shallow and deep zone distinctions for both structures (real property) and soil
- Three alternatives for **dispositioning** the **FSB**
 - Demolish and dispose of the entire **FSB**
 - Demolish the **FSB** walls to 15 ft below grade
 - Decontaminate the inside surfaces of the **FSB**.
- The **ARARs** are consistent with the **100** Area **ROD** (**15 mrem/yr** above background and *Model Toxics Control Act* [**MCTA**] for residual contamination levels in structures and soils)
- A distinction is made between “real property” and “non-real property.”

For the actual implementation of the **SAP**, two field implementation guides (**FIGs**) were developed to provide a clear, concise set of instructions to the radiological survey personnel and samplers in the field. **FIG 0100C-IG-G0002** (**BHI 1998b**) provides the instructions for performing the Phase I sampling in the **FSB** and the radiological surveys in the remainder of the below-grade structures. **FIG 0100C-IG-G0003** (**BHI 1998c**) provides the instructions for the Phase II sampling in all **non-FSB** below-grade structures.

Figure 9. Photo Showing Upper Reactor Roof Demolition in Progress.



The survey results and sample analysis results are subjected to a data quality assessment (DQA) to verify that the objectives of the DQO have been satisfied. The data were then used in the Residual Radioactivity Dose Model (RESRAD) and RESRAD-BUILD computer model to verify that cleanup criteria are satisfied. A brief summary of the data and the analysis results are included in a cleanup verification package (CVP) (BHI 1998i). This package is a brief report that summarizes and compares the results against the cleanup criteria. The CVP concludes that the residual contamination in the soil and the below-grade structures is less than the required cleanup standards. There is voluminous data to back up the CVP, and it is included in a technical memorandum and a calculation to the CVP.

4.10 BELOW-GRADE DEMOLITION

Prior to any below-grade demolition, the results of the RESRAD and RESRAD-BUILD analyses discussed in Section 4.9 had to show that the subject below-grade structure was below the cleanup criteria. Figure 10 shows the ceilings of the gas tunnel, compressor room, and vacuum system room demolished (the floors and walls ready for radiological surveys and sampling). Following radiological surveying, sampling, and analysis in the below-grade structures, the facility outside the SSE was demolished to 1 m below grade. The basement structure, located greater than 1 m below grade, was left in place only if the cleanup criteria were satisfied. All below-grade areas were backfilled to eliminate future subsidence.

4.11 FUEL STORAGE BASIN DEMOLITION AND TRANSFER PIT REMOVAL

In 1985, the sediment in the FSB and MEF was moved to the two transfer pits (UNI 1986b). The FSB and MEF walls and floor were cleaned and coated with asphalt emulsion, the sediment was de-watered, and the sediment in the transfer pits were covered with plywood covers (see Figure 11). In 1997, the ISS Project removed the plywood cover from each pit to expose the top surface of the sediment. For as low as reasonably achievable (ALARA) and cost reasons, the Project decided that the sediment should remain in the pits and should be removed as two large monoliths in lieu of vacuuming the sediment into 55-gallon barrels (see Sections 7.2 and 10.0).

To achieve this objective, grout caps were placed over the sediment, and sand was placed over the grout cap to protect the grout cap from falling debris.

Figure 12 is an old photograph depicting the wood planking and monorail system in the FSB. After the transfer pit grout cap and protective sand were in place, the above-grade FSB and MEF were demolished. The contamination levels on the FSB and MEF walls were too high to satisfy the cleanup criteria in the SAP; therefore, the walls had to be decontaminated or demolished. Cost, safety, and ALARA comparisons clearly demonstrated that demolition of the FSB and MEF walls to the -15-ft elevation was the preferred alternative. Thus, all walls were demolished to a minimum of 15 ft below grade. See Figure 13 for FSB below-grade demolition in progress. Two areas were demolished to the bottom of their foundations:

- The four MEF sumps
- The east wall of the FSB (for better access to the transfer pits).

Figure 10. Photo Showing Below-Grade Structure Roof Demolition.

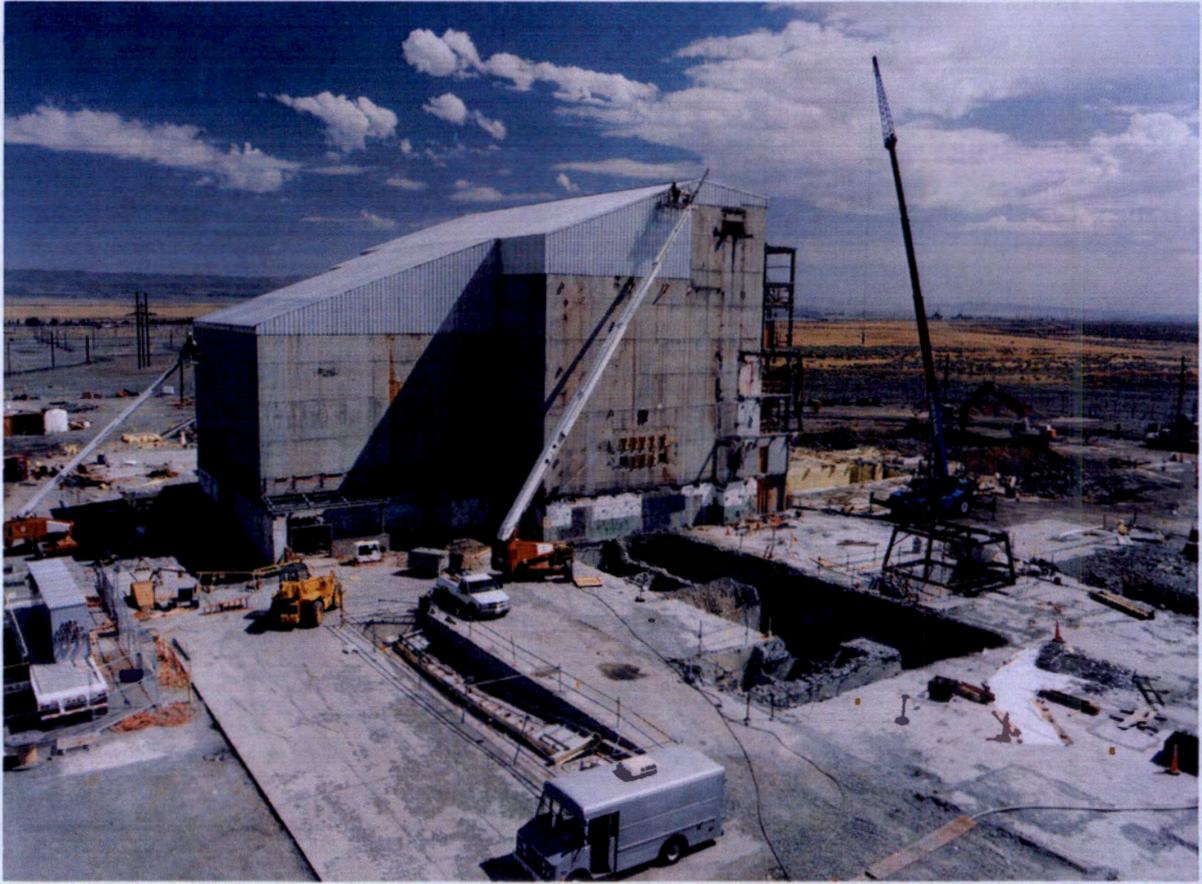


Figure 11. 1985 Photo of Transfer Pit Protective Cover.

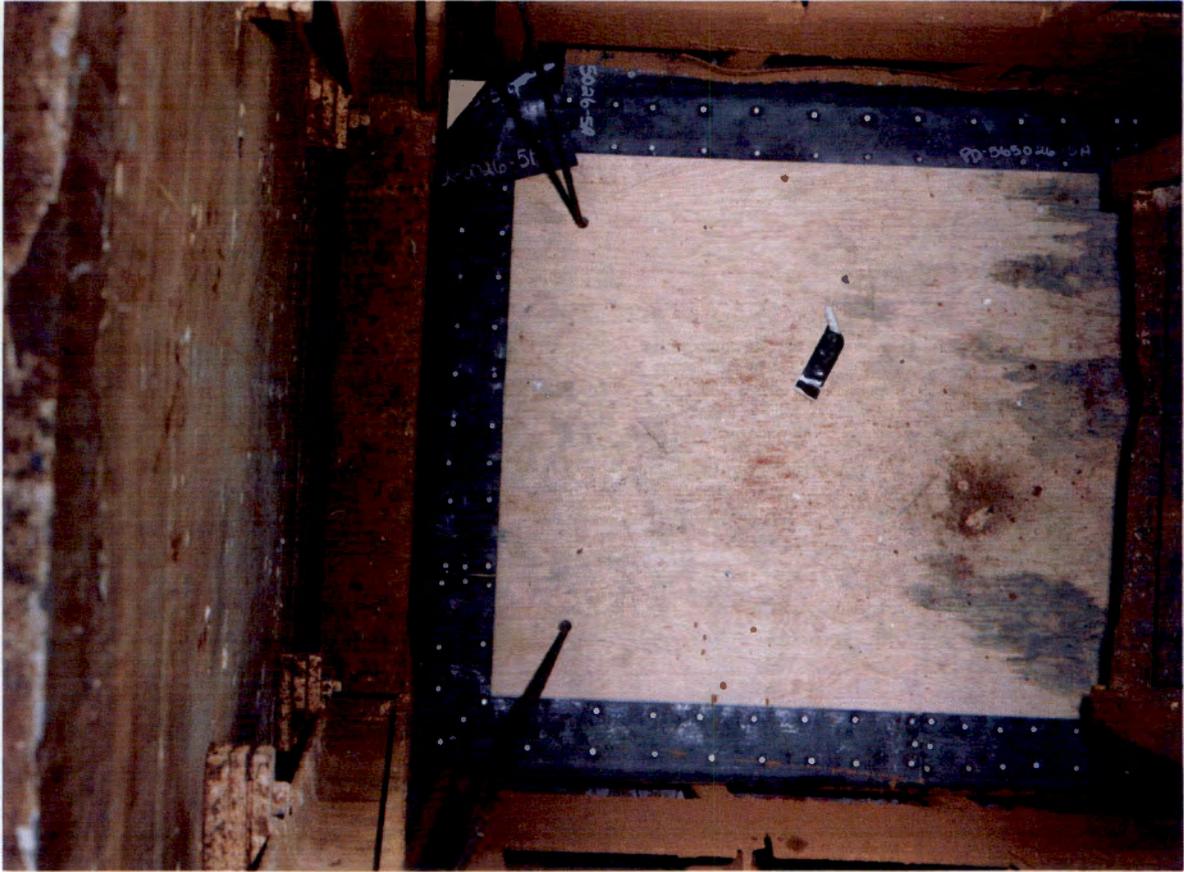


Figure 12. Old Photo Showing the FSB Wood Planking and Monorail System.



Figure 13. Photo of FSB Below-Grade Demolition in Progress.



After the east wall of the FSB was demolished with heavy equipment, the upper walls of the transfer pits were demolished down to the top of the protective sand layer. Diamond wire concrete cutting was then used to cut the transfer pits down to the final monolith size. Both monoliths were painted to fix any loose contamination that may exist. The monoliths were lifted using an FMC LinkBelt Model LS-518 crane and were transported to the ERDF one at a time (see Figure 14). At the ERDF, each monolith was pulled off the transport with a D8 Cat using specially prepared lubricated skid plates and a prepared disposal pad.

4.12 INTERFACE AT THE 190-C TO 105-C WATER TUNNELS

In preparation of the 105-C Reactor below grade demolition, the water tunnel piping and conduit running from 190-C to 105-C were severed at the first pipe support west of the 105-C Building. Following backfill operations, the backfill in each water tunnel was stabilized with 5 yd³ of concrete to prevent possible future subsidence in this area.

4.13 SITE RESTORATION

Upon completion of the demolition activities, the area was backfilled with a minimum of 1-m-thick soil/aggregate surface layer placed over the footprint of the facility and graded to match the surrounding terrain. The backfill was obtained from the 100-B Area and 100 Area Fire Station borrow pits. Figures 15 and 16 show views of the site after all site restoration activities were completed.

4.14 INTERFACE WITH REMEDIAL ACTION

Meetings were held with the 100-B/C Remedial Action Project to coordinate the interface point between the D&D and remedial action projects. In general, it was agreed that D&D would remove drain lines to approximately 1 m outside the boundary of the building, and the two process sewers (effluent lines) would be removed up to the expansion box (approximately 10 ft from the building edge). Additionally, drain/effluent piping exposed during excavations would be removed by the 105-C ISS Project (this resulted in significantly more pipe being removed than originally anticipated). An interoffice memorandum (BHI 1998k) provides the final interface points for the Remedial Action Project.

4.15 INTERFACE WITH SURVEILLANCE AND MAINTENANCE

During the ISS Project, the 105-C Reactor was temporarily under the control of the D&D Projects to perform the ISS work. At the completion of the ISS Project and the completion of the endpoint criteria, the 105-C Reactor was reassigned to the S&M Project. This change of control was accomplished by a memorandum of understanding (BHI 1998h).

Figure 14. Photo of FSB Transfer Pit Monolith Lift.



Figure 15. Aerial Photo of Completed SSE (Looking Northeast).



Figure 16. Aerial Photo of Completed SSE (Looking North).



A S&M plan (DOE-RL 1998) was developed as one of the endpoint criteria. The S&M Project has estimated that their cost will be \$5,000 per year for yearly radiological surveys and tumbleweed removal. Every fifth year the S&M cost will be \$16,000 in order to perform the surveillance of the inside of the SSE. The decreased S&M costs for the SSE result in an average annual savings of \$190,000 per year (this value excludes any major costs, such as the major roof repair that would have been required).

4.16 DEMOBILIZATION

Trailers, tools, equipment, and miscellaneous items were removed from the project site during demobilization activities that occurred in September 1998.

5.0 COST AND SCHEDULE

5.1 SCHEDULE

Some key dates for the 105-C ISS Project include the following:

- Trailer mobilization initiated August 1996
- D&D work started October 1996
- Awarded SSE subcontract December 1997
- FSB disposition letter to EPA December 1997 (Tri-Party Agreement Milestone)
- Completed 20 technology demonstrations March 1998
- Regulator SAP approval May 1998
- Completed SSE roof June 26, 1998
- Provided S&M plan to regulators July 30, 1998 (Tri-Party Agreement Milestone)
- Transfer pit monoliths removed September 2, 1998
- ISS work completed September 30, 1998 (Tri-Party Agreement Milestone)

5.2 COST

The total ISS Project cost (exclusive of the 1994 characterization task) is summarized by fiscal year. The tasks associated with each fiscal year are briefly described in Section 5.1. Approximately \$7 million of the total cost summarized below was related to the technology demonstration effort:

| | |
|--------|--------------------------------------|
| N 1996 | 4,042K |
| N 1997 | 10,500K |
| N 1998 | 12,791K |
| N 1999 | <u>453K</u> (estimate at completion) |
| | \$27,786K |

The SSE subcontractor's costs associated with FY 1998 and 1999 are summarized below:

| | |
|--------|--------------------------------------|
| N 1998 | 2,426K |
| N 1999 | <u>319K</u> (estimate at completion) |
| | \$2,745K |

6.0 RECYCLED MATERIAL AND WASTE DISPOSAL

One of the objectives of the 105-C Reactor ISS Project was to support recycling and waste minimization.

6.1 RECYCLING AND WASTE MINIMIZATION

Materials listed below were recycled during the 105-C Reactor ISS Project:

| | |
|-----------------------------------|---|
| Steel | 400 tons |
| Non-ferrous material | 5,000 lbs |
| Lead | 40 tons |
| Mercury | 1 gallon |
| W o o d | Re-used or sent to the City of Richland landfill for composting |
| Exhauster | Recycled from the 200 East Area (to be used for future exhausting of the reactor SSEs, as required) |
| Miscellaneous equipment and tools | Transferred to the 105-B Reactor (to be used for B Reactor Museum displays) |
| Load centers | 20 recycled from Washington Public Power Supply System Reactor #1, modified, and used in the kiosks |

The **105-C** Reactor field crew loaded material into recycle trucks, which was then sold for salvage. The project has successfully demonstrated good waste minimization practices where applicable.

6.2 WASTE DISPOSAL

Approximately **15,600** tons of low-level waste was disposed of at the **ERDF**. The two **70-ton** transfer pit monoliths are included in this total.

The deteriorating roofs had significant in-leakage from precipitation. Additionally, water was used throughout the project as a dust suppression method (this water drained to the lift station). A total of **215,000** gallons of water was pumped out of the lift station during various pump-out campaigns and was shipped to the Effluent Treatment Facility for disposal.

Nonradiologically contaminated asbestos was disposed of at the Roosevelt, Washington, landfill.

7.0 OCCUPATIONAL EXPOSURES

7.1 PERSONNEL INJURIES

During the duration of the project there were 0 lost work days and **14** Occupational Safety and Health Administration recordable cases. A total of approximately **276,300** hours (manual and non-manual) were spent on the entire project.

7.2 PERSONNEL RADIOLOGICAL EXPOSURES

There were no personnel skin contaminations to personnel during the entire project. This was achieved, in part, due to the technology demonstrations performed on disposable seam-sealed sack suits (see Section 9.3). Seven suits (**6** disposable and 1 baseline cotton) were evaluated and two of the suits' (one for winter wear and one for summer wear) were judged superior and deployed on all remaining work. The evaluation was based on a wide range of criteria (three of the criteria included radiological effectiveness, toughness, and worker comfort).

All work was performed based on the **ALARA** objective. The dose goal for the entire **105-C** Reactor **ISS** Project was based on Radiological Engineering quarterly dose estimates of upcoming work:

| | |
|---|------------------------|
| Dose goal (excluding the transfer pits) | 7.2 person rem |
| Dose goal (transfer pits) | <u>15.2 person rem</u> |
| Total Project goal | 22.4 person rem |

The total combined dose of all **105-C** Reactor personnel was approximately **3.4** person rem for the entire project duration (**15%** of the goal). This goal was achieved through the excellent

ALARA work of the entire Project team, with special credit to the radiological engineer, **RCT** supervisors and leads, **RCTs**, and D&D workers. The Project team also implemented an innovative method for handling the high-dose sediment in the **FSB** transfer pits (see Section 4.11). Vacuuming the sediment into drums was the original baseline method for removing the sediment from the pits. Following a plutonium uptake incident (see Section 10.0). The Project team had a meeting to discuss possible ways to remove the sediment. Three alternatives were evaluated for both cost and dose, and the monolith option was the clear choice based on both cost and dose. The estimated doses for each of the three options were as follow:

- Vacuum the sediment into drums 113.5 person rem
- Shovel sediment into drums with vacuum assist 71.0 person rem
- Removal of the pits as one-piece monoliths 15.2 person rem.

8.0 SAFE STORAGE ENCLOSURE

The Hanford Site's **105-C** Reactor was chosen as the first reactor to be placed into long-term safe storage due to advanced deterioration on roof sections of the reactor building that would require major maintenance expenditure. The primary objective of the **105-C** Reactor **ISS** Project is to provide storage up to **75** years with minimal maintenance required. Design objectives are summarized as follow:

- Safe storage for up to **75** years
- No credible releases of **radionuclides** to the environment under normal design conditions
- Interim inspection required only on a five-year frequency
- **SSE** configuration will not preclude or significantly increase cost of any final decommissioning alternative.

8.1 ROOF

After the upper reactor demolition was completed, new anchor bolts were grouted into the top of the concrete shield walls and new structural framing was installed. **Galvalum-coated** steel roofing (**22-gauge**) and siding (**24-gauge**) was then attached to the framework. **Galvalum** (also referred to as **55% Al-Zn**) is a coating that contains **55%** aluminum and **45%** zinc. The excellent corrosion resistance of **galvalum** is achieved by combining the barrier protection of an **aluminum** coating with the galvanic protection of a zinc coating. Refer to Section 11.1 for structural concrete, steel, and roofing/siding drawings.

8.2 ELECTRICAL SYSTEM

The 105-C Reactor SSE has permanent lighting installed along the surveillance route located on the lower level, at-grade, and upper levels and stairwells. All facility personnel and visitors must carry a light source for SSE rooms that are unlit and for egress if the lighting system should fail.

The 1 10-volt-alternating current (VAC) receptacles are located inside and outside the SSE utility room and at all levels inside the SSE from the basement at an elevation of -17.5 ft, up to the top of the reactor at elevation 45 ft. Refer to Section 11.2 for power and lighting drawings.

8.3 REMOTE MONITORING SYSTEM

The 105-C Reactor SSE is configured with two temperature sensors (resistance temperature detectors) and a flooding sensor (float switch), plus installed spares for each sensor.

A temperature sensor is located at grade level on the south side of the front face work area, near the reactor front face. The second temperature sensor is located at the south side of the 45-ft level (top of the reactor) near the F elevator. The flooding sensor is located at the south side of the -17.5 ft basement level near the stairwell. Refer to Section 11.3 for instrumentation drawings.

The 105-C Reactor remote monitoring system sensors are controlled through a programmable logic controller (PLC) powered from a utility room distribution panel. Signals are transmitted (via modem and a dedicated phone line) and continuously displayed at the operation supervisors workstation (located in the 271-U Building).

A loss of continuity to a resistance temperature detector will result in a loss of signal to the monitoring station in the 271-U Building. The flooding sensor is normally closed circuit, so a loss of continuity failure will result in a flooding alarm at the monitoring station at the 271-U Building. The flooding circuit is directly wired to the PLC. The temperature monitoring circuits operate on a 4-20 mA current loop from transmitters. The transmitters are supplied with 120 VAC for operating power. In the event of instrument failure, monitoring for both the temperature sensors and the flooding sensor can be manually switched to previously installed spares from the SSE utility room, eliminating the need to make a special entry into the SSE. The sensors inside the SSE are reliable, but if replacements are necessary, they can be accomplished during regularly scheduled surveillance periods.

8.4 VENTILATION

The 105-C Reactor SSE is a deactivated facility that is uninhabited and locked during storage, except during S&M activities. Many of the reactor's components were removed as part of the stabilization effort for SSE. Remaining equipment and components that contain radiological inventory have been sealed during the implementation of the SSE Project. Many accessible areas of the building's interior have had a fixative applied to limit the spread of contamination.

No mechanical ventilation of the building is necessary either during normal storage or during periodic surveillance. A provision has been made to ventilate the facility with exhaust fans for

entry and/or maintenance. The **105-C Reactor SSE** has been designed to use a **9,000-ft³/min** portable **exhauster** for building exhaust ventilation for non-routine maintenance. If building exhaust ventilation is required, the interior access door to the **SSE** shall be placed in the open position. Air is drawn into the **SSE** through the utility room vents. The size of these openings is sufficient to provide proper flow even when the exterior door to the **SSE** utility room is closed.

A ventilation system flow diagram can be found on drawing **0100C-DD-M0032** (see Section 11.4). The **exhauster** draws air through flanged, stainless-steel vent openings located on the north side of the **SSE**. When the portable **exhauster** is not connected, the connection point is sealed with bolted flanges. Additionally, welded stainless-steel security bars are provided behind the bolted flanges if the flanges should have been removed maliciously.

8.5 SECURITY

The access to the **105-C Reactor SSE** is through the utility room. During periods of storage, the door to the **SSE** (located inside the utility room) will be locked and spot welded shut. The door to the utility room will be locked except during routine S&M activities. The **SSE** is entered only for periodic S&M activities. The **3- to 5-ft-thick** concrete walls and the welded door provide the security barrier for the facility; therefore, a locked fence around the **SSE** is not required. There are no intrusion alarms or routine security patrols for the **105-C Reactor SSE**. The Hanford Patrol continues to provide routine security patrols in the vicinity as part of their patrol throughout the **100 Areas**. There are two other welded doors into the **SSE** (the inner rod room and the rear face) to allow greater flexibility if maintenance is required, but these doors will not be used as entrances for typical surveillance activities.

9.0 INNOVATIVE TECHNOLOGY DEMONSTRATION

9.1 OVERVIEW AND OBJECTIVES

A partnering of DOE Environmental Restoration (**EM-40**) and Science and Technology (**EM-50**) funded the **105-C Reactor ISS Project**. Thus, the **105-C Reactor ISS Project** became one of three large-scale technology demonstration and deployment projects (**LSDDP**) selected by the U.S. Department of Energy-Headquarters (**DOE-HQ**) D&D focus area (**DDFA**). A major goal of this project is to identify and demonstrate new and innovative D&D technologies that will benefit cost, schedule, and safety, and have potential for general use at many DOE facilities.

The **LSDDP** concept is designed to demonstrate the benefits of using a suite of improved D&D technologies to deactivate and/or decommission facilities owned by **EM-40** and **EM-60** using the following criteria:

- The large-scale demonstration should have a significant visible impact, such as removal of a building or structure.
- The large-scale demonstration should prove significant benefits of using a suite of improved technologies compared to baseline technologies.

- The large-scale demonstration should be conducted at a scale that is convincing to potential users.
- The large-scale demonstration project should assist DOE in accomplishing its ongoing and **planned** deactivation and decommissioning activities.
- Each of the large-scale demonstration projects should be managed and conducted by D&D integrating contractor who will transfer the experience and expertise gained to similar D&D jobs at other DOE facilities and commercial jobs.

The **105-C Reactor ISS Project** provides an excellent resource for accomplishing the intent of **EM-50** and for demonstrating improved technologies. The objectives are to evaluate, demonstrate, and select preferred technologies that will lower life-cycle costs, health and safety risks, detrimental risk to the environment, quantity of waste requiring disposal, secondary waste, and worker exposure during the **ISS Project** and future S&M activities. The goal is to allow for one baseline and one or more new/improved technologies that will facilitate a given scope of work and not unduly impact the cost or schedule for completion of the project.

These demonstrations provide performance evaluations of new and emerging technologies against current (baseline) technical approaches, and establish partnerships with private industry to develop further new technologies and technical approaches to cost-effectively manage DOE D&D legacy.

It was proposed that this new approach be accompanied by the intensive demonstration and use of innovative D&D technologies to lower the life-cycle costs, accelerate schedules, reduce worker exposure, and other benefits. The type of technologies associated with phases of this new approach include characterization, decontamination, dismantlement, demolition, waste minimization, facility monitoring and surveillance, and safety enhancements.

9.2 LARGE SCALE TECHNOLOGY DEMONSTRATION AND DEPLOYMENT PROJECTPURPOSE

The purpose of the **LSDDP** was to integrate a major Hanford Site **ISS** project with demonstrations of more than **20** new technologies to identify the best available technologies for D&D of the **105-C Reactor** and the remaining seven Hanford Site reactors. This integrated safe storage and technology demonstration project will provide DOE a major opportunity to achieve real progress at the Hanford Site in accomplishing highly visible D&D activities. The new D&D technologies can be categorized as follow:

- Characterization
- Decontamination
- Demolition
- Waste disposal and minimization
- Facility stabilization
- Worker health and safety.

This deployment project provides the clear identification of technologies that will be optimal for preparing the remaining seven surplus production reactors at the Hanford Site for similar low-cost **ISS**, or for D&D tasks at other DOE complex facilities and commercial sites.

9.3 TECHNOLOGY DEMONSTRATION RESULTS

The objectives of the **LSDDP** were to demonstrate the benefits of **20** improved D&D technologies to deactivate and/or D&D facilities that are owned by **EM-40** and the Nuclear Material and Facility Stabilization Division (**EM-60**). The **20** technology demonstrations included the following:

- Laser-Assisted Ranging and Data (**LARADS**)
- Gamma-Ray Imaging
- Position-Sensitive Radiation Detector
- Self-Contained Pipe Cutting Shears
- Mobile Integrated Temporary Utility System (**MITUS**)
- **STREAM**
- Heat Stress Monitoring System
- Seam-Sealed Sack Suit
- Wireless Remote Monitoring
- **2-D** Linear Motion System
- High-Speed Clam Shell Pipe Cutter
- Concrete Shaving
- Concrete Diamond Grinder
- Concrete **Spaller**
- Reactor Stabilization
- Automatic Dust Suppression System
- **RESRAD-BUILD**
- Nitrogen Cooled Diamond Wire Cutting
- Compact Subsurface Discreet Sampler
- Lead Decontamination (Chemical).

Thirteen of the above technologies have shown to be successful and have been added to the D&D toolbox. Brief summaries and results can be obtained from the technology factsheets. For in-depth evaluations, refer to the Innovative Technology Summary Reports. The following Internet sites provide information on the technologies performed during the **105-C** Reactor **ISS** Project and other technologies demonstrated across the DOE complex:

| | |
|-----------------------|---|
| ERC Home Page | http://www.bhi-erc.com |
| ERC Home Page | http://ftp.bhi-erc.com |
| FETC Home Page | http://www.fetc.doe.gov |

10.0 LESSONS LEARNED AND RECOMMENDATIONS

A plutonium uptake occurred during the removal of the south plywood cover in the **FSB** transfer pits (**BHI 1997i**). One D&D worker was assigned a final internal dose for 1997 of **120 mrem** committed effective dose equivalent. A similar occurrence at Building **224-B** resulted in Preliminary Notice of Violation (**PNOV EA-97-08**) (**DOE 1997**). The violations associated with these events were classified as Severity Level III, which is the lowest of the three levels because of the small exposures involved, but the incidents could have been much worse if greater quantities of nuclear material were involved. The **PNOV EA-97-08** reply (**BHI 1997g**) resulted in several actions and lessons learned, as summarized in **BHI 1997h**.

One of the main lessons learned during the **105-C** Reactor **ISS** Project is that the D&D work conducted inside and outside the **SSE** should have been essentially completed prior to the **SSE** subcontractor starting work in the field. It may be necessary to have the D&D work essentially completed prior to the **pre-bid walkdown** so the bidders have a clear understanding of the remaining scope of work. For a complete list of lessons learned during the **105-C** Reactor **ISS** Project, refer to **BHI 1998j**.

11.0 DRAWINGS

The following drawings show the as-built configurations for the **105-C** Reactor **SSE**.

11.1 STRUCTURAL

| Drawing No. | Title |
|----------------|--|
| 0100C-DD-C0001 | Structural Concrete, Plan Below El. 0'-0" |
| 0100C-DD-C0002 | Structural Concrete, Plan at El. 0'-0" |
| 0100C-DD-C0003 | Structural Concrete, Plan at El. 15'-0" |
| 0100C-DD-C0004 | Structural Concrete, Plan at El. 40'-0" |

The following vendor drawings show the **SSE** framing and roofing/siding:

Roof System Design Drawings:

0105C-SC-G0022-05-003-01 through -09

Framing Shop Detail Drawings:

0105C-SC-G0022-06-001-01 through -43

Joist and Girder Shop Detail Drawings:

0105C-SC-G0022-07-001-01

Roofing and Siding Shop Detail Drawings:
0105C-SC-G0022-08-001-01 through -30

11.2 ELECTRICAL

| <u>Drawing No.</u> | <u>Title</u> |
|--------------------|--|
| 0100C-DD-E0019 | SSE Permanent Power and Lighting System, One-Line Diagram |
| 0100C-DD-E0022 | SSE Power and Lighting System, Electrical Arrangement |
| 0100C-DD-E0023 | SSE Power and Lighting System, Electrical Arrangement |
| 0100C-DD-E0027 | Permanent Electrical Distribution System Plan, Section and Details |
| 0100C-DD-E0081 | 100-C Area 13.8 KV Overhead Line and Service Distribution Transformer & Cut Out Pole Details |
| 0100C-DD-E0088 | 100-C Area 13.8 KV Overhead Line and Service Distribution Center Layout |
| 0100C-DD-E0089 | 100-C Area 13.8 KV Overhead Line and Service Distribution Electrical, One-Line Diagram |

11.3 INSTRUMENTATION

| <u>Drawing No.</u> | <u>Title</u> |
|--------------------|---|
| 0100C-DD-J0021 | SSE Control and Monitoring System, Field Device List and Loop Diagram |
| 1000C-DD-J0044 | SSE Control and Monitoring System, Instrument Location Plan |

11.4 MECHANICAL

| <u>Drawing No.</u> | <u>Title</u> |
|--------------------|--------------------------------------|
| 0100C-DD-M0032 | SSE Ventilation System, Flow Diagram |
| 0100C-DD-M0038 | Reactor Ball Hopper Vent, Mechanical |

12.0 REFERENCES

- 58 FR 48509, "Record of Decision of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington," *Federal Register* 58 FR 48509 No. 178.
- BHI, 1996a, *Ecological Review for Temporary Office Installation at 100-C, 96-ER-028, CCN 034917*, dated July, 22, 1996, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1996b, *Cultural Resources Review – 100-C Area Temporary Office Installation Project, 96-100-040, CCN 034312*, dated July 22, 1996, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1996c, *Plant Forces Work Review, 8850-057-96*, dated August 1, 1996, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1996d, *Plant Forces Work Review, 8850-060-96*, dated August 1, 1996, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1996e, *Final Hazard Classification and Auditable Safety Analysis for the 105-C Reactor Interim Safe Storage Project, BHI-00837, Rev. 0*, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1996f, *Memorandum of Understanding for the 105-C Building, CCN 034768*, dated July 24, 1996, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1997a, *Definitive Design Report for the 105-C Reactor Interim Safe Storage Project, BHI-00948, Rev. 0*, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1997b, *Approval of 105-C Interim Safe Storage Non-Intrusive Asbestos Removal Readiness Evaluation, 105C-ISS/FY97-01, CCN 038027*, dated October 17, 1996, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1997c, *Approval of 105-C Interim Safe Storage Radiological Asbestos Removal (Phase II) Readiness Assessment, 105C-ISS/FY97-02, CCN 041607*, dated January 9, 1997, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1997d, *Approval of 105-C Interim Safe Storage General Housekeeping Readiness Assessment, 105C-ISS/FY97-03, CCN 041565*, dated January 20, 1997, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1997e, *Unreviewed Safety Question Determination for Discovery of Increased Concentrations of Radionuclides in 105-C Transfer Pit Sediments, USQD 0105C-US-N0001, Rev. 0*, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 1997f, *Unreviewed Safety Question Determination Monolithic Removal of 105-C Transfer Pit Sediments, USQD 0105C-US-N0002, Rev. 0*, Bechtel Hanford, Inc., Richland, Washington.

- BHI, 1997g, *Reply to Preliminary Notice of Violation, EA-97-08, CCN 052479*, dated October 24, 1997, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1997h, *Response to Corrective Action Request (CAR) EA-97-08-01 Through -04, CCN 053971*, dated December 15, 1997, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1997i, *Potential Unexpected Radiological Exposure*, Occurrence Report Number RL-BHI-DND-1997-0009, dated July 14, 1997, **Bechtel** Hanford, Inc. Richland, Washington.
- BHI, 1998a, *Data Quality Objectives Summary Report for the Release of the 105-C Below-Grade Structures and Underlying Soils*, BHI-01035, Rev. 0, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998b, *Field Instruction Guide for Release of the 105-C Below-Grade Structures and Underlying Soils*, Field Instruction Guide 0100C-IG-G0002, Rev. 2, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998c, *Field Instruction Guide for Verification Sampling of the 105-C Below-Grade Structures and Underlying Soils*, Field Instruction Guide 0100C-IG-G0003, Rev. 0 (plus Design Change Notices 1 and 2), **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998d, *Readiness Assessment, Removal of the Fuel Transfer Pits at 105-C*, BHI-RA-98-00005, CCN 060282, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998e, *Management of Change – Demolition Plan for Transfer Pit Walls Above Monoliths*, MOC-98-0024, Rev. 0, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998f, *Management of Change – Increase of Lift Height of Transfer Pit Monoliths*, MOC-98-0030, Rev. 0, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998g, *187-C High Tanks Final Decommissioning Report*, BHI-01118, Rev. 0, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998h, *Memorandum of Understanding for the 105-C Reactor SSE*, CCN 062759, dated October 21, 1998, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998i, *Cleanup Verification Package for the Release of the 105-C Below Grade Structures and Underlying Soils*, CVP-98-0009, Draft A, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998j, *Lessons Learned on the 105-C ISS Project*, CCN 062488, dated September 30, 1998, **Bechtel** Hanford, Inc., Richland, Washington.
- BHI, 1998k, *105 C ISS Project Interface with 100-B/C Remedial Action Project*, CCN 062758, dated November 3, 1998, **Bechtel** Hanford, Inc., Richland, Washington.
- CEES, 1994a, *105-C Facility Characterization Plan*, Rev. 0, Columbia Energy and Environmental Services Inc., Richland, Washington.

- CEES, 1994b, *105-C Building Characterization Survey Data Report*, Columbia Energy and Environmental Services Inc., Richland, Washington.
- DOE, 1992, *Final Environmental Impact Statement, Decommissioning of the Eight Surplus Production Reactors at the Hanford Site*, DOE/EIS-0119F, U.S. Department of Energy, Washington, D.C.
- DOE, 1997, *Preliminary Notice of Violation EA-97-08*, dated September 19, 1997, U.S. Department of Energy, Washington, D.C.
- DOE-RL, 1996a, *Radioactive Air Emissions Notice of Construction for the 105-C Reactor Safe Storage Enclosure*, DOE-RL-96-45, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE-RL, 1996b, *Engineering Evaluation Cost Analysis for the 100-B/C Area Ancillary Facilities and the 108-F Building*, DOE-RL-96-85, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE-RL, 1997a, *105-C Facility Characterization Plan*, DOE-RL-97-19, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE-RL, 1997b, *105-C Building Characterization Survey Data Report*, DOE-RL-97-20, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE-RL, 1997c, *Sampling and Analysis Plan for Release of the 105-C Below Grade Structures and Underlying Soils*, DOE-RL-97-37, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE-RI, 1998, *Surveillance and Maintenance Plan for the 105-C Reactor Safe Storage Enclosure*, DOE-RL-98-44, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOH, 1996, *Approval of Notice of Construction*, AIR 96-802, dated August 12, 1996, Washington State Department of Health - Richland Operations Office, Richland, Washington.
- DUN, 1971, *Radiological Status Report -Deactivation of the 105-C Reactor Plant*, DUN-7623, Douglas United Nuclear, Richland, Washington.
- Ecology, EPA, and DOE, 1994, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.
- EPA, 1996, *Approval of Notice of Construction*, QAQ-107, dated September 3, 1996, U.S. Environmental Protection Agency - Richland Field Office, Richland, Washington.

- EPA, 1997, *Action Memorandum; 100 B/C Area Ancillary Facilities and the 108-F Building Removal Action*, dated January 29, 1997, U.S. Environmental Protection Agency-Richland Field Office, Richland, Washington.
- UNI, 1986a, *116-C, -F, and -H Reactor Exhaust Ventilation Stack Demolition Hanford Site Individual Facility Report*, UNI-3855, United Nuclear Industries, Inc., Richland, Washington.
- UNI, 1986b, *Fuel Storage Basin Cleanup and Stabilization Project Report*, UNI-3958, United Nuclear Industries, Inc., Richland, Washington.
- UNI, 1987, *Radionuclide Inventory and Source Terms for the Production Reactors at Hanford*, UNI-3714, Rev. 1, United Nuclear Industries, Inc., Richland, Washington.
- WHC, 1989, *117-C Exhaust Filter Building, Facility Decommissioning Report*, WHC-SD-DD-TI-038, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1993, *Summary of 100-B/C Reactor Operations and Resultant Wastes*, WHC-SD-EN-RPT-004, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DISTRIBUTION

U. S. Department of Energy
Richland Operations Office

| | |
|-----------------------------------|--------------|
| J. M. Bruggeman | H0-12 |
| J. D. Goodenough | H0-12 |
| P. M. Pak | H0-12 |
| G. Richardson (3) | S7-55 |
| S. N. Saget | K8-50 |
| J. P. Sands | H0-12 |
| DOE-RL Public Reading Room | H2-53 |

ERC Team

| | |
|---------------------------------|--------------|
| J. F. Armatrout, BHI | H0-21 |
| R. G. Egge, BHI | S3-21 |
| R. H. Griffin, BHI | X0-17 |
| T. E. Logan, BHI | X9-08 |
| C. A. Palmquist, BHI (2) | H0-18 |
| J. P. Pizzarella, BHI | X0-17 |
| B. F. Marlin, BHI | H0-21 |
| P. J. Woods, BHI | S3-20 |
| P. A. Newman | T7-05 |
| S. K. Pulsford | H0-05 |

| | |
|--|--------------|
| D&D Project Files | X9-08 |
| S/M&T Project File | S3-20 |
| Document and Information Services (3) | H0-09 |
| Hanford Technical Library | P8-55 |

FETC

John Duda (2)
P.O. Box 880
Collins Ferry Rd.
Morgantown, WV 26507-0880

