BHI-00076
Rev. 01

105-B Reactor Facility Museum Phase I Feasibility Study Report

Environmental Excellence
HANFORD

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Bechtel Hanford, Inc.
Richland, Washington

Approved for Public Release

BHI-00076
REV: 01
OU: N/A
TSD: N/A
ERA: N/A

APPROVAL PAGE

Title of Document: 105-B REACTOR FACILITY MUSEUM PHASE I FEASIBILITY STUDY REPORT

Author(s): Battelle Pacific Northwest Laboratories
Parsons Environmental Services, Inc.
P. W. Griffin

Approval: B. W. Mathis, Project Manager, D&D Projects

Signature 9/18/95
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-DIS Cap 10-1-95

105-B REACTOR FACILITY MUSEUM
PHASE I FEASIBILITY STUDY REPORT

Revision No. 01

Issue Date ________

Impact Level ________

Author:
P. W. Griffin
Date 9-15-95

Concurrence by:
P. K. Jackson
D&D Projects Project Engineer
Date 9-15-95

For M. A. Mihalic
D&D Projects Task Lead
Date 9-15-95

BHI-00076
Rev. 01

105-B Reactor Facility Museum Phase I Feasibility Study Report

Authors
Battelle Pacific Northwest Laboratories
Parsons Environmental Services, Inc.
P. W. Griffin

Date Published
September 1995

Environmental Excellence
HANFORD

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Bechtel Hanford, Inc.
Richland, Washington

Approved for Public Release

EXECUTIVE SUMMARY

This report contains the results of the 105-B Reactor (B Reactor) Phase I Feasibility Study. The purpose of this feasibility study is to evaluate options for the dismantlement or reutilization of the B Reactor and determine the feasibility of each of these options.

The B Reactor complex was constructed in 1943 to provide nuclear materials for the war effort. The engineering and construction achievements of B Reactor are recognized as monumental as it was the world's first full-scale nuclear reactor. The operation of this reactor generated the plutonium used in the first atomic weapons test and in the bombing of Nagasaki, Japan. It is widely believed that this bombing was directly responsible for the end of World War II without a full-scale invasion of Japan. The technological and political impacts of the advent of nuclear reactors is immense and are still developing over 50 years later.

In 1985, an environmental impact statement was prepared (DOE 1989 and DOE 1992), and in 1993, a record of decision (ROD) (DOE 1993) was published for the dismantlement of Hanford's surplus reactors, including the B Reactor. Progress towards this dismantlement, including the decontamination of the reactors, has continued over time to accomplish the requirements of this ROD. Since the ROD was issued, B Reactor has been placed on the National Historic Register, and there is strong and growing support throughout the nuclear community to preserve the reactor as a museum. Preliminary steps have begun towards preservation through the installation of visitor displays and conducting controlled tours throughout portions of the reactor working areas. Some areas of the facility contain residual radioactive contamination and are not available for tours to the general public.

This study was conducted to define the activities necessary to continue using the B Reactor as a museum; evaluate the technical feasibility of those activities; examine the cost effectiveness of these actions versus dismantlement; and evaluate options which would improve the B Reactor as a museum attraction. To accomplish these goals, an extensive assessment of the physical site conditions was performed. In addition, an examination of the cultural value of the reactor was done, noting especially its relationship to the Hanford Site and place in national/international nuclear history.

Six alternatives were evaluated in this Feasibility Study. The first five alternatives (Alternatives A through E) each address the use of B Reactor as a museum, while the sixth alternative (Alternative F) addresses issues associated with dismantling the reactor. Table ES-1 summarizes the key aspects of each Alternative, which are further described in the following paragraphs.

Table ES-1. Summary of Alternatives' Key Elements.

ALTERNATIVE	DESCRIPTION	IMPROVEMENTS
Alternative A	Controlled Tour Access	Repair roof Improve ventilation and heating Upgrade fire protection Comply with ADA requirements Provide potable water/improve toilet facilities upgrade barriers/signs Abate asbestos hazard
Alternative B	Public Access With Current Displays	Implement Alternative A improvements Open access road from Vernita Bridge Upgrade Route 240 access gate Construct access road fence Improve parking lot Install direction signs Staff during operating hours
Alternative C	Public Access With Enhanced Displays	Implement Alternative A/ Alternative B improvements Upgrade current displays Provide presentation/demonstration area Improve entry lobby exhibits Implement access road/site exhibits
Alternative D	Public Access With Enhanced Displays and Additional Tours	Implement Alternative A/ Alternative B/Alternative C improvements Extend access to valve pit room Extend access to fan room Extend access to fuel storage basin
Alternative E	Public Access With Enhanced Displays, Additional Tours, and River Access/Cultural Center	Implement Alternative A/ Alternative B/Alternative C/ Alternative D improvements Provide open space/park reserve Provide day use/camping facilities Identify cultural/environmental site features USFWS wildlife refuge
Alternative F	Dismantling	Decommission and dismantle per ROD Comply with NHPA requirements

Alternative A, the continued use of B Reactor as a museum, requires some physical upgrades to meet federal standards. The key upgrades include fixation of asbestos throughout the facility, installation of a ventilation system to control natural radon levels, and physical facility enhancements to allow compliance with the Americans with Disabilities Act (ADA). The scheduled tour method currently used would continue to be utilized.

In addition to this option, four additional options are considered to enhance B Reactor as a museum. These options are identified as Alternatives B through E. Each of these options allows the public to visit without a prearranged tour and requires that one staff member be at the reactor at all times it is open. The four options vary in the areas of access and level of exhibits provided to the public.

Alternative B is the first of the enhanced museum options. This alternative allows for public access through the improvement of existing roadways and parking lots. In addition, fences would be constructed to limit public access to other areas of the Hanford Site. New roadway signs and exhibits at the Highway 240 access would also be included in this alternative to increase the public's awareness of the museum. All of the safety and ADA upgrades identified in Alternative A are also included.

Alternative C adds upgraded displays and an air conditioned auditorium, in addition to those upgrades identified in Alternatives A and B.

Alternative D requires upgrades to additional areas within the reactor to allow the public access to those areas. The technical significance of these areas is sufficient to warrant consideration of this action. This alternative would include all of the upgrades identified in Alternatives A, B, and C.

Alternative E provides for all of the previously discussed upgrades and adds a family picnic area and cultural resource center near the site.

Alternative F is the dismantlement of the reactor in compliance with a standing ROD obtained through the National Environmental Policy Act process. This dismantlement would not meet the intent of the listing on the National Historic Register or allow appropriate preservation of this historic accomplishment.

The remainder of the report describes the evaluation process. The alternatives were analyzed using a set of criteria. There are two general types of criteria. The first are physical criteria which must be met to ensure an alternative is technically and physically feasible. These criteria were applied to each of the alternatives as they were developed and are incorporated within the alternatives to address the necessary facility and structural upgrades to ensure feasibility. The second set of criteria are used to evaluate the relative merits of each alternative against the others. These criteria were developed using a cost/benefit rationale for evaluation.

A set of 12 benefits such as historical, public relations, and environmental were evaluated for each alternative. A forced-ranking for each benefit was then assigned. This ranking was developed as part of a prototypical workshop which included a cross-sectional representation of engineers, project managers, scientists, and technicians from the technical project team's organizations. From the rankings, a cost benefit analysis matrix was developed to identify a relative score for each alternative.

From this alternative analysis phase, several key conclusions were identified. The first conclusion is that the continued use of B Reactor as a museum provides a strong benefit to various areas of the public sector. The alternative which showed the greatest cost/benefit ranking was Alternative C. This alternative allows the public access to the reactor and improves the current displays. The second key conclusion from this study is that the five alternatives defined in this report where the reactor facility functions as a museum are technically feasible options and may be implemented separately in a time-phased manner. Finally, it was concluded that given the use of the reactor facility as a museum is technically feasible, key stakeholders from community, state, and federal agencies, the Indian Nations, and groups as appropriate should be involved in the decision-making process.

The next logical step is to perform the activities identified for Phase II. This study should provide sufficient design detail for each of the alternatives to permit the development of refined cost estimates and include stakeholder involvement.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

APPENDICES

TABLES

TABLE OF CONTENTS (Continued)

FIGURES

PHOTOGRAPHS

TABLE OF CONTENTS (Continued)

1.0 OBJECTIVE

1.1 INTRODUCTION

The B Reactor at the Hanford Site was the first full-scale production nuclear reactor ever constructed (Photograph 1-1, Figure 1-1). It is a single-pass, water-cooled, graphite moderator plutonium production reactor, the first of three virtually identical reactors built in a 15-month period as part of the Manhattan Project (Photograph 1-2). The B Reactor played an important role in the defense efforts during World War II as it produced the plutonium for the first atomic bomb tested at the Trinity Site in New Mexico and the plutonium used in the bomb dropped on Nagasaki, Japan, on August 8, 1945, which brought an end to the war.

The B Reactor was placed on the National Register of Historic Places on April 3, 1992, by the National Park Service (NPS) of the U.S. Department of the Interior (USDI). This reactor was also listed as a National Historic Mechanical Engineering Landmark in 1976 by the American Society of Mechanical Engineers' History and Heritage Committee. In October 1993, the American Society of Civil Engineers named the B Reactor a National Civil Engineering Landmark (ACSE 1993). The American Nuclear Society presented the Nuclear Historic Landmark Award to the B Reactor in 1992.

Photograph 1-1. 105-B Reactor During Production (1948).

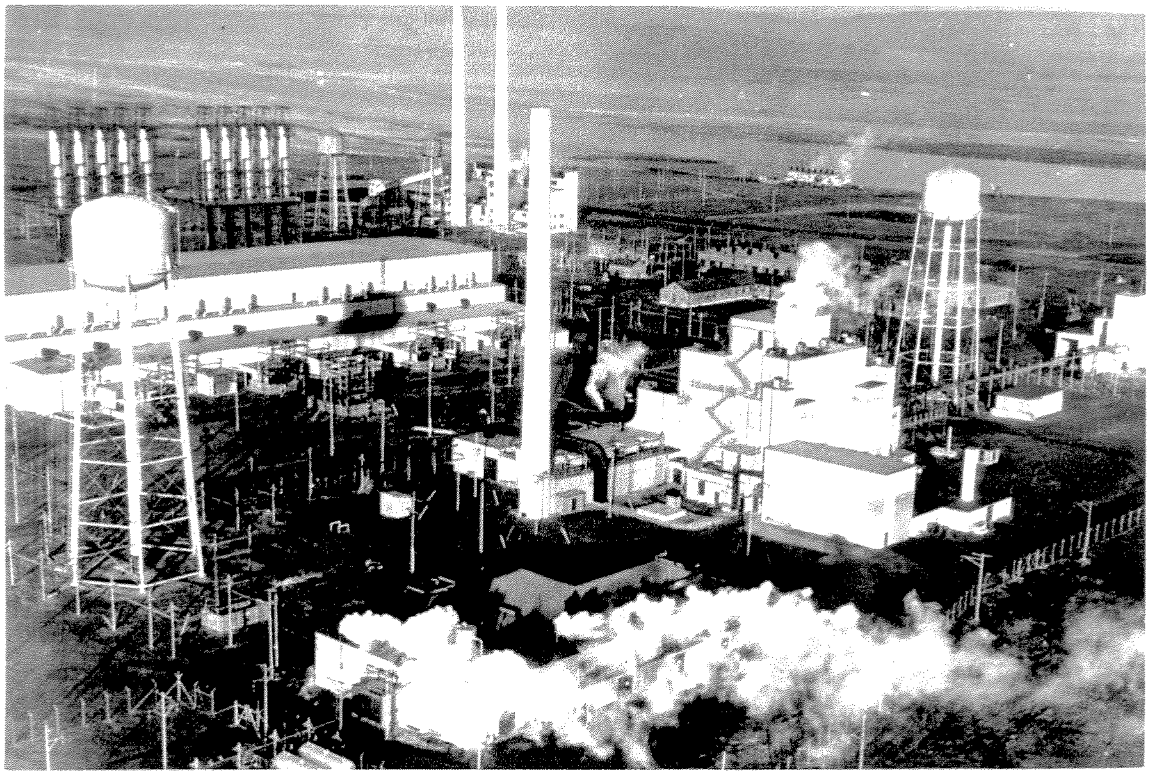
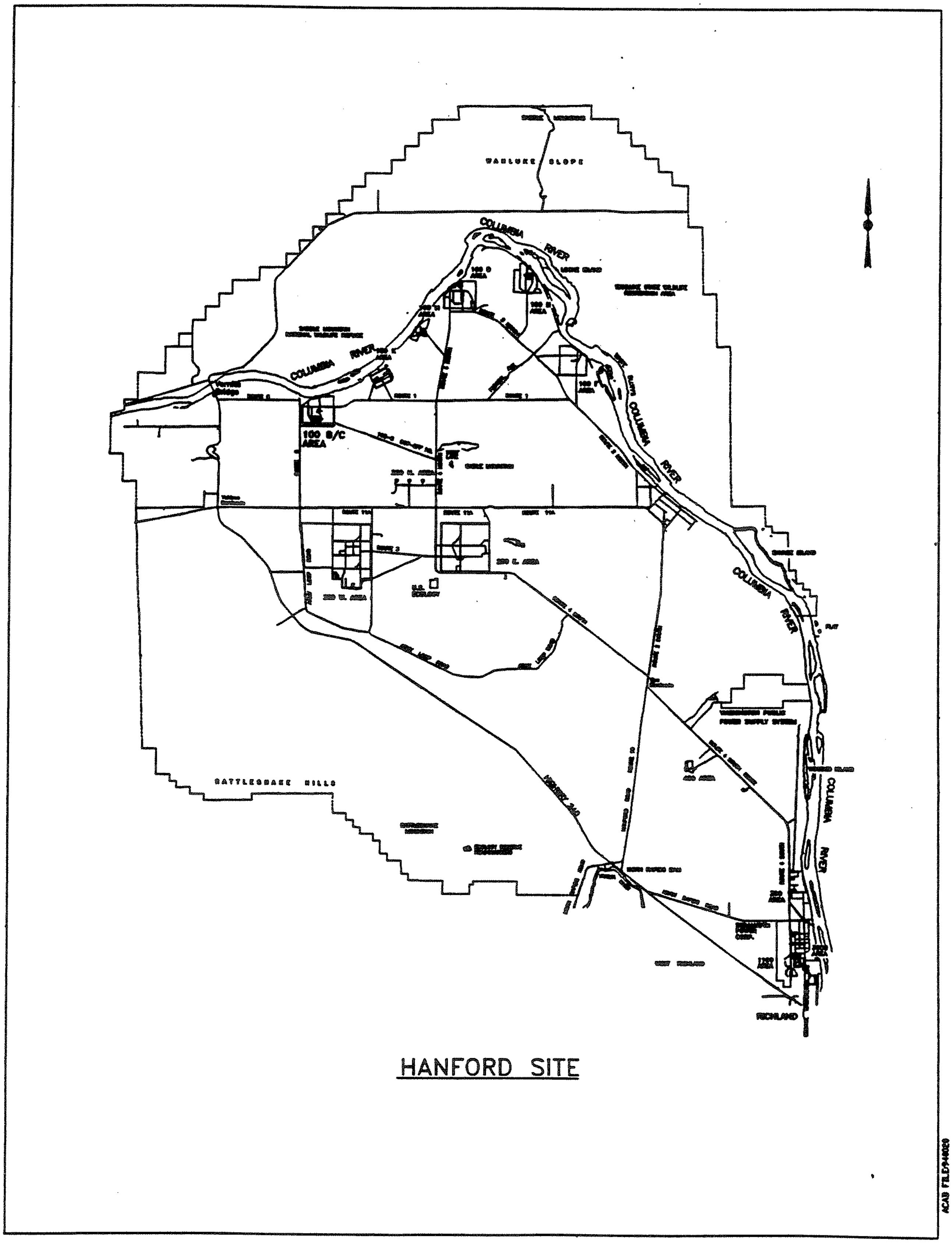
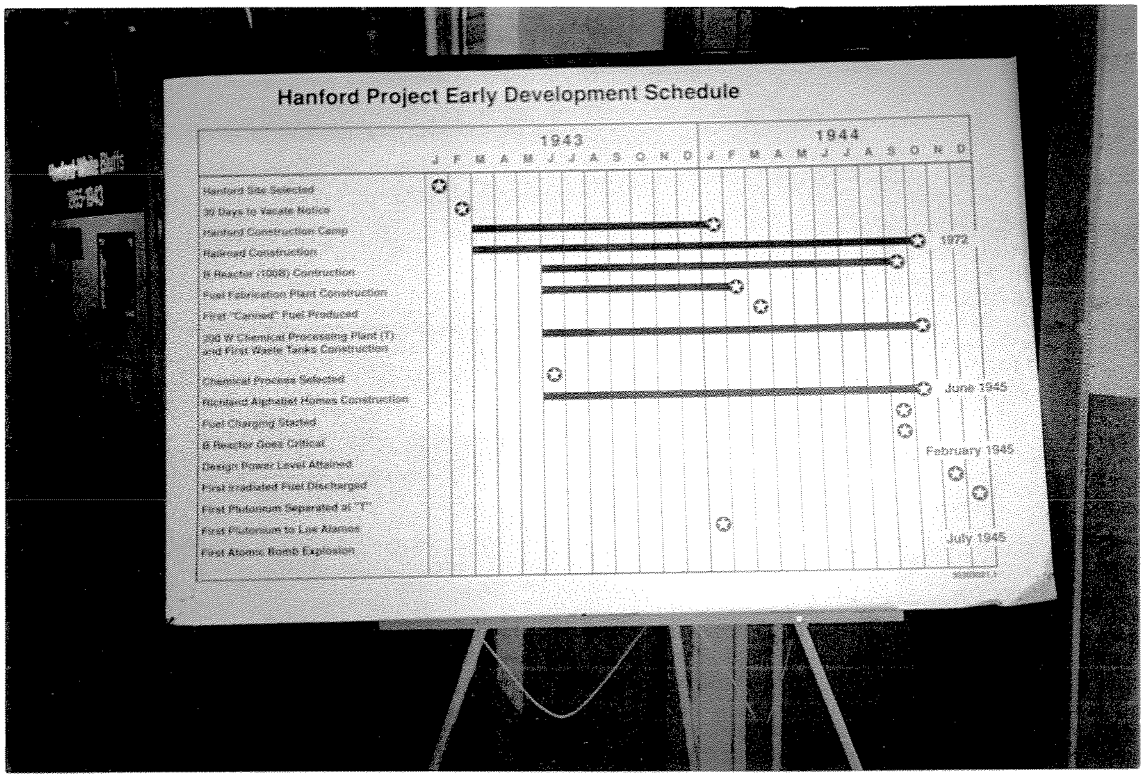


Figure 1-1. Hanford Site Map.



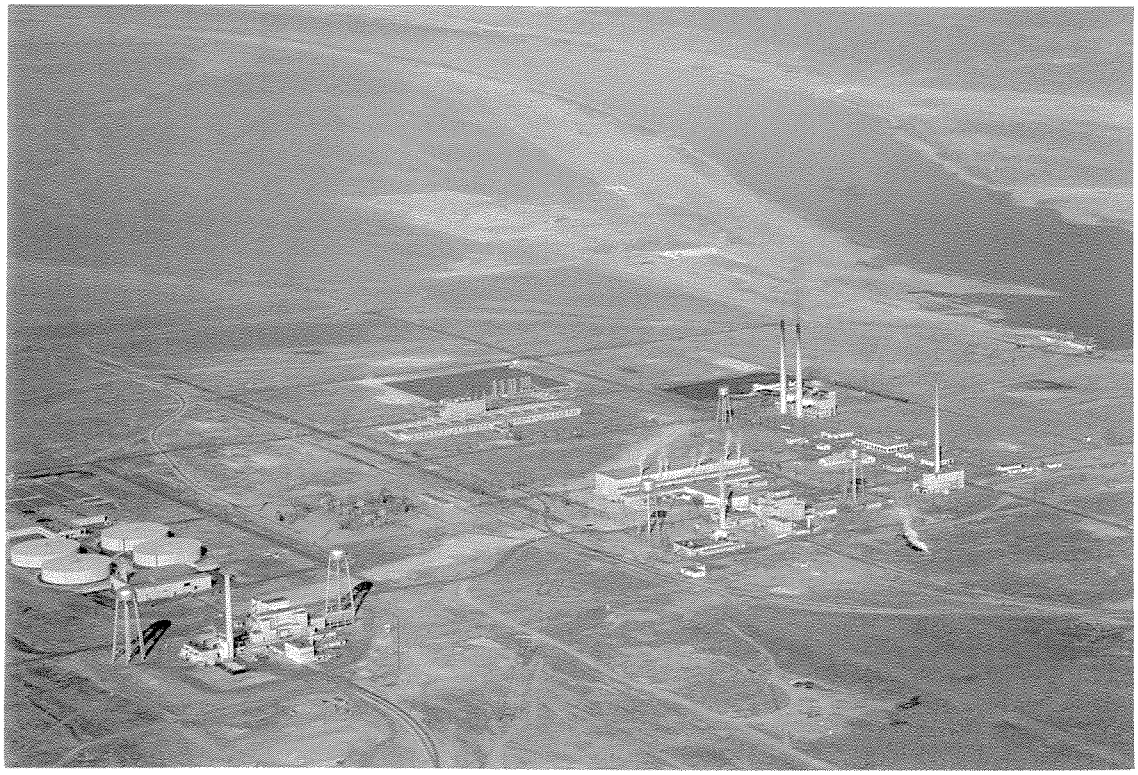
Photograph 1-2. Construction Schedule of B Reactor and Associated Facilities.



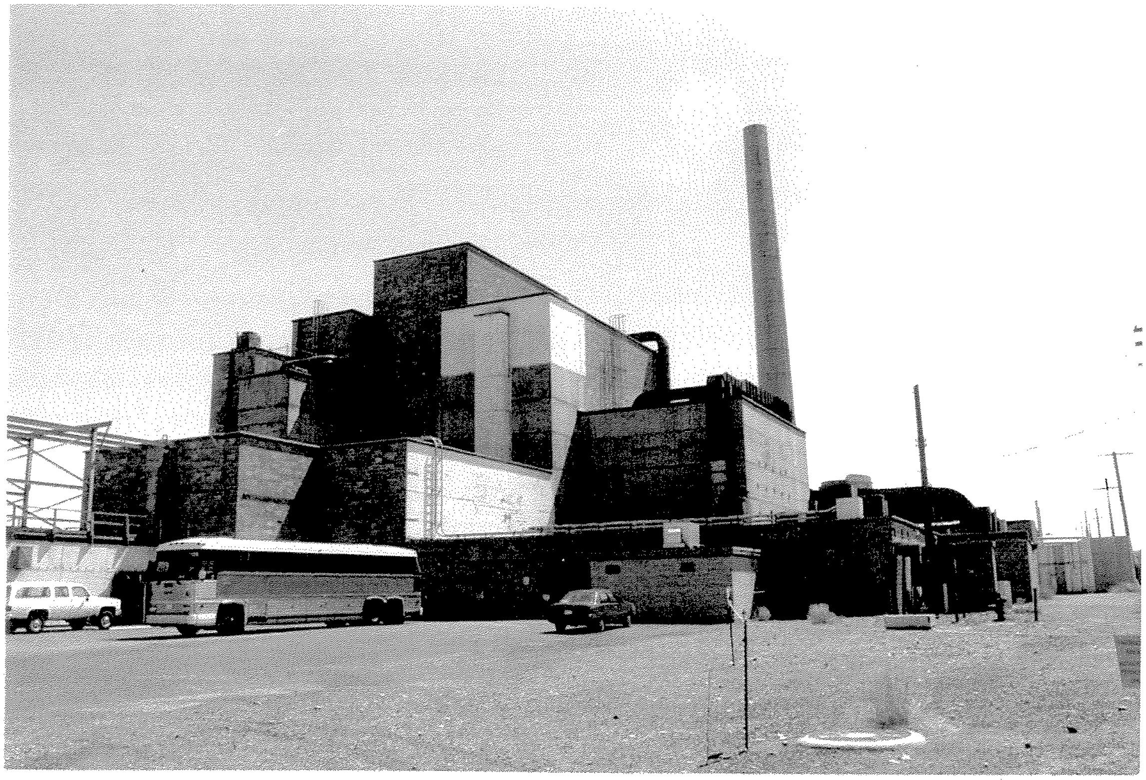
The Hanford 105-D Reactor's operator console and temperature measurement panel is currently on display at the Smithsonian Museum, in recognition to the Hanford Site's role in World War II and the Cold War. This control panel was contributed to the Smithsonian by the U.S. Department of Energy (DOE) to become part of the Smithsonian's 100 Years of American Technology Exhibit. Initially, the Smithsonian Institute requested components from the B Reactor, but due to the status as a National Historic Site and the possibility of maintaining it as a museum, the 105-D Reactor panel was restored to its original 1940's condition and was sent instead since it is of the same vintage.

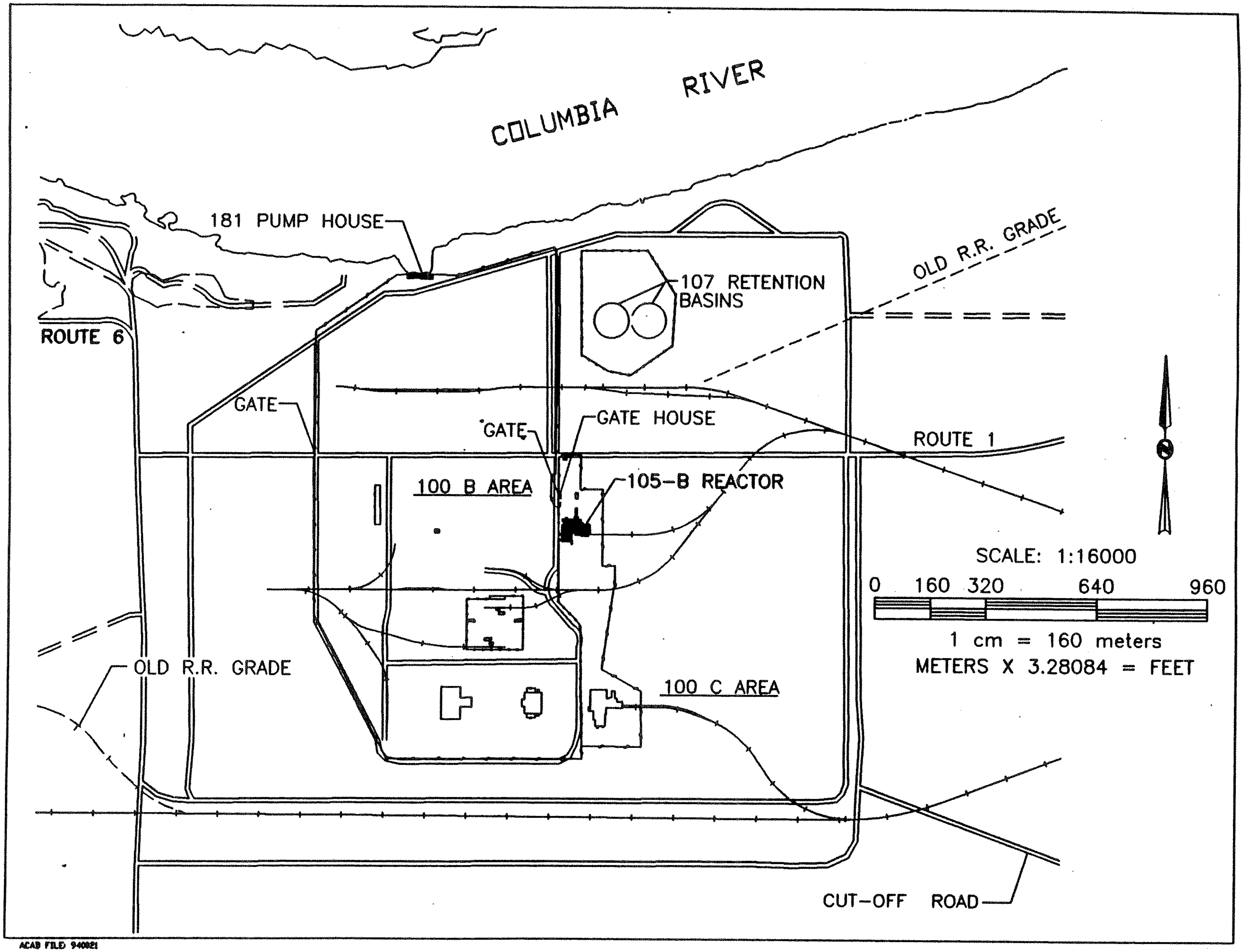
The B Reactor is currently functioning as a controlled-access museum in the 100-B/C Area of the Hanford Site (Photographs 1-3 and 1-4; Figure 1-2). For continued operation in this capacity, safety and access upgrades will be necessary and are discussed in this report. An estimated 5,000 visitors toured the reactor facility in fiscal year (FY) 1993. The museum, along with other existing and planned museums in the area, draws students, engineers, scientists, and historians locally and globally to the area. The B Reactor Museum provides a realistic human history of World War II and the Cold War and is able to preserve this history in an informative and useful manner.

Photograph 1-3. Aerial of the 100-B/C Area (Prior to Decontamination and Decommissioning Activities).



Photograph 1-4. 105-B Reactor Facility Museum.





ACAD FILE 940821

Figure 1-2. 100-B/C Area.

In December 1992, the *Final Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*, DOE/EIS-0119F (DOE 1992), was published to provide environmental information to assist in the selection of a decommissioning alternative for the eight surplus production reactors at the Hanford Site, including the B Reactor. Five alternatives were considered in that study. In September 1993, a record of decision (ROD) (DOE 1993) was issued, based on the preferred alternative identified in the Final Environmental Impact Statement (EIS). The recommended option was safe storage of the reactors with surveillance, monitoring, and maintenance, followed by deferred one-piece removal of the reactor block.

1.2 PURPOSE AND SCOPE

This Phase I feasibility study report addresses the opportunities and viability of 1) maintaining the existing B Reactor Museum with controlled access, 2) preserving and converting the 105-B Reactor Facility into a public-access museum or visitor center, or 3) dismantling the reactor. This phase of the study provides the information necessary to define and examine six alternatives for dismantling or reutilizing the 105-B Reactor Facility.

The technical and engineering aspects of the study address the existing conditions of the facility; physical requirements and industrial hygiene and safety issues; and compliance with the technical requirements of applicable regulations and requirements.

In remarks at the Hanford Summit, the United States Secretary of Energy, Hazel O'Leary, acknowledged the B Reactor Museum as a policy goal for the DOE. This feasibility study supports that goal by defining museum-oriented alternatives and evaluating the viability of those options.

The feasibility study (Phase I) for dismantling or reutilizing the 105-B Reactor Facility was initiated in FY 1994 by the Westinghouse Hanford Company (WHC) and finalized as part of the Environmental Restoration Contract under Bechtel Hanford, Inc. and CH2M Hill Hanford, Inc. Phase I activities were performed under WHC guidance. Phase II activities will be performed with guidelines as delineated by the succeeding organization.

1.3 ORGANIZATION OF REPORT

This Phase I feasibility study report is organized in the following sections.

1.0 Objective - Provides an introduction and background; identifies the purpose, scope, and need for performing a feasibility study of the 105-B Reactor; and provides a brief discussion of the organization of the feasibility study report.

2.0 Conclusions and Recommendations - Provides a brief summary of the findings of the Phase I study and the recommended actions for Phase II.

3.0 Existing Conditions - Discusses the site conditions, waste characterization, existing B Reactor Museum tours, and other local, national, and international centers.

4.0 Criteria for Developing Alternatives - Lists the criteria used as a basis for developing the alternatives.

5.0 Description of Alternatives - Identifies six alternatives for the 105-B Reactor Facility.

6.0 Analysis of Alternatives - Lists the criteria used for evaluating the alternatives; includes and describes the matrix developed for comparison of each of the alternatives; and provides those values determined representative of each alternative.

7.0 References and Bibliography

8.0 Contacts and Resources

2.0 CONCLUSIONS AND RECOMMENDATIONS

This section provides the conclusions and recommendations from this study. These conclusions are based on a detailed analysis of alternatives against two sets of criteria. The first set of criteria includes compliance with state and federal laws, safety, ability to implement, and political acceptability. From this set of criteria, all alternatives were found to be feasible. The second set of criteria included a cost/benefit analysis. These latter criteria were used to develop the conclusions and recommendations described in this chapter.

2.1 CONCLUSIONS

The analysis of this study allowed the following conclusions to be developed:

- The use of B Reactor as a museum is feasible and there are several identifiable improvements which could be done to enhance its value to the public.

- The achievements of the B Reactor construction represented significant scientific and engineering breakthroughs. Visitors currently come from around the world to view those areas of the Hanford Site which are accessible to them and are expected to be attracted to a B Reactor Museum. Development of the proposed Tri-Cities Cultural Center would also increase visitation to the B Reactor and provide a location where the B Reactor's role in World War II and the Cold War can be positively acknowledged.

- The 105-B Reactor Facility in its current configuration is already a useful and valuable museum. Reactor museums at other DOE sites have been operating for some years with good public acceptance and interest. These museums have been positive factors in educating the community about nuclear technology, the reactors' place in history, and the important roles played by the DOE and its Contractors. The estimated public visitation numbers for the B Reactor Museum and other reactor museums is provided in Section 3.0.

- The numbers of museum visitors would greatly increase if public access is allowed by providing access from Highway 240. This option can be provided at a relatively low cost and be accomplished without significant interference with ongoing Hanford Site cleanup activities. The present route to B Reactor through the Site is somewhat cumbersome and interferes with site traffic and ongoing activities for site cleanup. These improvements are described in Alternative C.

2.2 RECOMMENDATIONS

Based on the feasibility of continuing to use the B Reactor as a museum, it is recommended that Phase II activities be actively pursued. In the Phase II study, several goals are identified:

1. A stakeholder involvement process is to be defined and deployed. At a minimum, the prototypical process described in Section 6.0, should be refined and conducted with the identified stakeholder group. Fair and equal participation by all key stakeholders is crucial. Results should include recommendations for further work to develop definitive costs and schedule for one or more of the alternatives discussed in Section 5.0.

2. Engineering designs for upgrades required for selected alternatives should be prepared at a level of detail sufficient for cost estimating and preparation of procurement packages.

3. A limited radioassay examination of the B Reactor building should be conducted to confirm the earlier reports of residual radiation levels and the immobility of the materials and components which remain contaminated.

4. Fire hazards analyses should be conducted and included in the engineering design documentation.

5. An inventory of the quantity of hazardous waste (in the forms of asbestos, oils, and lead) should be performed. Requisite plans for resolving identified hazards should be prepared and initiated.

6. The necessary as low as reasonably achievable (ALARA) documentation identified in Section 4.0 should be prepared.

7. Public presentations should be prepared and presented to explain the process underway, the alternative(s) being investigated further, and seeking public input and support for the B Reactor Museum development as proposed.

2.3 STAKEHOLDER INVOLVEMENT

The importance of the B Reactor from both historical and scientific/engineering aspects creates a global, as well as local interest in the facility. Visitors already travel from throughout the world to visit Hanford and view the exhibits accessible to them. Drawing from the experiences of similar museums throughout the world that depict World War II events and history, it is anticipated that B Reactor will draw major public attention. It is the DOE policy to involve stakeholders on matters of public interest. It is, therefore, crucial to involve stakeholders in the decision process on the ultimate fate of the 105-B Reactor Facility and its development as a museum.

The contents of this report lay the technical groundwork for considering further development of the B Reactor as a museum facility, and include recommendations on alternative ways to proceed. In addition, a process for capturing stakeholder input was prototyped: evaluation criteria were developed; technically feasible alternatives were evaluated using these criteria; and the alternatives were then ranked according to those results.

Next steps beyond the work in this report include involvement of a representative body of stakeholders to refine this evaluation and participatory process. Their involvement is key to assuring decision-makers that stakeholder viewpoints and feedback have been considered in the decision-making process. Preliminary discussions have identified a number of potential participants in this process, and initial activities in Phase II are planned to clarify stakeholder involvement.

3.0 EXISTING CONDITIONS

3.1 WASTE CHARACTERIZATION

Any potential radiation or hazardous exposure to personnel depends upon the type of contaminants present in areas accessible by the public. Health physics and prevention of the spread of contamination are of paramount importance in assessing the feasibility and safety of converting an inactive reactor facility into a museum environment or providing personnel for decontamination and decommissioning of a facility.

3.1.1 Radionuclide Inventory

Table 3-1 provides the estimated radionuclide inventory of the 105-B Reactor Facility projected for March 1995. The projected values are based on values estimated for March 1985 in the *Radionuclide Inventory and Source Terms for the Surplus Production Reactors at Hanford*, UNI-3714, (Miller and Steffes 1987) using a ten-year decay period. These contaminations were determined to be residual radiation in the structure and components of the reactor. The original 1985 estimate was prepared based on a characterization performed at the 105-DR Reactor.

The first step in control of radiation exposure for the proposed 105-B Reactor Facility Museum is to ensure that areas to be accessed by the public are decontaminated to a degree that will not cause significant radiation exposure. This will involve the removal of residue radioactive sources in accessible areas (Photographs 3-1 and 3-2).

Dose readings for unrestricted areas should be below the maximum level legally permissible and should be ALARA for the safety and the welfare of the public. There are two tour route options for the proposed alternatives. The existing tour route encompasses the control room and the work area next to the graphite reactor block (with thermal shield, the biological shield and an airtight outer metal shell in between). The candidate tour route option adds to the first option, the valve pit, the fan house, and a corridor to the fuel storage basin viewing room. According to UNI-3714, all of the proposed unrestricted areas, except for the waste fuel storage basin area, are cleaned and/or are protected by multiple shields. For the storage basin, there are still residue amounts of radionuclides present in the area, even though the waste fuels have already been removed. Per Table 3-1, none of the volatile radionuclides is present in the storage basin. It is therefore very unlikely for those radionuclides to cause additional radiation exposure to the viewing public at the fuel storage basin viewing window. Thus, from the fixed source term distribution viewpoint, both tour route options are viable and practical.

Table 3-1. Radionuclide Inventory Estimate
B Reactor Summary as of March 1, 1985[a]

		Component (Curies)					
Radio-Nuclide	Half Life (Yrs)	Graphite Stack	Thermal Shield	Process Tubes	Control System	Bio-Shield	Storage Basin
^{3}H	12.3	4700	--	--	--	--	--
^{14}C	5730	4500	--	--	--	--	--
^{41}Ca	1.0×10^{5}	190	--	--	--	2	--
^{60}Co	5.3	26	2300	79	29	--	2.9
^{59}Ni	8.0×10^{4}	1	7	0.1	--	--	0.5
^{63}Ni	100	168	780	9.3	--	--	56
^{36}Cl	3.1×10^{5}	42	--	--	--	--	--
^{90}Sr	29	7.9	--	0.16	--	--	11
^{93}Zr	1.5×10^{6}	--	--	--	--	--	--
^{93}Mo	3.5×10^{3}	--	0.04	--	--	--	--
^{94}Nb	2.4×10^{4}	0.3	0.02	--	--	--	--
^{99}Tc	2.13×10^{5}	--	0.002	--	--	--	--
^{108}Ag	130	--	0.028	--	--	--	--
^{137}Cs	30.2	29	--	--	--	--	13
^{152}Eu	13.4	24	--	0.95	--	--	0.83
^{154}Eu	8.5	8.8	--	0.53	--	--	1.9
^{238}U	4.5×10^{9}	--	--	--	--	--	0.009
^{238}Pu	87.7	--	--	--	--	--	0.069
^{239}Pu	2.41×10^{4}	1	--	--	--	--	1.6
^{241}Am	2.44×10^{4}	0.3	--	--	--	--	0.5

[a] Based on estimate as of March 1, 1985 (Miller and Steffes, 1987)

An area of concern is the unaccountable radioactivity inventories. About 95% of the radionuclide source is accountable and is well confined within the reactor and its fuel storage basin. However, the remaining 5% of the radionuclide inventory is not easily accountable and is assumed to be distributed in piping, tunnels, and various other locations within the reactor building.

Photograph 3-1. Existing Contamination at 105-B Reactor Facility.

Based on Table 3-1 with the allowance for radioactive decays, the present accountable curie inventory is estimated to be 13,000 curies (Ci). Most of those accounted inventories are from radionuclides which are relatively immobile and are easily confined. Tritium is the only volatile radionuclide which has significant Ci inventory. Under normal conditions, tritium is well confined within the graphite. Under strenuous situations, such as earthquakes or excessive vibrations, the graphite may release tritium. As the outermost airtight metal shell remains intact, it is unlikely that the public will be directly exposed to the untrapped tritium. On the other hand, a significant part of the unaccounted curie inventory could be tritium. From the direct radiation emission viewpoint, the presence of tritium inside pipes is not a problem, because tritium emits betas which do not have the penetration power to go through the wall. Only the unforeseen release of tritium in the air would cause concerns. Pipes within the unrestricted areas access may require testing for the presence of tritium to ensure that in the event of pipe breakage (from corrosion, rusting, etc.), the public will be safeguarded against excessive exposure to radiation.

A detailed accounting for all the residual radionuclides in the areas open to the public will help in the assessment of the radiation impact on the public. For dose rate assessment, it is also necessary to account for the possibility of additional radiation exposures from the 105-C Reactor, which is in the general location.

Photograph 3-2. Contamination Sign Located Around the Facility.

The existing 105-B Reactor Facility Museum does not pose a major health hazard to the public. The dose rates should be kept below the legal limit and be kept ALARA. There is no reason to believe either the existing or the candidate additional tour routes will cause excessive radiation exposure to the public under normal conditions. For extraordinary situations, any potential public health hazard has been identified to be mainly due to exposure to tritium. A more detailed radionuclide inventory is required to fully assess and to circumvent this potential health hazard.

To protect the public from potential concerns of radiation exposure and to document that the risk of such exposure is insignificant, it is recommended that the following steps be taken as a precautionary measure:

1. Perform a radionuclide survey and confirm and recharacterize the amount of residual radioactivity, if any, in each of the areas potentially accessible by the public.

2. Perform air sampling to ensure that there is no potential for the presence of residual airborne radioactivity in the areas accessible to the public.

3. Check the pipes for possible cracks or corrosion so as to eliminate potential unobstructed pathways for tritium migration to the unrestricted areas.

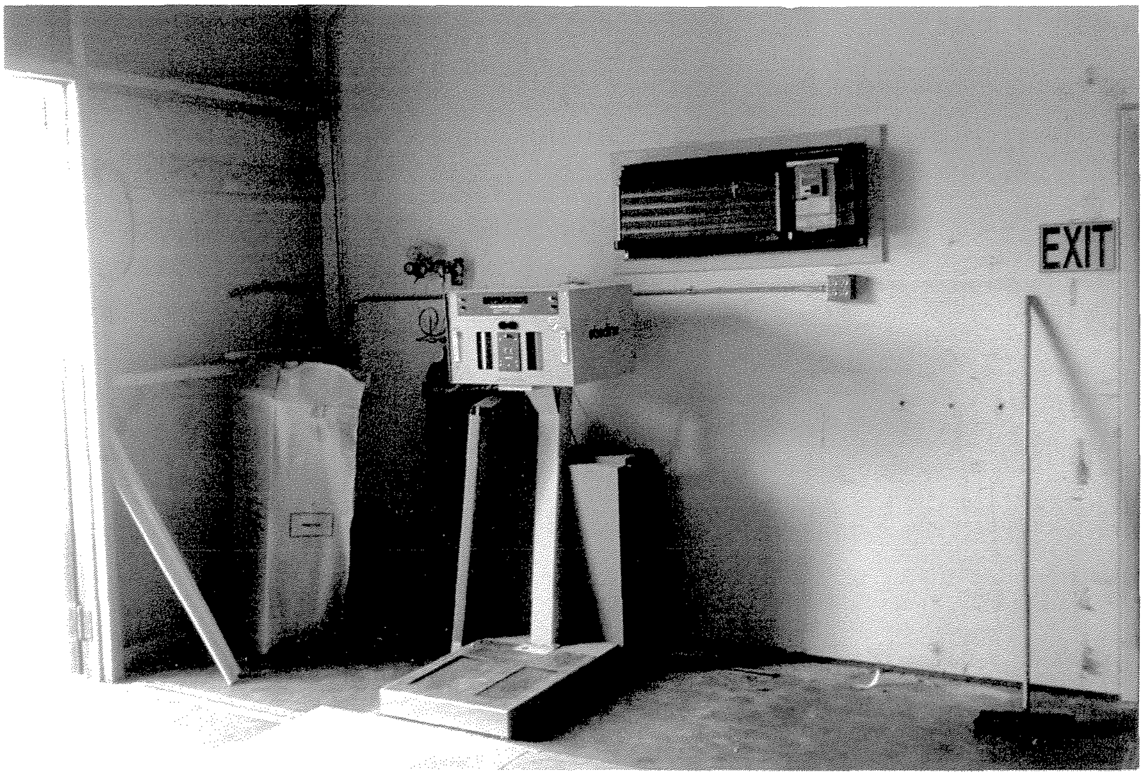
3.1.2. Radon Contamination

Radon contamination at the site occurs from natural sources in the basalt. Radon in its original form is not harmful, but radon is considered a health hazard due to the generation of the decay products, polonium, lead, and bismuth, which attach to airborne particulates and can be inhaled. The limiting activity of radon in the radon and thorium daughter chains is lead (with half lives of 26.8 minutes and 10.6 hours, respectively for each chain).

Radon particles attract by static electricity to clothing, materials, and personnel. Currently, the facility is opened up approximately one hour before a tour is scheduled. The exterior doors to the facility are opened and mobile floor fans are placed in several locations in the facility to vent the air from the tour route areas out of the facility.

Under current conditions, personnel visiting the museum are surveyed for radon contamination prior to exiting the facility (Photograph 3-3). The ventilation upgrades and silent alarm system identified in Alternative A would eliminate the need for personnel surveys.

Photograph 3-3. Personnel Survey Monitor.



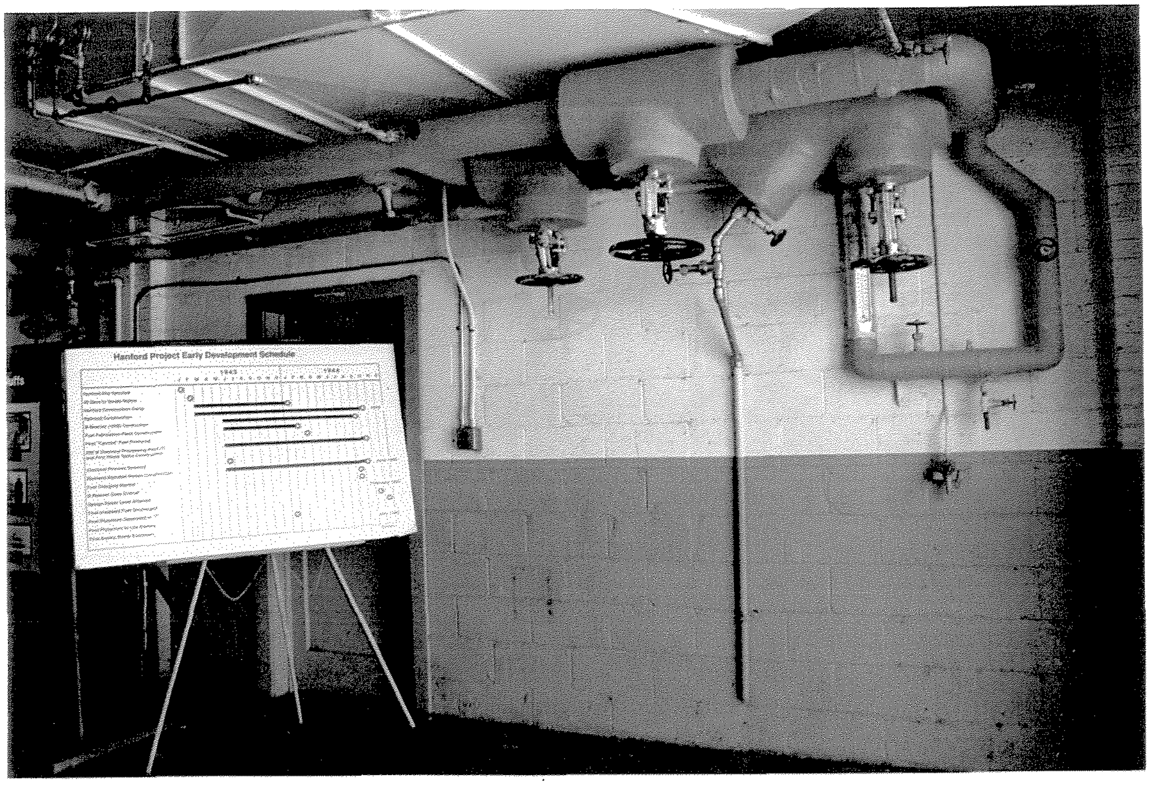
3.1.3 Asbestos

The asbestos in the reactor building is located in some of the piping and ductwork insulation, ceiling panels, and walls. An asbestos abatement program has not been performed at the site. Most of the asbestos has been identified and marked using pink paint and is currently contained or encapsulated (Photograph 3-4).

Those areas where asbestos has not been contained, such as the acoustical wall and ceiling panels in the control room, should be contained by suitable methods such as spraying with an adhesive to prevent the possibility of friable asbestos fibers. No other corrective action is expected unless it is decided necessary to utilize the existing ductwork for ventilation upgrades. An inventory of the amount and type of asbestos still uncontained in the facility should be performed in Phase II.

Asbestos in the Idaho EBR-1 Reactor Museum and Oak Ridge Graphite Reactor Museum, discussed in Section 3.4, was left in place and fixed with a coating to encapsulate the fibers.

Photograph 3-4. Asbestos Identified and Marked in the Facility.



3.2 SITE CONDITIONS

A risk assessment was performed at the 105-B Reactor Facility and other 100 Area facilities to assess the existing physical conditions of the facilities. A detailed account of the study is provided in the *Risk Management Study for the Retired Hanford Site Facilities, Qualitative Risk Evaluation for the Retired Hanford Site Facilities*, WHC-EP-0619 (Coles, et al. 1993). The results of the study are provided in Appendix A.

Walkdowns of the facility were conducted and cognizant personnel were contacted during Phase I of this feasibility study to determine the status of these conditions. Figure 3-1 details the facility layout of the 105-B Reactor Facility. These conditions need to be upgraded, independent of the future status of the site; modifications are addressed in the alternatives of Section 5.0. Facility personnel stated that most of the necessary modifications to the facility have been performed.

Appendix B provides physical location and background information on the site including the historical information which was the basis for listing the 105-B Reactor on the National Historic Register. Appendix C provides a catalog list of drawings retained for the 105-B Reactor Facility. The following is a summary of the remaining site conditions.

3.2.1 Building, Reactor Block, Fuel Storage Basin

The 105-B Reactor Facility was constructed of reinforced concrete and masonry blocks. The walls above the top of the core are unreinforced concrete blocks. Several visible cracks exist in the mortar of the masonry walls (Photograph 3-5).

Many confined spaces exist in the building, including the belowgrade portion of the valve pit area, which will not be accessed without a confined space entry permit.

There is a lack of caging at an access ladder off of the reactor, but this area will not be accessible and does not need to be modified.

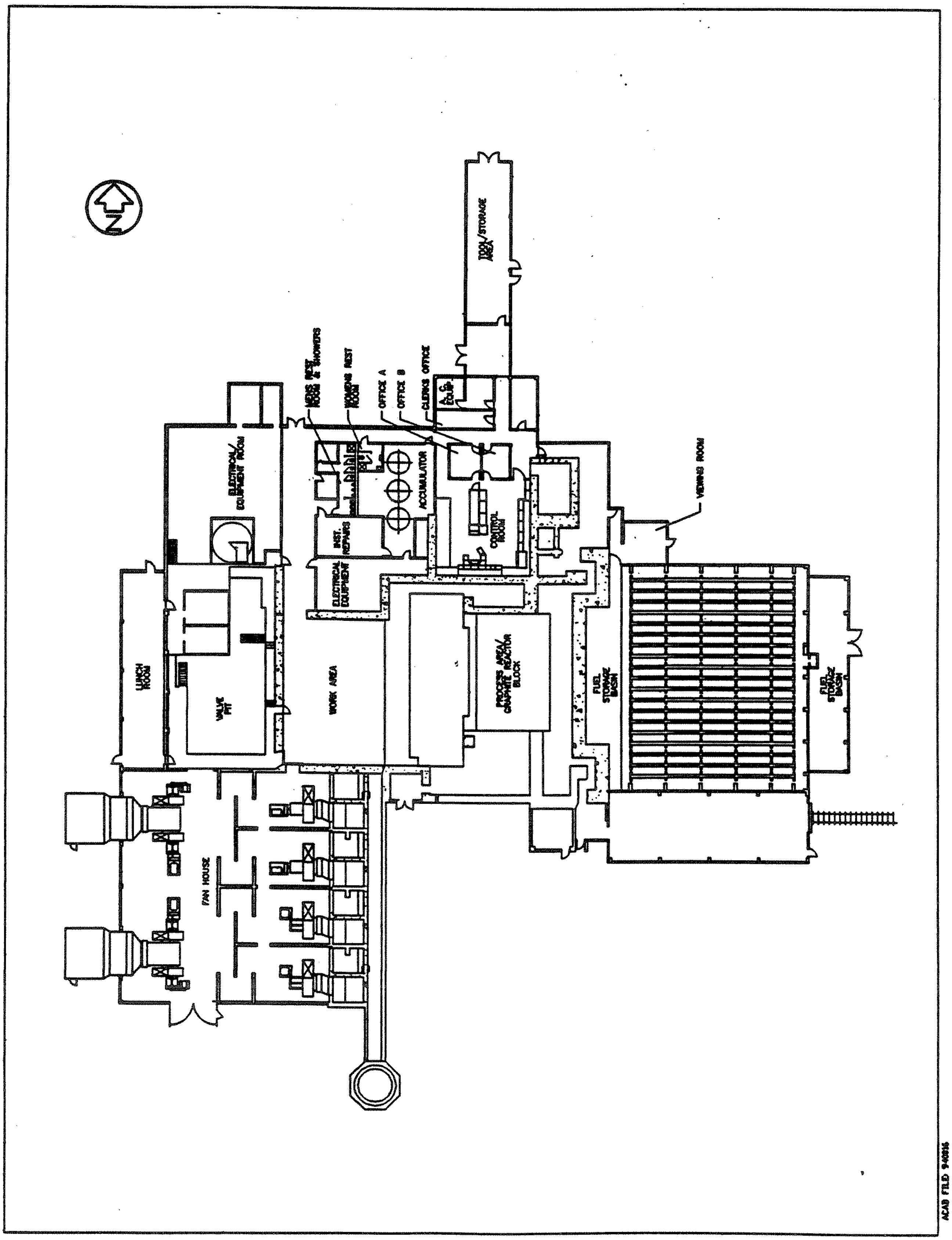
The facility does not currently meet all of the building accessibility requirements for disabled persons.

3.2.2 Roof

The roof is constructed of concrete panels with an asphalt and gravel surfacing. The concrete panels are not anchored to the metal support structure. The supporting steel joists are not anchored to the walls.

Evidence of oxidation and water accumulation was found throughout the building from leakage of the roof. The asphalt roof of the 105-B Reactor Facility was overcovered utilizing a membrane roof system approximately ten years ago.

Figure 3-1. 105-B Reactor Facility Layout.



The original concrete roof panels are still in place at the facility. Damaged and deflected roof panels were identified in the risk assessment (Photograph 3-6). Several panels have been strengthened with reinforcing brackets based on the information from the risk assessment.

3.2.3 Heating, Ventilation, and Air Conditioning

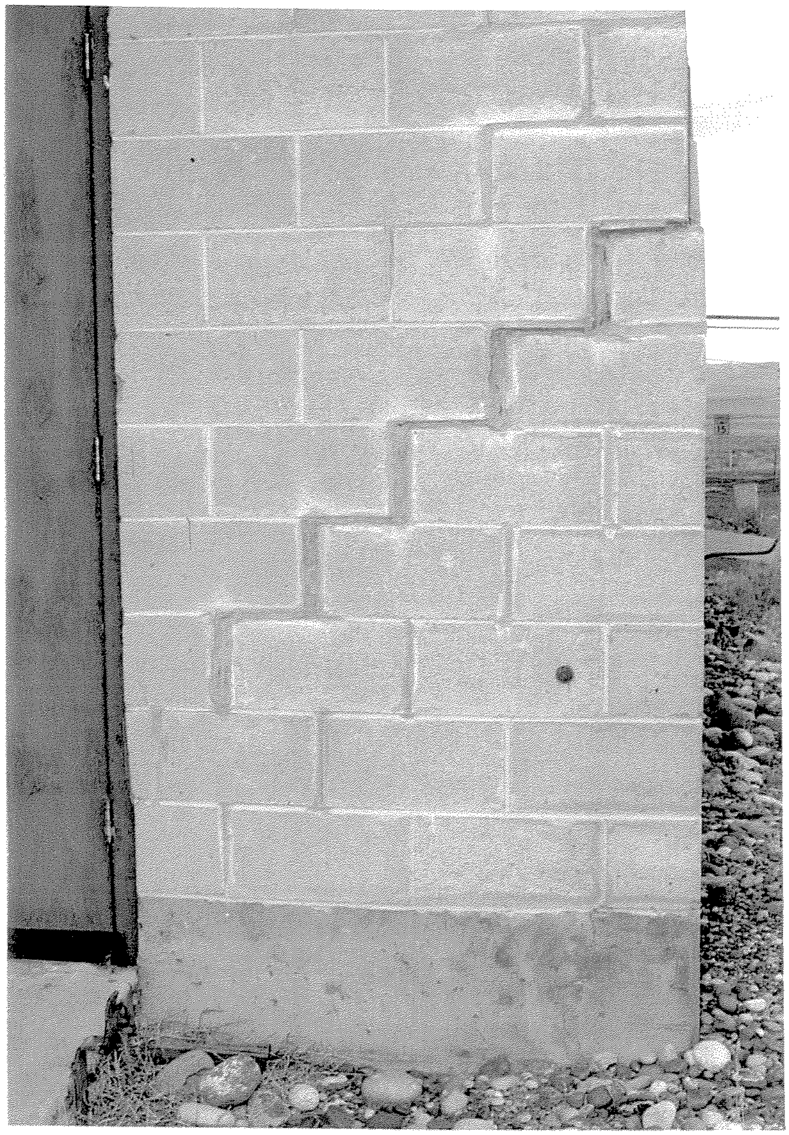
Natural radon gas is not controlled due to the lack of ventilation in the facility. There is no active heating or cooling system in much of building.

3.2.4 Electrical

Both 110-volt single phase and 480-volt three phase electrical power is readily available throughout the facility.

Modifications to the conditions identified in the risk assessment for the facility electrical system have been or are in the process of being completed.

Photograph 3-5. Cracks in the Mortar of the Exterior.



An electrical panel located in the fuel storage basin viewing room is currently not protected.

3.2.5 Lighting

Lighting in most of the facility is sufficient. Lighting upgrades have been performed in the valve pit room since the assessment study.

Photograph 3-6. Deflected Roof Panel.

3.2.6 Fire Protection

Fire sprinklers, located in the work area, are not working. The facility currently has eight emergency lights and five fire extinguishers (which are inspected on a monthly basis).

There are four heat detectors and one fire alarm bell currently in service. The detectors are located in the control room.

A fire hazard analysis should be performed in accordance with DOE 5480.7A (DOE 1993).

3.2.7 Industrial Hygiene

The results of the risk assessment showed that the overall building contained approximately 13,500 Ci radionuclides which are primarily activation products contained within the graphite core (comparable to estimate performed in Section 3.1.1), 98.5 tons of lead, and unknown quantity of asbestos. Lead in the facility exists in solid form with oxidized surfaces, primarily in radiation zone, transfer area, and lead-base painted surfaces. Very small quantities of mercury are contained in glass containers in switch on wall of northwest corner of the fuel storage basin. The quantities of hazardous and radioactive waste should be ascertained as an initial task in Phase II.

The postings for the radiation areas and items must be assessed to determine if they are mislabeled, misleading, not posted, or out of date.

Biological hazards at the facility include snakes, spiders, wasps, bats, and rodents.

Several chemicals and unlabeled containers were identified in the risk assessment. These have been removed from the facility.

3.3 EXISTING B REACTOR TOURS

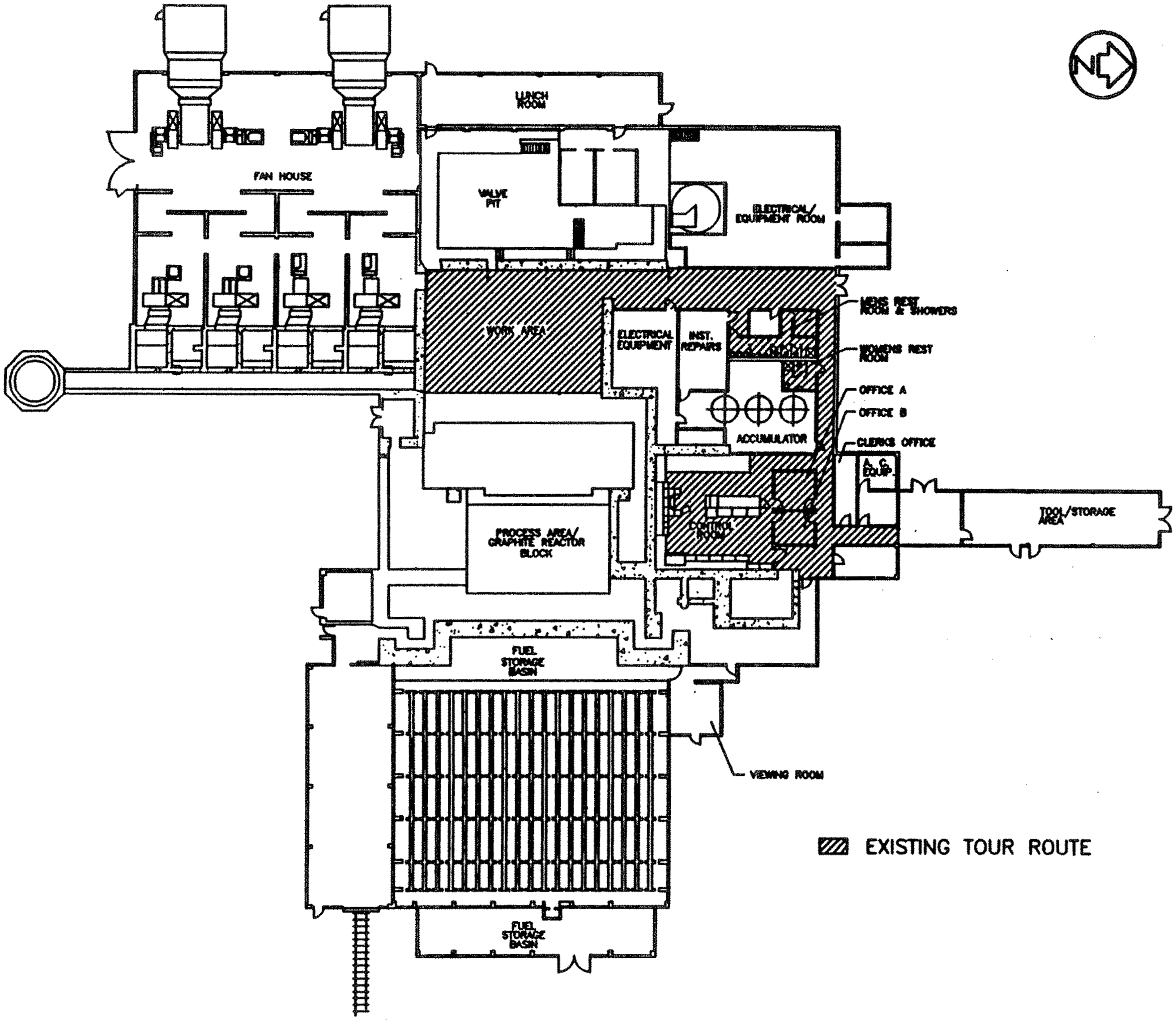
The 105-B Reactor Facility Museum currently conducts prearranged controlled access tours for site personnel and visitors. An estimated 5,000 persons visited the museum in FY 1993. The physical conditions requiring maintenance for the museum are identified in Section 3.2. The following discussion provides the serviceability of the existing museum tours.

3.3.1 Existing Tours

Existing tours through the building typically access the building through the double doors to the large corridor where several nice displays illustrate the pre-Hanford culture and major construction project undertaken in 1943. The "work area" room of the reactor is an impressive site by itself, but also has displays around the perimeter. The current tours then move to the offices areas and control room. Because there have been minimum changes to the control room, it provides a very interesting opportunity to experience its history. The tours then proceed towards the tool room area where the Radiation Control technicians (RCT) monitor visitors exiting the facility. The restroom facilities of the working facility are still available for use by visitors. The men's restroom meets the requirements and the women's restroom will meet the requirements of the Americans with Disabilities Act (ADA) (ATBCB n.d.) with minor modifications. Figure 3-2 shows the existing tour route at the museum. Photographs 3-7 through 3-12 display the accessible tour route areas.

3.3.2 Tour Organization

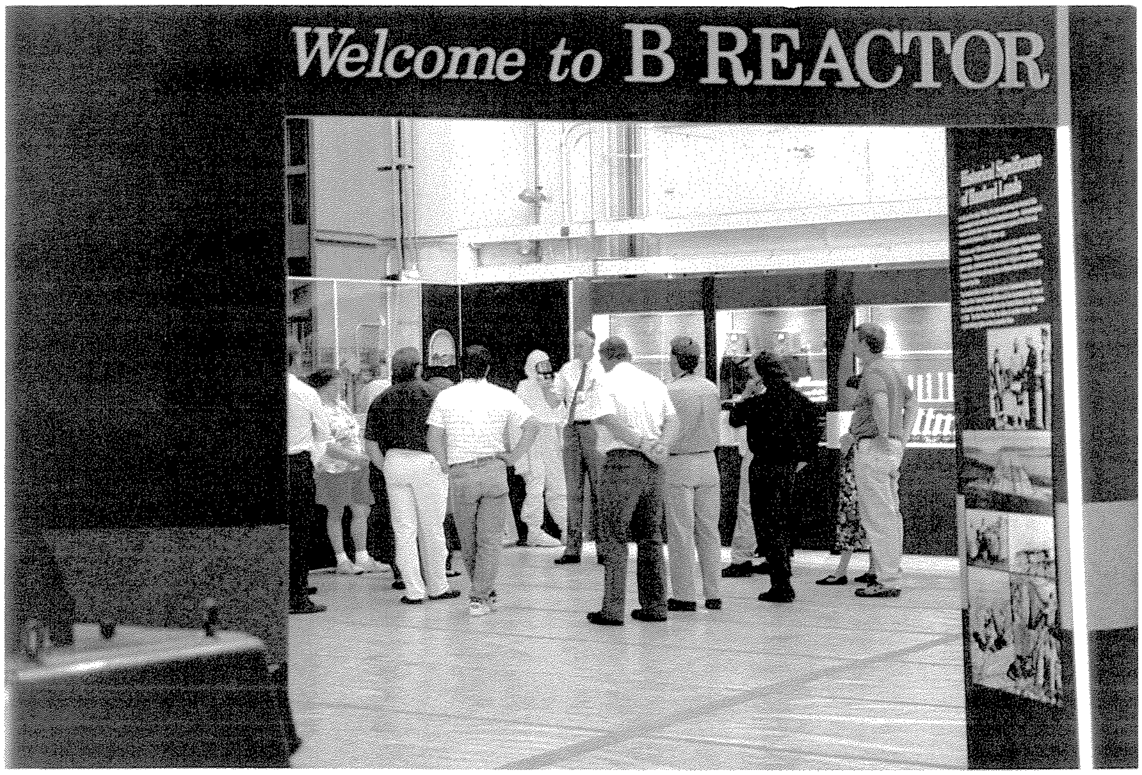
Tours of the 105-B Reactor Facility Museum have been conducted since 1983. While the tours have been conducted by WHC, several other organizations are involved in the procedure. A request for the tours is initiated by either an internal or external source. Internal requests for tours are typically requested for guests or contractors by the DOE or its primary contractors. External requests most often come from the Hanford Museums of Science and History.



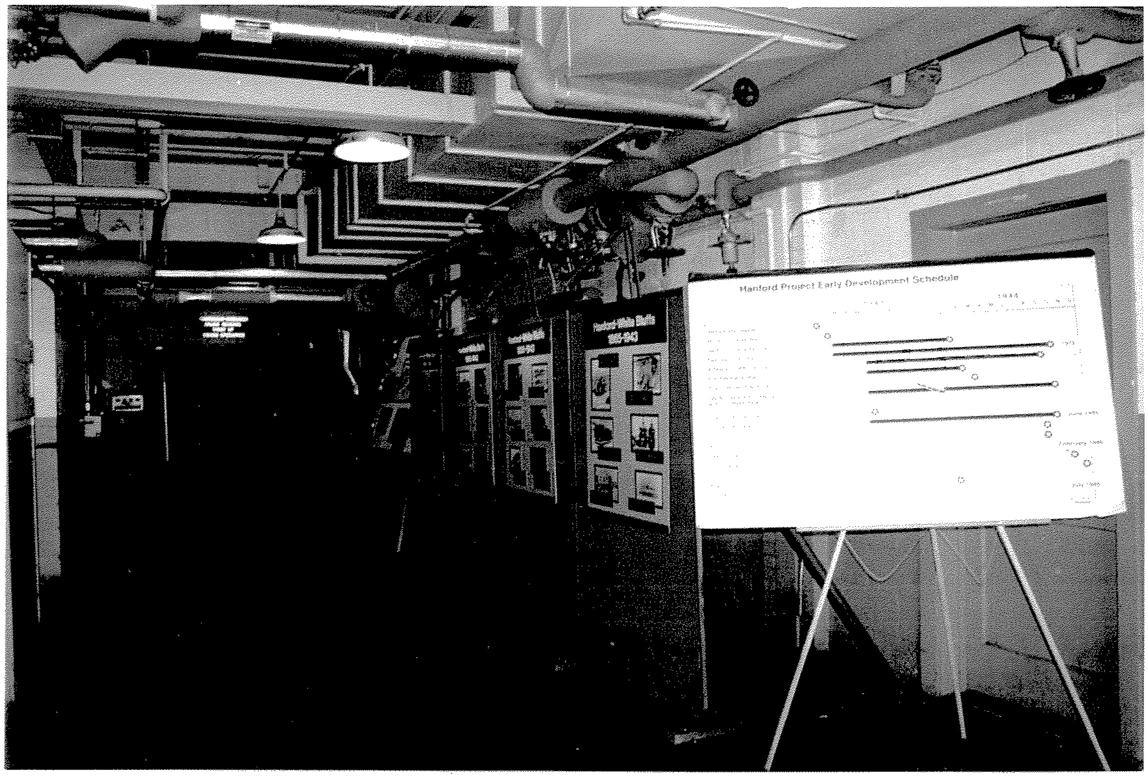
ACAD FILE 940903

Figure 3-2. Existing B Reactor Tour.

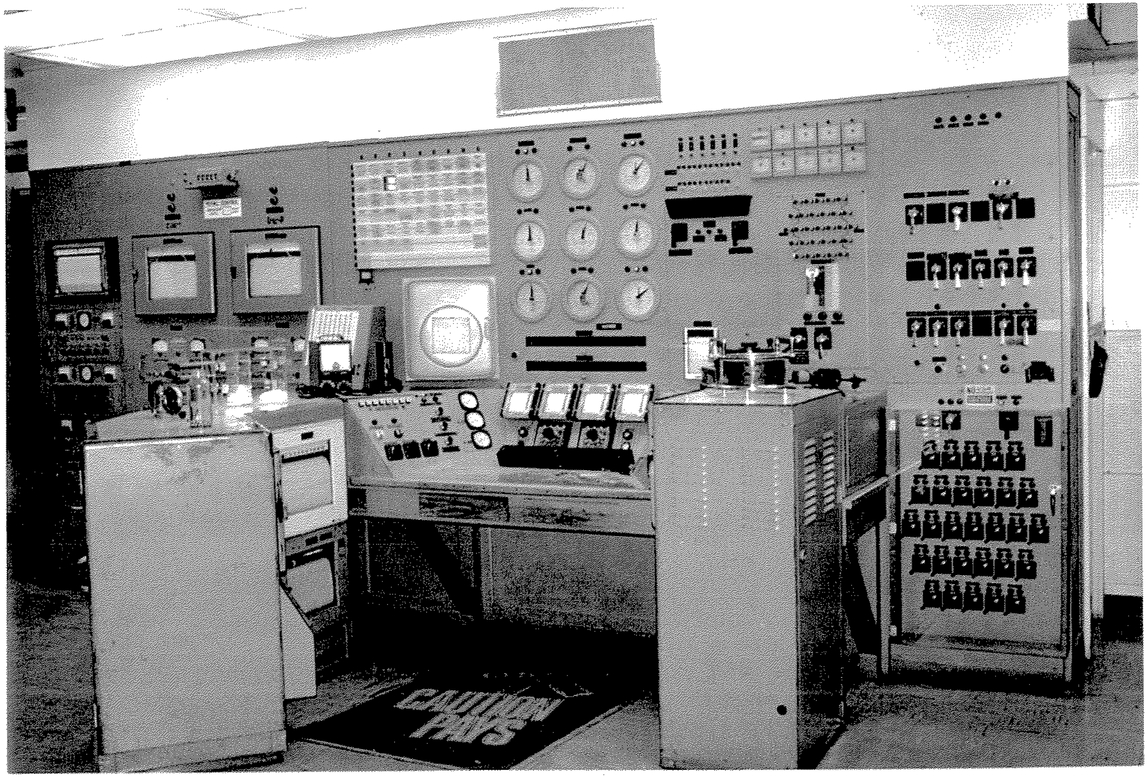
Photograph 3-7. Existing B Reactor Tours.



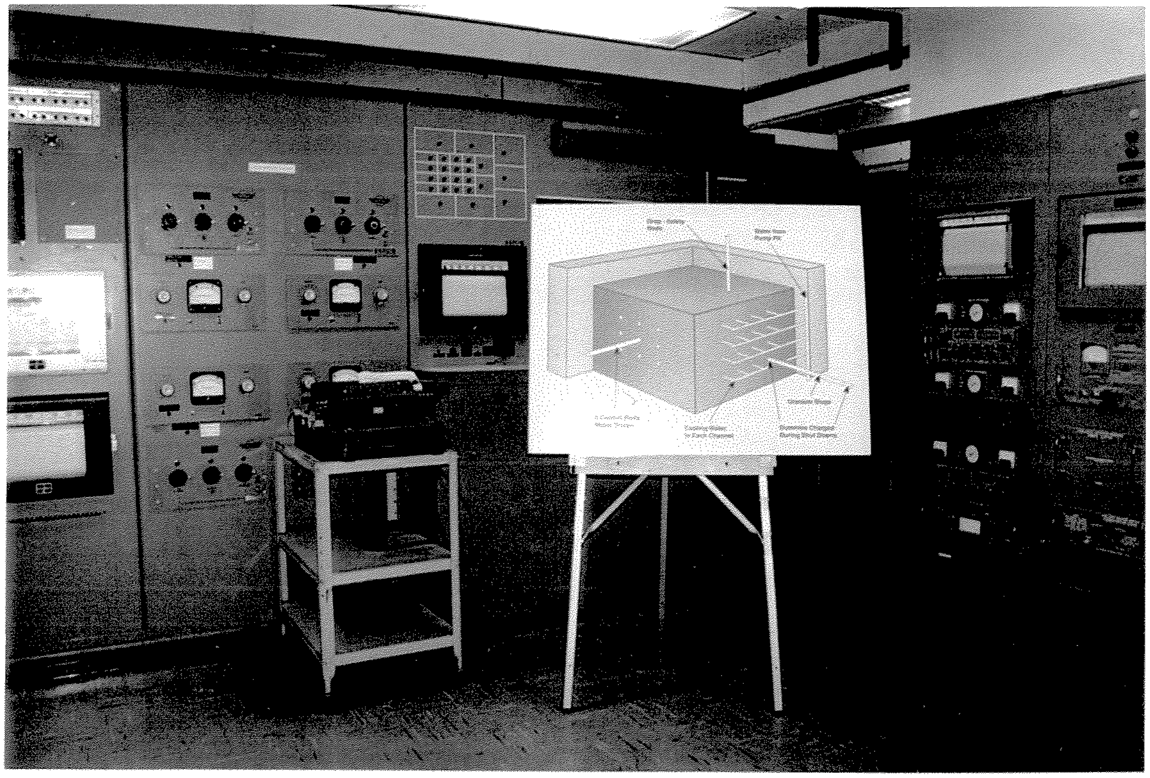
Photograph 3-8. Existing B Reactor Tours--Entrance Corridor.



Photograph 3-9. Existing B Reactor Tours--Control Room.

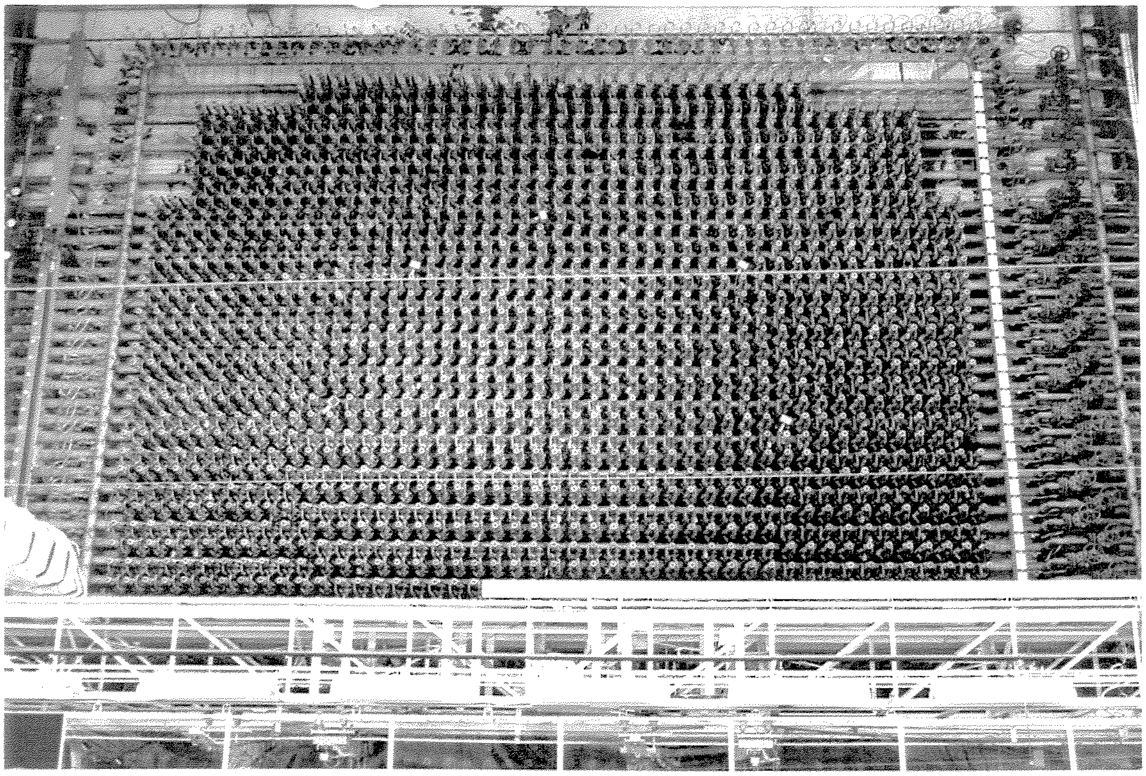


Photograph 3-10. Existing B Reactor Tours--Control Room.



Photograph 3-11. Existing B Reactor Tours--Work Area.

Photograph 3-12. Existing B Reactor Tours--Front Face of the Graphite Reactor Block.



3.3.3 Estimated Resources Requirements

The tours of B Reactor typically require the following tasks:

1. Obtaining clearances for contractors and guests. This typically requires not only the time required to complete the forms and issue the badges, but also time required by the host to coordinate.

2. Providing vehicular access to the building most often requires coordinating a bus and/or the host to drive to the site. This can involve securing a van or vehicle. The large bus tours typically pick up visitors near the Hanford Museum of Science and History. Round trip distance for these tours from Richland is nearly 100 miles.

3. Prior to entering the 105-B Reactor Facility, visitors must read and sign a facility orientation sheet. The building manager and/or his representatives must be present to monitor the tour. These individuals also often provide guided tours. Also before leaving the building, each individual must be monitored by an authorized RCT, which often can require several such technicians. The time required to travel to the site, open the building early for air circulation, and to close it up after the tour, normally totals at least three hours with several staff members.

3.4 SELECTED MUSEUM REVIEW

There currently exist several museums in the Hanford area which have provided the locals and tourists with information regarding past, current, and proposed actions at the Hanford Site. There are also various museums nationally and internationally which were created to convey the story of nuclear technology and its role in history.

The B Reactor Museum with its existing status provides symbiotic effects with the other museums and cultural centers nationally and internationally. The uniqueness of the current B Reactor Museum versus other DOE museums around the nation is due to the major historical achievement, the accessibility to view the massive graphite reactor block, and the ability to turn it into a public museum with little additional effort.

3.4.1 Hanford Museums of Science and History

The Hanford Museums of Science and History, formerly the Hanford Science Center, has been operating since 1962 as an interactive public involvement center. The center, originally located in the Richland Community House, is now located in the Richland Federal Building. The center is operated by WHC.

The Hanford Museums of Science and History operates from Monday though Friday 8 a.m. to 5 p.m. and Saturday 9 a.m. to 5 p.m. This center is maintained by a staff of four employees. Estimated visitation to the center in FY 1993 was approximately 22,000 persons.

Displays and exhibits include historical displays providing an inside look at the history of the Hanford Site and surrounding towns. Displays of current activities are included to provide information on the ongoing research and environmental technology occurring at the site. The Hanford Museums of Science and History provides brochures and handouts for the public. There are videos and interactive computer programs.

The Hanford Museums of Science and History also encourages the public visitation of the other visitors centers in the area. This allows the public to access portions of the site not otherwise available.

3.4.2 Fast Flux Test Facility Visitors Center

The Fast Flux Test Facility (FFTF) visitors center was located in the 400 Area of the Hanford Site. This center was a public accessible visitors center providing an informative look at liquid breeder reactor technology and its application on the Hanford Site. It also provided a brief look into the history of the Hanford Site, including the B Reactor.

The center was operated 4 days a week on Thursday and Friday from 11 a.m. to 4 p.m. and Saturday and Sunday from 12 p.m. to 5 p.m. Estimated visitation in FY 1993 was 5,800. The visitor center was staffed by Hanford retirees. The visit began with a video walk through the breeder reactor followed by a video of the future of the Hanford Site. Tours of the reactor area were conducted for large groups.

Along with the brochures and displays, the visitors center contained a model of the FFTF breeder reactor. This exhibit provided an engrossing view of the components of the reactor and its supporting systems.

3.4.3 Washington Public Power Supply System Visitors Center

The Washington Public Power Supply System (WPPSS) visitors center is located at the WPPSS site and is open on Thursday and Friday from 11 a.m. to 4 p.m. and Saturday and Sunday from 12 p.m. to 5 p.m. The staff of the visitor center is made up of approximately 10 Hanford retirees. Approximate visitation in FY 1993 was 3,400 (FY for WPPSS is from July 1 to June 30). Estimated visitation in FY 1994 was 3,500.

One of the outstanding displays at the WPPSS visitors center is controlled above the front desk. Two maps are posted on the wall, one of the United States and one of the world. Located on these maps are hundreds of small tack pins which are used to track the home town of visitors and indicate the large international as well as national interest in nuclear energy and the site. The recorded number of visitors from foreign countries in calendar year 1993 was 162, including visitors from 25 countries.

The visitors center provides brochures, displays, and videos of the reactors and the site. Tours of Washington Nuclear Plants No. 1 and No. 3 are available through the visitors center.

3.4.4 Proposed Tri-Cities Cultural Center

The Tri-Cities Cultural Center, an interpretive Native American cultural center and museum, is being considered for development at Columbia Point. A proposal is under development by the Washington State Historical Society, the Hanford Contractors, and the city of Richland.

The Three Rivers Cultural Coalition, which is heading this effort, has formed an alliance with the Hanford Museums of Science and History and other groups in this area.

The proposed cultural center would enhance the existing museums and visitors centers around the region by focusing on the Native American Indian's history at the Hanford Site and the surrounding regions. The center would also include exhibits on the Hanford Site's historical and current activities.

3.4.5 Oak Ridge Graphite Reactor Museum

After the achievement of a chain reaction in the Fermi Pile (CP-1) at the University of Chicago on December 2, 1942, the Manhattan Project quickly initiated projects to isolate sufficient quantities of fissile uranium and plutonium to create nuclear weapons. The plutonium side of the project started with the construction of the graphite reactor at the new Oak Ridge Laboratory facility. This reactor was the prototype for the first plutonium production reactor, the B Reactor (which was to be constructed concurrently at the new Hanford Site). The graphite-moderated reactor successfully produced irradiated fuel from which small quantities of plutonium were extracted. In 1966, the reactor was made a National Historic Landmark and converted to use as a museum.

This museum is open from 9 a.m. to 4 p.m. seven days a week. No staff is maintained in the facility, but staff led tours can be arranged. Approximate visitation to the reactor museum in FY 1993 was 29,500. Visitors are requested to sign a guest book at the entrance, but since some do not, these visitation numbers are not precise. The American Museum of Science and Energy in Oak Ridge is a large museum with cultural, historic, and scientific/engineering exhibits. The two museums refer visitors to each other and thereby increase total visitor count.

Precise separate operating costs for the museum are not maintained because parts of the building are still used for ongoing Oak Ridge National Laboratory (ORNL) project activities and the maintenance is integrated. Staff estimates are that less than one full time equivalent person is required for museum maintenance. Approximately one full-time equivalent (FTE) person is expended in tour coordination. Major building maintenance is within the overall lab budget because of the building's continuing use.

Visitors to the Oak Ridge area are encouraged to visit the graphite reactor as well as other maintained cultural, historic, and scientific/engineering exhibits. The American Museum of Science and Energy refers visitors to the Graphite Reactor Museum and thereby encourages extra time in the community by visitors. Some economic benefit accrues from this practice. A more thorough signing and referral practice would increase visitation. Visitors to the Graphite Reactor Museum receive important historical and technical information about nuclear technology and the community benefits from the increased public acceptance of nuclear technology.

Appendix D provides a detailed account of the conversion of the ORNL Graphite Reactor Museum.

3.4.6 Idaho National Engineering Laboratory EBR-1 Reactor Museum

The Idaho National Engineering Laboratory (INEL) EBR-1 Reactor was the source for the first electric power generated in the world from a Nuclear Power Reactor on December 20, 1951.

This reactor was also the first to demonstrate and prove technically feasible the process called "fuel breeding." EBR-1 was subsequently recognized as a U.S. National Historic Landmark and was presented by the American Nuclear Society with the Nuclear Historic Landmark Award.

The museum is open to public access and staffed with student guides from Memorial Day to Labor Day every year. Hours are 8 a.m. to 4 p.m., seven days a week. Attendance is now running at 10,000 per summer. Another 4,000 persons per year are brought to the museum for guided tours during the balance of the year. The museum is near the public highway providing access from Sun Valley to Twin Falls, or from Idaho Falls to Yellowstone Park. Many drop in visits occur from travelers. In addition to the summer staff, operating costs include one full time equivalent person for maintenance, and one person for tours and public relations.

The EBR-1 staff and the staff of the Idaho Falls Chamber of Commerce Museum were strongly convinced that each museum increases the interest and visitation at the other. The Chamber of Commerce Museum had 32,000 visitors in 1993. Approximately 2 million persons per year visit the Idaho Falls region. Guided tours of the EBR-1 Museum are stimulated and coordinated by the Chamber of Commerce Museum.

A detailed account of a visit to the EBR-1 Museum and the process of conversion into a museum is provided in Appendix D.

3.4.7 Nagasaki, Japan

The Nagasaki International Culture Hall (Atomic Bomb Museum) was built in 1955 to display photographs, relics, videos, and documents related to the 1945 atomic bombing of Nagasaki, Japan. The building was demolished in July 1993 and is being replaced by a new museum, planned for opening in April 1996. An entrance fee of 50 yen is required and the operating hours are from 9 a.m. to 5 p.m. (November to March) and 9 a.m. to 6 p.m. (April to October). The area is visited by millions of people from all over the world. There is an underground parking lot which allows space for 36 buses and 84 cars.

The World Peace Symbol Zone was established in 1978 in which nations around the world were invited to donate monuments symbolizing peace. Thirteen nations donated peace monuments, including the "Constellation Earth" donated from St. Paul, Minnesota, United States of America in 1992.

Table 3-2 is a summary of the museum and visitors centers discussed above.

Table 3-2. Selected Museum Review.

	Estimated Visitation in FY 1993	Approximate Staffing Requirements
Existing B Reactor Museum	5,000	1/2 FTE[a]
Hanford Museums of Science and History	22,000	4 FTE
Fast Flux Test Facility Visitors Center	5,800	[b]
Washington Public Power Supply System Visitors Center	3,500[c]	[b]
Proposed Tri-Cities Cultural Center	[d]	[d]
Nagasaki International Culture Hall	[d]	[d]
Oak Ridge Graphite Reactor Museum	29,500	1/2 FTE[a]
Idaho EBR-1 Reactor Museum	14,000	2 FTE

[a] Full Time Equivalent (FTE) estimated based on personnel requirements for bussing and RCT responsibilities for prearranged tours

[b] Staffed by Hanford retirees

[c] Based on WPPSS FY 1994 (July 1, 1993 to June 30, 1994)

[d] Information not available

4.0 CRITERIA FOR DEVELOPING FEASIBLE ALTERNATIVES

4.1 INTERPRETIVE PROGRAMMING

The B Reactor and overall development at Hanford have a rich history and unique opportunities to interpret one of this century's most significant engineering and scientific events. These and other resources worthy of interpreting include the following:

1. Archeology
2. Native American Indian Culture
3. Geology and National Resources Along the Columbia River
4. Impacts on Pre-Hanford Community Life
5. Engineering and Construction of Hanford
6. 105-B Reactor Facility
7. Scientific Accomplishments of Hanford
8. Environmental Impacts, Mitigation, and Restoration
9. Columbia River Environment

Several existing facilities currently provide interpretation for several of these resources. Most have developed and evolved over time based on response to specific needs. In particular, the Hanford Museums of Science and History provides an excellent interpretation of many of the engineering and scientific accomplishments at Hanford. A proposal has recently been initiated to develop a cultural center and museum, with a possible site being Columbia Point. Among those organizations supporting this concept are the Three Rivers Cultural Coalition and the State Historical Society. The Hanford Museums of Science and History has shown some interest because of their long-term expansion goals. These current and potential facilities appear to primarily address impacts on pre-Hanford community life, engineering and construction, and general aspects of the scientific accomplishments at Hanford.

Based on the focus of the other museum facilities described above, the B Reactor museum should focus its primary emphasis on interpreting the scientific accomplishments at Hanford with an equal emphasis on the required engineering and construction completed within an extremely tight schedule. Having the visitors at the actual facility provides an exciting experience that cannot be obtained in an offsite museum. The tour route through the reactor facility could be expanded to include the fan house, valve pit, lunch room, tool/storage room, and viewing area into the storage basin.

Other opportunities that have not been identified include an interpretation of the natural resources, Native American Indian culture, the Columbia River environment, and the environmental impacts, mitigation, and restoration that is being addressed today. Such opportunities could be provided along the proposed Route 6 from

Highway 240, for such activities as open space/park reserve, day-use park, park/camping facilities, natural/cultural resource interpretation, environmental interpretation, or wildlife refuge expansion.

4.2 DEPARTMENT OF ENERGY RECORD OF DECISION

On September 16, 1993, a ROD (DOE 1993) was issued in the Federal Register, Volume 58, Number 128 for the decommissioning of eight surplus production reactors at the Hanford Site, Richland, Washington. The ROD identifies a proposed action for decommissioning eight of the nine reactors used for the Nation's defense program at the site (B, C, D, DR, F, H, KE, and KW). These eight reactors have been retired from service and declared surplus by the DOE. The ninth reactor, N Reactor, is not covered under the scope of this ROD.

The recommendations of the ROD are based on the environmental information provided in the *Final Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington* (DOE/EIS-0119F) (DOE 1992) published in December 1992. Five alternatives for decommissioning were developed and evaluated in this phase of the study:

1. No Action
2. Immediate One-Piece Removal
3. Safe Storage Followed by Deferred One-Piece Removal
4. Safe Storage Followed by Deferred Dismantlement
5. In Situ Decommissioning

The proposed action, identified in the ROD, was safe storage followed by deferred one-piece removal. This alternative includes a safe storage period of 75 years with building security, radiation monitoring, and fire detection systems upgraded and building components and structures repaired as needed to provide safety, security, and surveillance as long as required. Following the safe storage period, the graphite block would be removed as one-piece and transported to the 200 West Area for disposal, along with the remaining contaminated portions of the facility. Uncontaminated structures and equipment would be demolished and placed in landfills in the vicinity of the reactor sites.

The ROD acknowledges the nomination and inclusion of the B Reactor on the National Register of Historic Places and the provisions of 36 *Code of Federal Regulations* (CFR) 800, "Protection of Historic and Cultural Properties." In this Federal Register, it states "Specific actions to mitigate the cumulative impacts of decommissioning on the historic preservation of B-Reactor will be determined later in accordance with 36 CFR 800. Actions to preserve this historic resource may include extensive recordation by photographs, drawings, models, exhibits, and written histories, and may also include preservation of some portions of the B Reactor for display on or near its present location or at some other selected location."

4.3 NATIONAL HISTORIC PRESERVATION ACT

Because the 105-B Reactor has been placed on the National Register of Historic Places, the DOE must comply with the National Historic Preservation Act (NHPA) (16 *United States Code* [USC] 470) prior to performing any action on the historic site. *The Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines for Rehabilitating Historic Buildings* (USDI 1992) provide ten rehabilitation standards and recommended guidelines for complying with these.

4.3.1 Section 106 Process

Section 106 of the NHPA requires the DOE to notify the Washington State Historic Preservation Office (SHPO) of any decision of proposed action on the site. The SHPO would determine the effect of the proposed action on the historic site, based on three main findings: 1) No Effect; 2) No Adverse Effect; or 3) Adverse Effect. The SHPO may also apply conditions to each of these findings.

If the action is considered to have No Effect or No Adverse Effect, the SHPO may require additional information (e.g., copies of plans, drawings, specifications, etc.). If no additional information is requested, the Section 106 process may be complete.

If the response by the SHPO is that the action is considered to have an Adverse Effect, the DOE shall submit a memorandum of agreement (MOA) to the SHPO and the Federal Advisory Council on Historic Preservation for approval. The MOA shall identify any mitigating measures that will be taken for implementing the action.

Once the MOA is approved, it is submitted along with background information and photographs to the NPS to determine the level of documentation necessary under the Historic American Buildings Survey (HABS)/Historic American Engineering Record (HAER) portion of the Section 110 process for the proposed adverse effect action. Generally the documentation is archival in nature, and includes photographs (interior and exterior architectural, historical, significant equipment/structures), reproductions of all drawings associated with the building, and written documentation including a detailed description of the building, controls and instrumentation, significant equipment/structures, and history of the building.

4.3.2 Standards for Rehabilitation

The proposed action will also be subject to the requirements of *The Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines for Rehabilitating Historic Buildings*. The ten standards outlined are "to be applied to specific rehabilitation projects in a reasonable manner, taking into consideration economic and technical feasibility." The following is a list of the ten standards extracted from the document:

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.

2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.

3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.

4. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.

5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a historic property shall be preserved.

6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8. Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

9. New additions, exterior alternations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

The guidelines provide general design and technical recommendations and are not requirements. These guidelines are incorporated into the alternatives to the most practical extent, including upgrades to the roof in Alternative A, enhancing the displays using authentic 1940's era furnishings in Alternative C, and containing asbestos in place to retain original walls.

4.4 SAFETY

A major consideration in developing alternatives for the 105-B Reactor Facility is the issue of public and environmental safety. This criteria element is considered directly in all actions at the Hanford Site using the requirements and fundamentals of the Occupational Safety and Health Act (OSHA) and the site-wide ALARA program. Section 3.1 provides the existing waste characterization information for the B Reactor. During Phase II additional information will be gathered as required and potential hazards will be mitigated through appropriate cleanup, encapsulation, or design change.

4.4.1 Occupational Safety and Health Act

The OSHA of 1970, 29 USC Sections 651 through 678, provides the federal requirements for safety in the workplace. The standards for implementing these requirements are provided in the 29 CFR 1910, "Occupational Safety and Health Standards." These standards shall be adopted and implemented in the development of all possible alternatives deemed feasible for the site.

A set of General Industry Safety and Health Standards recommended by OSHA was compiled to aid employers, supervisors, and safety personnel in achieving voluntary compliance with OSHA. The standards used in developing the alternatives for compliance with OSHA, include the following:

- occupational noise (1910.95)
- ionizing and nonionizing radiation (1910.96 and 97)
- asbestos (1910.1001)
- fire protection (1910.157)
- exits (1910.36 and 37)
- drinking water (1910.120)
- electrical (1910.303 through 305)
- lighting (various sections)

- personal protective equipment, foot and head protection (1910.132 through 136)
- toilets and washing facilities (1910.141).

4.4.2 As Low As Reasonably Achievable

The Hanford Sitewide ALARA Program is implemented for proposed actions on the site where employees are subject to, or there is a potential for, exposure to a hazardous substance or condition. The program requirements are outlined in the *ALARA Program Manual*, WHC-CM-4-11 (WHC 1988a). It is a policy of the DOE and its contractors to extend application of ALARA activities involving exposure to nonradiological hazardous substances and conditions. ALARA concepts shall be applied to minimize exposures where cost-effective (DOE 6430.1A [DOE 1989]).

Projects involving the construction or modification of facilities shall be designed in accordance with DOE Order 4700.1, "Project Management System" (DOE 1987), and WHC-SD-GN-DGS-30011, *Radiological Design Guide* (Evans 1994), which implements the radiation protection general design criteria. Facilities or modifications shall be designed to minimize exposure of personnel and facilitate control and containment of radioactive or hazardous materials.

An ALARA Checklist (Form number A-6000-291) is required during the conceptual design phase of a construction or modification project and should be updated as required. This checklist is intended to be used as a guidance tool in conjunction with established design criteria.

The ALARA Management Worksheet (AMW; Form number BC-6000-217) documents ALARA practices, prejob ALARA considerations, and estimated job dose. The need for a Prejob ALARA Review Record (Form number A-6000-870) and a Post ALARA Review (Form number A-6000-871) will be identified in the AMW.

A cost benefit analysis (CBA) (Form number A-6000-506) compares the cost and impact of a protective measure against the benefit derived from it. This worksheet is used when the cost effectiveness of a proposed ALARA protective measure requires formal verification. The requirements of the CBA are defined in WHC-SD-SQA-CSD-20003, *Cost Benefit Analysis - ALARA* (Brown 1992).

4.5 COST

Appendix E includes a preliminary estimated cost for each of the six alternatives identified in Section 5.0. These costs are estimated to the nearest $5,000 based on the Phase I alternative concepts with a contingency of 20 to 30%. In Phase II, the cost estimate will be based on a more detailed design providing a more accurate analysis.

Some cost has already been incurred for the necessary upgrades at the site identified in the risk analysis, as stated in Section 3.2. This cost is a large portion of what would be necessary for implementing most of the following alternatives.

5.0 DESCRIPTION OF ALTERNATIVES

This Phase I feasibility study report identifies and defines six alternatives for conversion of the 105-B Reactor Facility. These alternatives were developed during Phase I technical working sessions (PNL and Parsons 1994a). The six alternatives were developed to provide only feasible options for converting the facility. These options were developed to address physical modifications to the site along with serviceability and interpretive aspects. The six alternatives are:

Alternative A - Controlled Tour Access
Alternative B - Public Access With Current Displays
Alternative C - Public Access With Enhanced Displays
Alternative D - Public Access With Enhanced Displays and Additional Tours
Alternative E - Public Access With Enhanced Displays, Additional Tours, and River Access/Cultural Center
Alternative F - Dismantling

The proposed feasibility study workshop, identified in Section 2.2, should discuss how each of these alternatives is defined and evaluated. A detailed design should be performed in Phase II for each of the alternatives carried over for further evaluation into that phase of the study.

5.1 ALTERNATIVE A - CONTROLLED TOUR ACCESS

Alternative A includes using the facility as it currently exists as a museum. The current controlled access tour route is shown in Figure 3-2. Tours would continue to be provided by bussing personnel to the site by prearranged appointments under this alternative. Some safety and access modifications will be necessary, including roof repairs, ventilation, fire protection, building accessibility, water quality, barriers/signs, and asbestos abatement.

The existing security is adequate for the site. There are working phones in the control room and gatehouse near the facility. Access to the facility is north on Route 4 through the Wye Barricade then west on Route 1 (Figure 1-1). The property surrounding the 105-B Reactor Facility is fenced off and a gate restricts entry into the area.

The current tour route is discussed in Section 3.3. Displays are located throughout the facility which adequately portray the facility background and history of the facility and the site. Additional handouts and brochures could be made available, including brochures from other area visitor centers and museums and an explanatory brochure of the site background and the tour route areas.

5.1.1 Roof

5.1.1.1 Existing Roof. The existing roof decking consists primarily of precast concrete panels with overlain asphalt and gravel roofing. The structural support system for the roof decking consists of structural steel I beams. The original roof paneling system composite is provided as Figure 5-1.

The asphalt and gravel surface roofing was replaced approximately 10 years ago.

5.1.1.2 Proposed Roof. A repair of the 105-B Reactor Facility roof structure is currently ongoing. The scope of work for the roof repair work was determined based from the risk assessment identified in the *Risk Management Study for the Retired Hanford Site Facilities, Qualitative Risk Evaluation for the Retired Hanford Site Facilities*, WHC-EP-0619, Volume 3 (Coles, et al. 1993) and the *Structural Inspection of Hanford's 100 Area Facilities, Rev. 0*, ER1738-INSPECTION (KEH 1991).

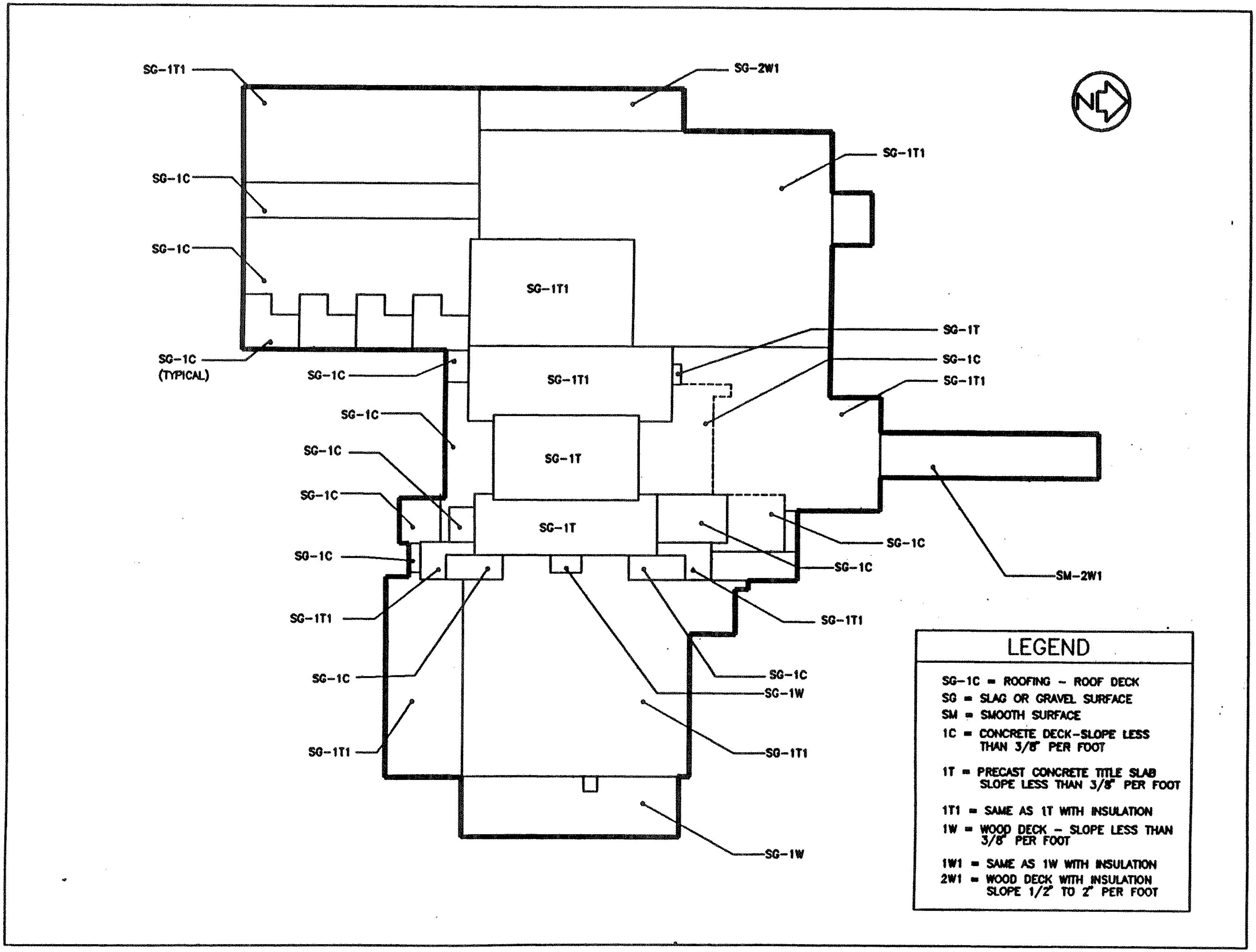
The procedures for current repairs to the roof are included in Engineering Change Notice (ECN) 600275 (WHC 1994a). These procedures identify fabrication and installation of Unistrut* field fit assemblies for the deflected and damaged panels identified in the risk assessment (Photograph 5-1). The repairs include bracketing the panels to the support structure, but not replacing panels.

The repairs are required to ensure panel stability and integrity for an estimated 10 year span. As part of Alternative A, the ongoing roof repairs to the 105-B Reactor Facility should be sufficient until the next maintenance cycle (less than 10 years). At that time the roof stability and integrity of the roof repairs should be reevaluated.

It is assumed that the roof directly over those areas which are to be included as part of the museum tour route would be replaced during the next maintenance cycle. Figure 5-2 shows those portions of the roof which must be replaced (includes those portions of tour routes identified in Alternative D). The figure identifies the roof elevations and square footage in each of these areas. Two options are recommended for replacing those portions of the roof, using a similar design and materials as originally installed or replacing the roof similar to the replacement currently ongoing at other reactor facilities around the site.

---

*Unistrut is a trade name of Unistrut Building System.

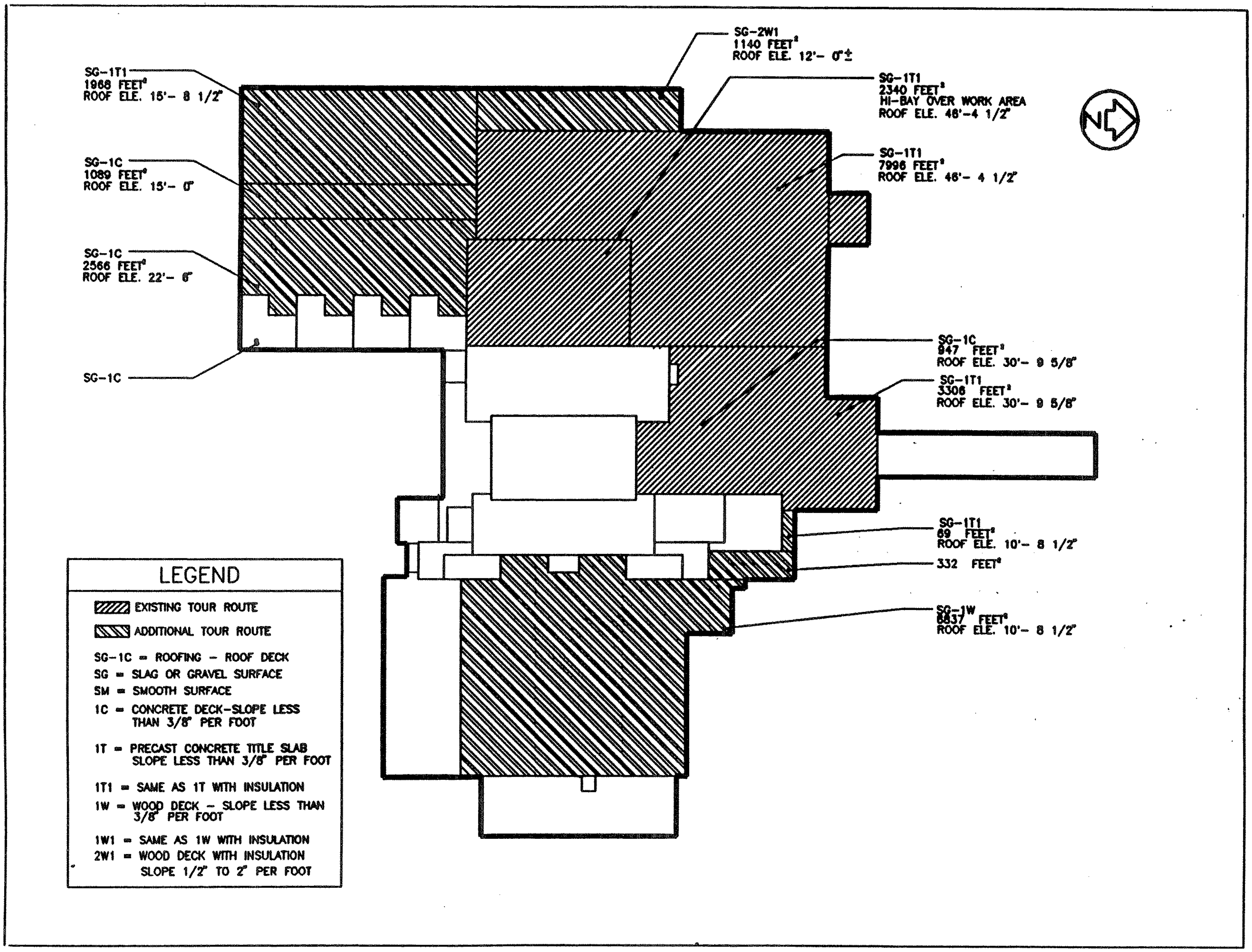


LEGEND

SG-1C = ROOFING – ROOF DECK
SG = SLAG OR GRAVEL SURFACE
SM = SMOOTH SURFACE
1C = CONCRETE DECK-SLOPE LESS THAN 3/8" PER FOOT
1T = PRECAST CONCRETE TITLE SLAB SLOPE LESS THAN 3/8" PER FOOT
1T1 = SAME AS 1T WITH INSULATION
1W = WOOD DECK – SLOPE LESS THAN 3/8" PER FOOT
1W1 = SAME AS 1W WITH INSULATION
2W1 = WOOD DECK WITH INSULATION SLOPE 1/2" TO 2" PER FOOT

ACAD FILD 940814

Figure 5-1. Original Composite of Roof Panels.



ACAD FILE: 940826

Figure 5-2. Roof Panels to be Replaced in 10 Years.

Photograph 5-1. Alternative A--Damaged Roof Panel.

Option 1 - Replace Roof with New Materials in Ten Years

This option would be to replace the roof using procedures and materials similar to the replacement at other reactor facilities at the site. The installation procedures for the 105-DR Reactor Building are included in ECN 600276 (WHC 1994b).

Using this option, the existing concrete roof panels will be removed and a steel, sheet metal roof deck will be installed. This decking should be secured to the existing support beams and concrete walls. If bubbling or flaking rust is encountered, the area should be cleaned and a rust resistant paint applied.

Once the decking is in place, the roof deck will be cleaned of residue and moisture, then sprayed with a foam insulation. As an overcoat, two applications of silicone rubber dispersion will be used.

The roof could be painted a light smokey grey color to match the existing roof and to give the authentic appearance of the original roof.

The original roof was designed to carry a 20 lb/ft^2 dead load and 30 lb/ft^2 live load. The replacement roofs currently ongoing are designed for a 8 lb/ft^2 dead load and 30 lb/ft^2 live load. This should be sufficient for persons walking on the roof, but should not be stressed by heavy machinery.

Option 2 - Replace Roof with Original Design Materials in Ten Years

The option of using the original design and similar materials is identified due to the recommendations of the NHPA. The guidelines for rehabilitation of historic buildings (USDI 1992) recommends that effort be taken to use the original design and materials during rehabilitation of historic structures.

Procedures for replacing the roof using this option would include removing the existing roof over those areas identified. Figure 5-1 shows a layout of the original roof decking and materials of the building (compiled from as-built drawings at the site).

The original roof was designed to carry a 20 lb/ft^2 dead load and 30 lb/ft^2 live load. It is estimated that this design load would be used for replacing the roof under this option of using the same design and materials as the original roof.

5.1.2 Ventilation

The regular inactivity of the 105-B Reactor Facility allows the accumulation of naturally occurring radon gas, in the building's interior. Currently, RCTs monitor the facility for this exposure and ventilate the areas with portable fans and selected door openings (Photograph 5-2).

Since ventilation effectively controls the accumulation of radon gas, a permanent ventilation system is being proposed to clear the radon gas.

All areas which are subject to public access will be scoured with fresh air by exhaust fans which will be roof or wall mounted depending on the type of room construction and configuration, which varies throughout the complex.

The work area will be ventilated at the roof level some 70 feet above the floor level with approximately 3,000 cubic feet per minute (cfm) of fresh air to clean the high bay areas in the vicinity of the process/reactor areas.

The control room area will be ventilated with a push-pull system utilizing some existing ductwork without asbestos insulation. This ductwork will be modified with the addition of a new supply fan and air inlet louver at the exterior building wall and connected to the existing duct system which was installed to furnish conditioned air to the control room area. The existing room diffusers will distribute the needed

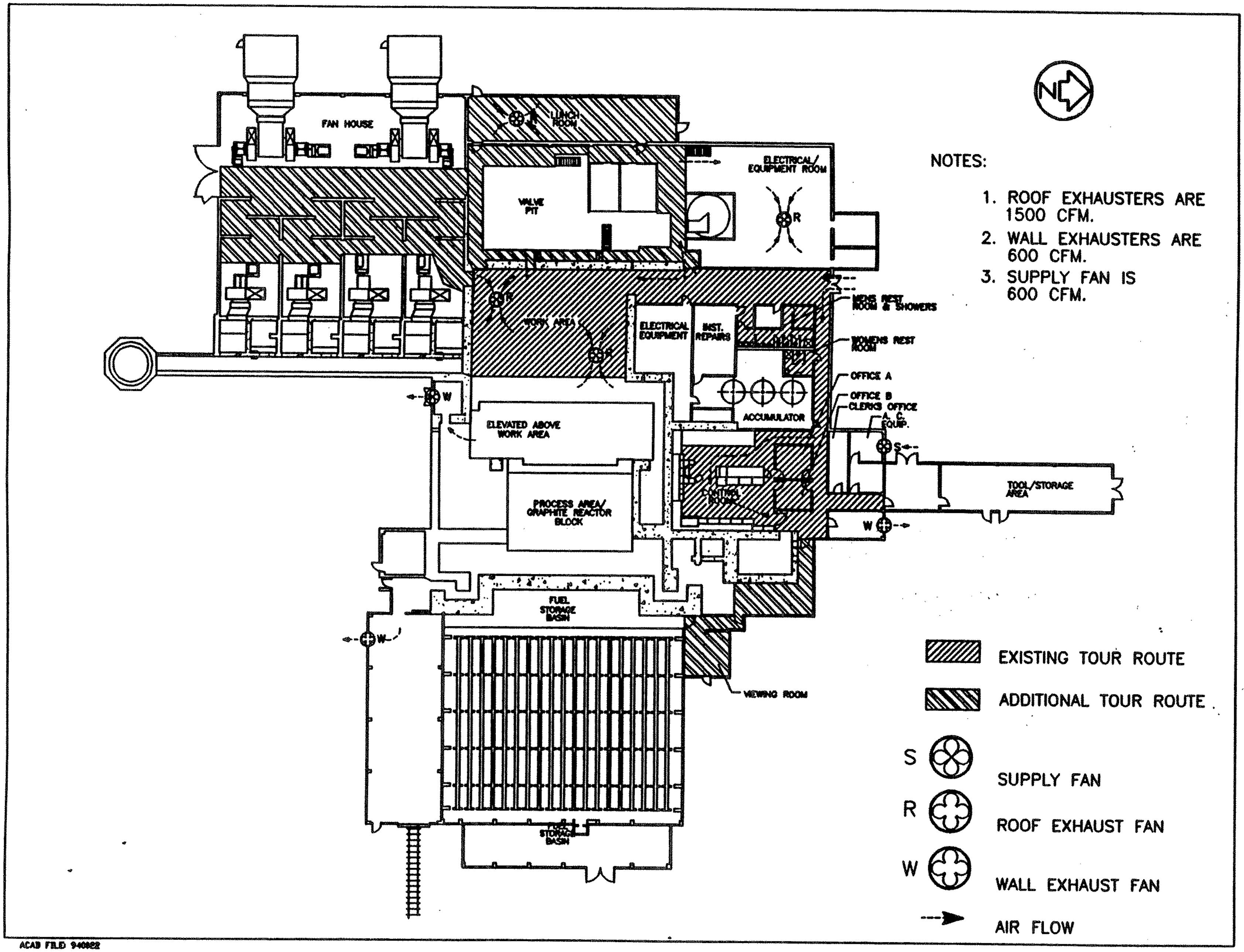
Photograph 5-2. Alternative A--Current Ventilation.

ventilation air to the south end of the control room and will be exhausted from the area through the adjoining clothing room storage area which will contain a 600 cfm wall type exhauster. The existing ductwork shall be vacuumed of dust and debris prior to reuse.

Additional areas to be ventilated will be the area south of the fuel storage basin, the area north of the valve pit, and the ceiling of the lunch room area. Figure 5-3 shows a plan of the areas with proposed locations of the new ventilators.

Certain areas of the 105-B Reactor Facility require heat for freeze protection of water systems yet in operation and those areas will be serviced with electric unit heaters to prevent system damage from freezing.

Radon detectors shall be installed to verify the safe system operation and silent alarms shall be installed to be monitored by guides/custodians for exhauster operation. Generally, operation of ventilation system for a period of ten minutes prior to public entry will clear the rooms of radon gas accumulation, and operation of ventilation systems during visitor hours will maintain that clean condition with night-time shut off.



NOTES:

1. ROOF EXHAUSTERS ARE 1500 CFM.
2. WALL EXHAUSTERS ARE 600 CFM.
3. SUPPLY FAN IS 600 CFM.

Figure 5-3. Proposed Ventilation Fan Locations.

All air discharge points will be registered with the Site Effluent Discharge Program. This may require high-efficiency particuate air filters and monitoring equipment to be installed.

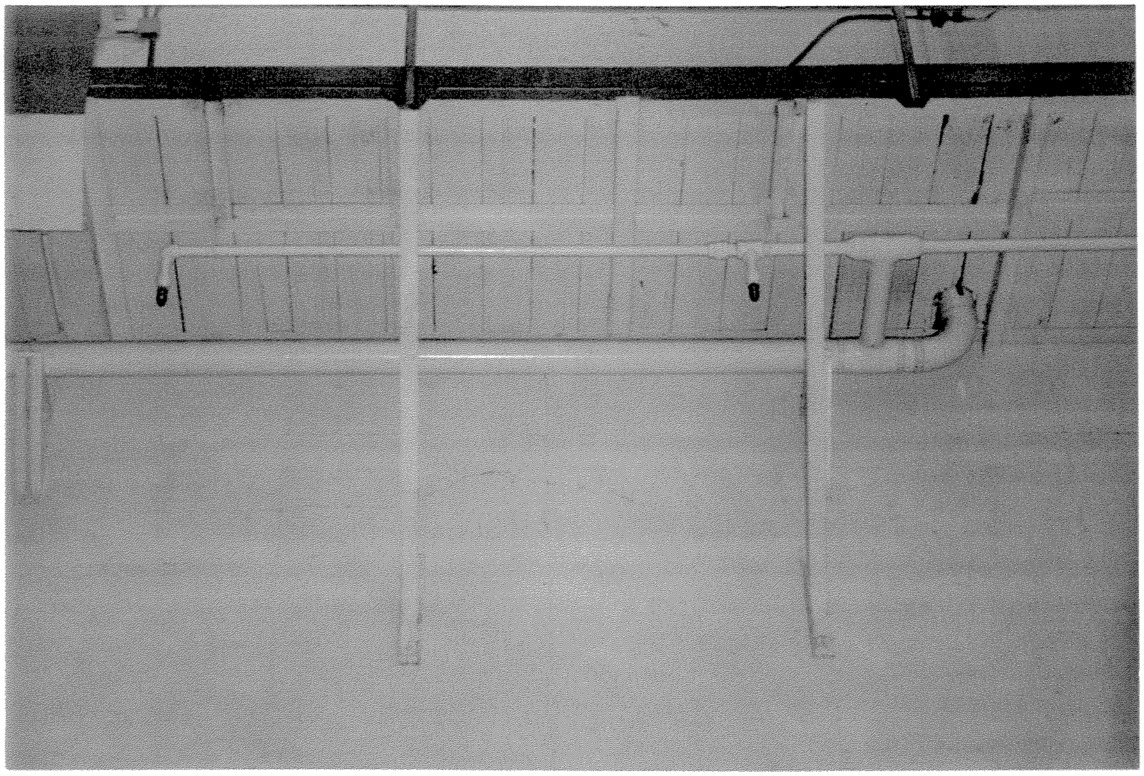
The floor in the work area is currently covered with a nylon-mesh sheet plastic (approximately 3/8 inch) for radon control. The floor is covered only in this room due to the large surface area and accumulation of natural radon. The ventilation upgrades will provide the protection necessary for controlling the radon contamination.

Installation of the new ventilation system would eliminate the cost of full-time RCTs at the site while ensuring a safe environment.

5.1.3 Fire Protection

The existing facility, in its "inactive" status, currently has eight emergency lights and five portable fire extinguishers which are to be inspected on a monthly basis (BHI-FS-02, *Field Support Work Instructions*, D-03-001, "Emergency Lights Inspection for 100 Area Inactive Facilities Surveillance and Maintenance" [BHI 1995]). Fire sprinklers are installed in the work area, but are not currently operable (Photograph 5-3).

Photograph 5-3. Alternative A--Fire Sprinklers in Work Area.



The *Integration of Fire Hazards Analysis and Safety Analysis Report Requirements*, WHC-SD-GN-FHA-30001 (Evans 1994), includes the following guidelines:

1. DOE 5480.7A (DOE 1993) specifies that an automatic suppression system is required if the maximum possible fire loss (MPFL) exceed $1 million.

2. Costs are based on "the dollar cost of restoring damaged property to its pre-fire condition (Refer to DOE 5484.1 [DOE 1994])."

3. MPFL is to be assessed based on the following:

    a. Property Replacement Costs
    b. Decontamination and Cleanup Costs
    c. Facility Restart Costs
    d. Loss of Program Continuity
    e. Cost to Restore Damaged Property to its Preoccurrence Condition
    f. Losses exclude the restoration of property that is scheduled for demolition and decommissioned property not carried on the books or property where there is no loss potential.

The 105-B Reactor Facility, as a museum, falls within a special category. The intrinsic value of the building is not the replacement cost for its original function but rather relates to its value as a museum and an historic site.

During Phase II, a fire hazards analysis should be conducted in accordance with DOE 5480.7A to identify potential hazards during upgrading of the facility and for the tour route and connecting areas after any upgrading has taken place. This analysis would include all anticipated museum and display items.

The INEL Reactor Museum discussed in Section 3.4 has a modern fire alarm system which was added during recent upgrades, but the museum was not required to add an automatic suppression system.

If the fire hazards analysis requires an automatic fire alarm system, it will be installed in the tour areas. All systems in this building are very old and replacement is the only option thus making it very expensive.

5.1.4 Building Accessibility

Formally opening the 105-B Reactor Facility Museum for tours will require compliance with the requirements of the ADA to provide accessible facilities. Section 4.1.7 of the ADA "Accessibility Guidelines" (ATBCB n.d.) addresses Accessible Buildings: Historic Preservation.

Building alterations required to comply with these regulations will be minimal, because this is a historically significant structure and is not new construction or even an alteration, but merely a change of occupancy. Changes of this type do not require complete compliance if the historic character of the building is adversely affected or compliance is technically unfeasible. ADA compliance considerations and/or anticipated alterations include the following:

1. Confirmation that tour buses meet ADA accessibility requirements.

2. Building Access - The building grades and door openings currently meet accessibility requirements from three doors on the north side of the B Reactor building, including the double doors, the door across from the accumulator room and the door into the former tool/storage wing to the north.

   If additional emergency egress is required these routes will require evaluation. For example, if the work area requires a secondary route through the valve pit and lunch rooms, the grating on the walk would require replacement with a smaller opening (1/2-inch versus the current 1-inch openings) and adequate grades and surfacing outside the door would be required. The guard rails along the route will also require upgrading.

3. One toilet facility must meet accessibility requirements, which can be designated as a unisex accessible facility. The door to the men's restroom is too narrow and the aisle to the stalls is too narrow (Photograph 5-4). However, the existing women's restroom currently comes close to meeting accessibility requirements. Under this alternate, the women's facility would be modified to fully meet these requirements. This would require removal (and possible replacement) of the stall enclosure, new lavatory, appropriate grab bars, and related accessories.

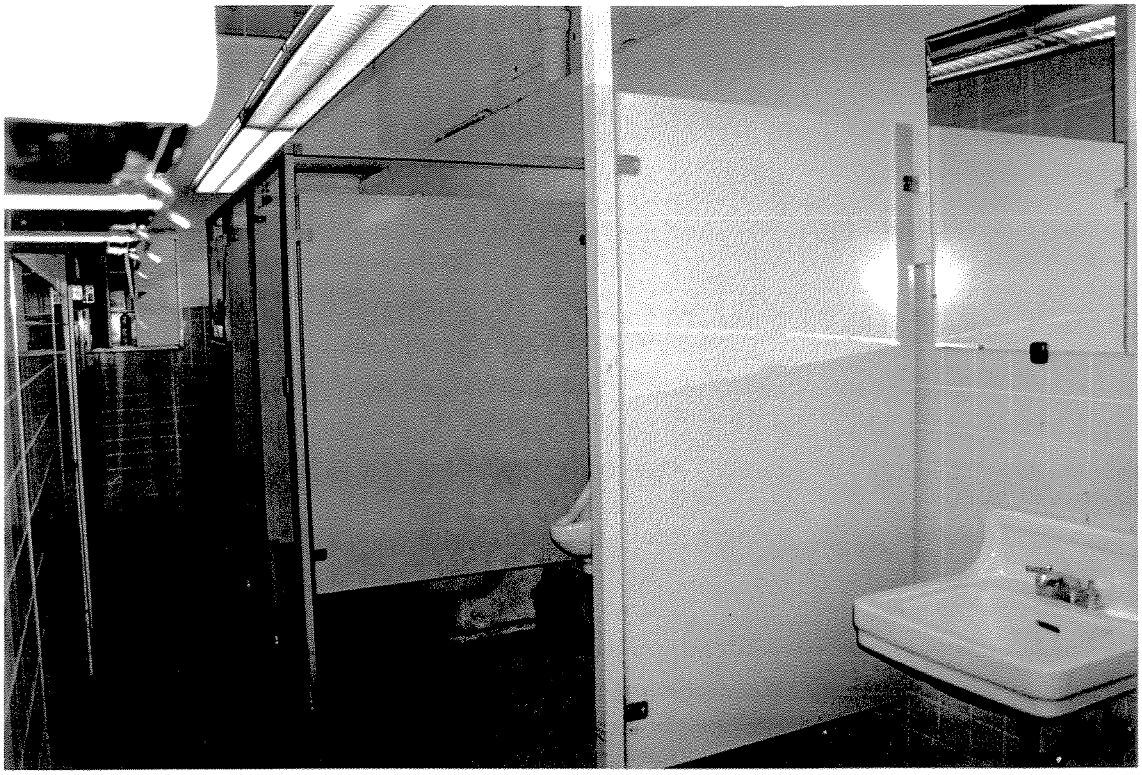
4. Displays and written information, documents, etc., should be located where they can be seen by a seated person. Exhibits and signage displayed horizontally (e.g., open books) should be no higher than 44 inches above the floor.

5. Signage should meet the requirements of Section 4.30 of the ADA "Accessibility Guidelines" (ATBCB n.d.).

5.1.5 Water Quality

The facility water at the site is currently nonpotable water from a filtered fire-line water supply.

Photograph 5-4. Alternative A--Building Accessibility.



A Culligan* Industrial Treatment System was installed for this line approximately seven years ago and was deactivated approximately two years ago. This system is composed of three treatment tanks and will treat the water to the state maximum contaminant limit standards required in the Washington Administrative Code.

The system is located in the accumulator room and is currently accessible for reactivation.

Bottled water is brought to the site for drinking purposes. This practice should be continued, as it may appeal to tourists.

The restrooms in the facility are currently used by facility personnel and visitors. The sinks and toilets are extremely stained. These should be cleaned and maintained to provide a more pleasant visit to the museum.

---

*Culligan is a trade name of Culligan International Co.

5.1.6 Barriers/Signs

A plexiglass barrier and countertop is currently used in the work area to restrict access and allow distance from the reactor block. Displays and signs are currently used as controls for restricting access to areas. Signs limiting access to most of the areas are adequately posted, but an assessment of the status of signs limiting access and identifying hazards should be performed in Phase II.

5.1.7 Asbestos

Asbestos in the facility is addressed in Section 3.1. A detailed inventory of the locations of existing asbestos should be performed in Phase II. This study should identify the location and status of the asbestos. All asbestos in the facility will be encapsulated and retained in place. Asbestos in the Idaho EBR-1 Reactor Museum and Oak Ridge Graphite Museum was encapsulated and left in place, Appendix D.

5.2 ALTERNATIVE B - PUBLIC ACCESS WITH CURRENT DISPLAYS

Alternative B provides opening the museum for the public to access the site without prior arrangement by tour. This alternative includes all of the upgrades defined in Alternative A plus upgrading the nearest access road and parking facilities and restricting access to other sites through fencing.

Zoning the entire portion of land north of Route 6 to the B Reactor should be evaluated under Phase II of this alternative in case future site plans warrant the viability of implementing some of the options discussed in Alternative E.

5.2.1 Access Road

The preferred access road to the site, Route 6 is a 3.5 mile arterial which parallels the Columbia River, east from State Highway 240 at the Vernita Bridge crossing (Photograph 5-5). Figure 5-4 shows the access route to the 105-B Reactor Facility from the access at Highway 240.

5.2.1.1 Existing Road. The existing pavement structure was adequate to handle the planned arterial traffic during production days of the B Reactor (HS-20 Loading). There are currently no signs of serious structural distress such as potholes or large ruts. Portions of the pavement are heavily cracked or have degraded to straight gravel in areas, in part due to recent heavy machinery activity along the stretch of road (Photograph 5-6). A majority of the existing road has vegetation growing through cracks in the asphalt.

Photograph 5-5. Alternative B--Access From Highway 240 and Vernita Bridge.

Photograph 5-6. Alternative B--Existing Route 6.

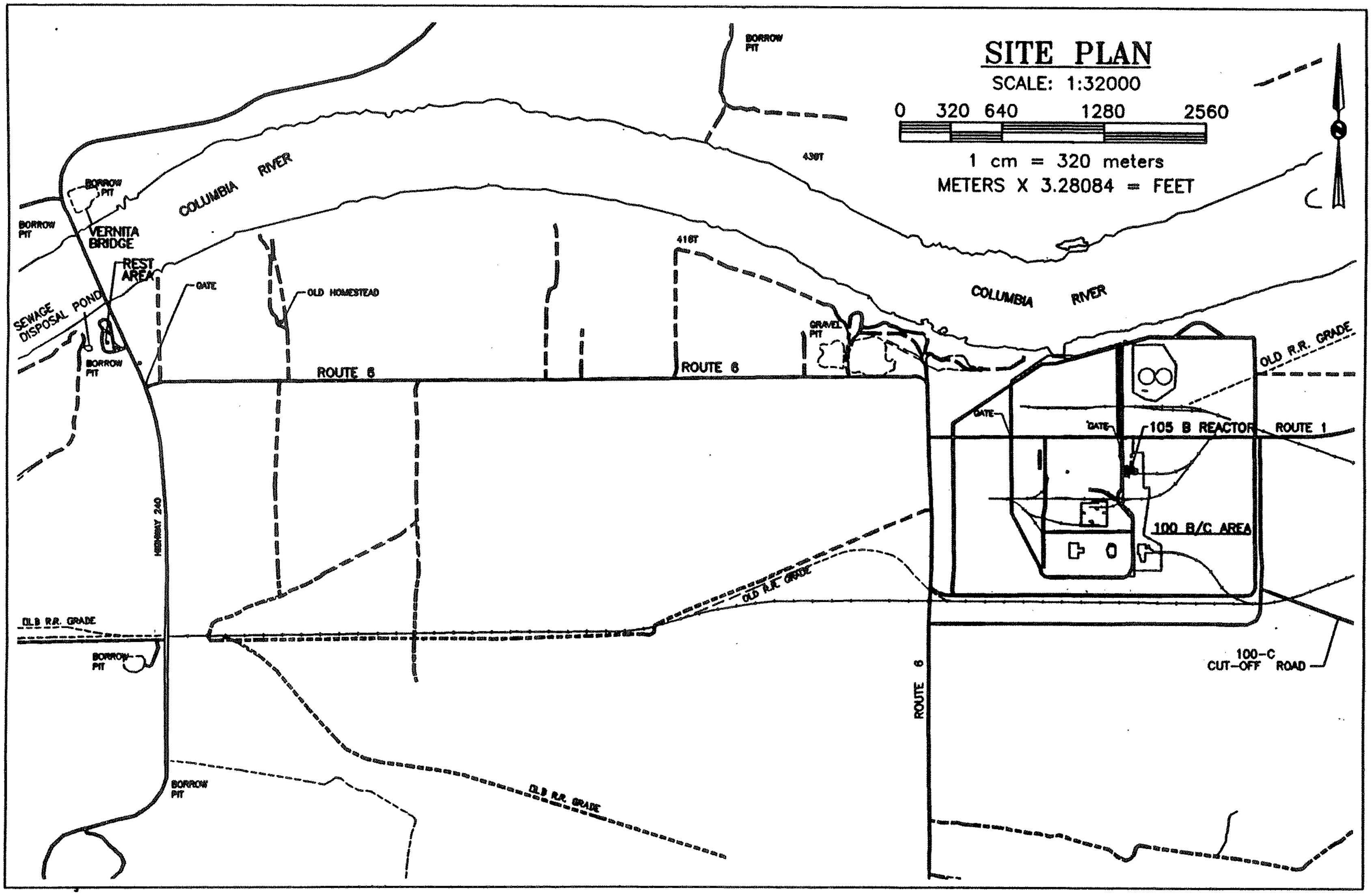


Figure 5-4. Access to 105-B Reactor Facility.

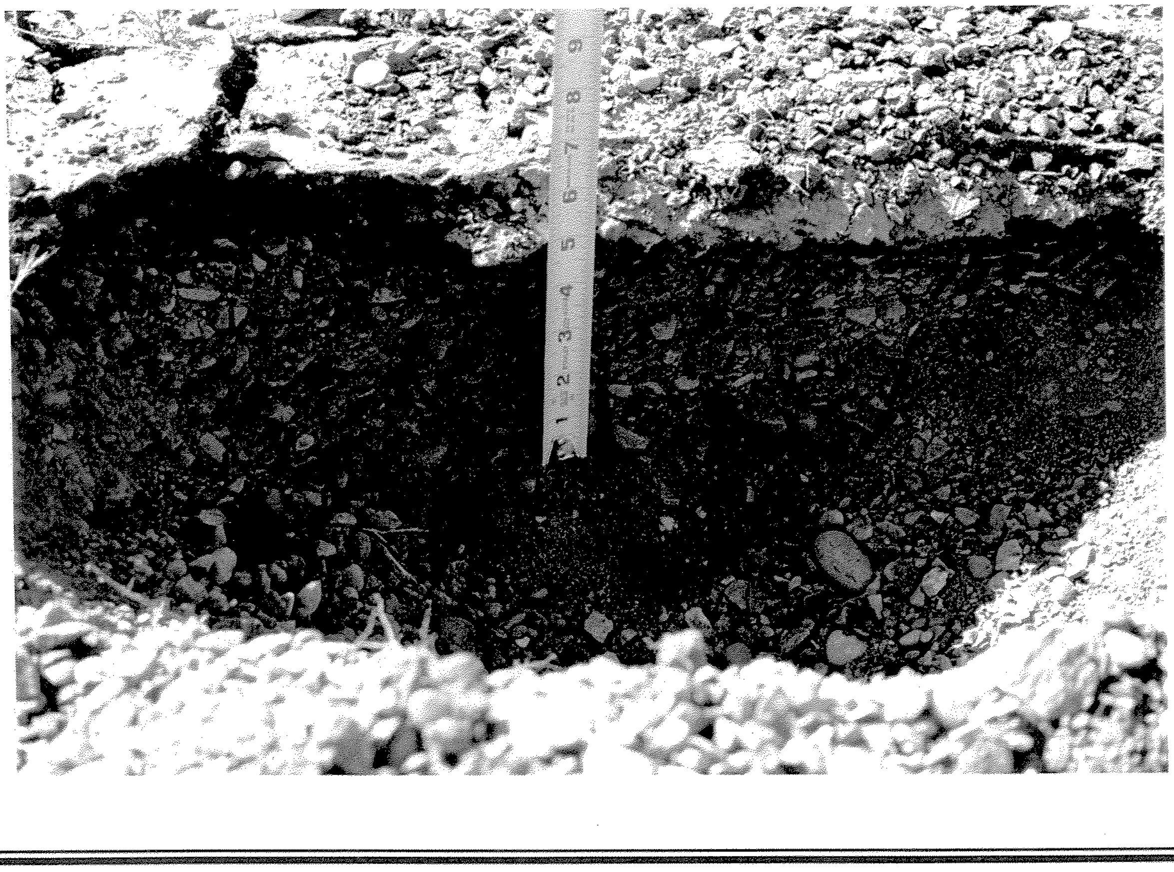
The existing road is surfaced with a light asphaltic treatment, commonly referred to as double chip seal, approximately 1 inch thick. Under this asphalt, the structure varies between 4 to 5 inches of leveling coarse material which appears to have been used to reshape the existing material in place (Photograph 5-7). The road width varies from 18 feet up to 36 feet in areas (16 to 18 foot traveled way plus shoulders). The slopes of the drainage ditches along the sides of the road vary from a foreslope of 1:3 or 4 (vertical to horizontal) and a backslope of 1:2 or 3 (vertical to horizontal). There was no evidence of drainage structures, such as culverts. Figure 5-5 represents a typical cross-section of the existing road.

The following existing conditions apply:

Type of Terrain:	Level
Current Average Daily Traffic (ADT):	<50 vpd
Current Design Hourly Volume (DHV):	<2 vph
Current Posted Speed:	25 mph

5.2.1.2 Proposed Road. The proposed Route 6 upgrade should adequately handle planned future traffic loads. The proposed road is designed as a rural arterial.

Photograph 5-7. Alternative B--Route 6 Sample Composite.



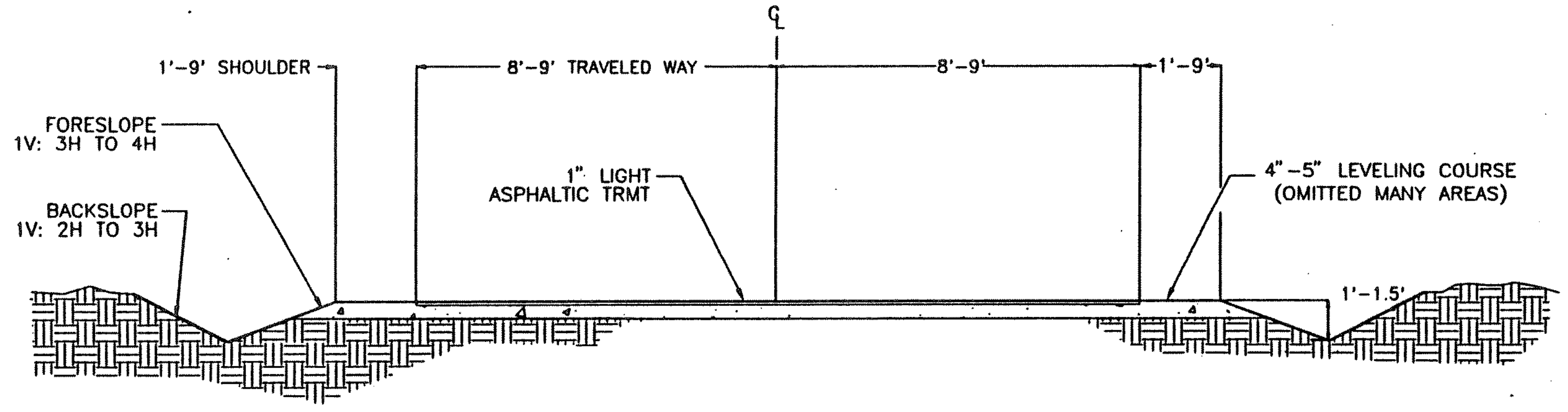


Figure 5-5. Existing Cross section of Route 6.

ACAD FILE: 940004

American Association of State Highway and Transportation Officials design standards (AASHTO 1990) were used as a basis for the access road improvements. The following conditions were used in designing the upgrades for Route 6:

Type of Terrain:	Level
Proposed ADT:	<250 vpd
Proposed DHV:	<50 vph
Proposed Posted Speed:	35 mph
Design Speed:	40 mph

The proposed road is a 22-foot traveled way width (11-foot each lane) and a 4-foot surfaced shoulder. Drainage ditches with a 1:4 vertical to horizontal slope foreslope and a 1:2 vertical to horizontal backslope is proposed. The horizontal and vertical alignments are adequate. No additional drainage will be provided. Figure 5-6 is a cross section of the proposed design for the Route 6 upgrade.

A major drainage point exists approximately 2 1/4 miles from Highway 240. There is no evidence of damage to the road structure in this area and it is assumed that drainage during infrequent storms is adequate. No improvements beyond widening are necessary.

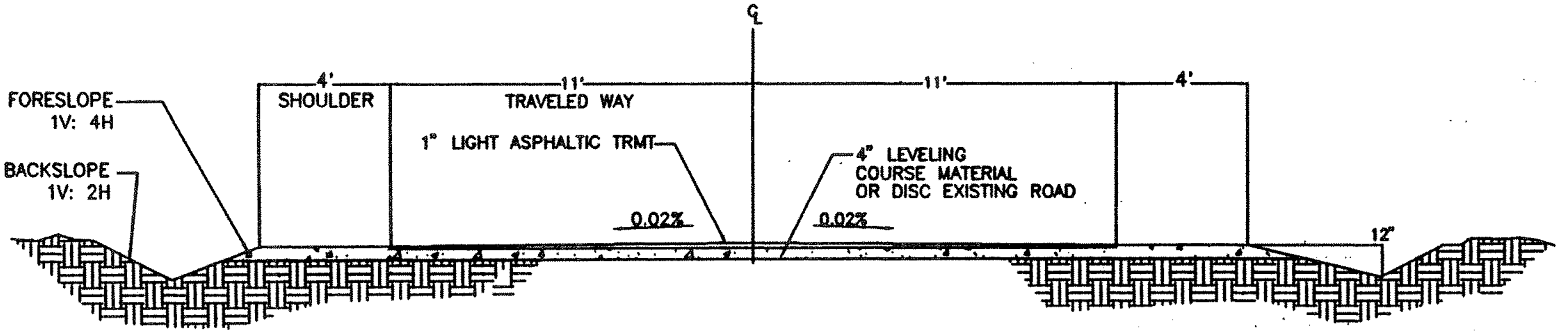
Composite samples should be taken at several locations on the existing road to determine the stability of the underlying structure. Two options are proposed for upgrading the existing road to this design.

Option 1 - Disc Existing Asphalt

The existing asphalt could be disced using a tractor-disc to break up the pavement. This material would be used in place of the leveling material to lower the cost of this alternative. The disced material would be watered and recompacted to a 0.02% slope. A soil sterilant should be applied to inhibit the vegetative growth prior to the light asphalt treatment.

Option 2 - Add New Leveling Material

Option 2 includes widening the existing route to the specified traveled way and shoulder width. A soil sterilant will be applied to inhibit vegetative growth, followed by 4 inches of coarse leveling material which should be graded to a 0.02% slope. A 1-inch light asphaltic treatment should be applied over the traveled way portion of the road.



ACAD FILE 940805

Figure 5-6. Proposed Cross Section of Route 6.

5.2.2 Locking Gate

The current gate at the State Highway 240 access, shown in Photograph 5-8, will be replaced with a more sturdy, double swing, pipe gate providing a 28-foot clear opening. A lock will be installed for operation by the B Reactor Museum staff or by security. Gate posts, with an outer diameter of approximately 6-1/2 inches and a minimum thickness of 0.28 inch, will be used to comply with Hanford Plant Standards (KEH 1991a).

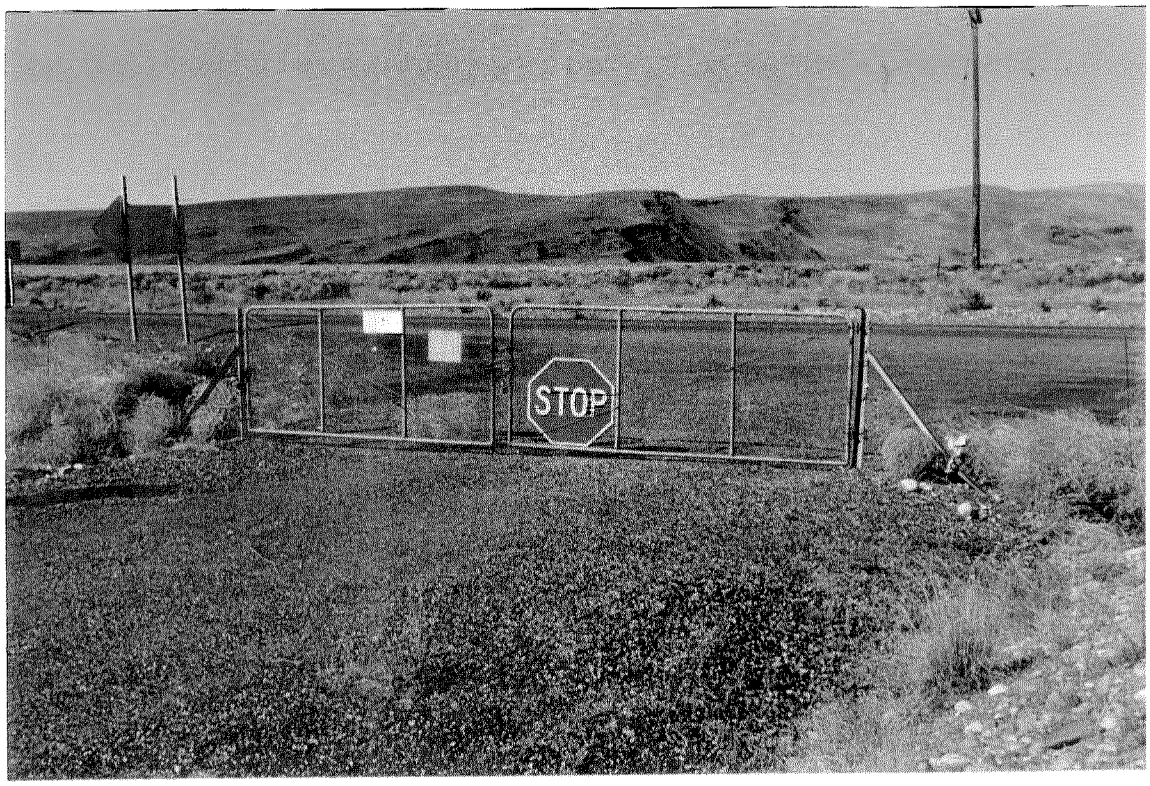
The proposed gate is shown in Figure 5-7.

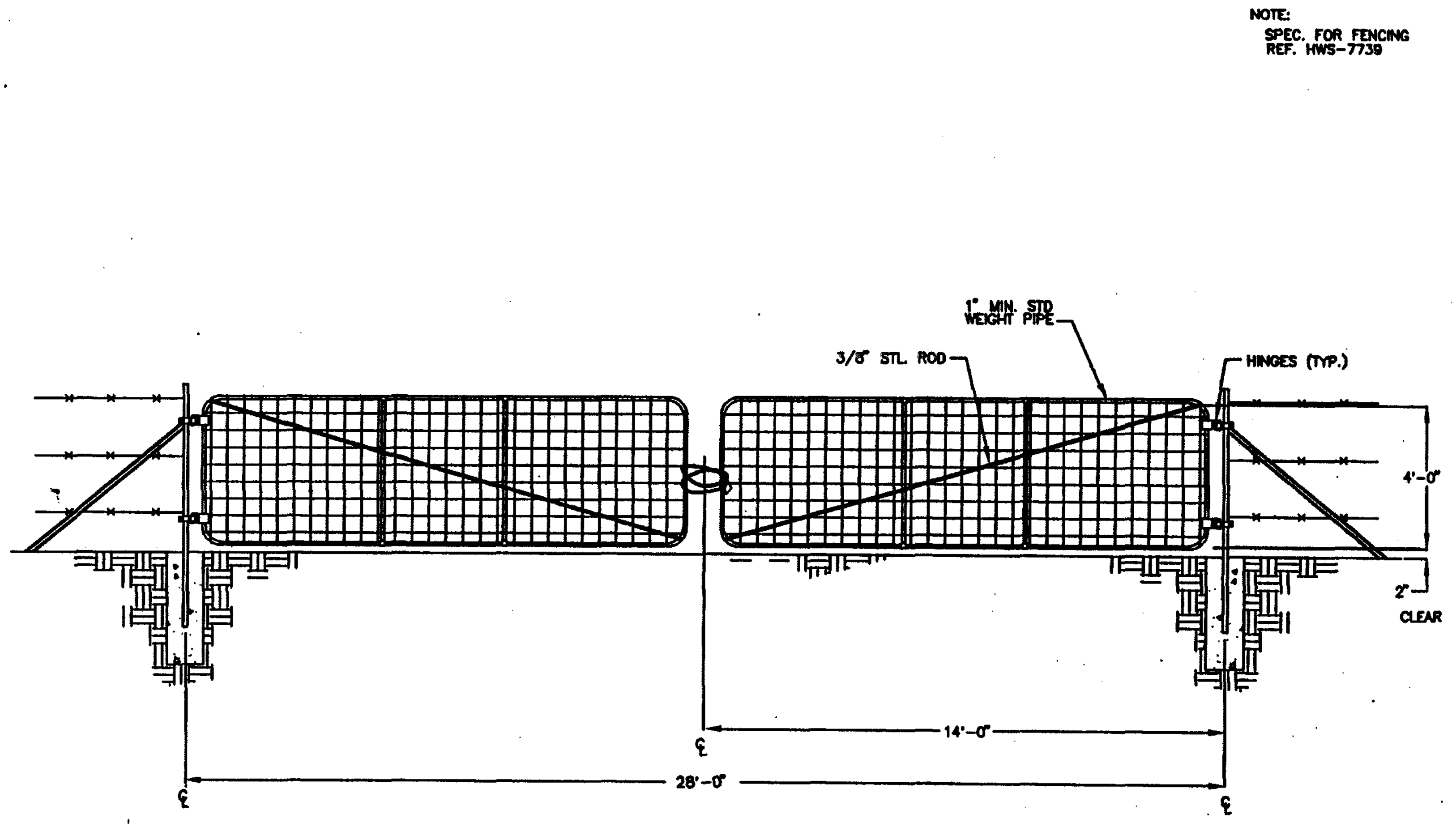
The current gate at the entrance to the parking lot of the 105-B Reactor Facility, which is shown in Photograph 5-9, is adequate for the site.

5.2.3 Fencing

A 4-foot-high, 3-strand barbed wire fence (Specification Reference HWS-7739) will be installed along the distance of Route 6. This fence will be constructed 50 feet from the proposed road centerline and will parallel the length of Route 6 to the

Photograph 5-8. Alternative B--Gate at Highway 240 Access.

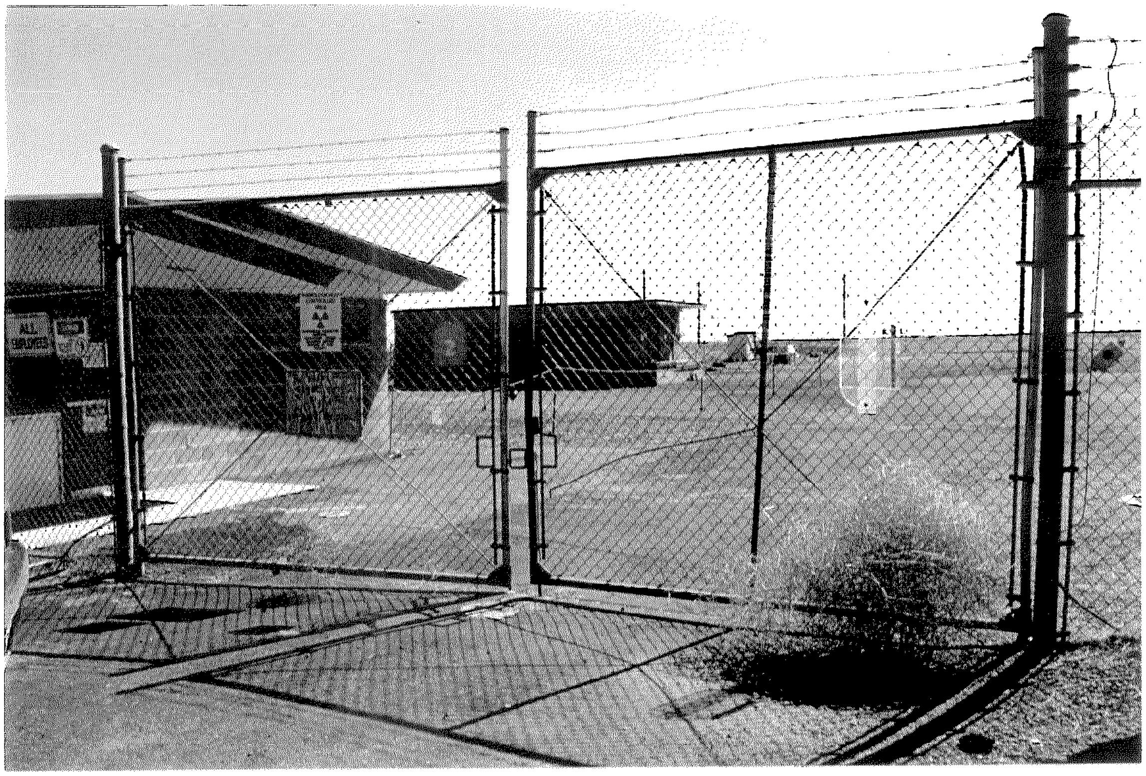




ACAD FILE 940813

Figure 5-7. Proposed Gate at Highway 240 Access.

Photograph 5-9. Alternative B--Gate at 105-B Reactor Facility.



entrance gate of the 105-B Reactor Facility. Posts will be installed at 15-foot intervals along the length of the fence. The fence would be placed on both sides of the road for Alternative B trough D. Alternative E would not need a fence on riverside of the road.

Consideration could be given in the design of portions of the fence to relate the detailing and materials to reflect the historic character of that used in the original perimeter security fencing.

5.2.4 Parking Lot

Minimal parking lot improvements could be made to the existing parking lot at the 105-B Reactor Facility by using the existing grade which slopes gently north (Photograph 5-10) and covering with a 1-inch light asphaltic treatment. Pavement markings would then be applied for an estimated four buses at 12 feet wide and 15 cars at 10 feet wide.

Additional ADA requirements would require designated parking for the handicapped. The parking should include accessible parking spaces in conformance with ADA Accessibility Guidelines (ATBCB n.d.), which will require a minimum of one space.

Photograph 5-10. Alternative B--Existing Parking Lot.

Lighting of the parking lot would not be necessary depending upon the staffing and operating hours.

5.2.5 Signage

Directing visitors to the 105-B Reactor Facility would require offsite signing, probably at locations along Highway 240 and from several points around Richland, Vantage, and the rest area at Vernita Bridge. It is estimated that eight to ten such directional signs would be required. These directional signs should be designed in a style that is coordinated with signage of the Hanford Museum of Science and History to convey a consistent image.

5.2.6 Staffing

Since this alternative allows the public to access the site, staffing of one FTE employee is proposed. Operating hours of the facility are proposed as seven days a week from 9 a.m. to 4 p.m.

Security for the employee would be necessary. Several levels of systems could be implemented from a high technology video monitoring system to an individual employee "tip over" badge. The "tip over" badge is used at the INEL Reactor Museum. This system monitors the vertical position of the person. If the person has fallen, an alarm is set off at a predesignated area.

5.3 ALTERNATIVE C - PUBLIC ACCESS WITH ENHANCED DISPLAYS

While this alternative includes the improvements identified within Alternatives A and B, the primary emphasis includes improvements to provide better interpretation of the historic facility and upgrades to the displays. The general goal of this alternative is to provide better interpretation through improving not only the displays, but also the presentation of the 105-B Reactor Facility.

Improvements identified in this alternative do not require implementation on a specific schedule. Most are independent and could be accomplished over an extended period of time to improve the interpretation of this significant structure.

5.3.1 Display Upgrades

While the current displays (Photograph 5-11) are excellent and more than equivalent to those in the Oak Ridge or INEL Museums, additional improvements could provide more text to describe the photographs, artifacts, and memorabilia.

The success of hands-on displays in museums has increased their popularity and strengthened this trend in interpretive programming. The B Reactor Museum has many exciting opportunities to provide such hands-on experiences.

Decorating with authentic 1940's era furnishings the highly visible rooms along the tour route would provide a more realistic image of the facility during early production. This would include the removal of some existing displays from significant B Reactor rooms, such as the work area. Recreating the image could include hands-on displays, with less formal displays and more adaptive settings. Lighting at levels similar to those originally used could be incorporated and supplemented with accent spot lighting. There are also opportunities to stimulate other senses, such as through audio effects recreating the tremendous sound of the 70,000 gallons per minute volume of water rushing through the reactor cooling channels.

5.3.2 Presentation/Demonstration Room

A room that could seat 40 to 50 was identified by other similar facilities as one of the best opportunities to successfully work with community groups, particularly school age children. This room could easily be built within the old tool/storage

Photograph 5-11. Alternative C--Existing Displays.

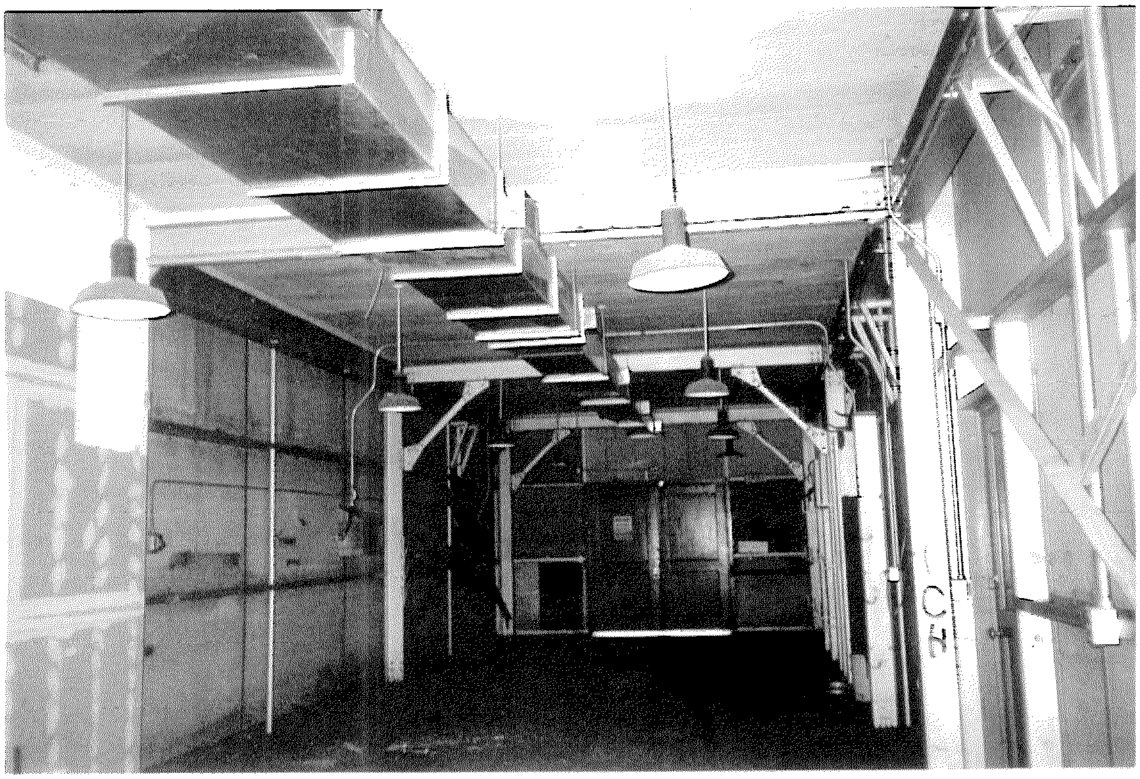
north wing of the B Reactor which is vacant (Photograph 5-12). Because it is somewhat separated from the main reactor structure and also close to the proposed entrance/exit, it provides an excellent location for such a use. This room could be easily air conditioned with a portable unit.

Section 106 of the NHPA requires that modifications to this National Register Site be completed in concert with the Washington SHPO and the Section 106/110 compliance process.

5.3.3 Exhibit/Entry Lobby

Utilizing the existing access door into the tool/storage north wing, provides an entry area and congregating area outside the primary reactor area and an excellent area to utilize the excellent displays that have been prepared. A small control counter/office area could be included here, providing an area where employees could be productive and still monitor access to the facility. Another critical need noted by other similar facilities was for a workroom for staff and volunteers to maintain, repair, and develop new displays.

Photograph 5-12. Alternative C--Tool/Storage Area--
Potential Space for Presentation Room.



The 105-B Reactor Building does not presently maintain additional electrical distribution in support of the added loads that have been identified in these alternatives. An upgrading of the electrical distribution system will be made to meet National Electrical Code regulations and safety for maintenance personnel and tour participants.

5.3.4 Side Exhibits

The "theme development" of the facility could start along the access road from Highway 240, where a security gate and even guard house could be constructed illustrating the tight security of the project during World War II, as well as during the cold war. Other elements that could be utilized to develop this preferred impression include original concrete post fencing with barbed wire, power pole replacement, securing old vehicles and equipment from this era, and other similar effects.

5.4 ALTERNATIVE D - PUBLIC ACCESS WITH ENHANCED DISPLAYS AND ADDITIONAL TOURS

The addition of several areas in the facility would enhance the current museum tour with minor upgrades for safety and disability access. These additions would add significantly to the technical and aesthetic value of the museum. The proposed additional tour route areas are the valve pit area, the fan house, the lunch room, and the fuel storage basin viewing area as shown in Figure 5-8. Alternatives A, B, and C would also be implemented under this option.

Each of these areas was an integral part of the entire plutonium production process. The valve pit area was the entry point of the cooling water supply into the facility from the 190 Building. Water was channeled through the valve pit and supplied the hollow aluminum process tube channels surrounding each rod for cooling the fuel.

The fan room houses the main blowers, heaters, air filters, and exhaust fans for the facilities heating, ventilation, and air conditioning system during reactor operations. The exhaust fans were attached to a concrete enclosed exhaust duct which exhausted the building air into the 200-ft high concrete stack, attached to the building. These massive units are located in individual fan cell rooms, accessed from the main fan room.

The fuel storage basin was a water shielded collection, storage, and transfer facility for the fuel elements discharged from the reactor. Typically, the fuel elements were sorted in the pickup chute area, hand-tonged into storage buckets, and transferred by the overhead monorail system to the storage area for decay of short-lived radionuclides. Then the buckets were moved by monorail to the transfer area and placed in railroad cask cars for transport to chemical reprocessing facilities in the 200 Area.

The ventilation upgrades addressed in Alternative A would be sufficient for venting the natural radon contamination throughout the additional tour route areas.

5.4.1 Valve Pit Room

The valve pit area is accessible from the corridor leading to the work area, from the fan room, and from the exterior of the facility.

A grated walkway on the ground level overlooks the perimeter of the valve pit (Photographs 5-13 and 5-14). The recommended access route through the valve pit area is from the corridor entrance to the lunch room, through the lunch room area from north to south, and into the fan room, as shown in Figure 5-8.

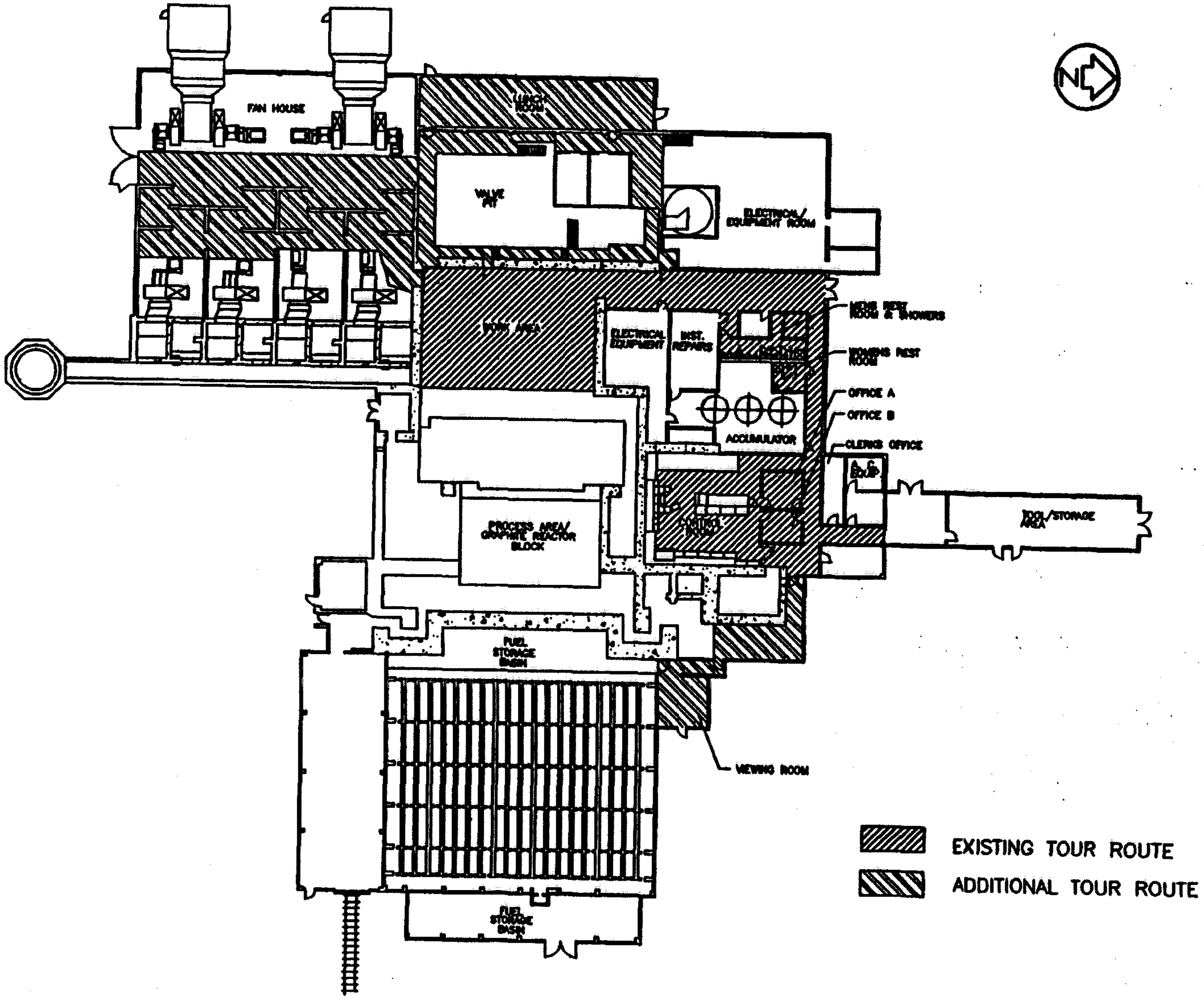
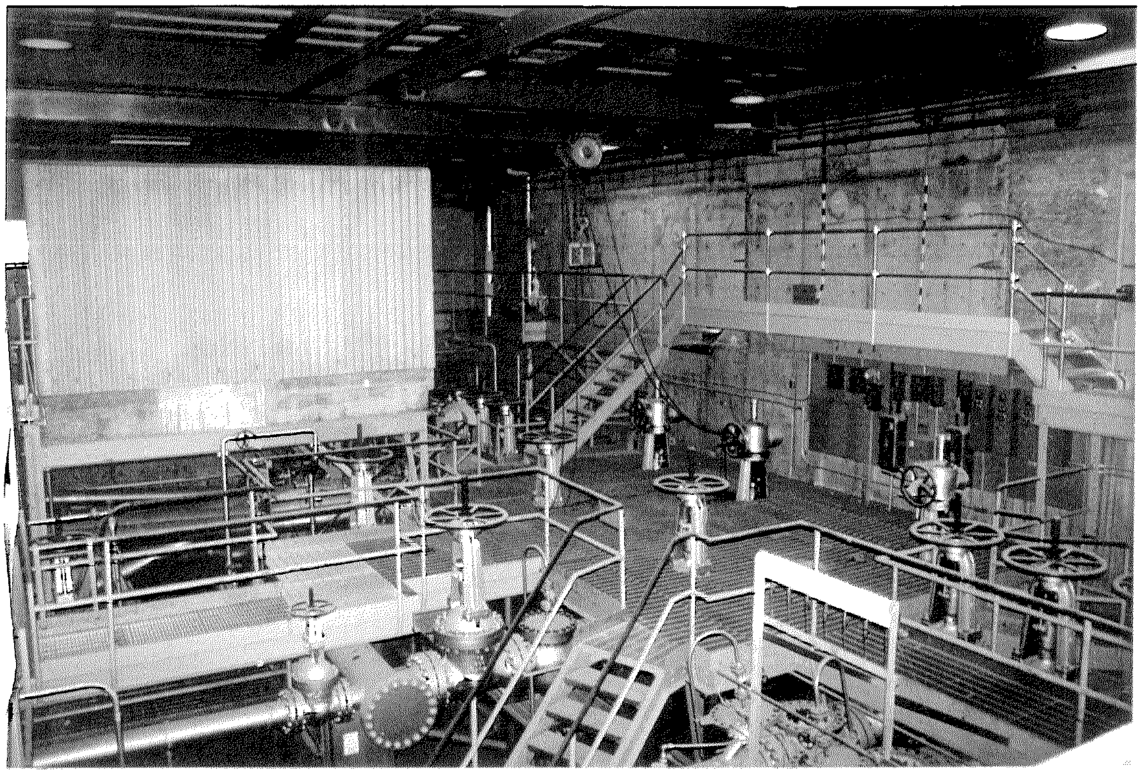
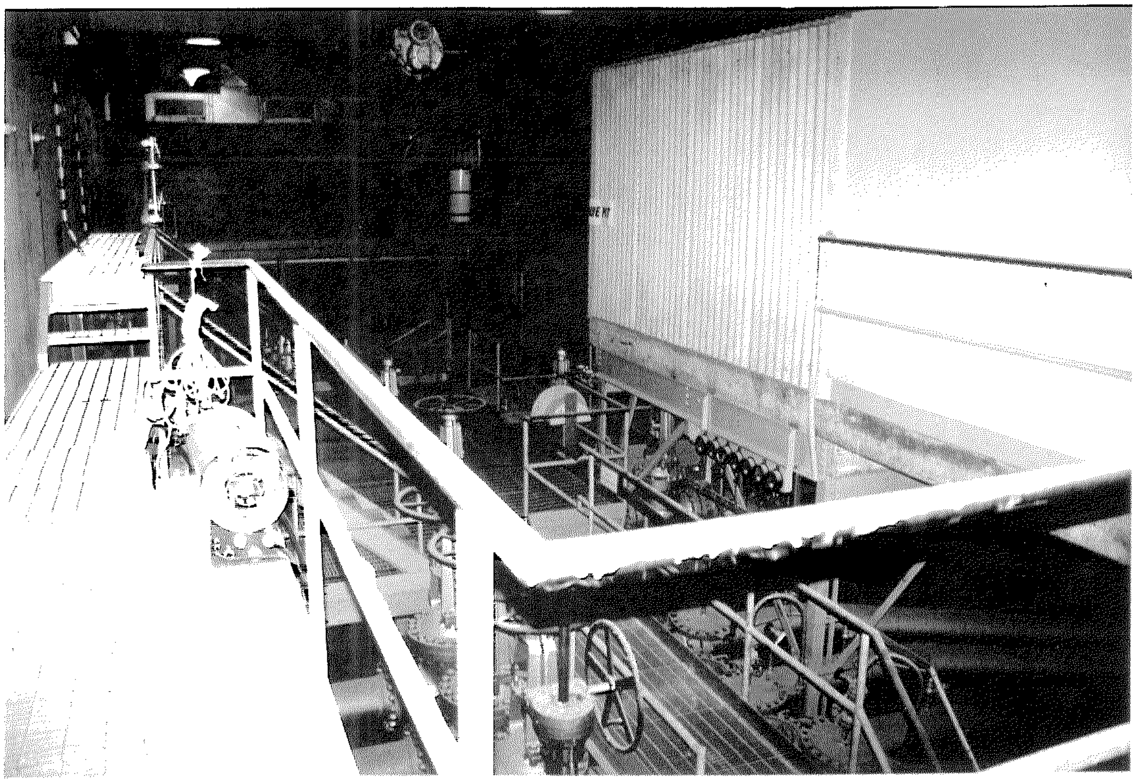


Figure 5-8. Tour Route Additions.

Photograph 5-13. Alternative D--Valve Pit Room.



Photograph 5-14. Alternative D--Valve Pit Room.



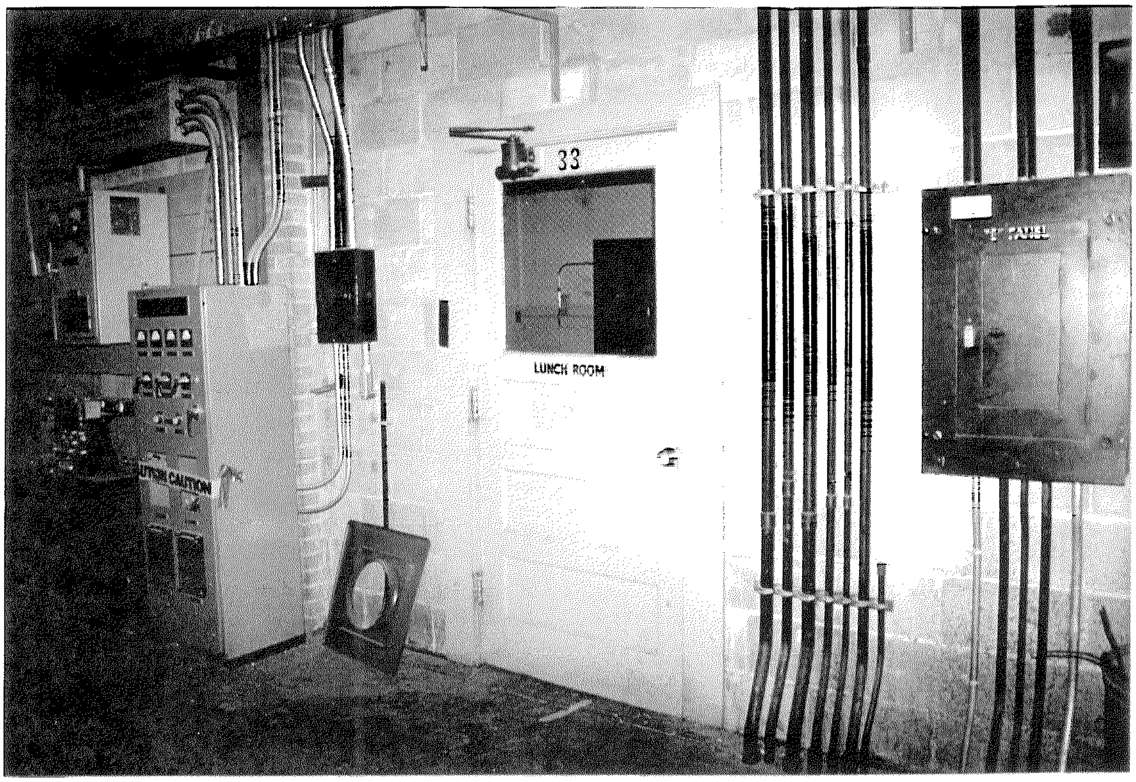
Two options are available for access compliance, the current grating has a 1-inch opening between grates, this grating could be replaced with 1/2-inch opening in the access path between the corridor entrance door and the north lunch room entrance and between the south lunch room entrance and the fan room. Another option is to lay and secure 1/4-inch wooden plywood planks in the same path identified. Using the similar grating would retain the historic aesthetic value.

Barriers and signs would be necessary to restrict access along the total perimeter of the valve pit. These signs should be posted at the locations of stairs leading to the lower level valve pit.

Lighting in this area was recently modified. Two-thirds of the existing ceiling lights in the room are currently on line. Modification of the remaining light fixtures should be evaluated in Phase II.

The lunch room area (Photograph 5-15) could serve as an additional display and video presentation area. Upgrades in this area include general housecleaning and removal or replacement of existing appliances (i.e., sink, stove, etc.), possible addition of a portable air conditioning unit, and access restriction to a lower level stairway. An exterior door is located in this area.

Photograph 5-15. Alternative D--Valve Pit Room/Lunch Room.



5.4.2 Fan Room

The fan room, located on the ground level, south of the valve pit is another potential area which could enhance the existing museum tour (Photograph 5-16). Access to this area includes the entrance from the valve pit area, access from the work area, and an exterior wall door.

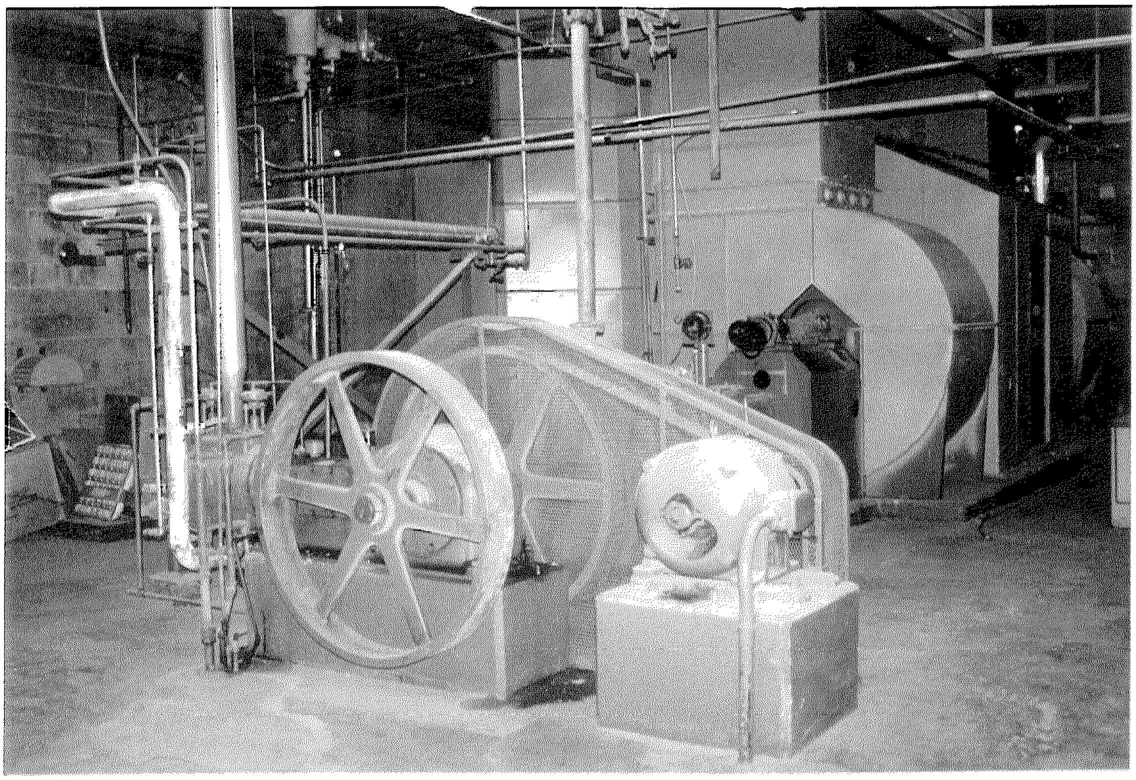
This area contains some tools and equipment which should be removed from the area and stored elsewhere. Those items or tools that were of the reactor operations heritage could be kept as part of the display. General housekeeping in this area would be necessary.

Barriers and controls would have to be erected for limiting access to areas and demonstrating the flow of foot traffic in that portion of the route. Barriers would also be necessary for restricting access in contaminated portions of the fan cell rooms.

Lighting in these areas is sufficient.

Disability access is not limited throughout the fan room.

Photograph 5-16. Alternative D--Fan Room.



5.4.3 Fuel Storage Basin

The fuel storage basin can be viewed from an adjacent room north of the basin (Photograph 5-17). This room can be accessed from the interior and the exterior of the facility. Access from the interior corridors of the facility meets the requirements for disability access, including the door and a ramp approaching the room. One wood wall partition (west wall) of the viewing room is not an original wall of the facility and could be removed to provide easier access to this room.

There are three sliding pane windows on the south wall of the room which can be opened to the fuel storage basin. These windows must be secured from allowing access.

Lighting in the viewing room is sufficient. The lighting above the basin can be improved simply by replacing the bulbs in the fixtures.

The electrical control panel for the lights is located in the viewing room and must be covered with a 1/4-inch plastic sheet screen to isolate the electrical equipment from the public. Photograph 5-18 shows the location of this panel on the north wall. The survey sign on the door is posted due to the current natural radon contamination which will be upgraded in Alternative A.

Photograph 5-17. Alternative D--Fuel Storage Basin Viewing Room.

Photograph 5-18. Alternative D--Viewing Room Electrical Panel.

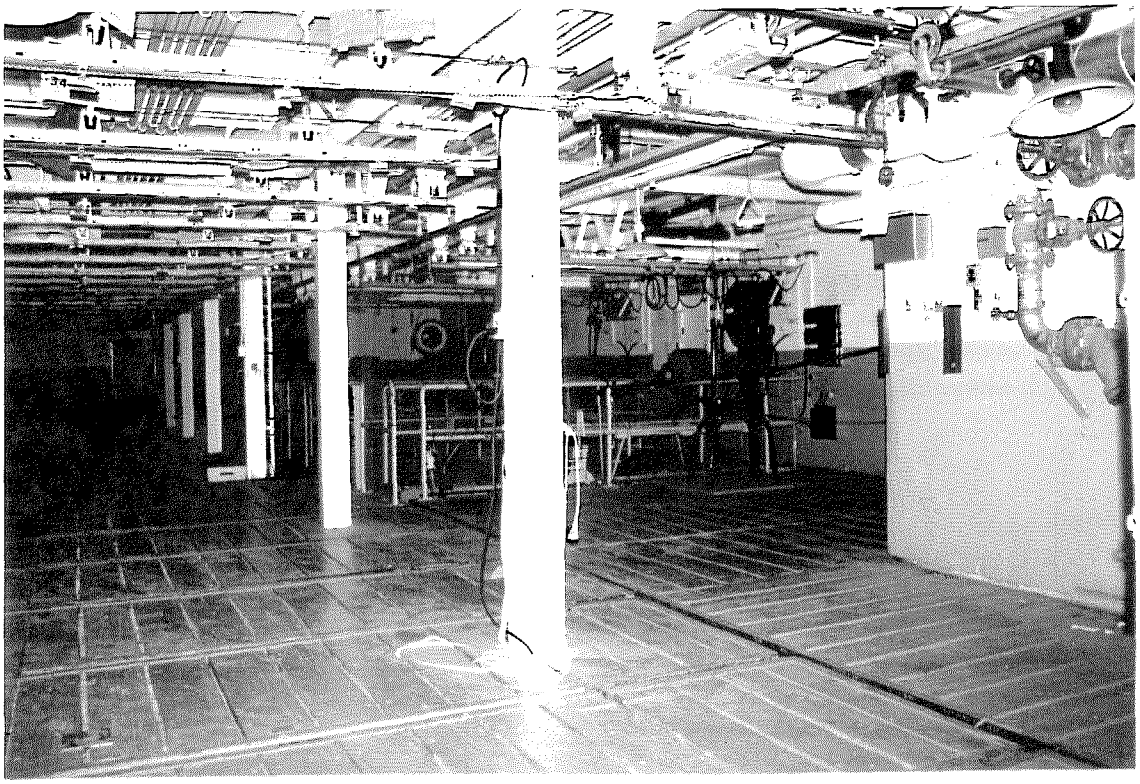
The fuel storage basin is currently covered with wooden planks (Photographs 5-19 and 5-20) which were used as a floor for the workers above. To improve the display, portions of the planks could be removed to show the basin. The overhead monorail system could be placed at this location with a bucket mounted to demonstrate the handling of the fuel, as described in Appendix B.

5.5 ALTERNATIVE E - PUBLIC ACCESS WITH ENHANCED DISPLAYS, ADDITIONAL TOURS, AND RIVER ACCESS/CULTURAL CENTER

The emphasis of this alternative focuses on providing interpretation of resources that were not part of the Hanford or B Reactor project. However, these resources are indirectly related in that each interpret impacts of sensitive issues related to the environmental and pre-Hanford conditions of the area. The improvements identified in this alternative also provide community service benefits through increased recreation opportunity and interpretation of important natural and cultural resources. This alternative is cumulative in that it includes the improvements identified in Alternatives A through D.

Photograph 5-19. Alternative D--Fuel Storage Basin.

Photograph 5-20. Alternative D--Fuel Storage Basin.



Improvements identified in this alternative do not require implementation on a specific schedule. Most are independent and could be accomplished over an extended period of time to improve the interpretation of this significant structure.

The improvements discussed in this alternative are located along the new access Route 6 (from Highway 240) and the Columbia River. The potential improvements listed below are independent, in that one or several could be pursued and may be implemented in a time-phased manner.

Initially (and as a minimum) the land along the new access road from Highway 240 could be designated as some type of open space providing recreation opportunities or interpretive enrichment programs (Photograph 5-21). Zoning this land early on as addressed in Alternative B, Section 5.2, could prove to be beneficial for future land use activities at the site. One or several of the following options could then be located on these lands.

Any actions described in this alternative would only be undertaken in concert with the Washington SHPO, and in accordance with the NHPA Section 106/110 compliance process.

Photograph 5-21. Alternative E--River Access.

5.5.1 Day Use Park

Under this option facilities would be provided to accommodate picnicking, playground, nature/interpretive trails, river access boat ramp, fishing, and related day use type facilities. Facilities could be provided to interpret the geologic, natural or cultural resources of the site.

5.5.2 Park/Camping Facilities

Overnight camping accommodations could be provided on the river side of the access road. These accommodations could include prepared tent-only camping sites, group camping sites, and recreational vehicle camp sites. Support facilities, such as restrooms with showers would be typical for whichever type camping was developed. Recreation available for campers would include river access/boating, fishing, canoeing, picnicking, playground, nature, interpretive trails, archery, and similar activities.

5.5.3 Resource Interpretive Facility

If public access to the 105-B Reactor Facility is provided along Route 6 from Highway 240, interpretive facilities could be developed between the road and the Columbia River that would be convenient and accessible to the many visitors to the museum. Possible interpretive themes could include geologic resources, the river (free flowing section), Native American Indian culture, pre-Hanford cultural characteristics, or environmental/ecological oriented displays.

The U.S. Fish and Wildlife Service (USFWS) manages the area across the river to the north. With the visitors passing this area on their way to the B Reactor, the USFWS might consider developing a visitors center to interpret the natural resources of the site and the purpose of their refuge along the Columbia River.

The old Bruggeman fruit warehouse, part of the Bruggeman farmstead and shown in Photograph 5-22, is located north of Route 6 and could be an additional historical access area. The historical significance of the pre-Hanford existence of this facility would provide a fascinating attraction. Renovation of this facility or providing limited access should be developed further in Phase II.

5.6 ALTERNATIVE F - DISMANTLING

Alternative F consists of decontamination and decommissioning (D&D) and dismantling of the 105-B Reactor Facility and compliance with the NHPA requirements.

Photograph 5-22. Alternative E--River Access/Old Homestead.

An EIS was performed in accordance with the National Environmental Policy Act (NEPA) on the potential impacts of decommissioning the surplus reactors at the Hanford Site. This study included the B, C, D, DR, F, H, KE, and KW Reactors. The results of this study were documented in the *Final Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington* (DOE 1992) which was the basis for a ROD (DOE 1993) published in the Federal Register on September 16, 1993.

The preferred alternative was based on total costs and principal environmental impacts, including short-term occupational radiation doses and long-term public radiation doses. The results of the study recognized the B Reactor as an historic site and states "Actions to preserve this historic resource may include extensive recordation by photographs, drawings, models, exhibits, and written histories, and may also include preservation of some portions of the B Reactor for display on or near its present location or at some other selected location."

5.6.1 Decontamination, Decommissioning, and Dismantling

The preferred decommissioning alternative was safe storage followed by deferred one-piece removal. With this option, each of the reactors would be placed in safe storage and routine maintenance, surveillance, and radiological monitoring activities would continue. A safe storage duration of 75 years is identified in the ROD. This schedule was not identified in the recent *Hanford Federal Facility Agreement and Consent Order* (Ecology, et al. 1989) modifications, as this D&D milestone will be addressed at a later time. After this period, the reactor block would be transported intact to the 200 West Area for disposal.

During preparation for safe storage, building structural repairs would be performed as necessary to ensure containment of radioactive materials. Building security, radiation monitoring, and fire-detection systems would be upgraded to provide safety and security controls and regulated surveillance during safe storage. These upgrades are paralleled to those upgrades necessary for Alternative A under this section.

During safe storage, surveillance, site and facility inspections, radiological and environmental surveys, and site and facility maintenance would be carried out. Major building maintenance would be performed at estimated 5-year and 20-year intervals.

At the end of the safe storage period, the reactor block would be removed and transported as a single piece by tractor-transporter to the 200 West Area. This process is estimated to take approximately 2.5 years for each reactor.

Contaminated materials and equipment would be removed and disposed in the 200 West Area. Uncontaminated portions would be removed (for access for the tractor-transporter) and placed in a landfill.

The Final EIS addresses the estimated dose rates which would result from this option. The dose rates were reported for the option of decommissioning all of the eight reactors in this fashion. The occupational radiation doses were estimated to be about 51 person-rem. Short-term public radiation doses were estimated to be near zero.

5.6.2 National Historic Preservation Act

Section 4.3 of this report identifies the requirements of the Section 106 and 110 processes of the NHPA.

Under this process, the DOE would be required to notify the SHPO of any proposed action on the site. The SHPO will judge whether this action has adverse effect and whether mitigation measures are required. During prior discussions with the SHPO, it was assumed that the option of decommissioning the 105-B Reactor Facility would be considered an adverse effect.

The DOE would be required to submit a MOA identifying the mitigation measures to be taken to the SHPO and the Federal Advisory Council on Historic Preservation for approval. After which time, it is submitted along with supporting information and photographs to the NPS to determine the level of documentation necessary for the action under the HABS/HAER portion of the Section 110 process.

The amount of required documentation will be determined during the HABS/HAER process by the NPS. Generally this includes the following documentation:

Photographs

- Interior and exterior architectural photographs
- Historical photographs
- Close-up photographs of significant equipment/structures

Drawings

- Photograph reproductions of all drawings associated with the building
- Model of the building

Documentation

- Detailed description of the building
- Detailed description of controls and instrumentation
- Detailed description of significant equipment/structures
- Documentation of history of the building

Also as a requirement under the NHPA, portions of the B Reactor may be removed and relocated in order to preserve a part of this historic site.

6.0 COMPARATIVE ANALYSIS

6.1 CRITERIA FOR EVALUATING ALTERNATIVES

The six alternatives discussed in Section 5.0 were evaluated based on two overall criteria, cost and benefit. These criteria were developed during Phase I technical working sessions (PNL and Parsons 1994a). The process used during the brainstorming technical working sessions was similar to the Delphi Process for analyzing alternatives. This process was used as a prototype for the proposed facilitated feasibility study workshop for stakeholders discussed in Section 2.0.

6.1.1 Cost

One of the criteria for evaluating alternatives in Phase I of this feasibility study is the relative cost of each alternative. This cost is based on preliminary information and is used as a level of magnitude estimate for comparison. The alternatives are ranked using a relative range of low to high.

6.1.2 Benefit

Twelve potential benefits of reutilizing or dismantling the 105-B Reactor Facility were developed, evaluated, and ranked during the Phase I technical working sessions. These benefits were ranked in order of importance using two systems, a forced ranking system and a direct comparison ranking system.

During the working sessions, the benefits were defined and ranked in the following order of importance as recommended by the initial Delphi analysis. Individual ranking scores from the direct comparison ranking system are shown in parentheses (the higher the number, the higher the rank). During the Phase II facilitated workshop with stakeholders, a system of weighing the benefits based on ranking could be implemented to provide a more refined approach.

1. Historical (40)

    - Preserve past technological achievement and provide a basis for future technological growth
    - Irreplaceable historical landmark, preserves nation's history
    - Provide long-term site history, including the standing old homestead, towns of Hanford and White Bluffs, cultural resources
    - Part of the history and development of Tri-Cities
    - History of DOE, Hanford Site, and B Reactor
    - History of site security and secretiveness

2. Education (35)

- Education of past, present, and future nuclear technology
- Provide history of first production reactor
- Educate on Hanford Site role (from past to present - World War II to Cold War)
- Show the entire process from nuclear weapons production to environmental remediation (full circle process)
- Observe ongoing D&D

3. Engineering (34)

- Historical engineering significance
- Streamlined construction engineering schedule
- Success and durability logistics
- Recognition of and by Engineering Societies
- Material innovation

4. DOE/Hanford Image (31)

- Explain DOE history/role
- Beneficial to DOE image
- End secretiveness
- Show completed projects at Hanford, demonstrates a successful long term, quality, nuclear project

5. Nuclear Support (25)

- Increase public confidence in nuclear safety
- Explain and encourage nuclear technology
- Show advancement of nuclear technology in 50 years
- Demonstrate control panel, containment story
- Benefits nuclear industry
- Show high quality of work

6. Tourism/Economic (25)

- Promote different aspects of tourism in area
- Tourism provides general economic growth
- Enhance public awareness through tourism
- Promote positive nuclear industry image
- Support region economy diversification
- Show self-supporting site

7. Public Relations (23)

   - Allow controlled access to the public to Hanford Site
   - Explain past and present DOE role
   - End secretiveness
   - Enhance stakeholder cooperation
   - International significance

8. Site Budget (19)

   - Build public support of DOE expanded mission
   - Provide understanding of site budget
   - Show DOE investment in education

9. Environmental (14)

   - Shows cleanup and reutilization is feasible
   - Showcase for environmental technology
   - Indian Cultural Resource Center
   - Promote public awareness of area environment
     - highlight groundwater and ecological monitoring
     - Arid Lands Ecology (ALE)
   - Demonstrate D&D

10. Scientific (11)

    - History of science
    - Stimulate public interest in science
    - Educate public in decontamination capabilities

11. Aesthetics (6)

    - ALE
    - Majestic size of reactor block
    - Promote positive emotional impact
    - Possible Wild and Scenic River designation
    - Show high quality craftsmanship for time period

12. Recreational (1)

    - Public access to free-flowing stretch of Columbia River
    - Old homestead
    - Picnics, boating, nature walks, bike path to Vernita Bridge
    - Native American Cultural Center

6.2 COMPARATIVE ANALYSIS MATRIX

Each of the six alternatives described in Section 5.0 was ranked against the cost/benefit criteria defined above. A comparative analysis matrix was developed during the technical working sessions, to provide a means of comparing the six alternatives (Table 6-1).

6.2.1 Criteria Ranking

The relative cost was initially assigned to each alternative as an incremental cost of 1 to 5, with a low cost of 1 and a high cost of 5. The benefits were assigned using an opposite range with 5 as a low benefit and 1 as a high benefit and were ranked in order of importance. A low total of cost plus benefit (minimum possible of 24, maximum of 120) is designed to identify the optimum situation; relatively low costs and high benefits.

The alternative comparison matrix was developed initially during the technical working sessions, as the alternatives were defined. The cost in this matrix was based on a relative cost between alternatives. Since that time, site visits and interaction with the facility personnel have aided in further defining and refining the alternatives and their associated costs. The cost estimates in Appendix E were developed based on the additional information. The initial cost ranking system was then reevaluated and was reassigned a range of 1 to 4, with 4 providing an undefined, relatively large cost.

6.2.2 Results

The results of the activity, Table 6-1, proved to be a useful tool for evaluation of alternatives by cost and benefit. Figures 6-1 and 6-2 provide a visual representation of this data.

Alternative C, Public Access With Enhanced Displays, had the lowest total value of 48.5. This alternative included upgrades of the existing displays and the addition of a presentation room. Under this alternative, the public can access the museum using an upgraded Route 6. This proved to have the highest benefit with a relatively low cost.

Alternatives A, B, and D provided results that were very close to each other. The incremental costs associated with implementing Alternative D, Public Access With Enhanced Displays and Additional Tours, are judged to be small comparatively. The addition of the fuel storage basin, valve pit and lunch room, and fan room would provide an increased educational and scientific benefit.

Table 6-1. 105-B Reactor Facility Alternatives Comparative Cost/Benefit Analysis Matrix.

COST/BENEFIT	RANK[b]	ALTERNATIVES											
		Alternative A		Alternative B		Alternative C		Alternative D		Alternative E		Alternative F	
		Cost[a]	Ben.[a]	Cost[a]	Ben.[a]	Cost[a]	Ben.[a]	Cost[a]	Ben.[a]	Cost[a]	Ben.[a]	Cost[a]	Ben.[a]
Education	2	1	3	1.5	2.5	2	1.5	3	1.5	4	1	4	5
Scientific	10	1	4	1.5	4	2	2	3	2	4	2	4	5
Tourism/Economic	6	1	3	1.5	2	2	1.5	3	1.5	4	1	4	5
Public Relations	7	1	4	1.5	2.5	2	1.5	3	1.5	4	1	4	5
DOE/Hanford Image	4	1	4	1.5	3	2	2	3	2	4	1	4	5
Nuclear Support	5	1	4	1.5	3	2	2	3	2	4	2	4	5
Site Budget	8	1	5	1.5	4	2	2	3	2	4	2	4	5
Historical	1	1	3	1.5	3	2	1.5	3	1.5	4	1	4	5
Environmental	9	1	4	1.5	3.5	2	2	3	2	4	1	4	5
Aesthetics	11	1	3.5	1.5	3	2	3	3	2.5	4	2	4	5
Engineering	3	1	4	1.5	4	2	2	3	1.5	4	1.5	4	5
Recreational	12	1	5	1.5	4.5	2	3.5	3	3.5	4	1	4	5
Individual Totals		12	46.5	18	39	24	24.5	36	23.5	48	16.5	48	60
TOTALS		58.5		57.0		48.5		59.5		64.5		108.0	

[a] Increment Cost - LO (12345) HI
Benefits - HI (12345) LO

[b] Rank extracted from Section 6.1.2

Figure 6-1. B Reactor Museum Feasible Alternatives: Cost and Benefits.

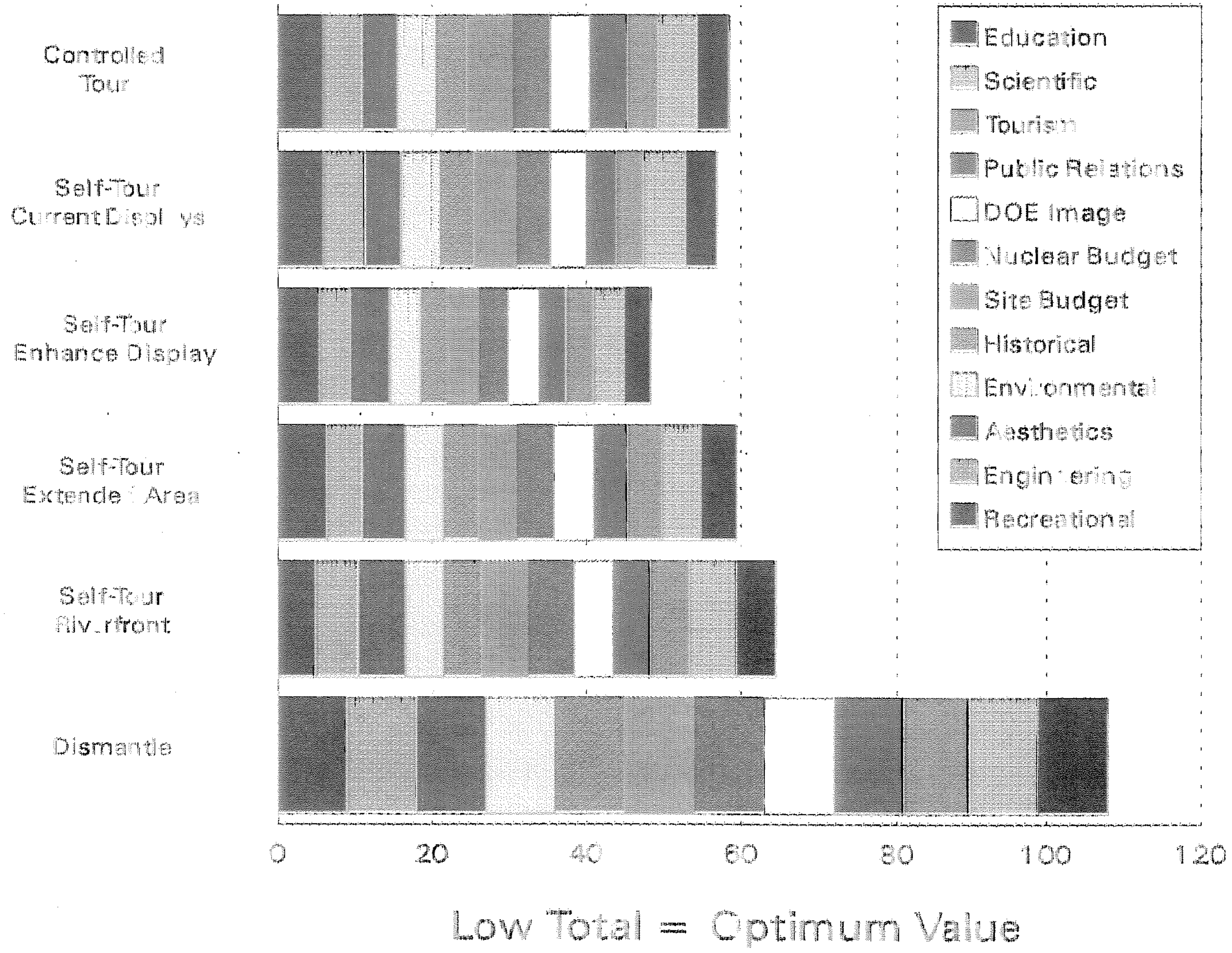
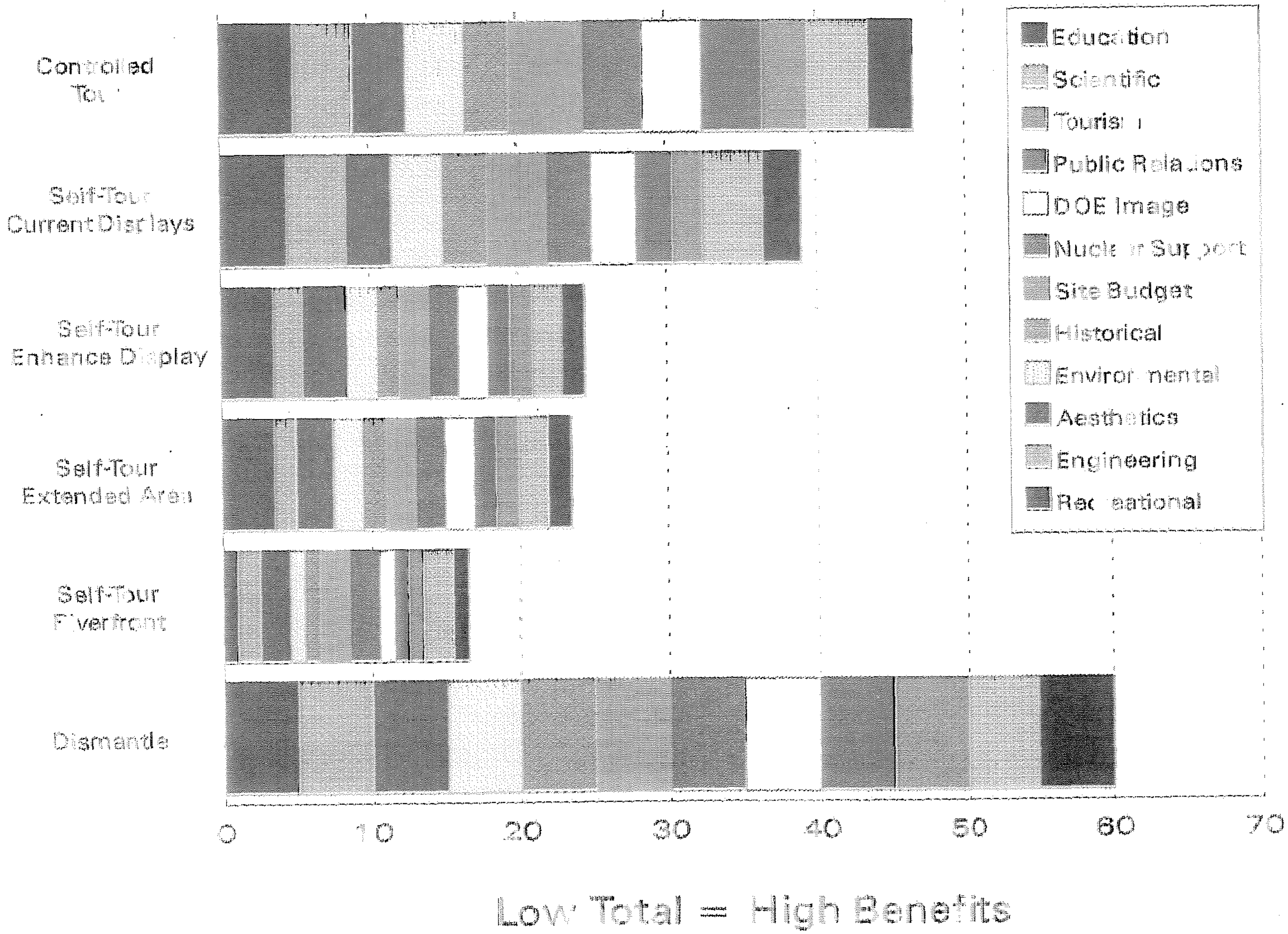


Figure 6-2. B Reactor Museum Feasible Alternatives: Benefits.



The high cost and low benefit associated with Alternative F are immediately evident from the high total score of 108. This option would entail tearing down the existing facility and necessary documentation for compliance with the NHPA. Refined cost data are expected to lend further weight to this argument.

7.0 REFERENCES

16 USC 470, "National Historic Preservation Act," *United States Code*, U.S. Department of the Interior, Washington, D.C.

29 CFR 1900, "Occupational Safety and Health Act," *Code of Federal Regulations*, as amended.

36 CFR 800, "Protection of Historic an Cultural Properties," *Code of Federal Regulations*, as amended.

AASHTO, 1990, *A Policy on Geometric Design of Highways and Streets*, American Association of State Highway and Transportation Officials, Washington, D.C.

ACHP, 1986, "A Five-Minute Look at Section 106 Process," Fact Sheet, Advisory Council on Historic Preservation, Washington, D.C.

ACSE, 1993, *Hanford B Reactor Nomination for Designation as National Historic Civil Engineering Landmark*, Columbia Section, American Society of Civil Engineers, Washington, D.C.

ATBCB, n.d., *American with Disabilities Act Accessibility Guidelines*, Architectural and Transportation Barriers Compliance Board, Washington, D.C.

BHI, 1995, "Emergency Lights Inspection for 100 Areas Inactive Facilities and Maintenance Facilities," D-03-001, BHI-FS-02, *Field Support Work Procedures*, Bechtel Hanford, Inc., Richland, Washington.

Briggs, W., 1994a, "A Landmark in History," *Tri-City Herald*, September 11, 1994, page C1, column 1, Tri-Cities, Washington.

Briggs, W., 1994b, "B Reactor Key to Helping U.S. Beat Nazis in Race to Make Nuclear Bomb," *Tri-City Herald*, September 11, 1994, pg C1, column 2-5, pg C4, column 1-4, Tri-Cities, Washington.

Brown, R. L., 1992, *Cost Benefit Analysis--ALARA*, WHC-SD-SQA-CSD-20003, Westinghouse Hanford Company, Richland, Washington.

Carpenter, R. W., 1994, *100-B Area Technical Baseline Report*, WHC-SD-EN-TI-220, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Coles, G. A., Shultz, M. V., and Taylor, W. E., 1993, *Risk Management Study for the Retired Hanford Site Facilities, Qualitative Risk Evaluation for the Retired Hanford Site Facilities*, WHC-EP-0619, Volumes 1 - 4, Westinghouse Hanford Company, Richland, Washington.

Cushing, C. E., 1992, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415, Rev. 5, Pacific Northwest Laboratory, Richland, Washington.

DOE, 1985, "Contractor Industrial Hygiene Program," DOE Order 5480.10, U.S. Department of Energy, Washington, D.C.

DOE, 1987, "Project Management System," DOE Order 4700.1, U.S. Department of Energy, Washington, D.C.

DOE, 1988, "Radiation Protection for Occupational Workers," DOE Order 5480.11, U.S. Department of Energy, Washington, D.C.

DOE, 1989a, "General Design Criteria," DOE Order 6430.1A, U.S. Department of Energy, Washington, D.C.

DOE, 1989b, *Draft Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*, DOE/EIS-0119-D, U.S. Department of Energy, Washington, D.C.

DOE, 1992, *Final Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*, DOE/EIS-0119-F, U.S. Department of Energy, Washington, D.C.

DOE, 1993a, *Record of Decision; Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*, Federal Register, Volume 58, Number 178, U.S. Department of Energy, Washington, D.C.

DOE, 1993b, "Fire Protection," DOE Order 5480.7A, U.S. Department of Energy, Washington, D.C.

DOE, 1994, "Environmental Protection, Safety and Health Information Reporting Requirements," DOE Order 5484.1, U.S. Department of Energy, Washington, D.C.

Duckett, A. J., 1989, *History of 100-B Area*, WHC-EP-0273, Westinghouse Hanford Company, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Evans, C. B., 1994, *Integration of Fire Hazards Analysis and Safety Analysis Report Requirements*, WHC-SD-GN-FHA-30001, Westinghouse Hanford Company, Richland, Washington.

Evans, R. A., 1994, *Radiological Design Guide*, WHC-SD-GN-DGS-30011, Westinghouse Hanford Company, Richland, Washington.

HSRCM, 1994, *Hanford Site Radiological Control Manual*, HSRCM-1, Rev. 2, prepared for the U.S. Department of Energy by the Hanford Site Contractors, Richland, Washington.

ICBO, 1994a, "Minimum Basic Wind Speeds and Seismic Zone Map," Figures 16.1 and 16.2, Uniform Building Code, International Conference of Building Officials, Whittier, California.

ICBO, 1994b, "Historic Buildings," Section 3403.5, Uniform Building Code, International Conference of Building Officials, Whittier, California.

ITE, 1992, *Traffic Engineering Handbook*, Institute of Transportation Engineers, Washington, D.C.

KEH, 1991a, Hanford Plant Standards, HPSACM, U.S. Department of Energy, Kaiser Engineers Hanford, Richland, Washington.

KEH, 1991b, *Structural Inspection of Hanford's 100 Area Facilities, Rev. 0*, ER1738-INSPECTION, Kaiser Engineers Hanford Company, Richland, Washington.

Mihalic, M. A., 1994, WHC, Letter to J. L. Bryant, PNL, 9453445, May 13, 1994, Richland, Washington.

Miller, R. L. and Steffes, J. M., 1987, *Radionuclide Inventory and Source Terms for the Surplus Production Reactors at Hanford*, UNI-3714, Rev. 1, UNC Nuclear Industries, Richland, Washington.

OAHP, 1991, National Register of Historic Places Registration Form, Hanford B Reactor, Office of Archaeology and Historic Preservation, Washington, D.C.

PNL and Parsons, 1994a, Alternative Brainstorming Session Meeting Minutes, August 9, 1994, between Pacific Northwest Laboratory and Parsons Environmental Services, Richland, Washington.

PNL and Parsons, 1994b, *Draft Project Definition Report*, Rev. 1, Pacific Northwest Laboratory and Parsons Environmental Services, Inc., Richland, Washington.

TCH, 1994, "Contractors Consider Columbia Point for Cultural Center Site," *Tri-City Herald*, August 19, 1994, page A3, column 1-2, Tri-Cities, Washington.

USDI, 1992, *The Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines for Rehabilitating Historic Buildings*, Preservation Assistance Division of the National Park Service, U.S. Department of the Interior, Washington, D.C.

Wahlen, R. K., 1991, *History of 100-B Area, 105 Building Construction Details*, WHC-EP-0273, Addendum 1, Westinghouse Hanford Company, Richland, Washington.

West, D., 1994, WHC, cc:Mail message to P. W. Griffin, WHC, June 1, 1994, Richland, Washington.

WHC, 1988a, *ALARA Program Manual*, WHC-CM-4-11, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988b, *Industrial Safety Manual*, WHC-CM-4-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988c, *Management Requirements and Procedures*, WHC-CM-1-3, Westinghouse Hanford Company, Richland, Washington
MRP 5.7, "Industrial Safety and Fire Protection"
MRP 5.37, "ALARA Program"
MRP 5.38, "Radiation Protection."

WHC, 1994a, "105-B Damaged Roof Panel Repair," Engineering Change Notice 600275, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, "105-DR Damaged Roof Replacement," Engineering Change Notice 600276, Westinghouse Hanford Company, Richland, Washington.

8.0 CONTACTS AND RESOURCES

LOCAL ENTITIES

1. Hanford Museums of Science and History, Richland, Washington
   Gwen Leth
   Phone: 509/376-5252 or 509/376-6374

2. Tri-Cities Visitors and Convention Bureau, Kennewick, Washington
   Chris Kelly Watkins, Executive Director
   Phone: 509/735-8486

3. B Reactor Museum Association, Richland, Washington

Don Sandberg	Fran Berting	Del Ballard
Phone: 509/376-0030	509/967-3924	509/946-6401

4. Tri-City Industrial Development Council, Kennewick, Washington
   Phone: 509/735-1000

5. Chamber of Commerce, Richland, Washington
   Phone: 509/946-1651

6. Kaiser Files, Tri-City Professional Building, Richland, Washington

Library (Jan)	Drawing Files (Dave)
Phone: 509/376-6941	509/376-6434

7. DOE Reading Room, Washington State University, Tri-Cities Campus
   Phone: 509/376-8583

8. PNL Technical Library, Richland, Washington
   Phone: 509/376-1606 or 5451

9. Richland Public Library, Richland, Washington
   Phone: 509/943-7454

10. 300 Area Photo Laboratory, Hanford Site
    Phone: 509/376-3836

11. Washington State University, Tri-Cities Campus
    Phone: 509/375-9200

12. FFTF Visitors Center, 400 Area, Hanford Site
    Now closed.

13. Washington Public Power Supply System Visitors Center, WPPSS Site
    Phone: 509/373-4558

OTHER ENTITIES

14. Federal Advisory Council on Historic Preservation, Washington, D.C.
    Phone: 202/606-8503

15. State Historic Preservation Office, Olympia, Washington

David Hansen, Dept. Director	Greg Griffith
Phone: 206/753-4117 or 5010	206/753-9116

16. American Society of Museums/Museum Hotline, Washington, D.C.
    Phone: 202/289-1818

17. Massachusetts Institute of Technology (MIT)
    Cathy Jones/Garmil (Programs Officer)
    Phone: 617/253-2613

18. National Park Service, Preservation Assistance Division, Washington, D.C.
    Phone: 202/343-9573

19. Smithsonian/Society of Museums, Washington, D.C.
    Robert
    Phone: 202/786-2271

20. National Parks Service, HABS-HAER Program, San Francisco, California
    David Mahl
    Phone: 415/744-3988

21. Raytheon - Savannah River Museum/Visitors Center
    Ray Silks
    Phone: 706/821-3114

22. Oak Ridge Graphite Reactor Museum
    Marilyn McLaughlin
    Phone: 615/574-4163

23. Idaho National Engineering Lab EBR-1 Museum
    Harlan Summers
    Phone: 208/526-1299

PERSONNEL

24. Michelle Gerber, Site Historian at the Hanford Site
    Phone: 509/376-1475

25. Ralph Wahlen, Hanford Retiree, Author of 105-B Reactor History, living near Portland, Oregon.
    Phone: 503/649-3768 or 503/293/6165.

26. Mary Goldie, DOE Tour Coordinator
    Phone: 509/376-5605

27. Denise Conner, Westinghouse Tour Coordinator
    Phone: 509/376-5605

28. Dick Winnship, B Reactor Tour Conductor
    Phone: 509/376-5768

29. Dennis DeFord, Hanford Historian
    Phone: 509/376-3841

30. Jim Hodgson, 105-B Reactor Facility Manager, Bechtel Hanford, Inc.
    Phone: 509/373-4522

31. David Hanson, State Historic Preservation Officer, Office of Archaeology and Historic Preservation, State of Washington
    Phone: 206/753-4117

32. Paul Lusignan, Northwestern US Regional Reviewer, Advisory Council on Historic Preservation, Washington, DC
    Phone: 206/343-1628

33. Myron J. (Jay) Haney, Former Manager of Hanford Science Center (Worked with Smithsonian, "D" Reactor Control Panel)
    Phone: 509/376-3719

34. John Baxter, Westinghouse Hanford Co. (WHC Central Engineering)
    Phone: 509/376-3350

35. Robert Egge, Bechtel Hanford, Inc.
    Phone: 509/376-3350

36. Milton Shultz, Westinghouse Hanford Co.
    Phone: 509/376-2215

37. Lyle Wilhelmi, Westinghouse Retiree, BRMA History Artifacts and Exhibits Committee Chairman
Phone: 509/946-4082

38. Jan Larkin, Westinghouse Communications, Representative to WHC Retiree Association
Phone: 509/376-0557

39. Don Lewis, B Reactor Engineer
Phone: 509/376-4994

40. Paul Vinther, Westinghouse Retiree, Past N Reactor Manager
Phone: a 509/376-2457

41. Dr. Stanley Goldberg, Manhattan Project, Historian
Phone: 202/541-6225

42. Dr. Paul Foreman, Smithsonian
Phone: 202/357-2820

43. Charles Pasternak, Helped Facilitate B Reactor on National Register
deceased

44. Floyd Harrow, Battelle, Photo Archive
Phone: 509/376-6374

45. Steve Upson, Boeing BCSR Video Studio
Phone: 509/376-2724

46. Mark Morton, BHI Roof Repairs
Phone: 509/373-5900

47. Paul Brenberger, HPT Manager, B/C Reactors
Phone: 509/373-4439

48. Bob Miller, Cognizant Engineer for Radiological Analysis
Phone: 509/373-4709

49. Dick Ciccone, Road Maintenance
Phone: 509/376-6754

50. Mike Schwenk, Proposed Tri-Cities Cultural Center
Phone: 509/373-1551

51. Wayne Martin, Tri-Cities Campus, Professor of Nuclear Engineering
Phone: 509/375-9335

52. Joanne Holinsteiner, ANS, Hinsdale, Illinois
Phone: 708/579-8254

53. M. Sudo, Parsons Polytech Inc., Tokyo, Japan
Phone: 03/5570-0310

54. John Rector, Retired Hanford engineer and retired owner of Western Sintering Company, Inc.
Phone: 509/375-1569

55. Miles Patrick, Retired Hanford engineer, BRMA Health, Safety & Engineering Committee Chairman
Phone: 509/545-8928

56. Delbert Ballard, Retired Hanford Engineer, BRMA Secretary
Phone: 509/946-6401

57. Roger Rohrbacher, Semi-retired Westinghouse Hanford engineer, BRMA Treasurer
Phone: 509/376-6376 (work)
509/783-0251 (home)

APPENDIX A

Risk Assessment Results

APPENDIX A

RISK ASSESSMENT RESULTS

Building, Reactor Block, Fuel Storage Basin

- Walls above the top of the core may be unreinforced concrete blocks.
- Many confined spaces exist in the building, both above and belowgrade.
- Evidence of oxidation and water accumulation throughout building.
- Large crack in southeast corner of storage basin.
- Load bearing wall severely cracked in basin, storage area.
- Slant cracks in south and west transfer area walls.
- Loose handrail in stairway above accumulator room.
- Broken concrete steps in charge prep area (Maintenance did not confirm).
- Workshop roof handrail degraded in workshop near control room (Maintenance stated this is probably handrail on second floor above control room).
- Projections into ladder space and lack of caging at access ladder off reactor.
- Slant crack over east door and slant, vertical, and horizontal cracks on south wall in fuel transfer area.
- Large vertical crack in southwest corner of south masonry wall of process area and control rod room.
- Fixture mounted at head height on rear stairwell, just out of zone.
- Mortar deterioration in radiation zones.
- Deteriorated doors in lab area on south side of reactor.

Roof

- Adequate to carry projected load, except beams in two areas require additional bracing.
- Panels must be anchored to metal support structure (unknown).
- Supporting steel joists must be anchored to walls (unknown).
- Some badly damaged precast concrete slab panels require modification or replacement.
- Three panels with large holes, two of which are dangerous in corridor to storage basin.
- One broken panel in fan room, leak from panel.
- One roof panel with 2-inch deflection and two cracked panels in process area, rod room (above control room).

Heating, Ventilation, and Air Conditioning

- Radon gas control.
- Inadequate guards in room 8 on heater fans.
- Building lacks ventilation.
- No active heating system in much of building.

Electrical

- Missing insulation, bare energized 480-volt wires.
- Hot circuits with missing bulbs.
- Improper labeling and tagging.
- Lack of preventative maintenance.
- Access problems.
- Temporary cords used for permanent power supply at general front face.
- Unknown condition of cables in front face curtain, could be corroded.
- Enclosure, main switch gear not grounded in main switch gear room, fault to cabinet occurs.
- Breaker not properly tested and maintained in main switch gear room.
- Enclosure not grounded in remote lighting panels, panel D, and south wall of vent room.
- Fault to cabinet occurs above panel E in valve pit room, electrical hookup is using groundpath for neutral return, raceway sections not firmly connected, results in energized condition.
- Switch using groundpath must be on, heat trace not protected in accumulator room mezzanine.
- Receptacles hanging loose, causing insulation abrasion in third fan room, circuits energized.
- Inconsistencies in tagging/labeling at fan room switch gear (480 volt)
- No panel directory in charging room, south side, panel C.
- Light fixtures with missing globes are mounted at same height as hand rails in walkway above ball hoppers.
- Nesting material present in energized electrical hardware at ball hopper mezzanine.
- Inconsistencies in tagging/labeling in balance of plant.
- Temporary cord is routed through walls and doorways subjecting it to abrasion in balance of plant.
- Temporary cord load capacity is not compatible with panel in balance of plant.

Lighting

- Poor illumination in far side stairway.
- Poor illumination in access ladders off reactor.
- Lamp has come loose from fixture at top of reactor in ceiling near stairwell.

Fire Protection

Fire hazard analysis should be performed in accordance with DOE 5480.7A (DOE 1993) (depending upon remodeling, carpeting, electrical, combustibles).

- Eight emergency lights.
- Five fire extinguishers (inspected on a monthly basis).

Industrial Hygiene

- Overall building contains approx 13,500 Ci radionuclides (primarily activation products contained within graphite core), 98.5 tons of lead, and unknown quantity of asbestos.
- Energetic gamma emitters possible in immediate vicinity of basin walls and activated structures (e.g., graphite blocks, thermal shield).
- Radiation areas and items are mislabeled or misposted, some postings are misleading or out of date.
- Asbestos throughout facility, a majority of which is identified and encapsulated.
- Lead in solid form with oxidized surfaces, primarily in radiation zone and transfer area.
- Observed lead oxidation rates in general greater than expected.
- Very small quantities of mercury contained in glass containers in switch on wall of northwest corner of fuel basin.
- Approximately 1,500 counts per minute highest level of smearable contamination in transfer area. Open pipes in lab area on south side of reactor
- Drains are labeled "uncontaminated", but not sealed in sink near accumulator room, unknown discharge point for drain.
- Unknown quantities of oil in vertical safety rod (VSR) drive motors.
- Oil-containing equipment, majority not leaking.
- Seals and gaskets may be deteriorating and may cause leaking.
- Oil in line oiler, industrial chemical in storage basin adjacent to door 37 at storage basin.
- Oil in rod drive system in outer rod and accumulative room.
- Oil in line oiler and steel tank at north end of 50-foot level.
- Oil on floor and drip pans in ball hopper area.
- Oil from fan bearings and regulators in cabinet in fan room.
- In line oiler and manifold in fan cell 8 at fan house.
- Biological hazards including spiders, wasps, bats, rodents, snakes, etc.
- A 5-gallon can of heptane in fan room at south end.
- Unknown aerosol can in fan room at southwest corner.
- Two 5-gallon containers of decontaminator label indicates harmful if inhaled in fan room at southeast corner.
- Two partially full 5-gallon containers of concentrating chlorinating solution at north end of mezzanine outside outer control rod room.

- A 55-gallon container of unknown material hand-labeled as vermiculite (unable to verify) in valve pit.
- Unknown chemical residues (suspected to be decontamination agent) on floor on north end.
- Most areas have small quantities of oil present
- Unknown solid material in two glass containers on X-2 level, could be cobalt chloride.
- Storage basin wash pad bucket elevator contains spray paint and container of bowl cleaner.
- Unknown mixture of blue crystalline material with liquid in waste basket in fan room at north end.

APPENDIX B

Background Information

APPENDIX B

BACKGROUND INFORMATION

B.1 SITE LOCATION

The Hanford Site is a 560 square mile area of land located in Benton, Franklin, and Grant counties in the south-central portion of the state of Washington. The 100-B/C Area is situated in the north-central portion of the Hanford Site along the southern shoreline of the Columbia River, approximately 28 mile northwest of the city of Richland, Washington (Figure 1-2).

The B Reactor is housed in the 105-B Reactor Facility in the 100-B/C Area of the Hanford Site. It is located approximately 0.5 miles south of the Columbia River and 3.5 miles east of State Highway 240 at the Vernita Bridge crossing.

The Hanford Site Plant coordinates for the B Reactor Location are N69050 and W80680.

The 105-B Reactor Facility is surrounded by most of the original plant facilities constructed to support the B Reactor operation as well as the cooling water retention basin systems for the B and C Reactors.

B.2 SITE HISTORY

The world's first controlled, self-sustaining chain reaction was produced in a simple pile of graphite blocks and natural uranium metal assembled by physicists at the University of Chicago in late 1942. It reached a power level of 200 watts.

A prototype graphite reactor plant was later constructed at the Clinton Engineer Works (later referred to as Oak Ridge) in Tennessee. This larger pile first operated on November 4, 1943, and within a few days reached a power level of 500 kilowatts. Improved cooling fans were installed later and it exceeded 1800 kilowatts in June 1944.

The 105-B Reactor, designed by the E. I. du Pont de Nemours Co. under direction of the Manhattan Project, was the first full-scale production reactor ever constructed. The reactor was one of the three original reactors built at the Hanford Site, formerly the Hanford Engineering Works.

Construction of the 105-B Reactor began June 7, 1943, and fifteen months later, on September 26, 1944, the reactor became operational.

The reactor construction included 2004 pressure tube channels, which was considered to be too conservative since the design originally included 1500 tubes. Additional amounts of uranium fuel were used in the extra pressure tubes which permitted the design to overcome xenon poisoning and move quickly to plutonium production.

The first production batch of irradiated fuel was discharged from the reactor on December 25, 1944, and was sent to a separation plant in the 200 Area and processed into plutonium nitrate.

The B Reactor operated from September 26, 1944, to February 12, 1968.

Operating initially at 250 megawatts (thermal) of power, power levels gradually increased over the years until 2,090 megawatts (thermal) was authorized in 1961. Operations continued at approximately that level until deactivation in 1968 (Carpenter 1994).

A more detailed account of the history of the B Reactor and the prototype leading to the design of this reactor can be found in the *History of the 100-B Area* (Duckett 1989) and the National Register of Historic Places Registration Form for the Hanford B Reactor. The *History of 100-B Area, 105 Building Construction Details*, WHC-EP-0273, Addendum 1 (Wahlen 1991) provides a specific description of the materials and quantities used in constructing the 105-B Reactor Facility.

B.3 FACILITY DESCRIPTION

Appendix C provides a catalog of reference drawings for the 105-B Reactor Facility, graphite reactor block, and the fuel storage basin. The B Reactor is housed inside the 105-B Building and is built of reinforced and unreinforced concrete, masonry block, and steel frame. The B Reactor is similar in size and construction materials to the C, D, DR, F, and H Reactors.

The existing tour areas include the work area and the control room. Candidate tour areas identified in this report include the valve pit, fan house, and fuel storage basin.

B.3.1 Existing Tour Route Areas

B.3.1.1 Work Area. The work area is a concrete enclosed area where the reactor was fueled. This area is opposite the front face of the reactor and is where the aluminum clad fuel slugs were loaded into the reactor and from which maintenance operations were performed.

B.3.1.2 Control Room. The main control room is separated from the left face of the reactor block by a 3-ft thick concrete wall. The control room is comprised of instrument panels (mostly hydraulically operated), electrical control systems, and a control panel.

The control room offices are adjacent to the control room separated by glass partitions. West of the control room is the accumulator room which contains an emergency hydraulic power source for shutting down the reactor.

B.3.2 Additional Tour Route Areas

B.3.2.1 Valve Pit. The valve pit area houses the main control valves for the process water used to cool the reactor. It is located adjacent to the work area. The valve pit room consists of a grated main floor level overlooking the underground process water intake lines and control valves. During operation, the water entered these lines at 70,000 gallons per minute.

B.3.2.2 Fan House. The main blowers, heaters, air filters, and exhaust fans used during reactor operations for the entire building heating and ventilation systems are located in the fan house room. Attached to the fan room is a concrete enclosed exhaust duct which exhausted the building air into the 200-ft high reinforced concrete exhaust stack. The building pressure during reactor operations was maintained at approximately 1 inch of water.

B.3.2.3 Fuel Storage Basin. The fuel storage basin was a water shielded collection, storage, and transfer facility for the fuel elements discharged from the reactor. It is separated from the rear face of the reactor by a concrete shield wall approximately 5 feet thick.

Typically, the fuel elements were sorted in the pickup chute area, hand-tonged into storage buckets, and transferred by the overhead monorail system to the storage area for decay of short-lived radionuclides. Then the buckets were moved by monorail to the transfer area and placed in railroad cask cars for transport to chemical reprocessing facilities in 200 Area.

The radionuclides from process tube scale and failed fuel elements were discharged into the basins and sludge accumulated on the floors of the basins. At the B Reactor, after reactor shutdown, the water was removed, the sludge was pumped into transfer area pits, and the walls were washed with high pressure water and coated with an asphalt emulsion.

The fuel storage basin viewing room is adjacent to the basin and overlooks slotted wood flooring panels which are covering the underground basin.

B.3.3 Graphite Reactor Block

The graphite reactor block, identified as the process area, is located near the center of the building and consists of a graphite moderator stack, biological and thermal shields, process tubes, and control and safety system. The physical characteristics of the graphite stack are shown in Table B-1.

The graphite moderator stack consists of 4-in long by 4 3/16 in^2 graphite blocks stacked to provide a central region for fuel loading and an outer region for a neutron reflector. The stack is cored to provide channels for the 2004 process tube openings and openings for the 9 control rods, 29 safety rods, 3 test facilities, and instrumentation equipment.

The radiation shielding was made up of thermal and biological shields. Materials with high hydrogen content were used for neutron absorption and materials with high density for gamma shielding. The thermal shield, which surrounded the graphite moderator stack, was constructed of cast iron with a nominal thickness of 10 inches. The biological shield surrounds the thermal shield and consists of alternating layers of masonite and steel. A steel outer shell with gas-tight seals for the reactor block penetrations surrounds the graphite stack.

The aluminum process tubes contained the uranium fuel elements and provided channels for cooling water flows.

B.3.4 Reactor Safety Systems

Nine water cooled horizontal control rods moved into and out of passages in the graphite core. These rods controlled the startup transients and power level during equilibrium operation. As the graphite stacks became distorted by growth and shrinkage, the control rod channels became distorted.

Twenty-nine vertical safety rods were designed to backup the control rods. Electromagnets held the rods with just the rod tips in the top thermal shield. Only on shutdown, automatic or intentional, were the safety rods dropped into the reactor. The safety rods became activated due to neutron streaming through the safety rod channels into the stack.

The Ball 3X System was an emergency shutdown system to back up the safety rods if they did not terminate the chain reaction. It consists of nickel-plated boron-steel balls that could be released into the vertical safety rod channels from hoppers above the reactor. The system was originally designed to use a liquid boron solution, but was later modified to use the neutron-absorbing balls.

Table B-1. Reactor Stack Physical Characteristics[a]

Parameter	Old Reactors
Dimensions of Stack:	
Side to Side	36 ft (11 m)
Top to Bottom	36 ft (11 m)
Front to Rear	28 ft (8.5 m)
Fuel Charge Length	23.8 ft (7.2 m)
Number of Process Tubes (Fuel Charges)	2004
Lattice Spacing for Process Tubes (Fuel Charges)	8-3/8 x 8-3/8 In.
Volumes:	
Entire Stack	1028 m^3
Active Zone	658 m^3
Reflector	370 m^3
Process Tubes	(24 m^3)[b]
Control and Safety Rods	(4.1 m^3)[b]
Test Facilities	(0.3 m^3)[b]
Density of Graphite	1.7 g/cm^3
Mass of Graphite:	
Active Zone	1.07×10^9 g
Reflector	6.3×10^8 g
Flux Levels (Neutrons/cm^2-s)	
Active Zone	$5 \times 10^{13}/cm^2$-s
Reflector (Center)	$5 \times 10^{12}/cm^2$-s
Reflector (Outer Edge)	$1 \times 10^{12}/cm^2$-s

---

[a] Extracted from UNI-3714 (Miller and Steffes 1987)

[b] Volume of openings not included in entire stack volume calculation.

This system was routinely tested to assure that all the balls in the hoppers would drain down into the channels in the stack. During later years of operation, due to cracks and general shifting of the stack, balls became trapped in the stack and caused loss of reactivity. This was overcome by adding more highly enriched fuel.

B.3.5 Support Systems/Facilities

B.3.5.1 Primary Cooling Water System. Pumping stations at the river pump house building (181 Building) on the Columbia River pumped water to an open concrete reservoir at the 182 Building. The water was then pumped to the 183 Filter Plant Building in which flocculents were added in a mixing chamber and sent to the settling basins (chlorine added for algae control) to remove the solids. Water entered gravity flow filters made of sand, gravel, and coal and flowed to underground concrete chambers, called clearwells and then into a pump room. The water was pumped to above ground steel storage tanks in the 190 Building. Sodium dichromate was added to inhibit corrosion of aluminum tubes and fuel jackets in the reactor. Turbine process pumps pumped water from the storage tanks to risers on the front face of the reactor. The cooling water flowed through the hollow aluminum tube channels surrounding each fuel rod.

B.3.5.2 Secondary Cooling Water System. In the event of total failure of electric power to the Hanford Site, a secondary coolant system was established. The 184-B Power House steam plant would supply power to steam turbines for driving a secondary cooling system. Boilers supplied steam to a distribution system in the 100 B/C Area in overhead lines. Steam-turbine vertical pumps were located at the 181 River Pump House, the 183 Filter Plant Pump House, and the 190 Building Storage Tanks.

B.3.5.3 Effluent System. The discharge outlet cooling-water piping system is located on the rear face of the reactor. Water from the process tubes flowed from the rear connector to the crossheaders, down baffles in the downcomer pipe into a concrete chamber, then the effluent flowed by gravity through a underground pipeline to the 107 Retention Basin.

B.3.5.4 Last Ditch System. The last ditch system was designed to provide adequate cooling water to meet the shutdown requirements indefinitely, using the reactor high tanks and export water system. The tanks had check valves which automatically supplied water whenever the static head pressure in the lines fell below those in the tanks.

B.3.5.5 Electrical Plant. Two separate power supplies were used throughout the building, as a protective system for equipment operation. Protective relaying was coordinated so that a minimum of equipment was affected by fault conditions. Emergency electric power was supplied by steam turbine generators, located in the

184 Building Power House. The emergency electrical power source for the instruments was from a gas powered emergency alternator located outside the 105-B Building.

B.3.5.6 Gas System. A mixture of helium and carbon dioxide was circulated through the reactor (1) to remove moisture and foreign gases; (2) to serve as a heat transfer media between the graphite and process tubes for removal of heat from the graphite; and (3) to detect water leaks within the reactor.

The apparatus for circulating, drying, and filtering the gas was located in the 115 Building. Piping in tunnels connected the 115 Building to the 105 Building. The 110 Building was the gas storage and unloading station.

Water leak detection systems consisted of gas sampling tubes spaced evenly on the discharge face of the reactor.

APPENDIX C

Reference Drawing Catalog

APPENDIX C

REFERENCE DRAWING CATALOG

SHEET NO.	DRAWING NO.	DESCRIPTION	REV	PROJECT
1	H-1-10973	105B Normal Lighting Panel Schedule	1	105B
2	H-1-10973	105B Normal Lighting Panel Schedule	1	105B
1	H-1-10974	105B Emergency Lighting Panel Schedule	1	105B
1	H-1-10975	105B Miscellaneous Lighting Panel Schedule	1	105B
1	H-1-10992	105B Normal Lighting One Line Diagram	1	105B
1	H-1-10993	105B Emergency Lighting One Line Diagram	1	105B
1	H-1-11261	Main Cont'l Cabinet Arr'g & Connection 105B	0	105B
1	H-1-11303	Power Supply Panel Connection Dia. 105B	0	105B
1	H-1-11304	Power Supply Panel Connection Dia. 105B	0	105B
1	H-1-11675	Block Dia. 105B	0	105B
1	H-1-13019	Instr. Electrical Control Desk, 105B	0	105B
1	H-1-13099	Inlet Water Panel Connection Dia. 105B	0	105B
1	H-1-13164	Main Annunciator Control Room 105B	0	105B
2	H-1-13164	Main Annunciator Control Room 105B	0	105B
3	H-1-13164	Main Annunciator Control Room 105B	0	105B
1	H-1-14007	Control Room Panel Arrangement 105B	0	105B
1	H-1-14008	Control Room Panel Arrangements 105B	0	105B
2	H-1-14008	Control Room Panel Arrangements 105B	0	105B
3	H-1-14008	Control Room Panel Arrangements 105B	0	105B
4	H-1-14008	Control Room Panel Arrangements 105B	0	105B
1	H-1-14009	Control Room Panel Arrangements 105B	0	105B
2	H-1-14009	Control Room Panel Arrangements 105B	0	105B
3	H-1-14009	Control Room Panel Arrangements 105B	0	105B
1	H-1-19184	Portable Control Console 105B	0	105B

SHEET NO.	DRAWING NO.	DESCRIPTION	REV	PROJECT
2	H-1-19184	Portable Control Console 105B	0	105B
1	H-1-19877	105B Ventilation Ductwork Mode.	1	105B
1	H-1-1997	IBM Machine Location in Control Room 105B	0	105B
1	H-1-26191	Instr'm Inlet Water Panel Arr'g. 105B	0	105B
1	H-1-26289	Electr. Inlet Water Wiring Diag. 105B	0	105B
1	H-1-33610	Elec. Press Mon. -Panel Conn. Diag. 105B	0	105B
1	H-1-80212	100-B/C Area Pre-Design Ext. Rds, Fens., RR	0	105B
2	H-1-80212	100-B/C Area Pre-Design Ext. Rds, Fens., RR	0	105B
3	H-1-80212	100-B/C Area Pre-Design Ext. Rds, Fens., RR	0	105B
4	H-1-80212	100-B/C Area Pre-Design Ext. Rds, Fens., RR	0	105B
5	H-1-80212	100-B/C Area Pre-Design Ext. Rds, Fens., RR	0	105B
4	H-1-80216	100-B/C Area Pre-Design Topo S.W. Plot Plan	0	105B
5	H-1-80216	100-B/C Area Pre-Design Topt N.W. Plot Plan	0	105B
1	H-1-80217	100-B/C Area Pre-Design Waste Site Plot Plan	0	105B
2	H-1-80217	100-B/C Area Pre-Design Waste Site Plot Plan	0	105B
3	H-1-80217	100-B/C Area Pre-Design Waste Site Plot Plan	0	105B
4	H-1-80217	100-B/C Area Pre-Design Waste Site Plot Plan	0	105B
5	H-1-80217	100-B/C Area Pre-Design Waste Site Plot Plan	0	105B
1	H-1-80223	100-B/C Area Pre-Design Spoil Handling Plan	0	105B
1	H-1-80225	100-B/C Area Pre-Design Railroad Car	0	105B
5	H-1-80227	100-B/C Area Pre-Design Excavation Plan	0	105B
6	H-1-80227	100-B/C Area Pre-Design Excavation Plan	0	105B
1	H-2-41126	Arch-Plot Plan	0	105B
1	H-2-41643	Arch-Drawing Key Plan	0	105B
1	H-2-73338	Piping Waste Tank Isolation CTank Farm Plan	0	105B
1	H-2-73340	Piping Waste Tank Isolation 241-C-101	0	105B
1	H-2-73342	Piping Waste Tank Isolation Tk 241-C-102	0	105B

SHEET NO.	DRAWING NO.	DESCRIPTION	REV	PROJECT
1	H-6-220	Site Plan Fences, Gates, Roads 105B	0	105B
1	H-6-384	West Boundary Fence-Hanford Res	0	105B
1	W-70481	105B Concrete Storage & Transfer Basin Plan	0	105B
1	W-70482	105B Concrete Storage & Trans Basin Details	0	105B
2	W-70483	105B Concrete Storage & Trans Basin Details	0	105B
1	W-70836	105B Storage Area Floor Plan	0	105B
1	W-70836	105B Storage Area Floor Plans	1	105B
1	W-70837	105B Storage Area Elev-Sect-Detail-Arch.	0	105B
1	W-70838	105B Transfer Area Section thru Line Pits	0	105B
1	W-70842	105B Concrete Section of Downcomer Stacks	0	105B
1	W-71630	Building 105-B Plot Plan	?	105B
1	W-71645	105B Electrical Ground Locations Dwg. Index	29	105B
1	W-71646	105B Motor List	1	105B
2	W-71646	105B Motor List	1	105B
1	W-71648	105B Basement Lighting Plan, Electrical	4	105B
1	W-71650	105B Ground Floor Lighting Electrical	1	105B
1	W-71651	105B Apparatus Floor Lighting Electrical	1	105B
1	W-71652	105B Apparatus Floor Lighting Electrical	1	105B
1	W-71653	105B Lighting @ 56' -4" Floor Plan	1	105B
1	W-71654	105B Lighting @ 80' -5 1/4" Floor Plan	1	105B
1	W-71655	105B Stack & Fan Lighting	1	105B
1	W-71656	105B Storage & Transfer Lighting Power	1	105B
2	W-71656	105B Storage & Transfer Lighting Power	1	105B
1	W-71657	105B Valve Pit Lighting & Power	1	105B
1	W-71658	105B Section A&B Lighting & Power	1	105B
1	W-71659	105B Section C Lighting & Power	1	105B
1	W-71667	105B Miscellaneous Details-Lighting	1	105B

SHEET NO.	DRAWING NO.	DESCRIPTION	REV	PROJECT
1	W-71689	105B- Concrete Details Sheet 8	0	105B
1	W-71833	Bldgs 105B Vent. Fan House Arrg't Plan	0	105B
1	W-71834	Building 105-B & 115-B Plot Plan	?	105B
3	W-71835	Building 105-B Plot Plan	?	105B
1	W-72091	B 105 Pipe Tunnels Lighting & Sect. Electrical	1	105B
1	W-72482	Bldg 105B Vent Air Supply System, Arrg't.	0	105B
1	W-72730	B Cover Struct Framing Layer Packing Device	0	105B
1	W-72748	105B B Cover Struct. Framing Left Side Plates	0	105B
1	W-72749	105B B Cover Struct. Framing Left Side Plates	0	105B
1	W-72758	105B B Cover Struct. Framing Top Plates	0	105B
1	W-72759	105B B Cover Struct. Framing Top Plates	0	105B
1	W-72760	105B B Cover Struct. Framing Top Plates	0	105B
1	W-72761	105B B Cover Struct. Framing Top Plates	0	105B
1	W-72762	105B B Cover Struct. Framing Top Plates	0	105B
1	W-72763	105B B Cover Struct. Framing Top Plates	0	105B
1	W-72764	105B B Cover Struct. Framing Top Plates	0	105B
1	W-72765	105B B Cover Struct. Framing Top Plates	0	105B
1	W-72766	B Cover Framing Left Side 105B	0	105B
1	W-72767	B Cover Framing Right Side Plated	0	105B
1	W-72769	B Cover Framing Top Side Plated	0	105B
1	W-72769	B Layer Struct Layer Erection Dia. Typ. Det.	0	105B
1	W-72875	Bldg 105B Vent Supply & Exhaust Arrg't	0	105B
1	W-72876	Bldg 105B Vent Supply & Exhaust Arrg't	0	105B
1	W-72877	Bldg 105B Vent Supply System Arrg't	0	105B
1	W-72878	Bldg 105B Vent Supply & Exhaust Arrg't	0	105B
1	W-73570	Bldg 105 Vent Exhaust System Arrg't	0	105B
1	W-74177	Bldg 105B Screen Over Supply Duct Outlet Arr	0	105B

SHEET NO.	DRAWING NO.	DESCRIPTION	REV	PROJECT
1	W-74569	B 105 Key Plan Index & Single Line Diagram	1	105B
1	W-74637	B 105 Valve Pit Lighting & Power Electrical	1	105B
1	W-75243	105B Observation Room Arch. & Steel	0	105B
1	W-76160	B 105 Valve Pit Flow Lab Lighting & Power	1	105B
1	W-76170	B 105 Discharge Area Special Light & Power	1	105B
1	W-79481	B 105 Concrete Storage & Transfer Plan	0	105B
1	W-79837	B 105 Storage Area Elev. Section Details	3	105B
1	W-80482	B 105 Concrete Storage & Transfer-Section	6	105B

APPENDIX D

Other Museum Conversions

APPENDIX D

OTHER MUSEUM CONVERSIONS

A team consisting of Ms. Janet Bryant of Pacific Northwest Laboratory and Mr. Neil Norman of Parsons Environmental Services visited the following two reactor museums. The summary of the INEL EBR-1 Reactor tour was written by Mr. Norman.

OAK RIDGE GRAPHITE REACTOR VISIT - AUGUST 2, 1994

1. The hospitality provided for this tour was excellent. Tour coordinator Ms. Marilyn MacDonald arranged for a skilled guide to meet us at the reactor and he spent all morning with us. In addition, she invited Mr. Jim Cox to come in off retirement to talk about specific problems encountered during the conversion in the early 1960's. Mr. Cox was the Director of Reactor Operations for the ORNL during that period and he located a number of valuable documents from the period which we have now copied. These papers had not previously been available to the museum staff and they were also very pleased to receive the references. They also brought together Mr. Peter Souza, Mr. Nick Weist, and Mr. Glen Dewall from the site to give us their cultural resources aspect of the Museum. They operate within NEPA and the National Historic Preservation Act (Mr. Souza, [615] 576-4231).

2. The handicapped access ramp cost $175,000 when first constructed, but errors in slope necessitated a $200,000 retrofit.

3. There are probably still several thousand curies in the reactor system mostly from failed fuel. The visitor setback from the face is about 6 feet. (Cox) There is no radon problem in the building.

4. Asbestos was encapsulated but not removed.

5. Fire sprinklers were in the original construction. An advanced smoke detection linear beam detection system is going to be added soon.

6. No seismic upgrades have been required.

7. A program using fiber optic cables would be used to visually examine the conditions of the graphite if needed.

8. The museum is open from 9 a.m. to 4 p.m. seven days a week with no staff on hand except for specially arranged tours.

9. The Graphite Museum staff arranged for Marion Marsee, Director of the American Museum of Science and Energy in Oak Ridge to also give us an excellent guided tour there. There is a strong symbiotic relationship between the two museums. The staffs of both museums believe that the total attendance at each is enhanced by the support relationship.

10. Reserved parking for eight cars is available.

11. Signing in the entrance walk gives history of the museum and other site details. A project is underway to convert the signs to metal, and they recommend that we start in metal for best appearance at about the same cost.

12. There are sampling wells visible near the entry walk which have not been signed. All agreed that they should be identified for their safety and environmental purpose.

SUMMARY OF INEL EBR-1 REACTOR TOUR - August 4, 1994

Mr. Harlan Summers of the EG&G Public Relations Department was our guide and spent most of the day with Mr. Noel Fehr and I. The following observations were collected during our tour of the EBR-1 reactor and in related meetings.

1. The museum conversion was done in 1966 by a local contractor, Mr. Harry Pearson.

2. A recent 14-month shutdown of the museum was caused by changes and/or reinterpretations of the DOE Rad Con and Safety Manuals. Changes made included accommodations for Americans with disabilities, asbestos encapsulation in place, and placing safety barriers in front of electrical panels and equipment.

   They need guidance now on DOE order interpretation. The INEL Advisory Committee entered into the dialogue with DOE and was credited by Mr. Summers with being the critical influence for being able to reopen the museum. Mr. Chuck Rice has been the Advisor Committee Chair. He is an old boss of mine from the Nuclear Engine for Rocket Vehicle Application (NERVA) Program and I talked with him for some time by telephone. He recommends that we recruit our Hanford Advisory Committee as a protagonist for the B Reactor Museum.

3. Museum hours are from 8 a.m. to 4 p.m., seven days a week from Memorial Day through Labor Day. Attendance was approximately 10,000 last summer. In addition, guided tours by bus or van are arranged throughout the year with 4,000 more visitors using that means.

   Museum visitation is enhanced because the reactor is on route between Sun Valley or Twin Falls and Idaho Falls or Yellowstone Park. Approximately one FTE person is involved in the tour operations. In addition, one/half of a FTE is devoted to maintenance, but the need is more like one FTE.

4. The Idaho Falls Chamber of Commerce Museum had 25,000 visitors in 1992 and 32,800 in 1993. The EG&G Public Relations staff coordinates tours of the EBR-1 Reactor Museum with the Chamber of Commerce Museum. Both museum staffs believe the cooperation between them leads to a greater total number of community museum visitors rather that providing a competition. The Department of Commerce at (208) 334-2270 has other statistics including the total number of visitors to the community.

5. College engineering students are used as staff, and are paid between $8 and $10 per hour. Guided tours are handled by the EG&G Public Relations Department. Student staff wears safety devices which alarm to the site security forces if the students are not vertical. Students interviewed were very positive about the museum and their summer jobs.

6. Bus tours can carry up to 60 persons. The EBR-1 Building limit is held to 150 persons because of fire safety rules.

7. There are no sprinklers in the building, but a state of the art "Cerberus" fire alarm system was added during the recent down time.

8. A maximum radiation level anywhere in the facility is about 4 mR/hr.

APPENDIX E

Alternative Cost Estimates

APPENDIX E

ALTERNATIVE COST ESTIMATES

SUMMARY TABLE

	ESTIMATED COST	RATIO
Alternative A - Controlled Tour Access	$145,000	1.00
Alternative B - Public Access with Current Displays	$605,000	4.17
Alternative C - Public Access with Enhanced Displays	$730,000	5.03
Alternative D - Public Access with Enhanced Displays and Additional Tours	$820,000	5.66
Alternative E - Public Access with Enhanced Displays, Additional Tours, and River Access/Cultural Center	$1,670,000	11.52
Alternative F - Dismantling	$21,228,163	146.40

PHASE I COST ESTIMATE

ALTERNATIVE A - CONTROLLED TOUR ACCESS

WORK ITEM	COST	TOTAL
Ongoing Repairs (Cost Already Incurred)	$0	$0
Option 1, New Materials in 10 years	$185,000	
Option 2, Original Materials in 10 years	$350,000	
Ventilation	$20,000	$20,000
Fire Protection	$30,000	$30,000
Accessibility	$10,000	$10,000
Water Quality	$5,000	$5,000
Barriers and Signs	$5,000	$5,000
Asbestos Encapsulation	50,000	$50,000
Structural Repairs	$25,000	$25,000
TOTAL ESTIMATED COST		**$145,000**

PHASE I COST ESTIMATE

ALTERNATIVE B - PUBLIC ACCESS WITH CURRENT DISPLAYS

WORK ITEM	COST	TOTAL
Alternative A	$145,000	$145,000
Route 6		
Option 1	$170,000	$170,000
Disk Existing Asphalt		
1-inch Asphalt Treatment		
Option 2	$340,000	
4-inch Leveling Course		
1-inch Asphalt Treatment		
Locking Gate	$10,000	$10,000
Fencing, 3 stranded barbed	$250,000	$250,000
Parking Lot Improvements	$15,000	$15,000
1-inch Asphalt Treatment		
Repaint and Stripe		
ADA Marking Requirements		
Signage (8 - 10)	$15,000	$15,000
TOTAL ESTIMATED COST		**$605,000**

PHASE I COST ESTIMATE

ALTERNATIVE C - PUBLIC ACCESS WITH ENHANCED DISPLAYS

WORK ITEM	COST	TOTAL
Alternatives A & B	$605,000	$605,000
Upgrade Displays	$30,000	$30,000
Presentation/Demonstration Room	$30,000	$30,000
Exhibit/Entry Lobby	$15,000	$15,000
Site Exhibits	$50,000	$50,000
TOTAL ESTIMATED COST		**$730,000**

PHASE I COST ESTIMATE

ALTERNATIVE D - PUBLIC ACCESS WITH ENHANCED DISPLAYS AND ADDITIONAL TOURS

WORK ITEM	COST	TOTAL
Alternatives A, B & C	$730,000	$730,000
Valve Pit Room	$40,00	$40,000
Grated Walkway		
Barriers and Signs		
Ventilation Upgrades		
Lighting		
Fan Room	$20,000	$20,000
Remove Tools/Equipment		
Barriers and Controls		
Ventilation Upgrades		
Fuel Storage Basin	$30,000	$30,000
Isolate Electrical Control Panel		
Upgrade Ventilation		
Remove Walkway Planks		
Overhead Monorail Static Display		
TOTAL ESTIMATED COST		**$820,000**

PHASE I COST ESTIMATES

ALTERNATIVE E - PUBLIC ACCESS WITH ENHANCED DISPLAYS, ADDITIONAL TOURS, AND RIVER ACCESS/CULTURAL CENTER

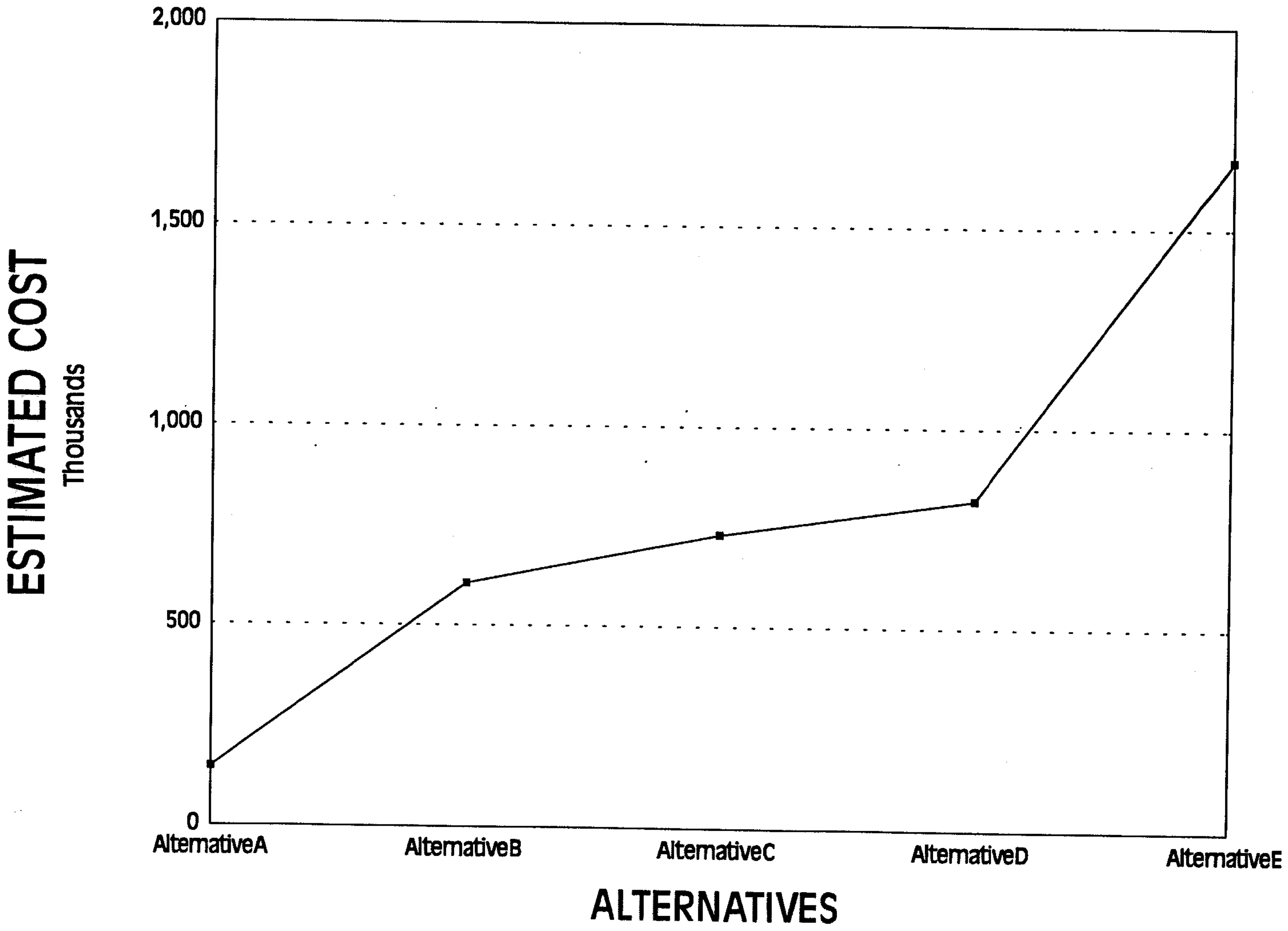
WORK ITEM	COST	TOTAL
Alternatives A, B, C & D	$820,000	$820,000
Day Use Park	$200,000	$200,000
Picnic Sites		
Playground		
Trails		
Boat Ramp		
Park/Camping Facilities	$300,000	$300,000
Camp Sites		
RV Hookups		
Restrooms & Showers		
Playground		
Trails		
Resource Interpretive Center	$350,000	$350,000
Geologic Resource Display		
Columbia River Display		
Indian Culture Display		
Pre-Hanford Cultural Display		
TOTAL ESTIMATED COST		**$1,670,000**

PHASE I COST ESTIMATE

ALTERNATIVE F - DISMANTLING

WORK ITEM	COST	TOTAL
Decontaminate and Decommission		
Safe Storage (75 years)*	$4,046,400	
Alt A Safety & Access Upgrades	$145,000	$145,000
Deferred Removal*	$20,583,163	$20,583,163
Comply with NHPA	$500,000	$500,000
*Extract from ROD		
TOTAL ESTIMATED COST		**$21,228,163**

Figure E-1. Phase I Estimated Cost for Alternatives.



DISTRIBUTION

Number of Copies

OFFSITE

5	Parsons Environmental Services 1955 Jadwin Avenue Richland, Washington 99352	
	N. A. Norman (5)	

ONSITE

3	U.S. Department of Energy, Richland Operations Office	
	J. M. Bruggeman	H4-83
	J. D. Goodenough	H4-83
	R. D. Hudson	H4-83
30	Bechtel Hanford, Incorporated	
	R. L. Dale	H4-81
	M. C. Hughes	H4-84
	M. A. Mihalic	X5-53
	P. W. Griffin	X5-53
	R. G. Egge	X5-53
	B. W. Mathis	X5-53
	D&D Project Files (18)	X5-53
	BHI Document Control (3)	H4-79
	BHI Project Files (3)	H4-79
	Environmental Resource Center	H6-07
5	Pacific Northwest Laboratory	
	J. L. Bryant (5)	K7-94
6	Westinghouse Hanford Company	
	G. Woodcock (5)	B2-16
	M. S. Gerber	N1-40