ARF # 16387

United States Department of Energy

Savannah River Site

Explanation of Significant Difference for the Revision 1.1 Early Action Record of Decision for the P Area Operable Unit (PAOU) (U)

CERCLIS Number: 94

SRNS-RP-2009-00704

Revision 1

July 2009

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Prepared for U.S. Department of Energy under Contract No. DE-AC09-08SR22470

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LIST OF ACRONYMS AND ABBREVIATIONS

ACI	American Concrete Institute
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ARRA	American Recovery and Reinvestment Act
ARF	Administrative Record File
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulation
Ci	curies
cm	centimeter
CM	contaminant migration
CMS	Corrective Measures Study
COC	constituent of concern
D_2O	deuterium oxide (heavy water moderator)
EAROD	Early Action Record of Decision
EDE	Estimated Dose Equivalent
EE/CA	Engineering Evaluation / Cost Analysis
ESD	explanation of significant difference
FS	Feasibility Study
ft	feet
ft^3	cubic feet
IC	Institutional Control
in	inches
ISD	*In situ* decommissioning
km	kilometer
L	liter
lbs	pounds
LLC	Limited Liability Company
LUC	Land Use Controls
m	meter
m^3	cubic meter
MCL	maximum contaminant limit
mi	mile
mrem	millirem
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge and Elimination System
OSWER	Office of Solid Waste and Emergency Response
PAOU	P-Area Operable Unit
PC	Performance Category
PCB	polychlorinated biphenyl
PRG	preliminary remedial goals

LIST OF ACRONYMS AND ABBERVIATIONS (continued)

PTSM	principal threat source material
RAO	remedial action objective
RBC	P-Reactor Building (105-P) Complex
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	Remedial Investigation
ROD	Record of Decision
RSER	Removal Site Evaluation Report
SCDHEC	South Carolina Department of Health and Environmental Control
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
TSCA	Toxic Substance Control Act
USDOE	United States Department of Energy – Savannah River
USEPA	United States Environmental Protection Agency
WSRC	Washington Savannah River Company LLC
yr	year

I. Introduction

This Explanation of Significant Difference (ESD) is being issued by the United States Department of Energy (USDOE), the lead agency for the Savannah River Site (SRS) remedial activities, with concurrence by the United States Environmental Protection Agency (USEPA) – Region 4, and the South Carolina Department of Health and Environmental Control (SCDHEC). The purpose of this ESD is to announce and provide rationale on the specific *in situ* decommissioning (ISD) alternative chosen for the P-Reactor Building (105-P) Complex. The ISD end state was selected as the preferred alternative in the *Early Action Record of Decision* (EAROD) *for the P Area Operable Unit* (PAOU), Revision 1.1 (WSRC 2008a) for the P-Reactor Building (105-P) Complex, which was issued on January 29, 2009. As part of the EAROD, a range of ISD alternatives were presented and discussed.

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 117(c), SRS is required to publish an ESD whenever there is a significant change to a component of a remedy specified in a record of decision (ROD). Sections 300.435(c)(2)(i) and 300.825(a)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) require the lead agency to provide an explanation of the difference and to make this information available to the public in the Administrative Record File (ARF) and information repositories.

The ESD is part of the ARF and is available for public review during normal business hours at the following information repositories.

US Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina – Aiken
171 University Parkway
Aiken, South Carolina 29801
(803) 641-3465

Thomas Cooper Library
Government Documents Department
University of South Carolina
Columbia, South Carolina 29208
(803) 777-4866

II. Site History, Contamination Problems, and Selected Remedy

This ESD documents the specific ISD alternative chosen for the P-Reactor Building (105-P) Complex. ISD was chosen in the EAROD as the preferred end-state for remediating P-Reactor Building (105-P)

Complex. The selection of the appropriate ISD alternative and associated details was to be addressed in the PAOU ROD. However, in light of the recent development in regards to the passing of legislation (i.e. American Recovery and Reinvestment Act [ARRA]), the PAOU project is being accelerated to reduce the SRS footprint. As a result of the project schedule acceleration, an ESD was necessary to present and discuss the selected ISD alternative and associated details. The discussion of the site history, contamination, and selected remedy in this ESD will focus on the selected ISD for the P-Reactor Building (105-P) Complex. Additional information on all PAOU subunits can be found in the PAOU EAROD (WSRC 2008a) and the *Resource Conservation and Recovery Act* (RCRA) *Facility Investigation* (RFI)/*Remedial Investigation* (RI) *with Baseline Risk Assessment* (BRA) *and Corrective Measures Study* (CMS)/ *Feasibility Study* (FS) *for the P Area Operable Unit* (SRNS 2008b).

The PAOU is located approximately 4 km (2.5 mi) east-southeast of the geographical center of SRS and about 6.4 km (4 mi) west of the nearest site boundary. PAOU encompasses approximately 51 hectares (126 acres) (including the P-Area Ash Basin) and is located in an upland area between Steel Creek and Lower Three Runs watersheds (Figure 1).

In February 1954, P-Reactor began operations. It was taken off-line for maintenance and safety upgrades in 1987, placed in warm standby in 1988, and placed in shutdown status in 1991. In 1993, the P-Reactor was put into a 'cold standby' status, followed by 'cold shutdown with no capability of restart'. The primary sources of radioactive contamination in P Area are activation products, fission products, and tritium, the majority of which were the consequence of operation of the P-Reactor. In its present state, all irradiated-fuel and target assemblies have been removed from the P-Reactor Building (105-P) Complex and the fluids have been drained from the process systems. Currently, P-Reactor Building (105-P) Complex, together with facilities within the P Area fence, is undergoing deactivation in preparation for decommissioning.

P-Area Reactor Building (105-P) Complex

The P-Reactor Building (105-P), in its entirety (referred to hereafter as the Reactor Building Complex [RBC]), is subdivided into three components based on total curie inventory, risk, and future remedial action(s) (Figure 2). For clarification, the RBC, as a whole, contains all three components which were integral to reactor operations. The three components are as follows:

- Reactor Vessel;
- Disassembly Basin; and
- P-Reactor Building (105-P) and ancillary structures (includes the Engine Houses [108-1P and 108-2P] and Standby Pumphouse [191-P]).

Reactor Vessel

The Reactor Vessel, embedded in the floor of the process room, was the location of a low pressure and low temperature fission reaction using uranium-235 as fuel with deuterium oxide (D_2O [heavy water moderator]) cooling the core. The nuclear fission process took place within the reactor tank, a cylinder composed of 304 stainless steel 1.3 cm (0.5 in) thick containing a lattice of fuel and target assemblies, control rods, and instrumentation submerged in the primary heavy water moderator/coolant. The vessel is primarily composed of the following parts:

- D_2O plenum constructed primarily with 304 stainless steel;
- Top shield constructed primarily with 304 stainless steel;
- Bottom shield constructed primarily with 304 stainless steel;
- Thermal shield constructed primarily with an iron alloy and stainless steel; and
- Biological shield constructed of approximately 1.5 m (5 ft) thick concrete with ancillary stainless steel piping and components that traverse through it.

There are no fuel or target assemblies within the reactor vessel and the fluids have been drained from the process systems. The components of the reactor vessel are in solid form and contain activated products that are part of and within the matrix material of the reactor vessel.

Disassembly Basin

The Disassembly Basin was used to cool (both thermally and radiologically) and process fuel and target assemblies for transfer to the separations facilities. The basin no longer contains irradiated fuel or target assemblies. However, the basin does contain aqueous and solid (sediment) media which contain fission and activation products. Additionally, the disassembly basin contains activated scrap metal and failed assembly storage containers.

A Removal Site Evaluation Report (RSER)/ Engineering Evaluation/Cost Analysis (EE/ CA) (WSRC 2008c) has been completed for disposition of the water in the Disassembly Basin. Per the Action Memorandum (USDOE 2009), forced evaporation was selected as the preferred alternative to reduce the volume of water in the Disassembly Basin. This action will support early action at the RBC.

P-Reactor Building (105-P) and Ancillary Structures

The P-Reactor Building (105-P) is a massive reinforced concrete structure of nuclear blast resistant design with multiple levels over 39.6 m (130 ft) above and 15.1 m (49.5 ft) below ground surface. The exterior wall thicknesses above-grade were dictated by a blast resistant design, while reinforcing bars provided for flexure during overpressure events. Walls, floors, and roofing of the building vary between approximately 1.4 m to over 3.2 m (4.5 ft to over 10.5 ft) in thickness of reinforced concrete.

Figure 2 illustrates general areas inside the P-Reactor Building (105-P) and includes the Assembly, Process, and Purification Areas. The Assembly Area received and prepared fuel and target rods from M Area. The rods were then sent to the Process Area. The Process Area houses the reactor vessel subunit, which is embedded in the floor of the process room. The Process Area also contains the shield water system, control and safety rod actuating mechanisms, heat exchangers, primary coolant circuit pumps, helium blanket gas system, and the main control room. The Purification Area was used to remove fission and activation products from moderator water and blanket gas. In the Purification Area, moderator water passed through filters, ion exchange resin, pH control, and then through distillation columns before being returned to the primary cooling water circuit. This process resulted in the accumulation of radionuclides in process vessels contained within shielded cells.

The Ancillary Structures associated with the RBC are outside of the main building, but are physically connected to the P-Reactor Building (105-P) (Figure 3). These structures include the two Engine Houses (108-1P and 108-2P) and the Standby

Pumphouse (191-P). The Engine Houses are two-level facilities that provided emergency backup power for operations. The basement for these facilities contained support equipment including diesel tanks, coolant tanks, and pumps. Two contaminated sand filters were removed from the Disassembly Basin roof and placed at the minus 6.1 m (20 ft) level in the two engine houses, with the top of the filters approximately 0.9 m (3 ft) above-grade.

Even though the building is over 50 years old, the structure is sound, with minimal evidence of subsidence or cracking (WSRC 2008b, WSRC 2008f). The P-Reactor Building (105-P) contains enough reinforcing steel to control cracking due to the normal loads and more than exceeds current code building code (American Concrete Institute (2008). Roof drainage systems show signs of some deterioration and some exterior steelwork shows evidence of paint peeling and localized corrosion.

The lack of ventilation inside the building has led to peeling paint, mold growth and rusting of some carbon steel components, machinery, and structural supports. However, the stainless steel piping and process equipment show no signs of corrosion or deterioration. There is some evidence of past water accumulation at the minus 12.2 m (40 ft) level due to faulty seals over the cell covers that allow access to the minus 12.2 m (40 ft). These seals and other areas where rainwater has entered the building have been corrected.

A structural engineering review completed for the building indicates that if vegetative growth is prevented on building roofs, the above grade structures should remain intact for about 1,400 years. The degradation mechanisms that will act on the proposed below-grade structures and grout monolith will occur very slowly over thousands of years (WSRC 2008f).

Scope of the Problems at the P-Reactor Building (105-P) Complex

At the RBC, various assessments were used to determine the overall contaminant inventory within the complex. Concrete samples were collected throughout the building along with water and sludge samples from the Disassembly Basin. Additionally, radiological surveys were performed. Modeling was used to determine the inventory within the reactor vessel.

General radiological levels within the P-Reactor Building (105-P) have been summarized (WSRC 2008d), and the process room, Disassembly Basin, purification wing, and minus 6.1 m (20 ft), minus 12.2 m (40 ft), and minus 15.1 m (49.5 ft) levels are all classified as radiological contamination areas. The radiation levels in these areas are due to the cumulative effect of residual fission and activation products remaining within the basins, tanks, stainless steel piping, valves, heat exchangers, pumps, instruments, etc. It is estimated that there is approximately 240,000 curies (Ci) of radionuclides present. Remaining areas within the building are classified as non-radiological. Certain localized regions within the contamination areas were identified as containing highly radioactive sources.

The Reactor Vessel, together with the thermal and biological shielding around the vessel, has been estimated to contain 211,000 Ci of neutron-activated metal and concrete (WSRC 2008e). The constituent concentrations in the Reactor Vessel were determined by elemental analysis of 304 stainless steel, then modeled to determine the degree of activity of each element. A coupon taken from the R-Reactor Vessel was analyzed in order to ground-truth the qualitative and quantitative presence of isotopes in the P-Reactor Vessel and to adjust the model results to be more realistic.

The Disassembly Basin is estimated to contain approximately 14,600 Ci of contaminated water, sediment, and activated scrap metal. The Disassembly Basin contains over 15 million L (4 million gallons) of radiologically contaminated aqueous phase media. Constituent concentrations for the sediment and aqueous-phase content of the Disassembly Basin were determined by qualitative and quantitative radiochemical analysis. The primary contaminant in the water is tritium. The total curie content of the Disassembly Basin water is approximately 5,000 Ci. The majority of the Disassembly Basin water (90%) will be dispositioned via forced evaporation (WSRC 2008c, USDOE 2009).

The Disassembly Basin contains approximately 122 m^3 (4,380 ft^3) of radiologically contaminated sludge. The total curie content of the Disassembly Basin sludge is approximately 57.5 Ci. The Disassembly Basin also contains approximately 1,500 lbs of activated equipment remnants (scrap metal) with a total curie content of approximately 9,630 Ci. Constituent concentrations of scrap metal, equipment, primary cooling loop, contamination and equipment in the Purification Wing, piping, heat exchangers, charge-discharge machines, seal head tanks, etc. were all based on process knowledge.

The remainder of the P-Reactor Building (105-P) is estimated to contain approximately 14,200 Ci of contaminated concrete and process related equipment. Constituent concentrations of concrete in the building were determined by qualitative and quantitative radiochemical analysis. Tritium is present throughout the building. Overall, tritium is responsible for 99% of concrete contamination throughout the building.

Other potentially hazardous non-radiological contamination is known to be present in the RBC and has been inventoried (WSRC 2008f). Lead (78%), iron (20%), and polychlorinated biphenyls (PCBs) (1%) constitute 99% of the total hazardous material inventory within the RBC. The remaining 1% is made up of other metal present in wiring, switches, sludge, and other system components. Approximately 67,000 lbs of these hazardous components are estimated to be present throughout the building. This material will remain in the facility as part of ISD.

Summary of P-Reactor Building (105-P) Complex Risk

A risk assessment was performed on the three components of the RBC (SRNS 2008b). Risk to the industrial worker is present and the greatest risk is associated with the P-Reactor Vessel. The routes of exposure included in the assessment of the reactor vessel subunit (metal media) and the building and attached structures subunit (concrete media) were incidental ingestion and external radiation. The routes of exposure included in the assessment of the Disassembly Basin (sediment media) were incidental ingestion, inhalation, and external radiation. Principal threat source material (PTSM [risk>1E-03]) is also present with the largest PTSM risk associated with the P-Reactor Vessel.

A Tier 2 contaminant migration (CM) groundwater model was performed for the base case (No Action) and four (4) ISD alternatives (SRNS 2008b). Specific details pertaining to the modeling results are discussed in Section IV.

III. Basis for the Explanation of Significant Difference

The purpose of this ESD is to present and discuss the specific ISD alternative chosen for the RBC. In the EAROD for PAOU, ISD was chosen as the preferred end-state for remediating RBC in the EAROD. The EAROD compared ISD, in general terms, against no action and complete removal. ISD included a range of alternatives from minimal removal of portions of the building (i.e., the stack and above grade portion of the Disassembly Basin) to removal of all above grade structures and the reactor vessel.

In the EAROD, USDOE, USEPA, and SCDHEC have agreed that selection of ISD as the preferred remedy for the RBC addresses known and potential threats to human health and the environment for the RBC and would allow subsequent engineering efforts and regulatory decisions to focus on technical approaches that are appropriate for the ISD end state which would:

- Stabilize/isolate contamination remaining within the structure;
- Prevent migration of radioactive and hazardous contaminants to groundwater to the extent practicable;
- Prevent exposure of radioactive and hazardous contaminants to the industrial worker; and
- Prevent human / animal intruder exposure to radioactive and hazardous contamination.

The USDOE, USEPA, and SCDHEC have agreed that details of the specific ISD alternative appropriate for the RBC can be presented in the ESD to the EAROD. This will allow for the closure activities for the RBC to proceed earlier, resulting in accelerated remediation by 2012, thus accelerating risk reduction and decreasing size of the contaminated footprint associated with SRS waste units sooner.

Preliminary evaluations for the No Action alternative (R-1) and a range of four alternatives for ISD (R-2) were conducted in the *105-P Alternatives Cost Analysis (U)* (WSRC 2008a). These remedial alternatives were subsequently screened in the PAOU RFI/RI/BRA/CMS/FS (SRNS 2008b). The No Action alternative (R-1) and two of the four ISD alternatives (R-2A, R-2C) were retained for further development and analysis. The two ISD alternatives are:

- R-2A – ISD with the Reactor Vessel grouted in place; and
- R-2C – ISD with the Reactor Vessel removed.

IV. Description of Significant Difference and the Basis for those Differences

The significant differences and the basis for those differences between the Revision 1.1 EAROD for the PAOU and this ESD are discussed in the following sections using the organizational structure of the EAROD, as noted in parentheses.

Scope and Role of the Operable Unit (Section IV)

The EAROD identifies ISD as the final end-state decision for the RBC. This decision is also an early action remedy for the RBC.

Operable Unit Characteristics (Section V)

The EAROD only briefly mentioned groundwater, since groundwater will be addressed as its own operable unit. However, the groundwater characteristics are relevant to the evaluation of alternatives for the RBC.

The current depth to groundwater is 15.5 m (51 ft), as indicated in Figures 2 and 4. However, the long-term average potentiometric data indicates that historically, the water table is about 3 m (10 ft) higher. Assessment of the structural integrity of the below-grade grout monolith and contaminant transport modeling will consider this variability.

The EAROD indicated that a more complex Tier 2 CM model was performed (SRNS 2008a), but the results were not available for incorporation into the EAROD by the time it was submitted. The model results are summarized below and listed in Table 1 for the three alternatives.

For the No Action Alternative, the deterministic best-estimate Tier 2 CM modeling of the RBC and its ancillary structures indicates that ten radionuclides and one hazardous constituent qualify as CM constituents of concern (COCs) as these COCs will exceed maximum contaminant limits (MCLs) / preliminary remedial goals (PRGs): calcium-41, carbon-14, chlorine-36, potassium-40, nickel-59, nickel-63, niobium-94, molybdenum-93, silver-108m, technetium-99, and lead (Table 1). These results were based on the Tier 2 CM model results presented in the PAOU RFI/RI/BRA/CMS/FS (SRNS 2008b). The model has since been modified to reflect an updated radionuclide inventory estimate (SRNS 2008c), which considered a metallurgical analysis that was completed on a coupon sample previously collected from the R-Reactor Vessel. Table 1 presents a summary of the contaminant migration results, including the maximum predicted groundwater concentration, the time of initial MCL/PRG exceedance, and the time of maximum concentration.

For Alternative R-2A, the model predicted that five radionuclides will exceed their respective MCLs/PRGs in the groundwater: carbon-14, chlorine-36, nickel-59, niobium-94, and molybdenum-93. However, none of the radionuclides are predicted to exceed regulatory standards within the next 1,000 years.

For Alternative R-2C (ISD with the Reactor Vessel removed), no constituents qualify as CM COCs (Table 1).

In summary, the modeling results provided in Table 1 show that there is a significant reduction in the number and degree of potential impact to groundwater when comparing Alternative R-2A to No Action (SRNS 2008b). Typically, fate and transport modeling is not conducted beyond 1,000 years due to the large uncertainties inherent in trying to model future concentrations beyond that timeframe. In this case however, model timeframes were extended to 500,000 years to account for the long-lived radionuclides. Additional uncertainties in this model, such as assumptions regarding the corrosion rate of stainless steel, further add to the uncertainty in the results. Given these uncertainties, the model should be applied in a limited way and should not be used to make definitive conclusions regarding compliance with environmental standards.

Summary of Operable Unit Risks (Section VII)

The results of the Tier 2 CM model were not available for inclusion in the EAROD (Subsection - Summary of Fate and Transport Analysis). Refer to the previous section for the results of the Tier 2 modeling. The results of the risk analysis for the Reactor Vessel, the Disassembly Basin, and the P-Reactor Building (105-P) were presented in the EAROD.

Remedial Action Objectives (RAOs) (Section VIII)

The second remedial action objective (RAO) for the P-Reactor Building (105-P): "Prevent migration of radiological and chemical contamination from P-Reactor Building (105-P) to groundwater" was modified from the EAROD to read "Prevent migration of radiological and chemical contamination from P-Reactor Building (105-P) to groundwater to the extent practicable". The fate and transport modeling indicated that alternative R-2A significantly reduces the potential groundwater impact as compared to the No Action alternative. Although five contaminants are predicted to exceed MCLs in groundwater, this does not occur until after 1,000 years, and these results are subject to higher uncertainty.

Additionally, the applicable or relevant and appropriate requirements (ARARs) for the RBC that were presented in the EAROD have been updated to reflect a more detailed assessment (Table 2).

Description of Alternatives (Section IX)

The EAROD described the Alternative R-2 - *In Situ* Decommissioning as a generic range of alternatives. Summary details of the minimum removal scenario for Alternative R-2 were discussed. Additionally, three other scenarios were evaluated for ISD. Each alternative evaluated additional removal of the building, various grouting scenarios, and removal of the reactor vessel. The purpose of this ESD is to provide the detailed information for the two specific ISD alternatives as described below.

For Alternative R-2A (ISD with the Reactor Vessel grouted in place), the Process, the Purification, and the Assembly Areas of the RBC as well as the actuator tower would be left in place, while the above-grade structure of the Disassembly Area would be demolished to grade-level. The contents of the Disassembly Basin would be grouted to stabilize the contaminants. A sloped concrete cover would then be placed over the grouted Disassembly Basin. The remaining contaminated equipment in the above-grade structure of the RBC will be left in place.

Although current levels of contamination for equipment in the Process and Purification Areas exceed 1E-03 risk levels, the residual risk for all equipment falls below 1E-04 within 300 years. Since 1) the structural integrity of these portions of the building are expected to last longer than 300 years with roofs designed, and maintained for a minimum of 300 years, in order to shed water and prevent vegetative growth, and 2) the building will be sealed to prevent human/animal access to the above-grade portions, there will be no risk of exposure to the above-grade equipment before the radionuclide activities have decayed to acceptable levels with institutional controls. Any residual contamination in the above-ground structures would remain. The above-grade structure also would be sealed to prevent human/animal access into the building. The stack would be removed above the plus 16.8 m (55 ft) elevation and a new partial roof would be placed over the exposed opening to prevent water ingress. The holes in the five foot thick floor of the plus 20.2 m (66 ft) elevation of the actuator tower, used as a throughway for the reactor control and safety rod actuator system latch extensions, would be grouted. The shield door gantry system will be removed from the roof of the building and a new partial roof would be constructed and sloped over the shield door slots to prevent rainwater ingress. The P-Reactor Vessel would be grouted in place with a concrete cap at ground-level. The cap would be sloped to allow water runoff. The Process Room would remain in its current state. Vacant spaces from 0 ft level (grade) down to the minus 15.1 m (49.5 ft) level would be grouted. The Purification Area will be grouted to the top of the cell wall at the plus 6.1 m (20 ft) level. The below-grade portions of the Purification Area will be grouted to the plus 1.5 m (5 ft) finished floor level. The Process and Purification Areas roofs will be engineered to ensure water run-off and prevent accumulation of water within the building.

ISD will maintain the structural integrity of the building for a period of at least 200 years. This timeframe is conservatively estimated to allow for 99.9% of the tritium in the above-grade areas of the building to decay (WSRC 2008b).

A long-term assessment of the Reactor Building (105-P) structure has been completed (WSRC 2008f). Degradation of the concrete below- and above-grade was evaluated. The following degradation mechanisms were addressed: 1) sulfate and magnesium attack; 2) alkali and calcium hydroxide leaching; 3) carbonation; 4) alkali-silica reaction; 5) freeze-thaw; 6) cracking; 7) rebar corrosion; and 8) vegetative growth.

The following conclusions were derived from the structural integrity analysis (WSRC 2008f):

- The primary degradation mechanism that could degrade the below-grade structure is sulfate/magnesium attack on the concrete that might be in contact with groundwater below the minus 12 m (40 ft) level. After 5,000 years, the amount of concrete lost is about 3.8 cm (1.5 in), which is insignificant compared to the wall thickness of several feet, not even considering the grout fill beyond that.
- The controlling degradation mechanism for above-grade concrete would be uncontrolled vegetative growth on the roofs, if allowed. At least partial collapse of some of the roof structures would occur in no more than 250 years, if left unattended.
- The existing P-Reactor Building (105-P) structure can be expected to support loads after a Performance Category (PC)-3 seismic event. A PC-3 seismic event is the maximum predicted seismic event having a return period of approximately 2,500 years (ACI 2008).
- At 2,500 years, a pile of rubble enveloped in vegetative growth would remain. The proposed grout monolith in the below-grade areas would still be intact with less than 1.9 cm (0.75 in) eroded due to sulfate and magnesium attack.

In order to prevent precipitation from entering the Process Room due to roof degradation and collapse, the roofs over portions of the Process Area would be designed, and maintained to 1350 years, to shed water and prevent vegetative growth. Maintenance activities included as part of Alternative R-2A include the prevention of vegetative growth on the roofs and the sealing of cracks in the cover system to prevent significant infiltration. The specific details concerning inspections, monitoring programs, and maintenance needed to ensure the integrity of the remedial action will be discussed in the Early Action RAIP for the PAOU and the final ROD and LUCIP for the PAOU.

Institutional controls (ICs) (i.e., land use controls [LUCs]) would be implemented for an indefinite period of time to prevent direct human exposure. However since LUCs and ICs are already in place for the PAOU, it is anticipated that no additional LUCs and ICs will be instituted for the RBC. Final ICs for the PAOU would be determined in the final ROD for the PAOU. Should results from groundwater monitoring associated with the ISD remedy indicate the need for additional LUCs in the future, they would be addressed through the five year remedy review process.

The present worth cost of Alternative R-2A is estimated to be $52,541,000 (Table 3). The cost includes ongoing inspections, monitoring programs, and maintenance as needed to ensure integrity of the remedial action. This alternative will include five year remedy reviews.

Alternative R-2C (ISD with the Reactor Vessel removed) is similar to Alternative R-2A except that this alternative involves removal of the reactor vessel instead of grouting of the reactor vessel. Because approximately 87% of the radioactivity within the building resides within the matrix of the reactor vessel activated metal, this alternative would eliminate the majority of the curie inventory.

The present worth cost of Alternative R-2C is $82,961,000 (Table 3). This estimate is a refinement of the estimate presented in the feasibility study (SRNS 2008b), which was $63,629,000. Since the issuance of the estimate provided in the RFI/RI/BRA/CMS/FS for removal of the Reactor Vessel, new information has been gathered that affects the methods and costs for the Reactor Vessel removal. The new information includes substantially higher radiological dose rates, refurbishment of the 120 ton crane (to remove the Reactor Vessel) and shield door gantry crane (to lift the shield doors), additional segmentation of the Reactor Vessel, and other costs associated with container design, fabrication, and shipping. The revised cost also includes ongoing inspections, monitoring programs, and maintenance as needed to ensure integrity of the remedial action. This alternative will include five year remedy reviews.

ICs (i.e., LUCs) would also be implemented for an indefinite period of time to prevent direct human exposure. However since LUCs and ICs are already in place for the PAOU, it is anticipated that no additional LUCs and ICs will be instituted for the RBC. Final ICs for the PAOU would be determined in the final ROD for the PAOU.

Comparative Analysis of Alternatives (Section X)

The comparative analysis of alternatives presented in the EAROD for the RBC included the generic version of ISD. The two more detailed ISD alternatives are now included in this comparison.

The alternatives are compared based on their relative achievement of threshold and primary-balancing criteria. Regulatory acceptance was received in the preferred remedy scoping meeting. Community acceptance is based on public input received at P Area workshops and comments received on the PAOU EAROD pertaining to the ISD end-state decision. Table 4 provides a summary of the comparison of alternatives for the RBC.

1. Overall Long-term Protection of Human Health and the Environment – The No Action alternative would not offer long-term protection of human health and the environment. Long-term deterioration of the building with the possibility of progressively increasing potential for contamination release makes the No Action alternative less than protective of human health and the environment.

Alternatives R-2A and R-2C will maintain long-term protectiveness and, as long as the encapsulation remains sound and is maintained, there is no credible release mechanism for contaminants while radioactive decay lowers the radioactivity inventory substantially over time. Therefore, the overall protection of human health and environment will be high for both of the ISD alternatives R-2A and R-2C.

Alternatives R-2A and R-2C will reduce and delay contaminant transport. For alternative R-2C, removal of the reactor vessel would yield approximately 87% reduction in risk and achieve the best overall protection of human health and environment and prevent contamination migration.

2. Compliance with ARARs - ARARs are federal and state environmental regulations that establish standards that must be met during conduct of remedial action activities. These are summarized in Table 2. These ARARs, therefore, would not apply to the No Action alternative. However, both ISD alternatives R-2A and R-2C would comply with state, federal and USDOE regulations concerning radioactive, hazardous, and toxic waste management and disposal regulations. The end state of the facility is predicted to meet state standards for groundwater protection for Alternative R-2C only. The Tier 2 CM model indicated that Alternative R-2A significantly reduces the potential groundwater impacts (Table 1). Although, five contaminants are predicted to exceed MCLs in groundwater, this does not occur until after 1,000 years, and these results are highly uncertain. Table 1 includes the estimated time of initial MCL/PRG exceedance, and the estimated time of maximum concentrations. Exceedances are predicted for thousands of years. However, compliance with MCLs is currently achieved.

3. Long-Term Effectiveness and Permanence - The remedial alternatives are assessed based on their ability to maintain reliable protection of human health and the environment after implementation. The No Action alternative does not provide adequate long-term protection as progressive deterioration of the structure could allow rain and groundwater ingress and egress, which would eventually transport contaminants into the environment. Alternatives R-2A and R-2C permanently grout contaminants within the RBC in-place and are considered long-term in nature.

4. Reduction of Toxicity, Mobility or Volume through Treatment - The remedial alternatives are assessed based on the degree to which they employ treatment that reduces toxicity (the harmful nature of the contaminants), mobility (the ability of the contaminants to move into the environment), or the volume of contaminants associated with the unit.

Reduction of contaminant mobility is low for the No Action alternative as it depends on the structural integrity of the building. Without engineering controls (encapsulation with grout) to restrict access, receptors could come into contact with high radioactivity levels, and without control of water ingress and egress, the probability of contaminant release into the environment will increase. The encapsulation and cover systems in alternatives R-2A and R-2C will reduce the mobility and toxicity through long-term stabilization and solidification of contaminants for a period of time allowing radioactivity to decay. Engineering and infiltration control, stabilization and solidification also have the advantage of treating contaminants to reduce mobility and to restrict receptor access to highly concentrated media. Alternative R-2C offers a greater level of reduction of toxicity, mobility, and volume due to the removal of the reactor vessel. However due to the half-life lengths of the specific radionuclides, the radioactivity from the reactor vessel will merely be transferred to an alternative disposal location.

5. Short-Term Effectiveness - The remedial alternatives are assessed based on factors relevant to implementation of the remedial action, including risks to the community during implementation, impacts to workers, potential environmental impacts, and the time until protection is achieved.

The No Action alternative would not involve any construction-related activities that could endanger public communities or remedial workers or adversely affect the environment. The No Action alternative also poses limited short-term risk to the environment. However, RAOs will not be achieved with the No Action alternative.

Alternative R-2A poses minimum risk to the decommissioning workers, the general public, and the environment. The highly activated vessel components would remain in place, hence worker exposure to radiation during decommissioning activities can be kept as low as reasonably achievable (ALARA), and environmental permits will mitigate disturbance during construction activities. RAOs would be achieved more rapidly as much of the equipment, including the Reactor Vessel, would be left in place; therefore, the remedy could be implemented more quickly.

Alternative R-2C poses significantly elevated risk to decommissioning workers as compared to Alternative R-2A. This elevated risk is associated with the activities required to completely remove the Reactor Vessel. The general public and the environment are also at a greater risk of exposure associated with the off-SRS disposal of the Reactor Vessel. RAOs would take longer to achieve in the short-term as the remedy will take longer to implement.

6. Implementability - The remedial alternatives are assessed by comparing the relative difficulty of implementing the alternatives, including technical feasibility, constructability, reliability of technologies employed, ease of undertaking additional remedial actions, monitoring considerations, administrative feasibility (regulatory requirements), and availability of services and materials.

No implementation is associated with the No Action alternative. Implementability of ISD Alternative R-2A would be highly practical as conventional technologies would be deployed (e.g., grout stabilization and infiltration control). For Alternative R-2C, it would be technically challenging to devise a methodology to remove the reactor vessel without exposing the workers to significant doses of radiation.

Removal and off site disposal of the reactor vessel, although undertaken during the decommissioning of commercial nuclear power generating plants, would not be as straightforward with the SRS reactors. The components that comprise the Reactor Vessel (reactor plenum, blanket gas space, top shield, thermal shield tanks, reactor tank [side wall plates], and bottom shield [including the reactor tank bottom plate], and biological shield [including concrete with carbon steel casing]) are not integrally connected nor easily separated from each other due to their placement in concrete and their weldments. Concrete (approximately 1.5 m [5 ft] thick) was poured into the biological shield after placement of the other Reactor Vessel components. Additionally, ancillary stainless steel piping and components traverse through the concrete. Significant amounts of concrete would need to be removed in order to access the Reactor Tank and Shield Tanks. The reactor tank and shield tanks would have to be size reduced either before or after removal from the biological shield encasement. Without being reduced in size, these components would be too large for either road or rail transportation to the final repository. The approximate weight of all 304 stainless steel in the reactor vessel is 567,000 kg (625 tons). The high gamma radiation field from the activated metal would mandate that all these operations be conducted remotely to reduce worker exposure. The complexity of the tasks involved in removing the reactor vessel would significantly increase the risk to the workers as a result of receiving an elevated radiological occupational dose.

7. Cost - Cost estimates for the comparison of the No Action and ISD Alternatives (R-2A and R-2C) are summarized in Table 4. Final project costs will depend on actual labor and material costs, actual site conditions, final project scope, schedule and other factors. The estimated cost difference between Alternatives R-2A and R-2C is approximately $30,000,000 for complete removal of the reactor vessel due to additional costs associated with crane refurbishment, implementability challenges, radiological control measures, container design, fabrication, transportation, and disposal necessary to remove the Reactor Vessel.

The Selected Remedy (Section XI)

In the EAROD, an ISD alternative was not specifically selected but rather the concept of ISD as the preferred end-state for the RBC was selected. This ESD to the EAROD presents the selected ISD alternative. The selected remedial alternative for the RBC is Alternative R-2A, ISD with the Reactor Vessel grouted in place. This alternative involves:

- The Process, the Purification, and the Assembly Areas of the RBC, as well as the actuator tower would be left in place;
- The above-grade structure of the Disassembly Area would be demolished to grade-level;
- The contents of the Disassembly Basin would be grouted to stabilize the contaminants;
- A sloped concrete cover would then be placed over the grouted Disassembly Basin;
- The remaining contaminated equipment in the above-grade structure of the RBC will be left in place. Any remaining residual contamination in the above-ground structure would remain;
- The P-Reactor Building (105-P) will be sealed to prevent human/animal access to the above-grade portions;
- The stack would be removed above the plus 16.8 m (55 ft) elevation and a new partial roof would be placed over the exposed opening to prevent water ingress;
- The holes in the five foot thick floor of the plus 20.2 m (66 ft) elevation of the actuator tower would be grouted.
- The shield door gantry system would be removed from the roof of the building and a new partial roof would be constructed and sloped over the shield door slots to prevent rainwater ingress;
- The Reactor Vessel would be grouted in place with a constructed concrete cover placed at ground-level. The cap would be sloped to allow water runoff;
- The Process Room would remain in its current state;

- Vacant spaces from 0 m (0 ft) level (grade) down to the minus 15.1 m (49.5 ft) level would be grouted in place;
- The Purification Area will be grouted to the top of the cell wall at the plus 6.1 m (20 ft) level. The below-grade portions of the Purification Area will be grouted to the plus 1.5 m (5 ft) finished floor level;
- The Purification Area roofs will be designed, and maintained for 300 years;
- The Process Areas roofs will be designed, and maintained for 1350 years;
- Continuation of ongoing inspections, monitoring programs, and maintenance as needed to ensure integrity of the remedial action. Groundwater monitoring will be conducted to verify that the remedy is protective of groundwater. Maintenance activities will include the prevention of vegetative growth on the roofs and the sealing of cracks in the cover system to prevent significant infiltration. The specific details concerning inspections, monitoring programs, and maintenance needed to ensure the integrity of the remedial action will be discussed in the Early Action RAIP for the PAOU and the final ROD and LUCIP for the PAOU; and
- ICs will be implemented through access controls for on-site workers via the Site Use Program, Site Clearance Program, work control, worker training, worker briefing of health and safety requirements and identification signs located at the waste unit boundaries and notifying the USEPA and SCDHEC in advance of any changes in land use or excavation of waste.

Alternative R-2A provides a remedy that meets the RAOs and provides the best balance among the nine criteria, focusing heavily on the short-term effectiveness, implementability, and cost criteria, while resulting in a remedy that is effective in the long-term due to the isolation from human exposure and minimizing contaminant mobility that it will provide. This remedy also provides for consolidation of remediation waste from other cleanup actions within P Area, but does not require those wastes to be consolidated therein if more cost-effective means of disposal are available. Present worth cost estimates for Alternative R-2A ISD is $52,541,000.

Figures 4 and 5 presents a conceptual depiction of what Alternative R-2A for the RBC would look like.

V. Statutory Determinations

The goals of remedial actions are to protect human health and the environment and to mitigate the effects of contamination. USEPA has established a structured process to identify and evaluate technologies for remedial applications. This process involves developing and screening a range of appropriate remedial options and selecting the most suitable approach(es) for corrective measures and remedial actions.

The NCP specifies six criteria for developing this range of remedial technologies [40 CFR Part 300.430(a)(1)(iii)(A-F)]:

- Whenever practical, use treatment to address principal threats posed by the unit;
- Use engineering controls for waste that poses a relatively low long-term risk or when treatment is impractical;
- Combine methods (for example, treatment plus engineering controls) to protect human health and the environment;
- Supplement engineering controls with institutional controls to prevent or limit exposure;
- Whenever practical, use innovative technologies; and
- Return usable groundwater to beneficial uses or prevent further degradation.

Based on the PAOU RFI/RI/BRA/CMS/FS report (SRNS 2008b), the RBC poses a threat to human health and the environment. Therefore, Alternative R-2A has been selected as the remedy for the RBC. The future land use of the PAOU is assumed to be industrial land use.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is and will continue to be protective of human health and the environment.

The selected remedy is protective of human health and the environment, complies with

Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action (unless justified by a waiver), is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of materials comprising principal threats through treatment) through grouting.

The selected remedy for the RBC leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for an indefinite period of time. While LUCs are expected to be part of the final remedy, this ESD to the Revision 1.1 EAROD does not select any specific LUCs. LUCs as elements of the remedy will be selected in the final PAOU ROD. Should results from groundwater monitoring associated with the ISD remedy indicate the need for additional LUCs in the future, they would be addressed through the five year remedy review process.

VI. Public Participation Activities

The public will be informed of the changes to the selected remedy as specified in this ESD through mailings of the *SRS Environmental Bulletin*, a newsletter sent to approximately 3,500 citizens in South Carolina and Georgia, and through the *Aiken Standard*, the *Allendale Citizen*, the *Barnwell People Sentinel*, *The State*, and the *Augusta Chronicle* newspapers.

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Alternatives, T-CLC-P-00004, Revision 0, Washington Savannah River Company, Savannah River Site, Aiken, SC.

ARF # 16387

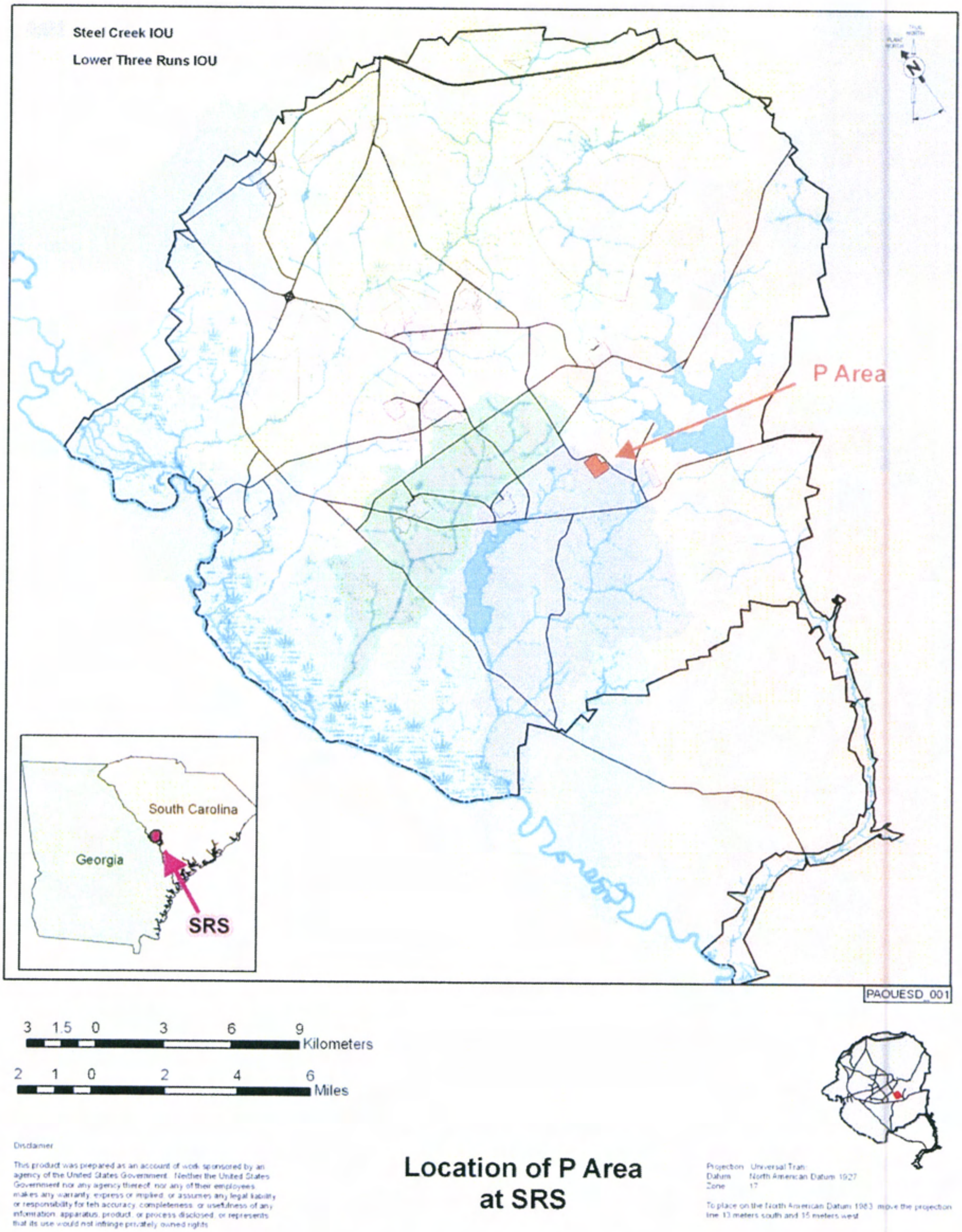

Figure 1. **Location of the PAOU within the Savannah River Site.**

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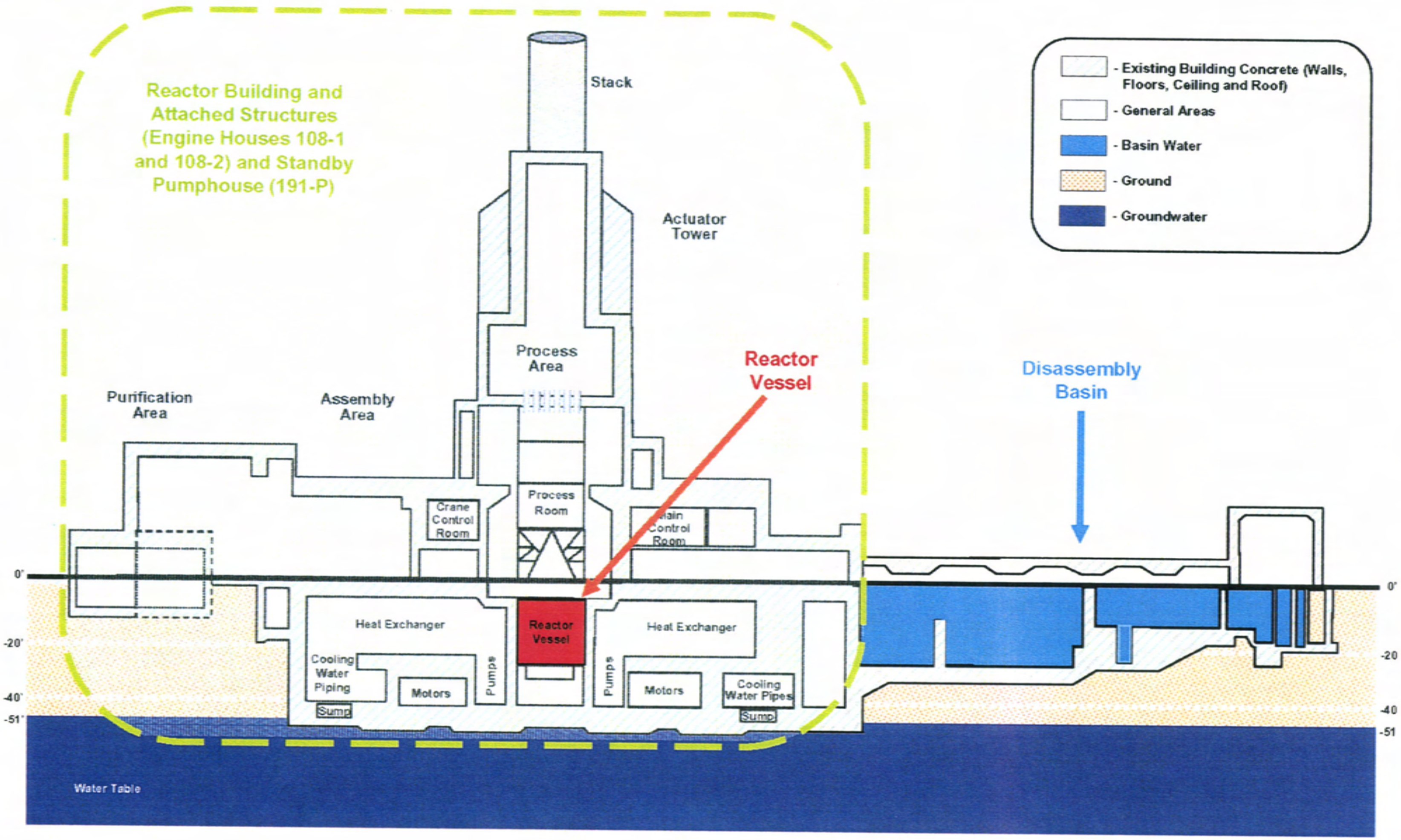

Figure 2. General Representation of the P-Reactor Building (105-P) Complex (Looking East).

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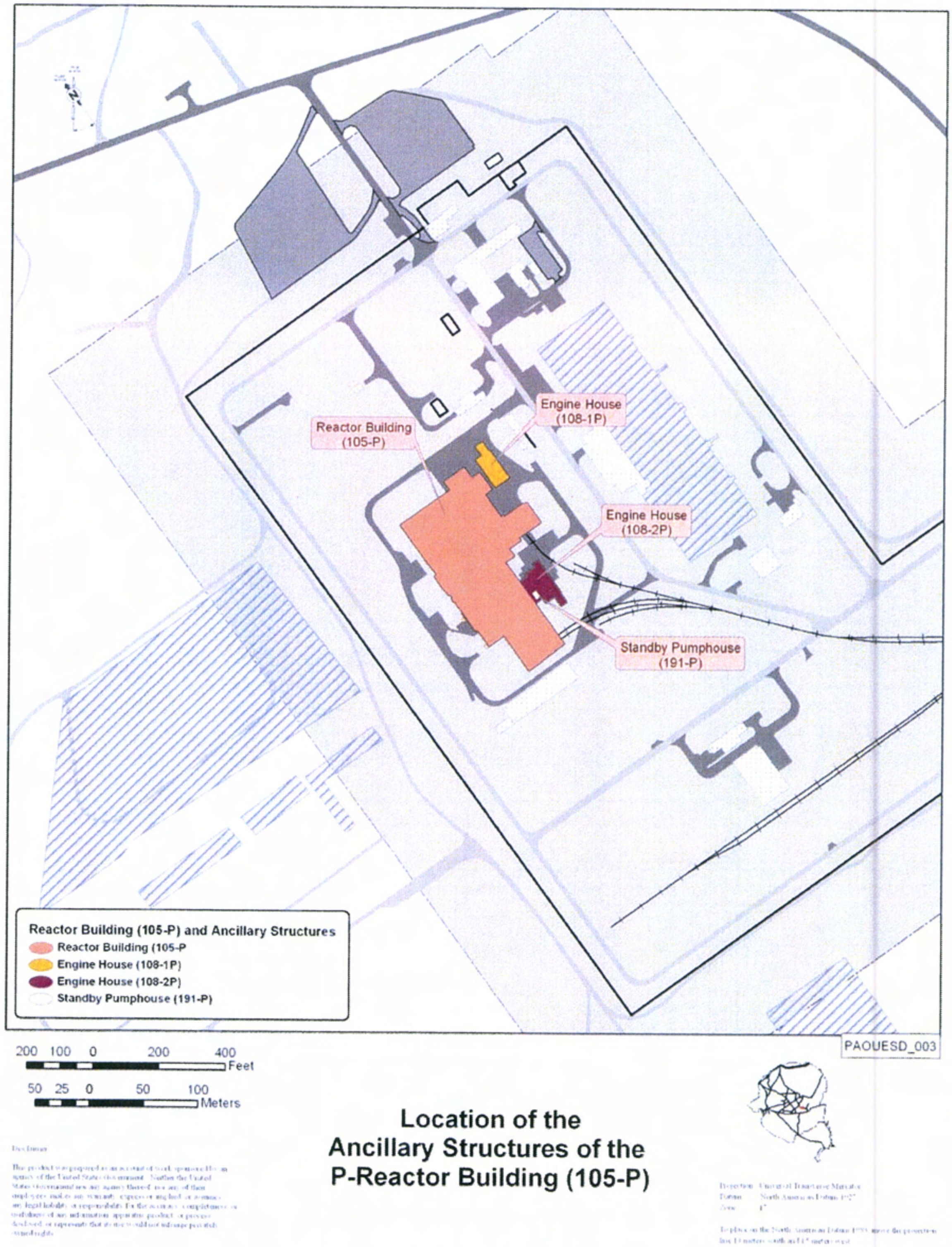

Figure 3. **Location of the Ancillary Structures of the P-Reactor Building (105-P).**

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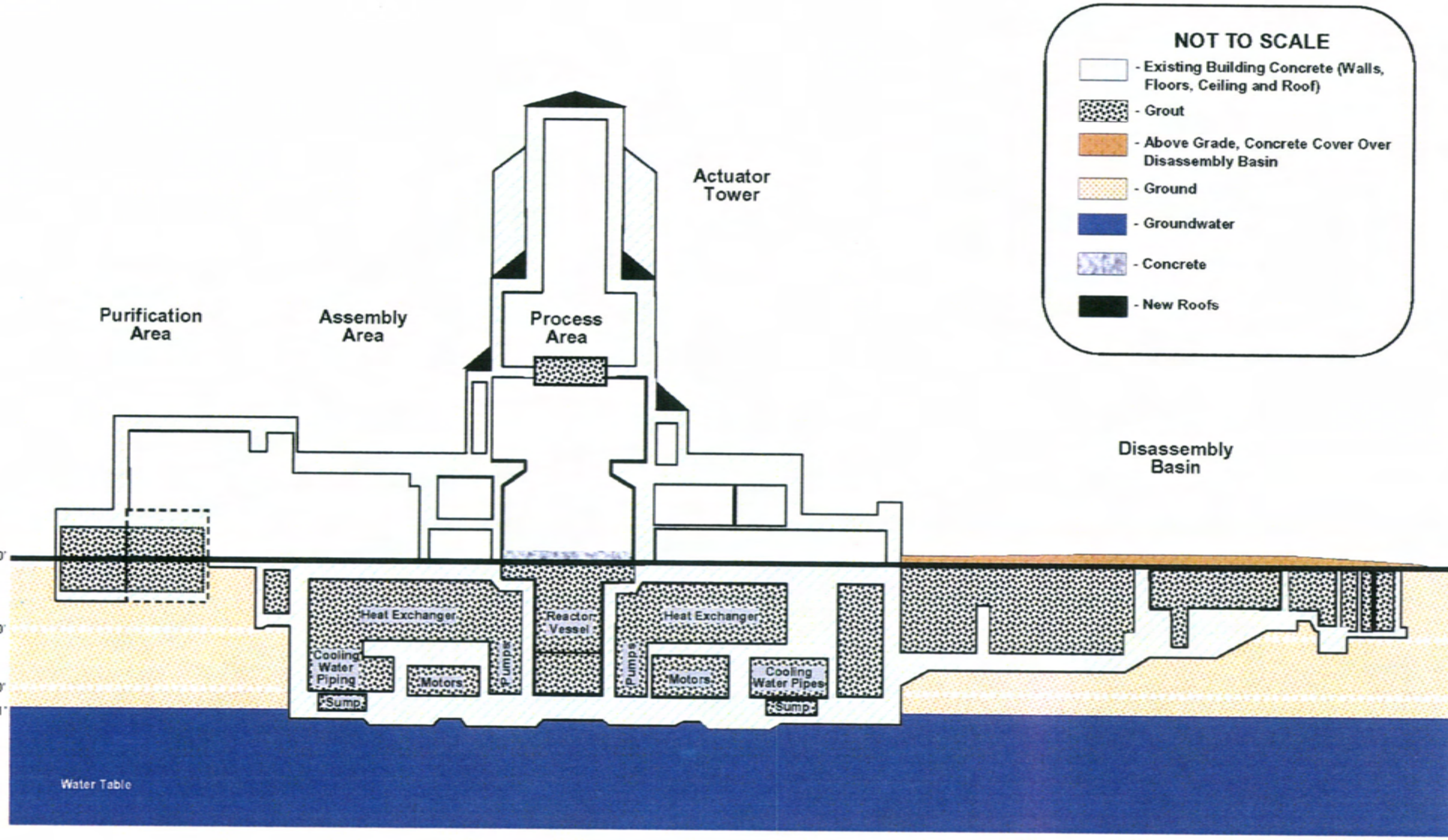

Figure 4. General Representation of the P-Reactor Building (105-P) depicting Alternative R-2A (ISD with the Reactor Vessel grouted in place).

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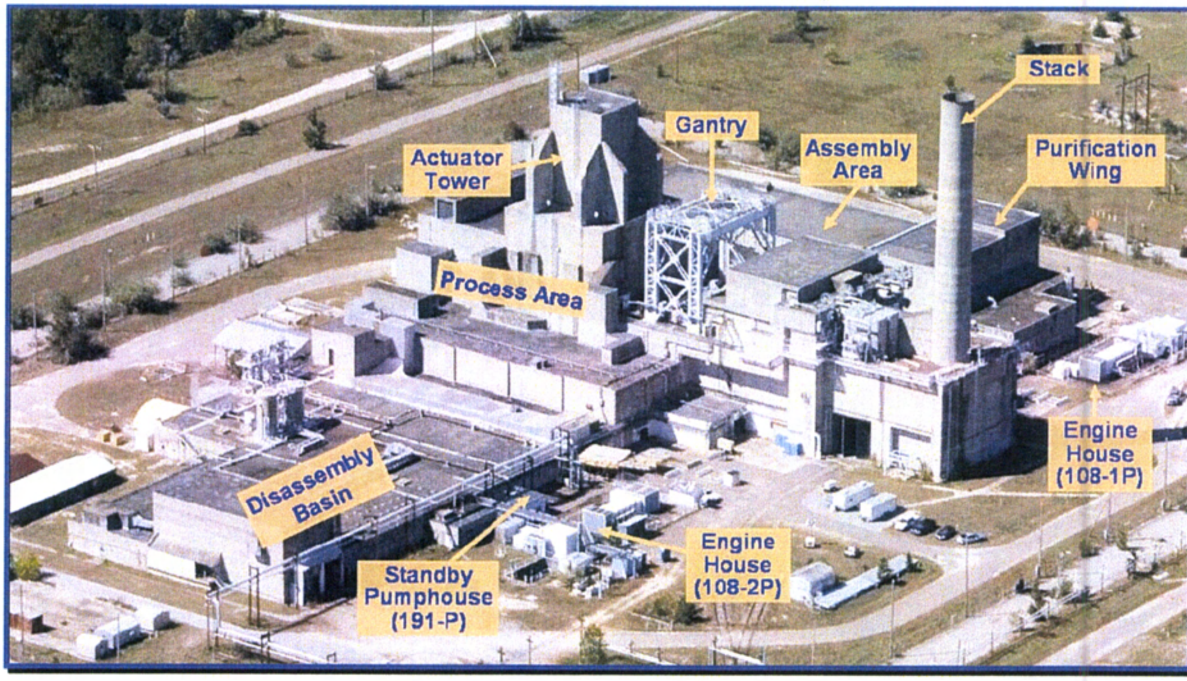
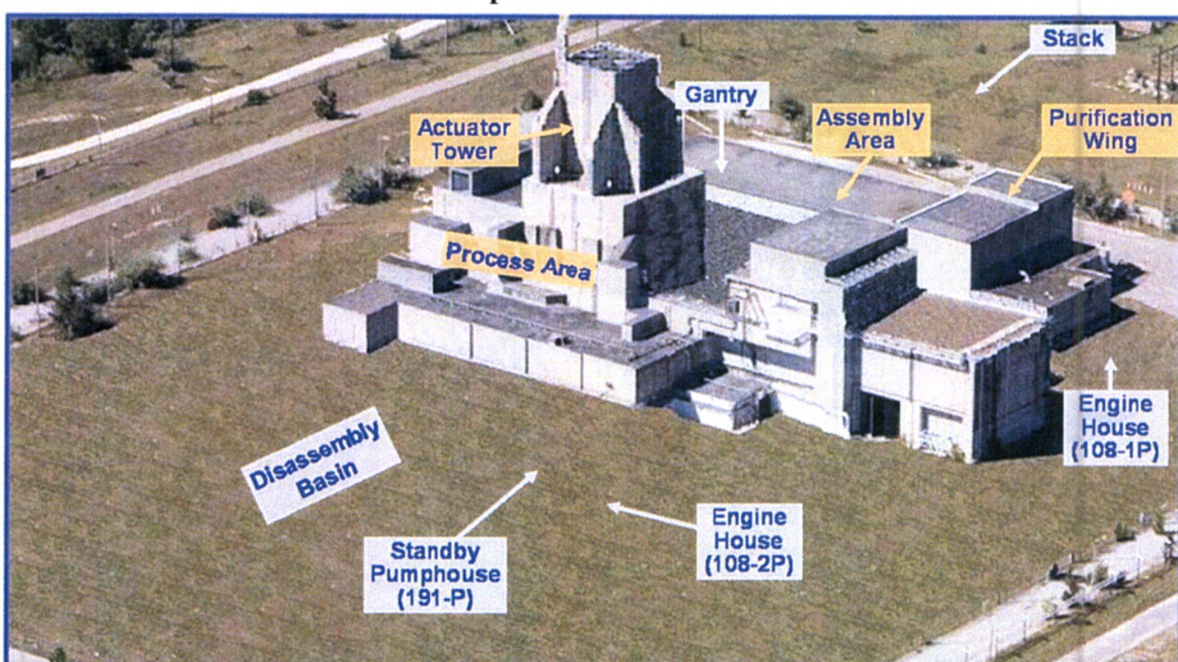
Current (Before Alternative R-2A)



After Completion of Alternative R-2A



Note: New Roofs are not depicted.

Figure 5. Alternative R-2A – P-Reactor Building (105-P) Complex - *In Situ* Decommissioning (Before and After)

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Table 1. Summary of Contaminant Migration Results (SRNS 2008b).

Constituent[1]	Concentration Time	MCL/PRG[2]	Alternatives[3] No Action	R-2A	R-2C
Carbon-14	Max. (pCi/L)	2,000	**220,000**	**6,000**	84
	Time of Peak (yr)		400	4,500	1100
	Time of Initial Exceedance (yr)		220	1,800	--
Chlorine-36	Max. (pCi/L)	700	**21,000**	**1,200**	0.0041
	Time of Peak (yr)		380	4,600	3500
	Time of Initial Exceedance (yr)		220	1,800	--
Potassium-40	Max. (pCi/L)	2	**3.9**	0.83	1.3
	Time of Peak (yr)		400	1,400	1,300
	Time of Initial Exceedance (yr)		300	--	--
Calcium-41	Max. (pCi/L)	135	**230**	21	25
	Time of Peak (yr)		2,200	10,000	6,200
	Time of Initial Exceedance (yr)		300	--	--
Nickel-59	Max. (pCi/L)	300	**28,000**	**6,400**	130
	Time of Peak (yr)		7,300	55,000	20,000
	Time of Initial Exceedance (yr)		520	25,000	--
Nickel-63	Max. (pCi/L)	50	**1,900**	-	-
	Time of Peak (yr)		660		
	Time of Initial Exceedance (yr)		420	-	-
Niobium-93	Max. (pCi/L)	6	**510**	**28**	--
	Time of Peak (yr)		2,400	30,000	--
	Time of Initial Exceedance (yr)		280	2,000	--
Molydenum-93	Max. (pCi/L)	14	**3,300**	**64**	2.1
	Time of Peak (yr)		500	3,000	940
	Time of Initial Exceedance (yr)		280	2,000	--
Technetium-99	Max. (pCi/L)	900	**1,100**	31	8.6
	Time of Peak (yr)		240	880	260
	Time of Initial Exceedance (yr)		220	--	--
Silver-108m	Max. (pCi/L)	6	**600**	0.032	0.0066
	Time of Peak (yr)		1,400	4,400	2,500
	Time of Initial Exceedance (yr)		620	--	--
Total Dose[4]	Max. (pCi/L)	4	**560**	**85**	3.8
	Time of Peak (yr)		400	55,000	1,300
	Time of Initial Exceedance (yr)		220	1,300	--
Lead (stable)	Max. (pCi/L)	15	**17**	9.1	5.2
	Time of Peak (yr)		180,000	380,000	500,000
	Time of Initial Exceedance (yr)		90,000	--	--

(1) Only constituents with at least one environmental exceedance are shown.
(2) Only potassium-40 and molydenum-93 use the PRGs.
(3) Shaded cells indicate a simulated exceedance of the MCL/PRG.
(4) Total dose includes contributions from modeled beta- and gamma-decaying radionuclides with a defined MCL (primarily carbon-14, chlorine-36, nickel-59, nickel-63, and technetium-99)

"-" = concentration less than 0.001 pCi/L.

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Table 2. List of ARARs for the P-Reactor Building (105-P) Complex.

Citation(s)	Status	Requirement Summary	Reason for Inclusion
Chemical-Specific			
National Emission Standards for Hazardous Air Pollutants (NESHAP) Subpart M, 40 CFR 61.140-141, 40 CFR 61.145 National Emission Standard for Asbestos	Applicable	Requirements for asbestos identification and control. Standards for demolition and renovation. Inspection, notification, and procedures for emission controls.	Given age and type of buildings covered, there is a potential for asbestos in building materials. Any investigation, removal, or handling of these materials would require compliance with these regulations.
NESHAP 40 CFR 61 Subpart H, 40 CFR 60.90-97 National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities.	Applicable	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 millirem (mrem) per year (yr).	Demolition of contaminated buildings, excavation activities, or grouting could produce airborne emissions of radionuclides which would be subject to the 10 mrem/yr limit for airborne radionuclide emissions during cleanup of federal facilities.
Toxic Substance Control Act (TSCA) 40 CFR 763 Asbestos Standard of Performance for Asbestos Projects SC R.61-86.1	Applicable	Applicability and state licensing and notification requirements. Inspection, testing, work practices, containerization and packaging requirements, air sampling and disposal requirements.	Given the age and type of buildings, there is a potential for asbestos in building materials. As such, worker training, company licensing, and work practices required by these regulations would be necessary during removal activities to protect workers.

Table 2. List of ARARs for the P-Reactor Building (105-P) Complex (continued).

Citation(s)	Status	Requirement Summary	Reason for Inclusion
Chemical-Specific			
Occupational Radiation Protection 10 CFR 835	Applicable	Establishes a total effective dose of 5 rem or specified doses to eyes or skin limits for general employees. Also establishes a 0.1 rem/yr total effective dose equivalent limit for members of the public entering controlled areas. Other sections of this regulation specify monitoring, recordkeeping, labeling, posting, and training requirements for occupational workers.	Since radionuclides are present, requirements related to worker dose limits, monitoring, labeling, training, and recordkeeping must be met. Exposure to members of the public to radionuclides must be controlled.
National Primary Drinking Water Regulations 40 CFR 141 SC R. 61-58 State Primary Drinking Water Regulations SC R. 61-68 Water Classification and Standards	Applicable	Establishes requirements and standards for chemicals and radionuclides to protect human health from the potential effects of drinking-water contamination.	The state of South Carolina classifies all groundwater as potential sources of drinking water and mandates that groundwater meet maximum contaminant levels (MCLs) established by the Safe Drinking Water Act.
Radiation Protection of the Public and the Environment DOE Order 5400.5	To Be Considered	Establishes standards and requirements for operations of the Department of Energy (DOE) and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation	Reactor facilities contain radioactive contamination and radioactive material. As such, the requirements of the Order must be followed.
Radioactive Waste Management DOE Order 435.1	To Be Considered	Ensures that all DOE radioactive waste is managed in a manner that protects the worker, public safety, and the environment.	Demolition could generate radioactive waste that would have to be managed appropriately at a DOE facility. Active SRS radioactive disposal facilities are authorized under this Order.

Table 2. List of ARARs for the P-Reactor Building (105-P) Complex (continued).

Citation(s)	Status	Requirement Summary	Reason for Inclusion
Chemical-Specific			
USEPA OSWER Directive 9200.4-18	To Be Considered	Cleanups of radioactive contamination outside the risk range (in general, exceeding 15 mrem/yr EDE which equates to approximately 3E-04 increased lifetime risk) are not protective.	EPA policy establishing protective range for radionuclide cleanups at CERCLA sites. Mandates use of CERCLA risk range rather than dose limits established under other regulations
The National Pollutant Discharge Elimination System (NPDES Permit SCR10000) SC R.61-9.122	Applicable	Requirements for permits and control of stormwater discharges.	Any stormwater discharges from demolition and remedial activities must meet permit conditions and standards established by state.
40 CFR 261, Identification and Listing of Hazardous Waste, 40 CFR 268, Land Disposal Restrictions Hazardous Waste Managements System SC R.61-79.261 and SC R.61-79.268	Potentially Applicable	Defines criteria for determining whether a waste is a solid waste and is RCRA hazardous waste. If a waste is RCRA, hazardous requirements for storage, treatment, disposal recordkeeping, and training of workers must be met.	If any hazardous waste is generated during demolition and remediation activities, these materials —such as piping, equipment, material, and concrete —removed from the facilities would have to be evaluated to determine if they are hazardous waste per RCRA.
Toxic Substances Control Act 40 CFR 761	Applicable	Identifies identification, sampling, marking, labeling, storage and disposal requirements for PCB remediation waste and bulk product waste.	Due to the age of the facilities, coatings, caulking, and lighting fixtures used in construction could contain PCBs. Demolition activities could generate concrete, piping, and electrical and mechanical equipment manufactured before PCB ban. If PCBs are identified in these materials, compliance with these requirements is necessary.

Table 2. List of ARARs for the P-Reactor Building (105-P) Complex (continued).

Citation(s)	Status	Requirement Summary	Reason for Inclusion
Action-Specific			
Control of Fugitive Particulate Matter 40 CFR 50.6 South Carolina Air Pollution Control Regulations and Standards SC 61-62.6 Control of Fugitive Particulate Matter	Applicable	Requires that fugitive particulate material be controlled with the use of water, chemicals, or other means in demolition or construction operations.	Demolition of existing structures, excavation of contaminated materials, grading of roads and other demolition/construction actions may require dust suppression, if potential exists for particulate emissions.
South Carolina Air Pollution Control Regulations and Standards SC 61-62.1 and 62.5	Applicable	Identifies allowable air concentrations and permit requirements for air emissions of toxic criteria and air pollutants for new and existing sources	Applicable to portable diesels (nonrad). Would apply to air emissions of Standard 2 Toxic Air Pollutants and Standard 8 Ambient Air Quality Standards and permitting.
The National Pollutant Discharge Elimination System (NPDES Permit SCR10000) SC R.61-9.122	Applicable	Requirements for permits and control of stormwater discharges.	Any stormwater discharges from demolition and remedial activities must meet permit conditions and standards established by state.
Standards for Stormwater Management and Sediment Reduction SC R.72-300	Applicable	Stormwater management and sediment control plan for land disturbances.	Demolition activities may require an erosion control plan to prevent environmental impacts from stormwater runoff

Table 2. List of ARARs for the P-Reactor Building (105-P) Complex (continued).

Citation(s)	Status	Requirement Summary	Reason for Inclusion
Action-Specific			
Solid Waste Management SC R.61-107.11 Construction, Demolition and Land Clearing Debris Landfills SC R. 61-107.258 Municipal Solid Waste Landfills	Applicable	Regulations governing disposal of nonhazardous solid waste.	Demolition activities would generate solid waste requiring disposal in accordance with these regulations.
SC R. 61-71, South Carolina Well Standards	Applicable	Regulations governing installation and abandonment of monitoring wells	Implementation of the remedy will require some wells to be abandoned
Radioactive Waste Management DOE Order 435.1	To Be Considered	Ensures that all DOE radioactive waste is managed in a manner that protects the worker, public safety, and the environment.	Demolition could generate radioactive waste that would have to be managed appropriately at a DOE facility. Active SRS radioactive disposal facilities are authorized under this Order.

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Table 3. Cost Summary for the P-Reactor Building (105-P) Complex.

Item	No Action	ISD R-2A	ISD R-2C
Direct Capital Costs			
Above Grade Decommissioning (Sealing openings, stack removal, modify roof, above grade structures demolition, disposal, etc.)	$0	$7,723,000	$7,723,000
Below Grade Decommissioning cost (Grouting, below grade equipment stabilization)		$13,280,000	$12,880,000
Support (Decontamination, Characterization and Surveys)		$2,800,000	$2,800,000
Removal of Reactor Vessel, Plenum and internals (includes disposal costs)	NA	$0	$14,370,000
Grade and Cover	$0	$1,700,000	$1,700,000
Total Direct Capital Costs	$0	$25,503,000	$39,473,000
Indirect Capital Costs			
Engineering and Management	$0	$5,540,600	$9,868,250
Total Indirect Capital Costs	$0	$5,540,600	$9,868,250
Direct O&M Costs			
200 years of O&M period	$0	$700,000	$700,000
Total Direct O&M Cost	$0	$700,000	$700,000
Indirect O&M Costs			
Contingency	$0	$7,760,900	$12,335,313
Overhead	$0	$13,036,485	$20,584,266
Total Indirect O&M Costs	$0	$20,797,385	$32,919,578
Total Estimated O&M Costs	$0	$21,497,385	$33,619,578
Total Estimated Cost	$0	$52,540,985	$82,960,828

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Table 4. Comparative Analysis Summary for the P-Reactor Building (105-P) Complex

Alternative	Effectiveness	Implementability	Overall Protection of Human health and the Environment	Compliance with RAOs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability		Cost	Overall Ranking (1 – 25)	Comments
R-1 – No Action	Not effective in eliminating possible contaminant release. Alternative does not treat or remove waste.	Not Applicable	No	NA	1	1	1	5	5	$0	13	No Action alternative is required by NCP.
R-2A –ISD 2A (Grout Reactor Vessel; Remove Disassembly Basin Above-Grade; Grout Below Grade Portions)	Effective in containing and treating waste and minimizing potential releases into environment for short- and long-term timeframe.	Readily Implementable	Yes	Yes	3	2	4	4	4	$52,540,985	17	Minimum scope for implementing ISD. Meets RAOs at minimum cost. Minimum risk to workers.
R-2C –ISD 2C (Remove Reactor Vessel; Remove Disassembly Basin Above-Grade; Grout Below Grade Portions)	Effective in containing and treating waste and minimizing potential releases into environment for short- and long-term timeframe.	Not readily implementable due to technical challenges and remediation worker radiation exposure associated with removing reactor vessel	Yes	Yes	4	4	2	1	3	$82,960,828	14	Meets RAOs. Risk to remediation workers from exposure to reactor vessel is potentially high.

* Difference in cost between Alternative R-2A and R-2C is estimated to be $30,000,000 for removal of the reactor vessel.

Notes:

- Numeric range 1 through 5, where 1 = worst and 5 = best.
- For overall ranking, 1 = worst and 25 = best.

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ARF # 16387

9/29/09
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