Establishing Final End State for a Retired Nuclear Weapons Production Reactor; Collaboration between Stakeholders, Regulators, and the Federal Government - 11052

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ABSTRACT

The Savannah River Site (SRS) is a 310-square-mile United States Department of Energy nuclear facility located along the Savannah River (SRS) near Aiken, South Carolina. Nuclear weapons material production began in the early 1950s, utilizing five production reactors. In the early 1990s all SRS production reactor operations were terminated.

The first reactor closure end state declaration was recently institutionalized in a Comprehensive Environmental Response and Compensation and Liability Act (CERCLA) Early Action Record of Decision. The decision for the final closure of the 318,000 square foot 105-P Reactor was determined to be in situ decommissioning (ISD). ISD is an acceptable and cost effective alternative to off-site disposal for the reactor building, which will allow for consolidation of remedial action wastes generated from other cleanup activities within the P Area.

ISD is considered protective by the regulators, U. S. Environmental Protection Agency (US EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC), public and stakeholders as waste materials are stabilized / immobilized, and radioactivity is allowed to naturally decay, thus preventing future exposure to the environment. Stakeholder buy-in was critical in the upfront planning in order to achieve this monumental final decision. Numerous public meetings and workshops were held in two different states (covering a 200 mile radius) with stakeholder and SRS Citizens Advisory Board participation. These meetings were conducted over an eight month period as the end state decision making progressed. Information provided to the public evolved from workshop to workshop as data became available and public input from the public meetings were gathered.

ISD is being considered for the balance of the four SRS reactors and other hardened facilities such as the chemical Separation Facilities (canyons).

BACKGROUND

The Savannah River Site (SRS) is a 310-square-mile United States Department of Energy nuclear facility located along the Savannah River (SRS) near Aiken, South Carolina **(Figure 1)**.

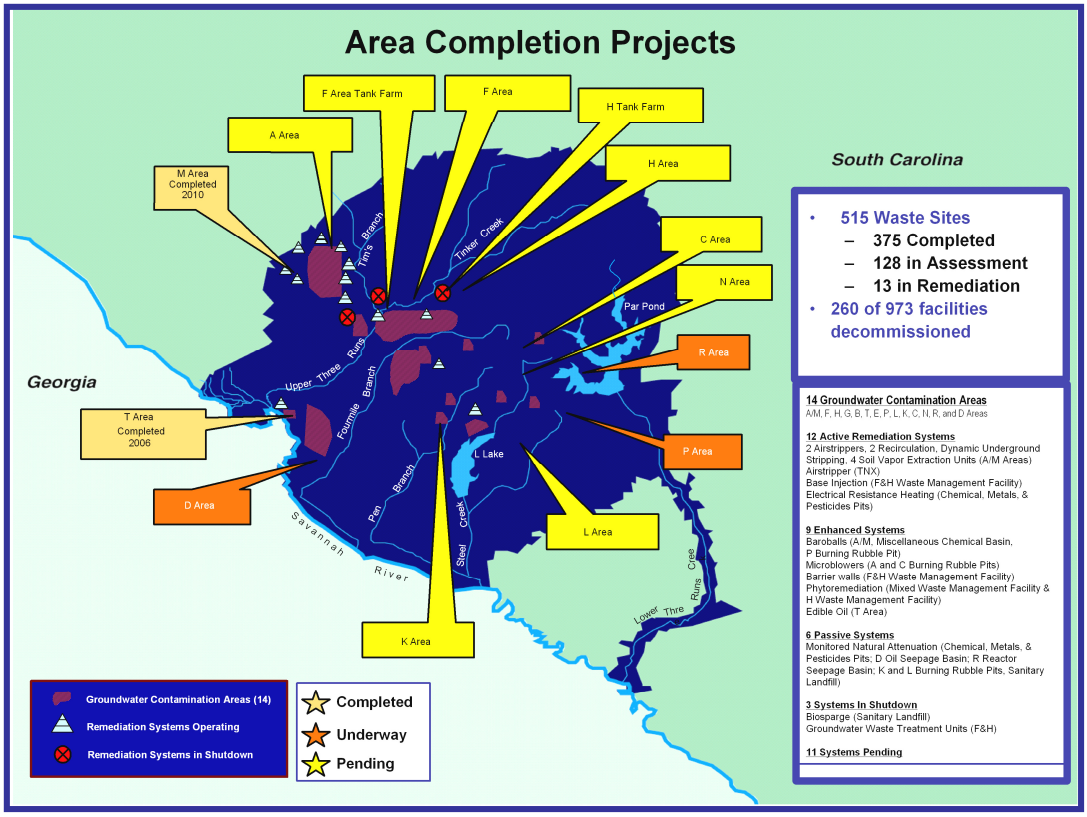

Figure 1. Savannah River Site – Area Completion Projects

Construction of SRS began in the early 1950s to enhance the nation's nuclear weapons capability. Nuclear weapons material production began in the early 1950s, eventually utilizing five production reactors constructed to support the national defense mission. SRS is located in the sandhills in Aiken, Barnwell, and Allendale counties of South Carolina. SRS is bounded by the Savannah River that runs between Georgia and South Carolina to the Atlantic Ocean at Savannah, Georgia, nearly 100 miles downstream of SRS.

The towns of Aiken, North Augusta, New Ellenton, and Jackson, South Carolina and Augusta, Georgia are closest to SRS; however, SRS operations spark interest in the citizens from the nearby communities as well as those all the way to the coast, including the downstream cities of Savannah, Georgia and Hilton Head, Charleston, and Beaufort, South Carolina.

With the end of the cold war, after 40 years of producing nuclear materials for defense and non-defense uses, the Department of Energy (DOE) shifted its strategic direction. In the early 1990s, SRS production reactor operations were officially terminated. This change in mission shifted SRS focus from reactor and nuclear materials production to environmental cleanup and

management. Environmental remediation work gained momentum, and by 2002, more than half the waste disposal areas had been completed. At this point, SRS also initiated an aggressive deactivation, decommissioning, and demolition program (D&D).

In their focus on waste unit cleanup and D&D activities, SRS and the regulators recognized that with a shift in how the two programs were being implemented, opportunities existed to accelerate both programs while also reducing the lifecycle costs. In May 2003, the Department of Energy, the US EPA, and SCDHEC signed a Memorandum of Agreement (MOA) to support accelerated cleanup of the SRS using an Area Completion strategy for cleanup. The SRS Federal Facility Agreement (FFA) and cleanup milestones were renegotiated to support the Area Completion strategy.

Under the Area Completion strategy, SRS uses an Area Operable Unit (AOU) concept to clean up and close large industrial areas of the Site. This strategy integrates D&D activities and soil and groundwater characterization, assessment, and remediation functions in each of the 14 SRS industrial areas to realize efficiencies of scale in the characterization, assessment, and remediation activities. With concurrence from US EPA and SCDHEC, this strategy focuses on addressing the contaminated surface units and the vadose zone and addressing groundwater plumes subsequently. This approach streamlines CERCLA documentation and enhances the ability to make large-scale cleanup decisions.

There are five reactor areas (P, R, C, K and L) that will undergo closure under Area Completion requirements consistent with the SRS FFA. The SRS reactors were built in the 1950s and 1960s and are extremely robust since they were designed and constructed to resist seismic and blast events. P and R Areas are the first reactor areas to under go the Area Completion process and are located approximately 2.5 miles east-southeast of the geographical center of SRS and about 4 miles west of the nearest site boundary. The areas have been unoccupied since the early 1990s when the decision was made to place the reactors in cold standby (i.e., never re-start the reactor). Both P and R Areas have been designated as having no future mission and thus, deactivation and decommissioning activities were initiated in these areas in the mid 2000 time-frame. To date, all ancillary buildings have been removed and only the reactor buildings remain. Each reactor building is “cold and dark” as all electrical and mechanical hazards have been eliminated and temporary power has been installed. All irradiated-fuel and target assemblies have been removed from the reactor vessels, and all fluids have been drained from the process systems. A core team from the US EPA, DOE, and SCDHEC meet regularly to review progress of P and R Area closures. It is anticipated that final decommissioning of these facilities will be complete by the end of 2011,five to six years ahead of the respective baseline schedules thanks to American Recovery and Reinvestment Act (ARRA) funding.

105-P/105-R REACTOR BUILDINGS

Similar to the other SRS reactors, P/R Reactors produced special nuclear materials for defense programs. To characterize the facilities, concrete samples were collected throughout the building along with water and sludge samples. In addition, radiological surveys were also performed. Modeling determined the radiological inventory within the reactor vessel. In P area, the reactor vessel has been estimated to contain 211,000 curies (Ci) of neutron-activated metal and concrete.

The balance of the building (including contaminated concrete and process related equipment), along with the disassembly basin, contains approximately 28,800 Ci **(Figure 2)**. Overall, tritium is responsible for approximately 99% of concrete contamination throughout the buildings. Approximately 88% of the radiological inventory in the reactor buildings is contained within the activated matrix of the stainless steel reactor vessels and associated concrete biological and thermal shields.

Between 90-95% of the radioactivity from 105-P will be decayed within 100 years and 99.9% within 1000 years. Structural analysis of the both the P and R Area buildings reveals that the building roof will last approximately 1400 years provided maintenance activities such as vegetation removal are performed.

Groundwater impacts were analyzed utilizing a tiered modeling approach. The intent was to determine if contaminants remaining in the facilities would pose an impact to groundwater over time. Modeling results showed that leaving the contaminants within the facilities would provide for groundwater conditions that are protective of human health and the environment for the long term.

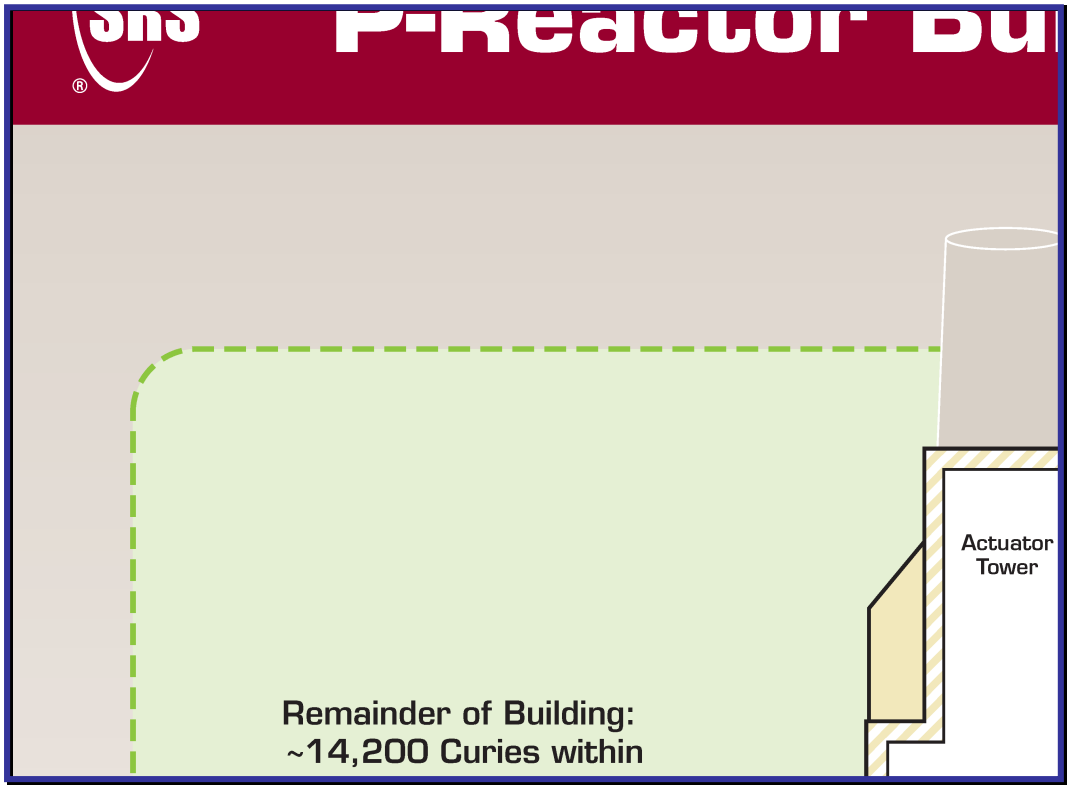

Figure 2. Savannah River Site P Reactor Cross Section

PUBLIC INVOLVMENT AND REMEDY SELECTION

The SRS public involvement program began in earnest with the signing of the SRS FFA in 1993. The FFA, a regulatory agreement between SRS, US EPA, and SCDHEC, established how SRS would perform cleanup while meeting requirements of major, but different, regulatory statutes. During the development of the FFA, stakeholders suggested to SRS, US EPA, and SCDHEC that an advisory board, composed of citizens who live and work in areas impacted by SRS operations, should be formed. The SRS Citizens Advisory Board (CAB) was established in 1994 to provide SRS and the regulators with advice on cleanup decisions. Since 1994, the SRS CAB has provided more than 250 recommendations on SRS remediation and nuclear materials and waste management issues. SRS, US EPA, and SCDHEC work closely with the SRS CAB and general public to bring the public into the cleanup and decision-making process early to ensure decisions that are made are understood and can be endorsed by the public. This approach to involving the public helps avoid making cleanup decisions that cannot be supported and may be challenged and / or overturned.

SRS, US EPA, and SCDHEC recognized very early in discussions on selecting cleanup remedies for the P-Area Operable Unit (PAOU), that public acceptance of the final end state for P Reactor would be critical. The parties recognized that any action selected for P Reactor would require stakeholder support and endorsement. While the sheer magnitude and complexity of the P Reactor and the nuclear processes that were conducted in the facility made the public involvement process daunting, the regulators and SRS committed to establishing a public involvement process that allowed complete and thorough understanding of the P Reactor and its various possible end states.

The three parties approached the SRS CAB to discuss opportunities and options for PAOU public involvement. Understanding the significance of closing the first SRS reactor and that decisions made for P Reactor would be precedent setting for other SRS reactors and hardened facilities, the CAB formally recommended that SRS, US EPA, and SCDHEC enter into an extensive public involvement process to solicit stakeholder input on the P Reactor end state decision. Further, the CAB recommended that the public involvement activities should focus not only on stakeholders in the immediate vicinity of the SRS, but also those living and working downstream of the SRS to the Atlantic coastal area. Upon receiving the recommendation, SRS and the regulators agreed to maintain active information exchange sessions with the CAB and public and to host workshops designed to help the CAB and public assess the potential end states for P Reactor.

In designing an effective public involvement program for this activity, SRS and the regulators understood there were several key attributes that would be required to effectively engage the stakeholders:

- Education about the history of the reactor facility, including construction details and operational history
- Current conditions of the reactor facility, such as the structural integrity
- Inventory of wastes and nuclear materials and equipment in the reactor facility
- Description of the 14 waste units within the 100-acre footprint of P Area that must be addressed and the contamination associated with each of the waste units

- Geologic conditions, including depth to groundwater, receptor points, migration pathways
- The regulatory required process to clean up the 14 waste units
- Typical reactor closure techniques used for commercial reactors
- Evaluation of each of the options that could be used to close the reactor facility, focusing primarily on cost and risk reduction
- Evaluation of post closure care and monitoring options designed to provide long term protection of human health and the environment

Over the next few years, SRS and the regulators deployed a public involvement process that enabled stakeholders to provide educated, meaningful, and timely input into the remedy selection process for the P Area Operable Unit, and specifically for the selected end state of the P Reactor. SRS developed specific communication tools, including posters, presentations, and animated graphics aimed at making the information regarding the complicated reactor facility and its past operations and current conditions "stakeholder friendly". Public involvement activities that were conducted included tours of the Reactor, three workshops in Aiken, South Carolina and Savannah, Georgia, nearly 10 briefings to the SRS CAB, and one-on-one meetings with stakeholders who needed additional information. These same approaches were used in the public involvement process for closure of the R Reactor Operable Unit.

These activities resulted in multiple formal and informal comments that were considered in the remedial action selection process and addressed in the regulatory documentation. Comments from each public meeting were captured along with responses. These comments helped in understanding the public's concerns and were used to improve each subsequent meeting or workshop. A collection of all the public comments and responses were included the responsiveness summaries included each of the P/R Area Early Action Record of Decision documentation. An advantage of performing this extensive public involvement process over several years was the public was given sufficient time to become informed on this complex topic so the input process was not rushed. Additionally, SRS and the regulators continued characterization activities, so as the three parties learned more information about the condition of the reactor facilities, they imparted this information to the public. This allowed SRS and the regulators to work in parallel with the public involvement process and maintain progress in reaching a decision on the appropriate remedial action.

In the summer of 2008, the SRS CAB and members of the general public provided SRS and the regulators with their input to support the remedial action selection for the reactor facility. The public endorsed leaving the reactor building in place while stabilizing the below-ground portions of the facility with grout to minimize contaminant migration. This approach was determined to be not only the most cost-effective approach, but also one that provided long term protection to human health and the environment. This input was used to select the final action for the reactor facility; additionally, stakeholders provided input for the cleanup of the waste units in the 100-acre P Area.

DESCRIPTION OF THE SELECTED REMEDY

Decisions regarding closure of P and R Areas have progressed since the projects were initiated in 2005. From 2006 through 2008, comprehensive sampling of soil, surface water, and

groundwater covering the P/R Area footprints (of nearly 220 acres in size) was performed to determine the nature and extent of contamination present in the areas. The findings demonstrated that impacts to the environment from reactor operations were relatively minimal. In P Area, Cesium was found in three localized soil locations and solvents were present in two locations within the vadose zone. The current land use for P/R Areas is industrial, and the decisions for the final end state of the Reactor buildings and the associated waste unit actions are based on the future industrial worker scenario.

Early Action Record of Decision documents (EA RODs) have been approved and outlines early remedial actions for select P/R Area waste units and a determination that in situ decommissioning will be the selected final remedial action for each reactor building. An early action document process was chosen in order to facilitate / engage early public involvement in this precedent setting decision. The remedies selected in the Early Action RODs are considered final actions. A final ROD for the PAOU was issued in 2010 with the RAOU Final ROD Issuance scheduled for mid 2011.

In situ reactor decommissioning will consist of minimal removal actions whereby the structure will remain basically intact. The stack will be removed and all of the below-grade equipment, including the vessel, would remain and be grouted in place. The Disassembly Basin would be demolished above grade, contents grouted in place, and covered. **Figures 3 and 4** illustrate the intended final end state. In addition, the regulatory agencies agreed that excavating radiologically contaminated soil and consolidating it within the reactor building for final disposition is sound and protective. It is anticipated that the selected in situ decommissioning remedy will avoid an additional $200M expenditure versus complete removal of the building.

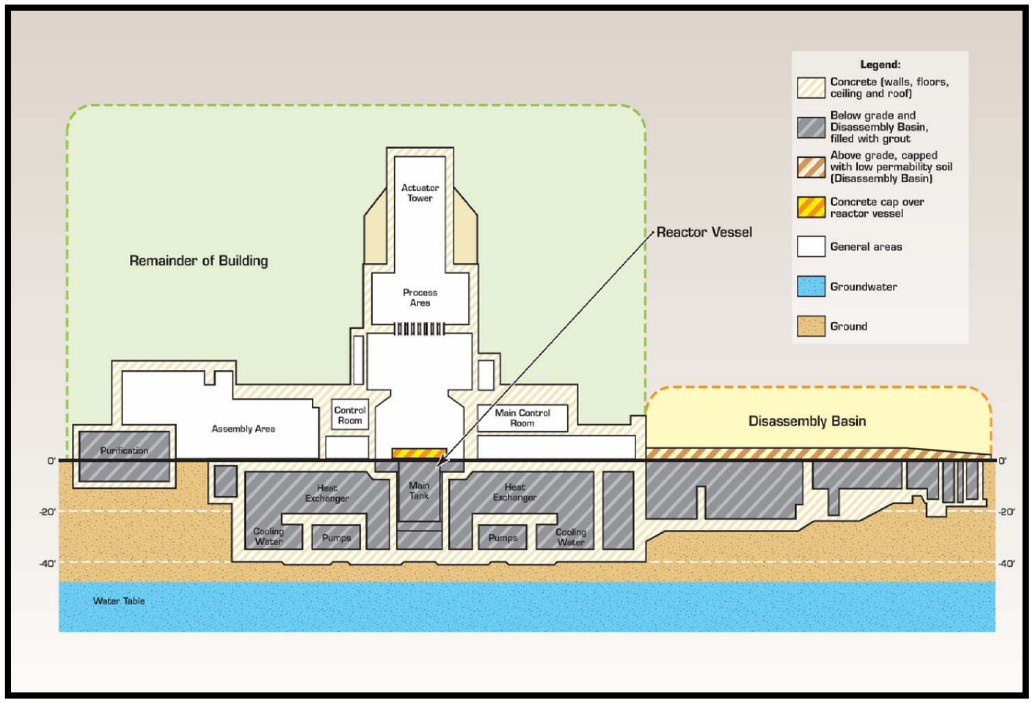

Figure 3. P Reactor In Situ Decommissioning

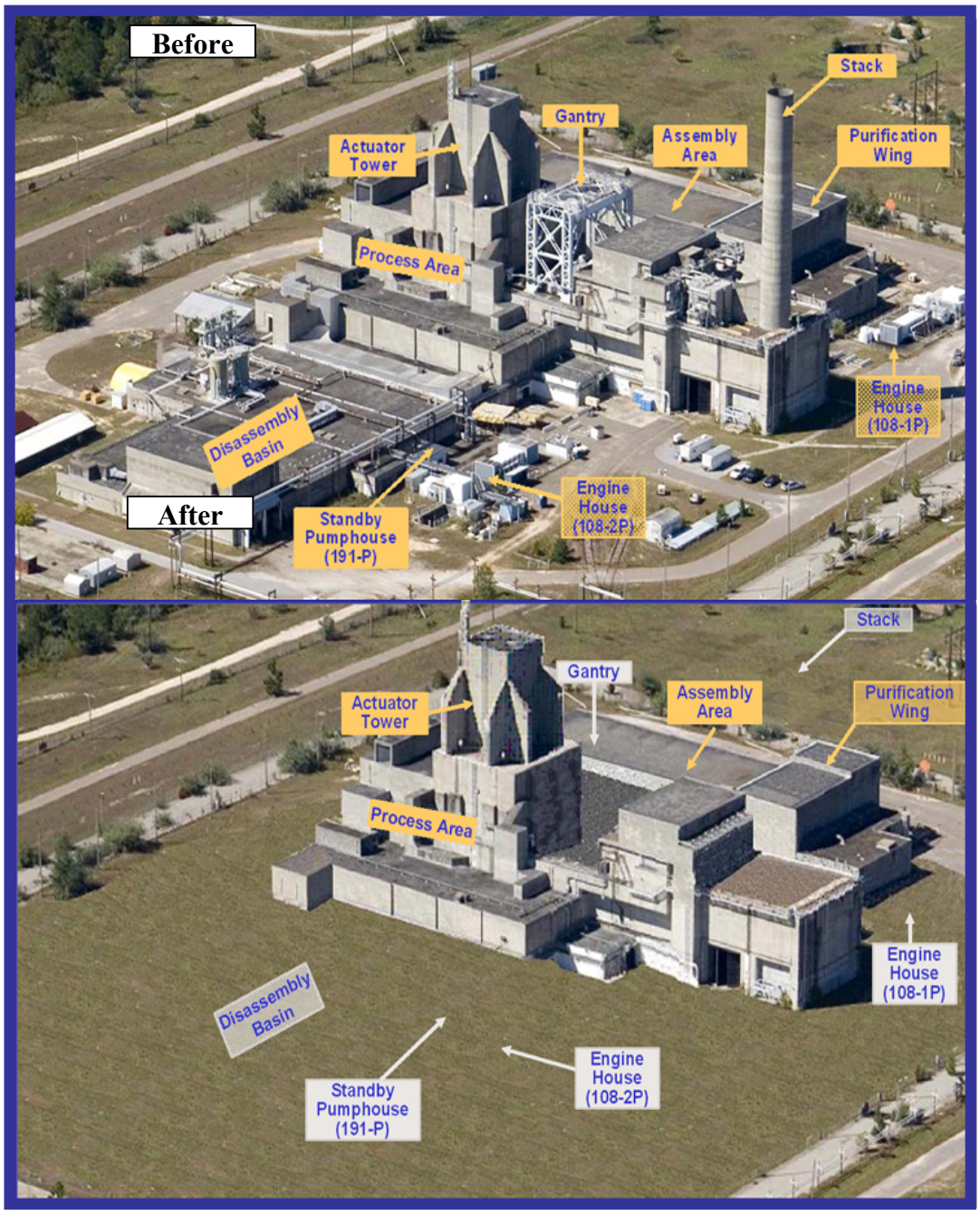

Figure 4. P Reactor – Current State and Following Completion

IMPLEMENTING THE STRATEGY

Deactivation has been completed in both reactor areas. Gantry Cranes that sat atop the reactor structure for raising and lowering the reactor shield doors were removed to promote long term integrity of the roofs. **Figure 5**

Figure 5. P&R Reactor Gantry Crane Removals

The 145 foot, 700 ton ventilation stacks were also removed (using explosives) since they could also impact the roof over time. **Figure 6**

Figure 6. P&R Reactor Stack Implosion

Grouting of the -20 and -40 elevations in P Reactor is nearly complete **(Figure 7)** and grouting within the R Reactor building was initiated in October 2010.

Figure 7. Grouting of P Reactor at -20 and -40 elevations

Clean-up actions outside the reactor facilities has progressed as well, one example is the closure of the former 17-acre R Area Ash Basin where contaminated soils were consolidated into the basin and covered with soil and grass to prevent accesses by and industrial worker to the waste material below. **Figure 9**

Figure 9. R-Ash Basin Sod and Grass Placement

CONCLUSIONS

Closure of the SRS P Reactor Area is precedent setting and sets the stage for closure of other reactors and hardened facilities. The DOE, US EPA, and SCDHEC engaged in active, up-front, and timely involvement with the SRS.

The SRS Citizens Advisory Board, elected officials, and citizens of South Carolina and Georgia met to discuss the P reactor area closure and associated risks. Early public involvement gave SRS and the regulators assurance that the selected decision was valid and would not be overturned. Public input improved the process and made sure that the important decision on the final end state of the reactor facilities was not made in a vacuum. Early end state decisions have been agreed upon in an Early Action Record of Decision and endorsed by the public. In situ decommissioning of P Reactor will provide adequate protection of human health and the environment and the lowest cost since short-term risk is minimized to remedial workers from exposure to contaminated equipment and facilities by leaving the reactor vessel in place allowing for radiological decay over time.