

A CASE HISTORY – SAVANNAH RIVER SITE TEST REACTOR PLACED IN LONG TERM STORAGE WITH ZERO FUTURE SURVEILLANCE AND MAINTENANCE COSTS

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ABSTRACT

In September of 1998, the Savannah River Site Heavy Water Components Test Reactor (HWCTR) was placed in a long-term safe storage condition with zero future surveillance and maintenance costs. The HWCTR Project team was able to accomplish long-term safe storage with no surveillance and maintenance costs objective by identifying all items that would potentially require surveillance and maintenance over the long-term storage period. Once surveillance and maintenance requirements were identified, a technical position was presented to justify the elimination of the requirement, or the item requiring surveillance or maintenance was removed from the facility.

INTRODUCTION

The Heavy Water Components Test Reactor (HWCTR, pronounced “Hector”) was a two loop pressurized heavy water test reactor. The facility and associated infrastructure were located in the northwest quadrant of the Savannah River Site, encompassing approximately two acres of land. HWCTR was a non-defense-related facility, used to test fuel elements and other reactor components for use in commercial heavy water power reactors. The nominal reactor power of 50 megawatts (thermal) was dissipated as free-release steam through a turbine generator and then directed to the atmosphere through a muffler assembly. The reactor containment building is 21.34 meters (70 feet) in diameter and rises 19.81 meters (65 feet) above ground with the lowest floor level at 15.85 meters (52 feet) below ground. The above ground section is constructed of 19.05 millimeters (3/4 inch) carbon steel for the vertical portion and 9.53 millimeters (3/8 inch) carbon steel for the domed portion. The below ground portion is constructed of pre-stressed concrete. The containment was designed to withstand an internal pressure of 1.69 kilograms per square centimeter (24 pounds per square inch). Operational support buildings, including a control building, health physics building, electrical distribution building and secondary cooling water auxiliary building, were in close proximity to the reactor containment building.

With construction activities beginning in 1959, HWCTR operated from March 1962 to December 1964. As research and development work on heavy water power reactors shifted to reactors cooled with organic materials, the HWCTR facility was no longer needed. In December of 1964, operations were terminated and the facility was placed in a standby condition. In 1965, all fuel assemblies and neutron sources were removed from the facility. All systems that contained heavy water were drained, vacuum dried and

placed under a nitrogen blanket to minimize corrosion. All fluid piping systems were drained, de-energized, and disconnected from plant services. The spent fuel basin was drained and dried. Only essential electrical systems remained energized. Site personnel maintained the facility in a standby status for about one-year, after which all ventilation systems were shut down, and the facility doors and security fence gates locked. In 1971, the practice of maintaining a nitrogen atmosphere was discontinued.

From 1965 until 1993, periodic surveillance was conducted, however little maintenance was performed. The site power feed to the reactor containment building was left energized so that yearly entries could be made by the responsible custodian organization. In 1993, condition assessment surveys of the HWCTR facilities were performed. It was determined to be economically advantageous to proceed with demolition of the facilities to reduce overall surveillance and maintenance costs. Demolition of the auxiliary buildings and outside equipment commenced and continued through 1996, with plans to provide release for unrestricted use of the original two-acre area by the end of the year 2000. In October 1997 due to funding availability beyond 1998, dismantlement of the remaining structures was deferred and the HWCTR was to be placed in an extended surveillance and maintenance mode. A project execution plan was prepared to place the containment facility into a long-term storage period of 60 years.

Key milestones are provided in the timeline below.

Suggest time line rather than table, but use milestone (in bold) with dates

Construction of facility began	1959
<i>Erection of dome began</i>	<i>May 1960</i>
Initial reactor testing commenced	September 1961
<i>Initial criticality achieved</i>	<i>March 3, 1962</i>
Final reactor shutdown	December 1964
Systems drained and vacuum dried, nitrogen purge applied	1965
Nitrogen purge curtailed	1971
<i>Limited radiological characterization study performed.</i>	<i>1975</i>
<i>First decommissioning plan issued</i>	<i>1976</i>
Demolished of site structures	1994 - 1996
<i>Asbestos insulation removed from steam generators and piping</i>	<i>1995</i>
<i>Detailed characterization study completed</i>	<i>September 1996</i>
Demolition deferred	October 1997

Figure 1. HWCTR Timeline

DISCUSSION

End State Vision

The objective of long term storage is to place and maintain a facility in a safe condition allowing for continuing care over an extended period. During this period, the facility is controlled and protected to preclude the exposure of workers, the public or the environment to residual radiological, chemical, or toxic hazards. Physical security measures are effected to preclude accidental intrusion and significantly hinder deliberate intrusion. All surveillance and maintenance activities required until final decommissioning is initiated are identified, and a methodology to fund these activities is undertaken. Measures to minimize the surveillance and maintenance costs are investigated and evaluated.

Project Strategy

The HWCTR Project Team established a final goal to achieve a condition of zero surveillance and maintenance costs during the duration of long term storage. A three-step process was established as a path to the final goal. The first step consisted of a screening process to identify general areas that posed a potential for requiring surveillance and/or maintenance over the storage period and those specific systems, structures or components that would be impacted. The second step served to identify cost-effective resolutions to minimize the necessary surveillance and maintenance actions identified. The resolution categories consisted of removing the item from the facility, performing a modification action to the item or providing a technical justification for no action. The third step was to perform the evaluations, studies or calculations necessary to support the desired end-state as suggested by step two. Figure 2 depicts this overall process:

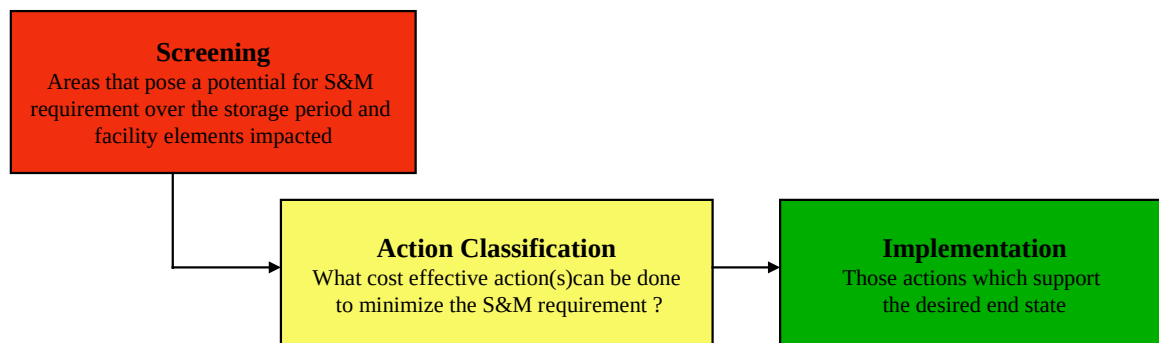


Figure 2. Logic Process for Minimization of Facility Surveillance and Maintenance

For the HWCTR project, the conclusion of step three defined the actions or endpoints used to define the scope of the HWCTR Project Execution Plan. With these endpoints, the project developed both cost and schedule for the deactivation activities to be implemented in the field during 1998.

“Jumping-off “ Point

Initially, the Project Team reviewed documents and conducted interviews with previous facility custodians that might provide understanding to the surveillance and maintenance activities. From 1971 to 1993, the HWCTR facility was in the surveillance and maintenance life cycle phase. Periodic yearly surveillance was conducted. Over the 22 years, the equipment and facilities outside of the containment dome were significantly degraded by the elements. Inside the containment building, the equipment, piping and other support equipment, including wood and paper, that had been abandon-in place, remained in the as-left condition. The air tightness of the dome provided excellent protection from the elements. Since entry into the facility was minimized, this infrequent intrusion did not allow air change cycles to take place from outside to inside the facility, bringing with it moisture. During the 22 years, no water intrusion was noted. Since the yearly entries during the 22 years found no significant changes to the as-left condition, once all hazards were addressed, elimination of yearly entries would minimize required surveillance and maintenance facility costs in future years.

RESRAD Info

In 1997 a series of RESRAD analyses were performed for the HWCTR facility to determine the extent of the necessary removal of radioactive material. The results are reported in “Residual Radioactivity Guidelines for the Heavy Water Components Test Reactor at the Savannah River Site”. The report concluded that after the reactor vessel and steam generators are removed, the remaining inventory of residual radionuclides, if left in the facility, would “produce less than one millirem per year above background to a hypothetical individual on the property.”

Application of the Process

The following text provides the specific details that the HWCTR Team derived using the logic process described above to successfully eliminate surveillance and maintenance for the HWCTR facility.

Step One - Screening

The screening process resulted in the following general areas where the potential existed for surveillance and/or maintenance actions to be performed during the long-term storage period:

- Facility structural integrity – all building and structures
- Hazardous material – as defined in the detailed facility characterization
- Environmental monitoring – air, surface and ground water
- Safeguards and security – facility classification and asset value
- Containment - from intrusion and extrusion
- Fire protection - from intrusion and extrusion

- Radiological Contamination – as defined in the detailed facility characterization
- Signage – those necessary after deactivation
- Grounds keeping – control of vegetation and storm water system

Step Two – Action Classification

Evaluation of structural integrity included all building and structures. The outside support buildings were in bad state of repair and would not survive the storage period without refurbishment and periodic maintenance. The same condition existed for outside structures such as stacks, fences and piping. Outside buildings and structures were classified for removal. The coating system for the containment dome had not been maintained and the dome was beginning to rust. The one other structural component under consideration was the below grade concrete portion of the containment building. The containment building was classified as requiring a structural analysis for the concrete and a structural and corrosion analysis for the steel portion.

Evaluation of hazardous material included Resource Conservation and Recovery Act (RCRA) and Toxic Substance Control Act (TSCA). A facility characterization was performed to identify types and quantities of hazardous materials. Hazardous materials under consideration included asbestos, lead, cadmium, mercury and polychlorinated biphenyl (PCB). Asbestos insulation, lead-shielding bricks, cadmium containing batteries, mercury thermometers and polychlorinated biphenyls in oil were classified for removal. Asbestos containing material in installed gaskets, encapsulated lead and polychlorinated biphenyl in cable insulation and paint were considered immobile and classified for justification for no action.

Evaluation of environmental monitoring requirements considered facility and site requirements for monitoring air, surface water and ground water. All aspects of environmental monitoring were classified as justification for no action.

Evaluation of safeguards and security considered the level of security required based on the facility classification, asset value and protection against physical intrusion. Safeguards and security from a physical protection was classified as no action. Protection from physical intrusion was classified as a modification action.

Evaluation of the containment envelope included the capability of the containment building to:

- remain sealed to prevent the release of the building contents
 - to prevent intrusion of animals, insects, vegetation, surface and ground water
 - prevent accidental intrusion and significantly hinder deliberate intrusion by man
- Sealing of the containment building was classified as a modification action.

Evaluation of fire protection requirements considered remaining combustible inside the containment, grass fires outside, probability of occurrence and the consequences. Fire protection was classified a modification action.

Evaluation of contamination considered the entire facility. The characterization report identified areas of contamination in underground components, soils and concrete. Contamination outside the containment building was classified as a removal action. Contamination inside was classified as both removal and justification for no action.

Evaluation of signage considered the posting and signage requirements and the durability of those systems to provide their intended purpose for the storage period. Classification of signage was both removal and modification.

Evaluation of groundskeeping considered the control of vegetation, erosion and maintenance of the storm drainage system. Classification of groundskeeping was justification for no action.

Step Three – Implementation

All structural integrity concerns for buildings and structures outside the containment building were resolved by dismantlement and removal. An engineering study was conducted to provide assurance that the remaining service life of the concrete structure exceeds the term of the storage period. Major causes of concrete deterioration such as freezing and thawing, chemical exposure, abrasion, corrosion of reinforcing, tension stresses and chemical reaction of aggregates were considered. It was determined that none of these adverse conditions exist. In addition, a visual examination was performed and indicated no cracking or abnormalities. A corrosion analysis was performed on the steel portion of the dome to determine the structural adequacy of the dome at the end of the storage period if left uncoated and free to rust. The engineering analysis provided technical justification to support the structural integrity of the containment building for the term of storage period.

Concerns for hazardous material were resolved by removal of all asbestos insulation, lead-shielding bricks, and cadmium containing batteries, mercury thermometers and polychlorinated biphenyls in oil. An evaluation was performed and concluded that asbestos containing material in gaskets, encapsulated lead shielding and polychlorinated biphenyls in cable insulation and paint was bound and no mechanism existed for release to the building. As evident during the previous 22 years of surveillance, these hazardous materials posed no threat for the storage period.

Evaluations for environmental monitoring requirements showed that the facility is not considered an air emission source under the Clean Air Act and air sampling conducted inside the containment building did not indicate air born contamination. The facility was previously removed from the National Pollutant Discharge Elimination System Permit due to absence of any industrial activity. The characterization study determined that ninety nine per cent of the total radioactivity is contained within the reactor vessel thereby providing a significant barrier to migration and release. The lowest floor elevation in the containment building is 20 meters (18.3 feet) above groundwater. Groundwater in the surrounding area is monitored under a separate site program. All liquids were removed from the facility negating the need to monitor for liquid

accumulation in the containment sump. Monitoring specific to the facility is not required.

Evaluations for safeguards and security requirements showed that the facility is located within the Savannah River Site boundaries, which is fenced and has guarded entrances to restrict public access. The facility is non-classified and has no economic value. No action is required to protect the facility. Protection from intrusion was accomplished by sealing all penetrations by welding. Site security forces during normal patrols will conduct routine security observations. Two personnel air locks and a roll up door provide access to the containment building. Numerous other penetrations existed. Modifications were made to ensure that the containment remains sealed consisted of welding all doors and penetrations closed.

Evaluations of fire protection requirements resulted in removing all transient combustibles from the containment building. All electrical and utilities had been disconnected eliminating a probable ignition source. Any fire would be self-extinguishing. The building has no economic or historical value. All requirements for a fire protection system were eliminated. Fire protection for outside the building will be by the existing site fire protection department.

Contamination outside existed in underground pipes and tanks, concrete driveways and soils. All contaminated areas and components outside the building were removed. An extensive soil sampling and analysis program was completed and confirmed the area to be clean. Loose contaminated material and equipment was removed from inside the building. A study was performed to determine exposure to individuals based on residual radioactivity using RESRAD computer model. Results of the RESRAD study concluded that exposures are below acceptable limits. Remaining contaminated areas inside the containment building were condensed in area and appropriately posted.

All non-durable posting and warning signs were removed from outside the building. A bronze placard was welded to each access door with instructions for entry. A study was conducted and concluded that the inside warning and posting signs will last for the storage period since the deterioration mechanism is exposure to ultra violet light.

The grounds outside the containment building have been turned over to the area administrator and a general site contractor will maintain mowing and cleaning, which is performed as a site wide program.

SUMMARY

The HWCTR Project Team was successful in identifying and justifying all actions necessary to achieve a long-term storage condition with no future surveillance and maintenance. The project team established a process that provided the required arguments and supporting documentation necessary for achievement of the project goals. The process implementation was straightforward and was executed with little difficulty. The project was successfully completed in September 1998 with the welding shut of the

reactor containment building doors. All documentation to support the end state condition has been placed in document control. A duplicate file was left inside the reactor containment building. This documentation provides a baseline for future decommissioning activities.

HWCTR is now in long-term safe storage until future decommissioning activities are undertaken.

REFERENCES

1. "Residual Radioactivity Guidelines for the Heavy Water Components Test Reactor at the Savannah River Site", U. S. Energy , April 1997
2. V-PMP-B-0000, "Deactivation Project Plan For the Heavy Water Components Test Reactor (HWCTR)", Revision 1
3. WSRC-TR-978-00419, "Long-Term Surveillance And Maintenance/Safe Storage Study, Heavy Water Components Test Reactor (HWCTR)", Revision 1