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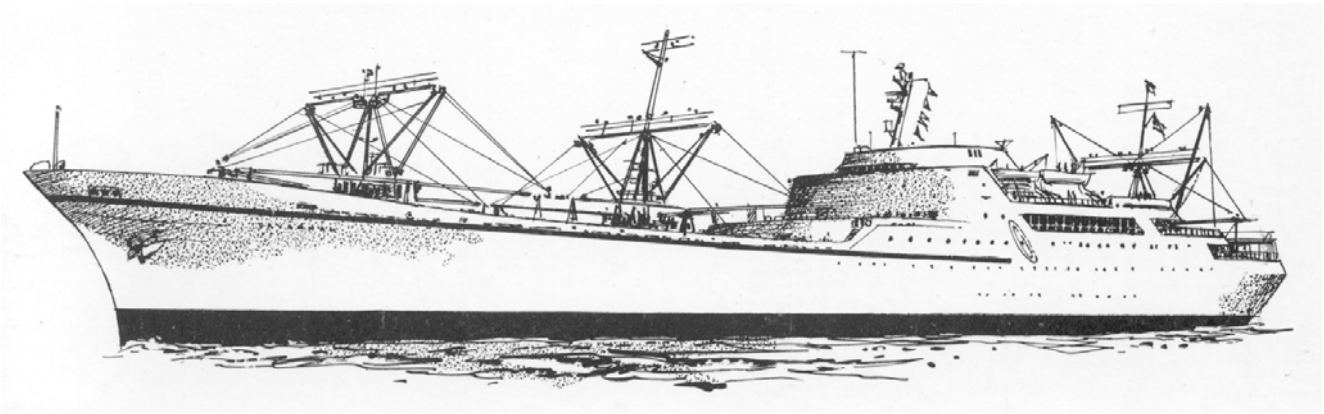

N.S. SAVANNAH

POST SHUTDOWN DECOMMISSIONING ACTIVITIES REPORT

STS-100
REVISION 1

Approved: APPROVED By Erhard W. Koehler at 1:06 pm, Dec 10, 2008 December 10, 2008

Senior Technical Advisor Date

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RECORD OF REVISIONS

Revision	Summary of Revisions
0	Original version of the Post Shutdown Decommissioning Activities Report submitted on December 11, 2006 and withdrawn on January 27, 2007.
1	This version is a revision in whole of the PSDAR.

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List of Acronyms

AEC	(U.S.) Atomic Energy Commission
ALARA	as low as reasonably achievable
CRD	Control Rod Drive
CV	Containment Vessel
DCGLs	Derived Concentration Guideline Levels
DH	Dehumidification
DHEC	Department of Health and Environmental Control (State of South Carolina)
DOT	(U.S.) Department of Transportation
EA	Environmental Assessment
EMOS	Engineering, Management and Oversight Support
ESC	Executive Steering Committee
FAR	Federal Acquisition Regulations
FONSI	Finding Of No Significant Impact
GEIS	Generic Environmental Impact Statement
GTCC	Greater-than-Class-C waste
HVAC	Heating, Ventilation and Air Conditioning
ICCP	Impressed Current Hull Cathodic Protection
JRRF	James River Reserve Fleet
LAR	License Amendment Request
LLRW	Low Level Radioactive Waste
LTP	License Termination Plan
MARAD	Maritime Administration (‘the Agency’ also “licensee”)
MSP	Manager, N.S. *Savannah* Programs
MW_{th}	Megawatt Thermal
NEPA	National Environmental Policy Act of 1969, as Amended
NHPA	National Historic Preservation Act of 1966, as Amended
NPDES	National Pollutant Discharge Elimination System
NRC	(U.S.) Nuclear Regulatory Commission

List of Acronyms (Continued)

NSS	Nuclear Ship *Savannah*
NST	Neutron Shield Tank
OMB	Office of Management and Budget
POL	Possession-only license
PPDA	Patriots Point Development Authority (State of South Carolina)
PSDAR	Post-Shutdown Decommissioning Activities Report
RCAs	Radiation Control Areas
RG	Regulatory Guide
ROM	Rough Order of Magnitude
SNEC	Saxton Nuclear Experimental Corporation
STA	Senior Technical Advisor
STS	*Savannah* Technical Staff
USDOE	U.S. Department of Energy

Other Decommissioning Acronyms Used

DECON is the decommissioning alternative in which the equipment, structures, and portions of the licensed facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use. DECON may occur shortly after cessation of operations, or after a period of SAFSTOR.

SAFSTOR is the decommissioning alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.

1.0 INTRODUCTION

The United States Department of Transportation (DOT), acting through the Maritime Administration (the "Agency" also "licensee") owns the Nuclear Ship *Savannah* ("NSS"), and holds License No. NS-1, Docket No. 50-238. In accordance with the requirements of 10 CFR § 50.82, "Termination of license," paragraph (a)(4)(i), this report provides Revision 1 to the Agency's Post-Shutdown Decommissioning Activities Report (PSDAR) for the NSS.

The Agency initially submitted Revision 0 of the PSDAR to the Nuclear Regulatory Commission (NRC) on December 11, 2006 (Reference a), and withdrew Revision 0 on January 27, 2007, prior to the NRC scheduling a PSDAR public meeting. The Agency explained the principal reason for withdrawal in Reference (b), and committed to resubmit the PSDAR when a reasonably stable[1] decommissioning approach could be determined.

1.1 PURPOSE

The PSDAR provides the NRC, states, and the public with a general overview of the licensee's proposed decommissioning activities. The PSDAR informs interested parties of the licensee's expected activities, costs, and schedule, facilitating planning for inspections and decisions regarding NRC oversight activities. The PSDAR also informs the public of the proposed decommissioning activities before the decommissioning activities are conducted.

1.2 ARRANGEMENT OF THE PSDAR

This report is arranged into sections that supply the information required in a PSDAR as described in 10 CFR § 50.82 and Regulatory Guide 1.185 (Reference c). The required content and the section(s) in which it is found includes:

- A description of the licensee's planned major decommissioning activities (Section 3.0);
- A schedule for completing these activities (Section 5.0 and Appendix B);
- A discussion regarding an estimate of the expected decommissioning costs (Section 6.0); and,
- A discussion that provides the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will be bounded by appropriate previously-issued environmental impact statements (Section 7.0).

Unlike a land-based nuclear plant, the NSS is waterborne, mobile and of unique historic significance, thus its decommissioning presents a number of unusual factors for consideration. The Agency has included additional content and sections in the PSDAR to address these factors. Section 2.0, "Background," provides a brief discussion of the design and history of the NSS, and a summary of the "mothballing" (decommissioning) actions completed after the ship was removed from service some 35 years ago. Section 3.0, "Description of Planned Decommissioning Activities," discusses the retention site options that may be available during the SAFSTOR operations period. Section 4.0 discusses "Other Decommissioning Issues," with some particular emphasis on contemporary SAFSTOR practices and their applicability to the NSS. Appendix A provides a detailed "Comparison of Mothballing and SAFSTOR Requirements" to describe the differences between the 1974 and current requirements for protective storage. Finally, Appendix C provides some discussion of potential decommissioning alternatives for the NSS. Appendix C is intended to foster future dialogue and should be considered in that light only.

[1] PSDAR Rev 0 was predicated on an incrementally-funded DECON effort beginning in FY 2007 and continuing through FY 2012. Appropriations bills for FY 2007 were not passed prior to or following the 2006 mid-term congressional elections, and the resulting Continuing Resolutions made the Rev 0 decommissioning schedule unachievable.

1.3 FINAL ENVIRONMENTAL ASSESSMENT (EA) AND FINDING OF NO SIGNIFICANT IMPACT (FONSI)

On May 14, 2008 (see Reference d), the Agency published notice of the availability of the Finding of No Significant Impact (FONSI), Reference (e), derived from a March 2008 Environmental Assessment (EA) regarding the Decommissioning of the Nuclear Ship *Savannah*, Reference (f). The FONSI documents the Agency's conclusion that the proposed federal action to decommission the NSS is consistent with existing national environmental policies and objectives as set forth in Section 101(a) of the National Environmental Policy Act of 1969, as amended (NEPA). The Agency concluded that the proposed action will not significantly affect the quality of the human environment or otherwise include any condition requiring consultation pursuant to Section 102(2)(c) of NEPA.

Because the NSS is a federally-owned facility, NEPA required that the Agency evaluate the available alternatives for the NSS prior to making an executive decision on decommissioning. The Agency released a draft EA documenting its evaluation of alternatives for public comment in 2006. As with Revision 0 of the PSDAR, that EA emphasized the DECON approach. The 2008 final EA incorporates public comments received, and expands the discussion and evaluation of the SAFSTOR decommissioning alternative. The EA has been independently evaluated and determined to adequately and accurately discuss the environmental issues and impacts of the proposed project. Because the Agency concluded that the proposed action will not significantly affect the quality of the human environment or otherwise include any condition requiring consultation, preparation of an Environmental Impact Statement, pursuant to NEPA, was not required. The FONSI was published instead.

See Section 7.0 for additional detail.

2.0 BACKGROUND

2.1 SAVANNAH PROGRAM CHRONOLOGY AND SUMMARY

The Maritime Administration is owner and licensee of NSS, the world's first nuclear powered merchant ship. Conceived in the 1950's as part of President Eisenhower's "Atoms for Peace" program, the NSS was designed, constructed and operated as a joint research and development project of the Department of Commerce, Maritime Administration and the Atomic Energy Commission (AEC). The Maritime Administration's contribution was the ship while the AEC's was the nuclear fuel, reactor and related nuclear systems. The NSS was designed with three primary goals:

- Demonstration of America's interest in the peaceful use of atomic energy;
- Use of the NSS as an atomic exhibit; and,
- Establishment of port entry criteria and worldwide acceptance of a nuclear merchant ship.

The NSS was not designed to be economically competitive with conventional ships.

The 80 MW_{th} reactor was first brought to power in 1961. Seagoing trials followed in 1962, with experimental operations and foreign voyages continuing into mid-1965. The AEC ended its participation in the project in 1965[2], transferring liability and title to the reactor to the Maritime Administration. NSS was operated in commercial demonstration service throughout the 1960's.

The only refueling was conducted in August to October 1968 at the Maritime Administration's Nuclear Servicing Facility, located at Todd Shipyards, Galveston, TX. This refueling was a "fuel shuffle" to extend the life of Core I. In this operation, the four center fuel elements were removed and replaced with four spare elements. The remaining 28 elements were rearranged to address fuel burnup (i.e., normal consumption). In general, the inner fuel elements were moved outwards, the outer fuel elements were moved inwards, and all elements were rotated 180^{o} relative to the core center. The new core design was designated Core Ia. Additionally, one control rod was replaced.

Having completed its research and commercial development program objectives, the ship was returned to Galveston, TX, and removed from service in the summer of 1970. The ship transited to New Orleans, LA, in October 1970 for drydocking, and the reactor was last operated in November of that year on the return voyage to Galveston. By the end of 1971 when alternatives for the immediate re-use for the ship failed to materialize, its nuclear power plant was defueled and prepared for long-term lay-up under contemporary best practices. Some minor, reversible decommissioning activities were undertaken at that time. The ship was moved to its homeport of Savannah, GA, in January 1972, as part of a plan to establish an "Eisenhower Peace Memorial" in that city. The intention of this effort was to permanently transfer title of the ship and the AEC license to the State of Georgia. The effort was not successful, and the ship was later moved to a Government berth at the North Charleston Army Terminal, SC.

In the interim the Agency concluded that the NSS would not be refueled and returned to service as a nuclear-propelled vessel[3]. The AEC issued a license amendment (Technical Specification Change 13) on January 29, 1973, that recognized the ship was in a "Fuel Removed Condition." Although the final reactor shutdown had occurred in November 1970 and the defueling was completed in fall 1971, these actions were not considered to be permanent until early 1973 when the decision was finally made to not

[2] The joint program terminated effective with the issuance of License NS-1, and the NSS became the sole subsequent responsibility of the Maritime Administration as owner and licensee.

[3] Studies to re-use the ship continued into the mid-1970's. A serious proposal to convert the *Savannah* into an Oceanographic Research Vessel held the most promise for re-use under nuclear propulsion. In 1974 a brief study was made to reactivate the ship to demonstrate its potential cost-savings during the first middle-east oil crisis. Studies to remove the reactor compartment and re-use the ship under conventional power continued into the late 1970's; the last of which was a proposal to convert *Savannah* into a hospital ship for the Rapid Deployment Force.

load Core II[4]. Therefore, the fall 1971 defueling retroactively became the *de facto* permanent defueling and cessation of operations with the issuance of Technical Specification Change 13.

Decommissioning activities resumed in 1975, when the NSS was "mothballed" per the contemporary requirements of Regulatory Guide (RG) 1.86, "Termination of Operating Licenses for Nuclear Reactors," Reference (g). This RG describes the now outmoded Mothballing option of protective storage. In 1988, the NRC formally identified the term SAFSTOR in the Generic Environmental Impact Statement (GEIS), NUREG-0586, Reference (h)[5]. The major difference between the two approaches (described more fully in Appendix A) is that the Mothballing process is a simplistic and prescriptive methodology that does not include the comprehensive and programmatic aspects of SAFSTOR.

In mid-1975 the ship was taken to Baltimore, MD, for routine drydocking. The NSS was returned to the North Charleston Army Terminal and maintained at layberth while the State of South Carolina pursued a new effort to place the ship into museum service.

By April 1976, additional decommissioning activities such as 1) disposing of primary purification system ion-exchanger resins, 2) removing the three primary purification system ion-exchangers and 3) dewatering the primary, auxiliary and secondary systems had been performed. The NSS possession-only license, Reference (i), was issued on May 19, 1976, for a ten-year term, and imposed the requirements associated with the Mothballed protective storage option. During the intervening 30 years, the ship has remained in the Mothballed condition.

The effort to make the ship a museum succeeded in 1981. The NSS was bareboat chartered[6] to the Patriots Point Development Authority (PPDA) of the State of South Carolina, for public display at the Patriots Point Naval and Maritime Museum, near Charleston, SC. During that period the PPDA was designated a "co-licensee" for the reactor and exercised custody of the ship and full management of the license. The vessel remained owned by the Maritime Administration, however. The bareboat charter was renewable on five year terms.

In 1981 the Maritime Administration was reorganized and transferred from the Department of Commerce to the Department of Transportation. From a licensing and funding standpoint this was an administrative change only.

In 1986 the NS-1 license was renewed for a ten-year term.

Shortly after the second bareboat charter renewal in 1991, a hull leak developed. After a series of surveys and inspections, it was concluded in 1993 that deterioration of the underwater hull body necessitated a drydocking, for which funding was requested from Congress. Unrelated to the underwater hull issue was internal deterioration from excessive water intrusion from the upper decks. The water intrusion condition began with Hurricane Hugo in 1989 and gradually worsened over time. In light of these issues and the effects they had on use of the ship, PPDA informally notified the Agency that it would exercise its right to terminate the charter effective with the ship's removal for drydocking.

Museum operations ended in early 1994, when industrial topside and internal repairs commenced in preparation for the drydocking and subsequent transfer of the *Savannah* to a reserve fleet. The NSS was

[4] Core II was fabricated but never possessed by the Maritime Administration.

[5] Draft Generic Environmental Impact Statement (GEIS) on Decommissioning Nuclear Facilities, NUREG-0586, January 1981, appears to be the first NRC document to introduce the term.

[6] A bareboat charter is an arrangement in which the bare ship is chartered without crew. The charterer becomes, for the period of the arrangement, practically the owner of the hired vessel. The charterer 1) appoints the captain, 2) engages the crew and pays their wages, 3) provisions and equips the ship, 4) becomes liable for all running charges 5) maintains the hull and machinery in efficient repair. The principal obligations of the charterer are to pay the owners an agreed sum and to redeliver her in the same condition as when chartered, ordinary wear and tear excluded. The statutory charter between the Agency and the PPDA was based on a bareboat concept, wherein PPDA exercised all custodial and "operational" (principally maintenance and repair) responsibility for the ship without remuneration to the Agency.

removed from the museum site on May 24, 1994 and in June 1994 was drydocked (again in Baltimore, MD) for hull maintenance and repair. Extensive repairs to deteriorated underwater hull plating were completed, and in July 1994 the *Savannah* was placed in the Agency's James River Reserve Fleet (JRRF) at Fort Eustis (Newport News), VA. License Amendment 12 was issued in July 1994, and among other things removed the PPDA as a co-licensee, and established the vessel's location as the JRRF. The NSS remained in protective storage there until August 15, 2006.

To prepare the ship for layup at JRRF, a number of conventional preservation measures were put into place. These included fitting a Dehumidification (DH) system to preserve the ship's interior, renovations to the Impressed Current hull Cathodic Protection (ICCP) system, and overhaul of the ship's existing fire, flooding and intrusion alarm systems. These modifications included long runs of portable ductwork and electrical cabling which generally obstructed the doorways, passageways and ladders throughout ship. Externally, deck drains were blanked off to reduce water intrusion into the ship's interior. No funds were available to correct the interior water damage effects; however, the DH did arrest any further degradation.

In preparation for, and during the lay-up period at the JRRF, no changes were made to radiological surveillance or monitoring plans and no substantive radiological work was performed. Radwork consisted exclusively of passive surveillance and monitoring in accordance with the circa 1981 surveillance plan. Only minimal modification, maintenance and testing of the alarm and monitoring systems required by Technical Specifications ("TS") were performed.

The Agency experienced a gradually diminishing institutional capacity to manage nuclear license operations through continuing retirements of experienced personnel, complacency with the absence of any significant radiological work and the routine renewal of health physics contracts[7]. In 1996 the Agency undertook its last substantive licensing action when it submitted a license renewal application that was returned by the NRC because new regulations were being implemented at that time (the "Termination of License" rulemaking, see Appendix A).

In early 2001 the NRC issued two Notices of Violation for failures to maintain emergency health physics support and an emergency radiological assistance team in accordance with the Technical Specifications. Action to address these violations was in-progress when the terrorist attacks of September 11, 2001 took place. In the wake of the attacks, the Maritime Administration expanded its license violation corrective actions to include an assessment of the ship's existing radiological vulnerabilities. In response the Maritime Administrator approved the February 2002 staff recommendation to advance the decommissioning of the ship's nuclear facilities and terminate the license. Initial activities undertaken in this decommissioning program included correcting the violations, basic engineering and planning, conducting a radiological and environmental characterization scoping survey, and implementing organizational and programmatic upgrades as described in sections 2.4 through 2.6. By early 2006 the decommissioning program was moving forward rapidly, with a draft Environmental Assessment completed, engineering support contracts under solicitation, and decommissioning site evaluation and selection in progress.

On August 15, 2006, the NSS was moved to Colonna's Shipyard, Norfolk, VA, for pre-decommissioning topside maintenance. By the end of the calendar year, emergent budgetary developments forced a reassessment of the decommissioning program (see section 6.1 for further detail). The NSS was maintained in a layberthed condition at facilities in the Hampton Roads area during the reassessment period. The reassessment eventually concluded that the NSS should be returned to protective storage until such time as a stable budgetary environment could support decommissioning and license termination. To place the ship into extended retention, a contemporary SAFSTOR compliance program is

[7] During the JRRF lay-up period, the *Savannah* was nested alongside the Army Corps of Engineers nuclear power barge *Sturgis*. NSS health physics / rad protection was provided by the Army Corps under a reimbursable agreement and addendum to the *Sturgis* health physics contract.

being developed and implemented. The program includes technical and industrial activities to be performed to the ship, and administrative activities to ensure the Agency maintains full compliance with all terms and conditions of its license.

On January 19, 2008, the NSS was drydocked at BAE Systems' Norfolk Ship Repair facility in South Norfolk, VA, for hull maintenance and exterior surface cleaning and preservation. Acting through its assigned General Agent, the Maritime Administration solicited competitive bids for a layberth to provide a secure retention site where SAFSTOR and license compliance activities could be completed. On May 7, 2008, the NSS left South Norfolk, VA, and arrived at Pier 13, Canton Marine Terminal at 4601 Newgate Ave., Baltimore, MD 21224 on May 8, 2008.

Calendar Year 2008 marks the beginning of a series of 50th Anniversary milestones for the ship and program. The anniversary of the ship's keel laying ceremony was commemorated on National Maritime Day, May 22, 2008. Milestone events will be commemorated through the August 2012 anniversary of the ship's maiden voyage to Savannah, GA.

Future planned activities are described in Section 3.0, "Description of Planned Decommissioning Activities."

2.2 SUMMARY OF COMPLETED DECOMMISSIONING ACTIVITIES (1971 – 1976)

The following discussion is a summary contained in Maritime Administration letters that supported issuance of Reference (i). An annotated explanation of the primary coolant system status is added to item 2.2.6.

2.2.1 REACTOR VESSEL

All 32 Core Ia fuel elements were removed from the reactor vessel to the spent fuel pool at the Agency Refueling Facility, Todd Shipyards, Galveston, TX. All reactor internal components were reinstalled, i.e., twenty-one control rods, core basket, upper grid plate, upper flow baffle. Thirty-six upper flow transition pieces and one additional irradiated control rod (cut in three pieces) were loaded into six fuel element channels in the core basket. Thirty-two upper flow transition pieces were from Core I and four were from Core Ia (i.e., the 1968 fuel shuffle). The additional control rod was the one replaced during the 1968 fuel shuffle. The reactor head was reinstalled with six of the original 48 reactor head hold down studs tensioned.

2.2.2 SPENT FUEL

Thirty six spent fuel elements (Core I plus the four "new" elements of Core Ia) were shipped from Galveston, TX to the AEC, now U.S. Department of Energy (USDOE), Savannah River Site, Aiken, SC, in nine shipments from October 4 through December 21, 1972.

2.2.3 FISSION CHAMBERS

All five fission chambers were removed and shipped to the Maritime Administration maintenance facility in Galveston, TX, in May 1973. On June 28, 1973, these five and an additional three stored on the NSV Atomic Servant (the nuclear services vessel for NSS) were shipped to Chem-Nuclear Systems, Inc., Barnwell, SC, for disposal.

2.2.4 PRESSURIZER

Relief valve PR-1V was removed. The nozzle flange was fitted with an absolute filter vent to allow for pressure equalization.

2.2.5 CONTROL ROD DRIVE SYSTEM

a. Electrical

The breakers for the rod drives were opened and tagged in the control rod drive electrical cubicle and the control room. The cables between the junction boxes on the control rod drive (CRD) structure and the junction boxes located around the periphery of the cupola were disconnected, coiled and secured on the CRD structure in the containment vessel (CV). The support wireways were removed, packaged and stored in Hold No. 4. In addition, the 21 buffer seal flow meter cables and the vibration monitor cables were disconnected.

b. Mechanical

All hydraulic oil was drained and the piping disconnected between the cupola and the CRD structure. Buffer seal system valves were closed and tagged out. The inlet and outlet header spool pieces between the cupola and structure were removed. The buffer seal system was drained.

The 21 control rods were disconnected from their respective CRD extension shafts and remain in their fully inserted position between the empty fuel location channels. The CRD extension shafts were disconnected from their lead screws and are fully inserted. The CRD lead screws were withdrawn and pinned in place. Steel caps were placed onto the 21 reactor head nozzles to completely seal the nozzle from the CV atmosphere and mechanically separate the CRD mechanism from the control rod.

2.2.6 PRIMARY COOLANT SYSTEM

The system was drained as completely as practical. All loop isolation inlet and outlet valves are open and back seated.

Primary Pump motors and impellers were removed. Blank flanges were installed over the volute openings. The grating, piping, valves, ducting, etc., disconnected while removing the pump motors and impellers, were left in the removed condition within the CV.

2.2.7 SECONDARY SYSTEM

Both steam generators and piping were drained of water as completely as practical. The non-radioactive water on the secondary side of the steam generators was transferred to a double bottom tank below the reactor compartment. The isolation valves outside of the CV were closed. There were no modifications to the secondary system.

2.2.8 AUXILIARY SYSTEMS

All nuclear related auxiliary systems were drained as completely as practical.

The three primary purification system ion-exchangers and their resins (28 Ci) were physically removed from the ship and their lines capped.

Non-radioactive water from the neutron shield tank was transferred to a double bottom tank below the reactor compartment. The equipment drain and waste collection system tanks were drained as completely as practical.

2.2.9 CONTAINMENT VESSEL (CV)

The forward and aft manway shield plugs were put in place with security seals installed. Entries into the CV were expected to be made through the aft airlock. The lifting chains and hooks were removed from the chain hoists used to handle the shield plugs to minimize the possibility of unauthorized CV

entry. The CV bilge was wiped clean. The inerting piping in the CV cupola head was disconnected outside and valves closed so that the integrity of the vessel was maintained.

2.2.10 RADIATION CONTROL AREA BOUNDARIES

Secured boundaries were established to prevent unauthorized access into Radiation Control Areas (RCAs). The secured entrances included the following spaces:

a. The Reactor Compartment;

b. The Port and Starboard Stabilizer rooms;

c. The Forward Control Areas (aka the Cold Water Chemistry Laboratory);

d. The Port and Starboard Charge Pump rooms; and,

e. The Hot Chemistry Laboratory, in the Control Room Area.

2.3 SUMMARY OF ROUTINE ACTIVITIES AFTER 1976

Until 2005, no significant decommissioning activities were performed following issuance of the Possession-only license (POL) in 1976. Routine activities under the POL included equipment corrective and preventive maintenance, inspection activities and housekeeping / ship husbandry operations conducted in accordance with established marine practices and the Technical Specifications. Systems/structures were monitored and maintained, as needed, to control the spread of radioactive material. A cathodic protection system was used to protect the underwater areas of the vessel's hull to minimize corrosion damage. Underwater inspections of the hull were conducted at least every four years to identify problems such as localized severe pitting, underwater plate thinning or other damage that would require corrective action.

When routine access was not required, the ship was locked and secured. Areas containing radioactive materials or other contamination were secured to prevent accidental intrusion and make deliberate intrusion difficult. Radiation protection activities were generally limited to those activities necessary to maintain exposures as low as reasonably achievable (ALARA).

In accordance with the NSS Technical Specifications, radiological and environmental surveillances were performed outside of the CV to ensure that radioactivity was not spread in the ship. Additionally, these surveillances ensure potential releases of radioactive material to the environment are detected and controlled.

2.4 REEVALUATION OF RADIOLOGICAL VULNERABILITIES

After the September 11, 2001, terrorist attacks, the Maritime Administration concluded actions should be taken to reassess the ship’s existing radiological vulnerabilities.

The general conclusion was that active decommissioning should be pursued with the goal of terminating the NS-1 license. At a minimum, the Agency concluded that contaminated structures, systems and components outside of the reactor compartment should be removed and decontaminated to reduce radiological hazards.

2.4.1 DECOMMISSIONING PLANNING AND RADIOLOGICAL AND ENVIRONMENTAL SCOPING CHARACTERIZATION SURVEY 2003-2005

A decommissioning planning contract was awarded in 2003, with performance continuing into mid-2004. A series of preliminary engineering studies was conducted, and an assessment of the radiological condition of the primary and auxiliary systems was made based on an analysis of the reactor power history. From this a summary bounding analysis against the NRC GEIS was performed, with a preliminary conclusion that the NSS decommissioning was bounded by the GEIS.

A follow-on contract was awarded in late 2004 to perform a radiological and environmental characterization scoping survey of the NSS. That survey was conducted in March and April 2005, while the ship lay at the JRRF. This characterization task was intended to provide a basis for estimating the cost of decommissioning and to determine the general level of contamination and induced activity in ship structures and systems. This survey is documented in NSS Radiological and Non-Radiological Spaces Characterization Survey Report, Reference (j).

The principle findings of the characterization scoping survey include the following:

- The CV entries were the first in over thirty years. The observed conditions generally supported the reported conditions of 1976. However, discrepancies were noted such as presence of hydraulic oils, migration of primary system water, significant quantities of trash/debris and superficial surface corrosion of components and lighting fixtures.
- Absence of fission products (other than trace quantities of cesium-137), uranium and its daughter isotopes, as well as transuranics (e.g., plutonium), indicates there were no significant fuel failures;
- Crud contribution to total curie content is minimal;
- No contamination was found in the non-radiological spaces;
- Minimal contamination was found in radiological spaces;
- Overall dose rates were much lower than calculated;
- Sites previously identified as radiologically contaminated were found uncontaminated; and,
- CV systems, structures and components were exceptionally radiologically clean.

The scoping survey concluded that the Nuclear Steam Supply System (primary system) is in very good condition from a physical and radiological perspective to support decommissioning. Of particular note was the discovery during the assessment that, in addition to the previously-known and earlier-documented water in the reactor vessel lower plenum up to the bottom of the cold leg inlets, primary coolant was present in several other port and starboard primary loop low points. These low points included short piping runs and the steam generator plenums and tubes. There was no water in the pump volutes or pressurizer pipe as these locations were above the natural drained level. The current state of the primary system is that it drained as completely as possible with the loop isolation valves opened wide and back seated. There is no reactor vessel low point drain valve in the system.

The water inventory in the loop piping and steam generator plenums adds several hundred gallons to the volume in the vessel, for an estimated total of approximately 1,470 gallons. The quantity was calculated by measuring the depth of water in the pipes and reactor vessel steam generator plenums (different in each loop) and calculating the water in the plenums, pipes and tube sides of the team generator "U" tube heat exchangers.

2.4.2 REACTOR PRESSURE VESSEL ANALYSIS 2005

As a direct result of overall dose rates being much lower than calculated in 2004, the Maritime Administration concluded the RPV and internals could be classified as Class A waste. To confirm the waste classification, intrusive sampling and analysis was conducted on the reactor pressure vessel and related components in August 2005, Reference (k).

The objective of this project was to refine the 2004 analysis and obtain a more accurate set of radionuclide activation measurements. These measurements are based on the 2005 RPV and internals conditions as observed from actual metal sampling in the reactor internals. All earlier analyses dating back to the late 1950's were based on theoretical design values which were very conservative.

This 2005 sampling and analysis found that if the reactor pressure vessel and related components were disposed as an intact package, the waste class would be Class A radioactive waste material at qualifying radioactive waste disposal facilities for land disposal purposes per 10 CFR § 61.55.

2.5 ORGANIZATIONAL UPGRADES AFTER 2005

In 2005, the Maritime Administration re-established the *Savannah* Technical Staff (STS) as an organizational entity within the Office of Ship Operations. Overall responsibility for the NS-1 license remained with the Senior Technical Advisor (STA). The initial STS organization included the Manager, N.S. *Savannah* Programs (MSP), supported by the Decommissioning Program Manager and Documentation Manager. The MSP functions as the administrative head of the STS, and executes all program functions. A single incumbent has been assigned to both the STA and MSP position since the latter was established.

In 2006, the technical capabilities of the STS were further improved by filling the following positions with experienced personnel:

- Facility Site Manager;
- Quality Assurance Manager;
- Licensing and Compliance Manager;
- Risk Manager;
- Marine Surveyor; and,
- Ship's General Agent (Keystone Shipping).

In addition, relationships were established with the DOT Volpe Center, Argonne National Laboratory (DOE Facility) and U.S. Merchant Marine Academy at Kings Point (Engineering Department) to provide additional technical support.

The 2006 decommissioning effort anticipated a three-phase approach to DECON, and two major contracts. An Engineering, Management and Oversight Support (EMOS) contractor would develop the decommissioning technical packages during the first phase; provide direct licensee oversight during the second phase (dismantlement), and finally would work directly with the licensee during the license termination phase. A second contractor would be acquired to dismantle the nuclear facilities and package and ship radiological waste during the second DECON phase. The EMOS solicitation was released in 2006, and eventually awarded to Areva Federal Services in early 2007. By that time the scope of the EMOS work was revised based on the decommissioning reassessment, and the contractor now principally performs the planning and engineering required to support the SAFSTOR program.

In 2007, MARAD continued its on-going efforts to improve the technical capabilities of the STS by filling the following positions with nuclear and/or maritime experienced staff:

- Nuclear Advisor;
- First Engineer;
- Electrician; and,
- Two General Vessel Assistants.

The current organization is shown in Figure 2-1, below.

2.6 PROGRAMMATIC UPGRADES AFTER 2005

In September 2005, the Maritime Administration performed an analysis to identify compliance with current NRC regulations and expectations. The results of the analysis allowed the Maritime Administration to prioritize efforts to bring the NSS licensing activities into compliance. It was initially intended to pursue and complete these compliance activities within the first phase of the DECON effort. As part of the 2007 decommissioning reassessment, the Agency adopted a strict compliance philosophy, and developed an ongoing license compliance implementation program.

The regulatory analysis identified maintenance of license basis documents as an area requiring major upgrade. Three significant licensing actions were completed in 2006 to address regulatory gaps identified in the assessment, of which two addressed outdated (or missing) basis documents.

- A license amendment request (LAR) was submitted to allow more efficient performance of pre-decommissioning activities (Amendment 13 was issued 1/31/2007);
- The Decommissioning Quality Assurance Plan was submitted to the NRC (following a discussion with NRC, Revision 1 to the plan was submitted 2/27/2007);
- The PSDAR, Revision 0, was submitted (As previously described in Section 1.0, the report was withdrawn on 1/27/2007).

In a concurrent action, the Agency prepared a Draft Environmental Assessment (EA) analyzing the impacts associated with the full radiological decommissioning of the NSS. The availability of this draft EA was noticed in the Federal Register on September 11, 2006. In the preceding month, the Agency conducted public "town hall" type meetings in the cities of Norfolk, VA; Wilmington, NC; and North Charleston, SC, to support selection of a future decommissioning site.

Additional activities to implement recommendations of the assessment included the following:

- Developing and implementing a comprehensive action item tracking system;
- Developing the training programs for General Employee Training and Radiation Protection Training;
- Developing a prioritized procedure development program;
- Upgrading the Radiation Protection Program; and,
- Conducting an independent review of the NSS document control system,

In 2007, two significant licensing actions were completed:

- License amendment request (LAR) 2007-001 was submitted to redefine RCAs, require visitors to be escorted, and resolve conflicts resulting from implementation of the Decommissioning Quality Assurance Plan; (Amendment 14 was issued on April 3, 2008) and,
- Revision IV of the Updated Final Safety Analysis Report (FSAR) was submitted on May 1, 2007 (first update since Revision III in 1968).

2.7 CURRENT ORGANIZATION

The STS is now the organizational unit within the Agency that is responsible for all NSS program activities. In an Agency-wide reorganization that was implemented in April 2007, the STS was administratively transferred from the Office of Ship Operations to the Office of Ship Disposal Programs. Both offices report to the Associate Administrator for National Security. The transfer better aligned the STS with the source of its appropriated funding and broader organizational functions.

Administration and execution of the NS-1 license is vested by the Maritime Administrator in a designated official holding the title Senior Technical Advisor (STA). This official may oftentimes be designated at or below the level of Office Director in the MARAD organization. The N.S. *Savannah* Executive Steering Committee (ESC) was re-established in 2006 to provide a framework for senior Agency officials to provide guidance to, and receive inputs from, the STA. A previous ESC existed from 1971 to about 1976 to oversee the initial NSS defueling and mothballing activities undertaken at that time.

The execution of all program activities including routine radiation surveillance, ship custody decommissioning and historic preservation is performed by the Manager, N.S. *Savannah* Programs (MSP), with guidance and oversight provided by the STA. The Maritime Administration may assign a single incumbent to both positions. This individual is assisted by a Decommissioning Program Manager, a Documentation Manager and a Facility Site Manager.

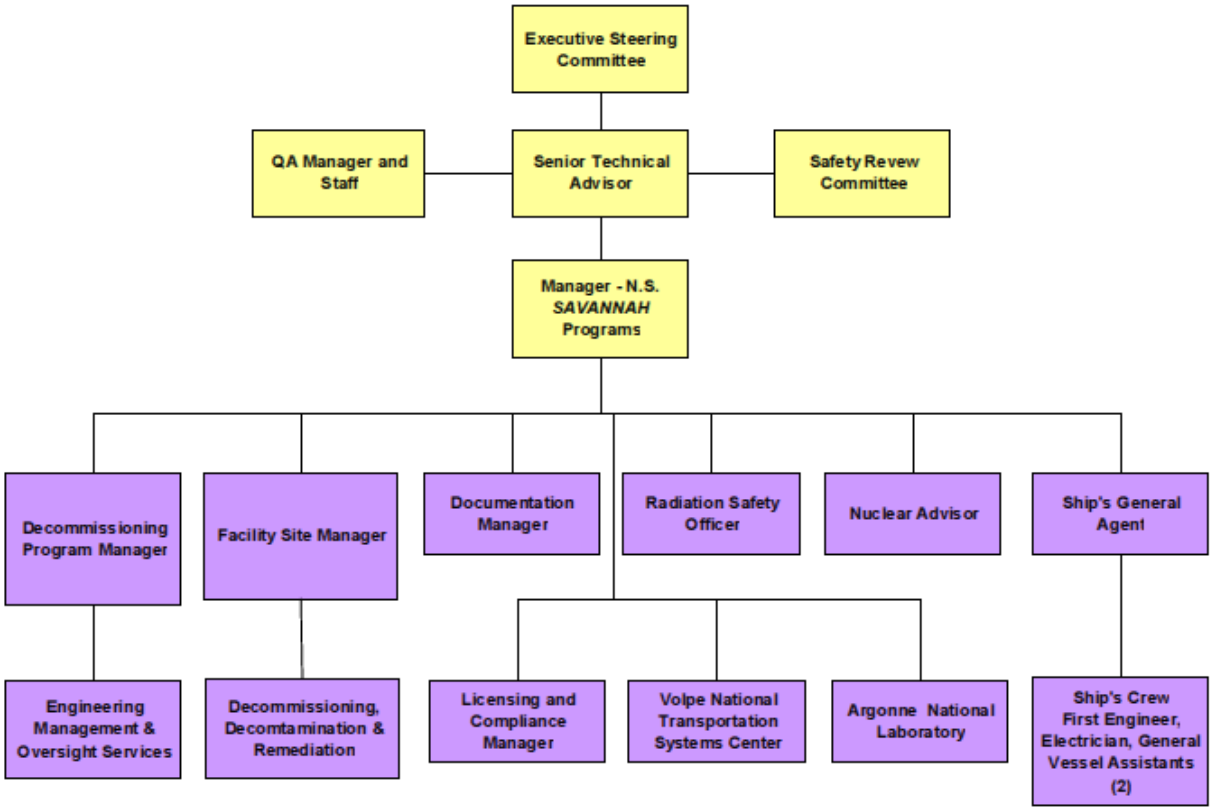


FIGURE 2-1 ORGANIZATION CHART

A significant portion of the decommissioning project work is intended to be performed by contractors. Maritime Administration personnel, reporting directly to the MSP, will be responsible for assigned contractors and providing the contractor direction, coordination and interfacing communications.

The QA Manager will provide independent verification of the contractors' work and the contractors' QA Manuals which will be approved by the NSS Project. Individuals from the Argonne National Laboratory and the Volpe National Transportation Systems Center were contracted to provide additional expertise in Decommissioning, Environmental and Maritime issues. The Safety Review Committee is a Technical Specification-required committee that provides independent oversight of licensed activities.

2.8 CURRENT STATUS OF N.S. SAVANNAH

The ship is in a Mothballed state of protective storage. Many weather openings are sealed. Almost no mechanical systems or equipment are functional. The functional systems include a significant portion of the electrical distribution system, the hull cathodic protection system, the DH system, the intrusion, fire and flooding alarm system and the anchor windlass. The DH system was newly-installed in 1994 and is mechanically independent of any other ship's system. Likewise, the alarm system was substantially renewed in 1994 and is isolated from any other ship's system except electrical distribution. Note that modifications associated with the DH and alarm systems (i.e., vent ducting and cabling) obstruct doors, passageways and ladders throughout the ship as is typical in the marine industry for deactivated ships.

Before 2007 the electrical distribution system, the hull cathodic protection system and the anchor windlass were the only functional portions of the ship's original outfit. Between 1994 and 2007, there was minimal maintenance and testing to the ship's electrical system. After 2007, electrical and

mechanical systems and components have been surveyed by qualified personnel prior to energizing and operating them. Since moving to Pier 13, Canton Marine Terminal, the aft mooring capstans have been repaired and returned to service (electrically and mechanically).

Equipment and systems independent of the original ship's outfit have been installed since 2006. The principal new equipment is an electro-mechanical stores davit fitted on the aft portside corner of the Promenade Deck. This 7.15 ton davit has an electrical hoist and mechanical swing. A simple weathertight stores hatch was fitted on the Main Deck with access into the number 7 cargo hold. A new Heating, Ventilation and Air Conditioning (HVAC) system is being adapted to original ductwork serving staterooms and the conference (training) room on B Deck aft of Frame 168 (cargo hold 6). The same system covers a block of spaces on C Deck between Frames 148 and 168 (cargo hold 5); which include the ship's Technical Library, Baggage Room (used for records storage) and the new Records Vault (combined from 6 staterooms). The system will provide climate-controlled storage for retention records.

3.0 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

The NSS has been maintained in a partially decommissioned, protective storage condition since 1976. From 2002 to 2006 the Maritime Administration planned to complete decommissioning and license termination of the NSS facility using the DECON method. From 2007 onwards the Agency was forced to reassess the DECON project, and at present has adopted a plan to return the NSS to protective storage by bringing the facility into full compliance with contemporary SAFSTOR requirements and criteria. After a period of SAFSTOR operations, the Maritime Administration will resume DECON with the intention of completing decommissioning and license termination no later than the defined regulatory completion date of December 2031.

The Agency's primary goal is to decommission the NSS in a safe and cost-effective manner. The overall plan for completing decommissioning of the NSS has been divided into six periods:

- SAFSTOR Preparations;
- SAFSTOR Operations (Retention);
- Preparations for DECON;
- Performance of DECON Activities;
- License Termination; and,
- Future Plans for the NSS.

The following provides a discussion of the current decommissioning plan, the significant specific activities and the general sequencing for each of the above periods. The planning required for each decommissioning activity, including the selection of the process to perform the work, will be completed prior to the start of work for that activity. A discussion of other issues related to decommissioning is included in Section 4.0. Finally, the Agency has developed and included Appendix C, Alternatives for Future Consideration, as an introduction to explore possible unique decommissioning scenarios and options for the NSS.

3.1 SAFSTOR PREPARATIONS

The circumstances which prompted the withdrawal of PSDAR Revision 0 are briefly described in Section 1.0. Section 6.1 provides a more detailed explanation of the appropriations shortfalls and budgetary instability that have hampered the NSS decommissioning effort. With the withdrawal of the PSDAR Revision 0, the Agency notified the NRC that the NSS would be remain in protective storage for at least a short-term period while longer-term options were being evaluated. Because the ship had already been removed from its reserve fleet site in preparation for drydocking, the protective storage condition was maintained at several Norfolk, VA berthing locations while the drydocking availability was solicited, negotiated and performed.

An early recognition by the Maritime Administration was that any long-term activities must be conducted in manner fully consistent with contemporary industry standards and practices, and in full compliance with all terms and conditions of the NS-1 license and regulations (see Section 2.6). Consequently, if the selected long-term option was deferred DECON, the necessary protective storage period would need to be conducted in accordance with current SAFSTOR criteria; not the circa 1974 Mothballing condition. In order to accomplish this objective it was necessary to perform a detailed comparison of the two sets of criteria, and identify the substantive differences between them. The resulting analysis is included in Appendix A - Comparison of Mothballing and SAFSTOR Requirements.

In 2007 the Maritime Administration revised its plans to pursue near term DECON in favor of a return to protective storage. The rationale for this decision is described in more detail in Section 6.1. The decision to return the NSS to protective storage after bringing it into contemporary SAFSTOR compliance does not preclude the Agency from making a subsequent decision to pursue a DECON approach, principally

because the SAFSTOR activities to be accomplished are pre-requisites for, or non-duplicative of DECON.

In 2007, the Agency tasked its EMOS contractor to prepare a SAFSTOR Plan, Reference (l), that includes the following work activities.

- Performing a detailed Historical Site Assessment. This assessment will follow current regulatory guidance in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). It will consider all available data on radiological and hazardous contaminants. It will include as much information as possible obtained from former crewmembers during the crew reunion held in May 2008.
- Developing Derived Concentration Guideline Levels (DCGLs) for residual radioactivity. These DCGLs will be developed using various computer codes to support the NRC standards for unrestricted release.
- Performing a characterization survey of the ship. A characterization survey is a type of survey that includes facility or site sampling, monitoring, and analysis activities to determine the type and extent of residual radioactivity on or in structures, residues, and environmental media. The survey should be sufficiently detailed to provide data for planning decommissioning actions, including necessary technical information to develop, analyze, and select appropriate cleanup (i.e., remediation) techniques, projected schedules, costs, waste volumes, and health and safety considerations during remediation. The characterization survey program will follow MARSSIM guidance.
- Hazardous and toxic contaminants, such as asbestos, will be addressed as part of the characterization survey.
- Making safety improvements. These activities will involve improving access to and egress from several areas, verification of electrical system safety, removal of dangerous substances (such as residual control rod drive system hydraulic oil), and removal or mitigation of hazardous and toxic materials.
- Improving ventilation in radiologically controlled areas. This will include the containment vessel.
- Further draining of the primary coolant system. As much as practicable of the approximately 1500 gallons of water remaining in the system will be drained and processed as low-level radioactive waste.
- Removing a limited amount of contaminated equipment. Equipment under consideration to be removed is the Buffer Seal System outside of the reactor compartment including three Buffer Seal Charge Pumps, two booster pumps and associated valves and piping.
- Reducing radiologically controlled areas. Selected areas – such as the Health Physics Lab on A Deck and the Hot Chemistry Lab on D Deck – will be decontaminated and released from radiological controls.
- Adding a new shore power switchboard. Moving power panel lighting load centers from the Main and Emergency switchboards to the new switchboard to allow deenergizing the Main and Emergency switchboards.

3.2 SAFSTOR OPERATIONS (RETENTION)

SAFSTOR Operations (Retention) is the extended time period of safe storage of the facility prior to DECON. This period may continue until 2023-2025 which will allow sufficient time to develop and implement all actions necessary to terminate the license by December 2031. Unlike the previous Mothballing period, the SAFSTOR retention period will be characterized by an active nuclear operations culture, albeit at activity levels commensurate to the facility location and condition.

Adequate staffing will be provided to ensure the Maritime Administration is compliant in (with?) all aspects of the license. Trained personnel will be available to maintain required systems, provide security

and perform radiological surveillance to ensure that radioactivity is not spread from the ship to the environment.

Equipment corrective and preventive maintenance, inspection activities, and routine operations will be performed. Systems/structures needed to support security, fire protection, and environmental and radiological monitoring will be maintained in a safe condition and in accordance with Technical Specifications and regulatory requirements. Abandoned systems will be monitored and maintained, as needed, to control radioactive material. Systems and equipment no longer needed may be removed from the site. In addition, the structural integrity of the ship will be monitored and maintained.

Areas that do not require routine access will be locked and secured. Areas containing radioactive materials or other contamination will be secured to prevent accidental intrusion. Shielding will be added, where necessary, to maintain radiation exposure to plant personnel as low as reasonably achievable (ALARA). Routine periodic radiological inspections of contaminated areas will be conducted. Decontamination activities will be generally limited to those necessary to maintain exposures ALARA.

Radiological and environmental surveillance programs will be carried out during the SAFSTOR Operations (Retention) period to ensure that potential releases of radioactive material to the environment are detected and controlled. The surveillance programs will be conducted in accordance with the facility Operating License, Technical Specifications, Final Safety Analysis Report and Offsite Dose Calculation Manual.

Throughout this and all subsequent phases of the work, the NSS will remain in the active custody and husbandry of the Maritime Administration at a safe and secure berthing site.

3.2.1 RETENTION SITE OPTIONS FOR SAFSTOR OPERATIONS

On the assumption that DECON and license termination remains deferred, the NSS will be moved to a retention site at the conclusion of the SAFSTOR Preparations phase. In general, there are three principal retention options available to the Agency, for which there are three rough analogues from the Mothballing period. From 1975 to 1981 the NSS was maintained by the Agency at a Government-owned layberth in North Charleston, SC. From 1981 to 1994 the vessel was chartered to the State of South Carolina for display at the Patriots Point Naval and Maritime Museum, in Mount Pleasant, SC. During this period of museum operations, the Agency virtually subrogated all husbandry and radiation protection programs to the State. Finally, from 1994 to 2006 the NSS was stored by the Agency in retention status at its James River Reserve Fleet facility near Newport News, VA. Only the first of these experiences, the Agency layberthing period (1975 – 1981), is directly comparable to the future SAFSTOR Operations period from the standpoint of active license management. Any discussion of the retention options must consider the following baseline factors that will be applicable regardless of the retention site or vessel use condition:

- That the Agency will actively maintain all license programs during the SAFSTOR period, including radiation protection and radiological monitoring and surveillance;
- That the License / Technical Specifications provisions governing mobility will be maintained.

The three prospective retention site options are discussed below.

3.2.2 LAYBERTHING FOR "PUBLIC USE" WHILE MAINTAINING LICENSE CONDITIONS

Under this scenario the Maritime Administration would affirmatively seek a public or private partner to provide berthing services for the ship, in exchange for which the Agency would make the ship available for heritage tourism / historic adaptive reuse, museum / memorial service, or other public activities. The scenario is only roughly analogous to the Patriots Point experience, because theAgency would maintain all licensee functions, and would not seek to mimic the PPDA "co-licensee" experience. Furthermore, the Agency would actively collaborate with the partner organization to further and continue the *Savannah*'s

public missions to promote the peaceful applications of nuclear power (*Atoms for Peace*), and to promote the American maritime industry and the United States Merchant Marine. This mission is wholly consistent with directives contained in the "*Preserve America*" and "*Save America's Treasures*" presidential executive orders, and stewardship obligations placed upon Federal owners of National Historic Landmarks as provided for in the National Historic Preservation Act of 1966, as amended.

An underlying intent of the two most recent license amendments was to revise and update the Technical Specifications, with particular consideration given to of the removal of the ship from unrestricted public access. Under this scenario, with the Agency maintaining license conditions, it is believed that no substantive changes to the Technical Specifications will be required. Instead, a mature administrative controls process will allow for public access to, and use of the ship. This again is a significant departure from the PPDA experience, but one that is based on historic precedents and contemporary lessons learned.

3.2.3 GOVERNMENT LAYBERTHING WITH RESTRICTED ACCESS

This scenario is comparable to the current SAFSTOR Preparations layberthing period, and to the 1975 – 1981 Government layberthing period in North Charleston, SC. Under this scenario the Government would acquire or otherwise secure a long-term berth for the ship that would afford routine and regular access by licensee staff and contractors. Public access to the ship would be limited, although not eliminated. Public activities might reasonably be limited to tours and invitational events as is currently practiced.

3.2.4 RESERVE FLEET LAY-UP AND RETENTION

From a nuclear programs and operations standpoint, the least desirable retention option is to return the NSS to one of the Agency's reserve fleet sites. The distance and remote riverborne locations of these fleet sites introduce organizational and staffing obstacles that severely reduce the efficiency of licensed operations. The fleet sites themselves are subject to stringent environmental operating restrictions that will prevent anything but minor topside maintenance of the ship (the licensed facility boundary). This will lead to deterioration of the structure, and a need for more frequent and expensive industrial off-site (i.e., shipyard) maintenance.

3.3 DECON AND LICENSE TERMINATION

Following SAFSTOR Operations/Retention, the Maritime Administration envisions DECON of the NSS nuclear reactor, primary system, reactor plant auxiliary systems and other contaminated systems/components as the next step in a continuous process that will result in license termination. Reactor plant auxiliary systems include all of those support systems to the primary system such as:

- Emergency Cooling (DK) System;
- Soluble Poison (SP) System;
- Primary Loop Purification (PP) System;
- Buffer Seal (SL) System;
- Hydrogen Addition (HA) System;
- Primary Relief (PR) System;
- Primary Sampling (SA) System;
- Intermediate Cooling Water (CW) System;
- Containment Cooling (CC) System;
- Shutdown Circulation (SC) System;
- Primary Pressurizing (PE) System;
- Control Rod Drive (CRD) system; and,
- Waste Management Systems -

- Equipment Drain and Waste Collection (PD) System;
- Gaseous Waste Collection and Disposal (WL) System; and,
- Containment Vessel Purge System (Ventilation).

There is no Agency intent to immediately dismantle the ship itself following License Termination (see section 3.4). Based on this premise and the fact that the ship is a registered National Historic Landmark, the Agency intends to pursue the DECON industrial work in a fashion that minimizes any physical affect to adjacent ship structure. This decision is supported by studies made during the EMOS acquisition process, and subsequent licensee evaluations of alternative methods to remove the plant components.

For conservative cost and schedule purposes, the Agency assumes that most primary and auxiliary system components are contaminated and subject to disposal as Low Level Radioactive Waste (LLRW). Surveys will be undertaken during DECON, and appropriate waste disposal will be determined for removed components and equipment. The Agency does not contemplate any significant radiological decontamination efforts of any component (e.g., vessel, piping, pumps, etc.) unless such efforts can provide a substantial and demonstrable cost benefit. Because all plant components were installed through the existing ship accesses, the Agency intends that industrial DECON will make use of these accesses to the greatest extent possible, and that intact component removal shall be preferred. Some components, such as the steam generators and neutron shield tank, will require partial in-situ dismantlement to permit their removal through the ship accesses; documentary research established that these components were similarly erected in place during the ship's construction.

When the decision to complete DECON is made, the Agency plans to perform limited, additional rehabilitation of shipboard spaces to make the ship habitable during the preparation for and performance of DECON activities. The Agency plans for contractor activities and facilities to be located onboard the ship to the greatest extent possible, with any required adjoining facilities located pierside. As in the 1971 defueling and subsequent decommissioning (mothballing), the ship itself will be the designated site for regulated activities.

3.3.1 DECON PREPARATIONS

Preparations for DECON Activities is the time period in anticipation of decommissioning activities when detailed preparations are undertaken to provide a smooth transition from SAFSTOR dormancy to DECON. Activities to be initiated and/or performed during this period include, but are not limited to, the following:

- Develop and implement a decommissioning organizational structure and select staff from assigned Agency staff and outside resources, as required;
- Obtain regulatory approvals to proceed with decommissioning (e.g., NRC, state and local authorities, etc.) as needed;
- Develop and implement all NSS programs, manuals, procedures, etc., to control DECON activities;
- Select the decommissioning location and subsequently, determine the location of the ultimate disposal site for low-level radioactive waste;
- Review and reclassify systems, structures and components consistent with DECON activities;
- Determine mechanical and electrical system functionality and status;
- Prepare site support and storage facilities, as required;
- Prepare work plans for decontamination and dismantlement (i.e., removal) activities;
- Determine transportation and disposal container requirements for radioactive materials and/or other hazardous materials, including shielding and stabilization;
- Develop activity specifications and task specific procedures for occupational exposure control, site security, industrial safety, control and release of liquid and gaseous effluents and processing of radwaste generated in decommissioning;

- Perform radiation safety activities such as radiation surveys and sampling, radioactive waste classifications and establishing Radiological Controlled Area entry requirements;
- Remove and package asbestos-containing insulation inside the CV and other Radiation Control Areas; and,
- Decontaminate structures and external surfaces of plant systems.

3.3.2 PERFORMANCE OF DECON ACTIVITIES

Performance of DECON Activities is the time period when the primary activity will be removing, packaging and shipping reactor plant systems. Activities to be performed during this period include, but are not limited to, the following:

- Conduct decontamination of components and piping systems, as required, to minimize worker exposure and spread of contamination;
- Remove and package the CRD structure for shipment;
- Remove and package the primary (neutron) shield water tank for shipment;
- Remove and package the reactor vessel, with its internals secured in place, for shipment;
- Remove and package steam generators for shipment;
- Remove and package the pressurizer for shipment;
- Remove and package the primary coolant piping and associated components for shipment;
- Remove and package auxiliary systems and associated components for shipment as they become nonessential to the vessel removal operations, related decommissioning activities, or worker health and safety (e.g., waste collection and processing systems, electrical and ventilation systems, etc.);
- Decontaminate the CV;
- Remove and package remaining components, equipment and plant services in support of the area release survey(s); and,
- Ship packaged waste items, as appropriate, to the waste disposal site.

3.3.3 LICENSE TERMINATION

License Termination Activities to be performed during this period of decommissioning activities include, but are not limited to, the following:

- At least two years prior to the anticipated date of license termination, prepare and submit the License Termination Plan (LTP) to define the details of the final radiological survey to be performed after all decontamination activities are completed;
- After NRC approval of the LTP, perform and document the final site survey to demonstrate that the site can be released for unrestricted use; and,
- Prepare and submit an application to terminate the NS-1 license.

3.4 PLANS FOR THE NSS AFTER LICENSE TERMINATION

As noted elsewhere herein, because the *Savannah* is a National Historic Landmark and occupies a unique place in the maritime and nuclear heritage of the United States, there is no present plan or intent to physically alter the ship's structure during decommissioning, or to dismantle the ship after license termination. Although there is a preferential intent to preserve the ship, it is unlikely if not impractical for the Maritime Administration alone to retain ownership and actively preserve or conserve the ship for any long period of time after license termination.

Ultimately the Maritime Administration will arrange for disposition of the ship. It is uncertain what forms of disposition might be available in the future if DECON remains deferred. At present the Agency has three principal methods of ship disposition / disposal: recycling (scrapping); artificial reefing; and donation. All of these methods are designed to remove a vessel from the Agency inventory in an environmentally responsible manner. It is presumed that an affirmative effort to donate the vessel will be

made, whether to an appropriate federal entity; to a state or local government; to a private / non-profit entity; or to some form of public-private partnership. Such disposition action is consistent with the stewardship obligations vested on the Agency under the NHPA, and with the provisions of the major executive orders related to historic preservation; particularly the Preserve America order of 2003.

The ultimate disposition of the ship will be carefully considered during the SAFSTOR Operations period, so that when DECON and License Termination plans are developed and implemented, the appropriate measures can be adopted.

4.0 OTHER DECOMMISSIONING ISSUES

The decontamination and/or disassembly of contaminated structures, systems and components may be accomplished by decontamination in place, decontamination and dismantlement, or dismantlement and disposal. A combination of these methods may be utilized to reduce contamination levels, worker radiation exposures and project costs.

4.1 SPECIFIC DECON ACTIVITIES RELATING TO REMOVAL OF SYSTEMS AND COMPONENTS

Components and any material generated in support of DECON activities (i.e., DECON waste) will be safely and efficiently removed using the techniques and methods determined to be the most appropriate for the particular circumstances. Currently, the Agency anticipates that disassembled/segmented/removed material will be routed to a central processing area on the ship. Any material or DECON waste below the applicable radiological limits will be released for unrestricted disposition. Because the ship is the site, radioactively contaminated or activated materials will be removed from the site as necessary to allow the NSS to be released for unrestricted use per NRC requirements.

Low-level radioactive waste will be processed in accordance with the NSS procedures and utilize available options. Radioactive waste material will be characterized and segregated for additional onboard decontamination or processing, off ship processing (e.g., disassembly, chemical cleaning, volume reduction, waste treatment, etc.) and/or packaged for controlled disposal at a low-level radioactive waste disposal facility. Appropriate contamination controls will be employed to minimize the spread of contamination and protect personnel.

4.2 LOW-LEVEL RADIOACTIVE WASTE DISPOSAL

Unlike most licensed facilities, the NSS is mobile and can be moved to many US locations during the SAFSTOR and DECON periods. The specific location for decommissioning the NSS has not been chosen. Flexibility in location allows the NSS to use any approved waste disposal site.

4.3 HAZARDOUS AND/OR MIXED WASTE DISPOSAL

Hazardous waste and mixed waste may be disposed during decommissioning. All waste will be managed according to all applicable federal and state regulations.

Hazardous material waste from the NSS will be transported only by authorized and licensed transporters and shipped only to authorized and licensed or permitted facilities. If technology, resources and approved processes become available, processes will be evaluated to render the mixed waste non-hazardous.

4.4 PROGRAMMATIC CONSIDERATIONS RELATED TO EXTENDED SAFSTOR RETENTION PERIOD

The NSS is in the unique position of being a stand-alone nuclear facility in protective storage. As part of its decommissioning reassessment and evaluation of retention options, the Maritime Administration is benchmarking other Part 50 reactors in SAFSTOR status. Such reactors include (but are not limited to) Dresden Unit One, Peach Bottom Unit One, Millstone Unit One, and Three Mile Island Unit Two. In general power reactors in SAFSTOR are co-located with operating units, some of which have been or are being re-licensed (i.e., license extension). The operating units provide the knowledgeable licensee staff, programs and processes necessary to safeguard and maintain the adjacent facility in SAFSTOR. By contrast, the NSS is a stand-alone facility and consequently must maintain an independent staff and program. The decision by the Agency to retain the NSS in SAFSTOR out to the maximum permissible retention period will be accompanied by a commitment to maintain an organic, competent NSS staff throughout that period.

The industry has developed a substantial body of experience and lessons learned during the 30+ years that the *Savannah* has been mothballed. This experience is captured in the contemporary SAFSTOR criteria, and is outlined in Appendix A. Among the more critical industry experiences was the Dresden Unit 1 Freezing event of 1994, which led to increased awareness of the need to actively manage decommissioned facilities. The Maritime Administration will ensure that this mindset is captured and incorporated in NSS daily activities by:

- Managing its decommissioned nuclear systems within regulatory compliance;
- Maintaining institutional knowledge by availability of senior personnel either from former staff or other experienced personnel and effectively using their expertise; and,
- Maintaining a committed, multi-disciplined nuclear and maritime organization including: operations, engineering, maintenance and construction, radiation protection, project controls /planning, quality and licensing expertise.

5.0 SCHEDULE OF PLANNED DECOMMISSIONING ACTIVITIES

Major milestones established for decommissioning NSS are listed in the table below and in more detail in Appendix B, Decommissioning Project Schedule. Although the mandated regulatory License Termination date is December 2031, contingency planning requires establishing a schedule that sets July 2028 as the date to terminate the license. To ensure the December 2031 license termination date is not exceeded, the periods are broken down as follows:

TABLE 5-1 SCHEDULE OF PLANNED DECOMMISSIONING ACTIVITIES

PERIOD	MONTHS	DATES
SAFSTOR Preparations	43	05/2008 - 12/2011
SAFSTOR Operations (Retention)	136	12/2011 - 04/2023
Preparations for DECON Activities	26	04/2023 – 06/2025
Performance of DECON Activities	24	06/2025 – 06/2027
Final Site Survey/License Termination	21	10/2026 – 07/2028

Given that FY 2025 is the last date by which full funding must be available to meet the 2031 license termination deadline, the Maritime Administration intends to make an earlier request for funding. Decommissioning fund appropriations will be subject to the normal federal budget process and the Agency will make every effort to obtain the funding necessary to meet the proposed schedule.

6.0 ESTIMATE OF EXPECTED DECOMMISSIONING COSTS

6.1 STATUS OF DECOMMISSIONING FUNDS

Funding for decommissioning the NSS is provided by federal appropriations. This form of decommissioning funding is specifically allowed by 10 CFR 50.75(e)(1)(v) which states that a federal power reactor licensee will obtain funding for decommissioning when necessary. The Maritime Administration recognizes that it bears ultimate responsibility for requesting budgetary resources in sufficient quantity to meet its decommissioning obligations, and will continue to work with the Executive offices and the Congress to ensure that such appropriations are provided in a timely manner, particularly with respect to the license termination deadline.

The Agency first determined to advance the NSS decommissioning in early calendar year 2002, and since that time has developed and submitted budget requests to support NSS decommissioning activities, with varying levels of success. From 2002 to 2006, the project staff, Agency and DOT management, and the Office of Management and Budget (OMB) supported these efforts, with the intent to complete the full decommissioning process, and terminate the facility license. For initial planning and budgetary purposes, decommissioning was estimated at $45,000k[8] and a multi-year incremental funding solution was proposed because the cost represented much too large a percentage of the Agency's annual budget to absorb in any single fiscal year. This process is described in substantial detail in the narratives of the President's Budget Requests for the Maritime Administration for Fiscal Years 2005, 2006, and 2007 (see Section 6.2 for a discussion of the FY 2008 request).

In late 2006 when the Congress again failed to pass appropriations bills (for FY 2007), it became apparent that the incremental approach lacked the stability necessary for an Executive commitment to decommissioning. Nor was there support for funding the decommissioning project as a one-time capital expenditure. Consequently, PSDAR Revision 0 was withdrawn, and the Agency reassessed alternatives short of full decommissioning and license termination. The Agency subsequently determined to pursue a program designed to bring the NSS into full contemporary compliance with its license, with initial emphasis on administrative corrective actions and program / process development. Additionally, a reprogramming request was successfully made to restore funding for the NSS drydocking availability in FY 2007.

The FY 2009 budget request narrative describes a SAFSTOR approach adopted by the Agency. Because of the advance nature of the federal budget cycle, this SAFSTOR request predates the final decision-making documents, such as the EA and Revision 1 to the PSDAR. The SAFSTOR approach is structured in such a way that a DECON approach could be adopted if the incoming administration chooses to do so within the context of the FY 2010 (or subsequent) budget request.

In the interim the Agency has continued to request funds for maintenance and operations of the NSS. These funds are sourced within the Agency's Ship Disposal appropriation. The Agency will continue to request resources to support the NSS as required. The status of NSS decommissioning funding is reported periodically to the NRC in accordance with 10 CFR 50.75(f)(1), "Reporting and recordkeeping for decommissioning planning."

6.2 2006 ROM DECOMMISSIONING COST ESTIMATE

In March 2006, the Agency prepared a Rough Order of Magnitude (ROM) site-specific decommissioning cost estimate. The ROM estimate included consideration of regulatory requirements, contingency requirements and low and high-level radioactive waste disposal availability. The 2006 ROM estimate

[8] The $45,000K figure was derived from a detailed decommissioning estimate, initially prepared in 1998-2000, for a similar Government-owned nuclear facility.

was developed based on the most cost effective assumption that decommissioning work begun in 2005-2006 would continue without delay. The original 2006 ROM estimate was $69,412k in 2006 dollars. Subsequent review by industry and the Agency indicated the need to adjust the labor costs to account for project overtime and to adjust the contingency factors for costs such as energy and LLRW disposal due to the somewhat unpredictable nature of these costs. The final 2006 ROM estimate was determined to be $75,553k. Independent reviewers, contracted by the Maritime Administration, agreed that the 2006 ROM estimate was reasonable in both price and methodology[9].

The 2006 ROM estimate formed the basis for the Agency's FY 2008 Budget Request, which was a major revision to the budget requests for 2005 – 2007. During the Budget Request development cycle, the Maritime Administration and the DOT budget office worked with theOMB to assess four funding alternatives for decommissioning the NSS. The first three were to: a) complete full decommissioning (DECON) on a one-time funding basis; b) to complete DECON on an incremental basis over five fiscal years; and c) to implement a SAFSTOR (deferred DECON) approach with outyear DECON funding. At the request of the OMB, the fourth alternative was to transfer the NSS to the U.S. Navy and include it in the Navy's nuclear submarine and cruiser decommissioning program. This latter alternative was eventually rejected by the Navy prior to finalizing the Agency's FY 2008 request. As part of this assessment process, the 2006 ROM estimate was inflated to provide a rough estimate of the cost of deferred decommissioning. The contemporary estimate was about $150,000k in 2006 dollars. The final FY 2008 Agency request for incrementally-funded DECON received initial approval by the OMB, but was re-scoped immediately before submission to the Congress based on the events described in paragraph 6.1. Because only the final budget documents are normally released, the previously-available public record for FY 2008 does not include any discussion of the programmatic and funding revisions adopted based on the 2006 ROM estimate and the evaluation of budgetary alternatives.

The 2006 ROM estimate similarly formed the basis for the decommissioning estimates referred to in Revision 0 of the PSDAR. At the time; however, the total dollar estimate was withheld in the PSDAR on the basis that it formed a Government procurement estimate for decommissioning. Active solicitations to support decommissioning were in process at that time, and the estimate was withheld under the applicable provisions of the Federal Acquisition Regulations (FAR). These conditions do not exist at this time; consequently, the following paragraphs include discussions of the full decommissioning estimates, as well as the Agency's projected costs to complete the administrative and technical activities necessary to return the NSS to a compliant SAFSTOR condition.

6.3 2008 ROM DECOMMISSIONING COST ESTIMATE

The 2006 ROM estimate was developed on the assumption that decommissioning work begun in 2005-2006 would continue without delay. Appropriations issues have forced a change in program direction not accounted for in the 2006 ROM estimate.

A new 2008 ROM estimate was developed following the format and content of the 2006 ROM estimate and reflects the revised decommissioning project costs. The 2008 ROM estimate does not include project expenses prior to October 2008. Because MARAD has adopted a SAFSTOR approach in its FY 2009 Budget Request, this 2008 ROM estimate is intended solely to meet the PSDAR requirement for a contemporary estimate of decommissioning (DECON) costs.

One adjustment made to the 2008 ROM estimate from the 2006 basis document is the addition of a Final Status Survey / License Termination drydocking availability. This availability was not accounted for in

[9] Reviewers included industry (BAE Systems), federal radiological decommissioning experts (Department of Energy, Argonne National Laboratory), and academia (independent professors associated with the Massachusetts Institute of Technology schools of Engineering and Business).

the 2006 ROM estimate on the basis that the pre-decommissioning drydocking would have met this requirement during the active DECON phase.

The October 2008 ROM estimate is **$71,431k** in 2008 dollars. Accounting for inflationary escalation during the five year performance period for DECON, the total cost is estimated to be **$77,997k** in actual dollars spent.

TABLE 6-2 2008 ROUGH ORDER OF MAGNITUDE COST ESTIMATE

Waste Removal Activity Dependent Costs	**2008 (K$)**
Removal of LLRW waste	10,570
Package LLRW waste	3,533
Transportation of LLRW waste	1,283
Direct burial/disposal of LLRW waste	10,926
Period Dependent Costs	
Energy	563
Material and Supplies	682
N.S. *SAVANNAH* Technical Staff	758
Other	486
Services Contracts	4,995
Towing, Layberth and Hotel Services	4,546
Engineering, Management and Oversight Contractor	12,780
DECON Contractor	8,488
Collateral and Special Item Costs	
Drydocking for Final Status Survey / License Termination	5,300
Ship Preparation	2,343
Site Surveys	703
Equipment and Tools	2,350
Regulatory Costs (MARAD support)	508
Regulatory Costs (NRC support)	616
Total	**71,430**

6.4 COST ESTIMATES FOR SAFSTOR / DEFERRED DECON

As previously described, this scenario (which represents the current Agency effort) requires three distinct periods; SAFSTOR Preparations (industrial and administrative compliance activities); SAFSTOR Operations (maintenance of the licensed facilities in active retention); and deferred DECON / License Termination. Cost estimates for each period are discussed in the following paragraphs.

6.4.1 2008 SAFSTOR PREPARATIONS COSTS

In 2007, the Agency reassessed the Mothballing process by which the NSS was initially prepared for retention in the mid-1970's and concluded the simple and prescriptive Mothballing methodology is no longer appropriate or allowed for nuclear facilities in decommissioning.

The cost for moving from Mothballing status to SAFSTOR status is significant. It is expected that much of the SAFSTOR Preparations costs will be costs that would be spent during the DECON period. These costs will be reallocated from DECON period to SAFSTOR PREPARATIONS period.

This industrial estimate does not include the concurrent MARAD costs for establishing and maintaining licensee competency (programs, processes, procedures); nor does it include the concurrent costs for ship custody and maintenance. These costs are presently provided for in MARAD's annual appropriation, and have been accounted for in the SAFSTOR Operations estimate.

The SAFSTOR PREPARATIONS activities cost is currently estimated at **$7,984k** in 2008 dollars.

6.4.2 SAFSTOR OPERATIONS (RETENTION) COSTS

The Maritime Administration has considerable experience and expertise in maintaining ships in a retention condition for extended periods of time. Consequently, the costs associated with the basic custody, husbandry and maintenance of the *Savannah* are well within the capacity of the Agency to manage. The more critical cost elements during the SAFSTOR Operations phase are those associated with maintaining a stand-alone, competent licensee organization and organic staff. The programmatic and technical considerations related to maintaining this competency are described in section 4.4.

There are three cost categories comprising the SAFSTOR Operations (Retention) costs:

- Licensee Competency and License Compliance: Licensee Competency and Compliance costs include programs and procedures to meet SAFSTOR regulatory and administrative requirements.
- Ship Husbandry: Ship Husbandry costs include towing, retention site, General Agent (when required), ship's maintenance, energy and security during the SAFSTOR period.
- Drydocking (routine MARAD required activity): Dry docking costs for SAFSTOR Operations period includes one dry dock period in 2018 (10 year interval from 2008).

The cost for the SAFSTOR OPERATIONS period (does not include SAFSTOR Preparations costs) is currently estimated to be **$31,327k** in 2008 dollars, of which $5,300k is for the drydocking availability described immediately above.

6.4.3 DECON AND LICENSE TERMINATION COSTS

Under the SAFSTOR scenario, decommissioning (DECON) is expected to resume in 2023. The deferred (2023) DECON and License Termination costs are developed from the 2008 ROM estimate, with appropriate adjustments to account for the SAFSTOR Preparations costs.

The cost for 2023 DECON and License Termination is estimated to be **$63,301k** in 2008 dollars. Similar to the 2008 ROM estimate (see 6.3), the estimated real dollar cost in 2023 (allowing for escalation over the 2023-2028 performance period) is **$124,823k**.

6.5 PROGRAMMATIC COST EFFECTS RELATED TO DEFERRED DECOMMISSIONING

The preceding cost estimates are presented as discrete elements, based on 2008 dollars, and estimated escalation to the year(s) in which the activity takes place. For a multi-year activity such as DECON (5-year performance period), an account for escalation during the performance period is made and an adjusted up-front cost is provided.

The cost escalation factors used in the 2006 and 2008 ROM estimate calculations are 6% for LLRWdisposal inflation and 3.5% for General Decommissioning inflation. These same factors and the validated methodology used in the 2006 ROM estimate are also used to calculate the estimated DECON cost beginning in 2023 (see 6.4 above). The earlier that DECON can be performed, the lower the overall project cost will be.

The estimated cumulative costs in actual dollars spent to 2028 is $171,968k; which includes SAFSTOR Preparations and Operations, Deferred DECON and License Termination. If License Termination is not concluded until the 2031 regulatory deadline, the cumulative costs will increase further.

An underlying assumption in these escalations is that other variables remain constant. Such variables include the industrial capacity to undertake and perform decommissioning work, and the availability of LLRW disposal facilities to accept NSS waste. These two variables are unlikely to remain stable over the extended SAFSTOR Operations period, and could contribute to substantially increased costs over time. For example, at present there is industrial capacity generally available to perform facility decommissioning; however, most large-scale first-generation decommissioning projects have now been completed or scheduled for completion. With the *Savannah* decommissioning deferred for about 20 years, it is likely that its future decommissioning will have to compete with other large-scale decommissioning projects as power plants that have been re-licensed in the past few years reach the end of their service. This will strain the industrial capacity. At the same time, projected new plant construction and maintenance will absorb some portion of that same industrial capacity. In short, there is high risk associated with even the conservative decommissioning cost assumptions presented herein.

7.0 ENVIRONMENTAL IMPACTS

10 CFR 50.82(a)(4)(i) describes the PSDAR and requires that it include "a discussion that provides the reasons for concluding that the environmental impacts associated with the site-specific decommissioning activities will be bounded by appropriate previously issued environmental impact statements."

Because the NSS was licensed prior to the National Environmental Policy Act of 1969, as Amended (NEPA), no Environmental Impact Statement for the NSS was required for the NS-1 Operating License. In Reference (i), the Maritime Administration stated its determination that they had "fulfilled its statutory responsibilities under the NEPA by preparing this [enclosed] Environmental Assessment and that no formal environmental impact statement would be required for the [Mothballing] actions that are being taken."

To meet the contemporary requirements of 10 CFR 50.82(a)(4)(i), Maritime Administration has recently completed an Environmental Assessment (EA) regarding the Decommissioning of the Nuclear Ship *Savannah*, Reference (h). This EA documents the applicable decommissioning alternatives for the NSS, and describes the potential environmental effects associated with each alternative - DECON, SAFSTOR and No Action. For each alternative, the EA considered potential effects to the natural and human environment including: air quality; water quality; geology and soils; coastal resources; terrestrial resources; aquatic resources; navigation; hazardous materials; cultural and historic resources; visual and aesthetic resources; and other topics associated with the proposed action.

In Reference (f), the Agency published notice of the availability of the Finding of No Significant Impact (FONSI), Reference (g). The FONSI is based on the analysis presented in the Nuclear Ship *Savannah* Decommissioning EA.

The FONSI documents the Maritime Administration's conclusion that the proposed federal action to decommission the NSS is consistent with existing national environmental policies and objectives set forth in Section 101(a) of NEPA.

The FONSI concludes the following:

- The No Action alternative does not meet the Maritime Administration's purpose and need for action.
  - The Maritime Administration would fail to comply with current NRC requirements for the safe-keeping of the NSS.
  - Future decommissioning costs would be substantially increased, and non-compliance would likely result in increased frequency and scope of NRC inspections and oversight.
- Either SAFSTOR or DECON meet the Maritime Administration's immediate purpose and need for action.

The EA and FONSI were provided to the NRC for information on October 3, 2008, Reference (m).

7.1 SPECIFIC ENVIRONMENTAL ISSUES

The effects of decommissioning activities with respect to specific environmental issues are discussed below.

7.1.1 RADIATION DOSE TO THE PUBLIC

As noted in 2.2.1 above, the reactor was defueled in 1971. The remaining radioactive material is primarily the activated pressure vessel and other primary system components. Reduction of this material through decay forms the basis for concluding radiation dose to the public will be maintained below levels comparable to when the NSS was operating. Application of radiation

protection and contamination controls will further ensure dose to the public is maintained lower than when the NSS operated.

7.1.2 OCCUPATIONAL RADIATION EXPOSURE

The occupational radiation exposure for decommissioning the NSS is estimated to be 38 person-Rem based on the actual occupational radiation exposure for decommissioning the Saxton Nuclear Experimental Corporation (SNEC) facility, Reference (n). The SNEC facility is more similar to the NSS than the large commercial pressurized water reactor (PWR) plant described in the GEIS, Reference (h). The SNEC facility, Reference (o), contained a 23.5-megawatt thermal (MW_{th}) reactor that operated from 1962 to 1972. After shutdown and fuel removal in 1972, the SNEC facility was placed in SAFSTOR. In 2006, decommissioning of the SNEC facility was completed and its NRC license was terminated.

TABLE 7-3 COMPARISON OF THE NSS AND SNEC

	NSS	SNEC facility
Power MW_{th}	80	24
Shutdown/Defueled	1970/1971	1972/1972
RPV neutron activation analysis	452.2 Ci (2005 estimate) using Metal Sample analysis, Reference (k)	1452 Ci (1996 estimate)

Per Table 4.3-2 of the GEIS, the reference PWR in SAFSTOR for 30 years is allocated 282.4 person-Rem for SAFSTOR preparation and 10.2 Person-Rem for SAFSTOR preparation truck shipments. The GEIS allocates 14 person-Rem for continuing care during the 30 years SAFSTOR period. For decontamination and decontamination truck shipments, the GEIS allocates 26.3 person-Rem.

Based on the GEIS, the NSS has 26.3 person-Rem "available" for DECON activities. The NSS estimate of 38 person-Rem (based on the SNEC facility) exceeds the GEIS estimate by 12.3 person-Rem. Basing the occupational radiation exposure estimate on the results of a similar sized nuclear facility that recently completed decommissioning is intuitively more appropriate than using the GEIS which was based on decommissioning a hypothetical plant. Therefore, the Agency estimates that the actual occupational radiation exposure for the NSS will be similar to that for the SNEC facility.

7.1.3 LOW-LEVEL RADIOACTIVE WASTE BURIAL VOLUME

The estimated low-level radioactive waste burial volume for decommissioning the NSS is 325 cubic meters. The GEIS estimates the volume to be 18,340 cubic meters for the reference PWR using the 30 year SAFSTOR alternative.

The Agency estimates there will be no waste requiring deep geological burial (i.e., GTCC waste) for the following reasons:

1) All spent fuel has been removed from the NSS; and,

2) The principle finding of the Reactor Pressure Vessel Drilling, Sampling and Radiochemical Analysis Project, Reference (k), is that if the vessel and internals were

disposed as an intact package, the reactor pressure vessel and related components on the NSS are Class A radioactive waste material for land disposal purposes per 10 CFR 61.55.

The GEIS estimated approximately 11 cubic meters of GTCC waste for the reference PWR.

7.1.4 NON-RADIOLOGICAL ENVIRONMENTAL IMPACTS

The non-radiological environmental impacts from decommissioning the NSS are similar to those that routinely occur at industrial facilities specifically designed to build, maintain and/or dispose of ships.

The largest occupational risk associated with the decommissioning is the risk of industrial accidents. This risk will be minimized by adherence to work controls during decommissioning that are based on current safety standards. Procedures controlling work related to asbestos, lead and other non-radiological hazards will be in place during all four periods of planned decommissioning activities.

The primary environmental effects of decommissioning the NSS will be essentially identical to those that routinely occur at industrial facilities involved in building, maintaining and/or disposing of ships. These environmental effects of decommissioning will involve no increases above those that typically occur at such sites. The Maritime Administration has identified no significant socioeconomic impacts other than those associated with the unique aspects of a decommissioning a nuclear ship (e.g., temporary increase of employment of radiologically trained individuals and the concurrent influx of money into the local economy of the selected decommissioning location). No impacts to local culture, archaeological, terrestrial, or aquatic resources have been identified other than those related to the ship itself which is a registered National Historic Landmark.

7.1.5 ADDITIONAL CONSIDERATIONS

While not quantitative, the following considerations are also relevant to concluding that decommissioning activities will not result in significant environmental impacts not previously reviewed:

- The release of effluents will continue to be controlled by plant license requirements and plant operating procedures throughout decommissioning;
- With respect to radiological releases, an Offsite Dose Calculation Manual will be developed and implemented during decommissioning;
- Releases of non-radiological effluents will continue to be controlled in accordance with the requirements of the National Pollutant Discharge Elimination System (NPDES) and the state where decommissioning is performed;
- Radiation protection principles will be in effect during decommissioning to ensure that protective techniques, clothing and breathing apparatus are used as appropriate;
- Sufficient decontamination prior to dismantlement will be performed to ensure that occupational doses and public exposures will not exceed those estimated in the GEIS;
- Transport of radioactive waste will be in accordance with plant procedures, applicable federal and state regulations and the requirements of the receiving facility; and,
- Site access control during decommissioning will ensure that residual contamination is minimized as a radiation release pathway to the public.

7.2 HISTORIC PRESERVATION CONSIDERATIONS

The EA includes a substantive analysis of historic preservation effects under Sections 106 / 110 of the NHPA and Section 4(f) of the Department of Transportation Act. In general, the conclusion is that

decommissioning will have an overall beneficial effect on the ship by removing any restrictions on its use imposed by the license, and because the decommissioning approach envisions no substantial destruction to the ship's structure. The EA analysis affirms that the removal of the power plant may diminish the ship's overall historic significance, but not to a point that it loses eligibility for either the National Register of Historic Places, or as a National Historic Landmark.

7.3 ENVIRONMENTAL IMPACTS CONCLUSION

Based on the above discussion, the potential environmental impacts associated with decommissioning the NSS have already been postulated in, and will be bounded by, the Finding of No Significant Impact, Reference (e), which is based on the Environmental Assessment regarding the Decommissioning of the Nuclear Ship Savannah, Reference (f).

The EA documents the available decommissioning alternatives for the NSS. The EA has been evaluated and determined to adequately and accurately discuss the environmental issues and impacts of the proposed project.

8.0 REFERENCES

a. Letter from Mr. E. W. Koehler (the Agency) to Document Control Desk (NRC), dated December 11, 2006, Submittal of Post Shutdown Decommissioning Activities Report, Revision 0

b. Letter from Mr. E. W. Koehler, (the Agency) to Document Control Desk (NRC), dated January 27, 2007, Withdrawal of Post Shutdown Decommissioning Activities Report, Revision 0

c. Regulatory Guide 1.185, Standard Format and Content for Post-Shutdown Decommissioning Activities Report, dated July 2000

d. Notice of the availability of a Finding of No Significant Impact, Federal Register: May 14, 2008 (Volume 73, Number 94)

e. Maritime Administration Finding of No Significant Impact, dated May 6, 2008

f. Nuclear Ship Savannah Decommissioning, Final Environmental Assessment, March 2008

g. Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, dated June 1974

h. NUREG-0586, Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, dated August 1988

i. Letter from Mr. Robert W. Reid (NRC) to Dr. Zelvin Levine (the Agency), dated May 19, 1976, Amendment 8 (Possession-only License)

j. NSS Radiological and Non-Radiological Spaces Characterization Survey Report, Revision 0, dated September 22, 2005

k. Reactor Pressure Vessel Drilling, Sampling and Radiochemical Analysis Project Report, Revision 1, dated January 31, 2006

l. SAFSTOR Plan, STS-104, Revision 0, October 2007

m. Letter from Mr. E. W. Koehler, (the Agency) to Document Control Desk (NRC), dated October 3, 2008, Submittal of Finding of No Significant Impact and Environmental Assessment

n. Saxton Nuclear Experimental Corporation Facility, License Termination Plan, Revision 1, dated September 25, 2002

o. Updated Safety Analysis Report for Decommissioning the SNEC Facility, Revision 3, dated February 2000

APPENDIX A. COMPARISON OF MOTHBALLING AND SAFSTOR REQUIREMENTS

As noted in Section 2.1 Background, the NSS was issued a Possession-only license in 1976 that placed the ship in a Mothballed state of protective storage. In 1988, the concept of SAFSTOR was formally introduced by Generic Environmental Impact Statement (GEIS), NUREG-0586, Reference (h). During the subsequent years, lessons learned from decommissioning a number of plants culminated in the 1996 change to the "Termination of license rule," 10 CFR 50.82. Regulatory Guides associated with implementing this rule change further developed the definition of SAFSTOR. By 2000, the SAFSTOR concept was sufficiently developed and subsequently described in Regulatory Guide 1.185, Standard Format and Content for PSDAR, Reference (a).

The need for creating the term SAFSTOR is clearly described in Reference (h) as follows.

> 2.4 Decommissioning Alternatives
>
> Once a nuclear facility has reached the end of its useful life, it must be decommissioned according to the definition contained in Section 2.3. Several alternatives are possible, although not all may be satisfactory for all nuclear facilities. These alternatives are: No Action, DECON, SAFSTOR, and ENTOMB.
>
> The terms DECON, SAFSTOR, and ENTOMB are relatively new in use. In the past, the nomenclature for describing these alternatives has not been consistent. Different documents have often used different terminology when referring to the same decommissioning alternative, thus causing some confusion. In the interest of ending the confusion, this section lists the following definitions of the major decommissioning alternatives and the following pseudo acronyms to clearly delineate each alternative *(author note – ENTOMB is not applicable to NSS and not defined below)*:
>
> DECON is the alternative in which the equipment, structures, and portions of the facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations.
>
> SAFSTOR is the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.

Therefore, the purpose of the comparison is to show the differences between the 1974 and 2000 requirements of protective storage. The NSS was placed in protective storage under the 1974 requirements of mothballing. As the definition of the SAFSTOR alternative was developing, the requirements on how to implement the SAFSTOR alternative were also changing from the 1974 requirements. In acknowledging these differences, the Maritime Administration is tasked to implement the SAFSTOR requirements prior to returning the NSS to protective storage.

A.1. PREPARATION FOR PROTECTIVE STORAGE - MOTHBALLED VS. SAFSTOR

As shown in the two following bulleted lists, as the definition of SAFSTOR was developed, the NRC established expectations for programmatic requirements during protective storage (i.e., SAFSTOR) and increased the requirements for SAFSTOR preparations compared to the limited and prescriptive Mothballing criteria.

A.1.1. MOTHBALLING (REGULATORY GUIDE 1.86)

- All fuel assemblies and the radioactive fluids and waste should be removed from the site; and,
- Adequate radiation monitoring, environmental surveillance, and appropriate security procedures should be established.

A.1.2. SAFSTOR (REGULATORY GUIDE 1.185)

- Shipment and processing or storage of the fuel and greater-than-Class-C waste;
- Draining of specific systems and removal of resins from ion exchangers;
- Inspection and monitoring plans during the storage period;
- Decontamination of specific high-dose areas;
- Removal of low-level waste that is ready to be shipped;
- De-energizing or deactivating specific systems;
- Reconfiguration of ventilation systems and fire protection systems for use during the storage period;
- Maintenance of any systems critical to final dismantlement during the storage period; and
- Changes in management and staffing to support all decommissioning periods (i.e., SAFSTOR Preparations).

A.1.3. SIGNIFICANT DIFFERENCES

- Implicit 'must' vs. 'should' regarding removal of fluids, fuel and resin;
- Reconfiguration of ventilation systems and fire protection systems for use during the storage period;
- Development of inspection and monitoring plans for plant structures, systems and components used during the storage period or expected to be used during final dismantlement; and,
- Development of management and staffing to support SAFSTOR Preparations.

A.2. PROTECTIVE STORAGE REQUIREMENTS - MOTHBALLED VS. SAFSTOR

The significant increase in the programmatic aspects of SAFSTOR operations (the period that the ship is in SAFSTOR following SAFSTOR preparations) is shown in the following table.

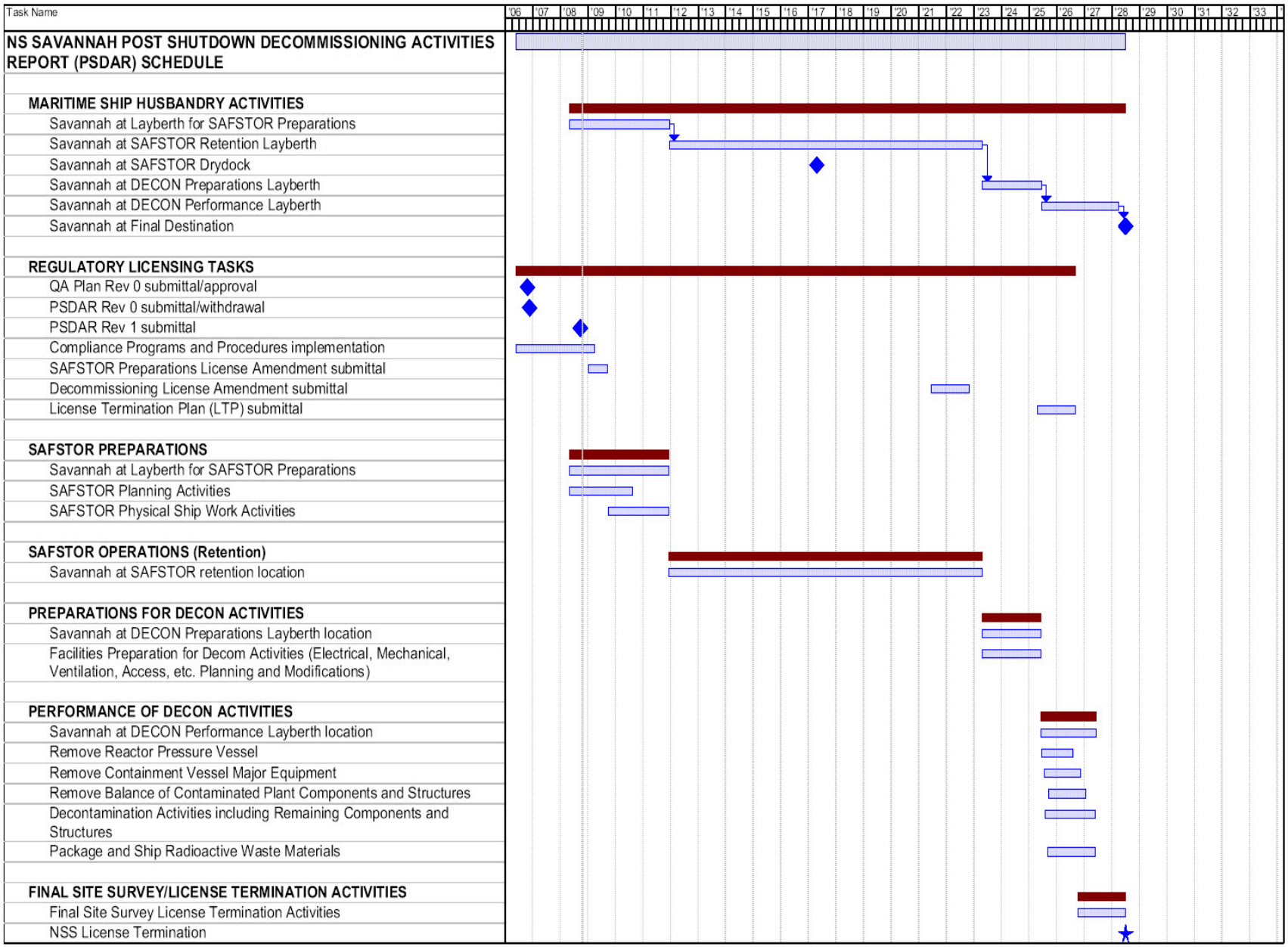
TABLE A.1 MOTHBALLING VS. SAFSTOR REQUIREMENTS

Mothball Requirements during Storage	SAFSTOR Requirements during Storage
Due to significant amount of radioactivity in the form of activated and contaminated hardware and structural materials, surveillance and commensurate security should be provided to assure that the public health and safety are not endangered	Development of a Quality Assurance (QA) Plan, Security Plan and a Radiation Protection Plan to support all decommissioning periods, [Implicit] if not established during the period of ship operations.
Physical barriers should be inspected at least quarterly to ensure locks are intact and the barriers have not deteriorated.	Maintenance and surveillance of security systems.
A site representative should be designated to be responsible for controlling access into and movement within the facility.	Implementation of a Security Plan.
Radiation surveys should be performed quarterly to verify that no radioactive material is escaping or	Implementation of a Radiation Protection Plan including maintenance and surveillances associated

Mothball Requirements during Storage	SAFSTOR Requirements during Storage
being transported past barriers.	with a radiation effluent and environmental monitoring programs.
Environmental radiation surveys should be performed at least semiannually to verify that no significant amounts of radiation have been released to the environment.	Processing of any radwaste generated (usually small amounts).
No comparable requirement.	Performance of preventive and corrective maintenance on plant structures, systems and components that will be operating and/or functional during SAFSTOR specifically ventilation and fire protection systems.
No comparable requirement.	Maintenance of any structures, systems and components critical to final dismantlement during the storage period.
No comparable requirement.	Maintenance to preserve structural integrity.
Administrative procedures should be established for the notification and reporting of abnormal occurrences: 1. entrance by unauthorized individuals into the facility and 2. a significant change in radiation or contamination levels in the facility.	As required by the QA Plan, develop procedures for all aspects of SAFSTOR operations, [Implicit] if not established during the period of plant operations.
Annual report and abnormal occurrence reports should be made.	As required by the Reporting requirements of 10 CFR Parts 20, 50, etc. and the QA Plan, develop procedures for all aspects of SAFSTOR operations, [Implicit] if not established during the period of plant operations.
Records and logs should be established and kept until the license is terminated: o Environmental surveys o Radiation surveys o Inspections of physical barriers o Abnormal occurrences	As required by the QA Plan, develop Records Management procedures, [Implicit] if not established during the period of plant operations.

In general, the difference between Mothballing and SAFSTOR is that the Mothballing option allows the facility to be routinely left unattended except during quarterly radiation surveys and security lock inspections. SAFSTOR is a performance based policy that requires programs and policies to remain in effect during SAFSTOR Operations/Retention and requires routine surveillance and monitoring activity at the facility.

APPENDIX B. DECOMMISSIONING PROJECT SCHEDULE



APPENDIX C. ALTERNATIVES FOR FUTURE CONSIDERATION

The decommissioning plan described in this PSDAR is consistent with the terms and conditions of the facility license, NS-1, and the described activities are based on compliance with the applicable regulations and regulatory guides under which the NSS license is maintained. Strict adherence to these regulations requires that the nuclear power plant be dismantled and disposed of (DECON), and the license terminated. However, the nuclear power plant is a substantial contributor to the ship's "exceptional national significance" as described in the 1991 National Park Service nomination of the *Savannah* as a National Historic Landmark, and as a consequence its disposal could be considered to be an adverse effect as defined in historic preservation statutes, regulations and directives.

Although the Agency is pursuing mitigative measures in anticipation of this adverse effect and has also concluded that decommissioning could have an overall beneficial impact to the ship, the purpose of this appendix is to foster a dialogue whose ultimate goal will be to discover whether options other than dismantling and disposal of the power plant may be reasonable and feasible to pursue. Several possibilities are suggested in this appendix; however, the Agency hopes that these will represent only a starting point for subsequent discussion.

The presumption in this appendix is that the underlying rationale for a DECON alternative is preservation of all, or part, of the licensed nuclear facility. Although costs to the Federal Government are always a factor in major capital projects, the mere reduction in cost appears to be insufficient justification for any alternative approach (if preservation is not the end state; then the eventual disposal of the ship would require that the nuclear facilities be dismantled under controlled conditions). Nor are there known or anticipated industrial factors that would prevent DECON in the foreseeable future (to 2031); although factors including the availability of future LLRW disposal sites, and workforce capacity to perform the DECON technical activities may have substantially greater future cost impacts to the project than the escalation factors used in Section 6 imply. Ultimately, the Agency's obligation to meet its licensing commitments has primacy over the cost for DECON and license termination. Therefore, the approaches outlined below are based on the regulatory alternatives that are presently available, with the view that any currently permissible alternative approach meets the intent of license compliance.

Before discussing the alternatives, it is useful to note the several examples of nuclear power plant preservation that already exist, both in the United States and elsewhere. This list may not be all-inclusive.

- **USS NAUTILUS (SSN 571):** The NAUTILUS is the first nuclear-propelled vessel of any kind in the world. A combatant submarine commissioned into the United States Navy in 1954, the NAUTILUS was designated a National Historic Landmark in 1982, only two years after it was decommissioned from naval service. The NAUTILUS remains owned, maintained and operated by the United States Navy and is located in New London, CT, at the Submarine Force Museum (also owned and operated by the Navy). The nuclear power plant is intact, but heavily shielded and not on display to visitors. The forward, non-radiologically controlled spaces of the submarine are available for tour. Preservation of the NAUTILUS was a seamless activity that immediately followed the ship's removal from service.
- **Hanford B Reactor:** The Hanford B Reactor is the world's first industrial-scale nuclear reactor, located on the Department of Energy's (DOE) Hanford Site in southeast Washington State. The B Reactor is a major legacy site of the Manhattan Project, and is among several extant sites being preserved by the DOE under its Manhattan Project Preservation Initiative. The plant is substantially intact and essentially little-changed from its appearance during the Second World War. The B Reactor ceased operations in 1968, and was maintained in a retention condition thereafter with controlled public access and visitation. DOE had originally intended to DECON the B Reactor, but chose instead to preserve it. On August 19, 2008 the B Reactor was designated a National Historic Landmark, and the DOE has established a public access program to permit more frequent and regular visitation to the site.
- **X-10 Graphite Reactor, Oak Ridge:** Similar to the B Reactor, the National Historic Landmark X-10 Graphite Reactor, located at the Oak Ridge National Laboratory in Tennessee, is another of the Manhattan

Project signature facilities that has been preserved by the DOE. Public access is available, and visitors may view the control room and graphite reactor face.

- **Nuclear Ship *Lenin*:** The world's first nuclear-powered surface ship is an icebreaker constructed by the former Soviet Union for arctic transportation. The *Lenin* was home-ported in Murmansk, Russia, from which it operated for some 30 years. The *Lenin* suffered from two now well-publicized radiological incidents during its career; however, it was repaired each time and returned to service. The *Lenin* was removed from service about 1989, and many sources report that it is being converted into a museum in Murmansk, due to open in 2009 on the 50th anniversary of the ship's entry in service. Information is sketchy and difficult to confirm; however, it appears that the nuclear power plant (replaced in 1970) is intact. The most recent reports also suggest that radiological remediation (similar to the SAFSTOR equivalent) is being performed outside of the reactor compartment in order to prepare the ship for museum use.
- **Nuclear Ship *Mutsu*:** The Japanese research vessel *Mutsu* was constructed beginning in the late 1960's. It suffered from a great deal of public relations difficulty prior to and immediately following its sea trials in 1974. During the trials a design flaw in the reactor shielding resulted in a minor radiation leak; the resulting public outcry, however, delayed repairs and operation of the vessel for nearly 20 years. Finally, after a short period of tests and trials in the early 1990's, the *Mutsu* was removed from service. The ship's nuclear power plant and steam turbine propulsion systems were removed from the ship; which was then converted to diesel propulsion and returned to service as the Oceanographic Research Vessel *Mirai*. The *Mutsu*'s reactor, control room, and other related equipment and features were "disposed" inside a specially constructed museum building, where they can be viewed by the public.

None of the vessels or facilities cited above are commercially-licensed, and thus are of relevance only in that they represent examples of historically significant nuclear facilities that have been preserved, and made available for public visitation under appropriate institutional controls.

A final objective, or prerequisite, to a preservation approach for the *Savannah* is to define the scope of planned public visitation within the preserved portions of the nuclear power plant. If the plant is merely maintained in-situ without provisions for public access, there is no advantage to this approach compared to decommissioning via DECON, except for cost avoidance.

C.1. LICENSE TERMINATION UNDER 10 CFR 20.1403 RESTRICTED CONDITIONS CRITERIA

10 CFR 20.1403 sets forth criteria for license termination under restricted conditions. Under these criteria the licensee must ensure the restrictions remain in effect after license termination. As noted in section 3.4, "although there is a preferential intent to preserve the ship, it is unlikely if not impractical for the Maritime Administration alone to retain ownership and actively preserve or conserve the ship for any long period of time after license termination." Therefore, any application for a restricted condition license termination could only be made after the future role of the Maritime Administration is defined.

Paragraph (a) establishes a residual radioactivity threshold that is ALARA (as low as reasonably achievable). To meet this threshold the Agency would need to complete the SAFSTOR Preparations described in section 3.1, and undertake at least those additional decommissioning activities required to reduce dose rates in areas intended for public access to the ALARA standard. Outside of the reactor compartment and other radiologically controlled spaces, the current radiological exposure is essentially background, and public visitation is conducted under appropriate administrative controls. Accordingly, it seems probable that the residual radioactivity threshold for 10 CFR 20.1403 license termination could be defined and met in the context of a planned preservation effort.

Paragraph (b) requires the licensee to make provisions for legally enforceable institutional controls to ensure that exposures do not exceed 25 mrem (0.25 mSv) per year to average members of the defined critical group. These

controls could be provided in a variety of methods, depending on the ultimate make-up of the preservation entity. Because it is implicit that the Maritime Administration must maintain some responsibility for the site after license termination, the Agency could structure that role in such a way as to provide the enforceable institutional controls. Similarly, the Agency could provide the Federal licensee financial assurance statement of intent to meet the requirements of paragraph (c).

C.2. LICENSE TERMINATION UNDER 10 CFR 20.1404 ALTERNATE CRITERIA

10 CFR 20.1404 sets forth conditions under which the Commission may terminate a license under alternate criteria. To some extent these alternate criteria are similar to the restricted release criteria under 10 CFR 20.1403, except that the provisions for financial assurances and enforceability are not included. Again the regulation requires the licensee to ensure the restrictions will remain in effect after license termination.

C.3. MAINTENANCE OF LICENSE / LICENSE RENEWAL

Although not defined in the regulations, a possible option would be to construct a form of license renewal. The terms and conditions of a new or renewed license might be similar to the restricted conditions of 10 CFR 20.1403. Maintaining a facility license would allow the NRC to retain jurisdiction. This ensures that the institutional controls proposed by the licensee for restricted release criteria under 20 CFR 1403(d)(1)(i) can be met with appropriate oversight and enforcement under 20 CFR 1403(d)(1)(i)(B). Such a license may require amendment of the Atomic Energy Act of 1954, as amended.

C.4. TECHNICAL CONSIDERATIONS REGARDING RESTRICTED RELEASE

The dose rates within the Containment Vessel are known to be generally low enough that a public visitation program could be designed. Based on the results of the 2005 Characterization Scoping Surveys and Reactor Pressure Vessel Sampling, as well as routine Containment Vessel surveys made since 2006, the greatest source of dose inside the CV is the RPV itself. The RPV remains shielded by the Neutron Shield Tank, such that dose rates at the exterior of the NST are quite low. With appropriate analysis and engineered safeguards, a pathway for visitors through the CV could be provided. Some redundant equipment, such as one of the steam generators, might be removed from within the CV to provide adequate space for a visitor pathway and entry and exit locations through the CV wall.

A further reduction in dose rate might be accomplished in one or more of the following ways:

- Retain the RPV, but remove Class B/C internals to reduce radiological inventory. Based on 2005 metallurgical and radiochemical analysis of the RPV, this action could substantially reduce external dose rates within the local environment of the RPV because the internals are the largest contributors to the external dose.
- Retain the RPV and internals; grout the interior to provide biological shielding and to stabilize loose components inside the RPV (this approach is already envisioned for removal of the RPV in DECON).
- Remove the RPV, NST and the Control Rod Drive assembly.

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