U.S. Department
of Transportation
**Maritime
Administration**

Savannah Technical Staff
Office of Ship Disposal

1200 New Jersey Ave., SE
Washington, DC 20590

Ref: 10 CFR 50.71(e)

May 1, 2013

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Docket No. 50-238; License No. NS-1; N.S. *SAVANNAH*
Submittal of Final Safety Analysis Report, Revision VII

Pursuant to 10 CFR 50.71(e), the Maritime Administration (MARAD) hereby submits Revision VII of the Final Safety Analysis Report as Enclosure (1). MARAD certifies that the updated information accurately presents changes made since the previous revision.

Revision VII is submitted on a replacement-page basis and includes a list which identifies the current pages of the FSAR following page replacement. The updated FSAR includes the effects of the following:

- all changes made in the facility or procedures as described in the FSAR;
- all safety evaluations performed to support a license amendments; and,
- all analyses of new safety issues performed by or on behalf of the licensee at Commission request.

This submittal contains no new Regulatory Commitments.

If there are any questions or concerns with any issue discussed in this request, please contact me at (202) 366-2631, and/or e-mail me at erhard.koehler@dot.gov.

Respectfully,

Erhard W. Koehler
Senior Technical Advisor, N.S. *SAVANNAH*
Office of Ship Disposal

Enclosure

Enclosure:
1. Change Instructions and Replacement Pages for Final Safety Analysis Report, Revision VII

cc:

Electronic copy
NSS ESC
NSS SRC

MAR 610, 612, 615

Hardcopy, cover letter only
MAR-600, 640, 640.2

Hardcopy w/ all enclosures
MAR-100, 640.2 (rf)
USNRC (John T. Buckley, Mark C. Roberts)
USNRC Regional Administrator - NRC Region I
MD Department of the Environment (Roland G. Fletcher; George S. Aburn, Jr.)
NC Department of Environment & Natural Resources (Beverly O. Hall)
SC Department of Health & Environmental Control (Susan E. Jenkins; Aaron Gantt)
VA Department of Emergency Management (Michael M. Cline)
VA Department of Health (Leslie P. Foldesi)

EWK/jmo

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of Transportation

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Docket No. 50-238; License No. NS-1; N.S. *SAVANNAH*

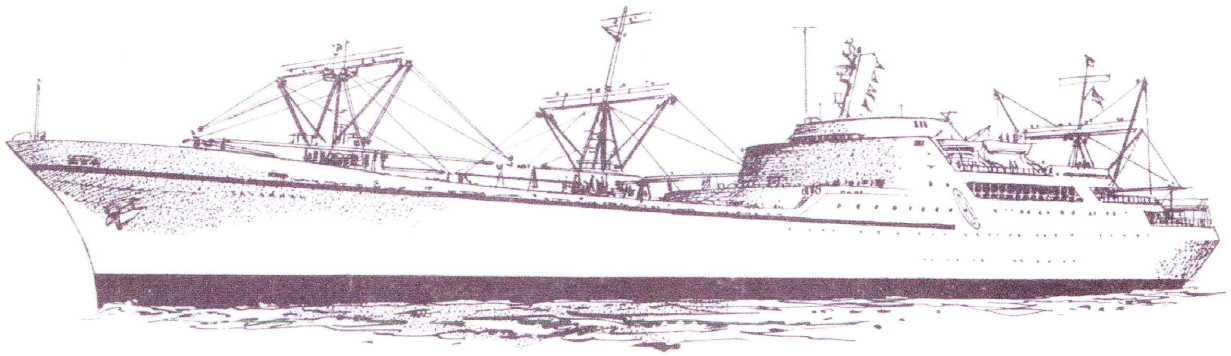
Enclosure 1 to Submittal of Final Safety Analysis Report, Revision VII

Change Instructions for Final Safety Analysis Report, Revision VII

Replace the following pages of the Final Safety Analysis Report, Revision VI with the attached revised pages. The revised pages are identified by revision number and contain marginal lines indicating the areas of change.

REMOVE	**INSERT**
Title Page	Title Page
ii through xiv	ii through xv
1-11	1-11
128	128

U.S. Department of Transportation
Maritime Administration
Office of Ship Disposal



N.S. SAVANNAH

UPDATED FINAL SAFETY ANALYSIS REPORT

STS-004-002
Revision VII

Approved: _____ 05/01/2013
Senior Technical Advisor Date

Prepared by:
Totes Services, Inc.

RECORD OF REVISIONS

Revision	Summary of Revisions Following Final Shutdown and Permanent Defueling
STS-004-002, UFSAR Revision IV	A complete revision to the FSAR that incorporates numerous changes that occurred from 1968 through March 2007
STS-004-002, Revisions 1-4	These revision numbers to the STS were not used. By not using these numbers, the revision number for the FSAR and the revision number to STS-004-002 will be the same revision number.
STS-004-002, Rev. 5; FSAR Revision V	This revision incorporates changes that occurred after March 2007. The most significant changes are in Chapter 2 (Fire Detection and Alarm Systems, Security Systems and General Alarm) and Chapter 3 (Ship Movement and Port Operating Criteria).
STS-004-002, Rev. 6; FSAR Revision VI	This revision incorporates changes that occurred after March 2009. The most significant change was the electrical modification to deenergize all originally installed 450 volt switchgear. All required 450/480 volt loads were moved to a new 800A Shore Power Switchboard. Chapter 2.4.2, Fire Detection and Alarm system (FA) and Chapter 2.9. Dehumidification System were rewritten.
STS-004-002, Rev. 7; FSAR Revision VII	This revision incorporates changes that occurred after March 2011. These changes correct historical discussion in Chapter 1 and correct grammatical errors in Chapter 11.

PREVIOUS ISSUES

N.S. *SAVANNAH* SAFETY ASSESSMENT, Volumes I-V, 1960-1962
N.S. *SAVANNAH* HAZARDS SUMMARY REPORT FOR DOCKSIDE OPERATION, September 1963
N.S. *SAVANNAH* HAZARDS SUMMARY REPORT FOR 1964 SEA TRIALS, December 1963
N.S. *SAVANNAH* SAFETY ASSESSMENT, Revision I, July 1965
N.S. *SAVANNAH* SAFETY ASSESSMENT, Revision II, March 1967
SAFETY ANALYSIS REPORT N.S. *SAVANNAH* FUEL SHUFFLE, December 1, 1967
N.S. *SAVANNAH* SAFETY ASSESSMENT, Revision III, October 1968
SAFETY ANALYSIS SUMMARY – N.S. *SAVANNAH* DEFUELING, February 1971
SUPPLEMENT NO. 1 TO SAFETY ANALYSIS REPORT N.S. *SAVANNAH* FUEL SHUFFLE – FUELING WITH CORE II, October 1971 (Note that Core II was never installed)
UPDATED FINAL SAFETY ANALYSIS REPORT, Revision IV, April 2007
UPDATED FINAL SAFETY ANALYSIS REPORT, Revision V, May 2009
UPDATED FINAL SAFETY ANALYSIS REPORT, Revision VI, May 2011

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FOREWORD TO REVISION VII (2013)

Revision VII to the UFSAR is the 2013 biennial update. This revision corrects historical discussion in Chapter 1 and grammatical errors in Chapter 11. Minor formatting changes are included to clarify the intent and structure of the document.

The ship and its nuclear facilities remain in protective storage. The ship is in an active layberthing condition, with a retention crew and regular attendance by the Maritime Administration's nuclear operations staff. This condition is projected to continue throughout the next two-year biennial UFSAR update period. The updated safety analyses found in this revision apply to all activities within the site boundary (i.e.; all shipboard activities), regardless of how they may be characterized.

FOREWORD TO REVISION VI (2011)

Revision VI to the UFSAR is the 2011 biennial update. This revision incorporates changes based on improved staff knowledge and understanding of the condition of the ship and its infrastructure based on continuous crewing since 2009. Revision VI also incorporates, as appropriate, materials and information contained in license submittals over the past two years. Minor formatting changes are included to clarify the intent and structure of the document.

The ship and its nuclear facilities remain in protective storage. The ship is in an active layberthing condition, with a retention crew and regular attendance by the Maritime Administration's nuclear operations staff. This condition is projected to continue throughout the next two-year biennial UFSAR update period. The updated safety analyses found in this revision apply to all activities within the site boundary (i.e.; all shipboard activities), regardless of how they may be characterized.

FOREWORD TO REVISION V (2009)

Revision V to the UFSAR is the 2009 biennial update. This revision incorporates changes based on improved staff knowledge and understanding of the condition of the ship and its infrastructure based on continuous crewing since 2007. Revision V also incorporates materials and information contained in license submittals over the past two years, including the most recent (April 2008) license amendment (14), the May 2008 Environmental Assessment (EA), and the December 2008 Post Shutdown Decommissioning Activities Report (PSDAR). Minor formatting changes are included to clarify the intent and structure of the document.

The ship and its nuclear facilities remain in protective storage. The ship is in an active layberthing condition, with a retention crew of four persons and regular attendance by the Maritime Administration's nuclear operations staff. This condition is projected to continue throughout the next two-year biennial UFSAR update period. The updated safety analyses found in this revision apply to all activities within the site boundary (i.e.; all shipboard activities), regardless of how they may be characterized.

The near-term focus of decommissioning planning, as described in the EA and PSDAR, is to bring the ship and its nuclear facilities into conformance with contemporary NRC SAFSTOR criteria, and to place the ship into active retention for a period of as much as 15 years before starting DECON and License Termination. This revision provides appropriate safety analyses and bounding conditions for these activities.

FOREWORD TO REVISION IV

Revision IV to the FSAR is intended to provide a 2007 status of the N.S. *SAVANNAH*. It is a complete rewrite of Revision III and includes a summary of numerous documents submitted to the NRC since the last update in 1968, including the most recent (January 2007) license amendment (13).

At the end of 1972, after the ship had been defueled and placed in wet layup status, the Maritime Administration decided not to refuel the ship and return it to service. In effect, this decision made the 1970 and 1971 actions permanent. The final shutdown was in November 1970 and the permanent defueling was completed in fall 1971, these actions are retroactively considered to be permanent cessation of operations. Therefore, the fall 1971 defueling became the de facto permanent defueling and cessation of operations with the issuance of Technical Specification Change 13.

The ship is in a state of protective storage. Most weather openings are sealed. Almost no mechanical system or equipment is functional excepted as noted in the following text. The functional systems include a significant portion of the electrical distribution system, the hull cathodic protection system, the dehumidification (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) generally obstructs the doorways, passageways and ladders throughout ship as is typical in the marine industry for deactivated ships.

The electrical distribution system, hull cathodic protection system and the anchor windlass are the only currently functional portions of the ship's original outfit. Since 1994, there has been minimal maintenance and testing to the ship's electrical system. Any future use of the electrical system would require surveying prior to energizing any of its currently deenergized portions.

1 INTRODUCTION AND SUMMARY

1.1 Summary of Significant Events

A nuclear merchant ship was first proposed by President Eisenhower in a speech in New York on April 25, 1955 as evidence of this country's interest in the peaceful uses of atomic energy. Construction was authorized by Public Law 848[1], which provided funds for the design and construction of a vessel, subsequently named the N.S. *SAVANNAH* (NSS).

On October 15, 1956, the President directed the Atomic Energy Commission (AEC) and the Maritime Administration (MARAD) to proceed with design and construction. To complement this effort, the entire project was placed under the direction of a dual status staff chosen jointly by MARAD and the AEC. The vessel was designed by George G. Sharp, Inc. Naval Architects of New York. The Babcock and Wilcox Company (B&W) was awarded a fixed price contract for the design and construction of the nuclear power plant auxiliaries. The New York Shipbuilding Corporation (NYS) was selected to construct and test the ship at their Camden, New Jersey shipyard. In 1958, the States Marine Lines, Inc. was engaged as the operating agent for the ship. Todd Shipyard Corporation was chosen to provide the maintenance facility in May 1960. In 1963, American Export Isbrandtsen Lines Inc. (AEIL) became the operating agent. The initial operating License was issued in August 1965. First Atomic Ship Transport Inc., (FAST) a subsidiary of AEIL, placed the NSS in routine cargo service in September 1965.

The NSS, a vessel of the P-2 class (specifically P2-Nl-MA40a) was powered by an 80 MW_{th} pressurized-water nuclear reactor and had a design speed of 22 knots at 22,000 shaft horsepower. The normal cruising speed was 20.25 knots at 20,000 shaft horsepower. The ship was intended to promote international goodwill by being displayed in the seaports of the world. Consequently, it was made as attractive and modern as any vessel of that era and its nuclear power plant was designed with an exceptional degree of reliability and safety.

The prime objectives of the creators of the NSS were to demonstrate the advanced technology and peaceful use of nuclear energy. The operation of a working test-bed laboratory ship provided a tool to be used in the development of economical ships and marine reactor operation. It also established acceptable standards for the design of ship and reactor, operating practices, manning, port entry and operation and safety of crew and the general public. It was necessary therefore, that entry into the domestic and foreign ports was in accordance with mutually acceptable regulations and operational procedures. The successful culmination of these objectives led to the general acceptance of the NSS's safety and reliability by governmental authorities, cargo shippers and the general public.

During its operating phase, regulatory procedures, inspection standards and training requirements were improved and implemented. The relation of manning to the ship's layout, design and service was studied. The high degree of safety, reliability and performance of the NSS increased an acceptance of nuclear ships in the ports visited.

A chronology of significant events in the NSS program is shown in Table 1-1.

[1] U.S. Congress, An Act to amend Title VII of the Merchant Marine Act, 1936, to authorize the construction of a nuclear-powered merchant ship for operation in foreign commerce of the United States, and for other purposes. 84th Congress, 2nd Session. Public Law 848, (H.R. 6243), 70 STAT. 731, 46 U.S.C. 1206, Approved July 30, 1956.

The NSS completed its program of domestic and foreign port visitation in March 1965. From that time until July 1970, the ship was in commercial cargo operations. The ports visited are listed in Table 1-2.

During the period of 1968 through 1970, future use options for the ship were studied and proposed. These included the following:

Conversion to:	Proposed by:
Fish Protein Concentrate Factory Ship	Marine Protein Incorporated
Ocean Science Ship	Westinghouse Electric Corp.
Marine Nuclear Training Center	Todd Shipyards Corp.
Containership including new Reactor and Steam Generators	AEIL

These options were ultimately rejected, and the ship was removed from service. The ship was permanently shutdown and placed in wet layup in November 1970. In Fall 1971, the nuclear plant was permanently defueled. In March 1976, the ship's primary, auxiliary, and secondary systems were drained as completely as practical.

The ship was bareboat chartered[2] to the Patriots Point Development Authority and berthed at the Patriots Point Naval and Maritime Museum, Mt. Pleasant, SC from 1981 through 1994. The ship was dry docked in Baltimore, MD for hull maintenance and preservation in 1975 and 1994. From 1994 to 2006, the ship was moored at the James River Reserve Fleet, Ft. Eustis, VA. In August 2006, the ship was moved to Colonna's Shipyard, Norfolk, VA for infrequent, required topside maintenance.

The NSS is one of the most historically significant ships in existence. It is one of the first ships to be registered as a National Historic landmark. It is registered as an International Historical Mechanical Engineering Landmark by the American Society of Mechanical Engineers. It is a registered landmark of the American Nuclear Society.

Table 1-1 Chronology of Significant Events

April 1955	President Eisenhower announced a proposal to build a nuclear powered merchant ship to demonstrate peaceful uses of the atom.
July 30, 1956	Congress passed P.L. 848, 84th Congress, authorizing construction of a nuclear powered merchant ship.
October 1956	Contract to Babcock & Wilcox to design and construct the reactor.
January 22, 1957	MOU established between MARAD and AEC to perform tasks related to design development, testing, initial operation and international acceptance of nuclear merchant ships.
April 1957	Contract to George Sharp to design hull.
December 10, 1957	Contract to New York Ship building to construct ship.

[2] A bareboat charter is an arrangement where the owner gives possession of the ship to the charterer but no crew or provisions are included as part of the agreement. The charterer is responsible for all operating expenses.

Table 1-1 Chronology of Significant Events

May 22, 1958	Keel laid.
September 1958	Contract signed with States Marine Lines, to operate ship under General Agency Agreement (AEC and MARAD).
July 21, 1959	Ship launched, crew training began.
May 1960	Selection of Todd Shipyard Corporation for nuclear maintenance.
July 1960	Component testing started.
November 1960	Systems testing started.
March 1961	Public hearing.
July 24, 1961	Authorization of AEC fueling and operation for test and demonstration purposes.
September 1961	Pre-fueling testing comp1ete.
November 11, 1961	Reactor Core installed.
December 21, 1961	Initial criticality.
1961	U.S. Coast Guard Certificate of Inspection issued (Doc. No. 287392), Passenger Nuclear.
January 1962	10% testing complete.
March 1962	Initial sea trials at Camden, NJ and Yorktown, VA.
April 19, 1962	States Marine Lines (Operator) under General Agreement.
May 1, 1962	Delivered to and accepted by the Government.
August 3, 1962	AEC provided interim sea and port operation authorization. Amended November 19, 1962 and May 1, 1963.
August 1962	Commencement of initial voyage. First voyage to commercial port Yorktown, VA to Savannah, GA. Demonstration phase of operations began with voyage from Savannah, GA to Norfolk, VA.
February 1963	Initial voyage complete.
May 1963	Cancellation of General Agent contract with States Marine Lines, Inc.
May 1963 to Spring 1964	Labor dispute halted operations.
June 1963	New staff formation.
July 23, 1963	New Contract signed with American Export Isbrandtsen Lines (AEIL) to operate ship under General Agency Agreement from 1964-1965 (New crew trained).

Table 1-1 Chronology of Significant Events

February 20, 1964	AEIL sea trials.
1964	Demonstration phase continued (May 1964) voyage from Galveston to East Coast, U.S. ports.
1964-65	Called at U.S. and Western European ports.
May 28, 1964	Resume port operation.
March 1965	Port visitation program complete and demonstration phase ended Mobile, Alabama to Galveston, TX for annual drydocking, maintenance and inspection.
May 11, 1965	First Atomic Ship Transport, Inc. (FAST) and AEIL agreement to operate as a commercial cargo freighter.
May 18, 1965	USCG Certificate of Inspection Renewed as Cargo Nuclear.
August 1965	AEC Operating License (NS-1) issued.
August 1965	Experimental commercial operations began. Bareboat chartered to First Atomic Ship Transport, Inc. (FAST) (a subsidiary of AEIL).
September 1965	Begin scheduled commercial operation.
August to October 1968	Commercial marine refueling at MARAD Refueling Faci1ity, Todd Shipyards, Galveston, TX. The "fuel shuffle" was intended to extend the life of Core I. At the end of Core I lifetime, a shuffle operation was conducted to configure Core Ia. In this operation the four center elements were removed and replaced with four spare elements, two of 4.6% enrichment and the other two of 4.2%. The remaining 28 elements were rearranged to increase reactivity. In general, the inside elements were moved out and the outside elements were moved in. Additionally, one control rod was replaced. During the last voyage before the Fuel Shuffle Outage, evidence of a minor fuel failure was detected. It appeared that small amounts of fission products were released to the primary coolant whenever there was a significant change in reactor power level. Post shuffle operation indicated that the situation still existed; however, it did not limit operation or access anywhere on the ship.
January 1, 1970	The National Environmental Policy Act of 1969 requires Environmental Impact Statements for proposed actions. Past actions such as the initial NS-1 operating license are exempt.
July 25, 1970	Commercial Operations ended. During experimental commercial operation August 1965 - July 1970, 32 domestic ports and 45 foreign ports were visited. NSS berthed at Pier "E" Todd Shipyards, Galveston, TX and Reactor Shutdown July 29, 1970.
November 6-8, 1970	Final Voyage to Pier "E" Todd Shipyards, Galveston, TX from annual drydocking 10/30 through 11/06 at Todd Shipyards, New Orleans, LA for maintenance per Operations Report, FAST-21 April 26 - November 9, 1970.

Table 1-1 Chronology of Significant Events	
November 8, 1970	Final Reactor shutdown at 5:50 PM and established Cold Iron condition at Todd Shipyard, Galveston, TX per FAST-21.
November 9, 1970	License NS-1 transferred from FAST to MARAD (License Amendment 7).
April 13, 1971	AEC approved Technical Specification Change 11 to defuel NSS.
Fall 1971	Ship at MARAD Refueling Facility, Pier "E" Todd Shipyards, Galveston, TX, for preparation of vessel for lay-up. Started removing fuel August 23, 1971. The last fuel element was removed September 29. Control rod drive (CRD) system disabled and sealed plates installed on 21 CRD head nozzles to separate drives from the control rods. 36 Fuel element flow nozzles were loaded into fuel channels in the reactor vessel. One control rod (cut into two six feet long pieces and one twelve inch piece) was placed in reactor vessel. This is the control rod removed during the 1968 fuel shuffle. RCP motors and impellers were removed. The RCP volutes were blank flanged. Reactor, secondary and saltwater system filled with water to establish wet lay-up conditions. The reactor vessel head was reinstalled with 6 of the normal 48 studs in place. The containment vessel, port and starboard charge pump room and lower reactor compartment bilges were decontaminated, washed, vacuumed and painted. All cargo holds were decontaminated.
October 24, 1971	U.S. Coast Guard Certificate of Inspection expired and was not renewed.
December 3, 1971	Permanent cessation of operations established by completing Layup Procedure LU-9. The Layup Procedure LU-9 is the procedure implemented by the defueling team. It reinstalled the reactor vessel head with six tensioned reactor head studs. This event establishes the date of permanent cessation of operations.
January 3-10, 1972	Towed to Savannah, GA and following a welcoming celebration, additional non nuclear layup work was performed (4/24/1972 Operations Report) [Not open to Public and primary system and steam generators (boilers) maintained in wet lay-up (MARAD letter Nov 19, 1971)].
April 4, 1972	AEC stopped review of Core II and noted "If reactivation of N. S. *SAVANNAH* should become planned, an appropriate scope of review would need to be established in light of … the regulatory safety and environmental requirements at that time."
December 21,1972	Thirty six spent fuel elements (32 plus the four replaced during the fuel shuffle) (Core I and Ia) were shipped from Galveston, TX to AEC - Savannah River Plant, Aiken, SC for reprocessing. (September 21, 1973, Operations Report).
January 29, 1973	License Amendment (Technical Specification Change 13) eliminated "Technical Specifications that referred to operational aspects since all nuclear fuel has been removed from the ship and the nuclear power plant (and the ship) is no longer operational." Note that even though the final shutdown was in November 1970 and the permanent defueling was completed in fall

Table 1-1 Chronology of Significant Events	
	1971, these actions were not considered to be permanent cessation of operations until the decision was finally made to not load Core II. Therefore, the fall 1971 defueling became the de facto permanent defueling and cessation of operations with the completion of Layup Procedure LU-9 on December 3, 1971.
1972-75	Legislation was introduced to authorize the Secretary of Commerce to transfer ship to the City of Savannah, GA.
January 31, 1975	MARAD memo "Supplemental Memo on *Working Document: Environmental Impact Analysis Nuclear Merchant Ship Program*" -MARAD recommended moving Core II from storage at Defense Atomic Support Agency, Killeen, TX to Nuclear Weapons and Storage Facility, Manzano Air Force Base, Albuquerque, NM for indefinite storage. This action would be taken via an Interagency Agreement by Energy Research and Development Administration (ERDA) (formerly AEC). Per NSS Defueling Log September 9, 1971, (MMA File 61-8), Core II consists of 36 new fuel elements.
April 3, 1975	Attachment 1 to memo for Assistant Administrator for Commercial Development states "In response to M-700 memo of December 23, 1974, … 5. Nuclear Fuel (Core II) it is understood this fuel will be returned to AEC [ERDA]."
July 28, 1975	City of Savannah, GA requested removal of the ship and the ship left Savannah, GA for Baltimore, MD drydocking.
August 11, 1975	Moved from Baltimore, MD Drydock to Detyens Shipyard, Inc. Charleston, SC (topside work).
August 29, 1975	Moved from Detyens Shipyard, Charleston, SC to N. Charleston Army Depot, SC pending the outcome of legislation before the Congress to permit use of the NSS as an addition to the Patriots Point Naval and Maritime Museum, Mt. Pleasant, SC.
March 1976	While at N. Charleston Army Depot, SC, the primary, auxiliary and secondary systems were drained by Todd Research and Technical Division as completely as practical. Per the September 14, 1976, Annual Operations Report, water from the reactor vessel shield water tank and secondary side of the steam generators was transferred to a double bottom tank below the reactor compartment. Demineralizer resins (28 Ci) and 12,200 gallons of liquid (Primary Coolant and liquid waste) were properly disposed. Three dewatered primary purification ion exchangers (demineralizers) were removed and disposed. Radiation levels in the containment vessel did not increase appreciably after the water was removed. Per March 9, 1976 MARAD memo "Status Report on the Transfer of N.S. *SAVANNAH* to [James River Reserve Fleet] JFFR," the water from the secondary system was analyzed and does not have to be disposed of as

Table 1-1 Chronology of Significant Events

	nuclear waste.
May 19, 1976	Possession Only License issued (License Amendment 8) and recognized the ship was in a state of protective storage. Total estimated residual activity 1.09E+5 Ci.
April 1980	Main reduction bull gear was removed (NRC Inspection Report 81-01, March 2, 1981).
August 28, 1980	Public law 96-331 was enacted to authorize the NSS to be sent to Patriots Point, Mt. Pleasant, SC for use as a Museum and other public purposes.
September 24, 1980	Bureau Radiological Health, SC Department of Health & Environmental Control certifies all ten remaining radioactive sources have been transferred from the ship to them.
August 14, 1981	Patriots Point Development Authority (PPDA) became a co-licensee and the ship was bareboat chartered for public display at the Patriots Point Naval and Maritime Museum, Mt. Pleasant, SC from 1981 through 1994.
October 15, 1983	The American Society of Mechanical Engineers designated the ship as the Fourteenth International Historic Mechanical Engineering Landmark.
July 15, 1986	The NS-1 License was renewed for ten years by License Amendment 11.
September 1989	Hurricane Hugo hits the Charleston, SC area.
July 17, 1991	The National Park Service designated the ship as a National Historic Landmark.
October 1991	The Board of Directors for the American Nuclear Society approved the ship for a Nuclear Historic Landmark Award.
July 1991	Shortly after the second bareboat charter renewal in 14 July 1991, a hull leak developed. After a series of surveys and inspections, funding was requested from Congress in 1993 to drydock the ship to correct deterioration of the underwater hull.
December 1993	Public Tours of the ship were no longer allowed.
May 24, 1994	NSS left Patriots Point on the spring flood tide to minimize silting effects from Hurricane Hugo of September 1989.
June 29, 1994	License Amendment 12 removed PPDA as co-licensee. After routine drydocking and hull maintenance in Drydock # 4, Sparrows Point, Baltimore, MD, the ship was placed in protective storage at the James River Reserve Fleet, Ft. Eustis, VA. Numerous minor modifications including installation of a DH system were completed. Modifications associated with the DH system (i.e., vent ducting and cabling) generally obstructs the doorways, passageways and ladders throughout ship as is typical in the marine industry for deactivated ships.
July 29, 1996	License Renewal was no longer required by the revised 10 CFR 50.51,

Table 1-1 Chronology of Significant Events	
	Continuation of license. (b) Each license for a facility that has permanently ceased operations, continues in effect beyond the expiration date to authorize ownership and possession of the production or utilization facility, until the Commission notifies the licensee in writing that the license is terminated.
August 15, 2006	NSS was moved to Colonna's Shipyard, Norfolk, VA for infrequent, required topside maintenance.
December 11, 2006	Post Shutdown Decommissioning Activities Report, Revision 0 was submitted but withdrawn on January 27, 2007.
January 30, 2007	NSS moved to Pier 23 Newport News, VA for temporary layberthing.
January 31, 2007	License Amendment 13 was issued. It included six administrative changes. The most significant change is following 30 day notification to NRC, the ship can be located at any appropriate U.S. domestic location with a MARAD approved Port Operating Plan.
May 31, 2007	NSS was moved to BAE Systems Norfolk Ship Repair facility in South Norfolk, Virginia in preparation for drydocking. On January 19, 2008, the NSS was placed onto the Titan Drydock and remained there until March 3 for hull maintenance and exterior surface cleaning and preservation. Hull inspections were conducted and identified no new degradation. These inspections included verifying the integrity of the underwater hull repairs made during the 1994 drydocking availability
April 3, 2008	License Amendment No. 14 was issued. It revised the Technical Specifications to match the current ship status and ship's programs, policies and procedures. The function of Review and Audit Committee was revised commensurate with the Decommissioning Quality Assurance Plan. The committee was renamed the Safety Review Committee.
May 8, 2008	NSS was moved to Pier 13, Canton Marine Terminal at 4601 Newgate Ave., Baltimore, MD.
December 11, 2008	Post Shutdown Decommissioning Activities Report, Revision 1 submitted.
November 2010	Completed the electrical modifications to deenergize all originally installed 450 volt switchgear. All required 450/480 volt loads were moved to a new 800A Shore Power Switchboard.

1.2 Principal Safety Features of the Ship

1.2.1 The Hull

This text is retained from Revision III for historical context. In particular, items (1), (3) and (4) from the list below describe structural features installed on the N.S. *SAVANNAH* to enable it to resist the effects of damage. Item (2) describes the hydrodynamic standard applied to allow the ship to

passively resist the effects of damage and remain afloat; this condition is referred to as "damaged stability." During the period of museum operations at PPDA, most of the transverse watertight bulkheads listed in (1) were penetrated at various locations to permit convenient personnel access and service connections between the compartments. Most of these penetrations were closed prior to the ship's removal from PPDA in 1994. Current operations only require the NSS to meet "intact stability" requirements, where intact stability refers to the capability of the ship to remain stable when not damaged. Based on stability calculations prepared in 1994 and the current (2008) baseline structural condition assessment, the NSS is presumed capable of meeting a "one compartment" damaged stability standard

For a ship of its generation, the hull design of the N.S. *SAVANNAH* was that of a conventional vessel with trim and modern lines, designed in accordance with the latest practice in naval architecture and hydrodynamics.

The principal safety features in the hull design may be summarized as follows:

1. The hull is divided by 10 watertight bulkheads terminating at the B-deck level.
2. The ship will remain afloat if any two of the nine compartment are flooded within the meaning of U.S. Coast Guard (USCG) stability requirements.
3. Conventional all-welded steel construction is employed with full-continuity of structural members, except for a few longitudinal riveted seams serving as crack arresters in accordance with contemporary practices.
4. A 5-foot deep watertight double-bottom extends under all nine compartments but not under fore peak or after peak ballast tanks.
5. Special care was taken in the selection of materials to minimize galvanic corrosion.
6. The reactor compartment is reinforced outboard of the containment vessel with additional longitudinal and athwartship bulkheads, in addition to a laminated redwood and steel collision mat on each side, to minimize penetration in the event of a collision amidships.
7. The design details and construction of all components and systems was in accordance with the contemporary regulations of the Safety of Life at Sea Convention (SOLAS), MARAD, USCG, the U.S. Public Health Service, the American Bureau of Shipping (ABS) and other regulatory bodies.

1.2.2 The Power Plant

From the beginning of the project, analyses of hypothetical casualties and topical reports covering every phase of the design were prepared and reviewed by the regulatory agencies as well as Oak Ridge National Laboratory (ORNL). In addition, a comprehensive analysis of reactor safeguards was prepared for review by the AEC and for the critical examination of the AEC's Advisory Committee on Reactor Safeguards (ACRS).

1.2.2.1 General

In the design and construction of the power plant, a special philosophy of safety and reliability was adopted at the outset of the project. Both preparatory and concurrent research and development work and special operational testing were undertaken in many areas, including a series of critical experiments on various configurations and designs for the reactor core, full scale testing of a prototype control rod drive mechanism and system under simulated reactor

conditions, irradiation tests of fuel elements and pellets, containment vessel leak rate tests and filter efficiency tests.

1.2.2.2 Particular Safety Features

The NSS has four remaining safety features in the power plant design that merit special mention:

1. Reactor System Containment - The reactor and primary coolant system are located inside a containment vessel. During the operating period, any failure of the primary system would have been contained by the containment vessel system. The CV system, consisting of a USCG approved pressure vessel and associated isolation valves, was designed and hydrostatically tested to withstand a pressure of 173 psig. During the operating period, the system was routinely pneumatically tested at 60 psig and demonstrated to have a leak rate of less than 1.2% of the contained volume per day. No integrated leak rate testing has been performed since the final shutdown in November 1970.
2. Containment Vessel Isolation – During the operating period, the reactor system was operated with the CV hermetically sealed at all times. The penetrating pipe lines were isolated by automatic valves if the pressure inside the containment vessel rose above 5 psig for any reason whatsoever. The steel containment vessel, moreover, was sufficiently thick that no danger of penetration existed from any high speed missiles within the containment vessel, such as a thermocouple well from the primary coolant system. No individual penetrations have been leak rate tested since the final shutdown in November 1970.
3. Radioactive Waste Control - During the operating period, the power plant operated with a minimum of radioactive waste disposal. Gaseous and liquid wastes were discharged in accordance with the "Standards for Protection Against Radiation" (10 CFR Part 20) and the Technical Specifications. Any solid wastes are kept aboard the ship and periodically discharged to a licensed waste disposal facility.
4. Shielding – During the operating period, the reactor vessel was surrounded laterally by 33 inches of water and 1 to 4 inches of lead shielding so that maintenance work was possible shortly after shutdown. In 1976, the reactor vessel shield water tank was drained. The secondary shielding around the containment vessel reduced the surface dose level at full reactor power to no more than 100 mR per week.

1.3 Ship and System Status – 1976 to Present

1.3.1 Power Plant Status as reported in April 1976

In support of the request for a possession only license in 1976, MARAD provided a "current" (i.e., contemporary) status of the ship. The April 1976 status of the NSS reactor plant following protective storage modifications to its operating condition was noted as follows:

1. Reactor Vessel - All 32 Core Ia fuel elements were removed from the reactor vessel to the spent fuel pool at the MARAD Refueling Facility, Todd Shipyards, Galveston, TX [License SNM-1015-YGP (Docket 70-1062)]. All reactor internal components are in place, i.e., core basket, upper grid plate, upper flow baffle. Thirty-six upper flow transition pieces and one irradiated control rod (cut in three pieces) have been 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 is in place with six of the original 48 reactor head hold down studs tensioned.

2. Spent Fuel - Per September 21, 1973, Operations Report, thirty six spent fuel elements (Core I and Ia) were shipped from Galveston, TX to AEC - Savannah River Plant, Aiken, SC in nine shipments from October 4 through December 21, 1972 via a lowboy trailer using the Piqua/Elk River Shipping cask.

3. Fission Chambers - Per September 21, 1973, Operations Report, five fission Chambers were removed and shipped to Todd Shipyards, Galveston, TX in May 1973. On June 28, 1973, these five and an additional three stored on the NSV Atomic Servant (the nuclear services barge for NSS) were shipped to Chem-Nuclear Systems, Inc., Barnwell, SC for disposition as radioactive material.

4. Pressurizer - One relief valve PR-1V was removed. The nozzle flange was fitted with an absolute filter vent to allow for pressure equalization. Circuit breakers for the heaters have been opened at the switchboard.

5. Control Rod Drive System -

    a. Electrical - The breakers for the rod drives have been 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 have been disconnected, coiled and secured on the CRD structure in the containment vessel. The support wireways have been removed, packaged and stored in Hold No. 4. In addition, the twenty one buffer seal flow meter cables and the vibration monitor cables have been disconnected.

    b. Mechanical - All hydraulic oil has been drained and the piping disconnected between the cupola and the CRD structure. Buffer seal system valves have been closed and tagged out. The inlet and outlet header spool pieces between the cupola and structure were removed. The buffer seal system has been 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 have been disconnected from the lead screw and are in a fully inserted position from the reactor head nozzles to the top of the control rods. The CRD lead screws were withdrawn and pinned in place. Steel caps are placed onto the 21 reactor head nozzles to completely seal the nozzle from the containment vessel atmosphere and mechanically separate the CRD mechanism from the control rod.

6. Primary Coolant System - The system has been 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 are installed over the volute openings. The grating, piping, valves, ducting, etc. that were disconnected while removing the pump motors and impellers are left in the removed condition within the containment vessel.

7. Secondary System - Both steam generators and piping were drained of water as completely as practical. The water on the secondary side of the steam generators was transferred to the double bottom tank below the reactor compartment. The isolation valves outside of the containment vessel are closed. There have been no modifications to the secondary system.

for health physics personnel. This document or any document that replaces it will be revised as necessary to support pre-decommissioning activities.

Procedures used for waste handling processing and characterization will be developed and used as required, with approval controls, throughout decommissioning. In addition, isotopic analyses, waste characterization computer codes and activation analyses are some of the methods which have been and will continue to be used to characterize the waste streams resu1ting from the NSS's decommissioning. The procedures will meet 10 CFR 20, 10 CFR 61, disposal site criteria, and other Federal and State regulations.

Radwaste shipping and handling will be performed in accordance with the Quality Assurance Plan, applicable NRC and DOT regulations and administrative procedures. Radioactive waste and material will be shipped either by truck including open and closed transport, trailer mounted shipping cask or by a combination of truck and rail. Shipments will be planned in a practical and efficient manner. Facility procedures will be used with appropriate quality oversight to ensure the shipments are in compliance with company procedures, regulations and the receiving site licensee. Packages, packaging, and labeling for radioactive materials and waste will meet all applicable regulations and requirements.

11.8 Industrial Safety

There is a potential for workers to experience injuries and fatalities as a result of accidents occurring during protective storage or decommissioning activities. Accidents could result from falling objects, fires, operation of equipment, use of tools, lighting equipment and other activities.

The Coast Guard regulations in § 33 CFR 150.600 Subpart G -Workplace Safety and Health discuss requirements for workplace safety and health on a deepwater port. As necessary, this regulation refers to 29 CFR 1910, Occupational Safety and Health Standards. 29 CFR 1910.15, Shipyard employment adopts 29 CFR 1915 for shipbreaking. Shipbreaking is defined as any breaking down of a vessel's structure for the purpose of scrapping the vessel, including the removal of gear, equipment, or any component of a vessel. Although MARAD is not scrapping the NSS, the projected industrial activities associated with decommissioning most closely conform to this definition. Therefore, the shipbreaking code will be adopted for this activity. The occupational health and safety of workers will be protected by implementing measures in accordance with these regulations.

11.8.1 Occupational Health and Environmental Control

Facilities and equipment will be provided to protect the occupational health of workers during the protective storage and decommissioning activities of the NSS. Such facilities and equipment include first aid kits within work areas, nearby medical facilities, transportation for injured workers, environmental controls in work areas (i.e. adequate ventilation, dust control, illumination, noise control, potable water and sanitary facilities), radiation protection and asbestos protection.

11.8.2 Personal Protection

Personal protection devices provided workers will include, as necessary, hardhats, hearing protection devices, eye and face protection devices, hand protection and respiratory protection devices.

11.8.3 Lifting and Handling Equipment

Lifting and handling equipment will comply with manufacturer's specifications and limitations. Requirements regarding the rated load capacities, operating speeds, hazard warnings or instructions will be followed.