Revision No. 1

Safety Analysis Report
N.S. Savannah
U.S. NRC License No. NS-1
Docket No. 50-238

Prepared to Support License Amendment and
Proposed Changes in Technical Specifications
for S.C. Patriots Point Development Authority
and
Maritime Administration
U.S. Department of Commerce

July 1981

Prepared by the
South Carolina Department of
Health and Environmental Control
Bureau of Radiological Health

Introduction

Pursuant to the provisions of Public Law 96-331, 94 Stat. 1055, of August 28, 1980, authorization was given for the Patriots Point Development Authority to enter into an agreement with the Maritime Administration, U.S. Department of Commerce, for the N.S. Savannah to be delivered to the Patriots Point Authority's facility at Mt. Pleasant, South Carolina. The vessel will be put on public display as part of the Patriots Point Authority's Maritime and Naval Museum. Numerous other naval and sea vessels will be included in the display. (See Attached Master Plan).

Initially, the N.S. Savannah will be open to the public for general tour as indicated in the attached diagram of the vessel's compartments. Long range plans call for activation of the galley, dining room, officer and crew messes; passenger accomodations on Promenade deck, and A, B, C decks; selected officer and crew accomodations on Boat deck and B and C decks. These areas will be used as temporary lodging and restaurant facilities for general public use. Museum type displays and memorabilia will be set up in some cargo holds.

Since the vessel still contains radioactive material in the form of contaminants and reactor components with induced radioactivity, a "possession-only" amendment to the current NRC license NS-1 is being requested as well as proposed changes to the Technical Specifications. This amendment request is to authorize co-licensure of the vessel between the Patriots Point Development Authority and the Maritime Administration. Each party will be responsible for certain aspects of this arrangement as spelled out in the Bareboat Charter.

Discussion of Current Ship Status

The N.S. Savannah is currently located at the U.S. Army Depot Pier in North Charleston, South Carolina. Plans are to deliver the vessel to the Patriots Point Authority facility at Mt. Pleasant, South Carolina once authorization is given by an amendment to license NS-1. It is understood that this delivery is to take place prior to August 28, 1981 as indicated in the enabling legislation.

The Nuclear powered merchant ship N.S. Savannah utilized a pressurized water reactor that operated at a maximum of 80 thermal megawatts. The reactor was shut down in November 1970, and all reactor fuel was removed. As recommended by certain radiological groups, primary and secondary reactor systems have been drained and all radioactive resins removed from the ship. All radioactive sealed sources used for instrument calibration and standards have also been removed and properly transferred to an authorized recipient. Solid radioactive waste generated as the result of certain operations on the vessel have been removed and transferred to a disposal facility.

The vessel does contain a certain curie content in the form of surface contamination and induced radioactivity in reactor component parts. However, this material is confined almost exclusively to controlled access areas. An update of the curie content may be performed, however, it is irrelevant, as regardless of the contents, the same precautions and license conditions will prevail for these quantities of radioactive materials.

It should be noted that over the display life of the N.S. Savannah, several nuclear half-lives will transpire with each reducing the residual activity of the irradiated components by one-half. For this reason, removal of the reactor components is not advisable with respect to ALARA principles. The subsequent delay time will result in a considerable decrease in exposure to salvage personnel when ultimate disposition occurs. Since all fluids have been drained from the systems, it is not likely any leakage will occur. Further, it is not likely that any additional system degradation will occur. However, certain inspections of the primary and secondary systems are made to determine any corrosion and leaks.

The hull of the vessel is and will be protected with a cathodic protection system to minimize corrosion damage. Drydocking of the vessel will be conducted when determined necessary to clean and paint her underwater parts.

On Board Radiological Evaluation

The majority of the radioactive material contained on the ship is confined to the containment vessel. The containment vessel is presently locked and sealed and unaccessible. The access ports to the containment vessel have been sealed with shield plugs. Lifting equipment for the shield plugs has been partially disassembled to prevent unauthorized access into the containment vessel. Radiation emitted from the activated components within the containment vessel is attenuated by concrete and lead shielding encompassing the containment vessel. The containment vessel itself is composed of 1½ inch thick steel to withstand any impacts. The reactor pressure vessel within the containment vessel is also inaccessible with a massive steel head which is bolted in place. Removal of the bolts would require special equipment which is not on board the ship.

A radiological survey conducted September 1975, by the South Carolina Department of Health and Environmental Control indicated the highest radiation level detected within the containment vessel was 200mR/hr at the surface of the starboard and port sides of the steam generator. However, in 1976 a survey was conducted following removal of the primary system fluids and a radiation levels of 900mR/hr was determined at this location. It can be presumed though that radiation levels are lower today due to the nuclear decay of the radioactive materials.

Radiological surveys of areas outside the containment vessel have indicated additional areas with radiation levels in excess of background radiation (0.02mR/hr).* The latest survey of the ship conducted on March 24, 1981 identified the following areas and the highest radiation levels found in those areas:

	mR/hr
Forward Control Room Upper Level	0.3
Forward Control Room Lower Level (overhead pipes and valves)	45.0
Reactor Compartment Upper Secondary	.04

* As measured with a GM survey instrument.

Port Charge Pump Room	1.5
Starboard Charge Pump Room	1.8
Upper and Lower Port Stabilizer Room	4.5
Reactor Compartment Lower Secondary	20.0
Hot Chemistry Lab	0.10

All of the above areas are considered radiation control areas and can only be entered under qualified health physics supervision and established health physics procedures. These areas are locked and sealed to prevent entry. In addition, these areas are posted with caution and warning signs.

The reactor compartment access is not only locked and sealed, but is provided with a visual and audible signal intrusion alarm. This will detect any unauthorized entry into the reactor compartment spaces. When the ship is relocated to the Patriots Point facility, visual and audible alarm signals from the reactor compartment intrusion alarm system will be monitored at a manned security guard post.

In addition to direct radiation surveys of the ship, surface contamination determinations have been made in all areas outside the containment vessel. In no case has surface contamination been determined in excess of the limits established in Reg. Guide 1.86 with the exception of the hot chemistry lab. All areas of the ship which will be considered unrestricted areas for use by the general public and Patriots Point employees have been satifactorily surveyed for removable surface contamination. Laboratory analysis of the samples indicated that surface contamination was non-existant. Additional contamination surveys will be conducted periodically to assure that all unrestricted areas of the vessel are maintained below Reg. Guide 1.86 limits before future planned uses of the vessel are open to the public and employees.

On March 23, 1981, a special radiation survey of all unrestricted areas of the ship was conducted to determine current radiation levels. A report of this survey indicating areas and findings is attached. Only one space was identified that had higher than average levels; Cargo Hold No. 4, B Deck near the aft bulkhead. A 22.5uR/hr field was determined in this location. Future radiation surveys will be made throughout the vessel to assure that all areas for unrestricted use will be maintained within the established radiation level criteria.

A review of all personnel whole body exposure records since 1978 was made. All reportable exposures for individuals badged entering the controlled areas were less than 100mRem for four individuals in 1978, 2 "no measurable exposure" and 2 less than 100mRem for 1979, and 4 with less than 100mRem in 1980. In April and May of 1980, 102 personnel were badged for removal of the ship's reduction gear. All whole body exposures reported for all personnel badged were reported as "No Measurable Exposure" for that period.

Environmental Radiological Evaluation

Periodic environmental evaluations have been made since the N.S. Savannah has been moored at the U.S. Army Depot Pier in Charleston, South Carolina. Surface water samples have been collected near the vessel semi-annually since 1975. Laboratory

analysis of this water has only detected background levels of tritium (400-800pci/l). Fission products were below minimum detectable limits. Bottom sediments beneath the vessel have only indicated slight concentrations of Cesium-137 (0.06 + .03 pci/gm). This is considered normal for this area due to weapons testing fallout. Direct radiation levels emitted from the ship are at background levels (0.02mR/hr).*

Since all fluids have been removed from the vessel, radiological liquid effluent discharges will not be necessary. Other type discharges such as sewage and other liquid discharges may be necessary. However, none of these discharges will exceed 10% of the limits specified in 10 CFR 20.

The reactor being decommissioned, no radiological gaseous discharges are anticipated. Any repairs to the ship such as cutting or welding would not create airborne releases in excess of 10% of the limits specified in 10 CFR 20. Should a situation warrant these type repairs are necessary, an evaluation can be made to determine consequential releases, and supported by air sample analysis.

Evaluation of Fires and Fire Protection

The N.S. Savannah does have certain combustible materials on board such as carpeting, linens, furniture, wiring, insulation, etc. However, since the vessel will be "permanently" moored, diesel fuel oils and lubricants, and other combustible materials are minimized to reduce fire potentials. Radiological airborne discharges caused by fire will be minimal since most of the radioactivity is confined to the containment vessel. The reactor components are of non-combustible materials.

Fire fighting support will be provided by the Mt. Pleasant Fire Department. A direct fire alarm will be installed between the manned security guard station at Patriots Point and the dispatcher's office at the fire department. The ship is also provided with an installed fire and flushing piping system. Due to U.S. Coast Guard requirements, the vessel is required to maintain adequate CO_2 and other portable extinquishers.

Administrative fire evacuation procedures have been developed by Patriots Point Authority.

Evaluation of Flooding and Flood Control Equipment

The vessel will be"permanently" moored and utilize standard mooring lines and steel wire cables attached to breasting/mooring platforms and concrete pile dolphins on the bow and stern. These are designed and constructed to withstand any anticipated hurricane force winds or tidal surges. Due to the relatively shallow depth, and the silting probability of her berth, sinking or flooding of the vessel is not likely. Inspection of the hull's draft markings will be made daily to determine any variations of draft. In the event of flooding, portable pumps are on board. In the event of major flooding, equipment from the U.S. Coast Guard and the U.S. Naval Base in Charleston, South Carolina is available. Any radiological discharges due to flooding will be insignificant since the radioactive material inventory is fixed as contaminants and irradiated reactor components. Rapid delution of radionuclides would be achieved due to the size of the harbor and tidal action.

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* As measured with a GM survey instrument.

Evaluation of Security Provisions

An intrusion alarm with an interlock will be maintained on the B Deck entry door into the reactor compartment with audible and visual signals located at manned security guard post, which can be both seen and heard by the security guard on duty. The museum areas will be separated from public accomodation spaces by physical barriers such as locked doors and false bulkheads. The vessel will be positioned alongside a pier with controlled access restricted to museum visitors and regular business during regular museum hours. After hours, the pier is secured utilizing an electrically controlled gate operated by a security guard. The pier entrance will be under 24 hours security.

Security personnel will patrol and visually inspect the vessel at the close of the museum each day, and physically secure with lock and key entrances and exits to museum spaces, and ensure that all other areas not in use are secured. Security personnel will patrol and inspect the vessel at least once each shift for possible fire, flooding and other abnormal occurrences. Police protection is also provided by the town of Mt. Pleasant, South Carolina.

Due to the location of the ship, it is highly unlikely that unauthorized personnel could board the ship undetected. Boarding the ship from the water would require specialized scaling equipment due to the height of the vessel.

All restricted areas of the vessel will be maintained under lock and key with seals provided. All keys and seals will be maintained by the Executive Director of the Patriots Point Authority or his designate.

It is concluded that adequate security will be provided to prevent unauthorized entry aboard the vessel or access into controlled areas.

Evaluation of Radiological Technical Qualifications and Capabilities

Since there will be no use of radioactive materials on the ship, training and qualification of security and staff personnel will only require minimal knowledge of basic radiological procedures, effects of radiation, basic radiological physics and how to use and read portable survey instruments. This will be handled through a training program to be conducted by the South Carolina Department of Health and Environmental Control, Bureau of Radiological Health.

Technical radiological support for conducting semi-annual surveys will be provided by the Department's Bureau of Radiological Health. This agency has numerous qualified health physicists, state-of-the-art portable and laboratory equipment, and a mobile radiological laboratory. In the event of a radiological emergency, a response team from the Department in Columbia, South Carolina will be provided with a four-hour response time.

For immediate emergencies and technical assistance, a qualified health physicist will be provided by the Medical University of South Carolina in Charleston. In addition, Charleston Naval Shipyard personnel from the Health Physics Support Department can be provided for any additional technical support.

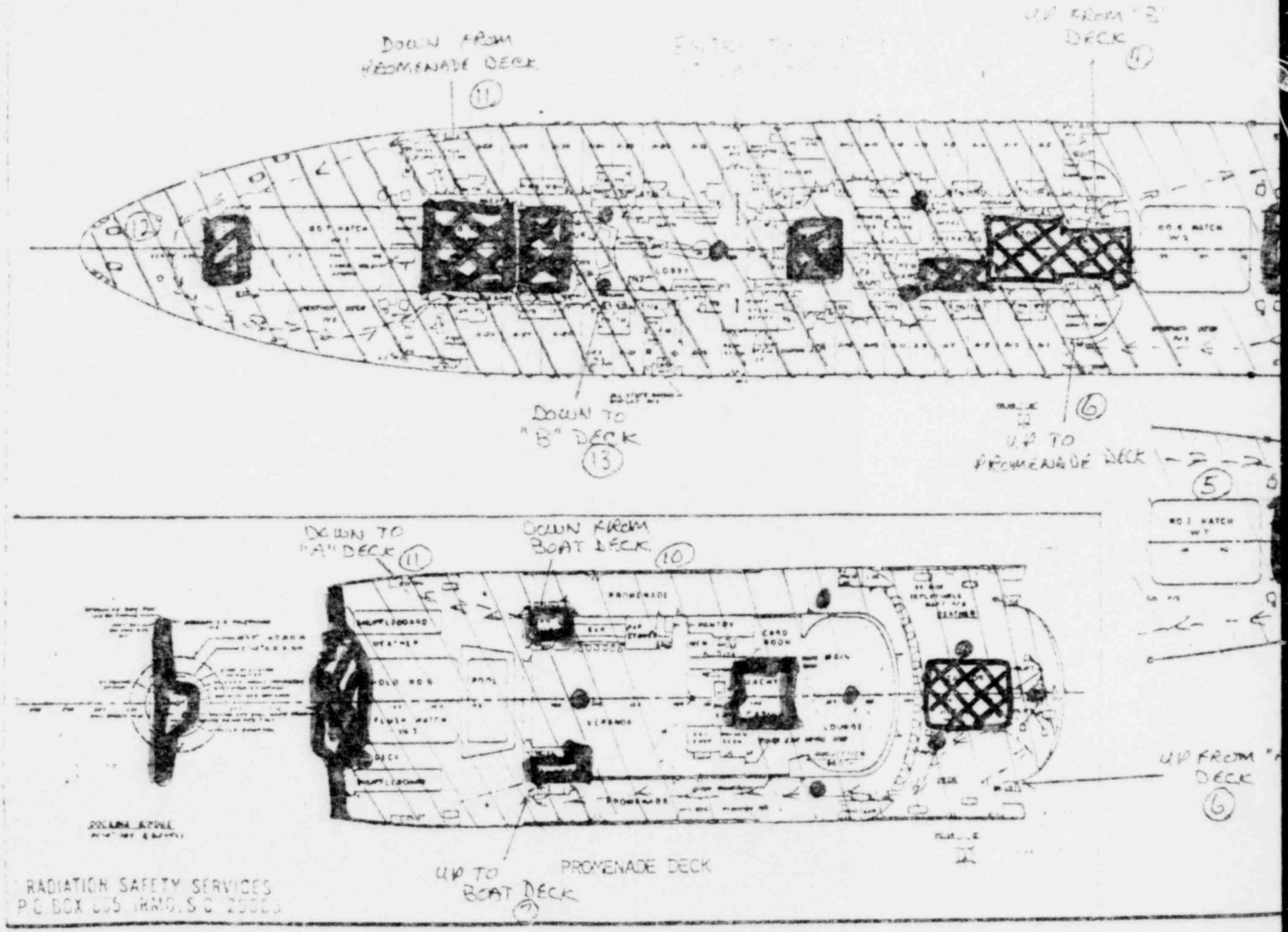
It is concluded that sufficient technically qualified personnel are available in the immediate vicinity as well as emergency response personnel to support any radiological contingency that may arise.

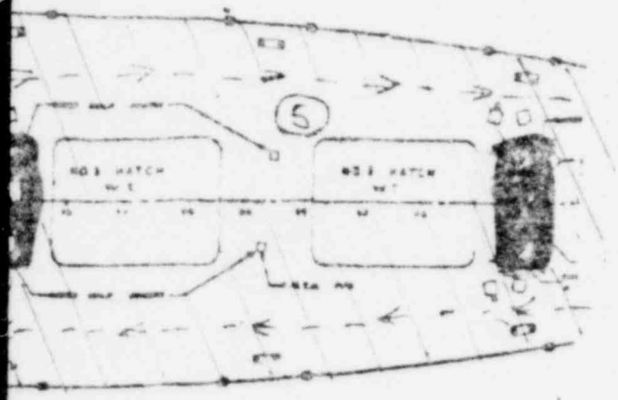
Conclusion

Based on the consideration and evaluation discussed above, it is concluded that the N.S. Savannah can be opened to the public as proposed. There is reasonable assurance that the health and safety of the public will not be endangered by the operation in the manner proposed. Protection of visitors and employees aboard the N.S. Savannah can be assured by the prevention of entry into the controlled acces· areas. Although there exist the possibility for catastrophic events such as earthquakes and hurricanes in the Charleston area, these events do not increase the potential consequences of a significant release of radioactive material available aboard the N.S. Savannah since the radioactive material is fixed as contaminants and irradiated reactor components. Fuel assemblies, liquids and ion exchange resins have been removed from the ship.

Equally important, the operation of the N.S. Savannah in the proposed manner will not increase significantly or cause any adverse effect on the environment.

Therefore, it is recognized that the activities proposed in the license amendment request will be conducted in full compliance with the U.S. Nuclear Regulatory Commission's regulations and Technical Specifications, the issuance of this amendment will not jeopardize the health and safety of the public, nor the Patriots Point Authority employees.





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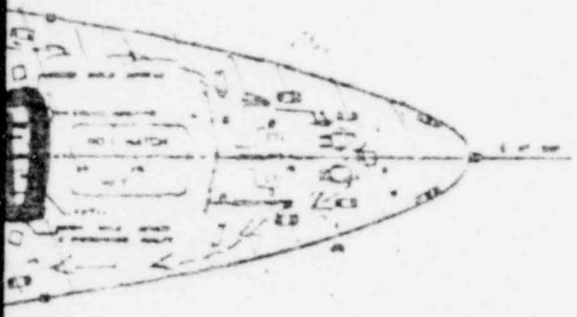
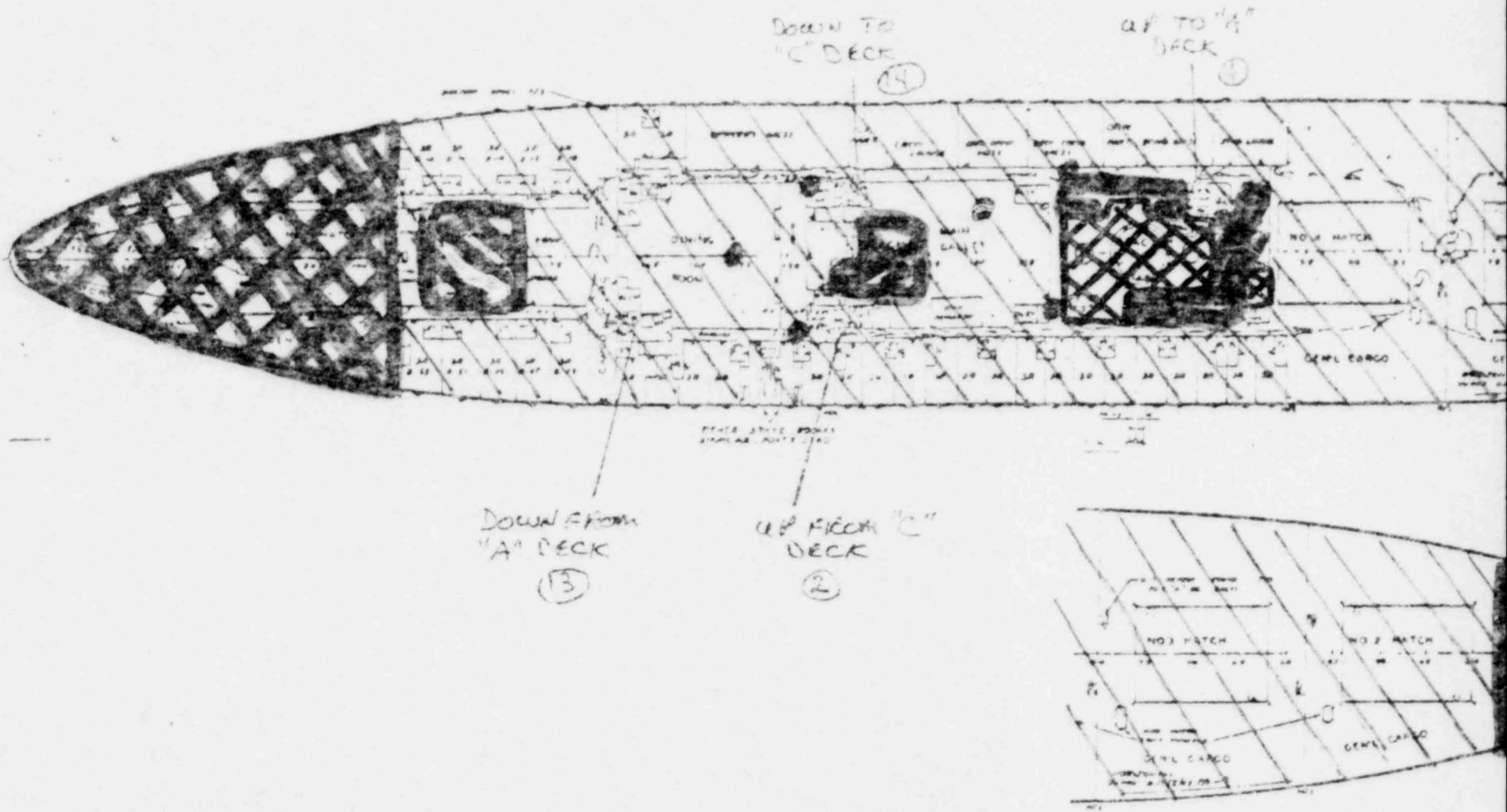
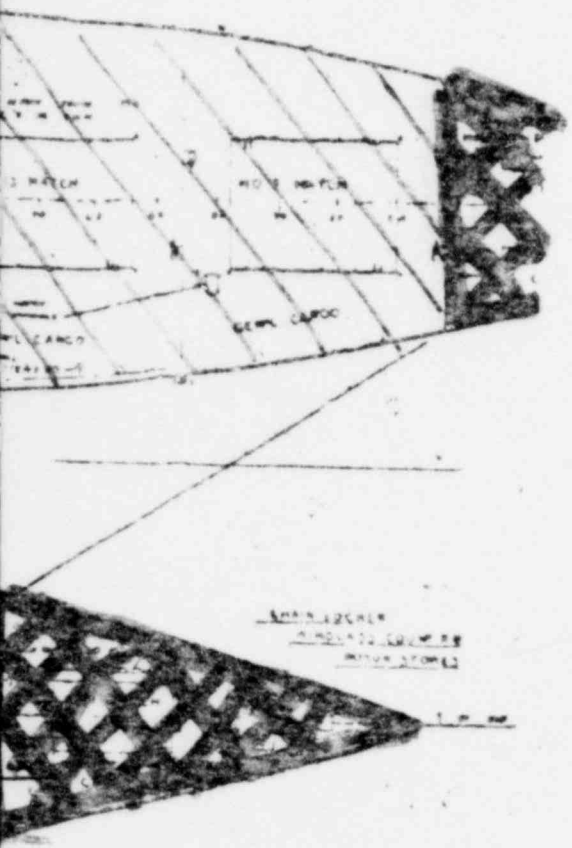


N. S. SAVANNAH



RADIATION SAFETY SERVICES
P.O. BOX 665, HAHD, S.C. 29063



B DECK

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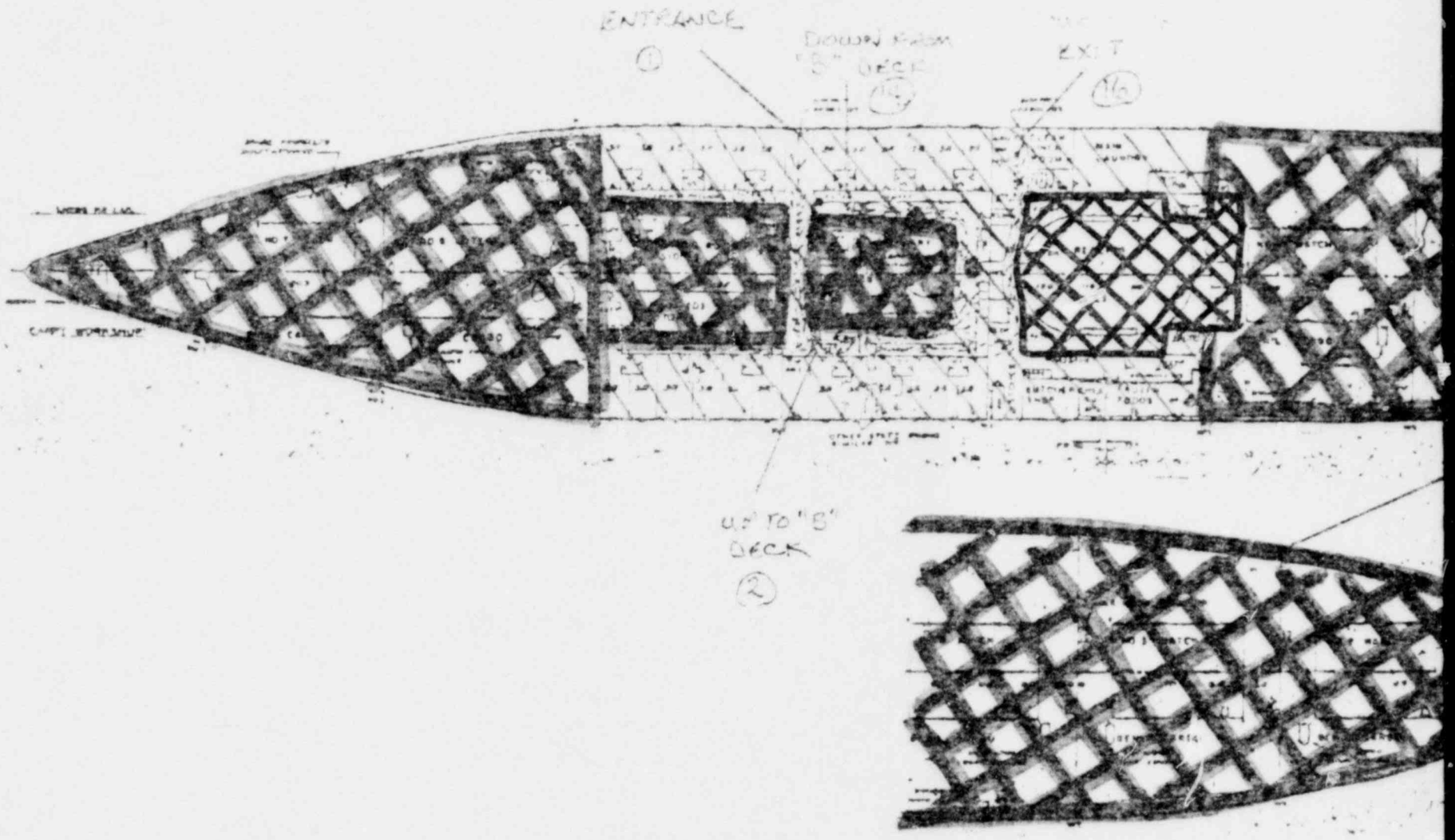

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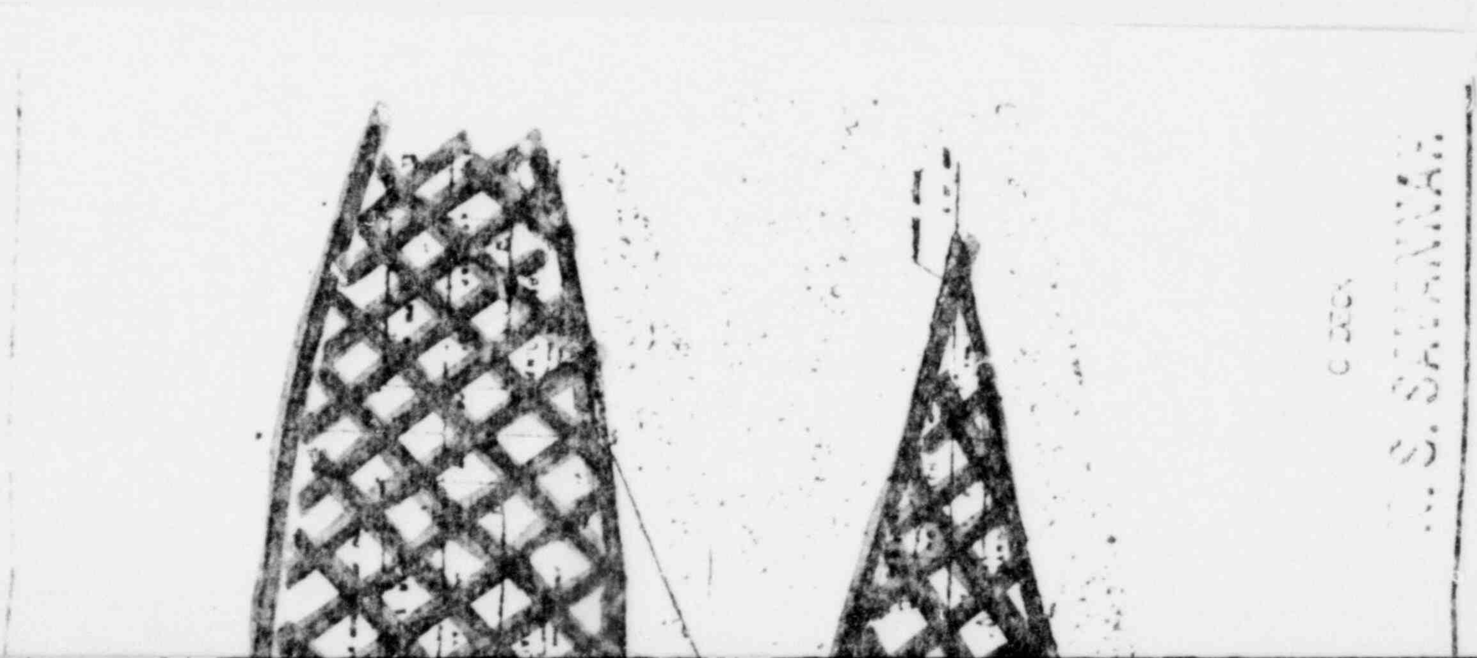
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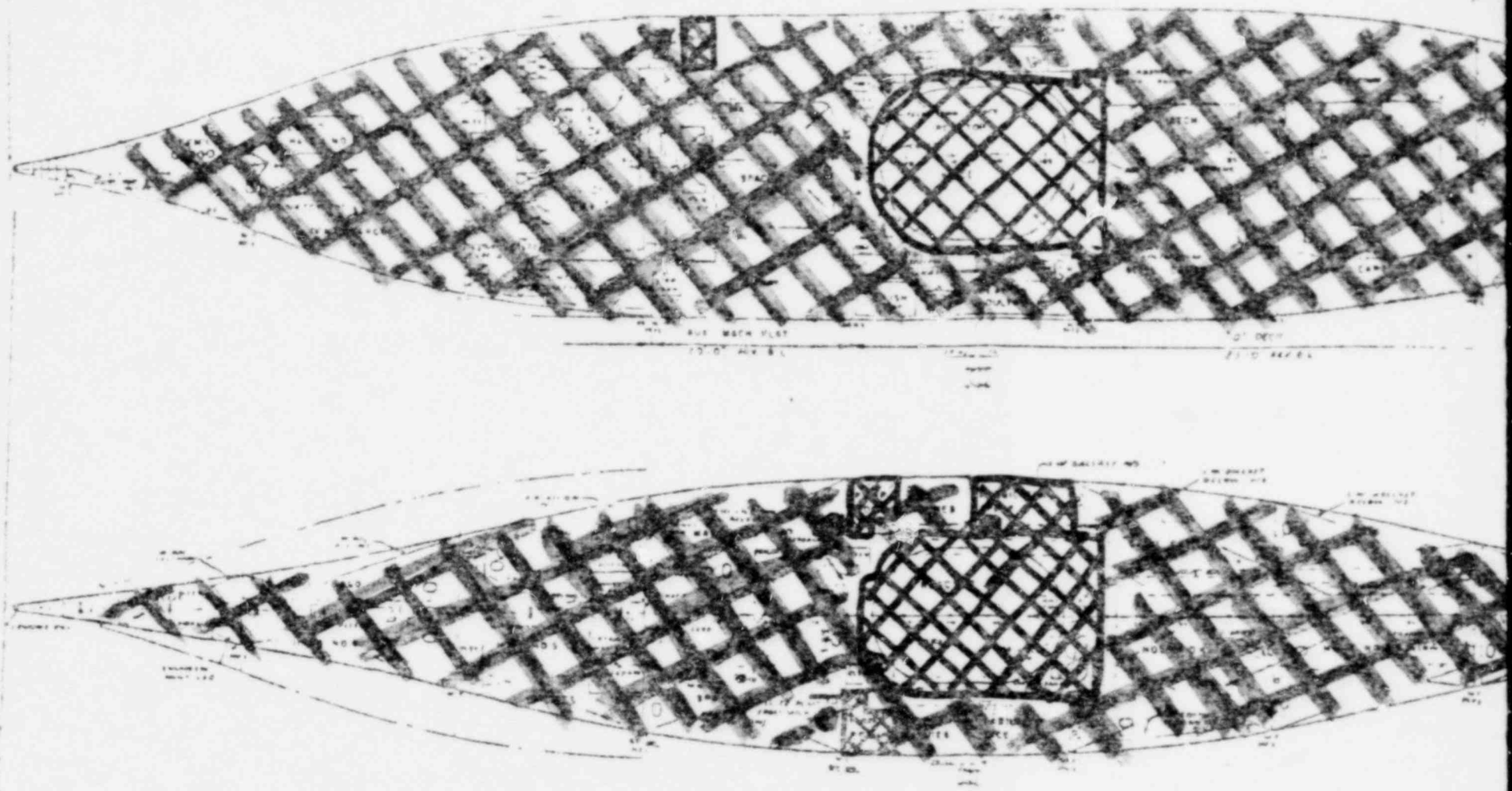

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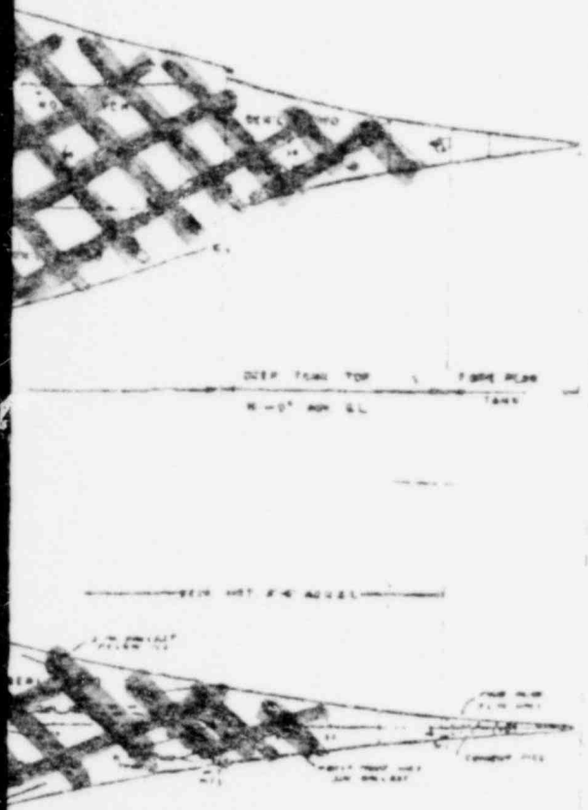

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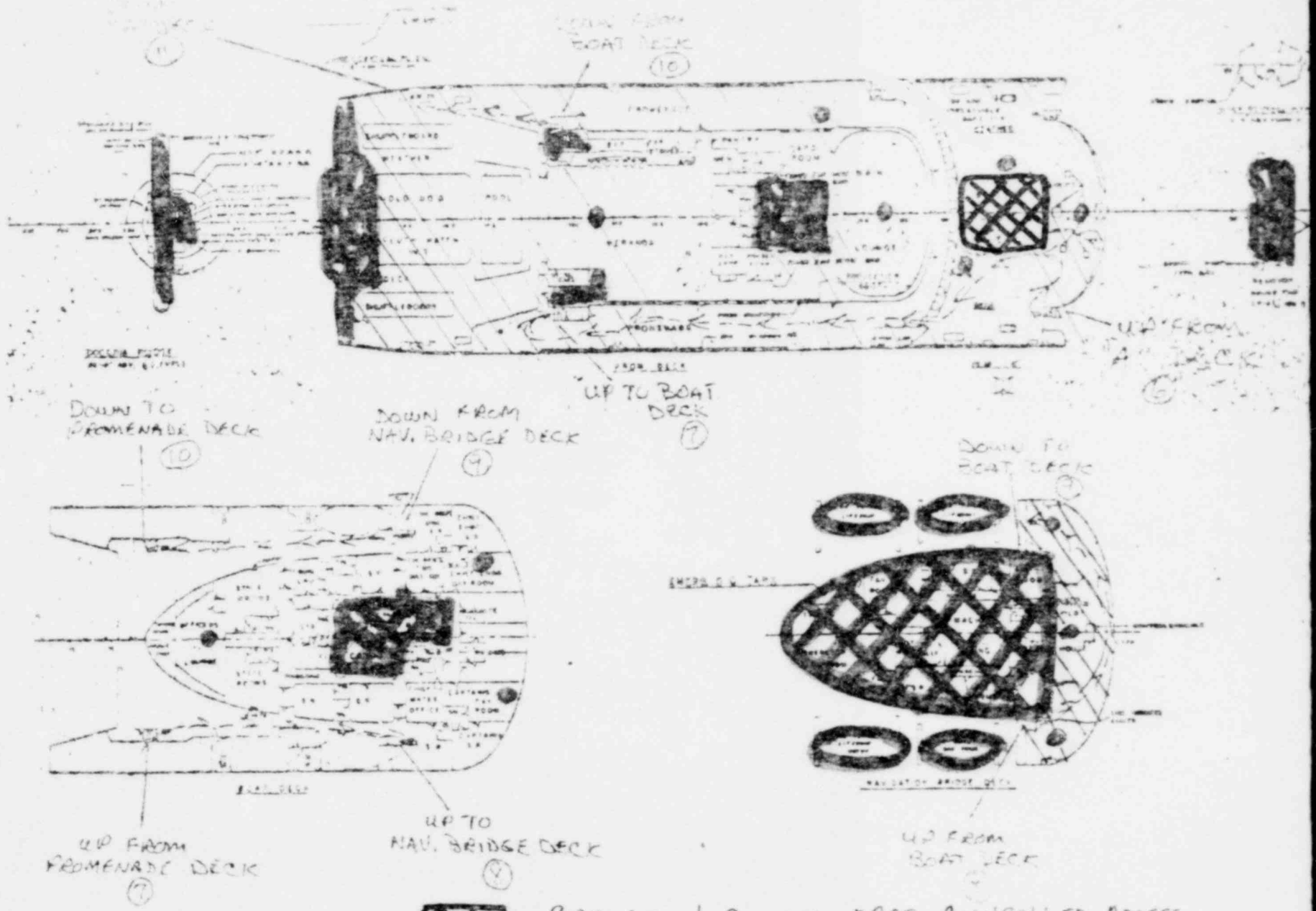

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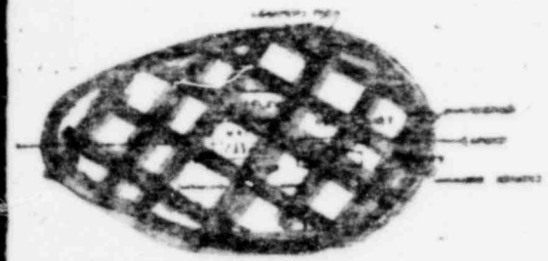

TOP OF HOUSE

U.S. SEISMIC

NL STATIONS

Area Surveyed	Direct Reading microR/hr	Reading, less 1.3 uR Bdgrd
NAVIGATION BRIDGE DECK		
In Pilot House at helm	3.1	1.8
Bridge Wing, Port Side	2.6	1.3
Bridge Wing, Starboard Side	2.6	1.3
Chart Room, Port Side	2.6	1.3
Radio Room, Starboard Side	2.9	1.6
Emergency Generator Room	1.7	0.4
BOAT DECK		
Chief Engineer's State Room, Port Side	4.4	3.1
Captain's State Room, Starboard Side	4.9	3.6
Chief Mate's Office, Starboard Side	4.5	3.2
Officer's Lounge, Aft	3.4	2.1
PROMENADE DECK		
At Aux. Reactor Hatch and Ducts (Weather Deck)	1.7	0.4
Top of Main Reactor Hatch	1.7	0.4
Fire Station #5, Starboard Side of Reactor Hatch	2.9	1.6
Fire Station #4, Port Side of Prom Deck	2.9	1.6
Fire Station #7, Starboard Side of Prom Deck	3.1	1.8
Center of Main Lounge	4.3	3.0
Center of Veranda	3.9	2.6
"A" DECK		
Fire Station #14, Port Passageway	3.4	2.1
Center of Main Lobby	3.4	2.1
Fire Station #16, Port Passageway	3.4	2.1
Fire Station #17, Starboard Passageway	3.3	2.0
Fire Station #15, Starboard Passageway	3.4	2.1
Doctor's Office, Hospital Area, Midship	3.4	2.1
Dispensary & Operating Room, Hospital Area	3.3	2.0
Health Physics Lab, Hospital Area	3.4	2.1
"B" DECK		
Fire Station #20, Port Passageway	3.4	2.1
Fire Station #22, Port Passageway	3.4	2.1
Center of Main Dining Room	3.4	2.1
Conference Room, Aft in Officer's Quarters	3.1	1.8
Fire Station #21, Starboard Side	3.4	2.1
Outside Reactor Compartment Door (closed)	4.3	3.0
Center of Main Galley	4.3	3.0
Passageway outside Steward's Mess & Lounge	3.4	2.1

"C" DECK

Visitor's Gallery, Above Engine Room	3.1	1.8
Outside Forward Control Door (closed)	4.3	3.0
Main Ship's Laundry, Port Side	3.4	2.1

"D" DECK

Center of Reactor Control Center	2.6	1.3
Outside Hot Chem Lab Door (closed)	4.3	3.0

OTHER READINGS TAKEN

Fan Room, B Deck, Starboard Side *	7.0	5.7
Near Aft Bulkhead, B Deck, Cargo Hold No. 4	23.8	22.5 **
On Dock, adjacent to N/S SAVANNAH (concrete dock)	3.4	2.1
1,000 ft away from dock and ship on dirt road	4.3	3.0

* Fan Room is a Controlled Area located above Forward Control.

** Cargo Hold No. 4 surveyed because one plan submitted by Patriot's Point indicated they may use this area for exhibits and displays.