ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
UNITED STATES ATOMIC ENERGY COMMISSION
WASHINGTON 25, D. C.

April 27, 1963

Honorable Glenn T. Seaborg
Chairman
U. S. Atomic Energy Commission
Washington, D. C.

Subject: REPORT ON N. S. SAVANNAH

Dear Dr. Seaborg:

At its forty-seventh meeting on April 11-13, 1963, the Advisory Committee on Reactor Safeguards reviewed the status of the N. S. SAVANNAH. This project was last considered at the Committee's meeting of January 31 - February 2, 1963, as reported on February 6, 1963. The Committee, in this most recent review, had the benefit of presentations by the AEC-Maritime Joint Group on N. S. SAVANNAH, States Marine Lines, U. S. Coast Guard, ORNL, Babcock & Wilcox Company and AEC staff, and of the reports referenced.

Numerous significant changes to the ship, its propulsion system, and its methods of operation are in progress or completed. The Committee considers that most of these changes improve operability or safety of the ship. Since there have been no reported malfunctions of the present control rod drives, the Committee believes that the continued temporary use of the present drives and the use of inert gas in the containment is acceptable pending installation of the new drives.

The Committee believes that the question of pressure relief and scram settings for operation at the proposed 80 MW(t) power level can be resolved by the AEC staff and the Joint Group, so as to insure that transient pressures do not exceed design values.

Concerning the removal of the loss of flow scram, the Committee suggests that the Joint Group and the AEC staff assure themselves that there is no reasonable possibility that a loss of coolant flow to the core could occur without causing a scram in time to prevent substantial core damage. Otherwise, this change does not appear to constitute a reduction in safety.

In view of the experience gained to date in the control of visitors, the Committee sees no objection to increasing the limit on the number of visitors on board at any one time to 750.

A two-day sea trial is proposed after completion of dockside testing. The Committee urges that both the dockside testing and the sea trials be of such duration and design as to test the new or modified installations thoroughly.

The Committee must emphasize the need for a greater variety of technical skills aboard this vessel than are customary on merchant ships. It is imperative that competence in nuclear skills must not be allowed to fall below that of similar land based power reactors, and that professional standards of such personnel as electronics experts and health physicists must not be compromised. It is noted that a re-alignment of operating personnel has been instituted, which, while it is expected to increase operational dependability through additional line function officers, does reduce the actual number of persons available in certain technical areas.

Operation of the N. S. SAVANNAH in crowded metropolitan areas can only be reconciled with current views on reactor siting by the incorporation of both assured engineered safeguards and assured ability to remove the ship rapidly in event of an accident. The Committee has given considerable attention to assuring itself that the engineered safeguards and mobility of the N. S. SAVANNAH are established and demonstrable beyond any reasonable doubt at all times when the ship is in such areas.

The two principal engineered safeguards that provide protection against release of radioactivity in the unlikely event of an accident are (1) the reactor containment vessel and (2) the reactor compartment with its air cleaning system. The design of these has been reviewed by the Committee previously. The containment vessel is believed to be structurally adequate, although its leak rate has increased since initial testing. The latest test shows that containment vessel tightness is still acceptable. However, since leakage may increase with plant operation, the Committee is of the opinion that 'as-is' leakage tests must be made at the proposed regular intervals. After the detection and elimination of leaks wherever possible, the containment vessel should then be retested. The Committee wishes to point out that the present maximum practical test pressure is a small fraction of the design pressure, and that extrapolation to higher pressure is necessarily uncertain, in particular since the high pressure may open leakage paths not found at lower pressures. The Committee suggests that a test procedure at the maximum practicable pressure be developed to provide the best possible basis for extrapolation from the leak test pressure to the pressure that would exist following a severe accident.

The reactor compartment is to be maintained at below atmospheric pressure so that any leakage will always be into the compartment. The minimum differential between the inside and the outside of the compartment has been established at about 0.5 inches of water. Since the pressure on opposite sides of the ship may differ by several inches of water due to wind effects, the adequacy of the selected compartment pressure and of the monitoring installation must be assured. Otherwise, a small out-leakage could exceed the total radioactive discharge from the air cleaning system.

The air cleaning system is relied upon to remove substantially all particulate and halogen radioactivity from the air exhausted from the reactor compartment. The system is designed as duplicate, parallel units of which one will be in service, and the other, in clean tested condition, will be available in an emergency. Filters of the type used in this system have been shown to be very effective on test materials. In addition, it is reported that the previous on-board installation did not deteriorate over its service period. However, the radioactive materials that might be released in event of an accident may be removed with different efficiencies than are found with test materials. In addition, the effectiveness of the air cleaning system depends on the integrity of its structure and on its installation and maintenance.

The Committee believes that as a factor of conservatism, the assumed performance of the air cleaning system should be lower than the test values due to (1) uncertainties in the parameters controlling the air cleaning process and (2) the possibility of faults in the installation or of deterioration during operation, particularly due to vibration. Furthermore, the failure of a penetration seal or the opening of a moderate size leak in the containment in case of an accident might produce sufficient pressure to rupture the filters of the cleaning system with substantial loss of filter protection.

The Committee has suggested installation of on-board testing equipment for frequent air cleaning efficiency determinations. It believes that such measurements should be made prior to each port entry. However, until such testing equipment is installed, the existing test procedures should be used for frequent checks. The present research programs on air cleaner performance and on the nature of actual accident releases should help to determine whether restrictions may be relaxed. Laboratory and operating tests to determine the effect of vibration on air cleaner performance are desirable. Installation of a pre-filter which would prevent damaging the 'absolute' filter and blanketing of the carbon beds by condensing steam should be considered.

In addition to engineered safeguards, the N. S. SAVANNAH depends upon its mobility to provide adequate protection in populated areas. This mobility in event of an accident may be achieved either by an adequate auxiliary power system or by prompt availability of tugs. In crowded waters, a reactor scram could lead to a loss of control of ship movement and therefore could contribute to a ship accident. The Committee is still of the opinion that an adequate auxiliary propulsion system is necessary in this prototype ship, and believes that the Joint Group should continue to explore with the Coast Guard and other responsible group ways to install such a propulsion system. This statement is intended to apply only to the N. S. SAVANNAH and does not pass judgement on future nuclear ships. Under present conditions, an acceptable temporary alternative appears to be to require tugs in attendance, or on 30-minute call at such times as required under the pre-Galveston porting criteria unless the reactor is shut down and at least partially depressurized. This restriction could be removed (except possibly for the largest cities) if auxiliary power suitable for maneuvers in restricted water during emergencies, even without tugs, can be installed aboard the SAVANNAH and adequately demonstrated.

If, due to any of a variety of reasons such as fog, pier blockage, or wrecks, the mobility of the N. S. SAVANNAH cannot be assured, the Committee believes that the reactor should be shut down and depressurized when at dock, unless the site meets the guide lines of 10CFR Part 100 as modified by permissible credit for the engineered safeguards and by the recent reactor operational history. The Committee believes that, on an interim basis, the values and calculational methods used in the pre-Galveston porting criteria as modified because of the immobility of the ship should be applied in evaluating the engineered safeguards.

The Committee considers the new "Proposed Interim Operating Specifications" to be simpler and more practical than the guides used prior to the Galveston overhaul. However, because of questions that have been raised about the containment leakage rate, the efficiency of the air cleaning system, and ship mobility under conditions which may exist in case of an accident, the Committee is of the opinion that the ship should continue to use the procedures and criteria in effect prior to the Galveston overhaul.

The pre-Galverson procedures and criteria state that "While under way and accompanied to two or more tugs, a one hour exposure limitation will be assumed in determining that exposure to any member of the general public will not exceed 25 rem whole body or 300 rem thyroid". The Committee believes that the one-hour exposure limitation can also be applied if the ship is at dockside, with two or more tugs under power and in attendance at the ship, and if no external conditions prevent movement of the ship.

In summary, the Committee has reviewed the operating history of the N. S. SAVANNAH up to the present period of overhaul at Galveston. It has reviewed the significant changes being made during this overhaul, and considers that these generally represent improvement in operability and safety of the ship. The Committee believes that, subject to the points specified in the above paragraphs, the N. S. SAVANNAH can continue to be operated and visit ports under the interim criteria of August 1, 1962, without undue hazard to the health and safety of the public.

Sincerely yours,

/s/
D. B. Hall
Chairman

References:

1. TODD/SML-NSS 6, N.S. SAVANNAH Operations, May 1962-March 1963, dated March 15, 1963.
2. TODD/SML-NSS-10, N.S. SAVANNAH Technical Specifications, dated March 1963.
3. BAW-1264, CA-7, N.S. SAVANNAH Safeguards Report for 80-MW Operation, February 1963.
4. Evaluation of Radiation Damage to the N.S. SAVANNAH Reactor Vessel, dated March 1963.
5. Evaluation of Electrical Cable Operation in the N.S. SAVANNAH Containment Cupola, dated March 1963.
6. "Organization Chart N.S. SAVANNAH, dated April 8, 1963", and attached summary of changes, dated April 10, 1963.
7. N. S. SAVANNAH - A Discussion of Take Home Motor Performance and Modifications, dated March 26, 1963.
8. Letter from O. C. Rohnke, U.S. Coast Guard, to H. L. Price, AEC, dated April 9, 1963, Subject: N.S. SAVANNAH Emergency Propulsion, U.S. Coast Guard Policy Concerning Requirements.
9. Proposed Interim Operation Specifications, dated March 15, 1963.
10. Evaluation of the Consequences of the Maximum Credible Accident for the N.S. SAVANNAH, dated March 1963.
11. Proposed Interim Operating Specifications, Revised April 9, 1963.
12. Proposed Significant Change No. 20, Memo 970/5530, dated Feb. 14, 1963.
13. Proposed Significant Change No. 21, Memo 970/5632, dated Feb. 25, 1963.
14. Proposed Significant Change No. 22, Memo 970/5730, dated March 8, 1963.
15. Proposed Significant Change No. 23, Memo 970/5810, dated March 20, 1963.
16. Proposed Significant Change No. 24, Memo 970/5811, dated March 21, 1963.
17. Proposed Significant Change No. 25, Memo 970/5879, dated March 22, 1963.
18. Proposed Significant Change No. 26, Memo 970/5884, dated March 26, 1963.