

N.S. SAVANNAH

The World's Reactors

No. 28 N.S. SAVANNAH

TYPE: Thermal, heterogeneous (PWR).

PURPOSE: Marine Propulsion Experiment.

OWNER: U.S. Maritime Administration.

MAIN CONTRACTOR: The Babcock and Wilcox Company.

STATUS: Critical 1960.

OUTPUT: Design, 74 MWt; normal 63.5 MWt; m.c.r., 69 MWt.

FUEL: Enriched uranium oxide (4.4% av.).
Initial loading 312.4 kg U²³⁵.

CORE: Cruciform prism, composed of 32 channels 8.5 in. (215.8 mm) square, arranged in rows of 4-6-6-6-4, and baffled for 3-pass cooling.
Equivalent diameter: 62.06 in. (1,376 mm).
Active height: 66 in. (1,676 mm).
Overall height: 90.24 in. (2,291 mm).
Volume fractions:
Water 0.5655.
Control rods 0.0405.
Helium gap 0.0052.
Fuel 0.2647.
Stainless steel 0.1421.
Excess reactivity for:
Temperature (including power coefficient) 3.2%
Xe and Sm 2.0%
Power Doppler 1.3%
Burn-up and isotope build-up 4.7%
Total excess reactivity 11.2% Δ k/k.
Neutron flux (thermal, average): 7.2 x 10¹² n/cm², sec.

FUEL ELEMENTS: Rod bundle type, with 164 rods, in four bundles of 41 rods at 0.663 in. (16.9 mm) centres.
Diameter of oxide pellets: 0.4255 in. (10.8 mm).
Thickness of stainless steel cladding: 0.035 in. (0.89 mm).
Outside diameter of rod: 0.5 in. (12.7 mm).

CONVERSION FACTOR: 0.4.

BURN-UP: 7,352 MWd/t (average).

CONTROL: Cruciform section boron stainless steel, clad in stainless steel, 8 in. (203 mm) square x 0.375 in. (9.52 mm) thick.
No. of rods: 21.
Effective length: 66 in. (1,676 mm).
Total worth of control rods: 14-18% Δ k/k.

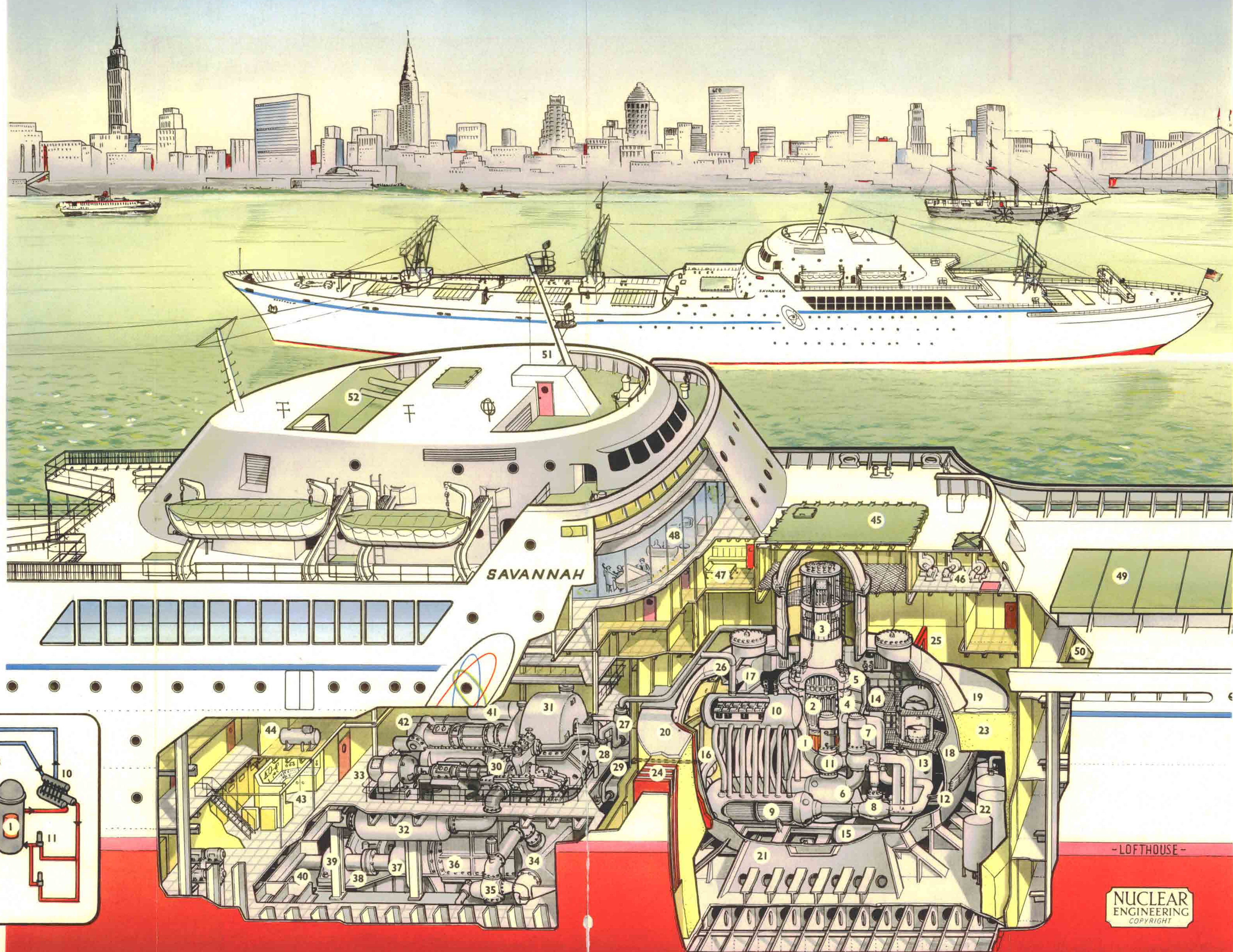
COOLANT: Pressurized water, in three vertical passes.
Inlet temperature: 495.6°F (257.5°C).
Outlet temperature: 520.4°F (271.3°C).
Hot channel: 541°F (282.7°C).
Max. fuel element temperatures:
Fuel: 3,794°F (2,090°C).
Cladding: 623°F (328.3°C).
Heat transfer area: 3,778 ft² (350.8 m²).
Coolant pressure: 1,750 p.s.i.a. (123.04 kg/cm² abs.).
Mass flow: 8 x 10⁴ lb/h (3,625 x 10³ kg/h).
Average velocity in core:
Outer pass: 9.29 ft/sec (2.83 m/sec).
Inner pass: 8.4 ft/sec (2.56 m/sec).

PRESSUR VESSEL: Carbon steel, clad internally with stainless steel.
Height: 26 ft 6 in. (8.077 m).
Inside diameter: 8 ft 2 in. (2.489 m).
Thickness: 6 in. (152.4 mm).
Design pressure: 2,000 p.s.i.a. (140.614 kg/cm² abs.).

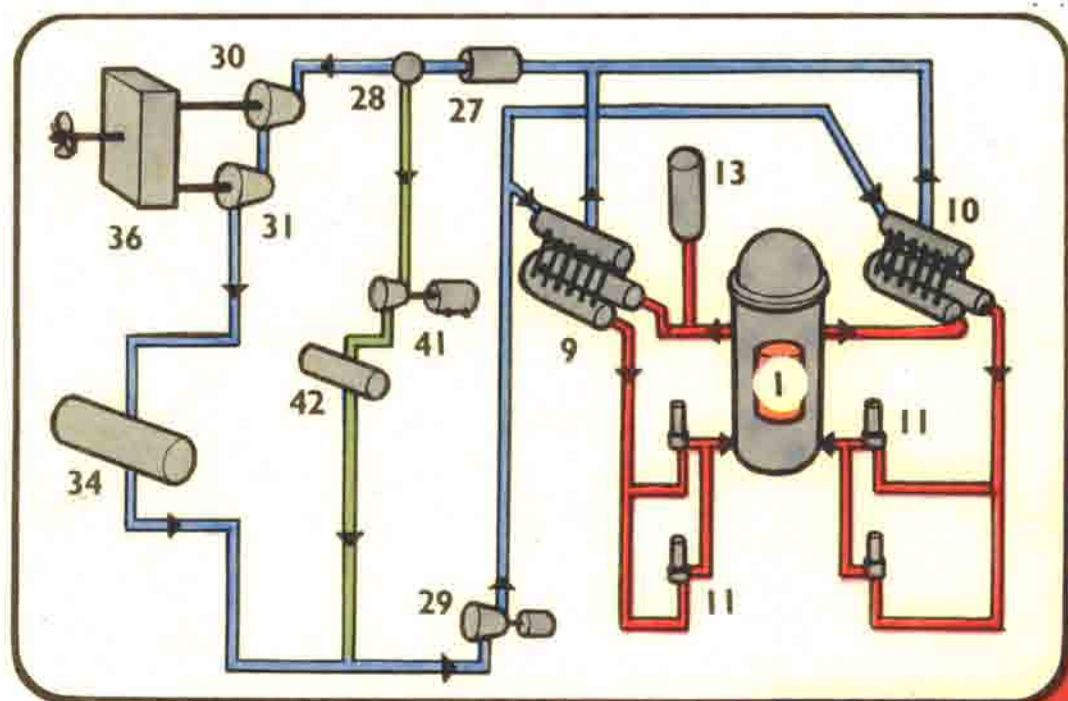
HEAT EXCHANGER: Two primary loops, each with two circulating pumps and one heat exchanger of the U-shell, U-tube type, having 800 ½-in. tubes on the primary side. Secondary (shell) side is connected by 13 risers and 8 downcomers to separate steam drum with cyclone separators and steam scrubbers.
Design pressures:
Tube side: 2,000 p.s.i. (140.614 kg/cm²).
Shell side: 800 p.s.i. (56.246 kg/cm²).
Design temperature: 650°F (343.3°C).
Steam conditions at normal load: 490 p.s.i.a. (34.45 kg/cm² abs.) dry saturated (0.25% moisture).
Feed temperature: 347°F (172.6°C).
Total steam generation at normal load: 242,000 lb/h (110,000 kg/h).
Total primary pumping power (4 pumps): 920 kW.

SHIELDING: Primary shielding (inside containment): Steel tank 17 ft (5.182 m) high, surrounding reactor with an annular thickness of water of 33 in. (0.838 m), surrounded by 2-4-in. thickness of lead. Secondary shielding (outside containment) is a composite arrangement of polythene up to 6 in. thick, lead, ordinary and barytes concrete, and water tanks, and collision mat of alternate layers of redwood and steel.

CONTAINMENT: Steel cylinder 35 ft (10.668 m) diameter, with hemispherical ends, overall length 50 ft (15.24 m). Thickness varies from 2½ in. (60.3 mm) to 4 in. (101.6 mm).



- KEY**
1. Core
 2. Control rods
 3. Control rod mechanism
 4. Reactor shell
 5. Lead covered neutron shield tank
 6. Primary inlet to reactor
 7. Primary outlet
 8. Gate valve
 9. Heat exchangers (2)
 10. Steam drums
 11. Primary pumps
 12. Surge line to pressurizer
 13. Pressurizer
 14. Condensing tank
 15. Drain tank
 16. Let-down coolers
 17. Cooling ducts
 18. Steel containment vessel
 19. Lead shielding
 20. Polyethylene shielding
 21. Vessel support members
 22. Water treatment plant
 23. Concrete shielding
 24. Steel and redwood laminated collision mat
 25. Anti-roll brackets
 26. Secondary steam outlet to turbines
 27. Main steam separator
 28. Throttle valve
 29. Main feed pumps and secondary return to heat exchangers
 30. H.P. turbine
 31. L.P. turbine
 32. Steam separator
 33. Take-home motor
 34. Main condenser
 35. Main condenser circulating pump
 36. Reduction gears
 37. Thrust bearing housing
 38. Coupling
 39. Propeller shaft steady bearing
 40. Propeller shaft
 41. Turbo-generators sets (2)
 42. Auxiliary condenser
 43. Control centre
 44. Water heater and tank
 45. Reactor hatch
 46. Fan room
 47. Sick bay
 48. Main lounge
 49. Cargo hatch
 50. Cargo hold
 51. Waste gas disposal channel
 52. Air conditioning exhaust



DETAILS OF SHIP

Length between perpendiculars	545 ft
Length overall	595 ft 6 in.
Beam	78 ft
Draught, fully loaded	29 ft 6 in.
Displacement, fully loaded	22,000 tons
Displacement, light	12,000 tons
Deadweight	9,900 tons
Cargo capacity	9,400 tons
Horsepower, (normal)	20,000 s.h.p.
Horsepower, (maximum)	22,000 s.h.p.
Speed	21 knots
Passengers	60
Crew	110
Cargo capacity	746,200 ft ³
Fuel radius (estimated)	300,000 naut. miles

- LOFTHOUSE -

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