

# The world's reactors no.65 CLINCH RIVER

Liquid Metal Fast Breeder Reactor Demonstration Plant

**OWNER**  
Project Management Corporation

**OPERATOR**  
Tennessee Valley Authority

**NUCLEAR STEAM SUPPLY (NSS) DESIGN**  
Westinghouse Electric Co.—Overall NSS, reactor system and primary heat transport system.

General Electric Co.—Intermediate heat transport system and steam generator system.

Atomics International Div. Rockwell International—Fuel handling system, maintenance, and auxiliary systems.

**ARCHITECT ENGINEER**  
Burns and Roe, Inc.

**LOCATION**  
On the Clinch River near Oak Ridge, Tennessee, U.S.A.

**TYPE**  
Sodium cooled fast breeder—loop type

**GENERAL PERFORMANCE**  
Total power 975 MW (th)  
Electrical power (gross) 380 MW (e)  
Heat transport systems (loops) 3

**REACTOR CORE**  
Core volume 2400 litres  
Core length (active) 36 in (914 mm)  
Axial blanket length 14 in (357 mm)  
Radial blanket length (both ends of core) 1150 kg (Pu-239 + 241)  
Critical mass 35 kg (U-235)  
Enrichment zones 2  
Fuel cycle period 12 months  
Fuel assemblies 198  
Lattice pitch 4.76 in (121 mm)  
Radial reflectors 150  
Removable shield material 316ss and Inco 718  
Blanket material Depleted UO<sub>2</sub>  
Blanket clad material 316ss, 20% cold worked  
Blanket clad thickness 0.015 in (0.36 mm)

**FUEL ASSEMBLIES**  
Fuel material PuO<sub>2</sub>/UO<sub>2</sub>  
Clad material 316ss, 20% cold worked  
Fuel pins per assembly 217  
Fuel pin outside diameter 0.23 in (5.8 mm)  
Clad thickness 0.015 in (0.36 mm)  
Fuel pin spacer (initial core) wire wrapped  
Peak burnup goals 80 000 MWd/t conservative design basis  
150 000 MWd/t goal for advanced cores

**CONTROL ASSEMBLIES**  
Primary control rods 15  
Secondary control rods 4  
Poison pins per assembly, primary/secondary 37/19  
Poison pin outside diameter, primary/secondary 0.611/0.660 in (15.5/16.8 mm)  
Poison pin clad thickness, primary/secondary 0.064/0.050 in (1.63/1.27 mm)  
Poison pin spacer Wire wrap  
Clad material 316ss

**PRIMARY SYSTEM**  
Flow rate per loop 13.82 x 10<sup>6</sup> lb/hr (6.26 x 10<sup>4</sup> kg/h)  
Hot leg temperature 995°F (534°C)  
Cold leg temperature 730°F (388°C)  
Hot leg material 316 ss  
Cold leg material 304 ss

**PUMPS**  
Number 3  
Type Vertical, single stage, free surface centrifugal  
Design speed 1150 rpm  
Power 5000 hp (3.7 MW)  
Design flow rate 33 000 gal/min (125 000 l/min)  
Head 450 ft (137 m)

**INTERMEDIATE SYSTEM**  
Flow rate 12.78 x 10<sup>6</sup> lb/hr (5.8 x 10<sup>4</sup> kg/h)  
Hot leg temperature 936°F (502°C)  
Cold leg temperature 651°F (344°C)  
Hot and cold leg material Austenitic stainless steel  
Steam generator material 2 1/4 Cr. 1 Mo ferritic steel

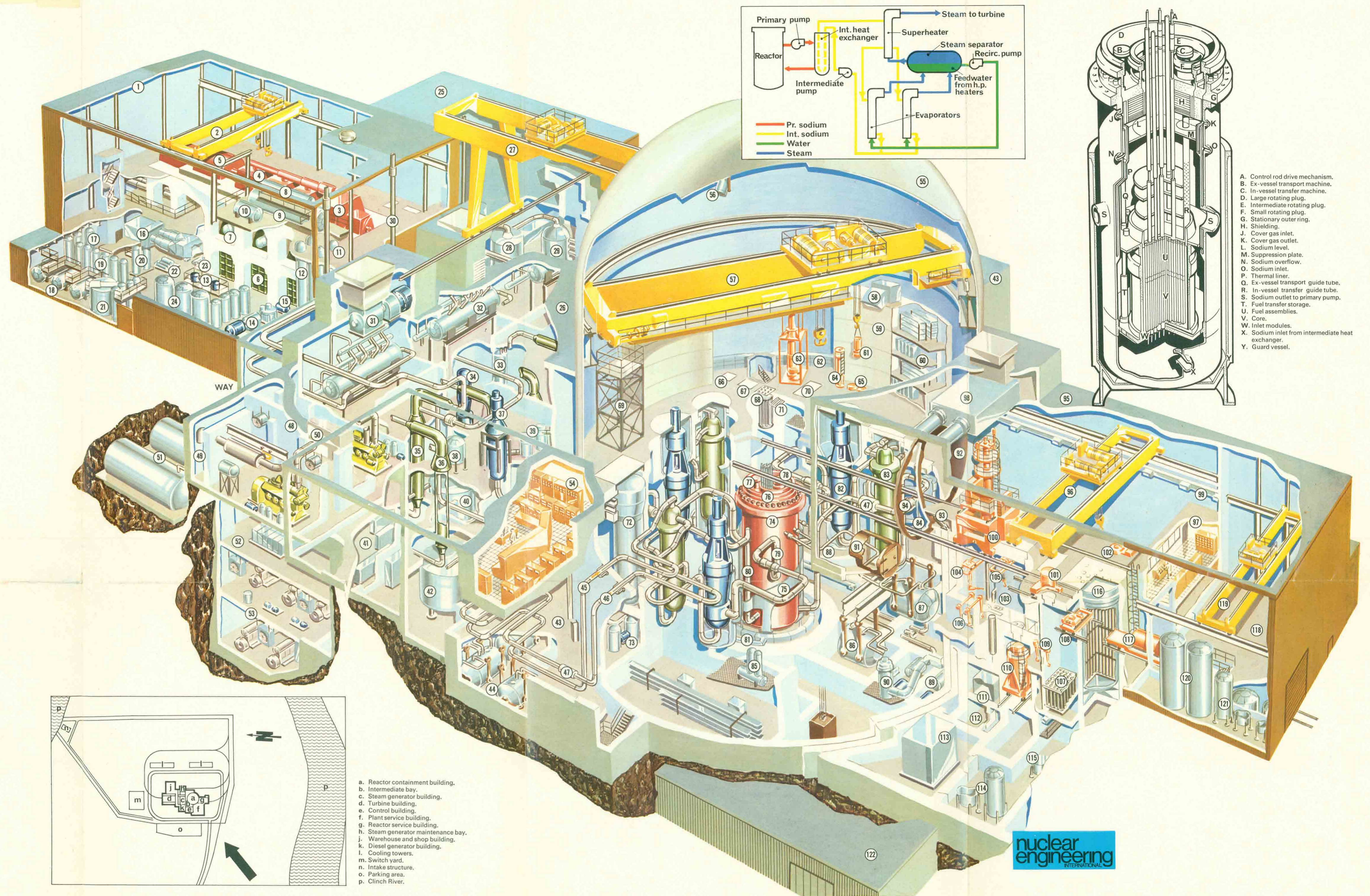
**PUMPS**  
Number 3  
Type Vertical, single stage, free surface centrifugal  
Design speed 1006 rpm  
Power 3600 hp (2.6 MW)  
Design flow rate 29 500 gal/min (112 000 l/min)  
Head 330 ft (101 m)

**STEAM SYSTEM**  
Steam flow rate 3.34 x 10<sup>6</sup> lb/hr (1.52 x 10<sup>4</sup> kg/h)  
Steam temperature (at throttle) 900°F (482°C)  
Steam pressure 1450 psi (102 kg/cm<sup>2</sup>)  
Feedwater temperature 450°F (232°C)  
Temperature entering evaporator 544°F (284°C)  
Temperature entering superheater 618°F (326°C)

**STEAM GENERATORS**  
Type Recirculation  
Number per heat transport loop 2  
Recirculation rate 2:1

**UNIQUE SAFETY FEATURES**  
Guard vessels for the reactor vessel, primary pumps, and intermediate heat exchangers  
Inerted cells for in-containment heat transport systems  
Decay heat removal provided by pony motor and/or natural circulation and steam generator heat removal system  
As low as practicable release design. Gaseous fission products and tritium release are below detectable limits  
Diverse secondary shutdown system.

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- 1. Turbine building.
- 2. Turbine building bridge crane.
- 3. High-pressure turbine.
- 4. Low-pressure turbines.
- 5. Generator.
- 6. Condenser.
- 7. Low-pressure heaters.
- 8. De-aerator heater.
- 9. Storage tank.
- 10. Surge tank.
- 11. High-pressure feedwater heaters.
- 12. Low-pressure feedwater heaters.
- 13. Condensate pumps.
- 14. Steam generator feed pumps.
- 15. Vacuum pumps.
- 16. Heating, ventilation and air conditioning equipment.
- 17. Chemical mix tanks.
- 18. Ammonia, caustic, and acid storage tanks.
- 19. Demineralizers.
- 20. Filters.
- 21. Clarifiers.
- 22. Stator winding cooler unit.
- 23. Condensate drain pumps.
- 24. Condensate polishing tanks.
- 25. Warehouse and shop building.
- 26. Steam generator building.
- 27. Steam generator building gantry crane.
- 28. Centrifugal separation tank.
- 29. Reaction products tank.
- 30. Igniter.
- 31. Steam generator auxiliary heat removal system air-cooled condenser.
- 32. Steam drum.
- 33. Water dump tank.
- 34. Recirculating pump.
- 35. Superheater.
- 36. Evaporators.
- 37. Intermediate pump.
- 38. Expansion tank.
- 39. Cold traps.
- 40. Instrumentation and control cabinets.
- 41. Plug handling machine.
- 42. Cable trays.
- 43. Auxiliary handling machine.
- 44. In-vessel transfer machine drive mechanism storage.
- 45. In-vessel transfer machine port adaptors.
- 46. Auxiliary bay.
- 47. Sodium dump tank.
- 48. Primary sodium storage tanks (shown on opposite side of plant for clarity).
- 49. Cold return to heat exchanger.
- 46. Steam feed from heat exchanger.
- 47. Flow meter.
- 48. Diesel generator building.
- 49. Diesel exhaust structure.
- 50. Air intake plenum.
- 51. Diesel fuel storage tanks.
- 52. Switchgear.
- 53. Chilled liquid rooms (water and dousing spray).
- 54. Control room.
- 55. Containment vessel.
- 56. Re circulating fans.
- 57. Reactor building polar crane.
- 58. Primary pump unit cooler.
- 59. Electrical equipment rooms.
- 60. Instrumentation and control cabinets.
- 61. Plug handling machine.
- 62. Cable trays.
- 63. Auxiliary handling machine.
- 64. In-vessel transfer machine drive mechanism storage.
- 65. In-vessel transfer machine port adaptors.
- 66. Equipment hatch.
- 67. In-vessel transfer machine storage.
- 68. Plug and sleeve storage.
- 69. Large maintenance stand.
- 70. Primary heat transfer system cell access hatch.
- 71. Electrical, instrumentation and control embedded conduits.
- 72. Large component cleaning and inspection vessel.
- 73. Large component cleaning and inspection vessel process equipment.
- 74. Reactor vessel.
- 75. Reactor guard vessel.
- 76. Rotating head plugs.
- 77. Ex-vessel transport machine plug.
- 78. In-vessel transfer machine plug.
- 79. Sodium from reactor to primary pump (hot leg).
- 80. Sodium from intermediate heat exchanger to reactor (cold leg).
- 81. Reactor cavity cooling duct.
- 82. Primary pump.
- 83. Intermediate heat exchanger.
- 84. Primary sodium cold traps.
- 85. Primary heat transfer system fan cooler unit.
- 86. Primary sodium storage vessel.
- 87. Reactor sodium overflow vessel.
- 88. Sodium drain pipe.
- 89. Primary sodium make-up pumps.
- 90. Primary sodium overflow and storage cell cooler unit.
- 91. Primary personnel access air lock.
- 92. Reactor containment building refuelling hatch.
- 93. Refuelling hatch floor tilting mechanism.
- 94. Primary check valve.
- 95. Reactor service building.
- 96. Reactor service building bridge crane.
- 97. Fuel handling control room.
- 98. Reactor containment air conditioning unit.
- 99. Reactor service building air ducts.
- 100. Ex-vessel transport machine.
- 101. Transfer dolly.
- 102. Floor valve.
- 103. Fuel handling cell.
- 104. Cell handling machine.
- 105. Cell bridge crane.
- 106. Fuel handling cell operating gallery.
- 107. New core component storage.
- 108. New core component cell bridge crane.
- 109. New core component cell operating gallery.
- 110. Spent fuel cask and transport dolly.
- 111. Fuel handling cell argon purification unit.
- 112. Mass spectrometer.
- 113. Radioactive argon processing system cold box.
- 114. Liquid nitrogen storage vessels.
- 115. Cell atmospheric processing system liquid collection tank.
- 116. Ex-vessel storage tank.
- 117. Spent fuel shipping cask on railroad car.
- 118. Decontamination area.
- 119. Decontamination area bridge crane.
- 120. Condensate storage tanks (liquid radwaste).
- 121. Monitoring tanks (liquid radwaste).
- 122. Plant service building.

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