# System Design and Operating Parameters

| | Unit 1 | Unit 2 |
|---|---|---|
| Original plant design life, years [1] | 40 | 40 |
| Number of heat transfer loops | 4 | 4 |
| Design pressure, psig | 2485 | 2485 |
| Nominal operating pressure, psig | 2235 | 2235 |
| Approximate total RCS volume (including pressurizer and surge line) with 0% steam generator tube plugging [2] | 12,540 $ft.^3$ | 12,470 $ft.^3$ |
| Approximate system liquid volume (including pressurizer water) with 0% steam generator tube plugging [2] | 11,640 $ft.^3$ | 11,570 $ft.^3$ |
| Approximate system liquid volume (including pressurizer water) at maximum guaranteed power with 0% steam generator tube plugging [3] | 11,990 $ft.^3$ | 12,019 $ft.^3$ |
| Total Reactor heat output (100% power) Btu/hr | $12,283 \times 10^6$<br>(3600 MWt) | $12,283 \times 10^6$<br>(3600 MWt) |

[1] Licensed life is 60 years in accordance with Chapter 15 of the UFSAR.

[2] This value is a best estimate based on ambient (70° F) conditions with 0% steam generator tube plugging. Refer to Westinghouse letter AEP-98-161 and IMP database SEC-SAI-4824-CO.

[3] This includes a 3% volume increase (1.3% for thermal expansion and 1.7% for pipe connections to the reactor coolant loops, volume in the rod drive mechanisms and calculation inaccuracies).

# System Design and Operating Parameters

| | **Unit 1** | **Unit 2** |
|---|---|---|
| | Bounding Conditions for Rerating Lower/Upper [4] | Bounding Conditions for Rerating Lower/Upper [4] |
| Reactor vessel coolant temperature at full power: | | |
| Inlet, nominal, °F | 511.7/549.3 | 511.7/549.3 |
| Outlet, nominal, °F | 582.3/616.9 | 582.3/616.9 |
| Coolant temperature rise in vessel at full power, avg., °F | 70.6/67.6 | 70.6/67.6 |
| Total coolant flow rate, lb/hr x $10^6$ | 139.5/133.2 | 139.5/133.2 |
| Steam pressure at full power, psia | 576/820 | 576/820 |
| Steam Temp. @ full power, °F | 481.8/521.0 | 481.8/521.0 |
| Approximate total RCS volume (including pressurizer and surge line) with 0% steam generator tube plugging. [2] | 12,540 ft.$^3$ | 12,470 ft.$^3$ |

[4] Limiting values based upon 3600 MWt rerating condition in WCAP-12135.

**Reactor Coolant System Design Pressure Settings**

| | Pressure (psig) | |
|---|---|---|
| | Unit 1 | Unit 2 |
| Design Pressure | 2485 | 2485 |
| Operating Pressure | 2235 | 2235 |
| Safety Valves | 2485 | 2485 |
| Power Relief Valves[1] | 2335 | 2335 |
| Pressurizer Spray Valves (Begin to Open) | 2260 | 2260 |
| Pressurizer Spray Valves (Full Open) | 2310 | 2310 |
| Pressurizer Pressure High - Reactor Trip | ≤2385 | ≤2385 |
| High Pressure Alarm | 2310 | 2310 |
| Pressurizer Pressure Low - Reactor Trip | ≥1950 | ≥1950 |
| Low Pressure Alarm | 2210 | 2210 |
| Pressurizer Pressure Low - Safety Injection | ≥1815 | ≥1815 |
| Hydrostatic Test Pressure | 3106 | 3107[2] |
| Backup Heaters On | 2210 | 2210 |
| Proportional Heaters (Begin to Operate) | 2250 | 2250 |
| Proportional Heaters (Full Operation) | 2220 | 2220 |

[1] During startup and shutdown, a manually energized safeguard circuit is in service while the reactor coolant system temperature is below 266°F for Unit 1 and 299°F for Unit 2. This allows automatic opening of that Unit's two power relief valves at ≤435 psig for low temperature overpressure protection (LTOP) of the reactor vessel. This safeguard circuit ensures that the reactor pressure remains below the ASME Section III, Appendix G "Protection against Non-ductile Failure" limits in the case of an LTOP event.

[2] Original design

# Reactor Vessel Design Data

| | |
|---|---|
| Design Pressure, psig | 2485 |
| Operating Pressure, psig | 2235 |
| Hydrostatic Test Pressure, psig | 3107[1] Unit 2 and 3106[2] psig Unit 1 |
| Design Temperature, °F | 650 |
| Overall Height of Vessel and Closure Head, ft-in. | 43-9$^{11}/_{16}$ (Unit 1) |
| (Bottom Head O.D. to top of Control Rod Mechanism Adapter) | 43-10 (Unit 2) |
| Thickness of Insulation, min., in | 3 |
| Number of Reactor Closure Head Studs | 54 |
| Diameter of Reactor Closure Head Studs, in | 7 |
| ID of Flange, in | 172½ |
| OD of Flange, in | 205 |
| ID at Shell, in | 173 |
| Inlet Nozzle ID, in | 27½ |
| Outlet Nozzle ID, in | 29 |
| Clad Thickness, min., in | $^{5}/_{32}$ |
| Lower Head Thickness, min., in (base metal) | 5⅜ |
| Vessel Belt-Line Thickness, min., in (base metal) | 8½ |
| Closure Head Thickness, in | 6½ |
| Total Water Volume Below Core, $ft^3$ | 1050 |
| Water Volume in Active Core Region, $ft^3$ | 665 |

[1] Original design

[2] Steam Generator Replacement Pressure

# Reactor Vessel Design Data

| | | |
|---|---|---|
| Total Water Volume to Top of Core, $ft^3$ | 2352 | |
| Total Water Volume to Coolant Piping Nozzles Centerline, $ft^3$ | 2959 | |
| Total Reactor Vessel Water Volume, $ft^3$ (estimated) (with core and internals in place) | 4660[3] | |
| | Unit 1 Bounding Conditions for Rerating Lower / Upper | Unit 2 |
| Reactor Coolant Inlet Temperature, °F | 514.9 / 545.2 | 541.27 |
| Reactor Coolant Outlet Temperature, °F | 579.1 / 607.5 | 606.35 |
| Reactor Coolant Flow, lb/hr x $10^6$ | 139.0 / 133.9 | 134.6 |

[3] This volume is a general number that approximates either Unit's Vessel. The actual volume of either vessel is cycle dependent and can be obtained from the Westinghouse IMP database for the specific cycle.

# Pressurizer and Pressurizer Relief Tank Design Data

| Pressurizer | |
|---|---|
| Design Pressure, psig | 2485 |
| Operating Pressure, psig | 2235 |
| Hydrostatic Test Pressure (cold), psig | 3106 Unit 1, 3107[1] Unit 2 |
| Design/Operating Temperature, °F | 680/653 |
| Pressurizer Water Level, Full Power[2] | 49.9% (Unit 1) / 55% (Unit 2) |
| Total Internal Volume[3], ft3 | 1800 |
| Surge Line Nozzle Diameter, in. | 14 |
| Shell ID, in. | 84 |
| Electric Heater Capacity, kW [4] | 1800 kW |
| Heatup rate of Pressurizer, °F/hr | 55 (approx.) |
| Start-up Water Solid, °F/hr | 40 |
| Hot Standby Condition, °F/hr | 70 |
| Design Spray Rate for Valves Full Open, gpm | 800 |
| Continuous Spray Rate, gpm | 1 |

[1] Original design

[2] Estimated values from operating data, actual values determined by $T_{ave}$ full-load.

[3] This volume is a general number that approximates either Unit's Pressurizer. The actual volume of either pressurizer can be obtained from the current Westinghouse IMP database for the Unit.

[4] Some heaters may be removed from service to a practical limit, greater than the TS minimum capacity, which supports plant evolutions.

# Pressurizer and Pressurizer Relief Tank Design Data

| **Pressurizer Relief Tank** | |
|---|---|
| Design Pressure, psig | 100 |
| Rupture Disc Release Pressure, psig | 100 |
| Design Temperature, °F | 340 |
| Normal Water Temperature, °F | Containment Ambient (120°F Max.) |
| Normal Operating Pressure, psig | 3 |
| Normal Water Volume, ft3 | 1430 |
| Normal Gas Volume, ft3 | 370 |
| Cooling time required following design maximum discharge, hr. | Approx. 1 |
| Number of spray nozzles | 5 |
| Total Spray Flow, gpm | 150 |
| Total Volume, ft3 | 1800 |
| Total Rupture Disc Relief Capacity, saturated steam, lb/hr | $1.6 \times 10^6$ |

## STEAM GENERATOR DESIGN DATA*

| | Unit 1 | Unit 2 |
|---|---|---|
| Number of Steam Generators | 4 | 4 |
| Design Pressure, Reactor Coolant/Steam, psig | 2485/1085 | 2485/1085 |
| Reactor Coolant Hydrostatic Test Pressure(tube side-cold), psig | 3106 | 3107 |
| Design temperature, Reactor Coolant/Steam, °F | 650/600 | 650/600 |
| Reactor Coolant Flow, lb/hr x $10^6$ | 33.9[1]<br>38.2[2] | 33.7 |
| Total Heat Transfer Surface Area, $ft^2$ | 54,927 | 54,500 |
| Rated Thermal Output/MWt) | 816 | 852.75 |
| Operating Parameters at 100% Load | | |
| Primary Side: | | |
| Heat Transfer Rate (per unit), Btu/hr x $10^6$ | 2773[3]<br>3070[4] | 2910 |
| Coolant Inlet Temperature, °F | 582.3 - 616.9 | 606.4 |
| Coolant Outlet Temperature, °F | 511.7 - 549.3 | 541.3 |
| Flow Rate, (per unit), lb/hr x $10^6$ | 33.9 (1)<br>3.82 (2) | 33.7 |
| Pressure loss, psi. | 32.05 | 26.1 |
| Secondary Side: | | |
| Steam Temperature at full power, °F | 481.8 - 521 | 521.1 |
| Steam Flow, lb/hr x $10^6$ | 3.53 (3)<br>3.9 (4) | 3.685 |
| Steam Pressure at full power, psia | 575.8 - 819.7 | 820 |
| Maximum moisture carryover, wt % | 0.045 | 0.15 |
| Feedwater Temperature | 440 @ nozzle | 431.3 @ #6<br>Heater Outlet |
| Fouling Factor, hr-$ft^2$ °F/Btu | 0.00005 | 0.00005 |
| Overall Height, ft-in | 67 - 7.25 | 67-8 |
| Shell OD, upper/lower, in | 175.75/135 | 175.9/135 |
| Number of U-tubes | 3496 | 3592 |

*Quantities are for each steam generator.
[1] RCS flow rate based on Thermal Design Flow of 88500 gpm at 536°F.
[2] RCS flow rate based upon Mechanical Design Flow of 99700 gpm at 535°F.
[3] Heat transfer rate and steam flow for 816 MWt per steam generator.
[4] Heat transfer rate and steam flow for 900 MWt per steam generator.

## STEAM GENERATOR DESIGN DATA*

| | | |
|---|---|---|
| U-tube outer Diameter, in | 0.875 | 0.875 |
| Tube Wall Thickness, (minimum), in | 0.044 | 0.050 |
| Number of manways/ID, in | 2/18<br>2/16 | 4/16 |
| Number of handholes/ID, in | 6/6 | 6/6 |
| Number of inspection ports/ID, in | 2/6 | 2/4 |
| **Unit 1** | **Rated Load** | **No Load** |
| Reactor Coolant Water Volume,** $ft^3$ | 1141.1[5] | 1141.1 [(5)] |
| Primary Side Fluid Heat Content, Btu x $10^6$ | 29.8[6] | 29.2[7] |
| Secondary Side Water Volume, $ft^3$ | 2035[8] | 3235 |
| Secondary Side Steam Volume, $ft^3$ | 3583 [(8)] | 2315 |
| Secondary Side Fluid Heat Content, Btu x $10^7$ | 5.69 [(8)] | 8.78[9] |
| **Unit 2** | **Rated Load** | **No Load** |
| Reactor Coolant Water Volume,** $ft^3$ | 1112 | 1112 |
| Primary Side Fluid Heat Content, Btu | 29.0 x $10^6$ | 28.46 x $10^6$ |
| Secondary Side Water Volume, $ft^3$ | 2077 | 3351 |
| Secondary Side Steam Volume, $ft^3$ | 3589 | 2315 |
| Secondary Side Fluid Heat Content, Btu | 5.18 x $10^7$ | 8.44 x $10^7$ |

*Quantities are for each steam generator.
** Values may change subject to steam generator tube plugging.
[5] Hot condition @ power.  Volume at ambient temperature is approximately 1130 $ft.^3$.
[6] Based upon hot volume and primary fluid @ 567.8°F and pressure of 2250 psia.
[7] Based upon hot volume and primary fluid @547°F and pressure of 2250 psia.
[8] Based upon secondary side fluid @ 515.2°F (saturated conditions).
[9] Based upon secondary side fluid @ 547°F (saturated conditions).

## REACTOR COOLANT PUMPS DESIGN DATA[1]

| | |
|---|---|
| Number of Pumps | 4 Design |
| Pressure/Operating Pressure, psig | 2485/2235 |
| Hydrostatic Test Pressure (cold), psig | 3106 Unit 1, 3107[2] Unit 2 |
| Design Temperature (casing), °F | 650 |
| RPM at Nameplate Rating | 1189 |
| Suction Temperature, °F | 536.3 (Unit 1)/541.00[3] (Unit 2) |
| Required net positive suction head, ft | 170 |
| Developed Head, ft | 277 |
| Capacity, gpm | 88,500 |
| Seal Water Injection, gpm | 8 |
| Seal Water Return, gpm | 3 |
| Pump Discharge Nozzle ID, in | 27.5 |
| Pump Suction Nozzle ID, in | 31 |
| Overall Unit Height, ft-in. | 27-0 |
| Water Volume, $ft^3$ | 81 |
| Pump-Motor Moment of Inertia, lb-$ft^2$ | 82,000 |

| MOTOR DATA: | |
|---|---|
| **Type** | **AC Squirrel Cage Induction, Single Speed, Air Cooled** |
| Voltage | 4000 |
| Insulation Class | F |
| Phase | 3 |

[1] Quantities are for each pump.
[2] Original design.
[3] Original design power capability parameter.

| MOTOR DATA: | |
|---|---|
| **Type** | **AC Squirrel Cage Induction, Single Speed, Air Cooled** |
| Frequency, Hz | 60 |
| Starting | |
| Current, amp | 4800 |
| Input (hot reactor coolant), kw | 4337 |
| Input (cold reactor coolant), kw | 5663 |
| Power, HP (nameplates ) | 6000 |
| Pump Weight, lb. (dry) | 175,200 |

# Reactor Coolant Piping Design Parameters

| | |
|---|---|
| Reactor inlet piping, ID, in | 27.5 |
| Reactor inlet piping, minimum[1] thickness, in | 2.56 |
| Reactor outlet piping, ID, in | 29 |
| Reactor outlet piping, minimum[1] thickness, in | 2.69 |
| Coolant pump suction piping, ID, in | 31 |
| Coolant pump suction piping, minimum[1] thickness, in | 2.88 |
| Pressurizer surge line piping, ID, in | 11.188 |
| Pressurizer surge line piping, nominal thickness, in | 1.406 |
| Design pressure, psig | 2485 |
| Operating Pressure, psig | 2235 |
| Hydrostatic test pressure (cold), psig | 3106 (Unit 1) / 3107[2] (Unit 2) |
| Design temperature, ºF | 650 |
| Design temperature (pressurizer surge line)ºF | 680 |
| Design pressure, pressurizer relief line, psig | [3] |
| Design temperature, pressurizer relief lines, ºF | [1] |
| Water volume (all 4 loops without surge line), $ft^3$ | 1185 |
| Surge line volume, $ft^3$ | 43 |

[1] Original procurement minimums

[2] Original design

[3] From pressurizer to safety valve: 2485 psig, 650°F; From safety valve to pressurizer relief tank: 500 psig, 470°F

# Pressurizer Valves Design Parameters

| **Pressurizer Spray Control Valves** | |
|---|---|
| Number | 2 |
| Design pressure, psig | 2485 |
| Design temperature, ºF | 650 |
| Design flow for valves full open, each, gpm | 400 |
| Fluid temperature, ºF | 530-550 |
| Position after failure of actuating force | Closed |
| **Pressurizer Safety Valves** | |
| Number | 3 |
| Relieving capacity, lb/hr | 420,000 |
| Set pressure, psig | 2485 |
| Fluid | Saturated steam |
| Constant back pressure: | |
| Normal, psig | 3 |
| Expected during discharge, psig | 350 |
| **Pressurizer Power Relief Valves** | |
| Number | 3[1] |
| Design pressure, psig | 2485 |
| Design temperature ºF | 680 |
| Design capacity at nominal set pressure 2350 psia, (each) lbm/hr | 210,000 |
| Fluid | Saturated steam or water |

[1] Only two required. Third valve is considered an installed spare.

# Reactor Coolant System Design Pressure Drop

| | Pressure Drop, psi (estimated) | |
|---|---|---|
| | Unit 1[1] | Unit 2[2] |
| Across Pump Discharge Leg | 1.3/1.1 | 1.4 /1.2 |
| Across Reactor Vessel, Including Nozzles | 52.0/44.6 | 50.4 / 48.5 |
| Across Hot Leg | 1.2/1.0 | 1.2 / 1.1 |
| Across Steam Generator, Including Nozzles | 33.4/50.9 | 33.1 / 36.1 |
| Across Pump Suction Leg | 3.1/2.6 | 3.2 / 2.9 |
| Total Pressure Drop | 91.0/100.2 | 89.3 / 89.9 |

Note that the first value provided coincides with the maximum Best Estimate Flow (minimum steam generator tube plugging, minimum reactor vessel average temperature, TPR) and that the second value provided coincides with the minimum Best Estimate Flow (maximum steam generator tube plugging, maximum reactor vessel average temperature, TPI).

(1) Data updated as a result of new Best Estimate Flows calculated in 2018.
(2) Data updated as a result of new Best Estimate Flows calculated in 2017.

# Design Thermal and Loading Cycles

| Item | Transient | Cycles [1] |
|---|---|---|
| Level A Limits (Normal) | | |
| 1 | Heatup at 100 °F/hr. | 200 |
| 2 | Cooldown at 100°F/hr. (Pressurizer @ 200 °F/hr.) | 200 |
| 3 | Unit Loading at 5% of full power/min. | 18,300/11,680 [2] [3] |
| 4 | Unit Unloading at 5% of full power/min. | 18,300/11,680 [2] [3] |
| 5 | Step Load Increase of 10% of full power | 2,000 [4] |
| 6 | Step Load Decrease of 10% of full power | 2,000 [4] |
| 7 | Large Step Decrease in load (with steam dump) | 200 |

[1] For Unit 1 Model 51R replacement steam generator manway and handhole stud preloads, the design considers 100 cycles each of tensioning and detensioning or torquing and detorquing, as appropriate.

[2] Unit 1 rerating to 3600 MWt.

[3] The Unit 1 Model 51R replacement steam generators have been structurally designed for the lower cycle limit for both 3264 MWt and the 3600 MWt power uprate condition. The RCS average temperature and steam temperature will deviate ± 3 °F in one minute. The corresponding RCS pressure variation will be ± 100 psi.

[4] WCAP-17588-P, D. C. Cook Unit 1 Lower Radial Support Clevis Insert Acceptable Minimum Bolting Pattern Analysis, used 200 Step Load Increase of 10% of full power and 200 Step Load Decrease of 10% of full power transients to qualify the minimum bolting pattern. A new procedural limit was set to account for the lower number of transients allowed for the Unit 1 Clevis Insert Bolts. WCAP-17588-P does not impact any other analyses performed using the transients described in Table 4.1-10.

# Design Thermal and Loading Cycles

| Item | Transient | Cycles [1] |
|---|---|---|
| 8 | Hot Standby Operation | 18,300 [5] |
| 9 | Turbine Roll Test | 10 |
| 10 | Steady State Fluctuations | Infinite [6] |
| Level B Limits (Upset) | | |
| 11 | Loss of Load (without immediate turbine or Reactor trip) | 80 |
| 12 | Loss of Power (blackout with natural circulation in Reactor Coolant System) | 40 |
| 13 | Loss of Flow (partial loss of flow one pump only) | 80 |
| 14 | Reactor Trip From Full Power | 400 |
| 15 | a) Operational Basis Earthquake (20 events of 20 cycles each event), except Reactor Vessel | 400 |
| | b) Operational Basis Earthquake, Reactor Vessel only (10 events of 20 cycles each event) | 200 |
| Level C Limits (Emergency) | | |

[5] Applies to steam generator only. Reflects cyclic limit for the feed ring of a rapid injection of cold feedwater.

[6] Reactor coolant system average temperature is assumed to increase and decrease a max. of 6°F in one minute. The corresponding reactor coolant pressure variation is less than 100 psi.

# Design Thermal and Loading Cycles

| Item | Transient | Cycles [1] |
|---|---|---|
| | None | |
| | Level D Limits (Faulted) | |
| 16 | Reactor Coolant Pipe Break (LOCA) | 1 |
| 17 | SSE | 1 |
| 18 | Steam Pipe Break | 1 |
| | Test Conditions | |
| 19 | Primary Side Hydrostatic Tests Before Initial Startup @ 3107 psig | 5 [7] |
| 20 | Primary Side ASME Section XI/Field Tests | 10 [8] |
| 21 | Secondary Side Hydrostatic Test Before Initial Startup at 1356 psig | 5 / 20 [8 9] |
| 22 | Primary to Secondary Leak Test | 50 / 90 [8] |
| 23 | Secondary to Primary Leak Test | 120 [8] |

[7] Unit 1 Model 51R replacement steam generator shop hydro was 3106 psig.

[8] Unit 1 Model 51R replacement steam generator.

[9] Unit 1 Model 51R replacement steam generator not subjected to secondary side shop hydro. Leakage test performed after installation in accordance with Code Case N-416-1.

## SUMMARY OF PLANT OUTAGE FOR YANKEE-ROWE (1964 - 1969)

| Starting Date | Duration Days/Hours | | Outage Type | Case Equipment/System |
|---|---|---|---|---|
| 1/17/64 | - | 3.1 | Forced | Turbine Trip |
| 2/12/64 | - | 21.8 | Scheduled | Control Rod Drop Testing |
| 3/11/64 | - | 4.5 | Forced | Moisture separator level switch tripped due to vibration |
| 3/26/64 | - | 4 | Forced | Control Valves Sticking |
| 5/18/64 | - | 5.4 | Forced | Low condensate pump discharge pressure |
| 8/2/64 | 35 | - | Scheduled | Refueling and general maintenance |
| 9/9/64 | - | 2.4 | Scheduled | Check of Overspeed Trip |
| 9/11/64 | - | 14.7 | Forced | Spurious Reactor Trip |
| 10/18/64 | - | 12.2 | Forced | Condenser Noise |
| 10/22/64 | - | 22.4 | Forced | Neutron Counter Gain Control |
| 2/12/65 | - | 15.2 | Forced | Switch yard Electric |
| 3/5/65 | - | | Scheduled | Switch yard Electric |
| 8/9/65 | 93 | 6 | Scheduled | Refueling |
| 11/26/65 | 2 | 20 | Scheduled | Turbine Repair-Physics Testing |
| 2/4/66 | - | 3.12 | Forced | Reactor Scram |
| 4/4/66 | - | 89.5 | Scheduled | Leaking Pressurizer Safety Valves |

## SUMMARY OF PLANT OUTAGE FOR YANKEE-ROWE (1964 - 1969)

| Starting Date | Duration Days/Hours | | Outage Type | Case Equipment/System |
|---|---|---|---|---|
| 7/10/66 | - | 3.68 | Forced | Reactor Scram |
| 8/25/66 | - | 2.40 | Forced | Reactor Scram |
| 10/4/66 | 34 | 10.23 | Scheduled | Refueling |
| 2/24/66 | - | 2.88 | Forced | Reactor Scram |
| 12/28/66 | - | 2.12 | Forced | Reactor Scram |
| 3/8/67 | 11 | 21 | Scheduled | Steam Generator Leak Repair |
| 5/12/67 | - | 16.87 | Scheduled | Condenser Cleaning |
| 7/9/67 | 17 | 1.5 | Scheduled | Steam Generator Leak Repairs |
| 10/28/67 | - | 9 | Scheduled | AEC Operator Examinations |
| 10/13/67 | - | 2.6 | Forced | Reactor Scram |
| 3/23/68 | 38 | - | Scheduled | Core VI-VII Refueling and maintenance |
| 7/20/68 | 1 | 10 | Scheduled | Repair Leak from No. 1 M.C. Pump Stator Cap |
| 11/8/68 | 6 | 16.42 | Scheduled | Repair No. 4 Main Coolant Pump Thermal Barrier Leak and other Maintenance |
| 1/18/69 | 1 | 2.1 | Scheduled | Operator Training |
| 2/15/69 | 1 | 1.8 | Scheduled | Operator Training |
| 3/1/69 | - | 11 | Scheduled | AEC Operator Examination |

## SUMMARY OF PLANT OUTAGE FOR YANKEE-ROWE (1964 - 1969)

| Starting Date | Duration Days/Hours | | Outage Type | Case Equipment/System |
|---|---|---|---|---|
| 4/11/69 | 4 | 18 | Forced | Repair Reactor Instrument Leak |
| 7/17/69 | - | 4.8 | Forced | Reactor Scram |
| 8/2/69 | 53 | 18.5 | Scheduled | Refueling Maintenance |
| 10/16/69 | - | 6.1 | Forced | Reactor Scram |
| 10/29/69 | - | 12 | Scheduled | Turbine Valve Flange Steam Leak Repair |

## UNIT 1 AND UNIT 2 - REACTOR COOLANT SYSTEM CODES[1]

| Component | Code | UNIT 1 Addenda and Code Cases |
|---|---|---|
| Reactor Vessel | ASME III [2] Class A | 1965 Edition through 1966 Winter Addenda, Code Cases 1332-2, 1358, 1339-2, 1335, 1359-1, 1338-3, 1336 |
| Reactor Vessel Closure Head (RVCH) | Class 1 (RVCH) | 1995 Edition through 1996 Addenda (RVCH) |
| Full Length Control Rod Drive Mechanisms | ASME III [2] Class 1 | 1965 Edition through 1966 Winter Addenda<br>1995 Edition through 1996 Addenda (RVCH) |
| Steam Generators (OSG Model 51 Steam Dome Shell) | ASME III [2] Class A | 1965 Edition through 1966 Winter Addenda<br>Code Cases 1401 and 1498 |
| Steam Generators (RSG Model 51R) | ASME III [2] Class 1 | 1989 Edition (No Addenda), Code Cases N-20-3, N-71-15, N-411-1, N-474-1, 2142-1, 2143-1, N-401-1, and N-416-1 |
| Reactor Coolant Pump Casings | No Code (Designed with ASME III [2] Article 4 as a Guide) | 1968 Edition |
| Pressurizer | ASME III [2] Class A | 1965 Edition through Winter 1966 Addenda, Code Cases 1401, 1459 |
| Pressurizer Safety Valves | ASME III [2] | 1968 Edition |
| Power Operated Relief Valves | B-16.5 | |
| Main Reactor Coolant System Piping | B31.1 [1] | 1967 Edition |
| Reactor Coolant System Valves | B-16.5 or MSS-SP-66, and ASME III 1968 Edition [2] | |

[1] Repairs and replacement for pressure retaining components within the code boundary, and their supports, are conducted in accordance with ASME Section XI.

[2] ASME Boiler and Pressure Vessel Code, Section III-Nuclear Vessels

## UNIT 1 AND UNIT 2 - REACTOR COOLANT SYSTEM CODES

| Component | Code | UNIT 2<br>Addenda and Code Cases |
|---|---|---|
| Reactor Vessel | ASME III [2] Class A<br>ASME III, Class 1 (RVCH) | 1968 Edition (1968 Summer Addenda),<br>Code Cases 1335-4 and N-60-5<br>1995 Edition through 1996 Addenda |
| Full Length Control Rod Drive Mechanisms | ASME [2] Class 1 | 1995 Edition through 1996 Addenda |
| Steam Generators | ASME III [2] Class A | 1968 Edition through Winter 1968 Addenda,<br>Code Cases 1401, 1498 for upper assemblies and<br>1983 Edition through Summer 1984 for replacement lower assemblies |
| Reactor Coolant Pump Casings | No Code (Designed with ASME III [2] Article 4 as a Guide) | 1968 Edition through Summer 1969 Addenda |
| Pressurizer | ASME III [2] Class A | 1965 Edition through Winter 1966 Addenda |
| Pressurizer Safety Valves | ASME III [2] | 1968 Edition |
| Power Operated Relief Valves | B16.5 | |
| Main Reactor Coolant System Piping | B31.1 [1] | 1967 Edition |
| Reactor Coolant System Valve | B-16.5 or MSS-SP-66, and ASME III, 1968 Edition [2] | |

## COMPONENT TRANSIENT LIMITS[1]

| Component | Cyclic Or Transient Limit | Design Cycle Or Transient |
|---|---|---|
| Reactor Coolant System | 200 heatup cycles @ ≤100ºF/hr and<br>200 cooldown cycles @ ≤100ºF/hr.<br>(pressurizer cooldown @ ≤200ºF/hr) | Heatup cycle - $T_{avg}$ from ≤200ºF to ≥547ºF.<br>Cooldown cycle - $T_{avg}$ from ≥547ºF to ≤200ºF. |
| | 80 loss of load cycles | Without immediate turbine or reactor trip |
| | 40 cycles of loss of offsite AC electrical power | Loss of offsite AC electrical power source supplying the onsite Class 1E distribution system |
| | 80 cycles of loss of flow in 1 reactor coolant loop | Loss of only 1 reactor coolant pump |
| | 400 reactor trip cycles | 100% to 0% of RATED THERMAL POWER |
| | 200 large step decreases in load | 100% to 5% of RATED THERMAL POWER with steam dump |
| | Operating basis earthquake | 400 cycles - 20 earthquakes of 20 cycles each (except Reactor Vessel) |
| | | 200 cycles – 10 earthquakes of 20 cycles each (Reactor Vessel only) |
| | 50 leak tests | Pressurized to 2500 psia |
| | 5 hydrostatic pressure tests | Pressurized to 3107 psig (3106 psig for Unit 1 Model 51R) |
| Secondary System | 1 steam line break | Break in a steam line 5.5" equivalent diameter |
| | 5 hydrostatic pressure tests | Pressurized to 1356 psig |

[1] A log of the actual number of transients is maintained.

## MATERIALS OF CONSTRUCTION OF THE REACTOR COOLANT SYSTEM COMPONENTS

| Component | Section | Material | |
|---|---|---|---|
| | | Unit 1 | Unit 2 |
| Reactor Vessel | Pressure Plate | ASTM A-533 Grade B Class 1 | ASTM A-533 Grade B Class 1 |
| | Pressure Forgings (excl. RVCH) | ASTM A508, Class 2 | ASTM A508, Class 2 |
| | RVCH | SA-508 Grade 3, Class 1 | SA-508 Grade 3, Class 1 |
| | Primary Nozzle Safe Ends | Type 316 forging overlaid on I.D. and O.D. with Type 308L and Inconel weld metal after final post-weld heat treatment | Type 316 forging overlaid on I.D. and O.D. with Type 316 weld metal prior to final post-weld heat treatment |
| | Cladding, Stainless | Combination of Type 308, Type 309 and Type 312 | Type 308L, Type, 309L |
| | Stainless Weld Rod | Type 308, Type 309 | Type 308L, Type 309, Type 309L, Type 316 |
| | O-Ring Head Seals | Inconel - 718 | Inconel - 718 |
| | CRDM's | Inconel and Stainless Type 304 | Inconel and Stainless Type 304 |
| | Studs | SA - 540 Grade B - 24 | SA - 540 Grade B - 24 |
| | Instrumentation Nozzles | Inconel and Stainless End Type 304 | Inconel and Stainless End Type 304 |
| | Insulation | Stainless Steel | Stainless Steel |
| Steam Generator | Pressure Plate | ASTM A 533 Grade A Class 1 | ASTM A 533 Grade A Class 1 for upper assembly (steam dome), ASTM |
| | Pressure Forgings Tubesheets | SA-508 Class 3a | ASTM A - 508 Class 2 A |
| | Transition Cone & Stub Barrels | SA-508 3a | ASTM A - 508 Class 3 |
| | Primary Nozzle Safe Ends | SA-336 Class F316N/F316LN | Stainless steel weld metal - carbon steel to stainless steel juncture on O.D. overlaid with Type 309 and 308L weld metal |
| | Cladding, Stainless | ER 308L, ER309L | Type ER 309L |
| | Stainless Weld Rod | Type 308L, Type 309 | Type 308L, Type 309L |
| | Cladding for Tube Sheets | UNS NO6082 | Inconel |
| | Tubes | SB-163 Alloy 690 TT | Inconel - 690 (TT) |

## MATERIALS OF CONSTRUCTION OF THE REACTOR COOLANT SYSTEM COMPONENTS

| Component | Section | Material | |
|---|---|---|---|
| | | Unit 1 | Unit 2 |
| | Channel Head Castings (Unit 1 Forging) | SA-508 Class 3A | ASTM A – 216 Grade WCC |
| Pressurizer | Shell | SA - 533 Grade A (Class 1) | SA - 533 Grade A (Class 2) |
| | Heads | SA – 216 Grade WCC | SA - 533 Grade A (Class 2) |
| | Support Skirt | SA - 516 Grade 70 | SA - 516 Grade 70 |
| | Nozzle Weld Ends | SA – 182 F316 | SA – 182 F316 |
| | Inst. Tube Coupling | SA – 182 F316 | SA – 182 F316 |
| | Cladding, Stainless | Type 308, Type 309 (modified) | Type 308 Type 309 (modified) |
| | Nozzle Forgings | Integrally cast with head | SA - 508 Class 2 Mn - Mo |
| | Heater Support Baffle Plate | SA - 240 Type 304 | SA - 240 Type 304 |
| | Inst. Tubing | SA - 213 Type 316 | SA - 213 Type 316 |
| | Heater Well Tubing | SA – 213 Type 316 Seamless | SA - 213 Type 316 Seamless |
| | Heater Well Adaptor | SA - 182 F316 | |
| Pressurizer Relief Tank | Shell | ASTM A- 285 Grade C | ASTM A- 285 Grade C |
| | Heads | ASTM A-285 Grade C | ASTM A -285 Grade C |
| | Internal Coating | Amercoat 55 | Amercoat 55 |
| Pipe | Pipes | ASTM A-351 Grade CF8M<br>ASTM A - 376 Grade TP 304 or TP 316 | ASTM A-351 Grade CF8M<br>ASTM A- 376 Grade TP 304 or TP 316 |
| | Fittings | ASTM A-351 Grade CF8M | ASTM A-351 Grade CF8M |
| | Nozzles | ASTM A- 182 Grade F316 | ASTM A- 182 Grade F316 |
| Pump | Shaft | ASTM A-182 Grade F347 | ASTM A- 182 Grade F347 |
| | Impeller | ASTM A-351 Grade CF8M | ASTM A- 351 Grade CF8M |
| | Casing | ASTM A-351 Grade CF8M | ASTM A- 351 Grade CF8M |
| Valves | Pressure Containing Parts | ASTM A-351 Grade CF8M and ASTM A-182 Grade F316 | ASTM A- 351 Grade CF8M and ASTM A- 182 Grade F316 |

**REACTOR COOLANT WATER CHEMISTRY SPECIFICATION**

| | |
|---|---|
| Electrical Conductivity | Determined by the concentration of boric acid and alkali present. Expected range is 1 to 40 µMhos/cm at 25ºC. |
| Solution pH | Determined by the concentration of boric acid and alkali present. Expected values range between 4.2 (high boric acid concentration) to 10.5 (low boric acid concentration) at 25ºC. |
| Oxygen, ppm, max. | 0.10 |
| Chloride, ppm, max | 0.15 |
| Fluoride, ppm, max. | 0.15 |
| Hydrogen, cc (STP)/kg $H_20$ | 25 – 50 |
| Total Suspended Solids, ppm, max. | 1.0 |
| pH Control Agent ($Li^7OH$) | Reactor coolant pH is controlled during power operation by adjusting lithium as a function of the coolant boron concentration. |
| Boric Acid as ppm B | Variable from 0 to 4000 |

**SUMMARY OF ESTIMATED PRIMARY PLUS SECONDARY STRESS INTENSITY FOR COMPONENTS OF THE REACTOR VESSEL (UNIT 1)[1]**

| Item | Stress Intensity (psi) | | Allowable Stress (psi) (at Operating Temperature) |
|---|---|---|---|
| | Original | Rerated | |
| Control Rod Housing | 55,300 | 66,050 | 69,900 |
| Head Flange | 50,400 | 54,380 | 80,100 |
| Vessel Flange | 45,350 | 65,850 | 80,100 |
| Primary Nozzles Inlet | 48,400 | 49,860 | 80,000 |
| Primary Nozzles Outlet | 54,060 | 59,580 | 80,000 |
| Stud Bolts | 95,870 | 83,320 | 104,400 |
| Core Support Pad | 40,800 | 69,700 | 69,900 |
| Bottom Head to Shell | 34,100 | 34,530 | 80,000 |
| Bottom Instrumentation | 53,400 | 51,490 | 69,900 |
| Vessel Wall Transition | 37,900 | 33,570 | 80,000 |

[1] The vessel stress intensities for Unit 2 are available in the Unit 2 Stress Report.

**SUMMARY OF ESTIMATED CUMULATIVE FATIGUE USAGE FACTORS FOR COMPONENTS OF THE REACTOR VESSEL (UNIT 1)[1]**

| Item | Usage Factor [2 and 3] | |
|---|---|---|
| | Original | Rerated |
| Control Rod Housing | .06 | 0.81 |
| Head Flange | .015 | 0.185 |
| Vessel Flange | .005 | 0.092 |
| Stud Bolts | .310 | 0.449 |
| Primary Nozzles Inlet | 0.020 | .098 |
| Primary Nozzles Outlet | 0.028 | .063 |
| Core Support Pad (lateral) | 0.015 | .693 |
| Bottom Head to Shell | 0.003 | .018 |
| Bottom Instrumentation | 0.142 | .122 |
| Vessel Wall Transition | 0.002 | .007 |

[1] The usage factors for Unit 2 are available in the Unit 2 Stress Report.
[2] Covers all transients.
[3] As defined in Section III of the ASME Boiler and Pressure Vessel Code, Nuclear Vessels.

## REACTOR COOLANT SYSTEM QUALITY CONTROL PROGRAM

| Component | | RT* | UT** | PT*** | MT**** | ET***** |
|---|---|---|---|---|---|---|
| 1. | Steam Generator | | | | | |
| | 1.1 Tube Sheet | | | | | |
| | 1.1.1 Forging | | yes | | yes | |
| | 1.1.2 Cladding | | yes(+) | yes(++) | | |
| | 1.2 Channel Head | | | | | |
| | 1.2.1 Casting | yes | | | yes | |
| | 1.2.2 Forging (Unit 1 Model 51R) | | yes | | yes | |
| | 1.2.3 Cladding | | | yes | | |
| | 1.3 Secondary Shell & Head | | | | | |
| | 1.3.1 Plates | | yes | | | |
| | 1.3.2 Forgings (Unit 1 Model 51R) | | yes | | yes | |
| | 1.4 Tubes | | yes | | | yes |
| | 1.5 Nozzles (forgings) | | yes | | yes | |
| | 1.6 Weldments | | | | | |
| | 1.6.1 Shell, longitudinal | yes | | | yes | |
| | 1.6.2 Shell, circumferential | yes | | | yes | |
| | 1.6.3 Cladding (Channel Head-Tube Sheet joint cladding restoration) | | | yes | | |
| | 1.6.4 Steam and Feedwater Nozzle to shell | yes | | | yes | |
| | 1.6.5 Support brackets | | | | yes | |
| | 1.6.6 Tube to tube sheet | | | yes | | |
| | 1.6.7 Instrument connections (primary and secondary) | | | | yes | |

* Radiographic
** Ultrasonic
*** Dye Penetrant
**** Magnetic Particle
***** Eddy Current
(+)Flat Surfaces Only
(++)Weld Deposit Areas Only

## REACTOR COOLANT SYSTEM QUALITY CONTROL PROGRAM

| Component | | RT* | UT** | PT*** | MT**** | ET***** |
|---|---|---|---|---|---|---|
| | 1.6.8 Temporary attachments after removal | | | | yes | |
| | 1.6.9 After hydrostatic test (after welds and complete channel head - where accessible) | | | | yes | |
| | 1.6.10 Nozzle safe ends (if forgings) | yes | | yes | | |
| | 1.6.11 Nozzle safe ends (if weld deposit) | | | yes | | |
| 2. | Pressurizer | | | | | |
| | 2.1 Heads | | | | | |
| | 2.1.1 Casting | yes | | | yes | |
| | 2.1.2 Cladding | | | yes | | |
| | 2.2 Shell | | | | | |
| | 2.2.1 Plates | | yes | | yes | |
| | 2.2.2 Cladding | | | yes | | |
| | 2.3 Heaters | | | | | |
| | 2.3.1 Tubing(+++) | | yes | yes | | |
| | 2.3.2 Centering of element | | | | yes | |
| | 2.4 Nozzle | | yes | yes | | |
| | 2.5 Weldments | | | | | |
| | 2.5.1 Shell, longitudinal | yes | | | yes | |
| | 2.5.2 Shell, circumferential | yes | | | yes | |
| | 2.5.3 Cladding | | | yes | | |
| | 2.5.4 Nozzle Safe End (if forging) | yes | | yes | | |
| | 2.5.5 Nozzle Safe End (if weld deposit) | | | yes | | |
| | 2.5.6 Instrument Connections | | | yes | | |
| | 2.5.7 Support Skirt | | | | yes | |
| | 2.5.8 Temporary Attachments after removal | | | | yes | |

(+++)Or a UT and ET

## REACTOR COOLANT SYSTEM QUALITY CONTROL PROGRAM

| | Component | RT* | UT** | PT*** | MT**** | ET***** |
|---|---|---|---|---|---|---|
| | 2.5.9 All welds and cast heads after hydrostatic test | | | | yes | |
| | 2.6 Final Assembly | | | | | |
| | 2.6.1 All accessible surfaces after hydrostatic test | | | | yes | |
| 3. | Piping repairs and replacements are conducted in accordance with ASME Section XI | | | | | |
| | 3.1 Fittings and Pipe (Castings) | yes | | yes | | |
| | 3.2 Fittings and Pipe (Forgings) | | yes | yes | | |
| | 3.3 Weldments | | | | | |
| | 3.3.1 Circumferential | yes | | yes | | |
| | 3.3.2 Nozzle to runpipe (except no RT for nozzles less than 4 inches) | yes | | yes | | |
| | 3.3.3 Instrument connections | | | yes | | |
| 4. | Pumps | | | | | |
| | 4.1 Castings | yes | | yes | | |
| | 4.2 Forgings | | | | | |
| | 4.2.1 Main Shaft | | yes | yes | | |
| | 4.2.2 Main Studs | | yes | yes | | |
| | 4.2.3 Flywheel (Rolled Plate) | | yes | | | |
| | 4.3 Weldments | | | | | |
| | 4.3.1 Circumferential | yes | | yes | | |
| | 4.3.2 Instrument connections | | | yes | | |
| 5. | Reactor Vessel | | | | | |
| | 5.1 Forgeries | | | | | |
| | 5.1.1 Flanges | | yes | | yes | |
| | 5.1.2 Studs | | yes | | yes | |
| | 5.1.3 Head Adapters | | yes | yes | | |
| | 5.1.4 Head Adapter Tube | | yes | yes | | |

**REACTOR COOLANT SYSTEM QUALITY CONTROL PROGRAM**

| | Component | RT* | UT** | PT*** | MT**** | ET***** |
|---|---|---|---|---|---|---|
| | 5.1.5 Instrumentation Tube | | yes | yes | | |
| | 5.1.6 Main Nozzles | | yes | | yes | |
| | 5.1.7 Nozzle safe ends (if forging is employed) | | yes | yes | | |
| | 5.2 Plates | | yes | | yes | |
| | 5.3 Weldments | | | | | |
| | 5.3.1 Main Steam | yes | | | yes | |
| | 5.3.2 CRD Head Adapter Connection | | | yes | | |
| | 5.3.3 Instrumentation tube connection | | | yes | | |
| | 5.3.4 Main nozzles | yes | | | yes | |
| | 5.3.5 Cladding | | Yes (++++) | yes | | |
| | 5.3.6 Nozzle-safe ends (if forging) | yes | | yes | | |
| | 5.3.7 Nozzle safe ends (if weld deposit) | yes | | yes | | |
| | 5.3.8 Head adaptor forging to head adaptor tube | yes | | yes | | |
| | 5.3.9 All welds after hydrotest | | | | yes | |
| 6. | Valves | | | | | |
| | 6.1 Castings | yes | | yes | | |
| | 6.2 Forgings (No NDE for valves two inches and smaller) | | yes | yes | | |

(++++)UT of Clad Bond-to-Base Metal