

UFSAR Revision 32.0

 An AEP Company	INDIANA MICHIGAN POWER D. C. COOK NUCLEAR PLANT UPDATED FINAL SAFETY ANALYSIS REPORT	Revised: 27.0 Table: 4.1-1 Page: 1 of 2
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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 x 10 ⁶ (3600 MWt)	12,283 x 10 ⁶ (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).

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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.

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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 297°F for Unit 1 and 291°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

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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)	5¾
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

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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.

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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 Unit 2
Design/Operating Temperature, °F	680/653
Pressurizer Water Level, Full Power ¹	49.9% (Unit 1) / 55% (Unit 2)
Total Internal Volume ² , ft ³	1800
Surge Line Nozzle Diameter, in.	14
Shell ID, in.	84
Electric Heater Capacity ³ , kW	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 Estimated values from operating data, actual values determined by T_{ave} full-load.

² 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.

³ Some heaters may be removed from service to a practical limit, greater than the TS minimum capacity, which supports plant evolutions.

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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, ft ³	1430
Normal Gas Volume, ft ³	370
Cooling time required following design maximum discharge, hr.	Approx. 1
Number of spray nozzles	5
Total Spray Flow, gpm	150
Total Volume, ft ³	1800
Total Rupture Disc Relief Capacity, saturated steam, lb/hr	1.6×10^6

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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 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 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⁾ 38.2 ⁽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⁾ 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 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.

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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 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).

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REACTOR COOLANT PUMPS DESIGN DATA¹

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.

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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

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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, °F	650
Design temperature (pressurizer surge line)°F	680
Design pressure, pressurizer relief line, psig	3
Design temperature, pressurizer relief lines, °F	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

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Pressurizer Valves Design Parameters

Pressurizer Spray Control Valves	
Number	2
Design pressure, psig	2485
Design temperature, °F	650
Design flow for valves full open, each, gpm	400
Fluid temperature, °F	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 backpressure:	
Normal, psig	3
Expected during discharge, psig	350
Pressurizer Power Relief Valves	
Number	3 ¹
Design pressure, psig	2485
Design temperature °F	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.

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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.

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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.

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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.

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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.

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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

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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

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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

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UNIT 1 AND UNIT 2 - REACTOR COOLANT SYSTEM CODES¹

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 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 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

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UNIT 1 AND UNIT 2 - REACTOR COOLANT SYSTEM CODES

Component	Code	UNIT 2 Addenda and Code Cases
Reactor Vessel	ASME III ² Class A ASME III, Class 1 (RVCH)	1968 Edition (1968 Summer Addenda), Code Cases 1335-4 and N-60-5 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, Code Cases 1401, 1498 for upper assemblies and 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	

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COMPONENT TRANSIENT LIMITS¹

Component	Cyclic Or Transient Limit	Design Cycle Or Transient
Reactor Coolant System	200 heatup cycles @ $\leq 100^{\circ}\text{F/hr}$ and 200 cooldown cycles @ $\leq 100^{\circ}\text{F/hr}$. (pressurizer cooldown @ $\leq 200^{\circ}\text{F/hr}$)	Heatup cycle - T_{avg} from $\leq 200^{\circ}\text{F}$ to $\geq 547^{\circ}\text{F}$. Cooldown cycle - T_{avg} from $\geq 547^{\circ}\text{F}$ to $\leq 200^{\circ}\text{F}$.
	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.

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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
Steam Generator	Insulation	Stainless Steel	Stainless Steel
	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)

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MATERIALS OF CONSTRUCTION OF THE REACTOR COOLANT SYSTEM COMPONENTS

Component	Section	Material	
		Unit 1	Unit 2
Pressurizer	Channel Head Castings (Unit 1 Forging)	SA-508 Class 3A	ASTM A – 216 Grade WCC
	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 ASTM A - 376 Grade TP 304 or TP 316	ASTM A-351 Grade CF8M 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

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REACTOR COOLANT WATER CHEMISTRY SPECIFICATION

Electrical Conductivity	Determined by the concentration of boric acid and alkali present. Expected range is 1 to 40 μ Mhos/cm at 25°C.
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 25°C.
Oxygen, ppm, max.	0.10
Chloride, ppm, max	0.15
Fluoride, ppm, max.	0.15
Hydrogen, cc (STP)/kg H ₂ O	25 – 50
Total Suspended Solids, ppm, max.	1.0
pH Control Agent (Li ⁷ OH)	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

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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.

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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.

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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

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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

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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		

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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