RG&E	GINNA STATION	COLR Cycle 28 Revision 0

CORE OPERATING LIMITS REPORT (COLR)

Responsible Manager

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R.E. Ginna Nuclear Power Plant

Core Operating Limits Report

Cycle 28

Revision 0

Note: This report is not part of the Technical Specifications. This report is referenced in the Technical Specifications.

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1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Ginna Station has been prepared in accordance with the requirements of Technical Specification 5.6.5.

The Technical Specifications affected by this report are listed below:

3.1.1	"SHUTDOWN MARGIN (SDM)"
3.1.3	"MODERATOR TEMPERATURE COEFFICIENT (MTC)"
3.1.5	"Shutdown Bank Insertion Limit"
3.1.6	"Control Bank Insertion Limits"
3.2.1	"Heat Flux Hot Channel Factor ($F_Q(Z)$)"
3.2.2	"Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)"
3.2.3	"AXIAL FLUX DIFFERENCE (AFD)"
3.4.1	"RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits"
3.9.1	"Boron Concentration"

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using the NRC approved methodologies specified in Technical Specification 5.6.5. All items that appear in capitalized type are defined in Technical Specification 1.1, "Definitions."

2.1 SHUTDOWN MARGIN (LCO 3.1.1)
(Limits generated using Reference 1)

2.1.1 The SHUTDOWN MARGIN in MODE 2 with $K_{eff} < 1.0$ and MODES 3 and 4 shall be greater than or equal to the limits specified in Figure 1 for the number of reactor coolant pumps in operation.

2.1.2 The SHUTDOWN MARGIN in MODE 4 when both reactor coolant pumps are not OPERABLE and in operation and in MODE 5 shall be greater than or equal to the one loop operation curve of Figure 1.

2.1.3 The SHUTDOWN MARGIN required in LCOs 3.1.4, 3.1.5, 3.1.6, 3.1.8, and 3.4.5 shall be greater than the limits specified in Figure 1 for the number of reactor coolant pumps in operation.

2.2 MODERATOR TEMPERATURE COEFFICIENT (LCO 3.1.3)
(Limits generated using Reference 1)

2.2.1 The Moderator Temperature Coefficient (MTC) limits are:

The BOL ARO/HZP - MTC shall be less positive than +5.0 pcm/°F for power levels below 70% RTP and less than or equal to 0 pcm/°F for power levels at or above 70% RTP.

The EOL ARO/RTP - MTC shall be less negative than -42.9 pcm/°F.

where:
ARO stands for All Rods Out
BOL stands for Beginning of Cycle Life
EOL stands for End of Cycle Life
HZP stands for Hot Zero THERMAL POWER
RTP stands for RATED THERMAL POWER

2.3 Shutdown Bank Insertion Limit (LCO 3.1.5)
(Limits generated using Reference 1)

2.3.1 The shutdown bank shall be fully withdrawn which is defined as ≥ 221 steps.

2.4 <u>Control Bank Insertion Limits</u> (LCO 3.1.6)
(Limits generated using Reference 1)

2.4.1 The control banks shall be limited in physical insertion as shown in Figure 2.

2.4.2 The control banks shall be moved sequentially with a 100 (±5) step overlap between successive banks.

2.5 <u>Heat Flux Hot Channel Factor ($F_Q(Z)$)</u> (LCO 3.2.1)
(Limits generated using References 1 and 2)

2.5.1 $F_Q(Z) \leq \frac{(F_Q)}{P} * K(Z)$ when $P > 0.5$

$F_Q(Z) \leq \frac{(F_Q)}{0.5} * K(Z)$ when $P \leq 0.5$

where: Z is the height in the core,

$F_Q = 2.45$,

K(Z) is provided in Figure 3, and

$P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$

2.6 <u>Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)</u> (LCO 3.2.2)
(Limits generated using Reference 1)

2.6.1 $F^N_{\Delta H} \leq F^{RTP}_{\Delta H} * (1 + PF_{\Delta H} * (1-P))$

where: $F^{RTP}_{\Delta H} = 1.75$,

$PF_{\Delta H} = 0.3$, and

$P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$

2.7 <u>AXIAL FLUX DIFFERENCE</u> (LCO 3.2.3)
(Limits generated using References 1 and 3)

2.7.1 The AXIAL FLUX DIFFERENCE (AFD) target band is ± 5%. The actual target bands are provided by Procedure RE-11.1.

2.7.2 The AFD acceptable operation limits are provided in Figure 4.

2.8 RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits (LCO 3.4.1)

(Limits generated using Reference 4)

2.8.1 The pressurizer pressure shall be ≥ 2205 psig.

2.8.2 The RCS average temperature shall be ≤ 577.5 °F.

2.8.3 The RCS total flow rate shall be ≥ 177,300 gpm (includes 4% minimum flow uncertainty per Revised Thermal Design Methodology).

2.9 Boron Concentration (LCO 3.9.1)

(Limits generated using Reference 1)

2.9.1 The boron concentrations of the hydraulically coupled Reactor Coolant System, the refueling canal, and the refueling cavity shall be ≥ 2300 ppm.

3.0 UFSAR CHAPTER 15 ANALYSIS SETPOINTS AND INPUT PARAMETERS

The setpoints and input parameters for the UFSAR Chapter 15 accident analyses are presented in Table 1. The values presented in this table are organized based on system and major components within each system. The failure of a component or system to meet the specified Table 1 value does not necessarily mean that the plant is outside the accident analyses since: (1) an indicated value above or below the Table 1 values may be bounded by the Table 1 values, and (2) the setpoint or parameter may not significantly contribute to the accident analyses final results. The major sections within Table 1 are:

1.0 Reactor Coolant System (RCS)
2.0 Main Feedwater (MFW)
3.0 Auxiliary Feedwater (AFW)
4.0 Main Steam (MS) System
5.0 Turbine Generator (TG)
6.0 Chemical and Volume Control System (CVCS)
7.0 Emergency Core Cooling System (ECCS)
8.0 Containment
9.0 Control Systems
10.0 Safety System Setpoints
11.0 Steam Generators

4.0 REFERENCES

1. WCAP-9272-P-A, Westinghouse Reload Safety Evaluation Methodology, July 1985.

2. WCAP-10054-P-A and WCAP-10081-A, "Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code," August 1985.

   WCAP-10924-P-A, Volume 1, Revision 1, "Westinghouse Large-Break LOCA Best-Estimate Methodology, Volume 1: Model Description and Validation Responses to NRC Questions," and Addenda 1,2,3, December 1988.

   WCAP-10924-P-A, Volume 2, Revision 2, "Westinghouse Large-Break LOCA Best-Estimate Methodology, Volume 2: Application to Two-Loop PWRs Equipped with Upper Plenum Injection," and Addendum 1, December 1988.

   WCAP-10924-P-A, Volume 1, Revision 1, Addendum 4, "Westinghouse Large-Break LOCA Best-Estimate Methodology, Volume 1: Model Description and Validation, Addendum 4: Model Revisions," March 1991.

   WCAP-13677-P-A, "10 CFR 50.46 Evaluation Model Report: WCOBRA/TRAC Two-Loop Upper Plenum Injection Model Updates to Support ZIRLO™ Cladding Option," February 1994.

   WCAP-12610-P-A, "VANTAGE + Fuel Assembly Reference Core Report," April 1995.

3. WCAP-8385, "Power Distribution Control and Load Following Procedures - Topical Report," September 1974.

4. WCAP-11397-P-A, "Revised Thermal Design Procedure", April 1989.

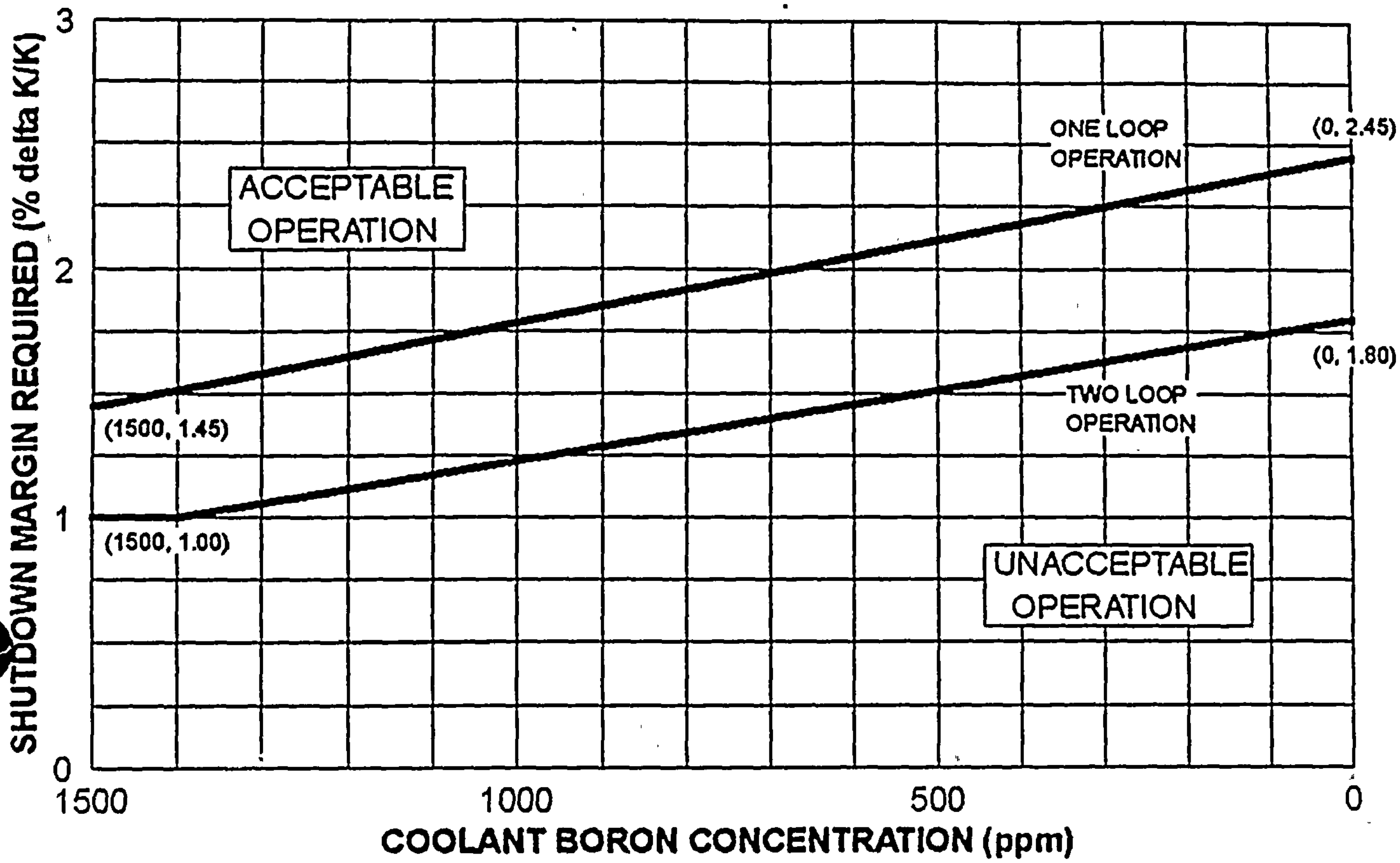
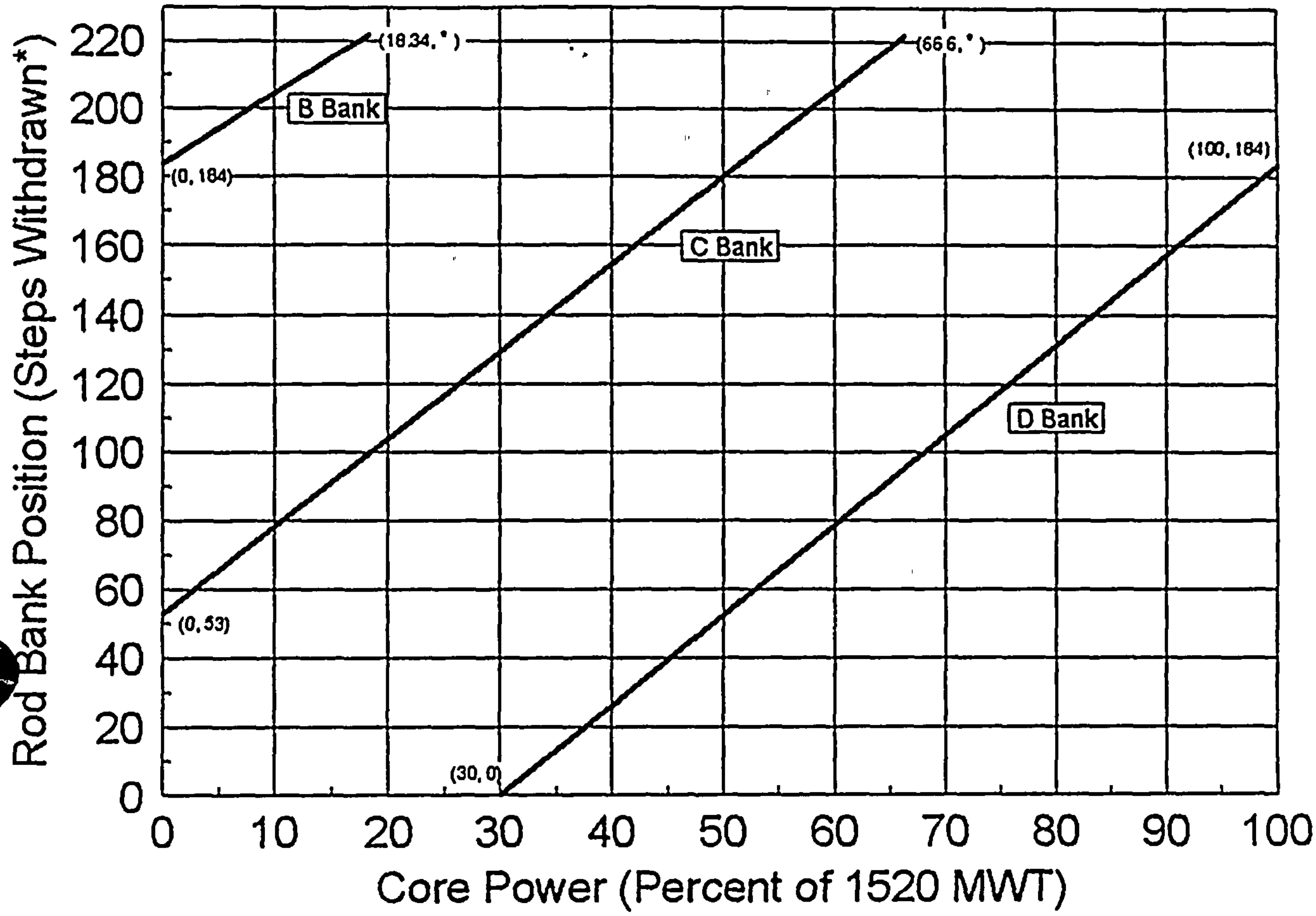


FIGURE 1
REQUIRED SHUTDOWN MARGIN



* The fully withdrawn position is defined as ≥ 221 steps.

FIGURE 2
CONTROL BANK INSERTION LIMITS

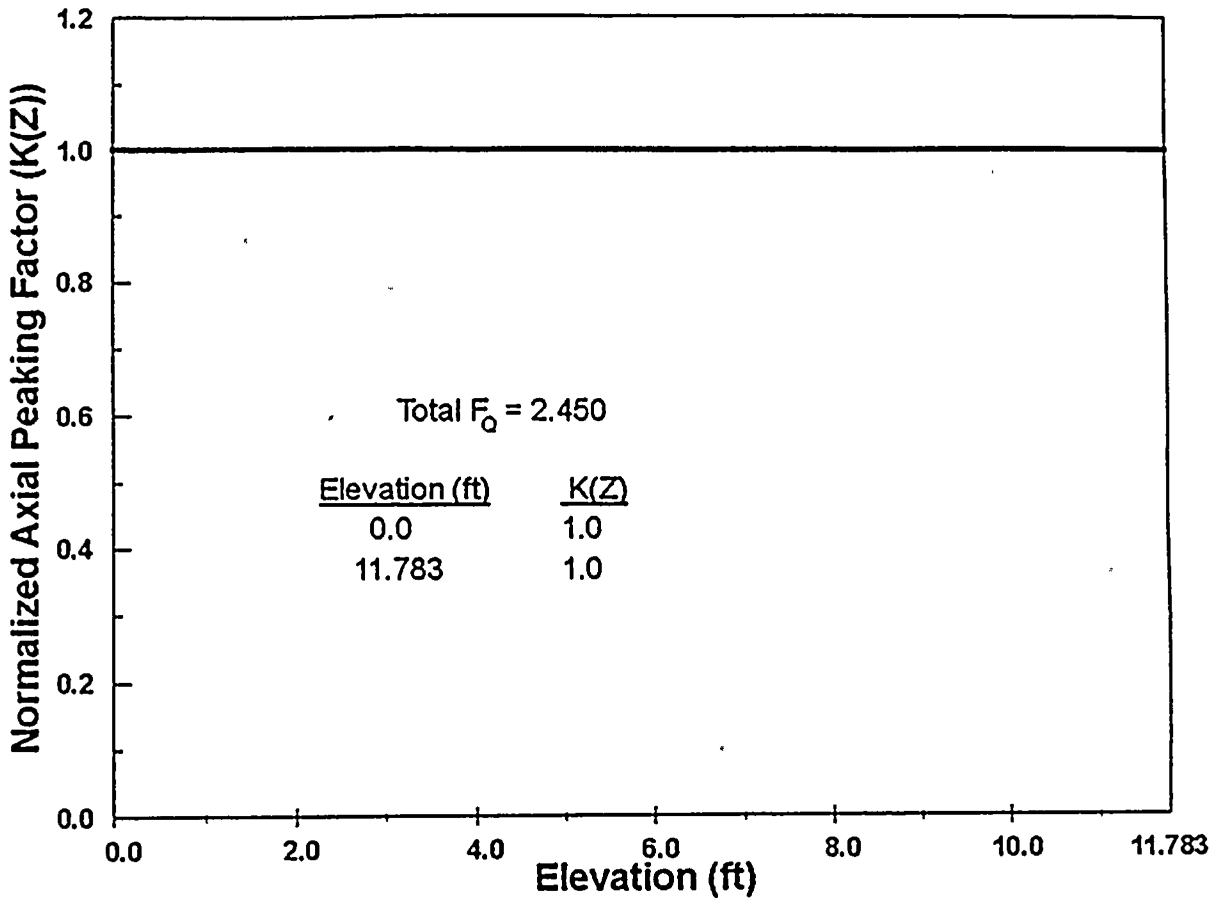


FIGURE 3
K(Z) - NORMALIZED $F_Q(Z)$ AS A FUNCTION OF CORE HEIGHT

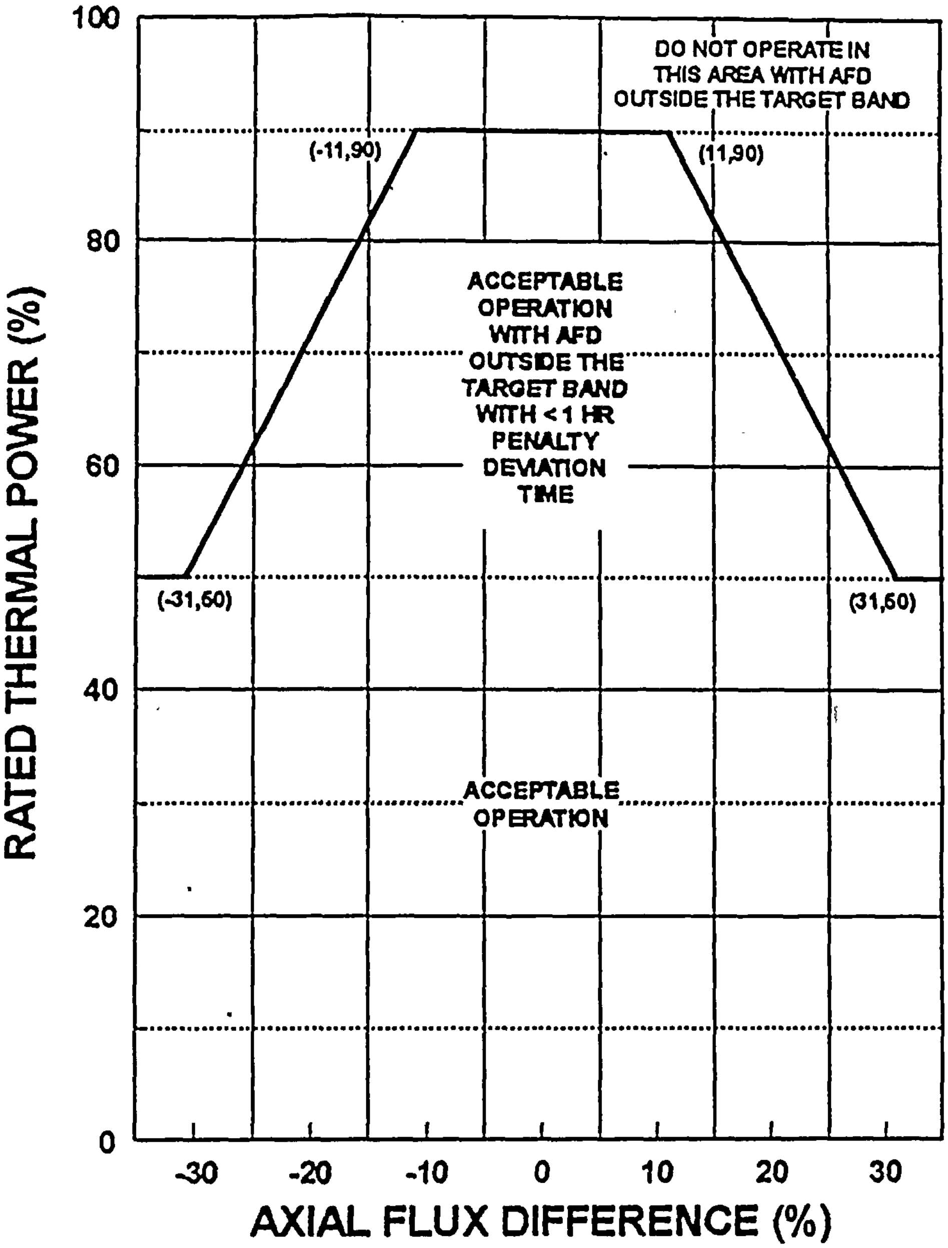


FIGURE 4
AXIAL FLUX DIFFERENCE ACCEPTABLE OPERATION LIMITS
AND TARGET BAND LIMITS AS A FUNCTION OF RATED THERMAL POWER

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
1.0	**Reactor Coolant System (RCS)**		
	Upper head volume, ft^3	300.0	Above upper support plate.
	Upper Plenum volume, ft^3	580.2	Bottom of upper core plate to top of upper support plate. Includes outlet holes in the barrel.
	Top of fuel volume, ft^3	50.3	Top of active fuel to bottom of upper core plate, inside barrel baffle.
	Inlet nozzle(s) volume, total of two, ft^3	43.2	
	Outlet nozzle(s) volume, total of two, ft^3	37.4	Includes nozzle forging protrusion into vessel. Does not include mating hole in barrel, this is included in the Upper Plenum volume.
	Active fuel volume, ft^3	367.6	Bottom of fuel to top of fuel
	Bottom of fuel volume, ft^3	11.0	Top of lower core plate to bottom of active fuel.
	Lower Plenum volume, ft^3	514.3	Below top of lower core plate
	Downcomer volume, above bottom of cold leg, ft^3	138.4	Above bottom of cold leg elevation to bottom of upper support plate
	Downcomer, lower core plate to elevation of the bottom of the cold leg volume, ft^3	278.2	Top of lower core plate to elevation of bottom of cold leg
	Barrel baffle, lower core plate to upper core plate volume, ft^3	128.5	Top of lower core plate to bottom of upper core plate.
	Total volume, ft^3	2449.1	Includes nozzles
	Hot leg pipe volume per loop volume, ft^3	78.7	
	Cold leg volume per loop + cross over, ft^3	cross over = 140.7 cold leg = 46.8	
	RC pump volume per pump, ft^3	192	
	Cold leg pipe ID, in./Pump suction ID, in.	27.5/31	
	Hot leg pipe ID, in.	29 (28.969)	
	Design pressure, psig	2485	
	Design temperature, F	650	
	Cold Leg and Hot Leg Centerline Elevation	246′ 10″	
1.1	**Reactor Coolant Pump**		
	Head-Capacity and NPSH curves for reactor coolant pumps/Homologous Curves	See Engineering	Homologous Curves are available in RETRAN
	Rated RC pump head and flow, ft & gpm	252; 90,000	
	Rated RC pump torque and efficiency @ rated head/flow, ft-lb, fraction	84% efficiency at hot conditions	
	RCP Pump Rated Power (hot, 556 degrees F)	4842 BHP	
	RCP Motor Rated Speed, RPM	1189	
	Moment of inertia of pump and motor, $lb\text{-}ft^2$	80,000	
	RC pump heat, MWt (max/min per pump)	5, 4	Pump power varies with RCS temp from approx 4 MWt to 5 MWt
1.2	**Core**		

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Rated power, MWt	1520	
	Reactor power uncertainty, % RTP	2	
	Bypass, %	6.5	Thimble plugs removed.
	Upper head bypass, %	W proprietary	
	Upper head temperature, degrees F	590	High T_{avg} value.
	Heat transfer area, ft^2	26,669	
	Average core heat flux, Btu/hr-ft^2	189,440	
1.3	**Fuel Assemblies**		
1.3.1	**Height**		
	Total, inches (length from bottom of assembly to top nozzle)	159.935	
	Fuel Rod Length, inches (length from bottom of pin to top of pin)	149.138	
	Active, inches	141.4	
1.3.2	**Fuel Assembly Geometry**		
	Mass of fuel, lbm	105,500	
	Mass of clad, lbm	25,927	
	Number of fuel pins per fuel assembly (FA)	179	
	No. of Fuel Assemblies	121	
	Fuel pin pitch, in.	0.556	
	Bottom nozzle weight and volume	9.1 lbs. 31.5 in^3	
	Top nozzle, w/ insert, weight and volume	18.15 lbs. 62.9 in^3	
	Fuel Assembly resistance [core dP f(flow)], psi f(lb/hr)	core delta P = 20 psi @ flow = 170,200 gpm	Thimble plugs removed.
	Fuel Assembly free flow area, in^2	34.75	Single assembly.
1.3.3	**Fuel pin geometry**		
	Pellet diameter, in.	0.3444	
	Clad OD/ID, in./in.	0.400/0.3514	
1.3.4	**Control Rod & Instrument Guide Tubes**		
	No. of control rod guide tubes	16	
	No. of instrument guide tubes	1	
	Control Rod Guide tube upper part OD/ID, in./in.	0.49/0.528	
	Instrument Guide tube OD/ID, in./in.	0.395/0.350	
	Guide tube lower part OD/ID, in./in.	0.4445/0.4825	
	Control Rod Drop Times, maximums, sec.	Non-LOCA 2.4 LOCA 3.0	Allowances are added to the Tech Spec allowable value.
	Control rod maximum withdrawal rate, in./min.	45	

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Control rod maximum insertion rate, pcm/sec.	90	
	Control rod insertion limits	See COLR	
	Hot channel radial peaking factor	1.75	
	Heat Flux Hot channel factor FQ	2.45	
1.4	**Pressurizer**		
	Code safety valve flow capacity, lbm/hr	288,000	Rating at 2485 psig plus 3% accumulation
	Code safety valve open time	0.8 sec seal clearing time	Crosby Model HB-BP-86, size 4K26
	Code safety valve setpoint	2485 psig	Tolerance is + 2.4%/-3%.
	Spray valve number	2	
	Spray valve flow capacity, gpm/valve	200	
	Spray valve setpoint- start open/full open	2260/2310	Proportional
	Spray valve time constant, sec.	5	Assumed value
	PORV number	2	
	PORV flow capacity, lbm/hr	179,000	Steam flow at 2335 psig
	PORV Cv	50 gpm/(psid)1/2	Rating is for liquid relief. Valve characteristic is quick opening see Copes Vulcan Selecting and Sizing Control Valves 8/75, page 8, Table 18 for Cv vs travel curve.
	PORV open time	1.65 sec + transmitter	LTOPs transmitter is Foxboro E11GM-HSAE1, with a time response of 1 sec (time to 90% of final value for step input)
	PORV close time	3.95 sec + transmitter	LTOPs transmitter is Foxboro E11GM-HSAE1, with a time response of 1 sec (time to 90% of final value for step input)
	PORV setpoint [normal] open/close, psig	2335/2315	
	PORV setpoint [LTOP] open/close, psig	430	
	PORV blowdown characteristic		
	Heater capacity w/ bank capacity and setpoints, kW	800	
	Control banks	0 kW at 2250 psig and 400 kW at 2220 psig	
	Backup Heaters	Full on at 2210 psig and resets at 2220 psig	
	Minimum heater capacity required for LOOP, kW	100	
	Heater bank controller type	proportional 400 kW	
1.4.1	**Pressurizer volume(s) (100% / 0% power)**		
	Water, ft^3 (100% / 0% power)	396/199	
	Steam, ft^3 (100% / 0% power)	404/601	
	Total, ft^3	800	
	Pressurizer ID, ft-in	83.624 in / cladding thickness is 0.188 in	

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Surge line ID, in.	8.75	Surge line is 10 in schedule 140
	Spray line ID, in.	3.062	
	Surge line volume, ft^3	18.4	
1.4.2	**Pressurizer Level**		
	Lower level tap elevation	257' 7	
	Upper level tap elevation	275' 1	
	Pressurizer level vs % power	%power Level 0 % 35% 100 % 50%	Pressurizer level is ramped linearly between these points. Not used in Chapter 15 analyses.
	Distance Hot Leg Centerline to Lower Tap, ft	10.750	
	Maximum level allowed for steam bubble, %	87	
1.5	**RCS Flows, Temperature and Pressures**		
	Total reactor coolant flow, gpm (15% plugging)	170,200	Use for non DNB
	Total reactor coolant flow, gpm (15% plugging)	177,300	Use for statistical DNB
	Average reactor coolant temperature, degrees F (Full power/HZP)	559 to 573.5/547	Cycle 26 T_{avg} = 561
	Reactor coolant pressure, psig	2235	
	Reactor coolant flow uncertainty, % nominal	4	
	Reactor coolant temperature uncertainty, degrees F	4	
	Reactor coolant pressure uncertainty, psi	± 30	
	DNB Limit (safety analysis limit)	1.40	
1.6	**Low Temperature Overpressure Protection (LTOP)**		
	Minimum RCS vent size, square inches	1.1	
	No. of SI pumps capable of injection (PORVs/vent)	0/1	
	Maximum pressurizer level for RCP start, %	38	
1.7	**Fuel Handling/Dose Calculations**		
	Maximum reactor coolant gross specific activity	$100/\bar{E}$ μCi/gm	
	Maximum reactor coolant dose equivalent I-131	1.0 μCi/gm	
	Maximum secondary coolant dose equivalent I-131	0.1 μCi/gm	
	Minimum reactor coolant boron concentration, ppm	2000	
	Minimum reactor coolant level	23 ft above flange	
	Minimum spent fuel pool level	23 ft above fuel	
	Minimum spent fuel pool boron concentration, ppm	300	
	Minimum spent fuel pool charcoal filter efficiency, % methyl iodine removal	70	TS testing requires 90% eff.
	Minimum post accident charcoal filter efficiency, % methyl iodine removal	70	TS testing requires 90% eff.

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Minimum control room charcoal filter efficiency, % methyl iodine removal	70	TS testing requires 90% eff.
	Minimum time between reactor criticality and fuel movement, hrs.	100	
	Source Terms used for dose calculations'	ORGEN 2	
	Dose conversion factors	ICRP-30	
	Maximum Gas Decay Tank Xenon-133 concentration, Ci	100,000	
2.0	**Main Feedwater (MFW)**		
	Feedwater temperature versus load	Power / Temperature 102% / 425 F 70% / 385 F 30% / 322 F 0% / 100 F	100% design temp is 432 degrees F
	Feedwater Suction Temperature vs Power, nominal	Power / Temperature 98% / 345 F 70% / 319 F 50% / 295 F 30% / 259 F	
	Feedwater Suction Pressure vs Power, nominal	Power / Pressure 98% / 277 psig 70% / 282 psig 50% / 305 psig 30% / 370 psig	
2.1	**Head-Capacity and NPSH curves**		
	Head-Capacity and NPSH curves for main feedwater pumps	See Engineering	Selected flow splits are provided for model validation.
	Main Feedwater pump - Rated Head	2150'	
	Main Feedwater pump - Rated Torque		
	Main Feedwater pump - Moment of Inertia		
	Elevation of steam generator inlet nozzle	289.612	
	Elevation of main feedwater pump, ft	257.75	Elevation is at center of shaft
	Elevation of condensate pump, ft	250.833	
	MFW regulating valve open time on demand, sec	5	
	MFW regulating valve close time on demand, sec	10	
	MFW regulating valve Cv, full stroke	725	Assumed value. Actual value = 684.
	Low load MFW regulating valve Cv, (bypass valves)	48.7	Effective Cv: includes bypass line
	MFW Heater resistance (delta P)	see Engineering	Design data on the High Pressure Heaters (2 in parallel) is provided
3.0	**Auxiliary Feedwater (AFW)**		
	Minimum design temperature of the water source service water / CST (degrees F)	30, 50	Initial AFW water source are the CSTs located in the Service Bldg. Safety Related source is the Service Water system (lake).
	Maximum design temperature of the water source service water / CST (degrees F)	80, 100	Initial AFW water source are the CSTs located in the Service Bldg. Safety Related source is the Service Water system (lake).

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Startup time for the auxiliary feedwater pumps, sec	*	*TDAFW starts on LO level (17%) in both gens or UV on both unit 4Kv busses. MDAFW starts on SI (seq), or LO level either SG, or trip of both MFP or AMSAC
	Minimum delay for AFW start, sec	TDAFW - 0, MDAFW - 1	MDAFW acceleration time test results show approximately 1.5 s.
	Maximum delay for AFW start, sec	60	Increased time of 600 sec. will be used in future analysis
	AFW control valve open time on demand, sec	N/A	MDAFW control valves are normally open and throttle closed to control flow between 200-230 gpm
	AFW control valve Cv[flow is f(dP)]	*	MDAFWP valves are 3 Rockwell model # A4006JKMY stop check valves. TDAFW control valves (4297, 4298) are 3 Fisher #470-HS.
	TDAFWP, maximum flow, gpm	600	
	AFW, minimum flows, both generators intact, gpm	TDAFWP 200/SG MDAFWP 200/SG	SBLOCA assumes 200 gpm per SG with the failure of one DG
	Minimum delay for standby AFW start, min	10	
4.0	**Main Steam System (MS)**		
	Location (and elevation) of condenser dump valves and atmospheric relief valves	CSD - elev 256' 8.875 ARV - elev 289' 0.563	
	Full load steam line pressure drop, psi	approx 45	This estimate, to the governor valves, is provided for comparison purposes only.
	MS Isolation valve close time [full open to full close] close time, sec	MSIV - 5.0 check valve - 1.0	The check valve is assumed to close in 1 sec under reverse flow.
	MS Isolation valve Cv [flow is f(dP)]	MSIV - 23500 check valve - 17580	
4.1	**Main Steam Code Safety Valves**		
	Number of valves (4 per line)	8	
	Valve flow capacities - Total, lbm/hr	6621000	Rated flow (3% accumulation per ASME, Section III): 1085 psig .... 797,700 lbm/hr (each) 1140 psig .... 837,600 lbm/hr (each)

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Valve Flow vs SG pressure (psia), total per bank (4 valves), lbm/sec.	1110 0 1115 40 1120 91 1125 141 1131 191 1136 222 1141 223 1151 225 1161 227 1166 228 1173 342 1181 494 1190 646 1200 799 1205 859 1209 920 1211 931	
	Number of valves in bank	4	
	Valve setpoint(s), (first/last three), nominal, psig	1085/1140	Valves are Crosby #HA-65 6R10 Setpoint tolerance is +1% / -3%. Model valve setpoint at 1.01 (nominal), and full flow at 1.04 (nominal).
	Valve blowdown characteristic	15% maximum	
4.2	**Atmospheric relief valves**		
	No. Atmospheric relief valves	2	
	Atmospheric relief valve setpoint/Air-operated, psig	1050	During Hot Standby operation setpoint is lowered to control no load Tavg
	Atmospheric relief valve setpoint/Booster, psig	1060	
	Atmospheric relief valve capacity, lbm/hr	313550 at 1060 psig	Max flow is 380000
5.0	**Turbine Generator (TG)**		
5.1	**Condenser**		
	No. of condenser dump valves	8	
	Condenser dump valve open time, sec	5	
	Condenser dump valve close time, sec	5	Assuming close time = opening time
	Condenser dump valve setpoint(s)	For TT: Tavg>555 4 valves, >563 4 valves; no TT: Tref +12 4 valves, Tref+20 4 valves	On TT valves control open at 6.7%/F (PID) above 547 with full open setpoints as described. On 10% step load decrease same ratio with a 6F deadband from Tref
	Condenser dump valve Cv [flow is f(dP)]	264	Design Cv (240) from design conditions (302,500 lbm/hr sat steam at 695 psig)
6.0	**Chemical and Volume Control System (CVCS)**		
	CVCS capacity/pump	3 pumps, 60 gpm max each	Normal ops: 2 charging pumps - one is manual at 15-20 gpm and the other in automatic. Charging pumps are PDPs w/ 46 gpm total - 8 gpm to seals - 3 gpm leakage + 5 gpm into RCS. 40 gpm letdown

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	CVCS minimum/pump, gpm	15	
	Type of controller (e.g., P + I) and gains	PID 100%,180 sec,10 sec	
6.1	**Reactor Makeup Water System (RMW)**		
	RMW capacity/pump	2 pumps, 60 gpm each	
7.0	**Emergency Core Cooling System (ECCS)**		
7.1	**ECCS Delivery vs RCS Pressure**		
7.1.1	**Residual Heat Removal (RHR) Delivery vs RCS Pressure**		
	Minimum RHR Delivery, train failure	see table below	LOCA Appendix K case. Train failure results in one pump running with 10% degradation with one line blocked.

RCS Pressure (psia)	Delivery (gpm)
155	0
152	0
150	0
140	250
120	648
100	836
80	985
60	1115
40	1232
20	1338
14.7	1365

Minimum RHR Delivery, two pumps running, one line blocked — LOCA Appendix K case (offsite power available). Two pumps running with 10% degradation with one line blocked.

RCS Pressure (psia)	Delivery (gpm)
155	0
154	0
152	160
150	252
140	516
120	830
100	1056
80	1243
60	1406
40	1552
20	1686
14.7	1720

7.1.2 **Safety Injection (SI) Delivery vs RCS Pressure**

Minimum SI delivery, 2 pumps operating, one line spilling — LOCA Appendix K case. Train failure results in two pumps running with 5% degradation with one line spilling to containment.

Press (psig)	Delivery (gpm)	Spill (gpm)
1375	0.0	465
1300	62	465
1200	125	465
1100	167	465
1000	201	465
900	229	465
800	253	465
700	273	465
600	289	465
500	305	465
400	321	465
300	336	465
200	352	465
100	368	465
0	384	465

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value			Remarks:
	Minimum SI delivery, 3 pumps operating, non-LOCA	Press (psia)	Delivery Loop 'A'	(gpm) Loop 'B'	Used for non-LOCA transients, 5% pump degradation
		1390	16	19	
		1315	87	97	
		1215	147	163	
		1115	193	214	
		1015	231	257	
		915	266	295	
		815	297	329	
		715	325	360	
		615	352	390	
		515	377	418	
		415	400	444	
		315	423	469	
		215	445	493	
		115	465	516	
		15	485	538	
	Minimum SI delivery, 2 pumps operating non-LOCA	Press (psia)	Delivery Loop 'A'	(gpm) Loop 'B'	Used for non-LOCA transients, 5% pump degradation.
		1390	8	8	
		1315	69	71	
		1215	121	126	
		1115	162	169	
		1015	197	206	
		915	228	239	
		815	255	269	
		715	281	296	
		615	305	322	
		515	328	346	
		415	350	369	
		315	370	391	
		215	390	412	
		115	409	432	
		15	427	452	
	Maximum SI delivery, 3 pumps operating, SGTR	Press (psig)	Loop A (gpm)	Loop B (gpm)	The KYPIPE model assumes no pump degradation. Loop A and B pressures are set equal. Used for SGTR.
		1375	76	84	
		1300	128	141	
		1200	180	198	
		1100	221	245	
		1000	258	285	
		900	290	321	
		800	320	354	
		700	348	385	
		600	374	413	
		500	398	440	
		400	421	466	
		300	443	490	
		200	464	514	
		100	485	536	
		0	504	558	
7.3	**Accumulators**				
	Number of accumulators	2			
	Total volume, each, ft^3	1750			
	Liquid volume, ft^3 - min/max	1111/1139			
	Liquid volume, ft^3 - Best Estimate	1140			
	Initial pressure, psig - Minimum / Maximum	700/790			

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Initial temperature, F	105	LBLOCA
	Boron concentration, ppm (min/max)	2100/2600	Note - EQ analyses use a maximum concentration of 3000 ppm
7.4	**RWST**		
	RWST Temperature, min / max, degrees F	60 / 80	Upper limit increased to 104
	Minimum RWST volume, gal	300,000	
	RWST boron concentration, ppm (min/max)	2300/2600	Note - EQ analyses use a maximum concentration of 3000 ppm
8.0	**Containment**		
	Initial containment pressure, psia	min - 14.5 max - 16.7	Minimum is used for LOCA analysis. Maximum is used for the containment integrity cases (SLB).
	Initial containment temperature (LOCA/SLB) degrees F	90/120	LOCA temperature lower for PCT calculations. SLB higher for containment integrity
	Initial relative humidity, %	20	
	SW temperature min/max, degrees F	30/80	
	Maximum containment leakage, wt%/day	0.2	
8.1	**Containment Heat Sinks**		
	Listing of Passive Heat Sinks, quantities, materials, and configurations	see Engineering	
8.2	**Densities, Thermal Conductivities and Heat Capacities of Heat Sinks**		
	Insulation density, conductivity, capacity	3.7 lbm/ft^3 0.0208 BTU/hr F ft 1.11 BTU/ft^3 F	
	Concrete density, conductivity, capacity	150 lbm/ft^3 0.81 BTU/hrFft 31.5 BTU/ft^3 F	note: minimum conductivity corresponds to maximum density, and maximum conductivity corresponds to minimum density.
	Steel density, conductivity, capacity	490 lbm/ft^3 28 BTU/hrFft 54.4 BTU/ft^3 F	
	Stainless steel density, conductivity, capacity	496 lbm/ft^3 15 BTU/hrFft 54.6 BTU/ft^3 F	
	Containment free volume, min / max, cu. ft.	1,000,000 / 1,066,000	
	Ground Temperature (degrees F)	55	below grade temperature
	Outside Air Temperature, min / max, degrees F	-10 / 100	
	HTC for outside surfaces	1.65 BTU/hr ft^2 degrees F	

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Containment fan cooler performance	Temp (deg F) / Min / Max (X106BTU/hr) 120 / 2.05 / 4.55 220 / 35.1 / 99.2 240 / 40.8 / 113.8 260 / 46.8 / 129.3 280 / 52.9 / 145.5 286 / 54.7 / 150.4	
	Containment spray flow , min / max, each, gpm	1300 / 1800	
8.3	**Delays for CRFCs and Spray Pumps**		
	CRFC delay, offsite power available, seconds	34	includes 2.0 sec SI delay
	CRFC delay, offsite power not available, seconds	44	includes 2.0 sec SI delay
	Containment Spray, 1300 gpm each pump, maximum delay, sec	28.5 - one pump 26.8 - two pumps	This delay is from the time Containment Hi-Hi setpoint is reached. It includes instrument delay and spray line fill time.
	Containment Spray, 1800 gpm each pump, minimum delay, sec	9 / (14 w LOOP)	This delay is from the time of break.
	Containment Design pressure, psig	60	
	Distance Basement floor to Springline, feet	95	
	Distance Springline to top of dome, feet	52.5	
8.4	**Containment Sump**		
	Minimum wt% of NaOH Tank	30	
9.0	**Control Systems (Reactor, FW, Przr Level, Turbine, AFW)**		
	Tavg versus power	N/A	Tavg ramps linearly from 547 degrees F at 0% power to 561 degrees F at 100% power
	Pressurizer pressure and level algorithms	N/A	Pressurizer pressure setpoint is constant at 2235 psig . Pressurizer level ramps from 35% to 50% for 0 to 100% power (547 - 561 degrees F).
	SG secondary level algorithm	N/A	Level remains constant at 52% to 100% power. (Power from turbine 1st stage press.)
10.0	**Safety System Setpoints**		
10.1	**Reactor Protection System**		
10.1.1	**Power range high neutron flux, high setting**		
	nominal	1.08	
	accident analysis	1.18	
	delay time, sec	0.5	
10.1.2	**Power range high neutron flux, low setting**		
	nominal	0.240	
	accident analysis	0.350	

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	delay time, sec	0.5	
10.1.3	Overtemperature delta T		
	nominal	Variable	
	accident analysis	Variable	
	delay time, sec	6.0	Total delay time - from the time the temperature difference in the coolant loops exceeds the trip setpoint until the rods are free to fall
10.1.4	Overpower delta T		
	nominal	Variable	
	accident analysis	Variable	Not explicitly modelled in safety analysis
	delay time, sec	2.0	
10.1.5	High pressurizer pressure		
	nominal, psig	2377	
	accident analysis, psia	2410	
	delay time, sec	2.0	
10.1.6	Low pressurizer pressure		
	nominal, psig	1873	
	accident analysis, psia	1775 (non-LOCA) 1730 (LOCA) 1905 (SGTR)	
	delay time, sec	2.0	
10.1.7	Low reactor coolant flow		
	nominal	91% of normal indicated flow	
	accident analysis	87% per loop	
	delay time, sec	1.0	
10.1.8	Low-low SG level		
	nominal	17% of the narrow range level span	While trip setpoint could be as low as 16%, AFW initiation limits to 17%
	accident analysis	0% of narrow range level span	
	delay time, sec	2.0	
10.1.9	Turbine Trip (low fluid oil pressure)		
	nominal, psig	45	
	accident analysis	N/A	Not explicitly modeled in safety analysis
	delay time, sec	2.0	

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
10.1.10	**Undervoltage**		
	nominal, V	3150	
	accident analysis	-	Safety analysis assumes RCCAs are released 1.5 sec. after setpoint is released.
	delay time. sec	1.5	
10.1.11	**Underfrequency**		
	nominal, Hz	57.7	
	accident analysis	57.0	Analysis is performed but not explicitly modeled in safety analysis.
	delay time	1.2	Safety analysis assumes RCCAs are released 1.2 sec after setpoint is reached.
10.1.12	**Intermediate range**		
	nominal, RTP	0.25	May fluctuate due to core flux
	safety analysis, RTP	N/A	Not explicitly modeled in safety analysis
	delay time, sec	N/A	
10.1.13	**Source Range**		
	nominal, cps	1.0E+5	
	accident analysis, cps	1.0E+5	
	delay time, sec	2.0	
10.1.14	**High Pressurizer level**		
	nominal	0.90	
	accident analysis	0.938	
	delay time, sec	2.0	
10.2	**Engineered Safety Features Actuation System**		
10.2.1	**Safety Injection System**		
10.2.1.1	**High containment pressure**		
	Nominal setpoint, psig	4.0	
	Accident Analysis setpoint, psig	6.0 *	*only modeled in accident analysis for start of containment fan coolers.
	Delay time, sec	34 44 w/ LOOP	Time delays are for start of containment fan coolers.
10.2.1.2	**Low pressurizer pressure**		
	Nominal setpoint, psig	1750	

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Accident Analysis setpoint, psia	1785, SGTR 1730, non-LOCA 1715, LOCA	
	Delay time, sec	2.0	
10.2.1.3	**Low steam line pressure**		
	Nominal setpoint, psig	514	
	Accident Analysis setpoint, psig	372.7	See Engineering
	Delay time, sec	2.0	See Engineering
10.2.2	**Containment Spray**		
	Nominal Setpoint, psig	28	
	Accident analysis setpoint, psig	32.5	See Engineering
	Delay time, sec	28.5	Delay time includes time to fill lines. See Engineering
10.2.3	**AFW System**		
	Low-low steam generator water level		
	Nominal Setpoint	17 % of narrow range instrument span each steam generator	
	Accident analysis setpoint	0 % of narrow range instrument span each steam generator	A positive 11% error has been included to account for the SG level measurement system at a containment temperature of 286 F
	Delay time, sec	2.0	
10.2.4	**Steam Line Isolation**		
10.2.4.1	**High containment pressure**		
	Nominal Setpoint, psig	18	
	Accident analysis setpoint	N/A	Not explicitly modeled
	Delay time	N/A	Not explicitly modeled
10.2.4.2	**High steam flow, coincident with low Tavg and SI**		
	Nominal Setpoint	0.4E6 lb/hr equivalent steam flow at 755 psig and Tavg < 545 F	Note: flow setpoint is below nominal full power flow and therefore this portion of logic is made up at power
	Accident analysis setpoint	N/A	Not explicitly modeled
	Delay time	N/A	Not explicitly modeled. Steam line isolation is assumed concurrent with SI (i.e. 2 s delay + 5 s valve stroke)
10.2.4.3	**High-high steam flow, coincident SI**		
	Nominal Setpoint	3.6E6 lb/hr equivalent steam flow at 755 psig	
	Accident analysis setpoint	N/A	Not explicitly modeled

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Delay time	N/A	Not explicitly modeled. Steam line isolation is assumed concurrent with SI (i.e. 2 s delay + 5 s valve stroke)
10.2.5	**Feedwater isolation**		
10.2.5.1	**High steam generator water level**		
	Nominal Setpoint	85% of the narrow range instrument span each SG	
	Accident analysis setpoint	100% of the narrow range instrument span each SG	
	Delay time	2.0	Instrument loop only
11.0	**BWI Steam Generators**		
	Heat load per SG, BTU/hr	2,602,000,000	
	Primary flow per SG, Klb/hr	Plugging% Flow Klb/hr 0 34950 5 34630 10 34280 15 33850	Design flows at T_{avg} = 573.5 F
	Steam flow per SG, lb/hr (clean, unplugged)	3,264,358 at 877 psia	Conditions for T_{avg} = 573.5 F
	Secondary design pressure, psig	1085	
	Secondary design temperature, F	556	
	Maximum moisture carryover, %	0.10	
	Narrow range level tap locations, inches above TS secondary face	$386^{3}/_{8}$ / $529^{3}/_{8}$	
	Wide range level tap locations, inches above TS secondary face	$8^{3}/_{4}$ / $529^{3}/_{8}$	
11.1	**SG Pressure Drops**		
	Secondary nozzle to nozzle dP @ full power, psi	14.7	Value is total static pressure drop.
	Secondary nozzle to nozzle dP @ full power, psi	7.5	Pressure drop from top of U-bend to outlet.
	Primary nozzle to nozzle unrecoverable pressure drop vs. plugging, psi	Plugging% Δp psi 0 31.01 5 33.27 10 35.82 15 38.72	See associated flows for % plugging.
11.2	**SG Tubes**		
	No. of tubes per SG	4765	
	Tube OD, inches	0.750	
	Tube average wall thickness, inches	0.043	
	Maximum tube length, ft	70.200	Includes length in tubesheet (2x25.625")
	Minimum tube length, ft	55.925	Includes length in tubesheet (2x25.625")
	Average length, ft	61.988	Includes length in tubesheet (2x25.625")

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Minimum U-bend radius, inches	3.979	Note: this is not the bend radius for the shortest tube.
	Maximum U-bend radius, inches	54.007	
	U-bend radius of shortest tube(s), inches	4.044	
	Average U-bend radius, inches	24.51	
	Tube straight length (one side) above secondary face, inches (min/max/average)	$303^{9}/_{16}$ / $310^{3}/_{4}$ / 308.182	
	Secondary heat transfer area, ft^2 per SG	54,001	
	Primary heat transfer area, ft^2 per SG	47,809	
	Overall bundle height, ft above secondary face of TS	30.427	
	Tube material	SB-163 Alloy N06690	
	SG Tube Material Thermal Conductivity, BTU-in/hr-ft^2-F	Temp F / Conductivity 200 / 93 300 / 100 400 / 107 500 / 114.5 600 / 122	
	SG Tube Material Specific Heat, BTU/lb-F	Temp F / Conductivity 200 / 0.112 300 / 0.1155 400 / 0.119 500 / 0.1225 600 / 0.126	
	Distance from top of tube bundle to 33% NRL, ft	5.703	
11.3	**SG Volumes**		
11.3.1	**SG Secondary Side Volumes**		
	Secondary volume, ft^3 (total)	4512.7	
	Secondary volume up to lower NRL tap, ft^3	1893.2	
	Secondary volume up to upper NRL tap, ft^3	3460.4	
11.3.2	**Riser Volumes**		
	Secondary side bundle volume (TS to top of U-bend inside shroud), ft^3	1281.8	
	Secondary riser volume, top of U-bend to spill-over point, ft^3	507.0	Equivalent to LOFTRAN riser volume.
11.3.3	**Downcomer Volumes**		
	Downcomer volume, top of TS to top of U-bend, ft^3	359.6	
	Downcomer volume, top of U-bend to spill-over point, ft^3	1437.3	
11.3.4	**SG Primary Side Volumes**		
	Inlet plenum per SG, ft^3	129.65	
	Outlet plenum per SG, ft^3	129.65	

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	Tube primary volume per SG, ft^3	710.3	
	Primary total volume per SG, ft^3	969.6	
	Circulation ratio (100% power, clean, unplugged)	5.39	Circulation ratio = bundle flow / steam flow. Assumes 40,000 lbm/hr blowdown.
	Tubesheet thickness, inches	25.625	Includes cladding.
11.4	**SG Primary Side Dimensions**		
	Primary head radius, inches	58.375	Radius to clad surface.
	Divider plate thickness, inches	1.875	
	Inlet and outlet nozzle, inside diameter cylindrical section, inches	31.200	
	Nozzle divergence angle, degrees	11°30′	
	Nozzle inside diameter at plenum, inches	37.0	
	Nozzle lengths, inches	cylindrical section 8.75 conical section 13.0 total length 21.75	
	Heigth from SG primary head bottom (outside) to top of TS, inches	$90^9/_{16}$	
	Distance tube sheet primary face to hot leg centerline, ft	6.654	
11.5	**SG Secondary Side Dimensions**		
	Lower shell inside diameter, inches	122	
	Lower shell thickness, inches	2.875	
	Tube shroud inside diameter, inches	114	
	Distance top of tube bundle to top of steam nozzle, inches	298.5	
	Steam nozzle flow restricter area, ft^2	1.4	
	Distance secondary face of TS to centerline of feedwater nozzle, inches	$407^7/_8$	
	Distance secondary face of TS to centerline of feed ring, inches	374	
	Cross-sectional area of tube bundle, ft^2	41.64	This value is total area inside shroud.
	Distance top of tube bundle to spill-over point, inches	178.0	This value is equivalent to the riser height for the OSG.
	Primary side roughness, micro-inches	Nozzles, head 60 Tubes 60	Values given are conservative assumptions.
11.6	**SG Secondary Side Water Masses**		
	Secondary water inventory, 100% power, T_{avg} = 573.5, no plugging, lbm	86,259 liquid 5,286 steam	Best estimate value.
	Secondary water inventory, 100% power, T_{avg} = 559, no plugging, lbm	85,547 liquid 4,675 steam	Best estimate value.
11.7	**SG Primary Side Head Loss Coefficients**		

Table 1: UFSAR Chapter 15 Analysis Setpoints and Input Parameters

Item #	Item/Name	Value	Remarks:
	SG inlet nozzle/plenum loss coefficient, ft/gpm^2	1.01E-09 for ID = 31.2"	
	SG outlet nozzle/plenum loss coefficient, ft/gpm^2	3.31E-10 for ID = 31.2"	
	SG tubing loss coefficient, ft/gpm^2	9.62E-09 for 0% plugging 1.32E-08 for 15% plugging	For tube ID = 0.664", $A_{0\%}$ = 11.458 ft^2, $A_{15\%}$ = 9.739 ft^2. Plugging is assumed to be uniform.
	SG tubing loss coefficient, straight section (in), ft/gpm^2	4.19E-09 for 0% plugging 5.73E-09 for 15% plugging	For tube ID = 0.664", $A_{0\%}$ = 11.458 ft^2, $A_{15\%}$ = 9.739 ft^2. Plugging is assumed to be uniform.
	SG tubing loss coefficient, U-bend section, ft/gpm^2	1.02E-09 for 0% plugging 1.40E-09 for 15% plugging	For tube ID = 0.664", $A_{0\%}$ = 11.458 ft^2, $A_{15\%}$ = 9.739 ft^2. Plugging is assumed to be uniform.
	SG tubing loss coefficient, straight section (out), ft/gpm^2	4.41E-09 for 0% plugging 6.08E-09 for 15% plugging	For tube ID = 0.664", $A_{0\%}$ = 11.458 ft^2, $A_{15\%}$ = 9.739 ft^2. Plugging is assumed to be uniform.