CHEMICAL AND VOLUME CONTROL SYSTEM CODE REQUIREMENTS[1]

Regenerative heat exchanger	ASME III [2], Class C
Letdown heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Mixed bed demineralizers	ASME III, Class C
Reactor coolant filter	ASME III, Class C
Volume control tank	ASME III, Class C
Seal water heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Excess letdown heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Cation bed demineralizer	ASME III, Class C
Seal water injection filters	ASME III, Class C
Boric acid filter	ASME III, Class C
Evaporator condensate demineralizers	ASME III, Class C
Concentrates filter	ASME III, Class C
Evaporator feed ion exchangers	ASME III, Class C
Ion exchanger filter	ASME III, Class C
Condensate filter	ASME III, Class C
Piping and valves	USAS B31.1[3] , ASME III Appendix F [4]

[1] Repairs and replacements for pressure retaining components within the code boundary, and their supports, are conducted in accordance with ASME Section XI.
[2] ASME III - American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section III, Nuclear Vessels.
[3] USAS B31.1 - Code for Pressure Piping, USA Standards, and special nuclear cases where applicable
[4] The evaluation criteria of ASME III Appendix F (faulted conditions) is applicable to: 1) RCP seal leak –off return line penetration piping between inside and outside containment isolation valves (CPN 37) and 2) Piping from the RCP seal bypass line check valves to the normally closed QRV-150 valve in the common discharge header.

CHEMICAL AND VOLUME CONTROL SYSTEM DESIGN PARAMETERS

General	
Original plant design life, years	40 [1]
Seal water supply flow rate:	
Normal, gpm	32
Maximum, gpm	Note [2]
Seal water return flow rate:	
Normal, gpm	12
Maximum gpm	Note (1)
Letdown flow:	
Normal, gpm	75
Minimum, gpm	45
Maximum, gpm	120
Charging flow:	
Normal, gpm	132 [3]
Minimum, gpm	25
Maximum, gpm	150 (3)
Temperature of letdown reactor coolant entering system, °F	Unit 1: 518.9 to 543.5 Unit 2: 511.4 to 547.6
Centrifugal pump miniflow, gpm	60 (each)
Temperature of charging flow directed to Reactor Coolant System, °F	495
Temperature of effluent directed to holdup tanks, °F	127

(volumetric flow rates in gpm are based upon 130°F and 2350 psig)

[1] Licensed life is 60 years in accordance with Chapter 15 of the UFSAR.
[2] This quantity is calculated, see Technical Specification #3.4.6.2e.
[3] Flow measured at QFI-200 (common discharge before RCP seal injection)

Principal Component Data Summary

Regenerative Heat Exchanger	
Number	1 (per unit)
Heat transfer rate at design conditions, Btu/hr	$10.3x10^6$
Shell Side	
Design pressure, psig	2485
Design temperature, °F	650
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal (Design)	**Maximum Purification**	**Heatup**
Flow, lb/hr	37,050	59,280	59,280
Inlet temperature, °F	545	545	547
Outlet temperature, °F	290	287	366

Principal Component Data Summary

Regenerative Heat Exchanger (cont)	
Tube Side	
Design pressure, psig	2735
Design temperature, °F	650
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal (Design)	**Maximum Purification**	**Heatup**
Flow, lb/hr	27,170	49,400	29,640
Inlet temperature, °F	130	130	130
Outlet temperature, °F	495	461	521

Principal Component Data Summary

Letdown Orifice	
Design pressure, psig	2485
Design temperature, °F	650
Normal operating inlet pressure, psig	2235
Normal operating temperature, °F	290
Material of construction	Austenitic stainless steel

	45 gpm	**75 gpm**
Number	1 (per unit)	2 (per unit)
Design flow, lb/hr	22,230	37,050
Differential pressure at design flow, psig	1900	1900

Principal Component Data Summary

Letdown Heat Exchanger	
Number	1 (per unit)
Heat transfer rate at design conditions (heatup), Btu/hr	14.8 x 106
Shell Side	
Design pressure, psig	150
Design temperature, °F	250
Fluid	Component cooling water[1]
Material of construction	Carbon steel

	Normal	**Heatup (Design)**	**Maximum Purification**
Flow, lb/hr	203,000	492,000	510,926
Inlet temperature, °F	95	95	95
Outlet temperature, °F	125	125	125

[1] The plant has been evaluated for a CCW Hx outlet temperature range of 60°F to 105°F. It is acceptable for the CCW temperature to rise to 120°F during cooldown and post-LOCA conditions. See Section 9.2.2.

Principal Component Data Summary

Letdown Heat Exchanger	
Tube Side	
Design pressure, psig	600
Design temperature, °F	400
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal	**Heatup (Design)**	**Maximum Purification**
Flow, lb/hr	37,050	59,280	59,280
Inlet temperature, °F	290	380 (max.)	380 (max.)
Outlet temperature, °F	127	127	127

Principal Component Data Summary

Mixed Bed Demineralizers	
Number	2 (per unit)
Type	Flushable
Vessel design pressure:	
Internal, psig	200
External, psig	15
Vessel design temperature, °F	250
Resin volume, each, ft^3	30
Vessel volume, each, ft^3	43
Design flow rate, gpm	120
Minimum decontamination factor as measured by I-131 removal[2]	10
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Resin type	Cation and anion
Material of construction	Austenitic stainless steel

[2] Assuming one per-cent of fuel containing clad defects.

Principal Component Data Summary

Reactor Coolant Filter General:	
Number	1 (per unit)
Type	Disposable Cartridge
Flow rate,	
Nominal, gpm	120
Maximum, gpm	150
Vessel:	
Design pressure, psi	200
Design temperature, °F	250
Material of construction	Austenitic stainless steel
Cartridge:	
Maximum Design ΔPressure, psi	75
Design Temperature °F	180
Absolute Retention Size, micron	$\leq$6

Principal Component Data Summary

Volume Control Tank	
Number	1 (per unit)
Internal volume, ft^3	400
Design pressure:	
Internal, psig	75
External, psig	15
Design temperature, °F	250
Operating pressure range, psig	0-40
Spray nozzle flow (maximum), gpm	120
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Centrifugal Charging Pumps	
Number	2 (per unit)
Type	Horizontal centrifugal
Design pressure, psig	2800
Design temperature, °F	300
Shutoff head, psi	2530
Normal suction temperature, °F	115
Design flow rate, gpm	150
Design head, ft.	5800
Available NPSH, ft.	30
Material	Austenitic stainless steel

Principal Component Data Summary

Positive Displacement Charging Pump	
Number	1 (per unit)
Type	Positive displacement with variable speed drive
Design head, ft.	5800
Design temperature, °F	250
Design pressure, psig	3200
Design flow rate*, gpm	98
Available net positive suction head, ft.	40
Suction temperature, °F	127
Discharge pressure at 130°F, psig	2500
Material of construction	Austenitic stainless steel
Hydrostatic test pressure, psig	3125

* At 130°F, 2500 psig

Principal Component Data Summary

Chemical Mixing Tank	
Number	1 (per unit)
Capacity, gal	5
Design pressure, psig	150
Design temperature, °F	200
Normal operating temperature	Ambient
Material of construction	Austenitic stainless steel
Boric Acid Tank	
Number	3 (shared)
Capacity (each), gal	11,000
Design pressure	Atmospheric
Design temperature, °F	250
Normal operating temperature, °F	110-120
Material of construction	Austenitic stainless steel
Boric Acid Tank Electric Immersion Heater	
Number (two per tank)	6
Heat transfer rate, each, kW	10
Material of construction	Austenitic stainless steel sheath

Principal Component Data Summary

Batching Tank and Batching Tank Heater Jacket	
Number	1 (shared)
Type	Cylindrical with jacketed base
Capacity, gal	800
Design pressure	Atmospheric
Design temperature, °F	300
Steam temperature, °F	250
Steam pressure, psig	15
Initial ambient temperature	32
Final fluid temperature, °F	120
Heatup time, hrs	3 (approximately)
Tank material of construction	Austenitic stainless steel
Jacket material of construction	Carbon steel
Batching Tank Agitator	
Number	1 (shared)
Fluid handled, boric acid, wt%	12
Service	Continuous
Operating temperature, °F	120
Operating pressure	Atmospheric
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Excess Letdown Heat Exchanger	
Number	1 (per unit)
Heat transfer rate at design conditions, Btu/hr	4.61×10^6

	Shell Side	**Tube Side**
Design pressure, psig	150	2485
Design temperature, °F	250	650
Design flow rate, lb/hr	115,000	12,380
Inlet temperature, °F	95	545
Outlet temperature, °F	135	195
Fluid	Component cooling water[3]	Borated reactor coolant
Material of construction	Carbon steel	Austenitic stainless steel

[3] The plant has been evaluated for a CCW Hx outlet temperature range of 60°F to 105°F. It is acceptable for the CCW temperature to rise to 120°F during cooldown and post-LOCA conditions. See Section 9.2.2.

Principal Component Data Summary

Seal Water Heat Exchanger	
Number	1 (per unit)
Heat transfer rate at design conditions, Btu/hr	2.49 x10^6

	Shell Side	**Tube Side**
Design pressure, psig	150	150
Design temperature, °F	250	250
Design flow, lb/hr	99,500	160,600
Normal operating flow, lb/hr (includes miniflow)	99,500	36,000
Design operating inlet temperature, °F	95	143
Design operating outlet temperature, °F	120	127
Fluid	Component cooling water[4]	Borated reactor coolant
Material of construction	Carbon steel	Austenitic stainless steel

[4] The plant has been evaluated for a CCW Hx outlet temperature range of 60°F to 105°F. It is acceptable for the CCW temperature to rise to 120°F during cooldown and post-LOCA conditions. See Section 9.2.2.

Principal Component Data Summary

Seal Water Filter	
General:	
Number	1 (per unit)
Type	Disposal Cartridge
Flow Rates,	
Nominal, gpm	12
Maximum, gpm	325
Vessel:	
Design pressure, psi	200
Design Temperature, °F	250
Material of construction	Austenitic stainless steel
Cartridge:	
Maximum Design ΔPressure, psi	80
Design Temperature, °F	200
Nominal Retention Size, micron	25

Principal Component Data Summary

Boric Acid Filter General:	
Number	1 (per unit)
Type	Disposable Cartridge
Design Flow Rate, gpm	150
Vessel:	
Design pressure, psi	200
Design Temperature, °F	250
Material of construction	Austenitic stainless steel
Cartridge:	
Maximum Design, ΔPressure, psi	150
Design Temperature, °F	250
Nominal Retention Size, micron	20

Principal Component Data Summary

Boric Acid Transfer Pump	
Number	4 (shared)
Type	Two-speed horizontal centrifugal
Design flow rate, each, gpm	75 at high speed
Design pressure, psig	150
Design discharge head, ft.	235
Design temperature, °F	250
Temperature of pumped fluid, °F	120
NPSHA at 135°F and 87.4 gpm, ft	11.75
NPSHR at 135°F and 87.4 gpm, ft..	7.24
Material of construction	Austenitic stainless steel
Boric Acid Blender	
Number	1 (per unit)
Design pressure, psig	150
Design temperature, °F	250
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Cation Bed Demineralizer	
Number	1 (per unit)
Type	Flushable
Vessel design pressure:	
Internal, psig	200
External, psig	15
Vessel design temperature, °F	250
Resin volume, ft^3	20
Vessel volume, ft^3	30
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Design flow, gpm	72
Resin type	Cation
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Chemical Mixing Tank Orifice	
Number	1 (per unit)
Design pressure, psig	150
Design temperature, °F	200
Design flow, gpm	2
Material of construction	Austenitic stainless steel
Boric Acid Tank Orifice	
Number	3 (shared)
Design pressure, psig	150
Design temperature, °F	200
Design flow, gpm	3
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Deborating Demineralizers	
Number	2 (per unit)
Type	Fixed bed
Vessel design pressure, psig	
Internal External	200 15
Vessel design temperature, °F	250
Resin Volume, ft^3	43
Vessel volume, ft^3	56
Normal flow, gpm	120
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Resin type	Anion
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Seal Injection Filters	
General:	
Number	2 (per unit)
Type	Disposal Cartridge
Flow Rates,	
Nominal, gpm	32
Maximum, gpm	80
Vessel:	
Design pressure, psig	2735
Design temperature, °F	200
Material of construction	Austenitic stainless steel Cartridge:
Cartridge:	
Maximum Design ΔPressure, psi	75
Design Temperature, °F	180
Absolute Retention Size, micron	≤ 6
No. 1 Seal By-Pass Orifice	
Number	4 (per unit)
Design pressure, psig	2485
Design temperature, °F	250
Design flow, gpm	1.0
Differential pressure at design flow, psi	300

Principal Component Data Summary

Holdup Tanks	
Number	5 (shared)*
Type	Horizontal, cylindrical
Capacity, each tank, gal.	64,000
Design pressure, psig	15
Normal operating pressure, psig	3
Design temperature, °F	200
Normal operating Temperature, °F	130
Material of construction	Austenitic stainless steel

* Two pairs of tanks plus single tank.

Principal Component Data Summary

Boric Acid Reserve Tank	
Number	1 (shared)
Type	Horizontal, cylindrical
Capacity, gal.	64,000
Design pressure, psig	15
Normal operating pressure, psig	2
Design Temperature, °F	200
Normal Operating Temperature, °F	115
Material of construction	Austenitic stainless steel
Recirculation Pump	
Number	1 (shared)
Type	Centrifugal
Design flow, gpm	500
Available NPSH at 130°F, ft.	15
Design head, ft.	100
Design pressure, psig	150
Design temperature, °F	200
Normal operating temperature, °F	150
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Boric Acid Evaporator Feed Pumps	
Number	3 (shared)
Type	Canned
Design flow, gpm	30
Design head (TDH), ft.	320
Design pressure, psig	150
Design temperature, °F	200
Normal fluid temperature, °F	115
Material of construction	Austenitic stainless steel
NPSH at 115°F, ft.	15
Boric Acid Evaporator Package	
Number	1 (other used for radwaste)
Design flow/unit; gas stripper feed, gpm	30
Evaporator condensate, gpm	30
Evaporator concentrates (batch flow), gpm	45
Decontamination factors (design):	
Gas stripper	Approx. 10^5 (for gas)
Evaporator	Approx. 10^6 (for liquid)
Concentration of concentrates, boric acid, wt%	4
Concentration of distillate	<10 ppm boron as H_3BO_3 Conductivity 2.0 umhos/cm
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Evaporator Condensate Demineralizers	
Number	1 (other used for radwaste)
Type	Fixed bed
Design temperature, °F	250
Design pressure:	
Internal, psig	200
External, psig	15
Resin volume, each, ft^3	20
Vessel volume, each, ft^3	30
Design flow, gpm	72
Normal operating pressure, psig	50
Normal operating temperature, °F	130
Resin type (south)	Anion
Resin type (north)	As required
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Monitor Tanks	
Number	2 (shared) (other 2 shared for radwaste)
Type	Diaphragm, Cylindrical
Volume, each, gal.	21,600
Design pressure	Atmospheric
Design temperature, °F	150
Normal operating temperature, °F	120
Material of construction	Stainless steel
Monitor Tank Pumps	
Number	2 (shared)
Type	Centrifugal
Design flow, gpm	150
Design head, ft.	200
Design pressure, psig	150
Design temperature, °F	200
Material of construction	Austenitic stainless steel
NPSH, ft	15

Principal Component Data Summary

Evaporator Feed Ion Exchangers	
Number	4 (shared)
Type	Flushable
Design temperature, °F	250
Design pressure:	
Internal, psig	200
External, psig	15
Resin volume, each, ft^3	20 (2 of 4 units), 27 (2 of 4 units)
Vessel volume, each, ft^3	30 (2 of 4 units)
Normal flow, gpm	30
Normal operating temperature, °F	130
Normal operating pressure, Psig	75
Resin type	Cation (2 of 4 units), Mixed Bed (2 of 4 units)
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Concentrates Filter General:	
Number	2 (shared)
Type	Disposable Cartridge
Design Flow Rate, gpm	40
Vessel:	
Design pressure, psi	200
Design Temperature, °F	250
Material of construction	Austenitic stainless steel
Cartridge:	
Maximum Design, ΔPressure, psi	75
Design Temperature, °F	200
Nominal Retention Size, micron	25
or	
Absolute Retention Size, micron	0.1 to 25

Principal Component Data Summary

Concentrates Holding Tank	
Number	1 (shared)
Type	Cylindrical, heated
Volume, gal.	2,000
Design Pressure	Atmospheric
Design temperature, °F	250
Normal operating temperature, °F	150
Material of construction	Austenitic stainless steel
Concentrates Holding Tank Electric Heater	
Number	1 (shared)
Heat transfer rate, KW	6.0
Material of construction	Austenitic stainless steel
Concentrates Holding Tank Transfer Pump	
Number	2 (shared)
Type	Centrifugal can
Design flow rate, gpm	40
Design head, ft.	150
Design temperature, °F	250
Design pressure, psig	150
Available NPSH at 180°F, ft.	10
Material of construction	Austenitic stainless steel

Principal Component Data Summary

Ion Exchanger Filter	
General:	
Number	2 (shared)
Type	Disposable Cartridge
Design Flow Rate, gpm	35
Vessel:	
Design pressure, psig	200
Design temperature, °F	250
Material of construction	Austenitic stainless steel
Cartridge:	
Maximum Design ΔPressure, psi	75
Design Temperature, °F	200
Nominal Retention Size, micron	25
or	
Absolute Retention Size, micron	0.1 to 25

Principal Component Data Summary

Condensates Filter	
General:	
Number	2 (shared)
Type	Disposable Cartridge
Design Flow Rate, gpm	35
Vessel:	
Design pressure, psi	200
Design Temperature, °F	250
Material of construction	Austenitic stainless steel
Cartridge:	
Maximum Design ΔPressure, psi	80
Design Temperature, °F	200
Nominal Retention Size, micron	25

Principal Component Data Summary

Relief Valves	No.	Fluid Discharged	Fluid Inlet Temperature	Set Pressure	Back Pressure psig		Capacity gpm
			°F	psig	Constant	Buildup	
Letdown line (HP)	1	Water-Steam Mixture	385 (max.)	600	3	50	98,000 lb/hr
Seal water return line	1	Water	150	150	3	50	225
Charging pump's discharge	1	Water	130	2735	15	75	100
Letdown line (LP)	1	Water	127	200	15	12	200
Volume control tank	1	Hydrogen, nitrogen or water	130	75	3	12	350
Holdup tanks	3	Nitrogen water	130	12	3	3	235
Boric Acid Reserve Tank	1	Nitrogen Water	115	12	3	3	187

FAILURE ANALYSIS OF THE CHEMICAL AND VOLUME CONTROL SYSTEM

Component		Failure	Comments and Consequences
a.	Letdown Line	Rupture in the line inside the reactor containment	The remote air-operated valve located near the main coolant loop is closed on low pressurizer level to prevent supplementary loss of coolant through the letdown line rupture. The containment isolation valves in the letdown line are automatically closed by the containment isolation signal initiated by the concurrent loss-of-coolant accident. The closure of these valves prevents any leakage of the reactor containment atmosphere outside the reactor containment.
b.	Normal and alternate Charging Line	See above	The check valves located near the main coolant loops prevent supplementary loss of coolant through the line rupture. The check valve located at the boundary of the reactor containment prevents any leakage of the reactor containment atmosphere outside the reactor containment.
c.	Seal Water Return Line	See above	The motor-operated isolation valves located inside and outside the containment are manually closed or are automatically closed by the containment isolation signal initiated by the concurrent loss-of-coolant accident. The closure of that valve prevents any leakage of the reactor containment atmosphere outside the reactor containment.
d.	Letdown Line	Rupture in the line outside the containment	Any break between containment and the letdown heat exchanger would potentially result in flashing hot letdown fluid and would be identified by lo flow in the letdown line and other system indications. The increase in letdown flow caused by a break downstream of the letdown flow indicator would be matched by an automatic increase in the charging flow and a HI Letdown Flow Alarm. An operational level in the pressurizer would, therefore, be maintained. Ultimately, the operator would be alerted by a Lo Lo level alarm in the volume control tanks. (Other indications would be an increased charging flow and falling volume control tank level. Also, the area monitors in the auxiliary building would detect any increase in activity). By observing the flow meter on the letdown line, the operator could detect the increase in flow, depending on the location of the break. The break could then be isolated by closing the redundant isolation valves in the letdown lines. Any spillage would be drained and collected in the Radioactive Waste Disposal System, while residual gases from any flashed coolant would be circulated through particulate filters before being discharged to the atmosphere through the plant vent.

RESIDUAL HEAT REMOVAL SYSTEM CODE REQUIREMENTS[1]

Residual Heat Exchangers (Tube Side)	ASME B&PV Code Section III, Class C
(Shell Side)	ASME B&PV Code Section VIII
Residual Heat Removal System Piping and Valves	USAS B31.1, 1967 Edition

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

RESIDUAL HEAT REMOVAL SYSTEM DESIGN PARAMETERS

General		
Original plant design life, years		40 [1]
Component cooling water supply temperature design, °F		95
Reactor coolant temperature at startup of decay heat removal °F		350
Time to cool Reactor Coolant System from 350°F to 140°F, hrs (design basis)		20
Refueling water storage temperature (minimum), °F		70
Decay heat generation at 20 hours after shutdown, Btu/hr		77×10^6
H_3BO_3 concentration in refueling water storage tanks, ppm boron		2400 to 2600 (Modes 1, 2, 3 & 4) 〈 2400 (Modes 5 & 6)
COMPONENTS		
Residual Heat Exchangers		
Number		2 (per unit)
Design heat transfer, Btu/hr		41.1×10^6
	Shell	Tube
Design pressure, psig	150	600
Design temperature, °F	200	400
Design flow rate, lb/hr	2.475×10^6	1.48×10^6
Design outlet temperature, °F	111.6	112.3
Design inlet temperature, °F	95	140
Fluid	Component cooling water [2]	Reactor coolant (borated demineralized water)
Material of construction	Carbon steel	Austenitic stainless steel

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

[2] The plant has been evaluated for a CCW Hx outlet temperature range of 60°F to 105°F. It is acceptable for the CCW temperature to rise to 120°F during cooldown and post-LOCA conditions. See Section 6.2.2.

RESIDUAL HEAT REMOVAL SYSTEM DESIGN PARAMETERS

Residual Heat Removal Pumps	
Number	2 (per unit)
Type	Vertical in-line, single stage, centrifugal
Design pressure, psig	600
Design temperature, °F	400
Shutoff head, psig	170
Design flow rate, gpm	3,000
Design head, ft.	350
Temperature of pump fluid, °F	70 - 350
Design Speed, rpm	1780
Motor Rating, HP	400
Normal fluid	Reactor coolant
Fluid during LOCA recirculation phase	Radioactive borated water with H_2 and NaOH in solution
Material of construction	Austenitic stainless steel

Piping and Valves	
Residual heat removal loop (piping and valves in isolated loop):	
Design pressure, psig	600
Design temperature, °F	400
Residual heat removal loop isolation valves and piping:	
Design pressure, psig	2,485
Design temperature, °F	650

RESIDUAL HEAT REMOVAL SYSTEM MALFUNCTION ANALYSIS

	Component	Malfunction	Comments and Consequences
1.	Residual heat removal pumps	Rupture of a pump casing	The casing and shell are designed for 600 psig and 400°F. The pump is protected from overpressurization by two normally closed valves in the pump suction line and by a relief line, containing a relief valve, back to the pressurizer relief tank. The pump is inspectable and is located in the auxiliary building protected against credible missiles. Rupture is considered unlikely but in any event the pump can be isolated.
2.	Residual heat Removal pump	Pump fails to start	One operating pump furnishes removal pump half of the flow required to meet design cooldown rate. Failure of the other pump to start increases the time necessary for plant cooldown.
3.	Residual heat removal pump	Manual valve on pump suction is closed	This is prevented by pre startup and operational check. The valve is normally locked or sealed open.
4.	Residual Heat removal pump	Stop valve on discharge line closed or check valve sticks closed.	Stop valve is locked or sealed open. Prestartup and operational checks confirm position of valves.
5.	Remote operated valves inside containment in pump suction line	Valve fails to open	In the improbable event that one of the remote operated valves on the suction line to the residual heat removal pumps is inoperable, an attempt will be made to open it manually. If this is impossible, the plant will be cooled to about 280 °F with steam dump from the team generators, and kept at that temperature for several weeks until decay heat could be matched by the letdown heat exchangers and by feed and bleed. Feed and bleed through the CVCS will done intermittently to prevent heat transfer through the regenerative heat exchanger. The pressurizer level will be to minimum during the bleed operation and to maximum during the feed operation. It is estimated that plant cooldown be accomplished within a month.
6.	Remote operated valves inside containment on pump discharge line	Valve fails to open	Pump discharge pressure gage shows pump shut-off head indicating no flow. An alternate return line may be opened and utilized to direct flow to the RCS.
7.	Residual heat exchanger	Tube or shell rupture	Rupture is considered unlikely, but in any event the faulty heat exchanger may be isolated.
8.	Residual heat exchanger vent or drain valve	Left open	This is prevented by prestartup operational checks.

SPENT FUEL POOL COOLING SYSTEM CODE REQUIREMENTS[1]

Spent Fuel Pool Heat Exchanger (tube side)	*ASME B&PV Code Section III, Class C*
(shell side)	*ASME B&PV Code Section VIII*
Spent Fuel Pool Filter	*ASME B&PV Code Section III, Class C*
Spent Fuel Pool Piping and Valves	*USAS B31.1*

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

SPENT FUEL POOL COOLING SYSTEM COMPONENT DESIGN DATA

System cooling capacity, Btu/hr	$29.8x10^6$
Spent fuel pool heat exchanger	
Number	2 (Shared)
Design heat transfer, Btu/hr	$14.9x10^6$

	Shell	Tube
Design pressure, psig	150	150
Design temperature, °F	200	200
Design flow rate, lb/hr	$1.49x10^6$	$1.14x10^6$
Design inlet temperature, °F	95	120
Design outlet temperature, °F	105	106.9
Fluid	Component Cooling Water[1]	Spent fuel pool (borated demineralized water)

Spent fuel pool pump	
Number	2 (shared)
Design pressure, psig	150
Design temperature, °F	200
Design flow rate, gpm	2300
Minimum developed head, ft.	125
Temperature of pumped fluid, °F,	80 - 180
Fluid	Spent fuel pool water(borated demin. water)
NPSH, ft. (available/required)	30/10
Material	Austenitic Stainless Steel

[1] The plant has been evaluated for a CCW Hx outlet temperature range of 60°F to 105°F. It is acceptable for the CCW temperature to rise to 120°F during cooldown and post-LOCA conditions. See Section 9.4.2.

SPENT FUEL POOL COOLING SYSTEM COMPONENT DESIGN DATA

Spent fuel pool skimmer pump	
Number	1 (Shared
Design pressure, psig	50
Design temperature, °F	200
Design flow rate, gpm	100
Minimum developed head, ft.	50
Temperature of pumped fluid, °F	75 - 150
Fluid	Spent fuel pool water
NPSH, ft. (available/required)	30/2
Material	Austenitic Stainless Steel
Refueling water purification pump	
Number	1
Design pressure, psig	600
Design temperature, °F	200
Design flow rate, gpm	Nom. 100, Max 150
Minimum developed head, ft.	130
Fluid	Refueling water
NPSH, Ft. (available/required)	@ 100gpm 30/5, @ 150 gpm 43/7
Material	Austenitic stainless steel
Spent fuel pool demineralizer	
Number	1 (Shared)
Type	Flushable
Vessel design pressure, psig	
Internal -	200
External -	15
Vessel design temperature, °F	250
Design flow rate, gpm Maximum	150
Normal flow, gpm	100, Max 150
Normal operating temperature, °F	120
Normal operating pressure, psig	Approx. 50
Resin type	anion and cation

SPENT FUEL POOL COOLING SYSTEM COMPONENT DESIGN DATA

Spent fuel pool filter	
Number	1 (Shared)
Type	Replaceable (Cellulose and/or glass resin)
Internal design pressure, psig	200
Design temperature, °F	250
Design flow rate, gpm	Nom. 100, Max. 150
Filtration requirement	98% retention of particles above 5 micron
Spent fuel pool skimmer filter	
Number	1 (Shared)
Type	Replaceable (Cellulose and/or glass resin)
Internal design pressure, psig	200
Design Temperature, oF	250
Design flow rate, gpm	150
Filtration requirement	98% retention of particles above 5 micron
Refueling water purification filter	
Number	1 (Shared)
Type	Replaceable (Cellulose and/or glass resin)
Internal design pressure, psig	200
Design temperature, °F	250
Design flow rate, gpm	Nom. 100, Max. 150
Particle size retained, minimum, micron	5
Spent fuel pool strainer	2 (Shared)
Design flow rate, gpm	2300
Fluid	Borated demineralized water

SPENT FUEL POOL COOLING SYSTEM COMPONENT DESIGN DATA

Spent fuel pool skimmer strainer	
Number	1 (Shared)
Type	Basket
Design flow rate, gpm	100
Design pressure, psig	50
Design temperature, °F	200
Spent fuel pool skimmers	
Number	2 (Shared)
Design flow rate per unit, gpm	50

SPENT FUEL POOL COOLING SYSTEM MALFUNCTION ANALYSIS

Component		Malfunction	Comments and Consequences
1.	Spent fuel pool pumps	Rupture of a pump casing	The casing is designed for 150 psig and 200 °F which exceeds maximum operating conditions. The pump is inspectable and is located in the auxiliary building protected against credible accidents. Rupture is considered unlikely; however, the pump can be isolated.
2.	Spent fuel pumps	Pumps stops running and cannot be restarted	The second cooling train is used.
3	Spent fuel pool pump	Manual valves on pump suction is closed	This is prevented by prestart-up and operational check, etc.
4.	Spent fuel pool pump	Suction strainer plugs	The second train is used
5.	Spent fuel pool heat exchanger	Tube or shell rupture	Rupture is considered unlikely because of low operating pressure; however, the faulty heat exchanger can be isolated
6.	Spent fuel pool skimmer pump	Pump stops running and cannot be restarted	Spent fuel assemblies continue to be cooled by spent fuel pool sump. Pool water may become slightly murky possibly decreasing visual observations until pump is restored to service. Fuel pool water is clarified to some extent by-passing spent fuel pool water through spent fuel pool demineralizer.

COMPONENT COOLING SYSTEM CODE REQUIREMENTS[1]

Component cooling heat exchangers	ASME B&PV Code Section VIII 1968 Edition[2]
Component cooling surge tank	ASME B&PV Code Section VIII 1968 Edition
Component cooling loop piping and valves	USAS B31.1 1967 Edition

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

[2] The component cooling water heat exchanger was designed and fabricated in accordance with ASME B&PV Code, Section VIII, 1968 edition requirements. Installation was in accordance with USAS B31.1, 1967 Edition.

COMPONENT COOLING WATER SYSTEM FLOW REQUIREMENTS PER TRAIN (GPM) [1]

Service	Normal Operation	LOCA Injection	LOCA Recirculation	Cooldown [2]
Safeguards Train [3]				
RHR Heat Exchanger	- [4]	- [5]	5000 [6]	4950
CCP PP Hx	45	26	45	45
SI PP Hx [7]		20	24	-
RHR PP Hx	-	5	10	10
CTS PP Hx [8]	-	3	3	-
Subtotal	45	54	5082	5005
Miscellaneous Train				
BA Evaporator	1442 [9]	-	-	-
SFP Hx [10]	2980	-		-
Waste Gas Compressors [11]	42.5	-		42.5

---

1 The values in this table are for the operating point described. Plant procedures may consider uncertainty as appropriate. See Section 9.5.

2 Cooldown refers to the operation that takes the reactor plant from hot shutdown (350 °F) and pressure to cold (140 °F) conditions. Once below 200 °F, which will preclude boiling, the CCW flow to the RHR heat exchanger may be reduced to accommodate the reduced RHR heat load.

3 The flows shown reflect the use of one safeguard's train. The second safeguard train may be placed in service provided the necessary equipment is operable. Single train operation results in minimum safeguard's requirements and a minimum cooldown.

4 This path is normally valved off with no flow through the path.

5 The flow through this path satisfies the miniflow requirements for the CCW Pump; there is no RHR heat load on CCW during LOCA injection.

6 UFSAR Chapter 14.3.4, "Containment Peak Pressure Transient", input assumption #21, provides the explanation of this input to the containment accident analysis of record.

7 Flow to the SI PP Hx and CTS PP Hx is not specified during the Normal or Cooldown mode since the SI PP and CTS PP are not required to operate during these modes of operation. However, the flow paths to the SI PP Hx and CTS PP Hx are open to permit flow.

8 Flow to the SI PP Hx and CTS PP Hx is not specified during the Normal or Cooldown mode since the SI PP and CTS PP are not required to operate during these modes of operation. However, the flow paths to the SI PP Hx and CTS PP Hx are open to permit flow.

9 Maximum flow; may be significantly reduced as necessary to control process temperatures.

10 SFP Hx is assumed to be on the non-accident unit.

11 Each of two, Waste Gas Compressor cooling can be aligned to either unit.

COMPONENT COOLING WATER SYSTEM FLOW REQUIREMENTS PER TRAIN (GPM) [1]

Service	Normal Operation	LOCA Injection	LOCA Recirculation	Cooldown [2]
Sample Coolers (U1/U2)	139/169 [12]	-		139/169 [13]
Post Accident Sampling System (U1/U2) [14]	-	-	8.5/32.5	-
Letdown Hx [15]	984 [16]	-	-	984 [17]
Seal Water Heat Exchanger	199	[4]	[4]	199
Ctmt. Pen. Cooling	300	-	-	300
CEQ Fan Mtrs [18]	-	15	15-	-
RCP Motors	404	-	-	404
RCP Thermal Barrier Hxs	140	-		140
Reactor Support Clrs	40	-	-	40
Subtotal (U1/U2)	6670.5/6700.5	15/15	23.5/47.5	2248.5/2278.5
Totals (U1/U2)	6715.5/6745.5	69/69	5105.5/5129.5	7253.5/7283.5

[12] Maximum flow; may be significantly reduced as necessary to control process temperatures.
[13] Maximum flow; may be significantly reduced as necessary to control process temperatures.
[14] The 8.5/32.5 gpm (U1/U2) flow is based on the use of 3 model QC-563 (8 gpm ea. Unit 2) and 1 model QC-501 (8.5 gpm) sample coolers (Unit 1 and Unit 2).
[15] The Letdown Hx is assumed to be inservice. The excess letdown Hx is placed inservice if the letdown Hx is unavailable. The excess letdown Hx's design flow rate is 230 gpm.
[16] Maximum flow; may be significantly reduced as necessary to control process temperatures.
[17] Maximum flow; may be significantly reduced as necessary to control process temperatures.
[18] For LOCA Injection and Recirculation only one CEQ fan is required. An analysis was performed which determined acceptable performance at a reduced flow of 15 gpm for 1 fan.

Component Cooling System Component Design Data

Component Cooling Pumps	
Quantity	5 (incl. 1 Maintenance spare)
Type	Horizontal, centrifugal
Rated capacity, gpm	9000
Rated head, TDH, ft	190
Rated motor horsepower, HP	500
Rated motor speed, rpm	1170
Casing material	Cast iron
Design pressure, psig	150
Design temperature, °F	200
Component Cooling Heat Exchangers	
Quantity	4
Type	Shell and Tube
Heat transferred, Btu/hr	76×10^6
Shell side	
Component cooling water outlet Temp., °F	95[1]
Component cooling water inlet Temp., °F	114
Component cooling water	
Design flow rate, lb/hr	4.0×10^6
Maximum flow rate, lb/hr	4.5×10^6
Design Temperature, °F	200
Design pressure, psig	150
Tube side	
Service water inlet temperature, °F	76[2]
Service water outlet temperature, °F	92
Service water flow rate, lb/hr	4.75×10^6
Design pressure, psig	150
Design temperature, °F	200
Tube material	Arsenical copper

[1] These data reflect the original design of the components. The CCW system has been designed and analyzed to operate in the range of 60°F to 105°F. It is acceptable for the CCW Hx outlet temperature to rise to 120°F during cooldown and post-LOCA conditions.

[2] These data reflect the original design of the components. The system has been evaluated for an ESW pump discharge temperature of 88.9°F.

INDIANA MICHIGAN POWER An AEP Company	INDIANA MICHIGAN POWER D. C. COOK NUCLEAR PLANT UPDATED FINAL SAFETY ANALYSIS REPORT	Revision: 17 Table: 9.5-4 Page: 1 of 1

COMPONENT COOLING SYSTEM MALFUNCTION ANALYSIS

Component	Malfunction	Comments and Consequences
1. Component cooling water pump	Rupture of a pump casing	Isolate pump and start redundant pump. Minimum safeguards requirements only one out of two pumps.
2. Component cooling water pump	Pump fails to start	One operating pump will supply sufficient flow. Redundancy is sufficient to provide ample flow for any condition.
3. Component cooling water pump	Manual valve on a pump suction line closed	This will be prevented by pre-startup and operational checks. Further, during normal operation, each pump will be checked on a periodic basis, which would show that a valve was closed.
4. Component cooling water pump	Stop valve on discharge line closed or check valve sticks closed	Stop valve will be checked open by pre-startup and operational checks. The stop valve and the check valve will be checked by periodic operation of the standby pump during normal operation.
5. Component cooling heat exchanger	Tube or shell rupture	Isolate and valve in standby train.
6. Component cooling heat exchanger vent or drain valve	Left open	This will be prevented by pre-startup and operational checks. On the in service heat exchangers such a situation would be readily assessed by makeup requirements to system. On the out-of-service heat exchangers such a situation would be assessed during periodic inspection of general area.
7. Thermal Barrier Heat Exchanger	Tube Leak or Rupture	See Section 9.5.4 Detection by CCW Radiation Monitor or Surge Tank level. Redundant containment isolation valves provide means to isolate if a leak is detected (isolation would require plant shutdown).

MODULE DATA

Module I.D.	Quantity	Array Cell Size	Total Cell Count for the Module Type
A*	5	13x14	910
B	4	12x14	672
C	4	13x12	624
D	2	12x12	288
E	4	13x11	572
F	2	12x11	264
G	1	12x10	120
H**	1	13x14 - (8x2)	166
Total	**23**		**3616**

* Three of the A modules have one triangle cell to accommodate pool corner curvature.
** Non-rectangular module

COMMON MODULE DATA

Storage cell inside dimension:	8.75" ± 0.04"
Storage cell height (above the baseplate):	168 ± 1/16"
Baseplate thickness:	0.75" (nominal)
Support leg height:	5.25" (nominal)
Support leg type:	Remotely adjustable legs
Number of support legs:	4 (minimum)
Remote lifting and handling provision:	Yes
Poison material:	Boral
Poison length:	144"
Poison width:	7.5"
Cell Pitch:	8.97" (nominal)

1100 ALLOY ALUMINUM PHYSICAL AND MECHANICAL PROPERTIES

Density	0.098 lb/cu. in. , 2.713 gm/cc
Melting Range	1190-1215 °F, 643-657 °C
Thermal Conductivity (77 °F)	128 BTU/hr/sq ft/°F/ft, 0.53 cal/sec/sq cm/°C/cm
Coef. of Thermal Expansion (68-212 °F)	13.1×10^{-6}/°F, 23.6×10^{-6}/°C
Specific heat (221 °F)	0.22 BTU/lb/°F, 0.23 cal/gm/°C
Modulus of Elasticity	10×10^{6} psi
Tensile Strength (75 °F)	13,000 psi annealed, 18,000 psi as rolled
Yield Strength (75 °F)	5,000 psi annealed , 17,000 psi as rolled
Elongation (75 °F)	35-45% annealed, 9-20% as rolled
Hardness (Brinell)	23 annealed, 32 as rolled
Annealing Temperature	650 °F, 343 °C

CHEMICAL COMPOSITION (BY WEIGHT) - ALUMINUM (1100 ALLOY)

99.00% min.	Aluminum
1.00% max.	Silicone and Iron
0.05-0.20% max.	Copper
.05% max.	Manganese
.10% max.	Zinc
.15% max.	others each

BORON CARBIDE CHEMICAL COMPOSITION, WEIGHT %	
Total boron	70.0 min.
B^{10} isotopic content in natural boron	18.0
Boric oxide	3.0 max.
Iron	2.0 max.
Total boron plus total carbon	94.0 min.

BORON CARBIDE PHYSICAL PROPERTIES	
Chemical formula	B_4C
Boron content (weight)	78.28%
Carbon content (weight)	21.72%
Crystal Structure	rombohedral
Density	2.51 gm./cc-0.0907 lb/cu. in.
Melting Point	2450°C (4442 °F)
Boiling Point	3500°C (6332 °F)
Microscopic thermal-neutron cross-section	600 barn

SUMMARY OF CRITICALITY SAFETY ANALYSES

NORMAL STORAGE CONFIGURATION

Design Basis burnups at 4.95% ±0.05% initial enrichment	0 in Region 1 50 in Region 2 38 in Region 3
Temperature for analysis	20°C (68°F)
Reference K_∞ (KENO-5a)	0.9160
Calculational bias, δk	0.0090
Axial burnup effect	0.0037
UNCERTAINTIES	
Bias statistics (95%/95%)	±0.0021
KENO-5a statistics (95%/95%)	±0.0012
Manufacturing tolerances	±0.0064
Water-gap	±0.0045
Fuel enrichment	±0.0034
Fuel density	±0.0035
Burnup (38 MWD/KgU)	±0.0019
Burnup (50 MWD/KgU)	±0.0047
Eccentricity in position	±0.0019
Statistical combination of uncertainties[1]	±0.0110
TOTAL	0.9287 ±0.0110
Maximum reactivity (k_∞)	0.940

[1] Square root of sum of squares.

SUMMARY OF CRITICALITY SAFETY ANALYSES

INTERIM CHECKERBOARD LOADING

Design Basis burnups at 4.95% ±0.05% initial enrichment	0 in Region 1, 50 in Region 2, Region 3 - CHECKERBOARD, (FRESH FUEL AND EMPTY)
Temperature for analysis	20°C (68 °F)
Reference K_∞ (KENO-5a)	0.9168
Calculational bias, δk	0.0090
Axial burnup effect	0.0037
UNCERTAINTIES (Assumed same as the reference case)	
Bias statistics (95%/95%)	±0.0021
KENO-5a statistics (95%/95%)	±0.0012
Manufacturing tolerances	±0.0064
Water-gap	±0.0045
Fuel enrichment	±0.0034
Fuel density	±0.0035
Burnup (38 MWD/KgU)	NA
Burnup (50 MWD/KgU)	±0.0047
Eccentricity	±0.0019
Statistical combination of uncertainties[1]	±0.0108
TOTAL	0.9295 ±0.0108
Maximum reactivity (k_∞)	0.940

[1] Square root of sum of squares.

Power Block Definition

Power Block Structure	Fire Area(s)
Auxiliary Building	AA1, AA3, AA5/6, AA7, AA8, AA9, AA10, AA11, AA12, AA13, AA14, AA15, AA23, AA24, AA25, AA26, AA27, AA29, AA30, AA31, AA34, AA35, AA36/42, AA37, AA38, AA39A, AA39B, AA40, AA41, AA43, AA44, AA45A, AA45B, AA54, AA55
Unit 1 Containment Building	AA56
Unit 2 Containment Building	AA58
Turbine Building	AA2, AA2C, AA16, AA17, AA18, AA19, AA20, AA21, AA22
Control Rooms, Cable Vaults, & HVAC Equipment Areas	AA46, AA47, AA48, AA50, AA51, AA52, AA57A, AA57B
Service & Office Build (Containment Cooling Area Only)	AA2
Fuel Handling Areas	AA3
Screenhouse, ESW Pump & Tunnel Areas and Water Intake & Discharge System	AA2, AA2C, AA32, AA33, YD
Fire Pump House	YD
Offsite power distribution equipment (i.e., unit auxiliary and reserve transformers), portions of the non-safety power distribution system (i.e., main generator step up transformer, 745-345 and 34.5 kv switchyard transformers), and the Supplemental Diesel Generator Area.	YD
Make Up Plant (MUP) Container Complex (Five ‘C Van’ Containers and Electrical Support: (3) Ultra Filtration, (1) Chemical and (1) Ancillary)	YD

COMPRESSED AIR SYSTEM DESCRIPTIVE INFORMATION[1]

PLANT AIR SYSTEM

PLANT AIR COMPRESSOR	
Number	2 (one for each unit)
Type	Centrifugal
Discharge Pressure, psig	100
Discharge Temperature (approximate)°F	266
Capacity, icfm (with inlet conditions of 14.3 psia and 110°F)	1,485
PLANT AIR COMPRESSOR AFTERCOOLER	
Number	1 per compressor
Type	Shell & Tube
Tube Side Flow, icfm (air)	1,500
Shell Side Flow, gpm (water)	23
Shell Side Design Pressure, psig	150
Tube Side Design Pressure, psig	150
Shell Material	Carbon Steel
Tube Material	Admiralty
Design Code	ASME B&PV Code Section VIII
PLANT AIR RECEIVER	
Number	2 (one for each unit)
Capacity, ft^3	200
Design Pressure, psig	125
Design Temperature, °F	300
Operating Pressure, psig	100
Operating Temperature, °F	105
Material	Carbon Steel
Design Code	ASME B&PV Code Section VIII

[1] The information in this Table reflects manufacturer equipment ratings and specifications for the compressed air systems components. These values do not necessarily reflect design basis values for the compressed air systems.

COMPRESSED AIR SYSTEM DESCRIPTIVE INFORMATION

CONTROL AIR SYSTEM

CONTROL AIR COMPRESSOR	
Number	2 (one for each unit)
Type	Reciprocating
Nominal Discharge Pressure, psig	100
Discharge Temperature, °F	320
Capacity, icfm	338, @29.92 in HgA inlet, 480 RPM, 100 psig discharge
CONTROL AIR COMPRESSOR AFTERCOOLER	
Number	1 per compressor
Type	Shell & Tube
Tube Side Flow, icfm(air)	338
Shell Side Flow, gpm (water)	5
Shell Side Design Pressure, psig	150
Tube Side Design Pressure, psig	150
Shell Material	Carbon Steel
Tube Material	Admiralty
Design Code	ASME B&PV Code Section VIII
CONTROL AIR RECEIVER (WET CONTROL AIR)	
Number	2 (one for each unit)
Capacity, ft^3	500
Design Pressure, psig	125
Design Temperature, °F	300
Operating Pressure, psig	100
Operating Temperature, °F	95
Material	Carbon Steel
Design Code	ASME B&PV Code Section VIII

COMPRESSED AIR SYSTEM DESCRIPTIVE INFORMATION

CONTROL AIR SYSTEM (CONT'D)

CONTROL AIR PREFILTER	
Number	4 (two for each unit in parallel strings)
Capacity, scfm	325
Inlet pressure, psig	100
Inlet temperature, °F (saturated)	95
Effluent Dewpoint °F(at design pressure)	-40
Retention Size, microns	5
Type	Adsorbent
CONTROL AIR DRIER	
Number	8 (four for each unit in two parallel strings)
Capacity, scfm	325
Dew Point at 100 psig, °F	-40
Type	Convection
CONTROL AIR AFTER FILTER	
Number	4 (two for each unit in parallel)
Capacity, scfm	840
Retention Size, microns	4
Type	Adsorbent
CONTROL AIR RECEIVER (DRY CONTROL AIR)	
Number	4 (two for each unit in parallel strings)
Capacity, ft^3	500
Design Pressure, psig	125
Design Temperature, °F	300
Operating Pressure, psig	100
Operating Temperature, °F	105
Material	Carbon Steel
Design Code	ASME B&PV Code Section VIII

COMPRESSED AIR SYSTEM DESCRIPTIVE INFORMATION

CONTROL AIR SYSTEM (CONT'D)

BACKUP PLANT AIR COMPRESSOR WITH INTEGRAL SKID MOUNTED AIRCOOLED AFTERCOOLER	
Number	1 (common for both units)
Type	Rotary Screw
Nominal Discharge Pressure	100
Discharge Temperature (approximate)°F	108
Capacity, icfm (with inlet conditions of 14.5 psia and 80°F)	668
BACKUP PLANT AIR COMPRESSOR AIR RECEIVER	
Number	1
Capacity, ft^3	100
Design Pressure, psig	150
Design temperature, °F	450
Operating Pressure, psig	100
Operating Temperature, °F	105
Material	Carbon Steel
Design Code	ASME B & PV Code section VIII

Service Water Systems Components Design Data

Non-Essential Service Water Pumps	
Quantity	4
Type	Horizontal Centrifugal
Rated TDH (ft.)	175
Rated Capacity - (GPM)	4,500
Rated Motor Horsepower (HP)	250
Rated Motor Speed	1800 (nominal)
Casing material	Cast Steel
Non-Essential Service Water Strainers	
Quantity	4
Type	Automatic – Self Cleaning
Essential Service Water Pumps	
Quantity	4
Type	Vertical
Rated TDH (ft.)	145
Rated Capacity - (GPM)	10,000[1]
Rated Motor Horsepower (HP)	450
Rated Motor Speed	900 (nominal)
Casing material	Cast iron or Cast steel
Essential Service Water Strainers	
Quantity	4
Type	Duplex-automatic backwashing

[1] Flow rates up to 12,200 gpm have been evaluated as acceptable.

Non-Essential Service Water Requirements [1]

	Quantity			Flow - GPM					
Service	**Installed**	**Min Req'd**	**Norm Req'd**	**Min. Design**	**Normal Design**	**Maximum Expected**	**Station Black-Out**	**Cont. or Inter. Serv.**	**Remarks**
Unit No. 1 Main Oil Coolers	2	1	1	1000	1000	1258	-	C	
Unit No. 2 Main Oil Coolers	4	2	2	1056	1056	1056	-	C	
Unit No. 1 FPT Oil Coolers	4	2	2	270	270	270	-	C	
Unit No. 2 FPT Oil Coolers	4	2	2	354	354	354	-	C	
Unit No. 1 Main Turbine and Feed Pump EHC Control Fluid Coolers	1	1	1	60	60	60	-	C	
Unit No. 2 Main Turbine and Feed Pump EHC Control Fluid Coolers	1	1	1	60	60	60	-	C	
Unit 1 Containment Chiller Condensers	3	2	2	2900	2900	2900	2900	C	

[1] Water requirements based on 76°F maximum lake temperature except as noted. The system has been evaluated for operation with an NESW cooling water temperature of 88.9°F

Non-Essential Service Water Requirements [1]

	Quantity			Flow - GPM					
Service	**Installed**	**Min Req'd**	**Norm Req'd**	**Min. Design**	**Normal Design**	**Maximum Expected**	**Station Black-Out**	**Cont. or Inter. Serv.**	**Remarks**
Unit 2 Containment Chiller Condensers	3	2	2	2900	2900	2900	2900	C	
Unit No. 2 Generator Seal Oil Coolers	2	2	2	160	160	160	-	C	Based on 95°F cooling water
Former Technical Support Center A/C Units	3 [2]	3	3	77	77	77	-	C	Shared System
Glycol Refrigeration Condensers	10	6	7	360	420	600	-	C	Shared System
Ice Storage Condensing Units	2	1	1	20	30	30		I	Shared System & Used During Ice Loading Only.

[2] Does not include the 4th and 5th air-cooled units.

Non-Essential Service Water Requirements [1]

	Quantity			Flow - GPM					
Service	**Installed**	**Min Req'd**	**Norm Req'd**	**Min. Design**	**Normal Design**	**Maximum Expected**	**Station Black-Out**	**Cont. or Inter. Serv.**	**Remarks**
Ice Machines	3	2	2	10	50	75		I	Shared System & Used During Ice Loading Only.
Air Cooler Stage 1	1	1	1	20	20	20		I	Shared System & Used During Ice Loading Only.
Air Cooling Condensing Units Stage 2 & 3	2	2	2	20	30	30		I	Shared System & Used During Ice Loading Only.
Mixed Borated Water Condensing Unit	1	1	1	20	30	30		I	Shared System & Used During Ice Loading Only.
Plant Air Compressors [3]	2	1	1	80	80	160	160	C	Shared System
Control Air Compressors [4]	2	0	0	0	0	10	10	I	Shared System

[3] Includes compressor oil cooler, aftercooler and 1st and 2nd stage intercoolers.

[4] Includes compressor jacket cooler and aftercooler.

Non-Essential Service Water Requirements [1]

	Quantity			Flow - GPM					
Service	**Installed**	**Min Req'd**	**Norm Req'd**	**Min. Design**	**Normal Design**	**Maximum Expected**	**Station Black-Out**	**Cont. or Inter. Serv.**	**Remarks**
Degassifier Vacuum Pump 1st Stage	1	1	1	25	25	25	-	C	Shared System
Degassifier Vacuum Pumps 2nd Stage	2	1	1	50	50	50	-	C	Shared System
Demineralizer Make-Up System	1	0	1	0	1093	1515	-	I	Shared System
Heating Boiler Blowdown Flash Tank	1	0	0	110	110	110	-	I	Shared System
Unit No. 1 Auxiliary Feed Pumps	3	3	3	6	6	6	-	I	Bearing cooling water for turbine and motor-driven pumps
Unit No. 2 Auxiliary Feed Pumps	3	3	3	6	6	6	-	I	Bearing cooling water for turbine and motor-driven pumps
Miscellaneous Sealing and Cooling Water System (MSCW)	-	-	-	-	-	300	-	C	
Totals				9,564[5]	10,787	12,062			

[5] Actual operational data with cold NESW temperatures indicate nominal minimal flow is approximately 8000 gpm

Chilled Water Subsystem Nominal Design Flow Rates
(Actual Values May Vary)

Containment Ventilation: Unit No. 1 Upper Units	93.9
Containment Ventilation: Unit No. 1 Lower Units	912
Containment Ventilation: Unit No. 2 Upper Units	93.9
Containment Ventilation: Unit No. 2 Lower Units	912
Unit No. 1 Instr. Room Vent	9.2
Unit No. 2 Instr. Room Vent	9.2
Unit No. 1 RCP Motor Air Coolers	148
Unit No. 2 RCP Motor Air Coolers	148

Chilled water can also be directed to the Steam Generator Blowdown Heat Exchanger at a design flow rate of 65 gpm and to the Steam Generator Blowdown Sample Heat Exchanger at a design flow rate of 14.1 gpm

Nominal Design Flow Rates for Alternate Configuration of NESW Directly To Containment AHUs:

Containment Ventilation: Unit No. 1 Upper Units	320
Containment Ventilation: Unit No. 1 Lower Units	1760
Containment Ventilation: Unit No. 2 Upper Units	320
Containment Ventilation: Unit No. 2 Lower Units	1760
Unit No. 1 Instr. Room Vent	50
Unit No. 2 Instr. Room Vent	50
Unit No. 1 RCP Motor Air Coolers	440
Unit No. 2 RCP Motor Air Coolers	440
Unit No. 1 Steam Generator Blowdown Sample Heat changer	11
Unit No. 2 Steam Generator Blowdown Sample Heat Exchanger	11
Unit No. 1 Steam Generator Blowdown Heat Exchanger	160
Unit No. 2 Steam Generator Blowdown Heat Exchanger	160

With less than design temperature NESW, actual flow rates may be lower and still provide adequate cooling.

Essential Service Water System Flow Requirements per Train (GPM)

Service [1]	Normal Operation	LOCA Injection	LOCA Recirculation	Cooldown
CCW HX	8700	5000 [2]	5000 [2]	9100
CTS HX	-	-	2400 (U2) [3] 2100 (U1) [4]	-
EDG CLRS	-	540	540	-
AFW SYS [5]	-	450	450	-
AFP Enclosure CLRS [6]	102	102	102	102
CRAC[7]	85	85	85	85
Totals	8887	6177	8277 - 8577	9287

[1] The flows shown reflect the use of one ESW train in service corresponding to one CCW safeguard's train. The second ESW train may be placed in service provided the necessary equipment is operable or the second CCW safeguard train is operating. Single train operation results in minimum safeguard's requirements and a minimum cooldown rate.

[2] Per update Westinghouse analyses, WCAP-14285, Revision 1, May, 1995.

[3] Per update Westinghouse analyses, WCAP-15302, December 13, 1999.

[4] Per EC-0000048860.

[5] This flow path is aligned manually and required only as a backup to the normal condensate supply to the Auxiliary Feedwater System.

[6] Auxiliary Feedwater Pump Enclosure Coolers will be provided with a continuous supply of ESW in all modes of operation. Flow is nominal based on cooler rated heat capacity. Different flows are allowable based on engineering analysis, provided required heat removal is achieved.

[7] Per FCN-51362-026 (U1-N), FCN-51362-016 (U1-S), FCN-51363-015 (U2-N), & FCN-51363-025 (U2-S)

ESSENTIAL SERVICE WATER SYSTEM MALFUNCTION ANALYSIS

COMPONENT		MALFUNCTION	COMMENTS AND CONSEQUENCES
1.	Essential service water pumps	Rupture of a pump casing	Isolate pump and start a redundant pump. Minimum requirements need only two out of four pumps.
2.	Essential service water pumps	Pump fails to start	One operating pump will supply sufficient flow for one operating Unit. Redundancy is sufficient to provide ample flow for any condition.
3.	Essential service water pump	Stop valve on discharge line closed or check valve sticks closed	The stop valve and the check valve will be checked by periodic operation of the off-duty pumps during normal operation.
4.	Essential service water pump strainer	Strainer casing rupture	Isolate and valve in spare train.
5.	Essential service water pump strainer vent or drain valve.	Left open	This will be prevented by prestartup and operational checks. On the out-of-service strainer, such a situation would be assessed during periodic checks.

CONTROL ROOM VENTILATION SYSTEM MALFUNCTION ANALYSIS

COMPONENT		MALFUNCTION	COMMENTS AND CONSEQUENCES
1.	Normal Intake Dampers	Failure to close	Two dampers in series ensure isolation of outside air normal intake.
2.	Pressurization/Cleanup Intake Dampers	Failure to open	Parallel dampers ensure outside air intake opens.
		Fully open or multiple dampers open	One damper partially open is correct alignment. A single failure may result in one damper fully open or 2 dampers partially open. Other failures are not considered credible.
3.	Pressurization/Cleanup Recirculation Damper	Failed to closed position	All air flowing through the filter is from the intake and air cleanup is limited to a single pass. Control Room dose consequences may increase. The position of the recirculation damper is administratively controlled so it does not need to change position in response to a radiological accident.