

INDIANA AND MICHIGAN POWER D. C. COOK NUCLEAR PLANT UPDATED FINAL SAFETY ANALYSIS REPORT

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



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



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



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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.



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



Mixed Bed Demineralizers	
Number	2 (per unit)
Туре	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.



Reactor Coolant Filter General:	
Number	1 (per unit)
Туре	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	_≤6



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



Centrifugal Charging Pumps	
Number	2 (per unit)
Туре	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



Positive Displacement Charging Pump	
Number	1 (per unit)
Туре	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



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



Batching Tank and Batching Tank Heater Jacket	
Number	1 (shared)
Туре	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



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Excess Letdown Heat Exchanger	
Number	1 (per unit)
Heat transfer rate at design conditions, Btu/hr	4.61x10 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.



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

	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.



Seal Water Filter	
General:	
Number	1 (per unit)
Туре	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 ∆Pressure, psi	80
Design Temperature, °F	200
Nominal Retention Size, micron	25



Boric Acid Filter General:	
Number	1 (per unit)
Туре	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



Boric Acid Transfer Pump	
Number	4 (shared)
Туре	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



Cation Bed Demineralizer	
Number	1 (per unit)
Туре	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



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



Deborating Demineralizers	
Number	2 (per unit)
Туре	Fixed bed
Vessel design pressure, psig	
Internal	200
External	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



Seal Injection Filters	
General:	
Number	2 (per unit)
Туре	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



Holdup Tanks	
Number	5 (shared) [*]
Туре	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.



Boric Acid Reserve Tank	
Number	1 (shared)
Туре	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)
Туре	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



Boric Acid Evaporator Feed Pumps	
Number	3 (shared)
Туре	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 ₃ BO ₃ Conductivity 2.0 umhos/cm
Material of construction	Austenitic stainless steel



Evaporator Condensate Demineralizers	
Number	1 (other used for radwaste)
Туре	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



Monitor Tanks	
Number	2 (shared)
	(other 2 shared for radwaste)
Туре	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)
Туре	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



Evaporator Feed Ion Exchangers	
Number	4 (shared)
Туре	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



Concentrates Filter General:	
Number	2 (shared)
Туре	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



Concentrates Holding Tank	
Number	1 (shared)
Туре	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)
Туре	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



Ion Exchanger Filter				
General:				
Number	2 (shared)			
Туре	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 ∆Pressure, psi	75			
Design Temperature, °F	200			
Nominal Retention Size, micron	25			
or				
Absolute Retention Size, micron	0.1 to 25			



Condensates Filter			
General:			
Number	2 (shared)		
Туре	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 ∆Pressure, psi	80		
Design Temperature, °F	200		
Nominal Retention Size, micron	25		



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Relief Valves	No.	Fluid Discharged	Fluid Inlet Temperature	Set Pressure	Back Pressure psig		Capacity
			°F	psig	Constant	Buildup	gpm
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