1.3 COMPARISON WITH OTHER PLANTS

Table 1-1 presents a summary of the original design characteristics of the CCNPP. The table includes similar data for Maine Yankee Unit 1, Turkey Point Units 3 and 4 and Palisades Unit 1. Bechtel Power Corporation (Bechtel) and CE are identified as contractors in Section 1.8. The Palisades plant is included in the table because its coolant system is similar to that of Calvert Cliffs, and because both Bechtel and CE were Palisades contractors. Maine Yankee is selected because its core is similar to that of Calvert Cliffs and it is a plant of vintage similar to Calvert Cliffs with which CE is associated. In particular, the reactor regulating system, the reactor coolant pressure regulating system, and the pressurizer level regulating system are essentially identical in design and function to the Maine Yankee systems except in the adaptation to the lesser number of similar inputs for a two-loop plant. Turkey Point is included because it is another comparable plant with which Bechtel is associated.

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[a]

	CALVERT CLIFFS UNITS 1 & 2	MAINE YANKEE[b]	TURKEY POINT UNITS 3 & 4[b]	PALISADES UNIT 1
HYDRAULIC AND THERMAL DESIGN PARAMETERS				
Total Core Heat Output, MWt	2560	2440	2200	2200
Total Core Heat Output, Btu/hr	8740×10^6	8328×10^6	7479×10^6	7509×10^6
Heat Generated in Fuel, %	97.5	97.5	97.4	97.5
Maximum Overpower, %	12	12	12	12
System Pressure, Nominal psia	2250	2250	2250	2100
System Pressure, Minimum Steady State, psia	2200	2200	2220	2050
Hot Channel Factors, Overall				
Heat Flux, Fq	3.00	2.89	3.23	3.80
Enthalphy Rise, F_{WH}	1.65	1.62	1.77	2.51
DNB Ratio at Nominal Conditions	2.18	2.45	1.81	2.00
Coolant Flow				
Total Flow Rate, lb/hr	122×10^6	122×10^6	101.5×10^6	125×10^6
Effective Flow Rate for Heat Transfer, lb/hr	117.5×10^6	117.5×10^6	97.0×10^6	121.25×10^6
Effective Flow Rate for Heat Transfer, ft^2	53.5	53.5	41.8	58.7
Average Velocity Along Fuel Rods, ft/sec	13.6	13.9	14.3	12.7
Average Mass Velocity, $lb/hr\text{-}ft^2$	2.20×10^6	2.9×10^6	2.32×10^6	2.07×10^6
Coolant Temperatures, °F				
Nominal Inlet	543.5	538.9	546.2	545
Maximum Inlet due to Instrumentation Error and Deadband, °F	548	546	550.2	548
Average Rise in Vessel, °F	52	51.1	55.9	46
Coolant Temperatures, °F				
Average Rise in Core, °F	54	53.1	58.3	47
Average in Core, °F	570.4	565.4	575.4	568.5
Average in Vessel	569.5	564.4	574.2	568
Nominal Outlet of Hot Channel	643	636	642	642.8
Average Film Coefficient, $Btu/hr\text{-}ft^2\text{-}°F$	5240	5300	5400	4860
Average Film Temperature Difference, °F	33.5	33	31.8	30

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[a]

	CALVERT CLIFFS UNITS 1 & 2	**MAINE YANKEE[b]**	**TURKEY POINT UNITS 3 & 4[b]**	**PALISADES UNIT 1**
Heat Transfer at 100% Power				
Active Heat Transfer Surface Area, ft^2	48,416	47,700	42,460	51,400
Average Heat Flux, Btu/hr-ft^2	176,000	170,200	171,600	142,400
Maximum Heat Flux, Btu/hr-ft^2	527,900	502,300	554,200	541,200
Average Thermal Output, kW/ft	5.94	5.74	5.5	4.63
Maximum Thermal Output, kW/ft	17.5	16.7	17.9	17.6[c]
Maximum Clad Surface Temperature at Nominal Pressure, °F	657	657	657	648
Fuel Center Temperature, °F				
Maximum at 100% Power	3780	3640	4030	4040
Maximum at Over Power	4070	3940	4300	4350
CORE MECHANICAL DESIGN PARAMETERS				
Thermal Output, kW/ft at Maximum Over Power	19.6	18.7	20.0	19.7[c]
Fuel Assemblies				
Design	CEA	CEA	RCC	Cruciform
Rod Pitch, in.	0.58	0.580	0.563	0.550
Cross-section Dimensions, in.	7.98x7.98	7.98x7.98	0.563	8.1135x8.1135
Fuel Weight (as UO_2), lbs	207,269	203,934	176,200	210,524
Total Weight, lbs	282,570	279,235	226,200	295,800
Number of Grids per Assembly	8	8	7	8
Fuel Rods				
Number	36,896	36,352	32,028	43,168
Outside Diameter, in.	0.440	0.440	0.422	0.4135
Diametral Gap, in.	0.0085	0.0085	0.0065	0.0065
Clad Thickness, in.	0.026	0.026	0.0243	0.022
Clad Material	Zircaloy	Zircaloy	Zircaloy	Zircaloy
Fuel Pellets				
Material	UO_2 Sintered	UO_2 Sintered	UO_2 Sintered	UO_2 Sintered
Diameter, in.	0.3795	0.3795	0.367	0.359
Length, in.	0.650	0.650	0.600	0.600

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[a]

	CALVERT CLIFFS UNITS 1 & 2	MAINE YANKEE[b]	TURKEY POINT UNITS 3 & 4[b]	PALISADES UNIT 1
Control Assemblies				
Neutron Absorber	B_4C/SS/Cd-In-Ag	B_4C/SS/Cd-In-Ag	Cd-In-Ag (5-15-80%)	Cd-In-Ag (5-15-80%)
Cladding Material	Inconel	Inconel	304 SSO Cold Worked	Stainless
Clad Thickness, in.	0.040	0.040	0.019	0.016
Control Assemblies				
Number of Assemblies, full/part length	77/8	77/8	53	4 1/4 Cruciform Rods
Number of Rods per Assembly	5	5	20	117 Tubes per Rod
Core Structure				
Core Barrel ID/OD, in.	148/149.75	148/149.75	133.875/137.875	149.75/152.5
Thermal Shield ID/OD, in.	None	156/162	142.625/148.0	None
NUCLEAR DESIGN DATA				
Structural Characteristics				
Core Diameter, inches (Equivalent)	136.0	136.0	119.5	136.71
Core Height, inches (Active Fuel)	136.7	136.7	144	132
Reflector Thickness & Composition				
Top - Water plus steel, in.	10	10	10	10
Bottom - Water plus steel, in.	10	10	10	10
Side - Water plus steel, in.	15	15	15	15
H_2O/U, Unit Cell (Cold)	3.44	3.44	4.18	3.50
Number of Fuel Assemblies	217	217	157	204
UO_2 Rods per Assembly, unshimmed/shimmed			204	212/208
Batch A	176	176		
Batch B	164	160		
Batch C	(176/164/164)	(176/164/160)		
Structural Characteristics				
Performance Characteristics Loading Technique	3 Batch Mixed Central Zone	3 Batch Mixed Central Zone	3 Regions Non-Uniform	3 Batch Mixed Central Zone
Fuel Discharge Burnup, MWD/MTU				
Average First Cycle	13,775	13,795	13,000	10,180
First Core Average	22,550	30,000	24,500	17,600

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[a]

	CALVERT CLIFFS UNITS 1 & 2	MAINE YANKEE[b]	TURKEY POINT UNITS 3 & 4[b]	PALISADES UNIT 1
Feed Enrichments wt%				
Region 1	2.05	2.01	1.85	1.65
Region 2	2.45	2.40	2.55	2.08/2.54
Region 3	2.99	2.95	3.10	2.54/3.20
Control Characteristics				
Effective Multiplication (beginning of life)				
Cold, No Power, Clean	1.194	1.170	1.180	1.212
Hot, No Power, Clean	1.152	1.129	1.38	1.175
Hot, Full Power, Xe Equilibrium	1.094	1.075	1.077	1.111
Control Assemblies Material	B_4C/SS-Cd-In-Ag	B_4C/SS-Cd-In-Ag	Cd-In-Ag (5-15-80%)	Cd-In-Ag (5-15-80%)
Number of Control Assemblies	85	85	53	45 Cruciform
Number of Absorber Rods per CEA (or RCC) Assembly	5	5	20	117 Tubes Welded to Form 13.5 in. Span
Total Rod Worth (Hot), %	≥9.6	≥9.9	7	8.6
Boron Concentrations				
To shut reactor down with no rods inserted, clean, Cold/Hot, ppm	1120/1095	945/935	1250/1210	1180/1210
To control at power with no rods inserted, clean/equilibrium xenon, ppm	960/725	820/590	1000/670	1070/830
Kinetic Characteristics, Ranger Over Life Moderator Temperature Coefficient k/k/F	-0.20×10^{-4} to -1.96×10^{-4}	-0.04×10^{-4} to 2.20×10^{-4}	$+0.3 \times 10^{-4}$ to -3.5×10^{-4}	-0.08×10^{-4} to -2.25×10^{-4}
Moderator Pressure Coefficient, /psi				
Hot, Operating				
Beginning-of-Life				
End-of-Cycle	$+0.3 \times 10^{-6}$ to 2.6×10^{-6}	$+0.65 \times 10^{-6}$ to $+2.39 \times 10^{-6}$	-0.3×10^{-6} to $+3.4 \times 10^{-6}$	$+0.10 \times 10^{-6}$ to $+1.7 \times 10^{-6}$

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[a]

	CALVERT CLIFFS UNITS 1 & 2	MAINE YANKEE[b]	TURKEY POINT UNITS 3 & 4[b]	PALISADES UNIT 1
Moderator Pressure Coefficient, Void, /% Void				
Hot, Operating				
Beginning-of-Life	-0.1×10^{-3}	-0.41×10^{-3} to	$+0.5 \times 10^{-3}$ to	0.06×10^{-3} to
End-of-Cycle	-1.3×10^{-3}	1.43×10^{-3}	-2.5×10^{-3}	-1.0×10^{-3}
Doppler Coefficient[d]	-1.46×10^{-5}	-1.45×10^{-5}	-1.0×10^{-5}	-1.56×10^{-5}
k/k/F	-1.06×10^{-5}	-1.07×10^{-5}	1.6×10^{-5}	-1.46×10^{-5}
REACTOR COOLANT SYSTEM - CODE REQUIREMENTS				
Reactor Vessel[f]	ASME III Class A	ASME III Class A	ASME III Class A	ASME III Class A
Steam Generator				
Tube Side	ASME III Class A	ASME III Class A	ASME III Class A	ASME III Class A
Shell Side	ASME III Class A	ASME III Class A	ASME III Class C	ASME III Class A
Pressurizer	ASME III Class A	ASME III Class A	ASME III Class A	ASME III Class C
Pressurizer Relief (or Quench) Tank	ASME III Class C	ASME III Class C	ASME III Class C	ASME III Class C
Pressurizer Safety Valves	ASME III	ASME III	ASME III	ASME III
Reactor Coolant Piping	ANSI B 31.7	ANSI B 31.1	ANSI B 31.1	ANSI B 31.1
PRINCIPAL DESIGN PARAMETERS OF THE REACTOR VESSEL				
Operating Pressure, psig	2235	2235	2235	2085
Reactor Inlet Temperature, °F	544.5	540	546.2	545
Reactor Outlet Temperature, °F	599.4	592.8	602.1	591.1
Number of Loops	2	3	3	2
Design Pressure, psig	2485	2485	2485	2485
Design Temperature, °F	650	650	650	650
Hydrostatic Test Pressure (cold), psig	3110	3110	3107	3110
Total Coolant Volume – cu.ft.	11,101	11,026	9,088	10,809

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[a]

	CALVERT CLIFFS UNITS 1 & 2	MAINE YANKEE[b]	TURKEY POINT UNITS 3 & 4[b]	PALISADES UNIT 1
PRINCIPAL DESIGN PARAMETERS OF THE STEAM GENERATORS				
Material	SA-533, Grade B, Class 1, low alloy steel, internally clad with Type 304 austerities SS equivalent	SA-533, Grade E Class 1 steel, forgings-A-508-64 Class 2, cladding-weld deposited 304 SS equivalent	SA-302, Grade B, low alloy steel internally clad with type 304 austerities SS equivalent	SA-302, Grade B low alloy steel internally clad with Type 304 austerities SS equivalent
Design Pressure, psig	2485	2485	2485	2485
Design Temperature, °F	650	650	650	650
Operating Pressure, psig	2235	2235	2235	2085
Inside Diameter of Shell, in.	172	172	155.5	172
Outside Diameter Across Nozzles, in.	253	266-5/8	236	254
Overall Height of Vessel and Enclosure Head to Top of CRDM Nozzle, ft.-in.	41-11-3/4	42-1-3/8	41-6	40-1-13/16
Minimum Clad Thickness, in.	1/8	1/8	5/32	3/16
Number of Units	2	3	3	2
Type	Vertical U-Tube with integral moisture separator	Vertical U-Tube with integral moisture separator	Vertical U-Tube with integral moisture separator	Vertical U-Tube with integral moisture separator
Tube Material	Inconel	Inconel	Inconel	Inconel
Shell Material	SA-533, Gr. B, Class 1 and SA-516 Gr 70	SA-533, Gr. B, Class 1 and SA-516 Gr 70	Carbon Steel	Carbon Steel
PRINCIPAL DESIGN PARAMETERS OF THE REACTOR COOLANT PUMPS				
Tube Side Design Pressure, psig	2485	2485	2485	2485
Tube Side Design Temperature, °F	650	650	650	650
Tube Side Design Flow, lb/hr	$61x10^6$	$40.67x10^6$	$33.93x10^6$	$62.5x10^6$
Shell Side Design Pressure, psig	985	985	1085	985
Shell Side Design Temperature, °F	550	550	556	550
Operating Pressure, Tube Side, Nominal, psig	2235	2235	2235	2085
Operating Pressure, Shell Side, Maximum, psig	885	885	1020	885
Maximum Moisture at Outlet at Full Load, %	0.2	0.2	1/4	0.2

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[(a)]

	CALVERT CLIFFS UNITS 1 & 2	MAINE YANKEE[(b)]	TURKEY POINT UNITS 3 & 4[(b)]	PALISADES UNIT 1
Hydrostatic Test Pressure, Tube Side (cold), psig	3110	3110	3107	3110
Steam Pressure, psia, at full power	850	815	745	770
Steam Temperature, °F, at full power	525.2	520.3	510	513.8
Number of Units	4	3	3	4
Type	Vertical, single stage centrifugal with bottom suction and horizontal discharge	Vertical, single stage centrifugal with bottom suction and horizontal discharge	Vertical, single stage radial flow with bottom suction and horizontal discharge	Vertical, single stage radial flow with bottom suction and horizontal discharge
Design Pressure, psig	2485	2485	2485	2485
Design Temperature, °F	650	650	650	650
Operating Pressure, nominal psig	2235	2235	2235	2085
Suction Temperature, °F	543.4	538.9	546.5	545
Design Capacity, gpm	81,200	108,000	89,500	83,000
Design Head, ft.	300	290	260	260
Hydrostatic Test Pressure, (cold), psig	3110	3110	3107	3110
Motor Type	A-C Induction Single Speed	A-C Induction Single Speed	A-C Induction Single Speed	A-C Induction Single Speed
Motor Rating, hp	7200 (cold)	9000	6000	6250 (cold)
PRINCIPAL DESIGN PARAMETERS OF THE REACTOR COOLANT PIPING				
Material	SA516-gr 70 with SS clad	SA516-gr 70 with SS clad	Austenitic SS	SA516-gr 70 clad with SS
Hot Leg - ID, in.	42	33.5	29	42
Cold Leg - ID, in.	30	33.5	27 1/2	30
Between Pump & Steam Generator - ID, in.	30	33.5	31	30

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[a]

	CALVERT CLIFFS UNITS 1 & 2	MAINE YANKEE[b]	TURKEY POINT UNITS 3 & 4[b]	PALISADES UNIT 1
CONTAINMENT SYSTEM PARAMETERS UNIT 1				
Type	Steel-lined, pre-stressed post tensioned concrete cylinder, curved dome roof	Steel-lined, reinforced concrete flat bottom and hemispherical dome	Steel-lined pre-stressed post tensioned concrete cylinder, hemispherical domed roof	Steel-lined pre-stressed post tensioned concrete cylinder, hemis-cylinder curved dome roof
Design Parameters				
Inside Diameter, ft.	130	135	116	116
Height, ft.	181-2/3	169-1/2	169	190
Free Volume, ft^3	2,000,000	1,855,000	1,550,000	1,600,000
Reference Incident Pressure, psig	50	55	59	55
Concrete Thickness, ft.				
Vertical Wall	3-3/4	4-1/2	3-3/4	3
Dome	3-1/4	2-1/2	3-1/4	2-1/2
Containment Leakage Prevention & Mitigation Systems	Leak-tight pene-tration & continuous steel liner. Automatic isolation where required. The exhaust from penetration rooms to vent	Leak-tight pene-tration & continuous steel liner. Automatic isolation where required.	Leak-tight pene-tration & continuous steel liner. Automatic isolation where required.	Leak-tight pene-tration & continuous steel liner. Automatic isolation where required.
Gaseous Effluent Purge	Discharge through vent	Discharge through stack	Through particulate filter and monitors part of main exhaust system.	Discharge through stack

TABLE 1-1

COMPARISON OF ORIGINAL PLANT CHARACTERISTICS[a]

	CALVERT CLIFFS UNITS 1 & 2	MAINE YANKEE[b]	TURKEY POINT UNITS 3 & 4[b]	PALISADES UNIT 1
ENGINEERED SAFETY FEATURES				
Safety Injection System				
No. of High Head Pumps	3	3 (Charging)	4 (Shared)	3
No. of Low Head Pumps	2	2	2	2
Containment Fan Coolers				
No. of Units	4	6	3	3
Air Flow Capacity, each at emergency condition, cfm	55,000	Not Applicable	25,000	25,000
Containment Spray No. of Pumps	2	3	2	2
Emergency Power Diesel Generator Units	3 total for both units[e]	2	2 total for both units	4
Safety Injection Tanks, Number	4	3	3	4

(a) The current design characteristics for Calvert Cliffs Units 1 and 2 may differ from those shown in this table.

(b) The values listed for these plants were taken from public documentation.

(c) Based on total heat output of the core rather than heat generated in the fuel alone.

(d) Values shown are for hot, zero power/beginning-of-life, full power conditions.

(e) The current design characteristics show four total emergency power diesel generators for both units.

(f) See Table 4-9 for the design code of the replacement RVCH.