INITIAL CORE MECHANICAL DESIGN PARAMETERS [1]

(ALL DIMENSIONS ARE FOR COLD CONDITIONS.)

Active Portion of the Core	
Equivalent Diameter, in.	132.7
Active Fuel Height, in.	
Region 1	144.0
Region 2	143.4
Region 3	142.8
Length-to-Diameter Ratio	1.09
Total Cross-Section Area, Ft^2	96.06
Fuel Assemblies	
Number	193
Rod Array	15 x 15
Rods per Assembly	204 [1]
Rod Pitch, in.	0.563
Overall Dimensions	8.426 x 8.426
Fuel Weight, (as UO_2), pounds	219,900
Total Weight, pounds	279,000
Number of Grids per Assembly	7
Number of Guide Thimbles	20
Diameter of Guide Thimbles (upper part), in.	0.545 O.D. x 0.515 I.D.
Diameter of Guide Thimbles (lower part), in.	0.484 O.D. x 0.454 I.D.

[1] Twenty-one rods are omitted: Twenty provide passage for control rods and one to certain in-core instrumentation.

INITIAL CORE MECHANICAL DESIGN PARAMETERS [1]

(ALL DIMENSIONS ARE FOR COLD CONDITIONS.)

Fuel Rods	
Number	39,372
Outside Diameter, in.	0.422
Diametral Gap, in.	
Regions 1, 2 & 3	0.0075
Clad Thickness, in.	0.0243
Clad Material	Zircaloy-4
Overall Length	149.7
Length of End Cap, overall, in.	0.688
Length of End Cap, inserted in rod, in.	0.250
Fuel Pellets	
Material	UO_2 sintered
Density (% of Theoretical)	
Regions 1, 2 & 3	94/95/95
Feed Enrichments w/o	
Region 1	2.25
Region 2	2.80
Region 3	3.30
Diameter, in.	
Regions 1, 2 & 3	0.3659
Length, in.	0.6000

INITIAL CORE MECHANICAL DESIGN PARAMETERS [1]

(ALL DIMENSIONS ARE FOR COLD CONDITIONS.)

Rod Cluster Control Assemblies	
Neutron Absorber	5% Cd, 15% In. 80% Ag
Cladding Material	Type 304 SS - Cold Worked
Clad Thickness, in.	0.019
Number of Clusters	
Full Length	53
Part Length	0
Number of Control Rods per Cluster	20
Length of Rod Control, in.	158.45 (overall)
	150.57 (insertion length)
Length of Absorber Section, in.	142.00 (full length)
Core Structure	
Core Barrel, in.	
I.D.	148.0
O.D.	152.5
Thermal Shield, in.	
I.D.	158.5
O.D.	164.0
Burnable Poison Rods	
Number	1434
Material	Borosilicate Glass
Outside Diameter, in.	0.4395
Inner Tube, O.D., in	0.2365
Clad Material	S.S.
Inner Tube Material	S.S.
Boron Loading, (natural), gm/cm of glass rod.	.0603

Nuclear Design Data

(These data are design values for cycle 1.
Updated design values starting with Cycle 8 operation are listed in Section 3.5.)

Structural Characteristics		
1.	Fuel Weight (UO_2), lbs	216,600
2.	Zircaloy Weight, lbs.	44,547
3.	Core Diameter, inches	132.7
4.	Core Height, inches	144
	Reflector Thickness and Composition	
5.	Top - Water Plus Steel	10 in.
6.	Bottom - Water Plus Steel	10 in.
7.	Side - Water Plus Steel	15 in.
8.	H_2O/U, (cold) Core	4.09
9.	Number of Fuel Assemblies	193
10.	UO_2 Rods per Assembly	204
Performance Characteristics		
11.	Heat Output, MWt (initial rating)	3,250
12.	Heat Output, MWt (maximum calculated heat removal rating)	3,391
13.	Fuel Burnup, MWD/MTU First Cycle First Cycle Enrichments, weight %	16,666
14.	Region 1	2.25
15.	Region 2	2.80
16.	Region 3	3.30
17.	Equilibrium Enrichment	2.90

Nuclear Design Data

(These data are design values for cycle 1.
Updated design values starting with Cycle 8 operation are listed in Section 3.5.)

18.	Nuclear Heat Flux Hot Channel Factor, F_Q^N	2.71[1]
19.	Nuclear Enthalpy Rise Hot Channel Factor, $F_\Delta^N H$	1.58[1]
	Control Characteristics	
	Effective Multiplication (Beginning of Life) With Burnable Poison Rods in; No Boron	
20.	Cold, No Power, Clean	1.183
21.	Hot, No Power, Clean	1.154
22.	Hot, Full Power, Clean	1.132
23.	Hot, Full Power, Xe and Sm Equilibrium	1.092
24.	Absorber Material	5% Cd; 15% In; 80% Ag
25.	Full Length	53
26.	Part Length	0
27.	Number of Absorber Rods per RCC Assembly	20
28.	Total Rod Worth, BOL, %: Boron Concentration for First Core Cycle Loading With Burnable Poison Rods	(See Table 3.3.1-3)
29.	Fuel Loading Shutdown; Rods in (k = .87)	2000 ppm
	Rods in (k = .90)	1714 ppm
30.	Shutdown (k = .99) with Rods Inserted Clean, Cold	945 ppm
31.	Shutdown (k = .99) with Rods Inserted, Clean, Hot	602 ppm
32.	Shutdown (k = .99) with No Rods Inserted, Clean, Cold	1414 ppm

[1] These data are design values for Cycle 1. The current Technical Specification limits are included in the Core Operating Limits Report for the current operating cycle.

Nuclear Design Data

(These data are design values for cycle 1.
Updated design values starting with Cycle 8 operation are listed in Section 3.5.)

33.	Shutdown (k = .99) with No Rods Inserted, Clean, Hot To Maintain k = 1 at Hot Full Power, No Rods Inserted	1385 ppm
34.	Clean	1152
35.	Xenon	868 ppm
36.	Xenon and Samarium	838 ppm
37.	Shutdown, All But One Rod Inserted, Clean Cold (k = .99)	1031 ppm
38.	Shutdown, All But One Rod Inserted, Clean Hot (k = .99)	734 ppm
	Burnable Poison Rods	
39.	Number and Material	1436 Borosilicate Glass
40.	Worth Hot Full Power Δρ	9.0%
41.	Worth Cold Δρ	7.0%
	Kinetic Characteristics	
42.	Moderator Temperature Coefficient at Full Power (Δρ/°F)	-0.3×10^{-4} to 3.2×10^{-4}
43.	Moderator Pressure Coefficient (Δρ/psi)	$+ 0.3 \times 10^{-6}$ to 4.0×10^{-6}
44	Moderator Density Coefficient, Δρ/gm/cm^3	-0.1×10^{-5} to 0.8×10^{-5}
45.	Doppler Coefficient (Δρ/°F)	-1.0×10^{-5}- 1.7×10^{-5}
46.	Delayed Neutron Fraction, %	0.51 to 0.70
47.	Prompt Neutron Lifetime, sec	1.4×10^{-5} to 2.0×10^{-5}
48.	Boron Worth Δρ/ppm	1.4×10^{-4} to 0.09×10^{-4}

REACTIVITY REQUIREMENTS FOR CONTROL RODS

Requirements	Per Cent Δρ Beginning of Life	End of Life
Control		
Power Defect	1.70	3.05
Rod Insertion Limit	0.70	0.50
Total Control	2.40	3.55

CALCULATED ROD WORTHS $\Delta\rho$

Core Condition	Rod Configuration	Worth	Less 10%*	Design Reactivity Requirement	Shutdown Margin
BOL, HFP	53 rods in	8.15%			
BOL, HZP	52 rods in; Highest Worth Rod Stuck Out	6.65%	5.98%	2.40%	3.58%
EOL, HFP	53 rods in	7.96%			
(3rd Cycle)					
EOL, HZP	52 rods in; Highest Worth Rod Stuck Out	6.16%	5.54%	3.55%	1.99%**

BOL = Beginning of Life
EOL = End of Life
HFP = Hot Full Power
HZP = Hot Zero Power

* Calculated rod worth is reduced by 10% to allow for uncertainties.
** The design basis minimum shutdown is 1.3%.

THERMAL AND HYDRAULIC DESIGN PARAMETERS

	Cycle 1 Design Parameters[1]
Total Heat Output, MWt	3250
Total Heat Output, Btu/hr	$11{,}090 \times 10^{6}$
Heat Generated in Fuel, %	97.4
Maximum Thermal Overpower, %	112
Nominal System Pressure, psia	2250
Hot Channel Factors	
Heat Flux	
Nuclear, F_q	2.60
Engineering, F_q^E	1.03
Total	2.80
Enthalpy Rise	
Nuclear $F_{\Delta H}^N$	1.55
Coolant Flow	
Total Flow Rate, lbs/hr	135.6×10^{6}
Average Velocity along Fuel Rods, ft/sec	15.5
Average Mass Velocity, lb/hr-ft^2	2.53×10^{6}
Coolant Temperature, °F	
Design Nominal Inlet	536.3[2]
Average Rise in Vessel	63.0
Average Rise in Core	65.7
Average in Core	570.3
Average in Vessel	567.8
Nominal Outlet of Hot Channel	667.5
Heat Transfer	
Active Heat Transfer Surface Area, ft^2	52,200
Average Heat Flux, Btu/hr-ft^2	207,000
Maximum Heat Flux, Btu/hr-ft^2	579,600
Maximum Thermal Output, kw/ft	18.8
Maximum Clad Surface Temperature BOL at Nominal Pressure, °F	657
Maximum Average Clad Temperature BOL at Rated Power, °F	720

[1] See Table 3.5.3-1 for current cycle design parameters.
[2] Best Estimate Nominal Inlet Temperature is 533.0 °F

THERMAL AND HYDRAULIC DESIGN PARAMETERS

Fuel Central Temperatures (Region 3-BOL) or nominal fuel rod dimensions, °F		
Maximum at 100% Power		4250
Maximum at 112% Power		4500
	Design Parameters	
DNB Ratio		
Minimum DNB Ratio at nominal operating conditions	1.97	
Pressure Drop, psi		
Across Core	32	
Across Vessel, including nozzles	51	

ENGINEERING HOT CHANNEL FACTOR

F_q^E	Pellet Diameter, Density Enrichment, and Eccentricity Rod Diameter, (Pitch and Bowing)	1.03
	Pellet Diameter, Density, Enrichment	
		1.08
$F_{\Delta H}^E$	Rod Diameter, Pitch and Bowing Inlet Flow Maldistribution	1.01
	Flow Redistribution	1.03
	Flow Mixing	0.90*
	Resulting $F_{\Delta H}^E$	1.01

* To point of minimum DNB ratio.

SENSITIVITY ANALYSIS

EFFECT OF VARYING THE POWER DISTRIBUTION				
Power Distribution	**Power % of Rated**	**Tin**	**Pressure**	**Statistical Number Of Fuel Rods Which May Experience DNB**
Design	112	536.3	2250	0.54
Best Estimate	112	536.3	2250	0.09

EFFECT OF VARYING POWER LEVELS				
Power Distribution	**Power % of Rated**	**Tin**	**Pressure**	**Statistical Number* of Fuel Rods Which May Experience DNB**
Best Estimate	100	536.3	2250	0.01
Best Estimate	112	536.3	2250	0.09

EFFECT OF VARYING FLOW RATE AT 112% POWER				
Power Distribution	**Flow % of Rated**	**Tin**	**Pressure**	**Statistical Number* of Fuel Rods Which May Experience DNB**
Best Estimate	100	536.3	2250	0.09
Best Estimate	95	536.3	2250	0.18
Best Estimate	90	536.3	2250	0.42

* The statistical number of rods which could experience DNB takes into account the distribution of the experimental data from which the W-3 DNB correlation was developed and the distribution of the power in the core.

Westinghouse 15x15 Fuel Design Parameters

Parameter	15x15 W Upgrade Fuel Assembly Design
Fuel Assembly Length, in.	159.975
Fuel Rod Length, in.	152.88
Assembly Envelope, in.	8.426
Compatible with Core Internals	Yes
Fuel Rod Pitch, in.	0.563
Number of Fuel Rods/Assembly	204
Number of Guide Thimbles/Assembly	20
Number of Instrumentation Tube Assembly	1
Compatible with Moveable In-Core	Yes
Detector System Fuel Tube Material	ZIRLO™
Fuel Rod Clad OD, in.	0.422
Fuel Rod Clad Thickness, in.	0.0243
Fuel/Clad Gap, mil	7.5
Fuel Pellet Diameter, in	0.3659
Guide Thimble Material	ZIRLO™
Guide Thimble ID, in.[1]	0.499
Structural Material - Five Inner Grids	ZIRLO™
Structural Material - Two End Grids	Inconel

[1] Above dashpot

Parameter	15x15 W Upgrade Fuel Assembly Design
Grid height, in.	1.90 (Inner Grids)
Valley-to-Valley, in.	1.522 (End Grids) 0.875 (IFMs) 0.972 (Robust Protective Grid)
Bottom Nozzle	Reconstitutable
Top Nozzle Holddown Springs	3-leaf

COMPARISON OF BURNABLE ABSORBER RODS DESIGN PARAMETERS

Parameter	**W** **Wet Annular Burnable Absorber (BA)**	**W** **Borosilicate Glass BA 15x15 Fuel Assembly (FA)**
Overall Length, in	150.00**	152
Absorber Length, in	134.00**	142.7
Absorber Material	$A1_2O_3$-B_4C	B_2O_3
Absorber Form	Annular Pellet	Glass Tube
Outer Clad O.D., in	.381	.439
Absorber Clad Material	Zircaloy	Stainless
Absorber Thickness, in	.020	.077
Guide Thimble I.D., in	.499	.499

** Typical length which can be changed to accommodate specific plant fuel cycle application.

SUMMARY OF FUEL ASSEMBLY NORMALIZED GRID IMPACT FORCES

		SSE/DBE[1] and LOCA	OBE
GRID TYPE		force/limit = ratio	force/limit = ratio
15Upgrade	Mid	32.5%	44%
	IFM	45.2%	49%

[1] SSE (Safe Shutdown Earthquake) is DBE (Design Basis Earthquake) for D.C. Cook.

Maximum Thimble Tube and Fuel Rod Stresses

		Maximum Thimble Tube Stress, - Ksi			Maximum Fuel Rod Stress, Ksi		
Grid Type		SSE + LOCA	Limit	Ratio	SSE + LOCA	Limit	Ratio
15 Upgrade	Pm	13.35	24.35	54.8%	21.82	45.96	47.5%
	Pm + Pb	22.87	36.53	62.6%	24.52	68.95	35.6%

		Maximum Thimble Tube Stress, - Ksi			Maximum Fuel Rod Stress, Ksi		
Grid Type		OBE	Limit	Ratio	OBE	Limit	Ratio
15 Upgrade	Pm	6.101	11.6	53%	20.463	21.89	93%
	Pm + Pb	17.309	17.4	99%	23.059	32.84	70%

FUEL ASSEMBLY DESIGN PARAMETERS

COOK NUCLEAR PLANT UNIT 1 - CYCLE 22

Region	**23A**	**23B**	**24A**	**24B**	**24C**	**24D**
Enrichment (w/o U_{235})	3.715*	4.200*	3.800	4.200	1.500	1.600
Density (percent theoretical)	95.548*	95.411*	95.50	95.50	95.50	95.50
Number of Assemblies	51	32	48	36	25	1
Approximate Burn up at Beginning of Cycle 22 (MWD/MTU)**	22,105	21,364	0	0	0	0
Approximate Burn up at End of Cycle 22 (MWD/MTU)***	40,301	43,331	23,653	23,964	8,619	7,891

* All values are as-built.
** Based upon the Nominal EOC 21 burn up of 18,351 MWD/MTU
*** Assumes EOC burn up of 19,960 MWD/MTU

KINETICS CHARACTERISTICS

COOK NUCLEAR PLANT UNIT 1 CYCLE 22 WITH W 15X15 UPGRADE FUEL

Most Positive Moderator Temperature Coefficient (pcm/°F)[1]	+5.0 ≤ 70% RTP[2] linear ramp to 0.0 from 70 to 100% RTP
Doppler Temperature Coefficient (pcm/°F)	-0.9 to -3.2
Least negative Doppler - Only Power Coefficient, Zero to Full Power (pcm/% power)	-9.55 to -6.11
Most Negative Doppler - Only Power Coefficient, Zero to Full Power (pcm/% power)	-19.4 to -12.79
Delayed Neutron Fraction, β_{eff} (%)	0.40 to 0.70
β_{eff} (%) minimum (BOL rod ejection only)	≥ 0.5
Maximum Differential Rod Worth of Two Banks Moving Together at HZP with 100% overlap (pcm/sec)	≤ 75
ARO Shutdown Boron (ppm) NOXE, PKSM, K=0.99 For Most Reactive Time in Life	<2,200
Worth of Most Reactive Rod (ppm)	155.1

[1] 1 pcm = $1.0 \times 10^{-5}\ \Delta\rho$

[2] RTP = Rated Thermal Power

SHUTDOWN REQUIREMENTS AND MARGINS

COOK NUCLEAR PLANT UNIT 1 - CYCLE 22

Control Rod Worth (%Δρ)	**BOC**	**EOC**
Available Rod Worth Less Worst Stuck Rod	6.158	6.222
(A) Less 10%	5.542	5.600
Control Rod Requirements (%Δρ)		
Reactivity Defects (Doppler, T_{avg}, RIA, Redistribution)	1.400	2.113
Void Allowance	0.050	0.050
(B) Total requirements	1.450	2.163
(C) Shutdown Margin [(A)-(B)] (%Δρ)	4.092	3.437
(D) Required Shutdown Margin (%Δρ)	1.300	1.300
Excess Shutdown Margin [(C) – (D)] (%Δρ)	2.792	2.137

Cook Nuclear Plant Unit 1
Thermal-Hydraulic Design Parameters For Upgrade Fuel

THERMAL AND HYDRAULIC PARAMETERS	DESIGN PARAMETERS [1]
Reactor Core Heat Output, MWt	3,304
Reactor Core Heat Output, 10^6 Btu/hr	11,273
Heat Generated in Fuel, %	97.4%
Core System Pressure, Nominal, psia	2,115
Pressurizer Pressure, Nominal Steady-State, psia	2,100
Minimum DNBR at Nominal Conditions	
Typical Flow Channel	2.18 [1]
Thimble (Cold Wall) Flow Channel	2.09 [1]
Safety Analysis DNBR for Design Transients	
Typical Flow Channel	1.55 [1]
Thimble Flow Channel	1.55 [1]
DNB Correlation	WRB-1
Coolant Conditions	
Minimum Measured Flow, 10^3 gpm	362.9
Effective Flow Area for Heat	
Transfer, ft^2	51.5
Average Inlet Velocity along Fuel Rods, ft/sec	15.35 [2]
Average Mass Velocity, 10^6 lbm/hr-ft^2	2.606 [2]
Nominal Vessel/Core Inlet Temperature, °F	543.6 [2]

[1] Based upon Revised Thermal Design Procedure (RTDP)
[2] Based on Thermal Design Flow = 354,000 gpm

Cook Nuclear Plant Unit 1
Thermal-Hydraulic Design Parameters For Upgrade Fuel

THERMAL AND HYDRAULIC PARAMETERS	DESIGN PARAMETERS [1]
Vessel Average Temperature, °F	575.4 [3]
Core Average Temperature, °F	579.2 [2]
Vessel Outlet Temperature, °F	607.2 [2]
Average Temperature Rise in Vessel, °F	63.6 [2]
Average Temperature Rise in Core, °F	67.9 [2]
Average Enthalpy Rise in Core, Btu/lbm	91.52 [2]
Heat Transfer	
Active Heat Transfer, Surface Area, ft^2	52,100
Average Heat Flux, Btu/hr-ft^2	210,900
Maximum Heat Flux for Normal Operation, Btu/hr-ft^2 [4]	489,300
Average Linear Power, kW/ft	6.83
Peak Linear Power for Normal Operation, kW/ft [4]	15.85
Maximum Clad Surface Temperature, °F	653
Fuel Centerline Temperature	
Temperature at Peak Linear Power for Prevention of Centerline Melt, °F	4700
Calculational Factors	
Engineering Heat Flux Factor	1.000
Fuel Densification Factor (axial)	1.002

[3] Evaluations have been performed utilizing available DNB margin to support a maximum vessel average temperature of 576.3 °F.

[4] Based upon 2.32 F_Q Peaking Factor

Cook Nuclear Plant Unit 1
Thermal-Hydraulic Design Parameters For Upgrade Fuel

THERMAL AND HYDRAULIC PARAMETERS	DESIGN PARAMETERS [1]
Radial Peaking Factor	
Design Nuclear Enthalpy Rise Hot Channel Factor	1.545
Pressure Drop	
Across Core, psi (Best Estimate Flow)	25.4 [5]

[5] Includes the effect of IFMs and thimble plug removal