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Docket No.: 50-315

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Donald C. Cook Nuclear Plant Unit 1
CORE OPERATING LIMITS REPORT

Indiana Michigan Power Company, the licensee for Donald C. Cook Nuclear Plant Unit 1, is submitting the Core Operating Limits Report (COLR) for Unit 1 Cycle 27 in accordance with Technical Specification 5.6.5. Revision 0 of the Unit 1 Cycle 27 COLR is provided as an enclosure to this letter.

There are no new or revised commitments in this letter. Should you have any questions, please contact me at (269) 466-2649.

Sincerely,

Michael K. Scarpello
Regulatory Affairs Manager

DMB/kmh

Enclosure:

Donald C. Cook Nuclear Plant Unit 1 Cycle 27 Core Operating Limits Report, Revision 0

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A001
NRR

ENCLOSURE TO AEP-NRC-2016-41

Donald C. Cook Nuclear Plant Unit 1 Cycle 27

Core Operating Limits Report
Revision 0

Donald C. Cook Nuclear Plant
Unit 1 Cycle 27
Core Operating Limits Report

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Donald C. Cook Nuclear Plant Unit 1 Cycle 27 design has been prepared in accordance with the requirements of Technical Specification 5.6.5.

The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC in:

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

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

c. WCAP-10216-P-A, Rev. 1A, Relaxation of Constant Axial Offset Control/F_Q Surveillance Technical Specification, February 1994

d. Plant-specific adaptation of WCAP-16009-P-A, Revision 1, Realistic Large Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM), as approved by NRC Safety Evaluation dated October 17, 2008

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

f. WCAP-8745-P-A, Design Bases for the Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions, September 1986

g. WCAP-13749-P-A, Safety Evaluation Supporting the Conditional Exemption of the Most Negative EOL Moderator Temperature Coefficient Measurement, March 1997

h. WCAP-12610-P-A & CENPD-404-P-A, Addendum 1-A, Optimized ZIRLO™, July 2006.

The Technical Specifications affected by this report are listed below:

2.1.1	Reactor Core Safety Limits
3.1.1	SHUTDOWN MARGIN (SDM)
3.1.3	Moderator Temperature Coefficient (MTC)
3.1.5	Shutdown Bank Insertion Limits
3.1.6	Control Bank Insertion Limits
3.2.1	Heat Flux Hot Channel Factor ($\mathbf{F_Q(Z)}$)
3.2.2	Nuclear Enthalpy Rise Hot Channel Factor ($\mathbf{F^N_{\Delta H}}$)
3.2.3	AXIAL FLUX DIFFERENCE (AFD)
3.3.1	Reactor Trip System (RTS) Instrumentation
3.4.1	RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits
3.9.1	Boron Concentration

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using the NRC-approved methodologies specified in Technical Specifications 5.6.5.

2.1 SAFETY LIMITS

2.1.1 Reactor Core Safety Limits (Specification 2.1.1)

In Modes 1 and 2, the combination of thermal power, pressurizer pressure, and the highest loop average temperature ($\mathbf{T_{avg}}$) shall not exceed the limits as shown in Figure 6 for 4 loop operation.

2.2 REACTIVITY CONTROL

2.2.1 SHUTDOWN MARGIN (SDM) (Specification 3.1.1)

Shutdown margin shall be greater than or equal to 1.3% Δk/k for $T_{avg} > 200°F$
Shutdown margin shall be greater than or equal to 1.0% Δk/k for $T_{avg} \leq 200°F$

2.2.2 Moderator Temperature Coefficient (MTC) (Specification 3.1.3)

a. The Moderator Temperature Coefficient (MTC) limits are:

The BOL/ARO-MTC shall be less positive or equal to the value given in Figure 1.

The EOL/ARO/RTP-MTC shall be less negative or equal to –4.54E-4 **Δk/k/°F**.

This limit is based on a $\mathbf{T_{avg}}$ program with HFP vessel $\mathbf{T_{avg}}$ of 569.0 to 573.0 °F.

Where: ARO stands for All Rods Out
BOL stands for Beginning of Cycle Life
EOL stands for End of Cycle Life
RTP stands for Rated Thermal Power
HFP stands for Hot Full Thermal Power

b. The MTC Surveillance limit is:
The 300 ppm/ARO/RTP-MTC should be less negative or equal to –3.84E-4 **Δk/k/°F** at a HFP vessel $\mathbf{T_{avg}}$ of 569.0 to 573.0 °F.

c. The Revised Predicted near-EOL 300 ppm MTC shall be calculated using Figure 7 and the following algorithm:

Revised Predicted MTC = Predicted MTC + AFD Correction + Predicted Correction*

* Predicted Correction is -0.30E-4 **Δk/k/°F**.

If the Revised Predicted MTC is less negative than the SR 3.1.3.2 limit (COLR 2.2.2.b) and all of the benchmark data contained in the surveillance procedure are met, then a MTC measurement in accordance with SR 3.1.3.2 is not required.

d. The MTC Surveillance limit is:
The 60 ppm/ARO/RTP-MTC should be less negative or equal to -4.41E-4 **Δk/k/°F** at a HFP vessel $\mathbf{T_{avg}}$ of 569.0 to 573.0 °F

2.2.3 Shutdown Bank Insertion Limits (Specification 3.1.5)

The shutdown rods shall be withdrawn to at least 228 steps.

2.2.4 Control Bank Insertion Limits (Specifications 3.1.6)

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

b. Successive Control Banks shall overlap by 100 steps. The sequence for Control Bank withdrawal shall be Control Bank A, Control Bank B, Control Bank C and Control Bank D.

2.3 POWER DISTRIBUTION LIMITS

2.3.1 AXIAL FLUX DIFFERENCE (AFD) (Specification 3.2.3)

a. The Allowable Operation Limits are provided in Figure 3.

b. The AFD target band is ±5% for a cycle average accumulated burnup ≥0.0 MWD/MTU.

2.3.2 Heat Flux Hot Channel Factor ($F_Q(Z)$) (Specification 3.2.1)

$$F_Q^C(Z) \leq \frac{CF_Q}{P} * K(Z) \qquad for\ P > 0.5$$

$$F_Q^C(Z) \leq 2 * CF_Q * K(Z) \qquad for\ P \leq 0.5$$

$$F_Q^W(Z) \leq \frac{CF_Q}{P} * K(Z) \qquad for\ P > 0.5$$

$$F_Q^W(Z) \leq 2 * CF_Q * K(Z) \qquad for\ P \leq 0.5$$

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

a. $\mathbf{CF_Q} = 2.09$

b. **K(Z)** is provided in Figure 4.

c. $\mathbf{F_Q^C(Z)}$ is the measured hot channel factor including a 3% manufacturing tolerance uncertainty and a 5% measurement uncertainty.

d. **W(Z)** is provided in Table 1 for ±5% AFD target band.

e. $\mathbf{F_Q^W(Z) = F_Q^C(Z)}$ x $\mathbf{W(Z)}$ x $\mathbf{F_P}$

The W(z) values are generated assuming that they will be used for a full power surveillance. When a part power surveillance is performed, the W(z) values should be multiplied by the factor 1/P, when P is > 0.5. When P is ≤ 0.5, the W(z) values should be multiplied by the factor 1/(0.5), or 2.0. This is consistent with the adjustment in the $F_Q(z)$ limit at part power conditions.

f. For Cycle 27, $\mathbf{F_P}$ = 1.02 for all burnups associated with Note 2a of SR 3.2.1.2, except as shown in the table below. When no penalty is required, $\mathbf{F_P}$ = 1.00.

Cycle Burnup (MWD/MTU)	F_P Penalty Multiplier
1762	1.0200
1908	1.0225
2055	1.0237
2201	1.0245
2348	1.0245
2494	1.0239
2641	1.0227
2787	1.0213
2934	1.0200

The burnup range only covers where F_P exceeds 1.02. Linear interpolation is adequate for intermediate cycle burnups.

2.3.3 Nuclear Enthalpy Rise Hot Channel Factor ($\mathbf{F^N_{\Delta H}}$) (Specification 3.2.2)

$$\mathbf{F^N_{\Delta H}} \leq \mathbf{CF_{\Delta H}} * (1 + \mathbf{PF_{\Delta H}} *(1\text{-}P))$$

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

a. $\mathbf{CF_{\Delta H}}$ = 1.53

b. $\mathbf{PF_{\Delta H}}$ = 0.3

c. $\mathbf{F^N_{\Delta H}}$ is the measured Enthalpy Rise Hot Channel Factor including a 4% measurement uncertainty.

2.4 INSTRUMENTATION

2.4.1 Reactor Trip System (RTS) Instrumentation (Specification 3.3.1)

The Overtemperature **ΔT** and Overpower **ΔT** setpoints are as shown in Figure 5.

2.5 REACTOR COOLANT SYSTEM

2.5.1 RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits (Specification 3.4.1)

a. Pressurizer Pressure shall be ≥ 2168 psig $^{+}$

b. Reactor Coolant System T_{AVG} shall be ≤ 580.5°F $^{+}$

c. Reactor Coolant System Total Flow Rate shall be ≥ 362,900 gpm

2.6 REFUELING OPERATIONS

2.6.1 Boron Concentration (Specification 3.9.1)

The boron concentration of all filled portions of the Reactor Coolant System, the refueling canal and the refueling cavity shall be greater than or equal to 2400 ppm^{++}.

$^{+}$ These are Safety Analysis values. With readability allowance, the corresponding values are 578.2°F for $\mathbf{T_{avg}}$, and 2200 psig for Pressurizer Pressure.

$^{++}$ This concentration bounds the condition of $K_{eff} \leq 0.95$ which includes a 1% Δk/k conservative allowance for uncertainties. The boron concentration of 2400 ppm includes a 50 ppm conservative allowance for uncertainties.

FIGURE 1

MODERATOR TEMPERATURE COEFFICIENT (MTC) LIMITS

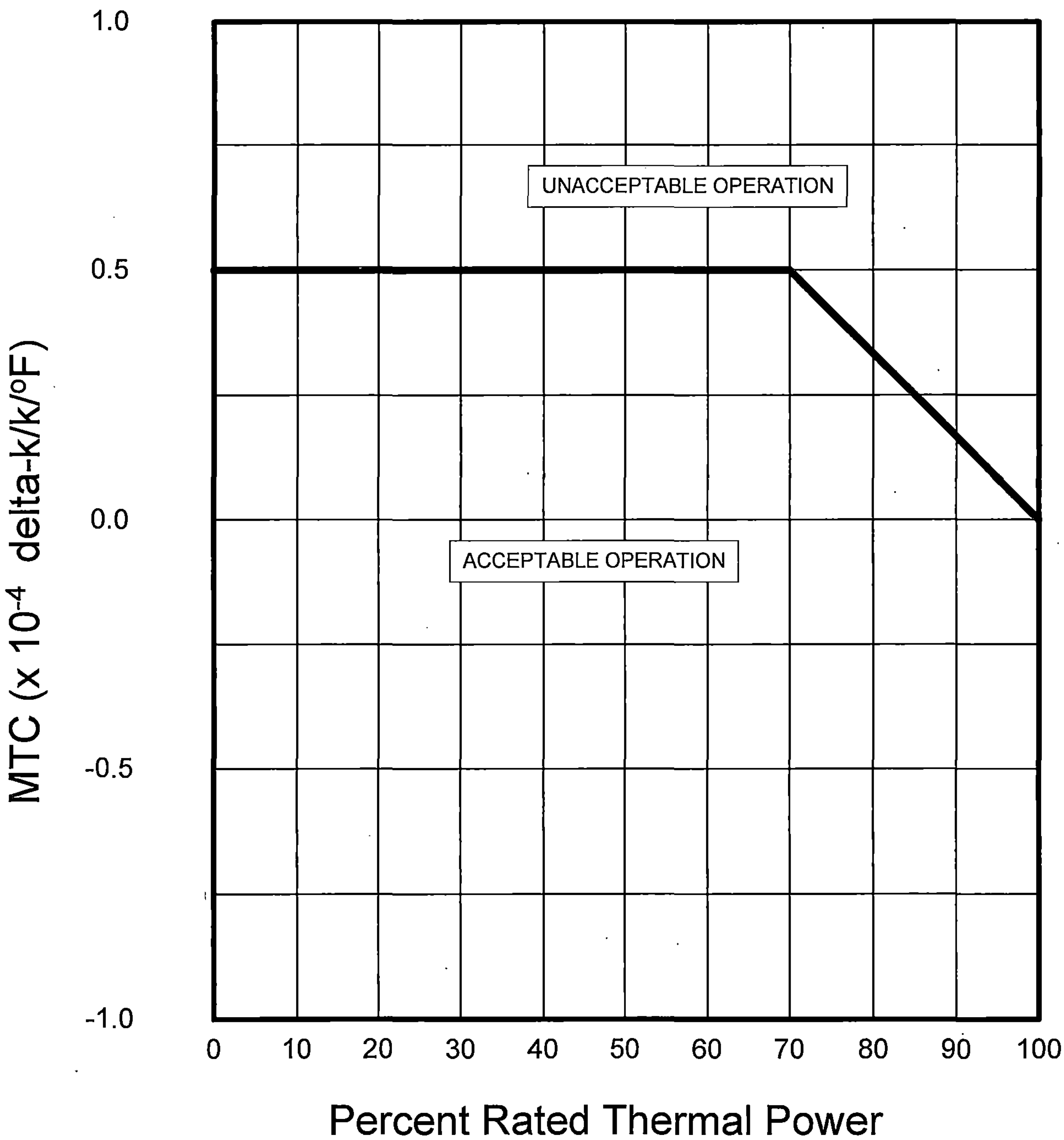


FIGURE 2

ROD BANK INSERTION LIMITS VERSUS THERMAL POWER

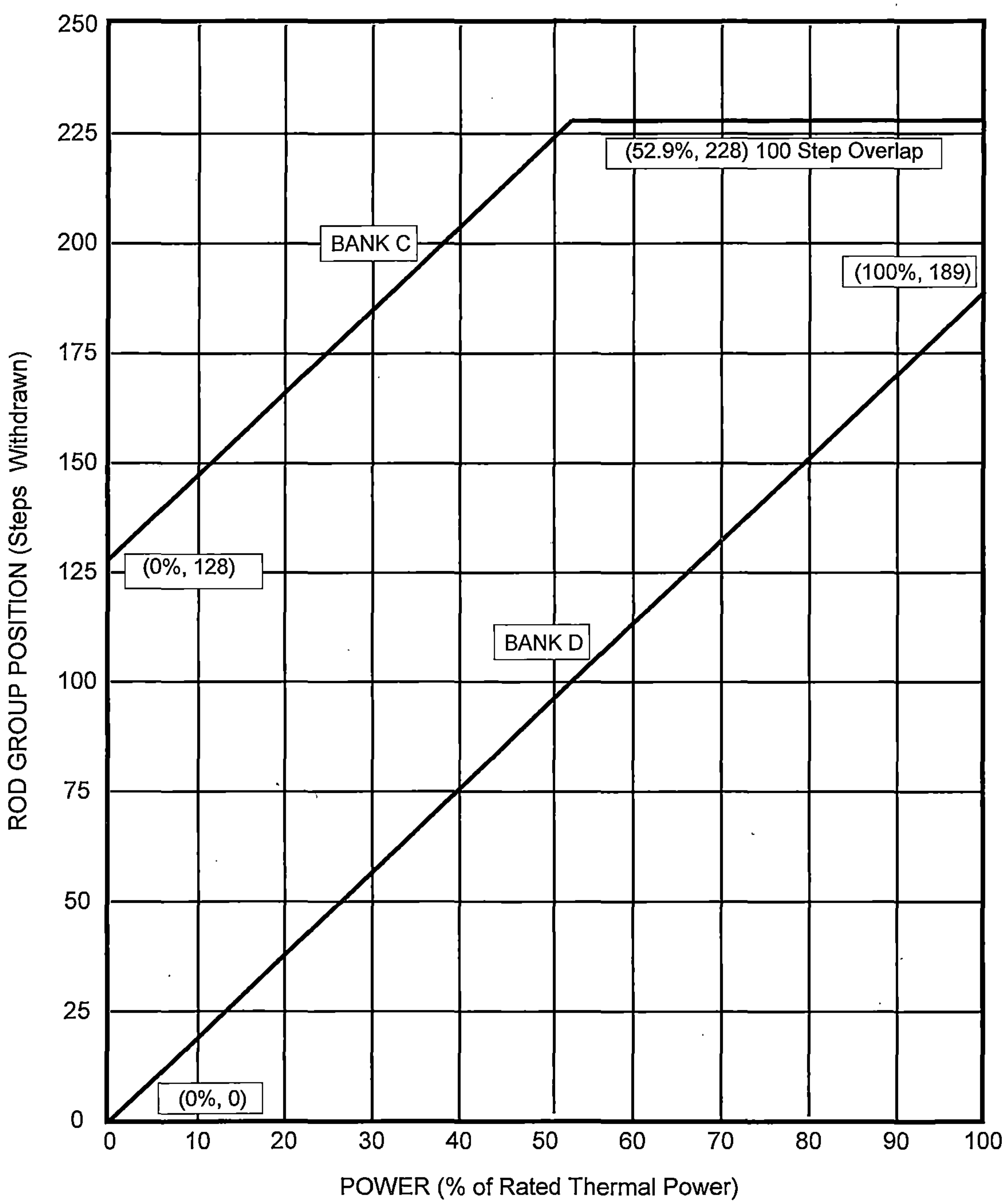


FIGURE 3

AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF RATED THERMAL POWER (RTP)

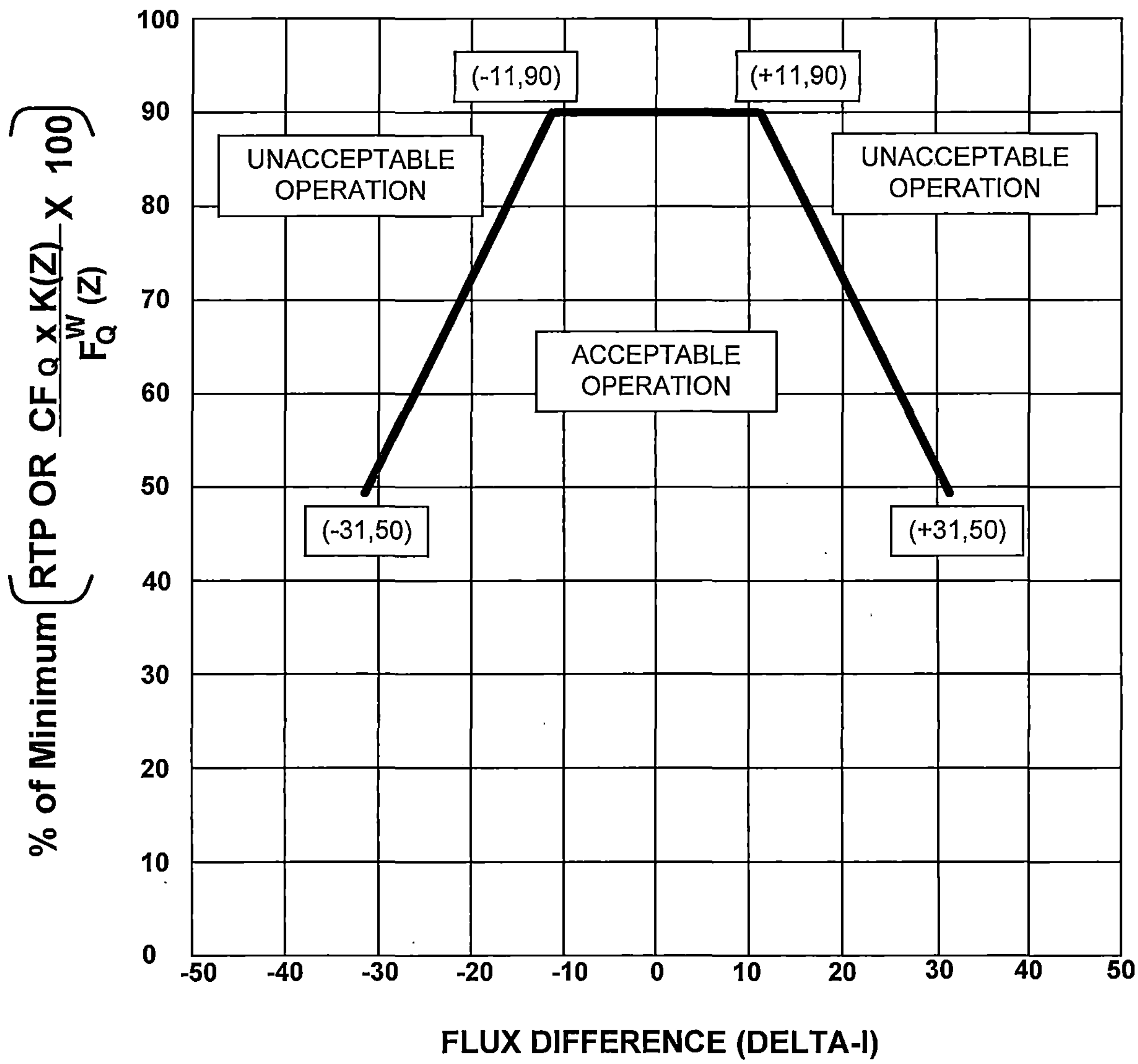


FIGURE 4

K(Z) – NORMALIZED $F_Q(Z)$ AS A FUNCTION OF CORE HEIGHT

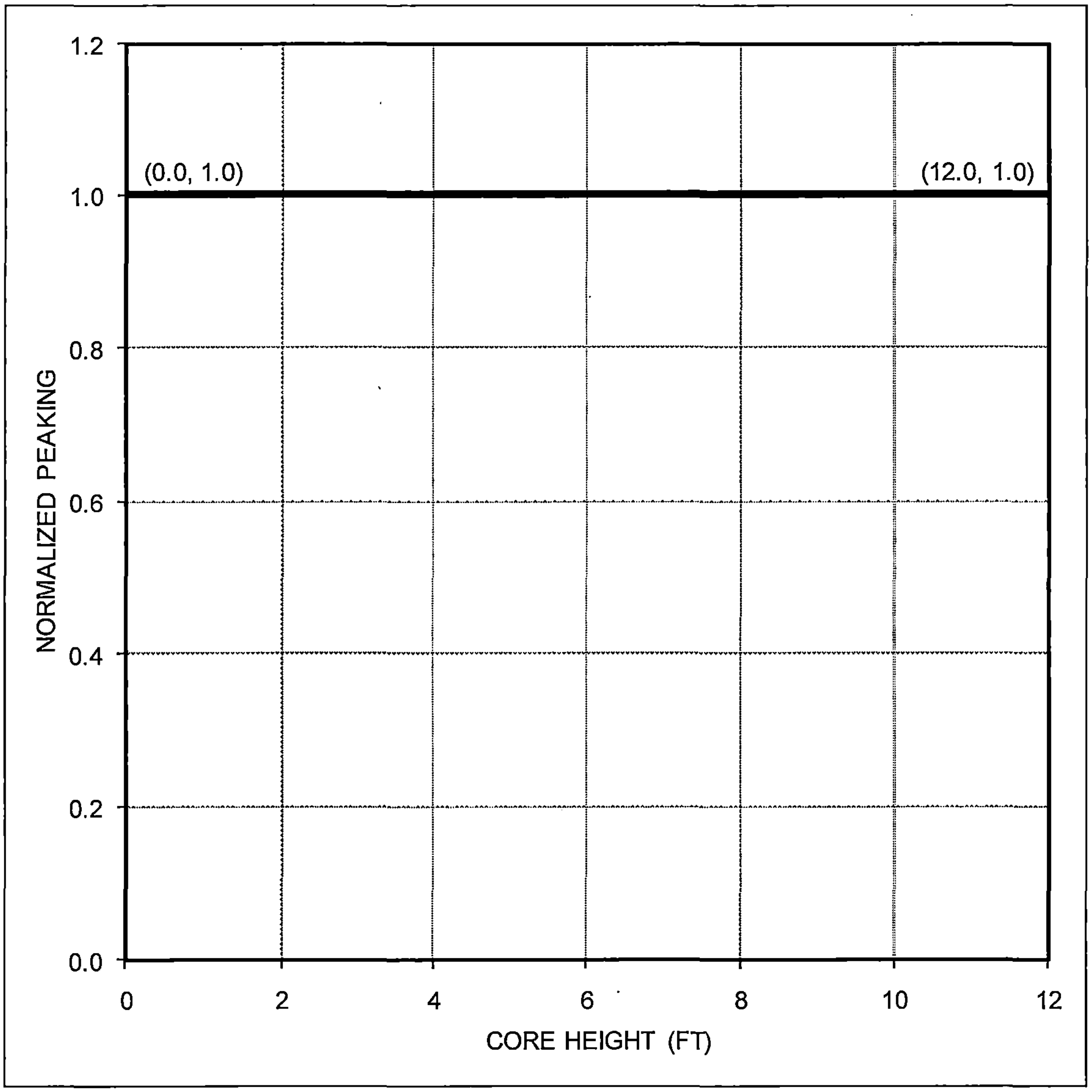


FIGURE 5

(Page 1 of 2)

Reactor Trip System Instrumentation Trip Setpoints

Overtemperature ΔT Trip Setpoint

$$\text{Overtemperature } \Delta T \leq \Delta T_0 \left[K_1 - K_2 \left[\frac{1+\tau_1 s}{1+\tau_2 s}\right] (T-T') + K_3 (P-P') - f_1(\Delta I)\right]$$

Where:

ΔT	=	Measured RCS ΔT, °F
ΔT_0	=	Indicated ΔT at RATED THERMAL POWER, °F
T	=	Average temperature, °F
T'	=	Nominal T_{avg} at RATED THERMAL POWER (≤ 575.4 °F)
P	=	Pressurizer pressure, psig
P'	=	Nominal RCS operating pressure (2235 psig)
$\frac{1+\tau_1 s}{1+\tau_2 s}$	=	The function generated by the lead-lag controller for T_{avg} dynamic compensation
τ_1, τ_2	=	Time constants utilized in the lead-lag controller for T_{avg} $\tau_1 \geq 22$ secs. $\tau_2 \leq 4$ secs.
S	=	Laplace transform operator, sec^{-1}
K_1	≤	1.35 *
K_2	≥	0.0230/°F
K_3	≥	0.00110/psi
$f_1(\Delta I)$	=	$-0.33\{37\% + (q_t - q_b)\}$ when $q_t - q_b \leq -37\%$ RTP 0% of RTP when -37% RTP $< q_t - q_b \leq 3\%$ RTP $+2.34\{(q_t - q_b) - 3\%\}$ when $q_t - q_b > 3\%$ RTP

where q_t and q_b are percent RATED THERMAL POWER in the upper and lower halves of the core respectively, and $q_t + q_b$ is total THERMAL POWER in percent RATED THERMAL POWER.

* This is a Safety Analysis value. Refer to Technical Requirements Manual for nominal value of this coefficient used in programming the trip setpoint.

FIGURE 5

(Page 2 of 2)

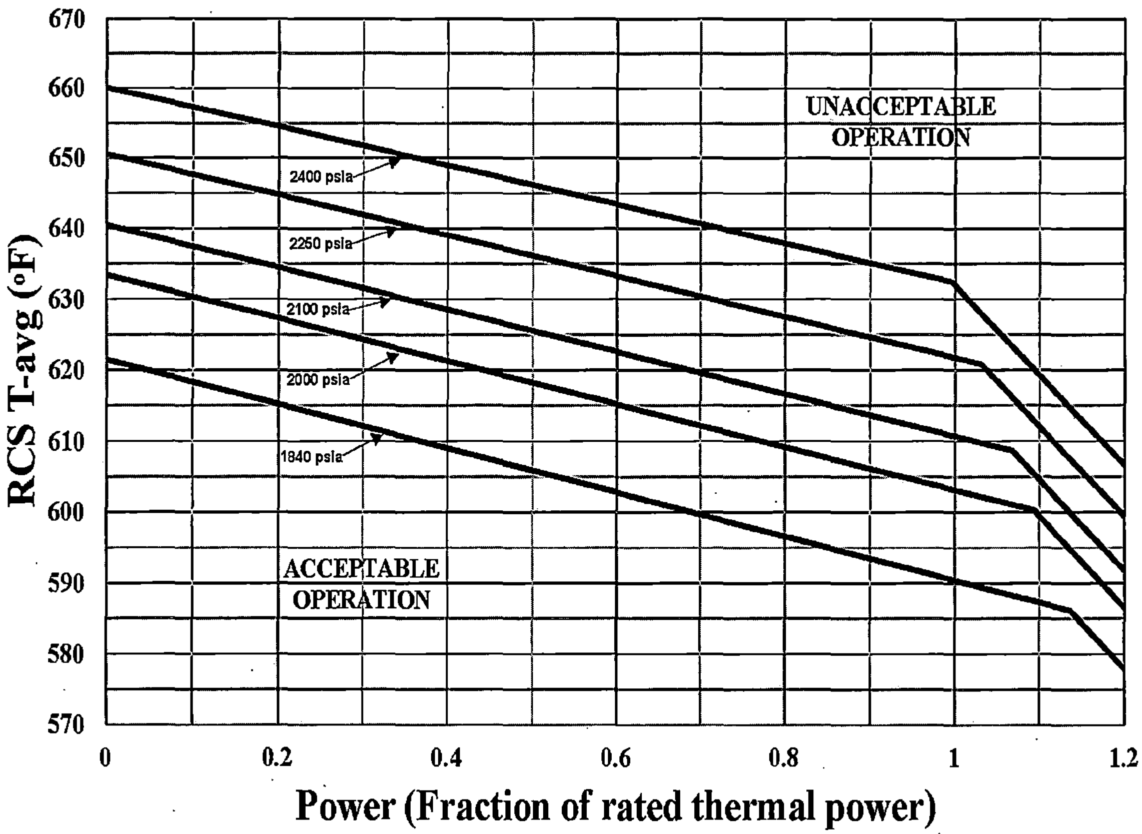
Overpower ΔT Trip Setpoint

Overpower $\Delta T \leq \Delta T_o \; [K_4 - K_5 \left[\frac{\tau_3 S}{1+\tau_3 S}\right] T - K_6 (T - T'') - f_2(\Delta I)]$

Where:	ΔT	=	Measured RCS ΔT, °F
	ΔT_o	=	Indicated ΔT at RATED THERMAL POWER, °F
	T	=	Average temperature, °F
	T''	=	Nominal T_{avg} at RATED THERMAL POWER (≤ 575.4 °F)
	K_4	≤	1.172 *
	K_5	≥	0.0177/°F for increasing average temperature ; K_5 = 0 for decreasing average temperature
	K_6	≥	0.0015/°F for **T** greater than **T''** ; K_6 = 0 for **T** less than or equal to **T''**
	$\frac{\tau_3 S}{1+\tau_3 S}$	=	The function generated by the rate lag controller for T_{avg} dynamic compensation
	τ_3	=	Time constant utilized in the rate lag controller for T_{avg} $\tau_3 \geq 10$ secs.
	S	=	Laplace transform operator, sec^{-1}
	$f_2(\Delta I)$	=	0.0

* This is a Safety Analysis value. Refer to Technical Requirements Manual for nominal value of this coefficient used in programming the trip setpoint.

FIGURE 6
Reactor Core Safety Limits

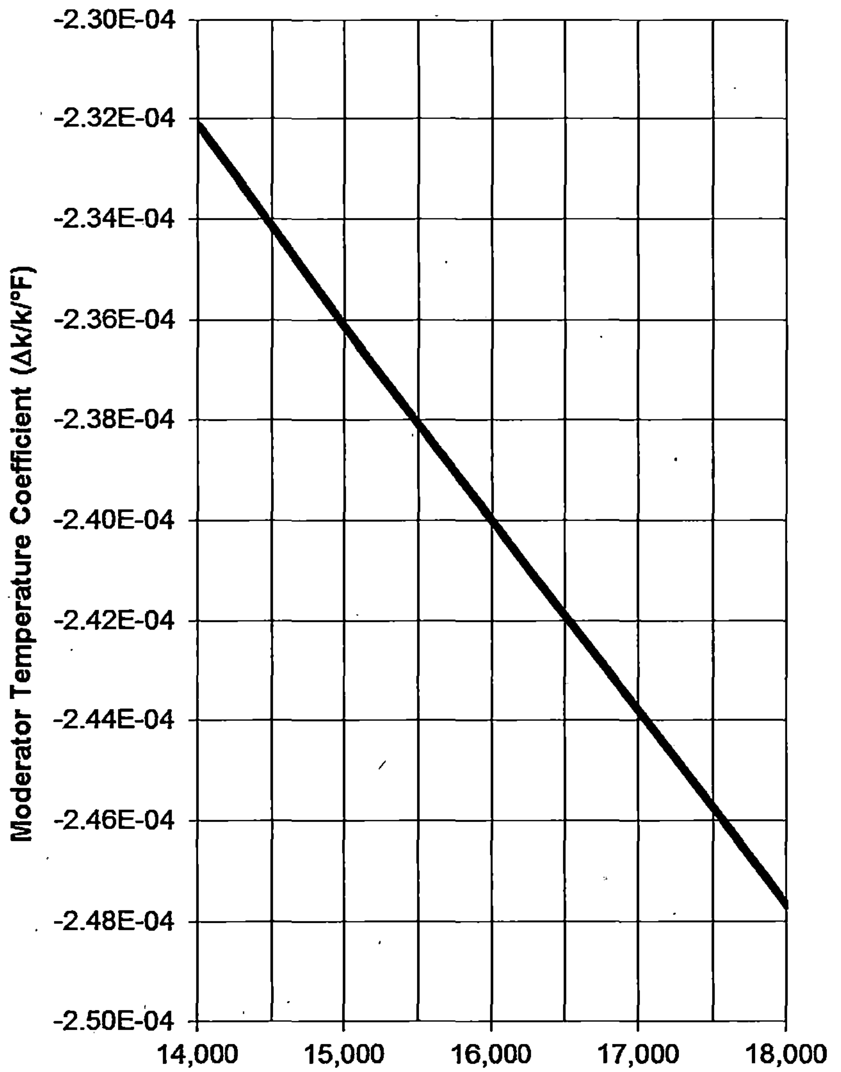


DESCRIPTION OF SAFETY LIMITS

Pressure (psia)	Power (frac)	Tavg (°F)	Power (frac)	Tavg (°F)	Power (frac)	Tavg (°F)	Power (frac)	Tavg (°F)
1840	0.0	621.48	0.02	620.86	1.136	586.17	1.2	577.94
2000	0.0	633.39	0.02	632.79	1.094	600.31	1.2	586.52
2100	0.0	640.44	0.02	639.85	1.068	608.72	1.2	591.77
2250	0.0	650.54	0.02	649.96	1.031	620.83	1.2	599.40
2400	0.0	660.08	0.02	659.52	0.996	632.42	1.2	606.63

FIGURE 7

Unit 1 Cycle 27 Predicted HFP ARO 300 PPM MTC Versus Burnup



Burnup (MWD/MTU)	MTC (pcm/°F)	MTC (Δk/k/°F)
14,000	-23.213	-2.3213E-04
15,000	-23.614	-2.3614E-04
16,000	-24.002	-2.4002E-04
17,000	-24.379	-2.4379E-04
18,000	-24.766	-2.4766E-04

TABLE 1
DONALD C. COOK UNIT 1 CYCLE 27
W(Z) FUNCTION

Node	Height	Burnup (MWD/MTU)					
#	(ft)	150	1000	2000	4000	6000	8000
1	0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.2	1.1052	1.1018	1.0987	1.0966	1.0995	1.1052
8	1.4	1.1047	1.1017	1.0989	1.0971	1.0999	1.1051
9	1.6	1.1040	1.1013	1.0989	1.0974	1.1000	1.1049
10	1.8	1.1030	1.1007	1.0987	1.0975	1.0999	1.1042
11	2.0	1.1018	1.0999	1.0982	1.0973	1.0995	1.1032
12	2.2	1.1002	1.0988	1.0975	1.0969	1.0988	1.1019
13	2.4	1.0984	1.0974	1.0966	1.0963	1.0978	1.1003
14	2.6	1.0963	1.0958	1.0954	1.0954	1.0966	1.0983
15	2.8	1.0940	1.0940	1.0940	1.0943	1.0951	1.0960
16	3.0	1.0914	1.0918	1.0923	1.0929	1.0932	1.0934
17	3.2	1.0887	1.0896	1.0904	1.0913	1.0912	1.0906
18	3.4	1.0865	1.0877	1.0889	1.0899	1.0894	1.0880
19	3.6	1.0854	1.0870	1.0884	1.0895	1.0885	1.0866
20	3.8	1.0847	1.0864	1.0880	1.0891	1.0878	1.0854
21	4.0	1.0843	1.0859	1.0874	1.0884	1.0871	1.0850
22	4.2	1.0841	1.0854	1.0867	1.0877	1.0868	1.0852
23	4.4	1.0837	1.0848	1.0859	1.0869	1.0862	1.0851
24	4.6	1.0831	1.0840	1.0849	1.0857	1.0854	1.0847
25	4.8	1.0824	1.0831	1.0838	1.0845	1.0843	1.0841
26	5.0	1.0814	1.0820	1.0825	1.0831	1.0831	1.0833
27	5.2	1.0804	1.0807	1.0811	1.0816	1.0817	1.0824
28	5.4	1.0797	1.0796	1.0796	1.0796	1.0799	1.0810
29	5.6	1.0792	1.0785	1.0779	1.0774	1.0777	1.0792
30	5.8	1.0783	1.0770	1.0759	1.0748	1.0755	1.0777

Top and bottom 10% of core excluded.

TABLE 1 (continued)
DONALD C. COOK UNIT 1 CYCLE 27
W(Z) FUNCTION

Node	Height	Burnup (MWD/MTU)					
#	(ft)	150	1000	2000	4000	6000	8000
31	6.0	1.0771	1.0752	1.0736	1.0723	1.0736	1.0770
32	6.2	1.0756	1.0733	1.0712	1.0699	1.0721	1.0767
33	6.4	1.0737	1.0710	1.0686	1.0673	1.0702	1.0758
34	6.6	1.0712	1.0681	1.0654	1.0641	1.0678	1.0745
35	6.8	1.0696	1.0665	1.0638	1.0626	1.0665	1.0731
36	7.0	1.0683	1.0656	1.0632	1.0624	1.0662	1.0725
37	7.2	1.0678	1.0649	1.0624	1.0615	1.0655	1.0722
38	7.4	1.0711	1.0668	1.0630	1.0608	1.0653	1.0732
39	7.6	1.0742	1.0703	1.0668	1.0650	1.0693	1.0769
40	7.8	1.0777	1.0746	1.0719	1.0706	1.0745	1.0811
41	8.0	1.0816	1.0788	1.0764	1.0753	1.0787	1.0845
42	8.2	1.0850	1.0828	1.0808	1.0800	1.0829	1.0877
43	8.4	1.0882	1.0865	1.0850	1.0844	1.0867	1.0905
44	8.6	1.0910	1.0899	1.0888	1.0885	1.0903	1.0930
45	8.8	1.0935	1.0929	1.0924	1.0924	1.0936	1.0952
46	9.0	1.0956	1.0956	1.0956	1.0959	1.0964	1.0970
47	9.2	1.0973	1.0979	1.0985	1.0991	1.0988	1.0982
48	9.4	1.0986	1.0998	1.1010	1.1017	1.1006	1.0987
49	9.6	1.1000	1.1018	1.1034	1.1044	1.1023	1.0993
50	9.8	1.1010	1.1034	1.1056	1.1067	1.1037	1.0993
51	10.0	1.1018	1.1049	1.1077	1.1091	1.1053	1.0998
52	10.2	1.1019	1.1056	1.1089	1.1110	1.1073	1.1017
53	10.4	1.1029	1.1066	1.1101	1.1124	1.1091	1.1038
54	10.6	1.1089	1.1134	1.1176	1.1199	1.1151	1.1076
55	10.8	1.1068	1.1113	1.1155	1.1184	1.1145	1.1082
56	11.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
57	11.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
58	11.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
59	11.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
60	11.8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	12.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Top and bottom 10% of core excluded.

TABLE 1 (continued)
DONALD C. COOK UNIT 1 CYCLE 27
W(Z) FUNCTION

Node #	Height (ft)	Burnup (MWD/MTU) 10000	12000	14000	16000	18000	19516
1	0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.2	1.1114	1.1169	1.1217	1.1266	1.1319	1.1358
8	1.4	1.1110	1.1160	1.1205	1.1251	1.1299	1.1335
9	1.6	1.1102	1.1148	1.1189	1.1230	1.1274	1.1307
10	1.8	1.1090	1.1131	1.1167	1.1203	1.1241	1.1270
11	2.0	1.1073	1.1108	1.1139	1.1170	1.1202	1.1227
12	2.2	1.1053	1.1082	1.1107	1.1131	1.1157	1.1177
13	2.4	1.1029	1.1051	1.1070	1.1088	1.1107	1.1122
14	2.6	1.1001	1.1016	1.1028	1.1040	1.1053	1.1063
15	2.8	1.0970	1.0977	1.0984	1.0989	1.0995	1.1000
16	3.0	1.0935	1.0935	1.0935	1.0934	1.0933	1.0932
17	3.2	1.0898	1.0891	1.0885	1.0878	1.0871	1.0866
18	3.4	1.0866	1.0856	1.0850	1.0845	1.0838	1.0833
19	3.6	1.0848	1.0843	1.0847	1.0856	1.0863	1.0866
20	3.8	1.0836	1.0835	1.0847	1.0868	1.0887	1.0896
21	4.0	1.0835	1.0837	1.0854	1.0881	1.0905	1.0918
22	4.2	1.0842	1.0848	1.0866	1.0894	1.0919	1.0934
23	4.4	1.0846	1.0855	1.0877	1.0907	1.0935	1.0952
24	4.6	1.0848	1.0865	1.0894	1.0933	1.0970	1.0993
25	4.8	1.0849	1.0874	1.0914	1.0965	1.1014	1.1045
26	5.0	1.0847	1.0880	1.0930	1.0994	1.1054	1.1094
27	5.2	1.0843	1.0884	1.0943	1.1017	1.1088	1.1134
28	5.4	1.0836	1.0884	1.0951	1.1034	1.1115	1.1168
29	5.6	1.0825	1.0879	1.0953	1.1045	1.1135	1.1194
30	5.8	1.0817	1.0877	1.0956	1.1052	1.1145	1.1208

Top and bottom 10% of core excluded.

TABLE 1 (continued)
DONALD C. COOK UNIT 1 CYCLE 27
W(Z) FUNCTION

Node #	Height (ft)	Burnup (MWD/MTU) 10000	12000	14000	16000	18000	19516
31	6.0	1.0819	1.0884	1.0961	1.1054	1.1146	1.1207
32	6.2	1.0826	1.0892	1.0966	1.1050	1.1135	1.1194
33	6.4	1.0825	1.0892	1.0962	1.1039	1.1116	1.1172
34	6.6	1.0819	1.0887	1.0952	1.1019	1.1089	1.1141
35	6.8	1.0805	1.0869	1.0927	1.0985	1.1047	1.1093
36	7.0	1.0794	1.0855	1.0909	1.0963	1.1021	1.1064
37	7.2	1.0793	1.0855	1.0909	1.0962	1.1019	1.1061
38	7.4	1.0815	1.0881	1.0934	1.0983	1.1037	1.1079
39	7.6	1.0847	1.0909	1.0956	1.0999	1.1047	1.1085
40	7.8	1.0878	1.0931	1.0972	1.1008	1.1049	1.1081
41	8.0	1.0904	1.0949	1.0983	1.1013	1.1046	1.1073
42	8.2	1.0926	1.0962	1.0989	1.1011	1.1037	1.1058
43	8.4	1.0943	1.0970	1.0989	1.1005	1.1023	1.1038
44	8.6	1.0957	1.0975	1.0986	1.0994	1.1004	1.1013
45	8.8	1.0967	1.0976	1.0979	1.0979	1.0980	1.0982
46	9.0	1.0973	1.0972	1.0967	1.0960	1.0953	1.0950
47	9.2	1.0974	1.0967	1.0961	1.0955	1.0948	1.0943
48	9.4	1.0972	1.0968	1.0974	1.0987	1.0997	1.1001
49	9.6	1.0970	1.0970	1.0988	1.1019	1.1046	1.1060
50	9.8	1.0962	1.0964	1.0994	1.1043	1.1086	1.1110
51	10.0	1.0959	1.0963	1.1002	1.1067	1.1123	1.1154
52	10.2	1.0977	1.0982	1.1024	1.1092	1.1151	1.1184
53	10.4	1.1001	1.1007	1.1049	1.1115	1.1173	1.1206
54	10.6	1.1020	1.1016	1.1058	1.1128	1.1190	1.1222
55	10.8	1.1034	1.1034	1.1075	1.1143	1.1201	1.1233
56	11.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
57	11.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
58	11.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
59	11.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
60	11.8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	12.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Top and bottom 10% of core excluded.