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October 6, 2022

AEP-NRC-2022-30
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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 31 in accordance with Technical Specification 5.6.5. Revision 0 of the Unit 1 Cycle 31 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 Director

JMT/mph

Enclosure: Donald C. Cook Nuclear Plant Unit 1 Cycle 31 Core Operating Limits Report, Revision 0

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ENCLOSURE TO AEP-NRC-2022-30

Donald C. Cook Nuclear Plant Unit 1 Cycle 31

Core Operating Limits Report
Revision 0

Donald C. Cook Nuclear Plant
Unit 1 Cycle 31
Core Operating Limits Report
Revision 0

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Donald C. Cook Nuclear Plant Unit 1 Cycle 31 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, 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 (**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 **T_{avg}** program with HFP vessel **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)

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

$$F_Q^C(Z) \le 2 * CF_Q * K(Z) \qquad \textit{for } P \le 0.5$$

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

$$F_Q^W(Z) \le 2 * CF_Q * K(Z) \qquad \textit{for } P \le 0.5$$

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

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

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 31, FP = 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, FP = 1.00.

Cycle Burnup (MWD/MTU)	Penalty Factor $F_Q(z)$
2169	1.020
2352	1.022
2536	1.028
2719	1.032
2903	1.035
3086	1.035
3270	1.033
3453	1.030
3637	1.027
3820	1.022
4004	1.020

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

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

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

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

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

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

c. $F^N_{\Delta H}$ 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 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

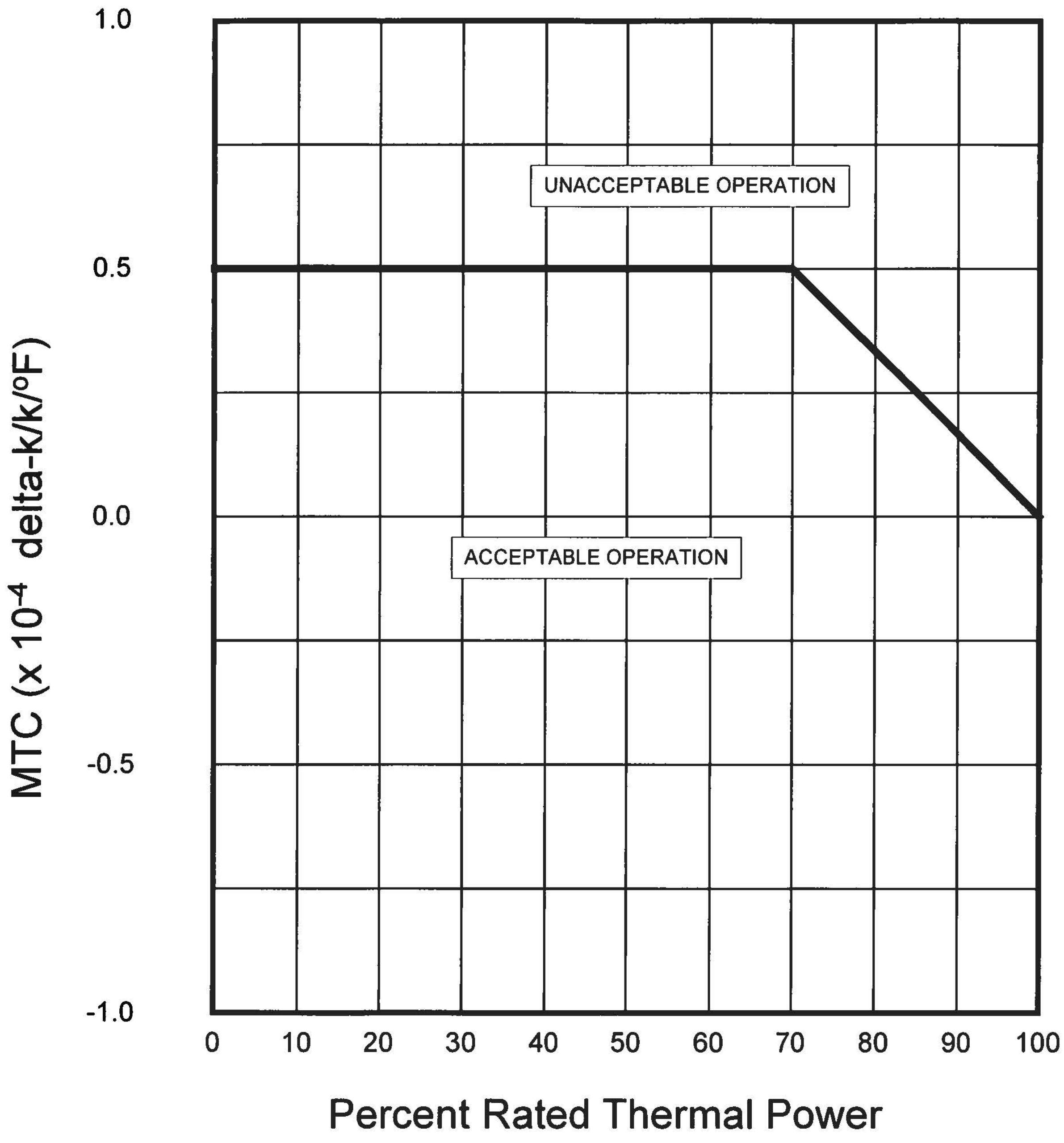


FIGURE 2

ROD BANK INSERTION LIMITS VERSUS THERMAL POWER

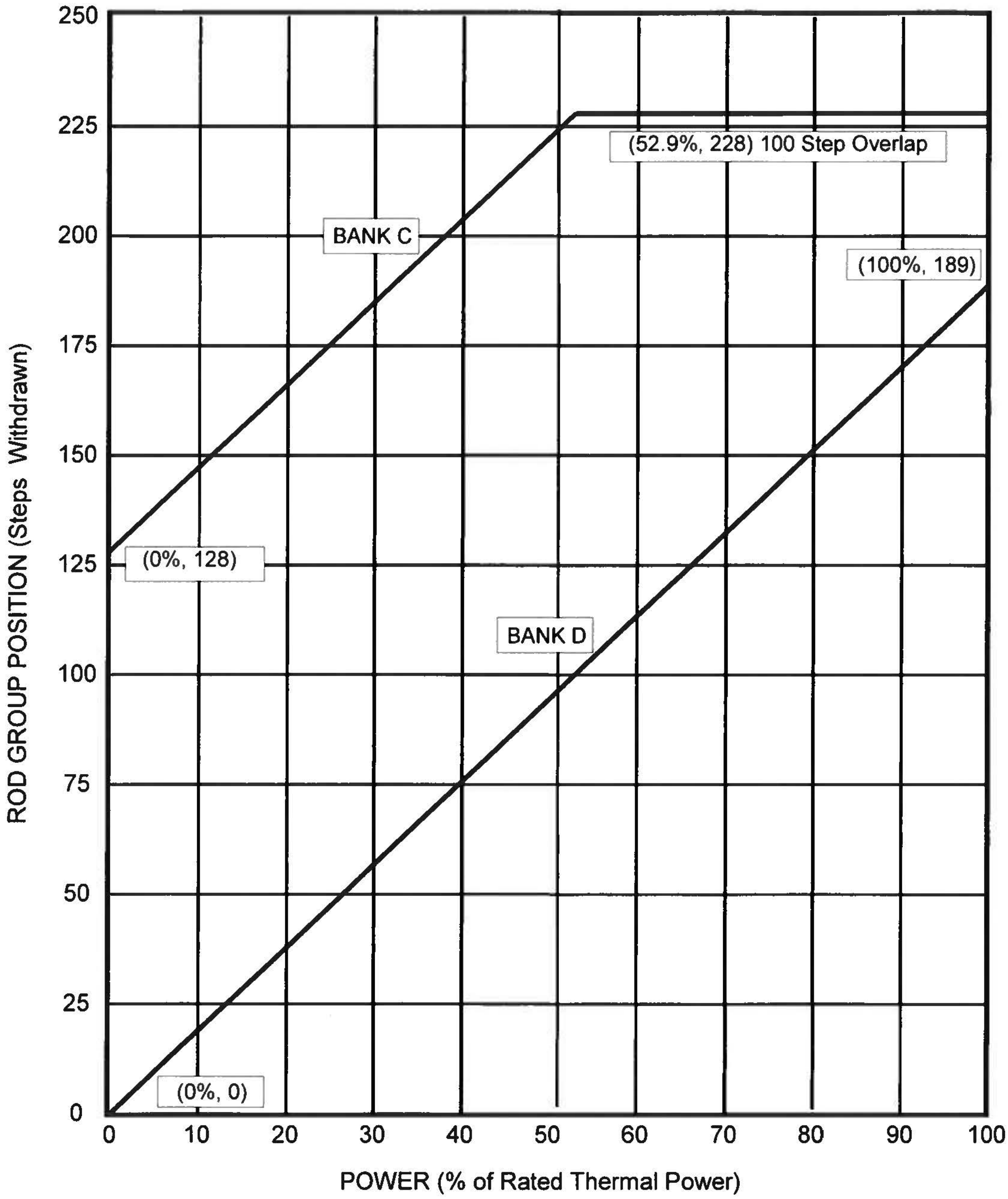


FIGURE 3

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

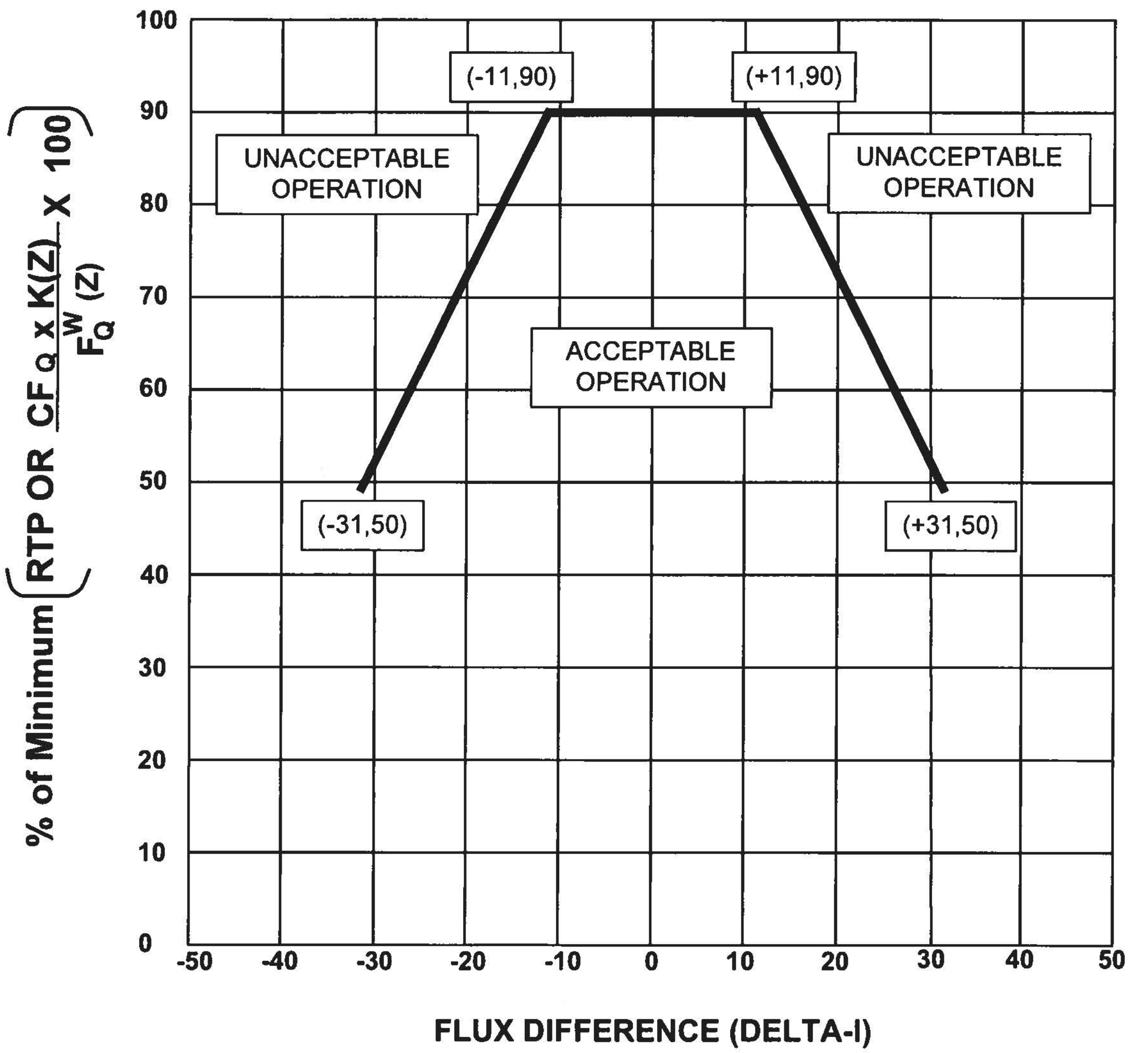


FIGURE 4

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

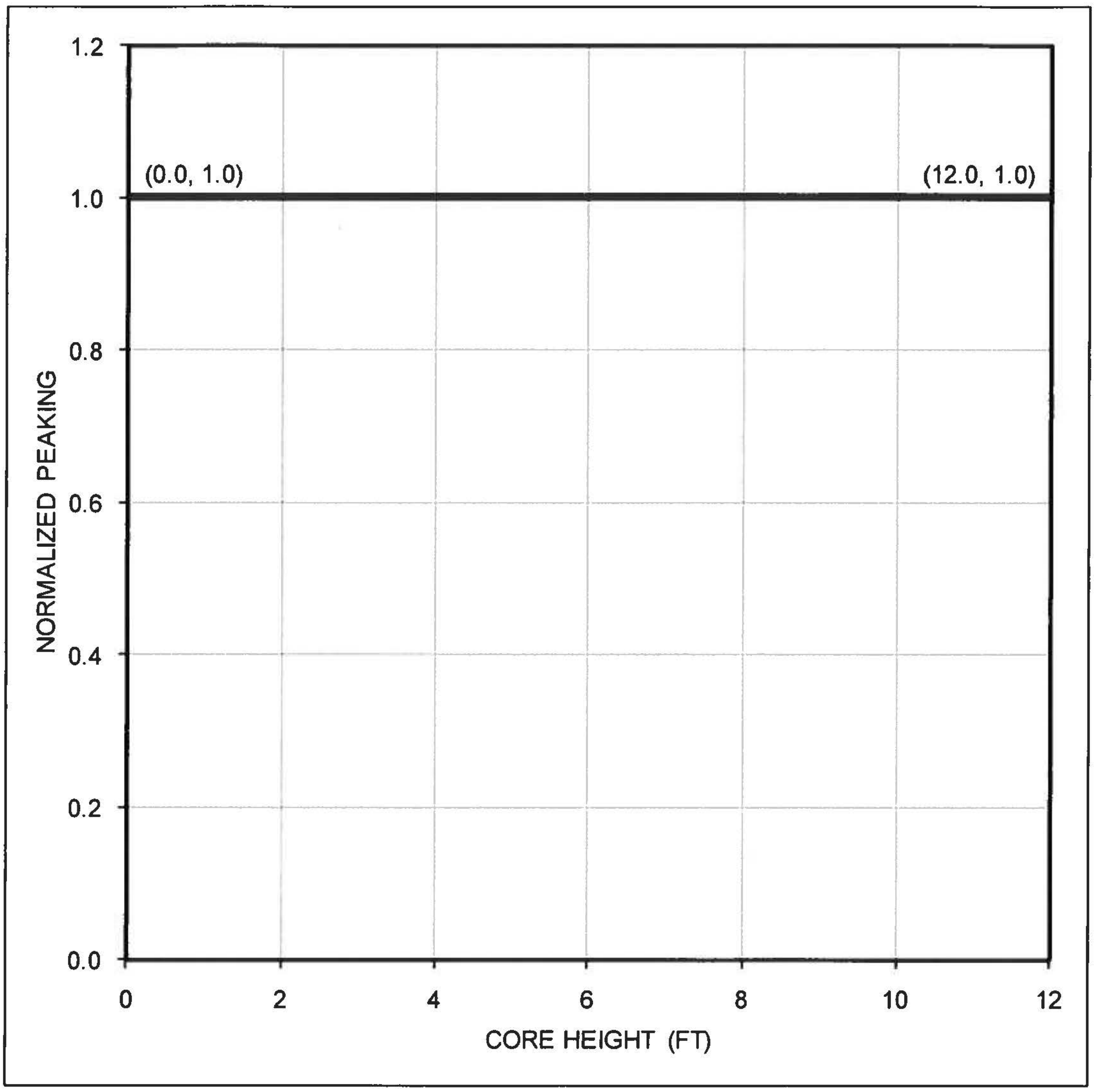


FIGURE 5
(Page 1 of 2)

Reactor Trip System Instrumentation Trip Setpoints

Overtemperature ΔT Trip Setpoint

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

Where:

ΔT	=	Measured RCS ΔT, °F
ΔT_o	=	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} $\tau_1 \ge 22$ secs. $\tau_2 \le 4$ 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 $q_t - q_b \le -37\%$ RTP 0% of RTP when -37% RTP $< q_t - q_b \le 3\%$ 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

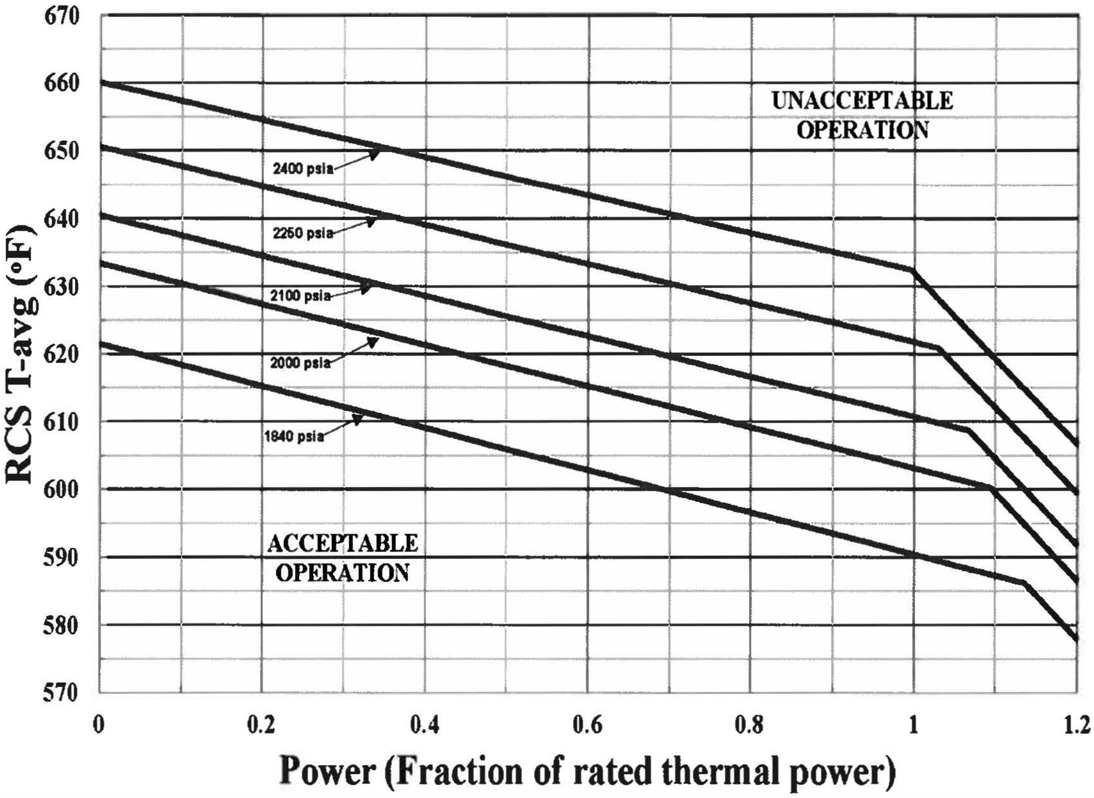
$$\text{Overpower } \Delta T \leq \Delta T_o \left[K_4 - K_5 \left[\frac{\tau_3 S}{1+\tau_3 S}\right] T - K_6 (T - T'') - f_2(\Delta I)\right]$$

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

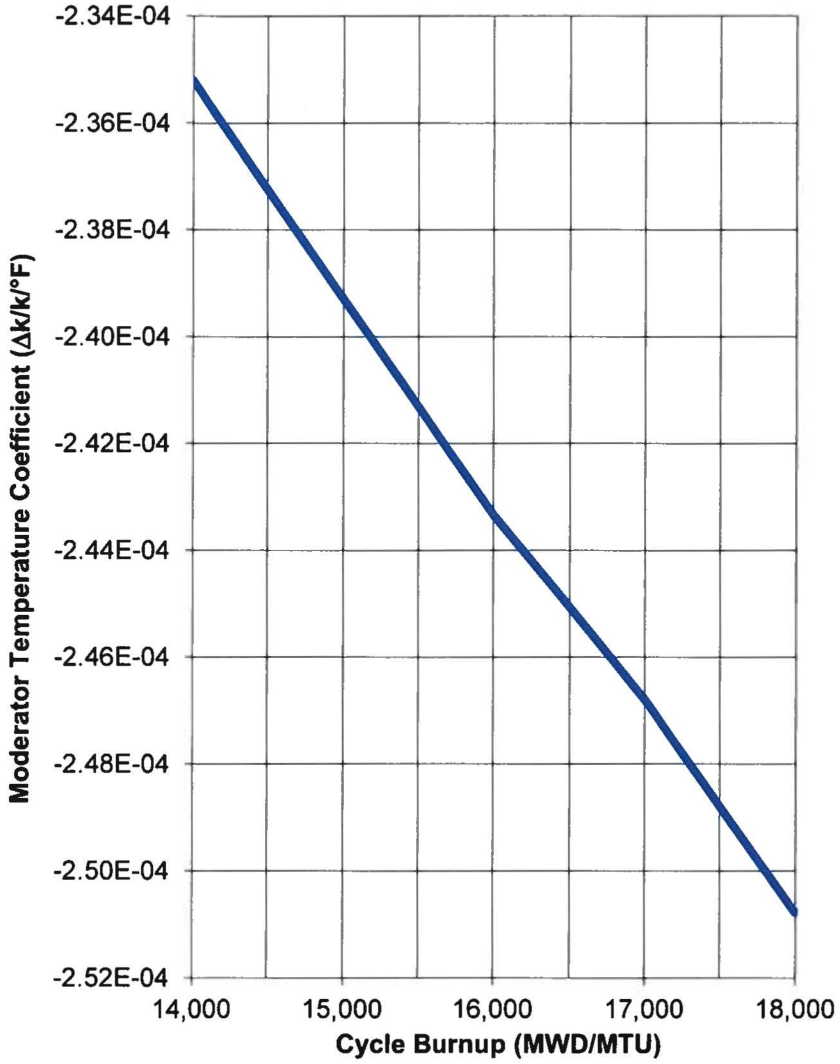


DESCRIPTION OF SAFETY LIMITS

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	599.4
2400	0.0	660.08	0.02	659.52	0.996	632.42	1.2	606.63

FIGURE 7

Unit 1 Cycle 31 Predicted HFP ARO 300 PPM MTC Versus Burnup



Burnup (MWD/MTU)	MTC (pcm/°F)	MTC (Δk/k/°F)
14,000	-23.520	-2.3520E-04
15,000	-23.930	-2.3930E-04
16,000	-24.334	-2.4334E-04
17,000	-24.679	-2.4679E-04
18,000	-25.078	-2.5078E-04

TABLE 1
DONALD C. COOK UNIT 1 CYCLE 31
W(Z) FUNCTION

Node #	Height (ft)	Burnup (MWD/MTU) 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	1.1100	1.1103	1.1106	1.1105	1.1097	1.1091
8	1.4	1.1091	1.1088	1.1085	1.1080	1.1077	1.1080
9	1.6	1.1079	1.1070	1.1063	1.1055	1.1056	1.1067
10	1.8	1.1063	1.1050	1.1038	1.1028	1.1034	1.1052
11	2.0	1.1044	1.1027	1.1011	1.0999	1.1009	1.1033
12	2.2	1.1022	1.1004	1.0987	1.0974	1.0986	1.1013
13	2.4	1.0997	1.0983	1.0970	1.0961	1.0973	1.0996
14	2.6	1.0969	1.0962	1.0955	1.0952	1.0962	1.0979
15	2.8	1.0940	1.0939	1.0939	1.0942	1.0949	1.0958
16	3.0	1.0906	1.0913	1.0919	1.0928	1.0933	1.0934
17	3.2	1.0874	1.0887	1.0899	1.0913	1.0915	1.0909
18	3.4	1.0852	1.0869	1.0885	1.0902	1.0899	1.0887
19	3.6	1.0842	1.0862	1.0880	1.0897	1.0889	1.0870
20	3.8	1.0847	1.0863	1.0878	1.0889	1.0877	1.0855
21	4.0	1.0857	1.0867	1.0876	1.0879	1.0866	1.0847
22	4.2	1.0864	1.0868	1.0871	1.0869	1.0857	1.0842
23	4.4	1.0870	1.0868	1.0865	1.0858	1.0848	1.0839
24	4.6	1.0874	1.0866	1.0857	1.0845	1.0837	1.0835
25	4.8	1.0876	1.0862	1.0848	1.0830	1.0824	1.0828
26	5.0	1.0876	1.0856	1.0837	1.0814	1.0811	1.0820
27	5.2	1.0874	1.0849	1.0825	1.0797	1.0795	1.0810
28	5.4	1.0868	1.0838	1.0809	1.0777	1.0776	1.0796
29	5.6	1.0860	1.0826	1.0794	1.0758	1.0758	1.0781
30	5.8	1.0848	1.0812	1.0777	1.0738	1.0738	1.0764

Top and bottom 10% of core excluded.

TABLE 1 (continued)
DONALD C. COOK UNIT 1 CYCLE 31
W(Z) FUNCTION

Node #	Height (ft)	Burnup (MWD/MTU) 150	1000	2000	4000	6000	8000
31	6.0	1.0832	1.0794	1.0756	1.0715	1.0715	1.0742
32	6.2	1.0813	1.0772	1.0733	1.0689	1.0690	1.0720
33	6.4	1.0789	1.0746	1.0705	1.0662	1.0668	1.0705
34	6.6	1.0759	1.0716	1.0675	1.0636	1.0652	1.0701
35	6.8	1.0734	1.0692	1.0652	1.0619	1.0641	1.0695
36	7.0	1.0726	1.0683	1.0643	1.0610	1.0636	1.0695
37	7.2	1.0731	1.0683	1.0638	1.0603	1.0636	1.0705
38	7.4	1.0764	1.0703	1.0646	1.0599	1.0635	1.0714
39	7.6	1.0794	1.0734	1.0679	1.0633	1.0668	1.0744
40	7.8	1.0817	1.0768	1.0723	1.0687	1.0719	1.0786
41	8.0	1.0842	1.0802	1.0765	1.0737	1.0767	1.0825
42	8.2	1.0870	1.0837	1.0807	1.0785	1.0811	1.0860
43	8.4	1.0896	1.0870	1.0847	1.0831	1.0852	1.0891
44	8.6	1.0918	1.0900	1.0884	1.0874	1.0890	1.0919
45	8.8	1.0937	1.0927	1.0918	1.0914	1.0925	1.0944
46	9.0	1.0952	1.0950	1.0949	1.0951	1.0958	1.0966
47	9.2	1.0963	1.0970	1.0977	1.0985	1.0987	1.0983
48	9.4	1.0969	1.0985	1.1001	1.1015	1.1010	1.0995
49	9.6	1.0978	1.1001	1.1024	1.1043	1.1031	1.1005
50	9.8	1.0983	1.1015	1.1045	1.1069	1.1050	1.1013
51	10.0	1.0986	1.1027	1.1066	1.1095	1.1067	1.1015
52	10.2	1.0982	1.1032	1.1079	1.1114	1.1079	1.1016
53	10.4	1.0986	1.1035	1.1082	1.1121	1.1093	1.1037
54	10.6	1.1044	1.1104	1.1161	1.1207	1.1172	1.1102
55	10.8	1.1019	1.1082	1.1142	1.1191	1.1153	1.1080
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 31
W(Z) FUNCTION

Node #	Height (ft)	10000	12000	14000	16000	18000	20043
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	1.1098	1.1129	1.1179	1.1246	1.1320	1.1376
8	1.4	1.1095	1.1127	1.1174	1.1235	1.1300	1.1353
9	1.6	1.1089	1.1121	1.1165	1.1218	1.1275	1.1323
10	1.8	1.1078	1.1111	1.1149	1.1194	1.1244	1.1286
11	2.0	1.1063	1.1095	1.1128	1.1165	1.1205	1.1241
12	2.2	1.1045	1.1074	1.1101	1.1130	1.1161	1.1191
13	2.4	1.1023	1.1046	1.1067	1.1089	1.1112	1.1135
14	2.6	1.0997	1.1013	1.1028	1.1042	1.1058	1.1073
15	2.8	1.0968	1.0976	1.0984	1.0992	1.0999	1.1007
16	3.0	1.0935	1.0935	1.0936	1.0936	1.0935	1.0935
17	3.2	1.0901	1.0894	1.0888	1.0881	1.0874	1.0867
18	3.4	1.0872	1.0861	1.0854	1.0847	1.0839	1.0831
19	3.6	1.0852	1.0843	1.0843	1.0848	1.0852	1.0852
20	3.8	1.0837	1.0832	1.0839	1.0854	1.0869	1.0878
21	4.0	1.0832	1.0832	1.0844	1.0864	1.0886	1.0900
22	4.2	1.0834	1.0838	1.0852	1.0876	1.0901	1.0919
23	4.4	1.0837	1.0845	1.0862	1.0886	1.0914	1.0933
24	4.6	1.0839	1.0851	1.0870	1.0895	1.0924	1.0945
25	4.8	1.0839	1.0854	1.0874	1.0900	1.0929	1.0952
26	5.0	1.0837	1.0856	1.0879	1.0906	1.0937	1.0963
27	5.2	1.0833	1.0858	1.0887	1.0920	1.0958	1.0990
28	5.4	1.0826	1.0860	1.0898	1.0942	1.0991	1.1034
29	5.6	1.0816	1.0857	1.0903	1.0957	1.1018	1.1069
30	5.8	1.0804	1.0850	1.0903	1.0966	1.1036	1.1095

Top and bottom 10% of core excluded.

TABLE 1 (continued)
DONALD C. COOK UNIT 1 CYCLE 31
W(Z) FUNCTION

Node #	Height (ft)	10000	12000	14000	16000	18000	20043
31	6.0	1.0786	1.0837	1.0897	1.0969	1.1048	1.1115
32	6.2	1.0767	1.0823	1.0888	1.0965	1.1051	1.1124
33	6.4	1.0759	1.0818	1.0884	1.0961	1.1046	1.1119
34	6.6	1.0762	1.0824	1.0886	1.0955	1.1031	1.1100
35	6.8	1.0760	1.0821	1.0878	1.0939	1.1005	1.1068
36	7.0	1.0762	1.0820	1.0871	1.0923	1.0979	1.1034
37	7.2	1.0779	1.0838	1.0884	1.0926	1.0972	1.1022
38	7.4	1.0799	1.0862	1.0909	1.0949	1.0994	1.1044
39	7.6	1.0826	1.0887	1.0930	1.0968	1.1009	1.1056
40	7.8	1.0857	1.0910	1.0948	1.0980	1.1016	1.1056
41	8.0	1.0886	1.0931	1.0963	1.0989	1.1018	1.1051
42	8.2	1.0911	1.0948	1.0973	1.0993	1.1014	1.1040
43	8.4	1.0932	1.0960	1.0978	1.0991	1.1005	1.1024
44	8.6	1.0948	1.0967	1.0978	1.0984	1.0991	1.1002
45	8.8	1.0962	1.0972	1.0975	1.0975	1.0975	1.0979
46	9.0	1.0972	1.0972	1.0968	1.0960	1.0952	1.0946
47	9.2	1.0977	1.0969	1.0958	1.0946	1.0931	1.0920
48	9.4	1.0979	1.0969	1.0965	1.0962	1.0959	1.0953
49	9.6	1.0981	1.0972	1.0975	1.0987	1.0999	1.1003
50	9.8	1.0981	1.0972	1.0984	1.1009	1.1036	1.1050
51	10.0	1.0972	1.0964	1.0985	1.1025	1.1069	1.1093
52	10.2	1.0964	1.0956	1.0985	1.1039	1.1097	1.1131
53	10.4	1.0992	1.0986	1.1015	1.1065	1.1119	1.1151
54	10.6	1.1041	1.1024	1.1043	1.1087	1.1132	1.1156
55	10.8	1.1018	1.1004	1.1033	1.1088	1.1147	1.1180
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.