# DONALD C. COOK NUCLEAR PLANT UNIT 1 CYCLE 13
# CORE OPERATING LIMITS REPORT

Revision 2

November 1992

## 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report for Donald C. Cook Nuclear Plant Unit 1 Cycle 13 has been prepared in accordance with the requirements of Technical Specification 6.9.1.11.

The Technical Specifications affected by this report are listed below:

| | |
|---|---|
| 3/4.1.1.4 | Moderator Temperature Coefficient |
| 3/4.1.3.1 | Movable Control Assemblies Group Height |
| 3/4.1.3.3 | Rod Drop Time |
| 3/4.1.3.4 | Shutdown Rod Insertion Limits |
| 3/4.1.3.5 | Control Rod Insertion Limits |
| 3/4.2.1 | Axial Flux Difference |
| 3/4.2.2 | Heat Flux Hot Channel Factor |
| 3/4.2.3 | Nuclear Enthalpy Hot Channel Factor |
| 3/4.2.6 | Allowable Power Level |

## 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 Specification 6.9.1.11.

### 2.1 Moderator Temperature Coefficient (Specification 3/4.1.1.4)

2.1.1 The Moderator Temperature Coefficient (MTC) Limits are:

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

The EOL/ARO/RTP-MTC shall be less negative than -4.59E-4 $\Delta k/k/^{\circ}F$.

This limit is based on a $T_{avg}$ program with HFP $T_{avg}$ of 553 $^{\circ}F$

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

2.1.2 The MTC Surveillance limit is:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -3.67E-4 $\Delta k/k/^{\circ}F$ at a vessel average temperature of 553 $^{\circ}F$.

2.2 Rod Drop Time Drop Height (Specification 3/4.1.3.3)

2.2.1 All rods shall be dropped from 231 steps.

2.3 Shutdown Rod Insertion Limit (Specification 3/4.1.3.4)

2.3.1 The shutdown rods shall be withdrawn to 231 steps.

2.4 Control Rod Insertion Limits (Specifications 3/4.1.3.5 and 3/4.1.3.1)

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

2.4.2 Successive Control Banks shall overlap by 103 steps. The sequence for Control Bank withdrawal shall be Control Bank A, Control Bank B, Control Bank C, and Control Bank D.

2.5 Axial Flux Difference (Specification 3/4.2.1)

2.5.1 The Allowable Operation Limits are provided in Figure 3.

2.5.2 The AXIAL FLUX DIFFERENCE (AFD) target band during base load operations is +3%, -3% (not applicable for this cycle).

2.5.3 The AFD target band is +5%, -5% for a cycle average accumulated burnup $\geq$ 0.0 MWD/MTU.

2.6 Heat Flux Hot Channel Factor - $F_Q(Z)$ (Specification 3.2.2)

$$F_Q(Z) \leq \frac{CFQ}{P} * K(Z) \qquad \text{for } P > 0.5$$

$$F_Q(Z) \leq 2 * CFQ * K(Z) \qquad \text{for } P \leq 0.5$$

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

2.6.1 CFQ= 2.15 for Westinghouse fuel

2.6.2 K(Z) is provided in Figure 4 for Westinghouse fuel

2.7 Nuclear Enthalpy Rise Hot Channel Factor - $F^N_{\Delta H}$
(Specification 3/4.2.3)

$$F^N_{\Delta H} \leq CFDH * (1 + PFDH * (1-P))$$

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

2.7.1 CFDH = 1.49 for Westinghouse fuel

2.7.2 PFDH = 0.3

2.8 Allowable Power Level - APL (Specification 3.2.6)

$$APL = \min \text{ over } Z \text{ for } \frac{CFQ * K(Z)}{F_Q(Z) * V(Z) * F_P}$$

2.8.1 V(Z) is provided in Table 1 for ± 5% AFD target band

2.8.2 CFQ and K(Z) are provided in COLR Sections 2.6.1 and 2.6.2, respectively

2.8.3 $F_P$ is provided in Technical Specification 3.2.6

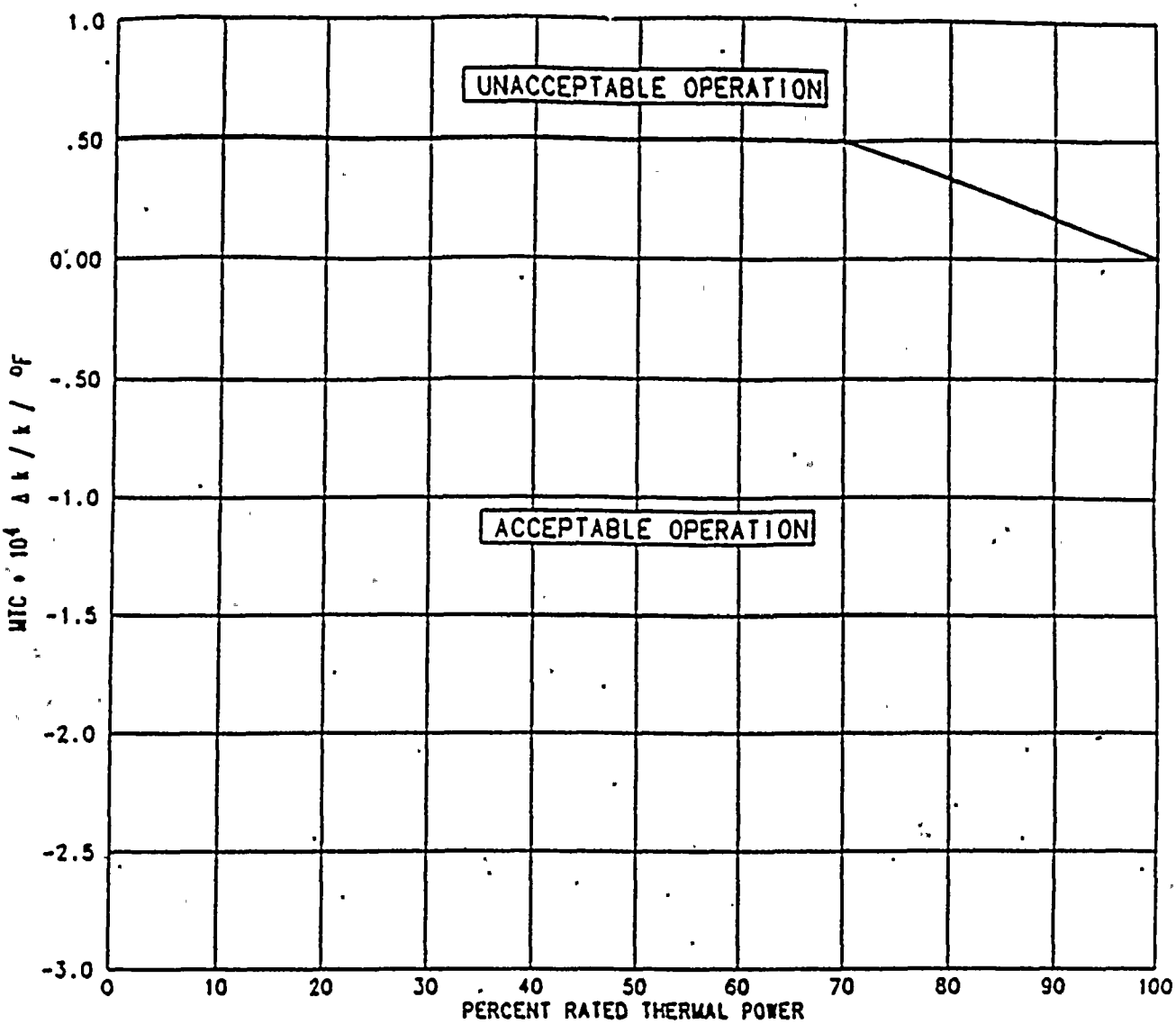


FIGURE 1

MODERATOR TEMPERATURE COEFFICIENT (MTC)

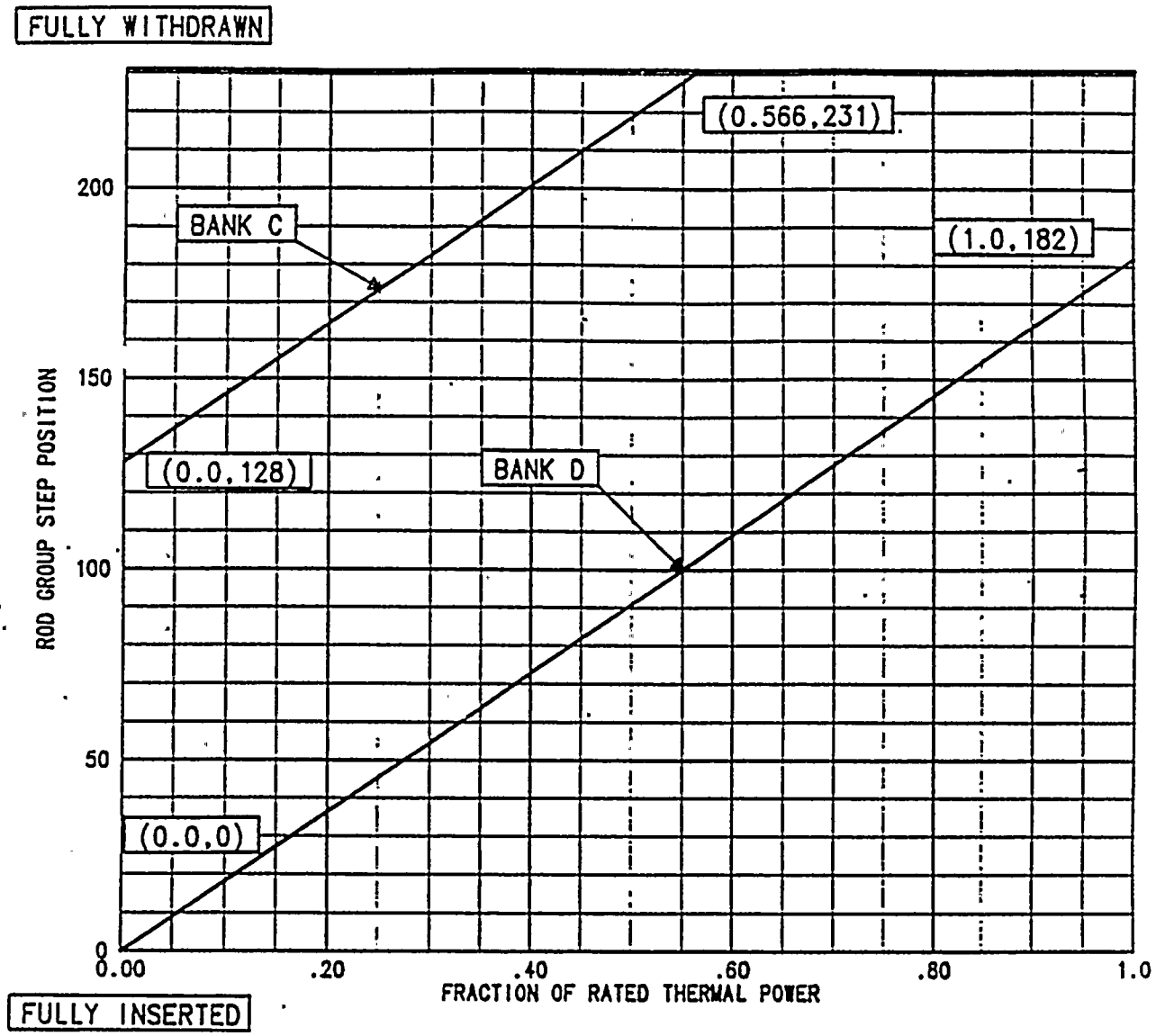


FIGURE 2

ROD BANK INSERTION LIMITS VERSUS
THERMAL POWER FOUR-LOOP OPERATION

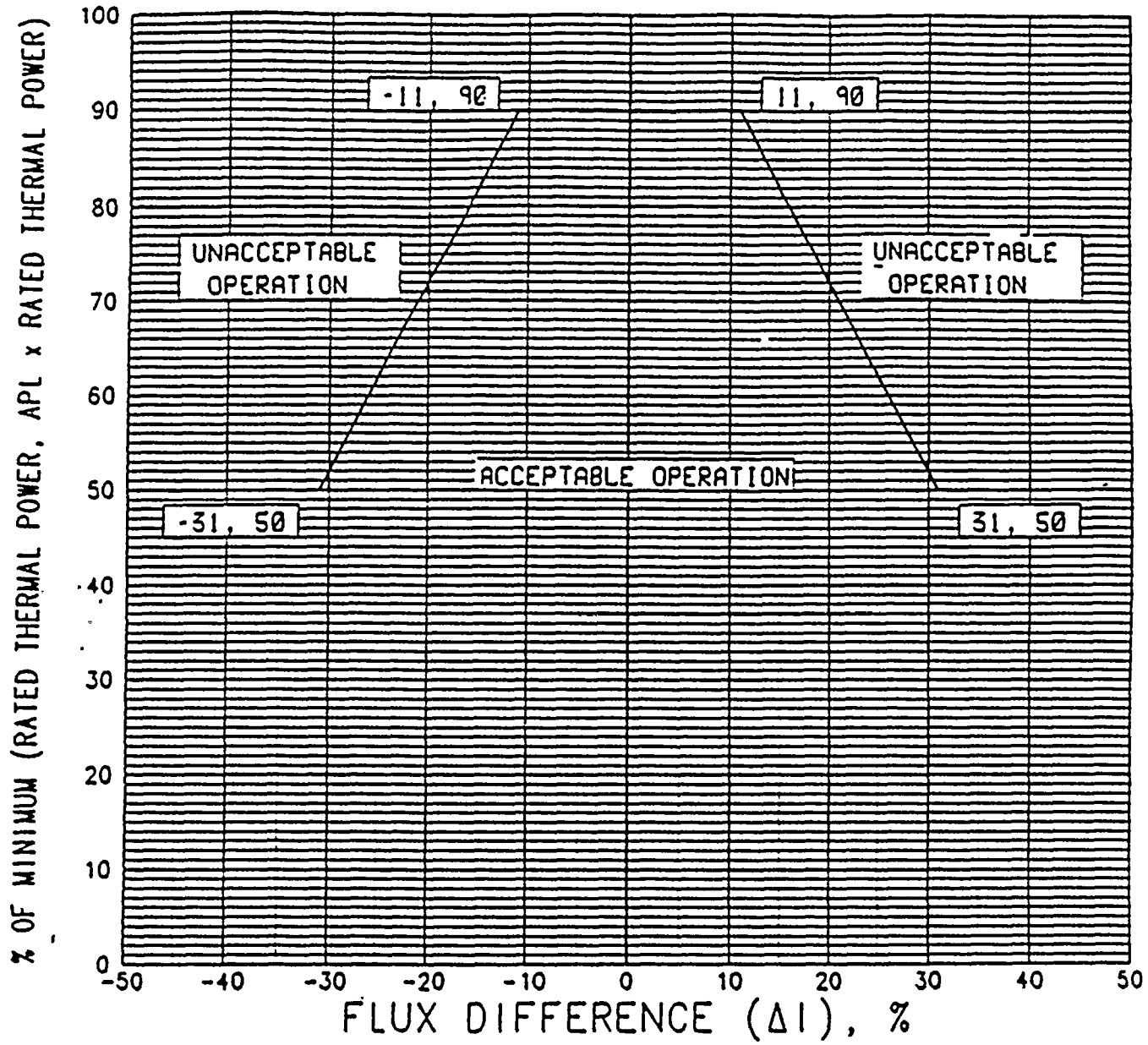


FIGURE 3

AXIAL FLUX DIFFERENCE LIMITS
AS A FUNCTION OF RATED THERMAL POWER

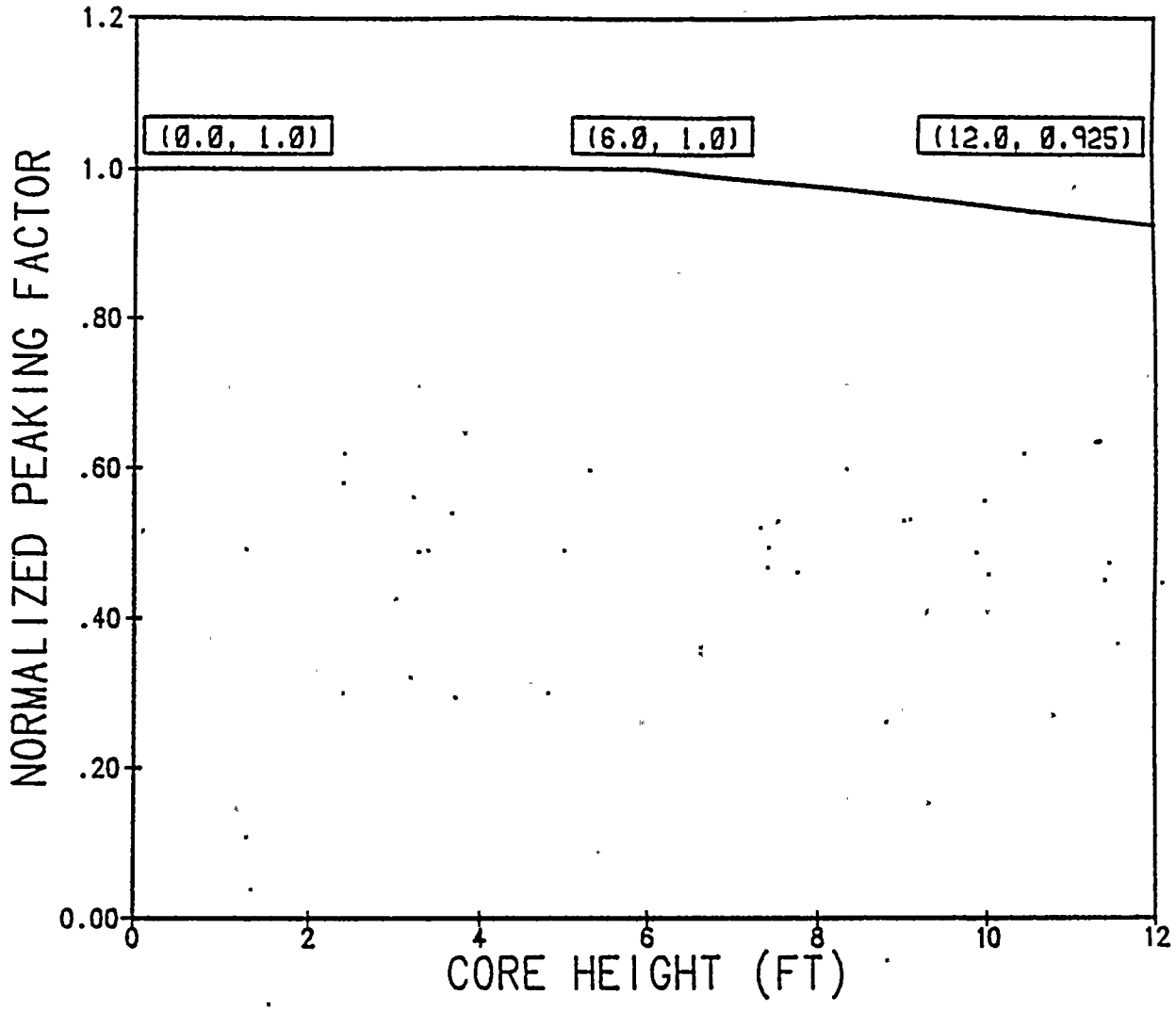


FIGURE 4

K(Z) - NORMALIZED $F_Q(Z)$ AS A FUNCTION

OF CORE HEIGHT FOR WESTINGHOUSE FUEL

| MESH NO. | AXIAL ELEV. (FT) | BURNUP RANGES (MWD/MTU) 0 150 | 150 1000 | 1000 2000 | 2000 4000 | 4000 6000 | 6000 8000 | 8000 10000 | 10000 12000 | 12000 14000 | 14000 EOL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 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 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 3 | 0.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 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 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 5 | 0.8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 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 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 7 | 1.2 | 1.1030 | 1.1033 | 1.1041 | 1.1066 | 1.1106 | 1.1159 | 1.1228 | 1.1311 | 1.1408 | 1.1408 |
| 8 | 1.4 | 1.1008 | 1.1015 | 1.1026 | 1.1056 | 1.1097 | 1.1149 | 1.1213 | 1.1289 | 1.1376 | 1.1376 |
| 9 | 1.6 | 1.0986 | 1.0996 | 1.1009 | 1.1043 | 1.1084 | 1.1135 | 1.1193 | 1.1261 | 1.1337 | 1.1337 |
| 10 | 1.8 | 1.0974 | 1.0985 | 1.0999 | 1.1032 | 1.1071 | 1.1116 | 1.1168 | 1.1226 | 1.1291 | 1.1291 |
| 11 | 2.0 | 1.0969 | 1.0979 | 1.0992 | 1.1021 | 1.1054 | 1.1093 | 1.1137 | 1.1186 | 1.1239 | 1.1239 |
| 12 | 2.2 | 1.0964 | 1.0972 | 1.0983 | 1.1007 | 1.1035 | 1.1066 | 1.1101 | 1.1140 | 1.1183 | 1.1183 |
| 13 | 2.4 | 1.0955 | 1.0962 | 1.0971 | 1.0990 | 1.1012 | 1.1035 | 1.1061 | 1.1090 | 1.1120 | 1.1120 |
| 14 | 2.6 | 1.0945 | 1.0951 | 1.0957 | 1.0971 | 1.0985 | 1.1001 | 1.1017 | 1.1035 | 1.1053 | 1.1053 |
| 15 | 2.8 | 1.0933 | 1.0937 | 1.0941 | 1.0948 | 1.0956 | 1.0963 | 1.0970 | 1.0977 | 1.0984 | 1.0984 |
| 16 | 3.0 | 1.0918 | 1.0919 | 1.0921 | 1.0922 | 1.0922 | 1.0922 | 1.0920 | 1.0917 | 1.0913 | 1.0907 |
| 17 | 3.2 | 1.0905 | 1.0905 | 1.0902 | 1.0899 | 1.0894 | 1.0894 | 1.0882 | 1.0878 | 1.0870 | 1.0865 |
| 18 | 3.4 | 1.0896 | 1.0896 | 1.0888 | 1.0879 | 1.0878 | 1.0870 | 1.0862 | 1.0873 | 1.0889 | 1.0889 |
| 19 | 3.6 | 1.0890 | 1.0890 | 1.0880 | 1.0872 | 1.0861 | 1.0852 | 1.0869 | 1.0905 | 1.0945 | 1.0945 |
| 20 | 3.8 | 1.0889 | 1.0889 | 1.0876 | 1.0866 | 1.0851 | 1.0865 | 1.0904 | 1.0951 | 1.0999 | 1.0999 |
| 21 | 4.0 | 1.0889 | 1.0889 | 1.0878 | 1.0869 | 1.0870 | 1.0892 | 1.0937 | 1.0993 | 1.1049 | 1.1049 |
| 22 | 4.2 | 1.0885 | 1.0885 | 1.0878 | 1.0873 | 1.0887 | 1.0917 | 1.0969 | 1.1033 | 1.1096 | 1.1096 |
| 23 | 4.4 | 1.0880 | 1.0880 | 1.0875 | 1.0882 | 1.0904 | 1.0940 | 1.0998 | 1.1069 | 1.1138 | 1.1138 |
| 24 | 4.6 | 1.0871 | 1.0871 | 1.0873 | 1.0889 | 1.0918 | 1.0960 | 1.1024 | 1.1100 | 1.1175 | 1.1175 |
| 25 | 4.8 | 1.0863 | 1.0865 | 1.0872 | 1.0894 | 1.0929 | 1.0978 | 1.1047 | 1.1126 | 1.1206 | 1.1206 |
| 26 | 5.0 | 1.0856 | 1.0862 | 1.0871 | 1.0899 | 1.0939 | 1.0992 | 1.1064 | 1.1148 | 1.1230 | 1.1230 |
| 27 | 5.2 | 1.0851 | 1.0859 | 1.0870 | 1.0902 | 1.0946 | 1.1002 | 1.1077 | 1.1159 | 1.1247 | 1.1247 |
| 28 | 5.4 | 1.0844 | 1.0853 | 1.0866 | 1.0902 | 1.0949 | 1.1008 | 1.1084 | 1.1165 | 1.1256 | 1.1256 |
| 29 | 5.6 | 1.0833 | 1.0844 | 1.0859 | 1.0898 | 1.0948 | 1.1008 | 1.1085 | 1.1164 | 1.1256 | 1.1256 |
| 30 | 5.8 | 1.0820 | 1.0832 | 1.0848 | 1.0890 | 1.0941 | 1.1002 | 1.1079 | 1.1156 | 1.1248 | 1.1248 |
| 31 | 6.0 | 1.0803 | 1.0817 | 1.0835 | 1.0878 | 1.0930 | 1.0991 | 1.1067 | 1.1141 | 1.1230 | 1.1230 |
| 32 | 6.2 | 1.0783 | 1.0798 | 1.0817 | 1.0861 | 1.0913 | 1.0973 | 1.1047 | 1.1118 | 1.1204 | 1.1204 |
| 33 | 6.4 | 1.0759 | 1.0774 | 1.0794 | 1.0838 | 1.0889 | 1.0948 | 1.1019 | 1.1087 | 1.1167 | 1.1167 |
| 34 | 6.6 | 1.0730 | 1.0746 | 1.0766 | 1.0810 | 1.0860 | 1.0916 | 1.0983 | 1.1046 | 1.1121 | 1.1121 |
| 35 | 6.8 | 1.0698 | 1.0714 | 1.0733 | 1.0775 | 1.0823 | 1.0875 | 1.0939 | 1.0997 | 1.1065 | 1.1065 |
| 36 | 7.0 | 1.0654 | 1.0671 | 1.0691 | 1.0734 | 1.0792 | 1.0830 | 1.0887 | 1.0939 | 1.0998 | 1.0998 |
| 37 | 7.2 | 1.0626 | 1.0653 | 1.0671 | 1.0700 | 1.0772 | 1.0772 | 1.0825 | 1.0870 | 1.0924 | 1.0924 |
| 38 | 7.4 | 1.0628 | 1.0654 | 1.0660 | 1.0668 | 1.0741 | 1.0741 | 1.0756 | 1.0793 | 1.0837 | 1.0837 |
| 39 | 7.6 | 1.0626 | 1.0649 | 1.0656 | 1.0682 | 1.0704 | 1.0720 | 1.0731 | 1.0737 | 1.0737 | 1.0737 |
| 40 | 7.8 | 1.0663 | 1.0678 | 1.0694 | 1.0718 | 1.0735 | 1.0743 | 1.0743 | 1.0741 | 1.0731 | 1.0712 |
| 41 | 8.0 | 1.0714 | 1.0722 | 1.0730 | 1.0745 | 1.0754 | 1.0760 | 1.0761 | 1.0761 | 1.0758 | 1.0750 |
| 42 | 8.2 | 1.0759 | 1.0762 | 1.0765 | 1.0771 | 1.0777 | 1.0784 | 1.0790 | 1.0800 | 1.0802 | 1.0802 |
| 43 | 8.4 | 1.0804 | 1.0806 | 1.0809 | 1.0814 | 1.0820 | 1.0826 | 1.0833 | 1.0854 | 1.0854 | 1.0848 |
| 44 | 8.6 | 1.0848 | 1.0851 | 1.0855 | 1.0863 | 1.0870 | 1.0876 | 1.0882 | 1.0905 | 1.0905 | 1.0893 |
| 45 | 8.8 | 1.0890 | 1.0895 | 1.0900 | 1.0910 | 1.0918 | 1.0924 | 1.0929 | 1.0953 | 1.0953 | 1.0934 |
| 46 | 9.0 | 1.0929 | 1.0935 | 1.0942 | 1.0954 | 1.0963 | 1.0970 | 1.0974 | 1.0997 | 1.0997 | 1.0975 |
| 47 | 9.2 | 1.0986 | 1.0973 | 1.0980 | 1.0993 | 1.1003 | 1.1011 | 1.1016 | 1.1038 | 1.1036 | 1.1019 |
| 48 | 9.4 | 1.1000 | 1.1007 | 1.1014 | 1.1028 | 1.1040 | 1.1051 | 1.1059 | 1.1075 | 1.1075 | 1.1071 |
| 49 | 9.6 | 1.1029 | 1.1039 | 1.1049 | 1.1068 | 1.1085 | 1.1100 | 1.1113 | 1.1124 | 1.1132 | 1.1132 |
| 50 | 9.8 | 1.1065 | 1.1076 | 1.1087 | 1.1109 | 1.1129 | 1.1147 | 1.1164 | 1.1179 | 1.1192 | 1.1192 |
| 51 | 10.0 | 1.1103 | 1.1113 | 1.1124 | 1.1147 | 1.1168 | 1.1189 | 1.1209 | 1.1229 | 1.1248 | 1.1248 |
| 52 | 10.2 | 1.1137 | 1.1146 | 1.1158 | 1.1181 | 1.1204 | 1.1227 | 1.1250 | 1.1273 | 1.1297 | 1.1297 |
| 53 | 10.4 | 1.1167 | 1.1178 | 1.1187 | 1.1210 | 1.1234 | 1.1259 | 1.1285 | 1.1311 | 1.1339 | 1.1339 |
| 54 | 10.6 | 1.1192 | 1.1201 | 1.1212 | 1.1235 | 1.1259 | 1.1285 | 1.1313 | 1.1343 | 1.1374 | 1.1374 |
| 55 | 10.8 | 1.1211 | 1.1221 | 1.1234 | 1.1259 | 1.1286 | 1.1313 | 1.1342 | 1.1372 | 1.1402 | 1.1402 |
| 56 | 11.0 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 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 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 58 | 11.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 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 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 60 | 11.8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 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 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

Top and bottom 10% of core are excluded as per Technical Specifications.

TABLE 1

DONALD C. COOK UNIT 1 CYCLE 13
V(Z) FUNCTION