DONALD C. COOK NUCLEAR PLANT UNIT 2 CYCLE 11

CORE OPERATING LIMITS REPORT

Revision 4

April 1996

COLR for DONALD C. COOK NUCLEAR PLANT UNIT 2 CYCLE 11

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report for Donald C. Cook Nuclear Plant Unit 2 Cycle 11 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
3/4.1.3.4	Rod Drop Time
3/4.1.3.5	Shutdown Rod Insertion Limit
3/4.1.3.6	Control Rod Insertion Limits
3/4.2.1	Axial Flux Difference (AFD)
3/4.2.2	Heat Flux Hot Channel Factor - $F_Q(Z)$
3/4.2.3	Nuclear Enthalpy Hot Channel Factor - $F^N_{\Delta H}$
3/4.2.6	Allowable Power Level - (APL)

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 6.9.1.9.4.

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 -5.00E-4 $\Delta k/k/^{o}F$.

This limit is based on a T_{avg} program with HFP vessel T_{avg} of $574^{o}F$

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 -4.15E-4 $\Delta k/k/^{o}F$ at a HFP vessel T_{avg} of $574^{o}F$.

2.2 Rod Drop Time Drop Height (Specification 3/4.1.3.4)

2.2.1 All rods shall be dropped from 231 steps.

2.3 Shutdown Rod Insertion Limit (Specification 3/4.1.3.5)

2.3.1 The shutdown rods shall be withdrawn to 231 steps.

2.4 Control Rod Insertion Limits (Specifications 3/4.1.3.6 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 Rod Banks shall overlap by 103 steps. The sequence for Control Rod Bank withdrawal shall be Bank A, Bank B, Bank C, and 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 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: $P = \dfrac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$

2.6.1 CFQ= 2.335

2.6.2 K(Z) is provided in Figure 4

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 = 1.56

2.7.2 PFDH = 0.3

2.8 Allowable Power Level - APL (Specification 3.2.6)

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

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 The following table shows F_p values which correspond to F_Q margin decreases that are greater than 2% per 31 Effective Full Power Days (EFPD). These values shall be used to adjust APL as per Surveillance Requirement 4.2.6.2. A 1.02 penalty factor shall be used at all cycle burnups that are outside this range.

Cycle Burnup (MWD/MTU)	F_p
473	1.0200
634	1.0342
795	1.0328
957	1.0291
1118	1.0244
1279	1.0200

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

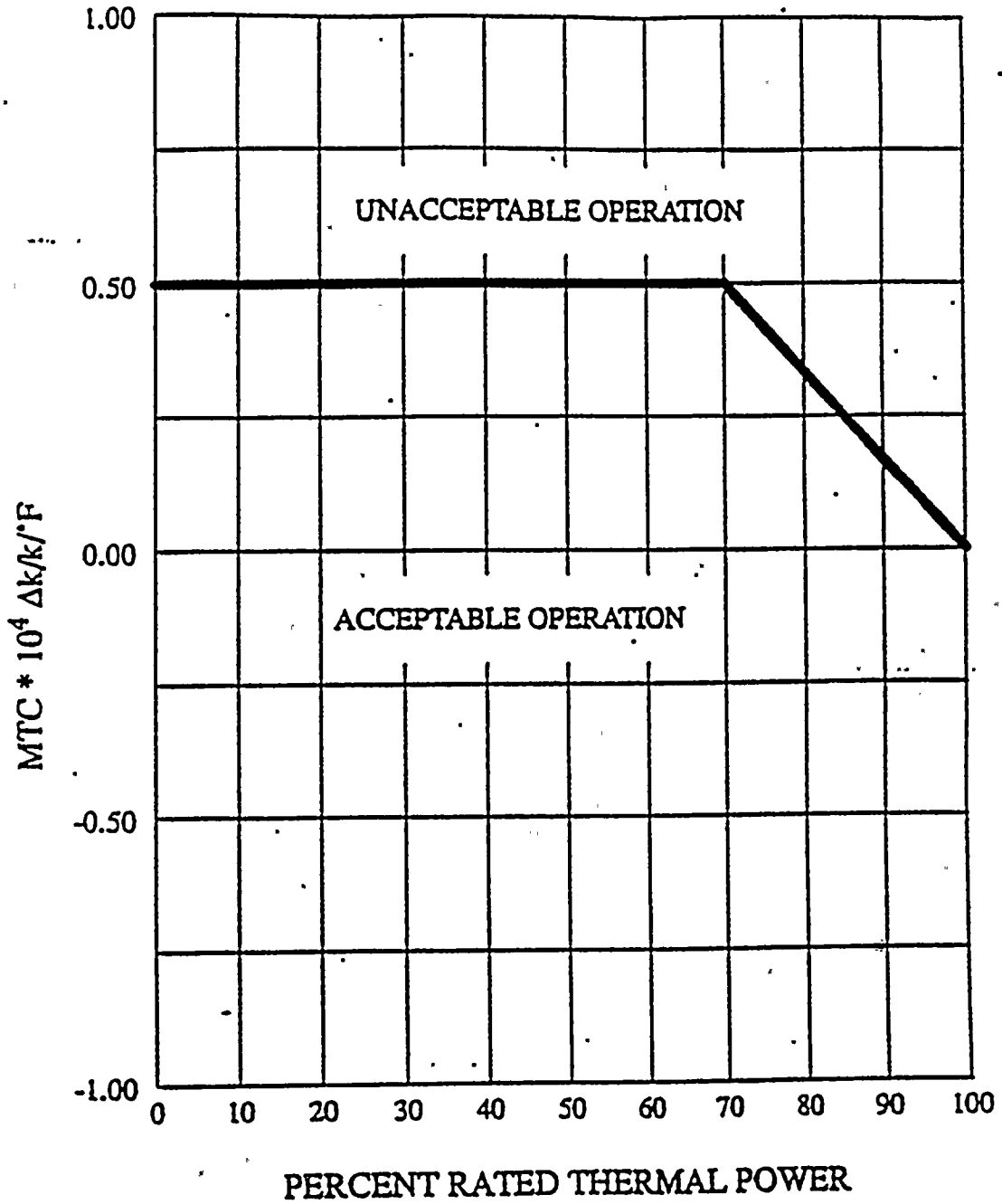
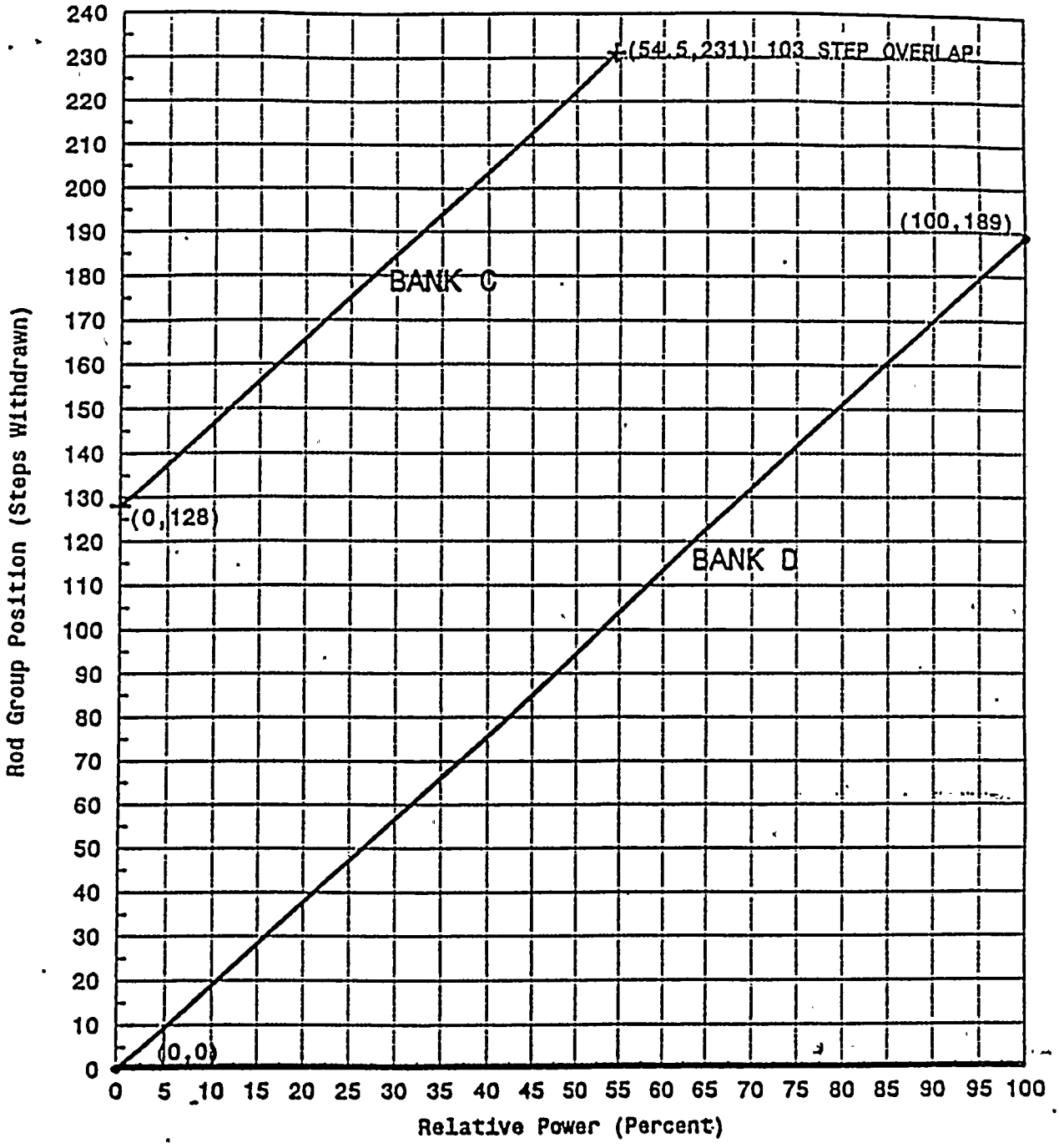


FIGURE 1

MODERATOR TEMPERATURE COEFFICIENT (MTC) LIMITS



D BANK

RIL = (1,89)(% POWER) + 0

C BANK

RIL = (1.89)(% POWER) + 128

FIGURE 2

CONTROL ROD BANK INSERTION LIMITS VERSUS
THERMAL POWER FOUR-LOOP OPERATION

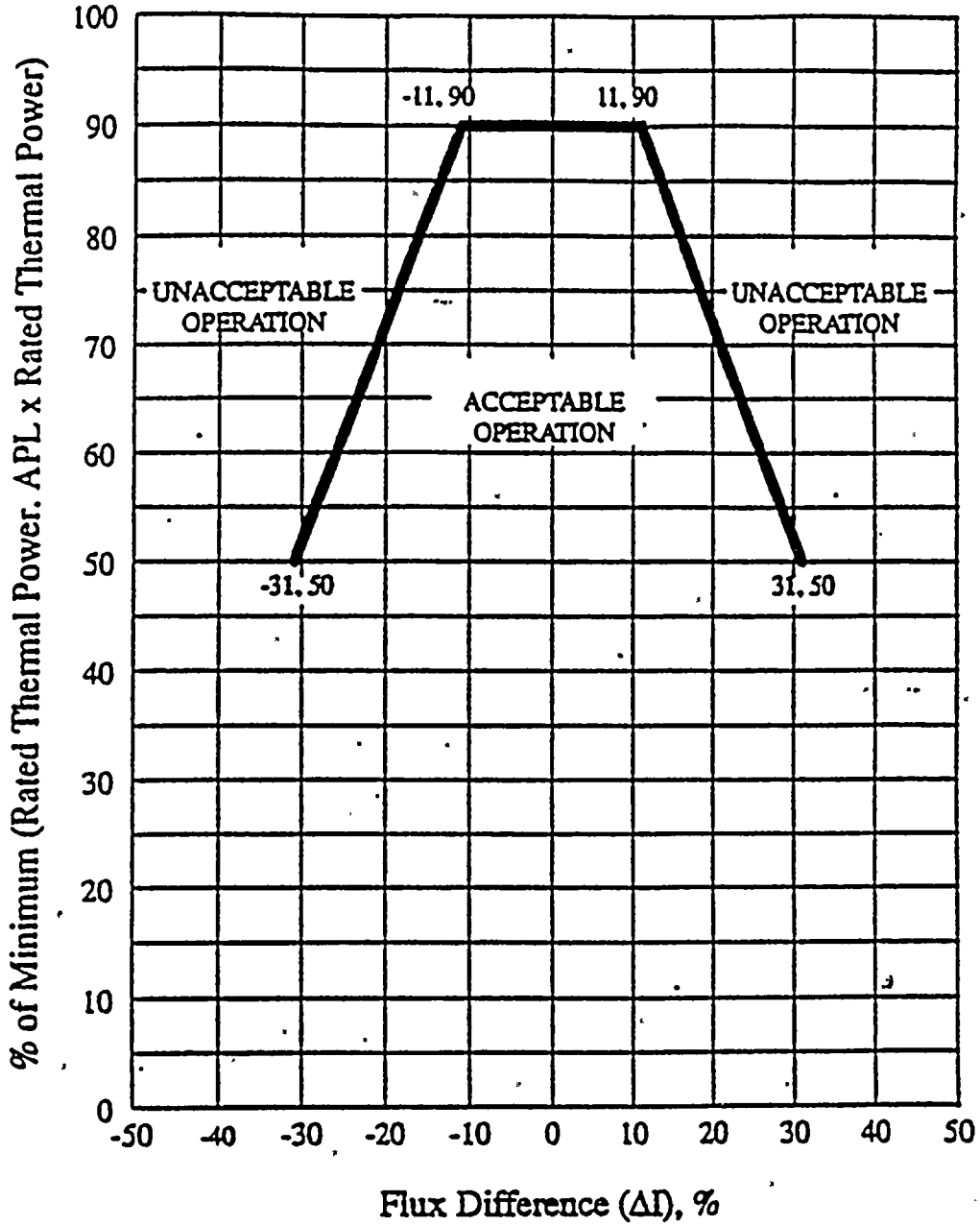


FIGURE 3

AXIAL FLUX DIFFERENCE LIMITS
AS A FUNCTION OF RATED THERMAL POWER

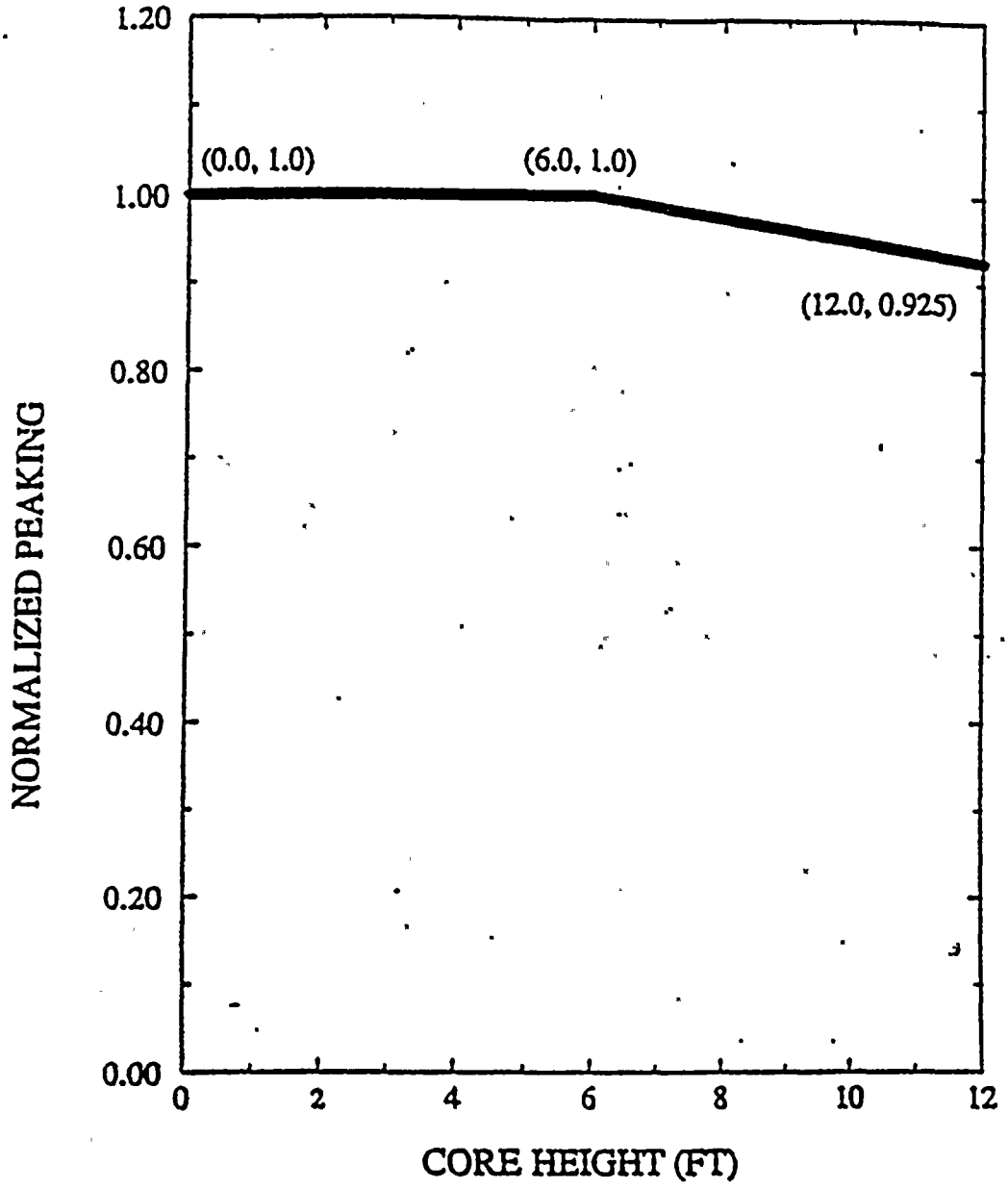


FIGURE 4

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

OF CORE HEIGHT

TABLE 1
DONALD C. COOK UNIT 2 CYCLE 11
V(Z) FUNCTION

	HT.	BURNUP (MWD/MTU)													
	(FT)	150	1000	2000	3000	4000	6000	8000	10000	12000	14000	16000	18000	19825	21325
1	0.0	1.0000	1.0000	1.0000	1.0000	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	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	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	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	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	1.0000	1.0000	1.0000	1.0000
7	1.2	1.1068	1.1056	1.1046	1.1040	1.1037	1.1042	1.1063	1.1100	1.1152	1.1218	1.1299	1.1395	1.1456	1.1505
8	1.4	1.1060	1.1050	1.1041	1.1036	1.1034	1.1041	1.1062	1.1098	1.1147	1.1210	1.1286	1.1377	1.1434	1.1481
9	1.6	1.1049	1.1041	1.1034	1.1031	1.1030	1.1038	1.1059	1.1093	1.1139	1.1197	1.1268	1.1351	1.1404	1.1448
10	1.8	1.1036	1.1029	1.1024	1.1022	1.1023	1.1032	1.1052	1.1083	1.1125	1.1178	1.1241	1.1316	1.1364	1.1404
11	2.0	1.1019	1.1015	1.1012	1.1011	1.1012	1.1022	1.1041	1.1070	1.1107	1.1154	1.1209	1.1273	1.1315	1.1350
12	2.2	1.0999	1.0997	1.0996	1.0997	1.1000	1.1010	1.1028	1.1053	1.1086	1.1125	1.1171	1.1224	1.1260	1.1289
13	2.4	1.0976	1.0977	1.0978	1.0981	1.0985	1.0996	1.1012	1.1034	1.1061	1.1092	1.1128	1.1169	1.1198	1.1222
14	2.6	1.0951	1.0953	1.0957	1.0961	1.0966	1.0978	1.0993	1.1011	1.1031	1.1054	1.1080	1.1109	1.1130	1.1147
15	2.8	1.0923	1.0928	1.0934	1.0940	1.0946	1.0958	1.0971	1.0984	1.0998	1.1012	1.1027	1.1042	1.1055	1.1066
16	3.0	1.0892	1.0899	1.0907	1.0915	1.0922	1.0934	1.0945	1.0954	1.0961	1.0967	1.0971	1.0973	1.0978	1.0982
17	3.2	1.0861	1.0870	1.0880	1.0888	1.0896	1.0909	1.0918	1.0922	1.0923	1.0920	1.0913	1.0903	1.0900	1.0898
18	3.4	1.0835	1.0844	1.0854	1.0863	1.0871	1.0883	1.0892	1.0896	1.0897	1.0893	1.0886	1.0874	1.0871	1.0868
19	3.6	1.0823	1.0828	1.0834	1.0840	1.0846	1.0858	1.0871	1.0884	1.0897	1.0911	1.0925	1.0940	1.0952	1.0962
20	3.8	1.0829	1.0828	1.0828	1.0830	1.0832	1.0842	1.0857	1.0879	1.0906	1.0939	1.0977	1.1021	1.1051	1.1075
21	4.0	1.0842	1.0835	1.0829	1.0825	1.0825	1.0832	1.0849	1.0878	1.0918	1.0967	1.1027	1.1098	1.1144	1.1181
22	4.2	1.0852	1.0841	1.0831	1.0824	1.0822	1.0827	1.0848	1.0884	1.0935	1.1000	1.1079	1.1173	1.1233	1.1282
23	4.4	1.0861	1.0847	1.0835	1.0827	1.0823	1.0829	1.0854	1.0897	1.0957	1.1035	1.1130	1.1243	1.1315	1.1373
24	4.6	1.0868	1.0851	1.0837	1.0828	1.0823	1.0830	1.0857	1.0907	1.0977	1.1067	1.1177	1.1308	1.1390	1.1457
25	4.8	1.0873	1.0854	1.0837	1.0827	1.0822	1.0829	1.0859	1.0915	1.0993	1.1094	1.1218	1.1364	1.1457	1.1532
26	5.0	1.0875	1.0854	1.0836	1.0824	1.0818	1.0826	1.0859	1.0920	1.1006	1.1116	1.1252	1.1413	1.1514	1.1597
27	5.2	1.0874	1.0851	1.0832	1.0819	1.0813	1.0821	1.0857	1.0922	1.1014	1.1133	1.1279	1.1452	1.1561	1.1650
28	5.4	1.0870	1.0847	1.0826	1.0813	1.0807	1.0816	1.0854	1.0922	1.1020	1.1145	1.1298	1.1481	1.1595	1.1689
29	5.6	1.0863	1.0840	1.0819	1.0806	1.0800	1.0810	1.0851	1.0922	1.1023	1.1152	1.1310	1.1498	1.1616	1.1713
30	5.8	1.0856	1.0832	1.0811	1.0798	1.0792	1.0802	1.0843	1.0916	1.1019	1.1151	1.1312	1.1503	1.1623	1.1722
31	6.0	1.0845	1.0821	1.0800	1.0786	1.0780	1.0790	1.0831	1.0904	1.1008	1.1140	1.1302	1.1495	1.1616	1.1716
32	6.2	1.0830	1.0806	1.0784	1.0770	1.0764	1.0773	1.0814	1.0886	1.0989	1.1121	1.1282	1.1474	1.1595	1.1694
33	6.4	1.0809	1.0785	1.0764	1.0750	1.0743	1.0752	1.0791	1.0862	1.0963	1.1092	1.1251	1.1439	1.1558	1.1655
34	6.6	1.0782	1.0759	1.0738	1.0724	1.0717	1.0725	1.0763	1.0831	1.0929	1.1054	1.1208	1.1391	1.1505	1.1599
35	6.8	1.0762	1.0737	1.0713	1.0697	1.0688	1.0691	1.0724	1.0788	1.0880	1.1001	1.1149	1.1328	1.1438	1.1528
36	7.0	1.0773	1.0749	1.0727	1.0712	1.0703	1.0703	1.0730	1.0784	1.0863	1.0968	1.1097	1.1251	1.1347	1.1425
37	7.2	1.0800	1.0782	1.0766	1.0755	1.0748	1.0749	1.0769	1.0810	1.0869	1.0947	1.1043	1.1159	1.1230	1.1288
38	7.4	1.0817	1.0805	1.0793	1.0785	1.0780	1.0780	1.0794	1.0822	1.0864	1.0918	1.0986	1.1067	1.1117	1.1158
39	7.6	1.0831	1.0822	1.0814	1.0808	1.0804	1.0805	1.0816	1.0837	1.0868	1.0908	1.0958	1.1019	1.1056	1.1086
40	7.8	1.0840	1.0834	1.0828	1.0825	1.0823	1.0824	1.0833	1.0849	1.0872	1.0901	1.0938	1.0981	1.1008	1.1030
41	8.0	1.0843	1.0840	1.0837	1.0835	1.0835	1.0837	1.0844	1.0856	1.0873	1.0895	1.0921	1.0952	1.0971	1.0987
42	8.2	1.0840	1.0840	1.0839	1.0840	1.0841	1.0845	1.0851	1.0860	1.0871	1.0885	1.0901	1.0919	1.0931	1.0941
43	8.4	1.0833	1.0835	1.0837	1.0839	1.0841	1.0846	1.0851	1.0857	1.0864	1.0872	1.0880	1.0888	1.0895	1.0901
44	8.6	1.0838	1.0837	1.0836	1.0836	1.0837	1.0840	1.0846	1.0854	1.0865	1.0878	1.0893	1.0910	1.0922	1.0932
45	8.8	1.0858	1.0858	1.0859	1.0860	1.0862	1.0868	1.0876	1.0887	1.0901	1.0917	1.0935	1.0956	1.0971	1.0983
46	9.0	1.0885	1.0889	1.0894	1.0899	1.0905	1.0916	1.0929	1.0942	1.0956	1.0972	1.0988	1.1005	1.1019	1.1030
47	9.2	1.0908	1.0916	1.0925	1.0934	1.0943	1.0960	1.0976	1.0992	1.1007	1.1022	1.1036	1.1049	1.1063	1.1074
48	9.4	1.0931	1.0942	1.0955	1.0967	1.0979	1.1002	1.1023	1.1041	1.1058	1.1073	1.1086	1.1097	1.1111	1.1122
49	9.6	1.0951	1.0966	1.0983	1.0999	1.1014	1.1041	1.1066	1.1087	1.1105	1.1119	1.1131	1.1139	1.1152	1.1163
50	9.8	1.0980	1.0997	1.1015	1.1033	1.1050	1.1080	1.1106	1.1128	1.1145	1.1158	1.1166	1.1171	1.1183	1.1192
51	10.0	1.1014	1.1031	1.1050	1.1069	1.1086	1.1117	1.1143	1.1165	1.1182	1.1195	1.1203	1.1207	1.1219	1.1228
52	10.2	1.1047	1.1064	1.1083	1.1102	1.1119	1.1150	1.1176	1.1198	1.1216	1.1229	1.1238	1.1243	1.1255	1.1265
53	10.4	1.1076	1.1093	1.1112	1.1129	1.1146	1.1177	1.1204	1.1227	1.1245	1.1260	1.1271	1.1278	1.1291	1.1302
54	10.6	1.1099	1.1115	1.1133	1.1150	1.1167	1.1198	1.1226	1.1250	1.1271	1.1289	1.1304	1.1317	1.1333	1.1347
55	10.8	1.1118	1.1134	1.1153	1.1170	1.1186	1.1216	1.1242	1.1264	1.1283	1.1297	1.1308	1.1315	1.1328	1.1339
56	11.0	1.0000	1.0000	1.0000	1.0000	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	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	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	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	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	1.0000	1.0000	1.0000	1.0000

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