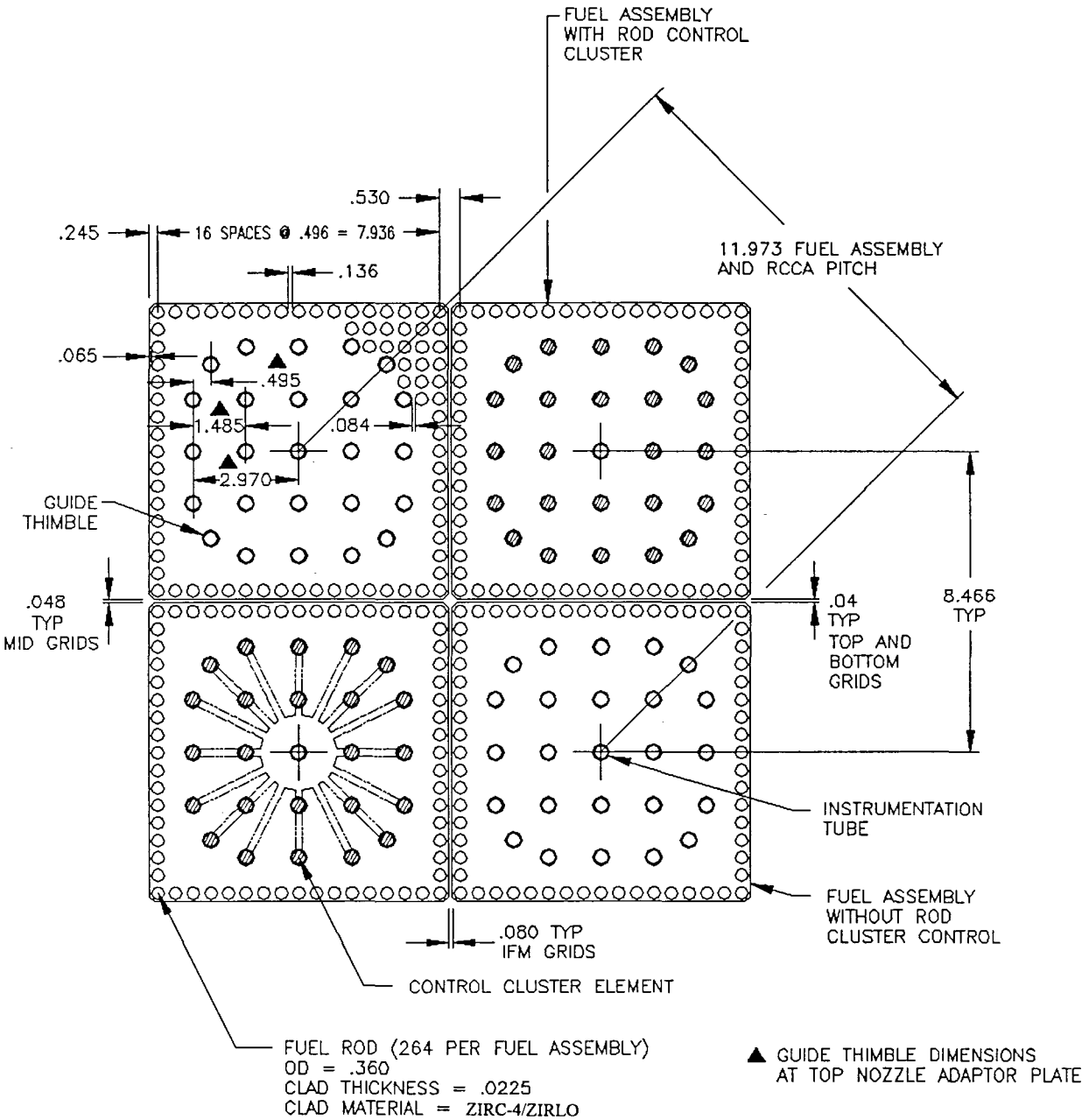


DIMENSIONS ARE IN INCHES (NOMINAL)

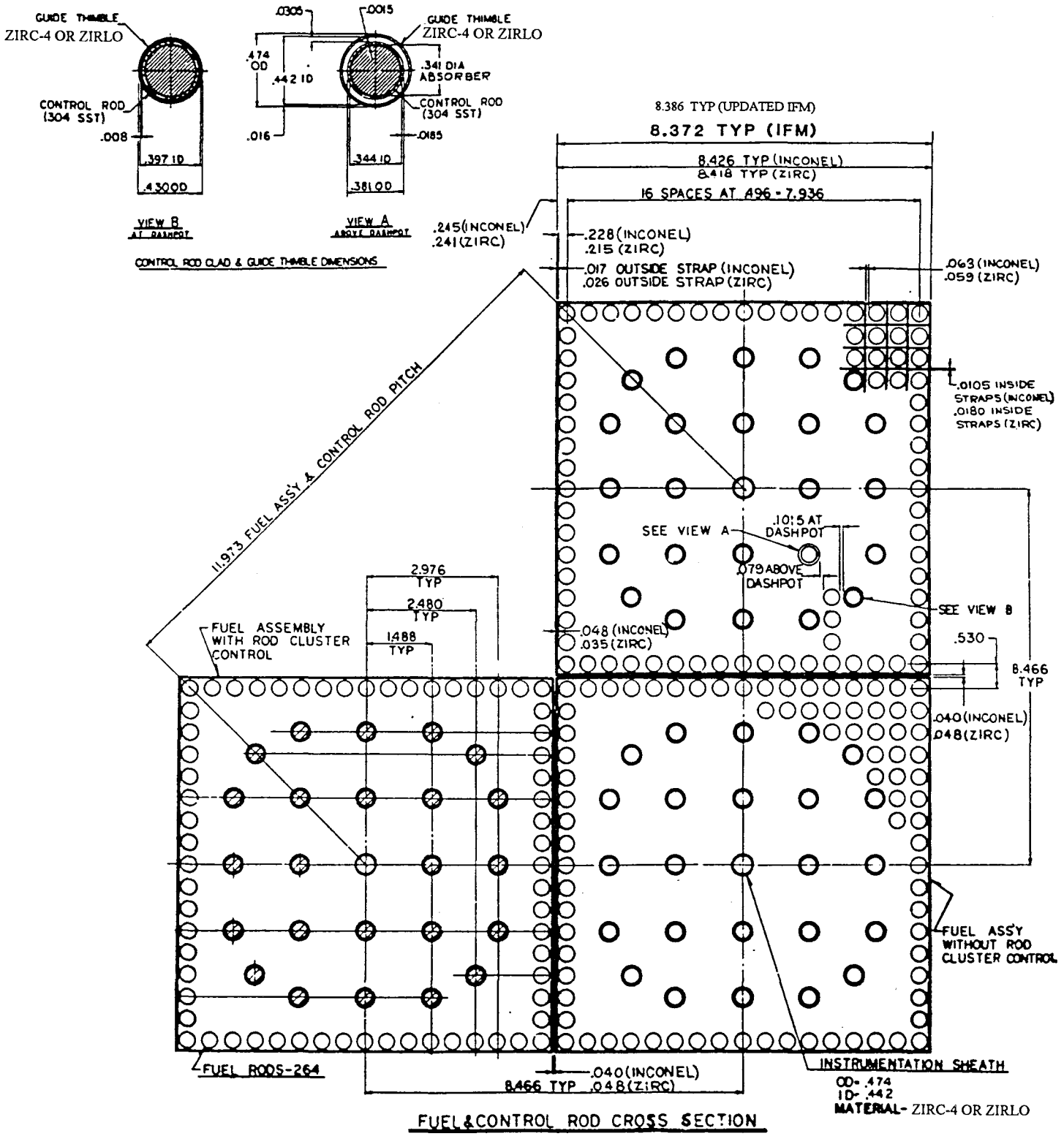
CALLAWAY PLANT

FIGURE 4.2-1

FUEL ASSEMBLY CROSS SECTION
17 X 17 VANTAGE 5/V+

REV. OL-9
5/97

SHEET 1



CALLAWAY PLANT

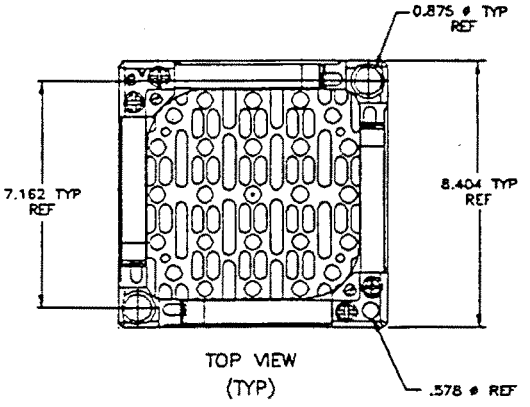
FIGURE 4.2-1

FUEL ASSEMBLY CROSS SECTION
17 X 17 VANTAGE 5/V+

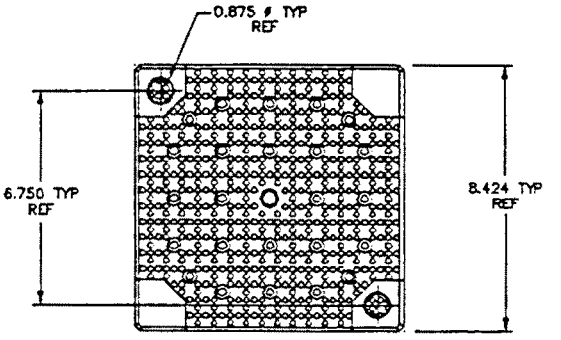
REV. OL-9
5/97

SHEET 2

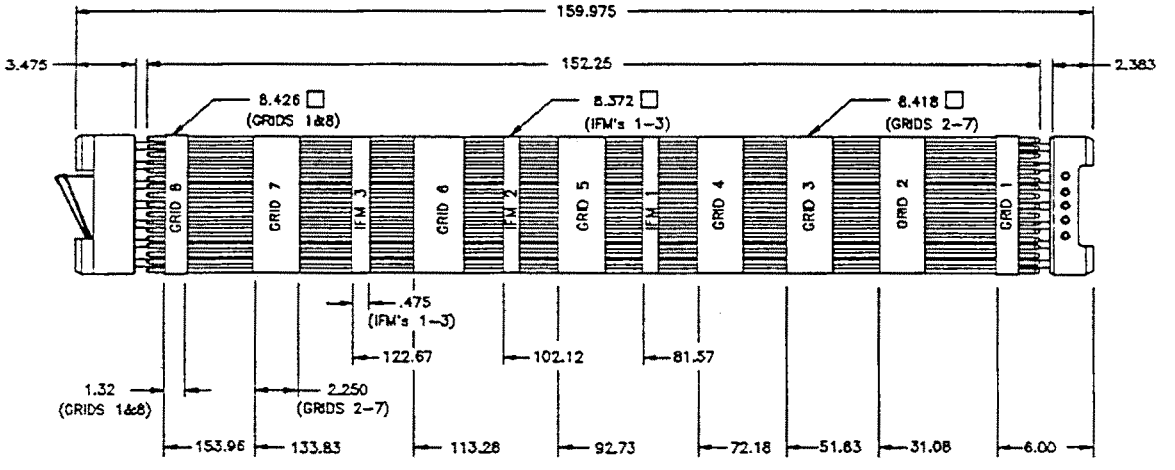
Figure 4.2-1A has been deleted.



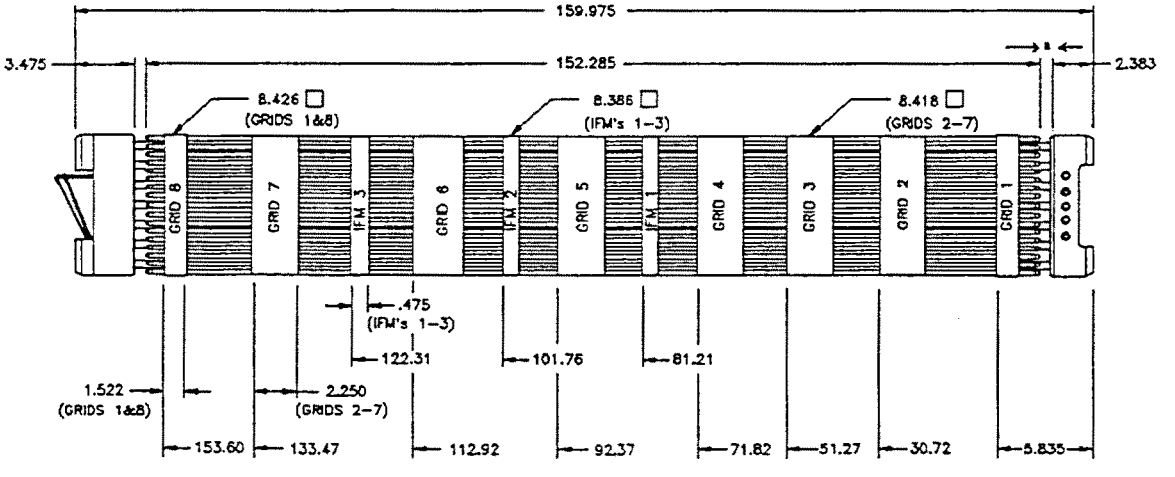
TOP VIEW
(TYP)



BOTTOM VIEW
(TYP)



17X17 VANTAGE 5 FUEL ASSEMBLY



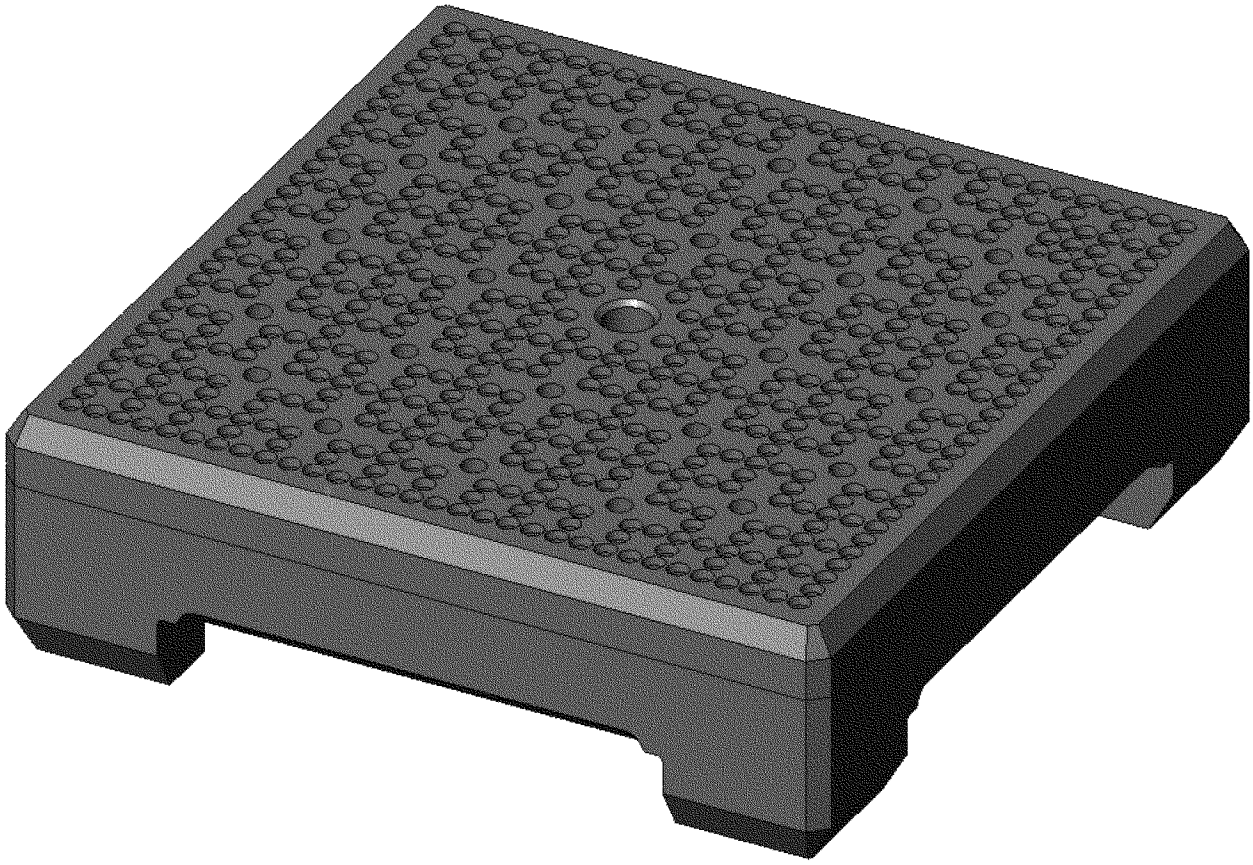
17X17 VANTAGE 5 UPDATE FUEL ASSEMBLY

REV. OL-7
5/94

(a) Gap reduced from 1.10 inches to 0.465 inches.

DIMENSIONS ARE IN INCHES (NOMINAL)

CALLAWAY PLANT
FUEL ASSEMBLY OUTLINE 17x17 VANTAGE 5 FIGURE 4.2-2

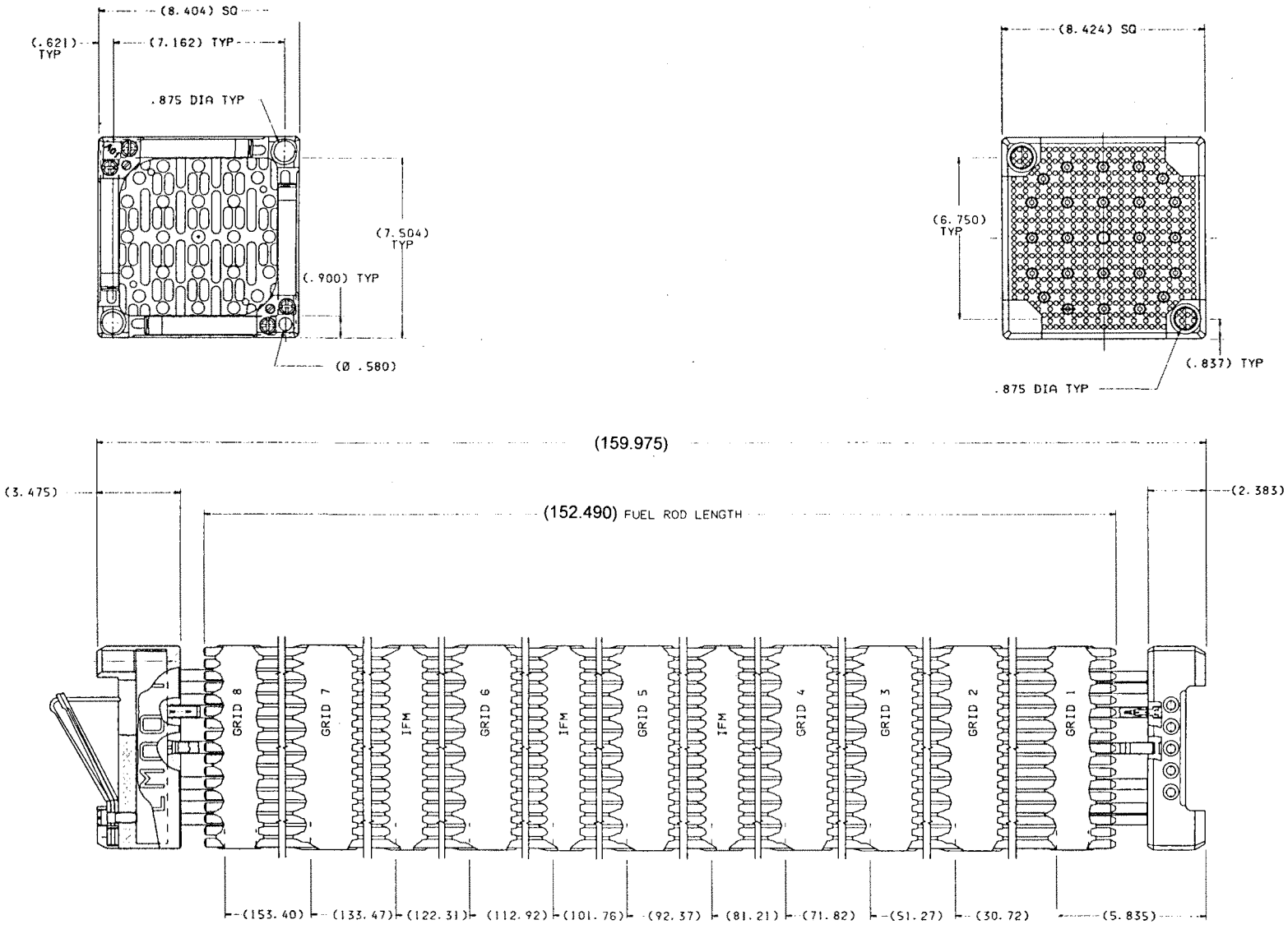


CALLAWAY PLANT

FIGURE 4.2-2A

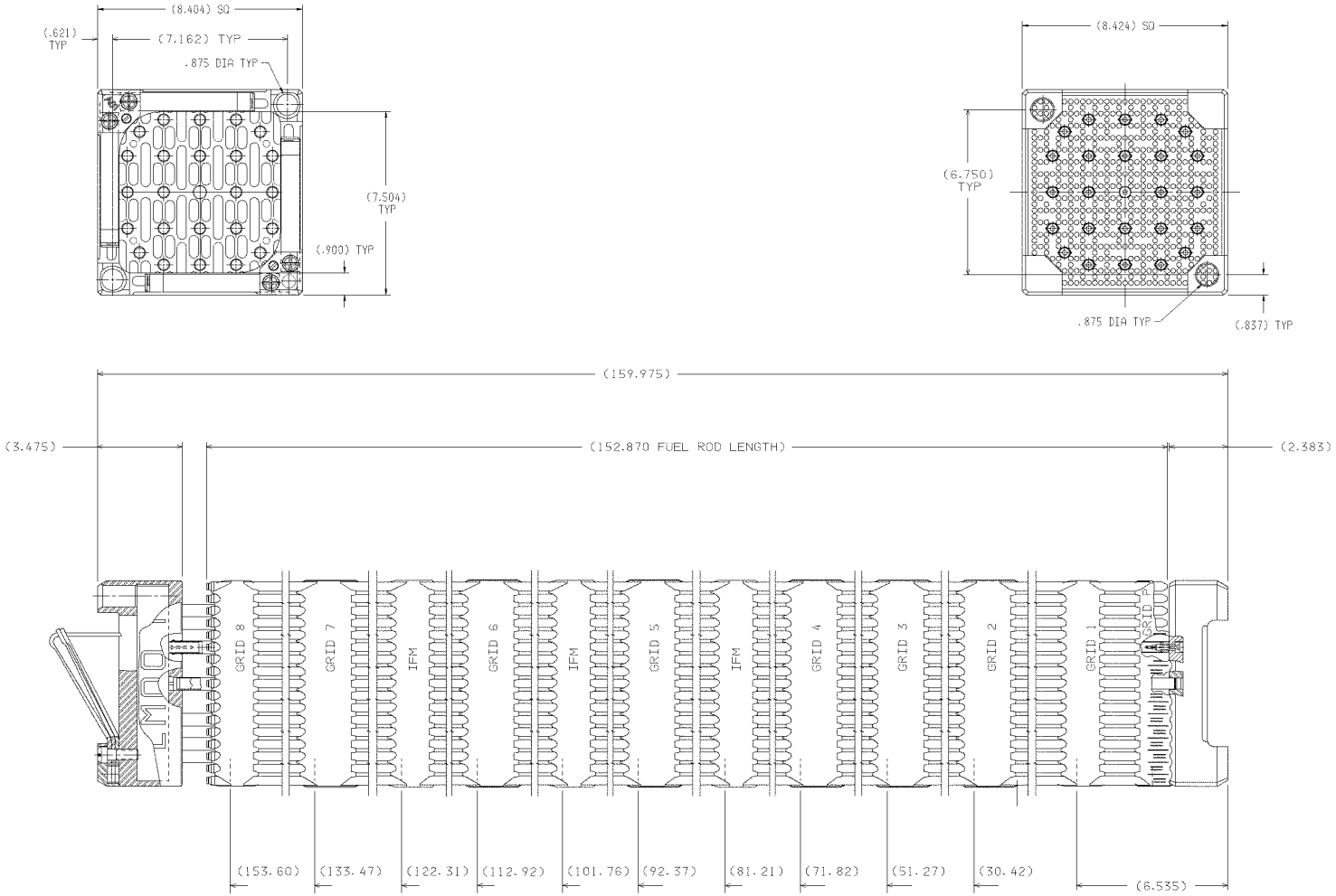
STANDARDIZED BOTTOM NOZZLE
PICTURE OF 17 X 17 SDFBN

REV. 6 5/12



REV OL-11
5/00

CALLAWAY PLANT
17X17 VANTAGE + FUEL ASSEMBLY (ZIRLO) FIGURE 4.2-2B

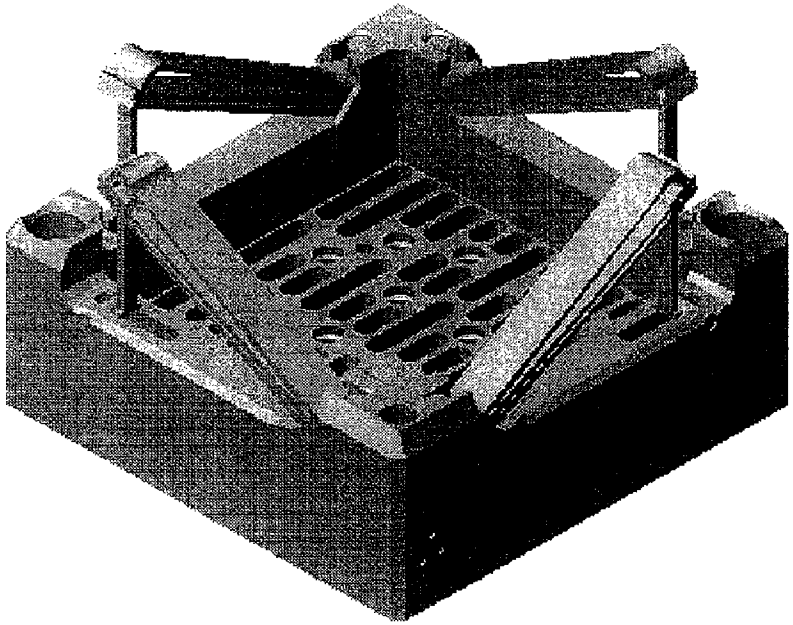


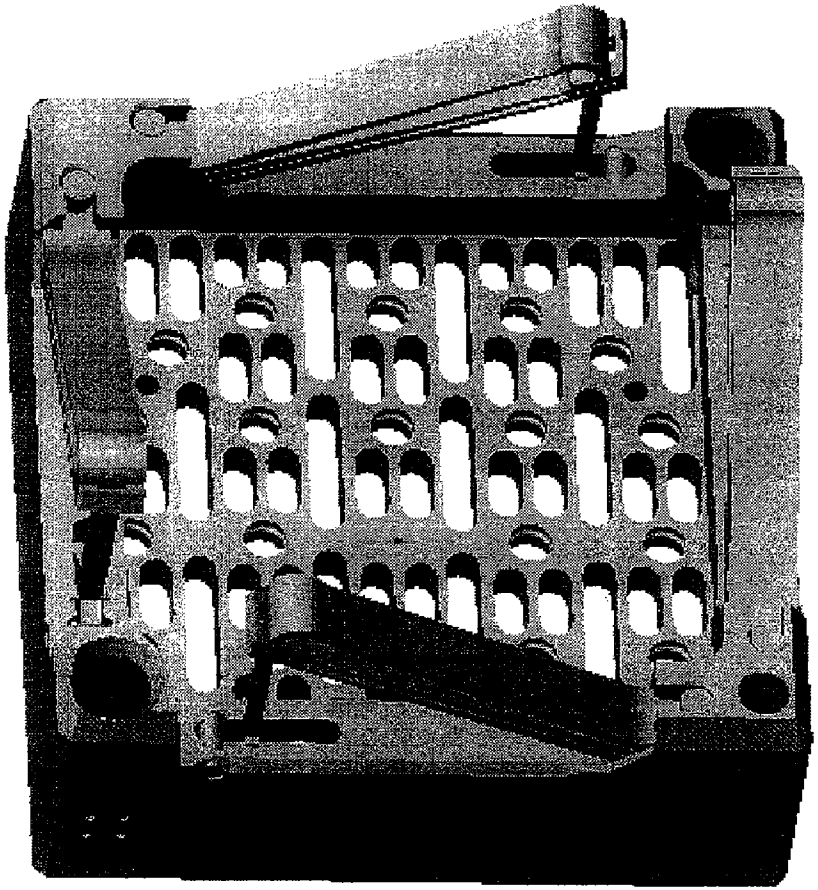
CALLAWAY PLANT

FIGURE 4.2-2C

17X17 PERFORMANCE+
FUEL ASSEMBLY

REV. 14 5/12



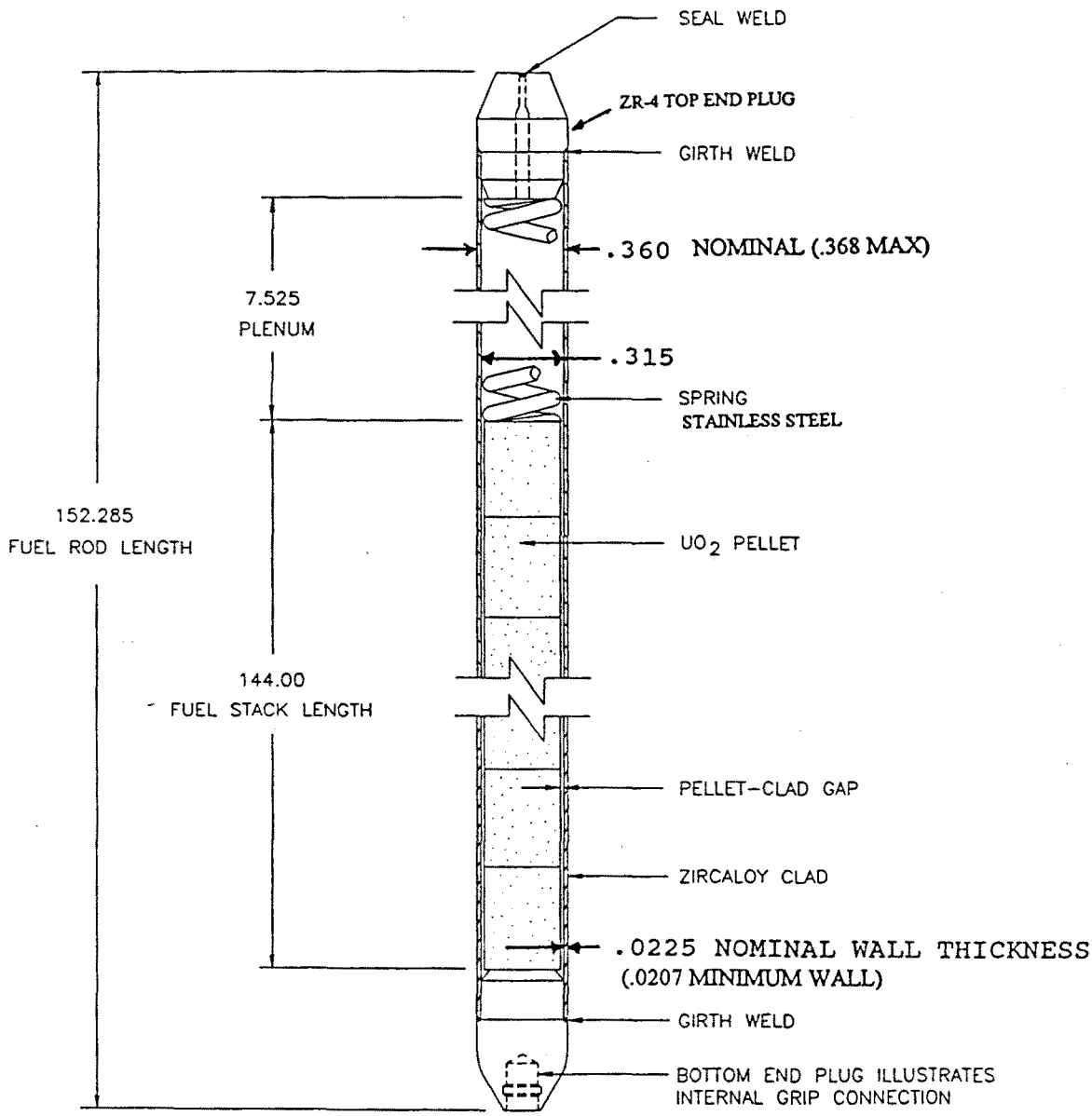


CALLAWAY PLANT

FIGURE 4.2-2D

WESTINGHOUSE INTEGRATED NOZZLE PICTURE OF WIN TOP NOZZLE

REV. 0 2/09



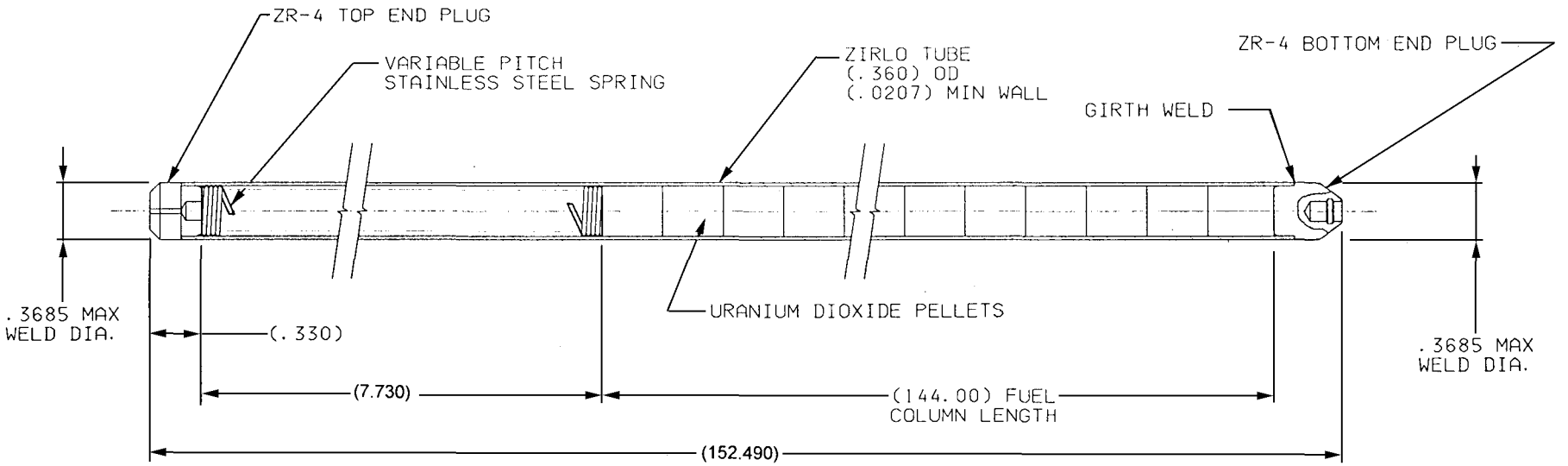
17x17 VANTAGE 5 UPDATE FUEL ROD ASSEMBLY

SPECIFIC DIMENSIONS DEPEND ON DESIGN VARIABLE SUCH AS PREPRESSURIZATION, POWER HISTORY, AND DISCHARGE BURNUP (SEE ALSO FIGURES 4.2-3B AND 4.2-3C)

DIMENSIONS ARE IN INCHES (NOMINAL)

REV. OL-13
05/03

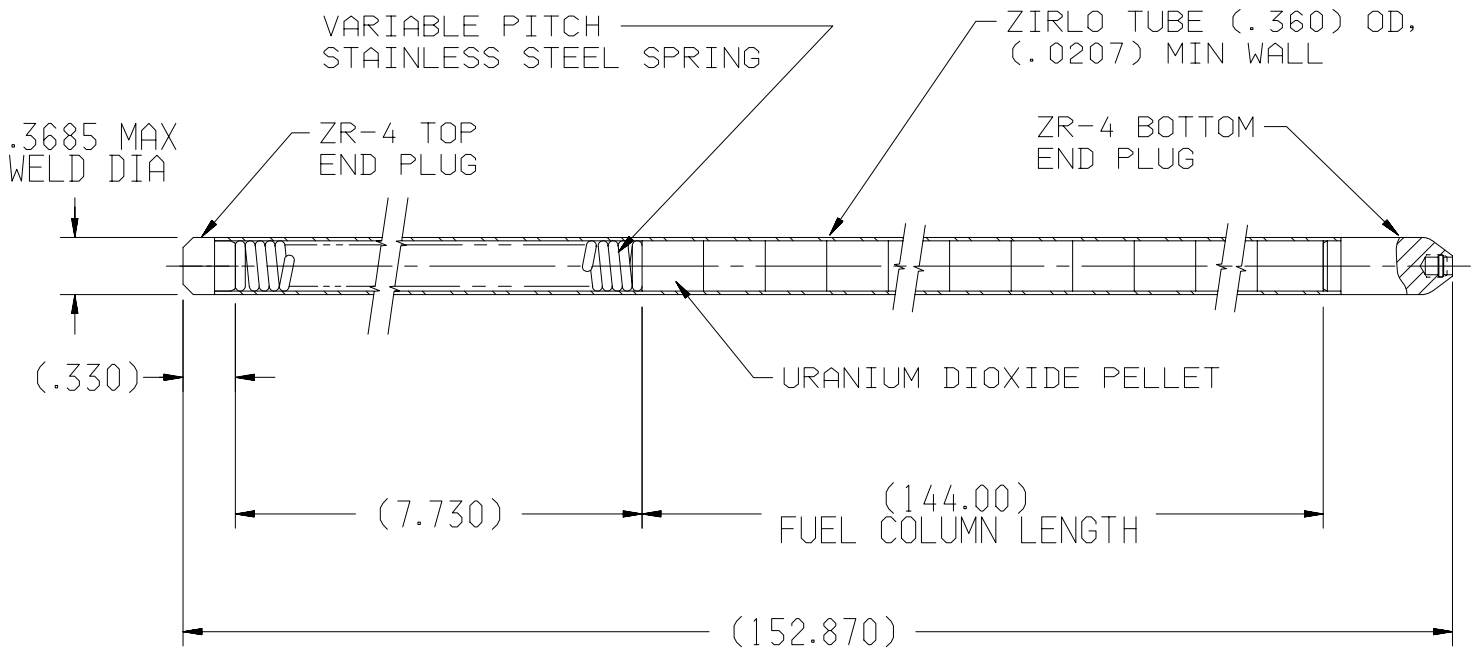
CALLAWAY PLANT
FUEL ROD SCHEMATIC FIGURE 4.2-3



REV OL-13
05/03

CALLAWAY PLANT

17X17 VANTAGE +
FUEL ROD
ZIRLO™
FIGURE 4.2-3A

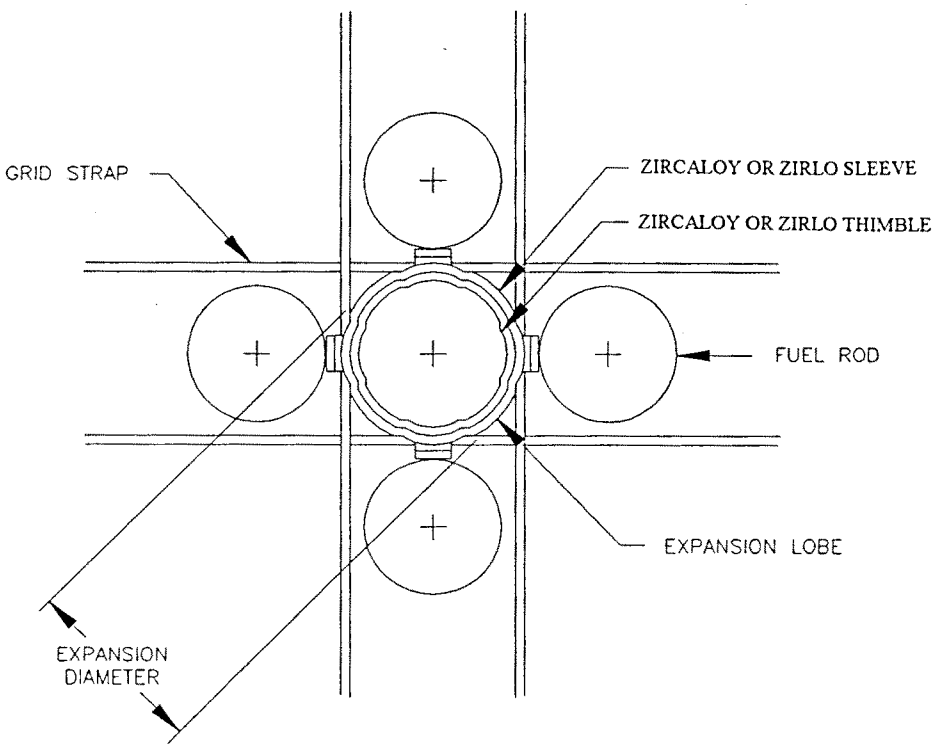


REV OL-13
05/03

CALLAWAY PLANT

**17X17 PERFORMANCE+
FUEL ASSEMBLY**

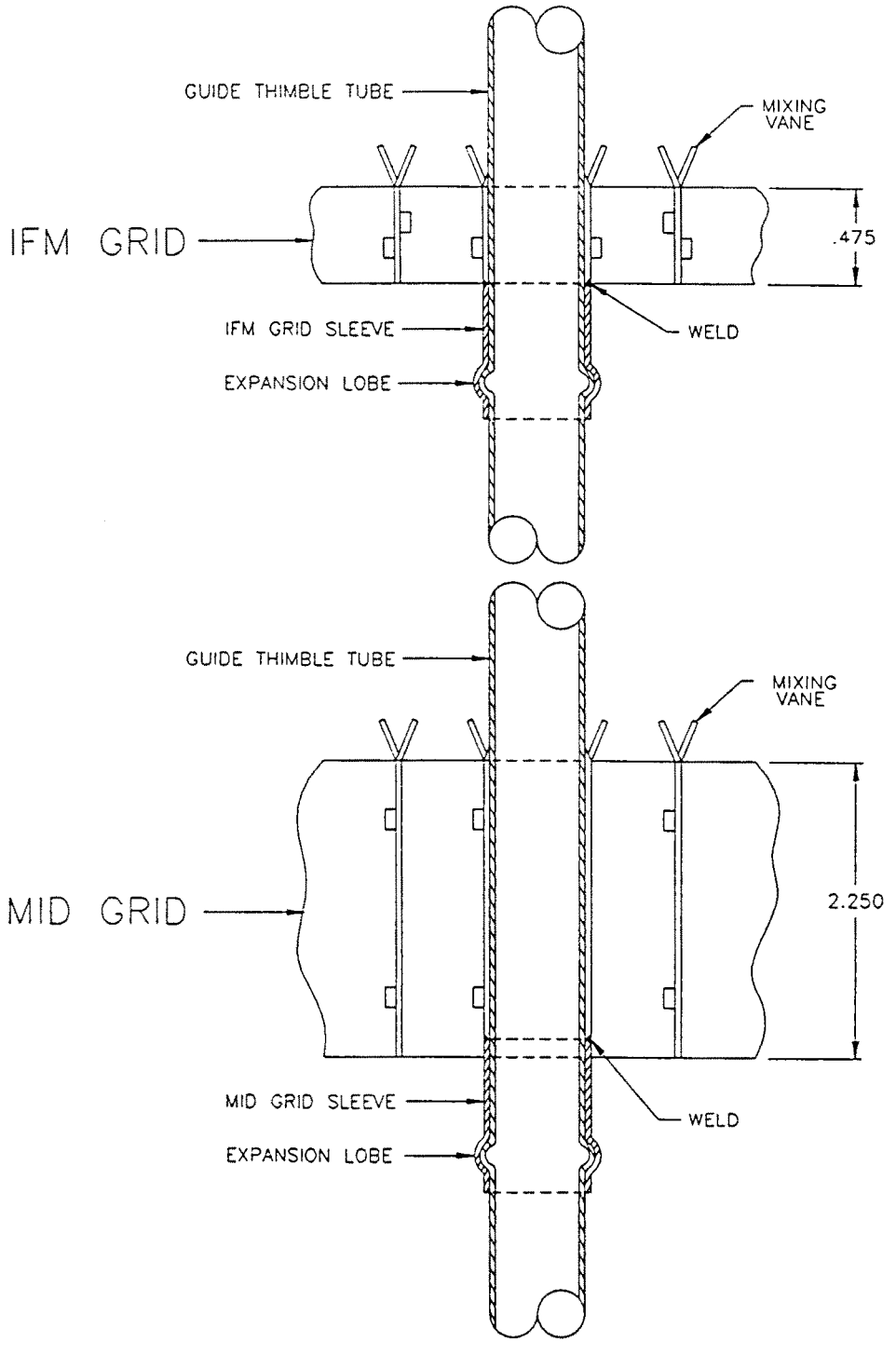
FIGURE 4.2-3B



IFM AND MID GRID EXPANSION JOINT DESIGN

REV. OL-9
5/97

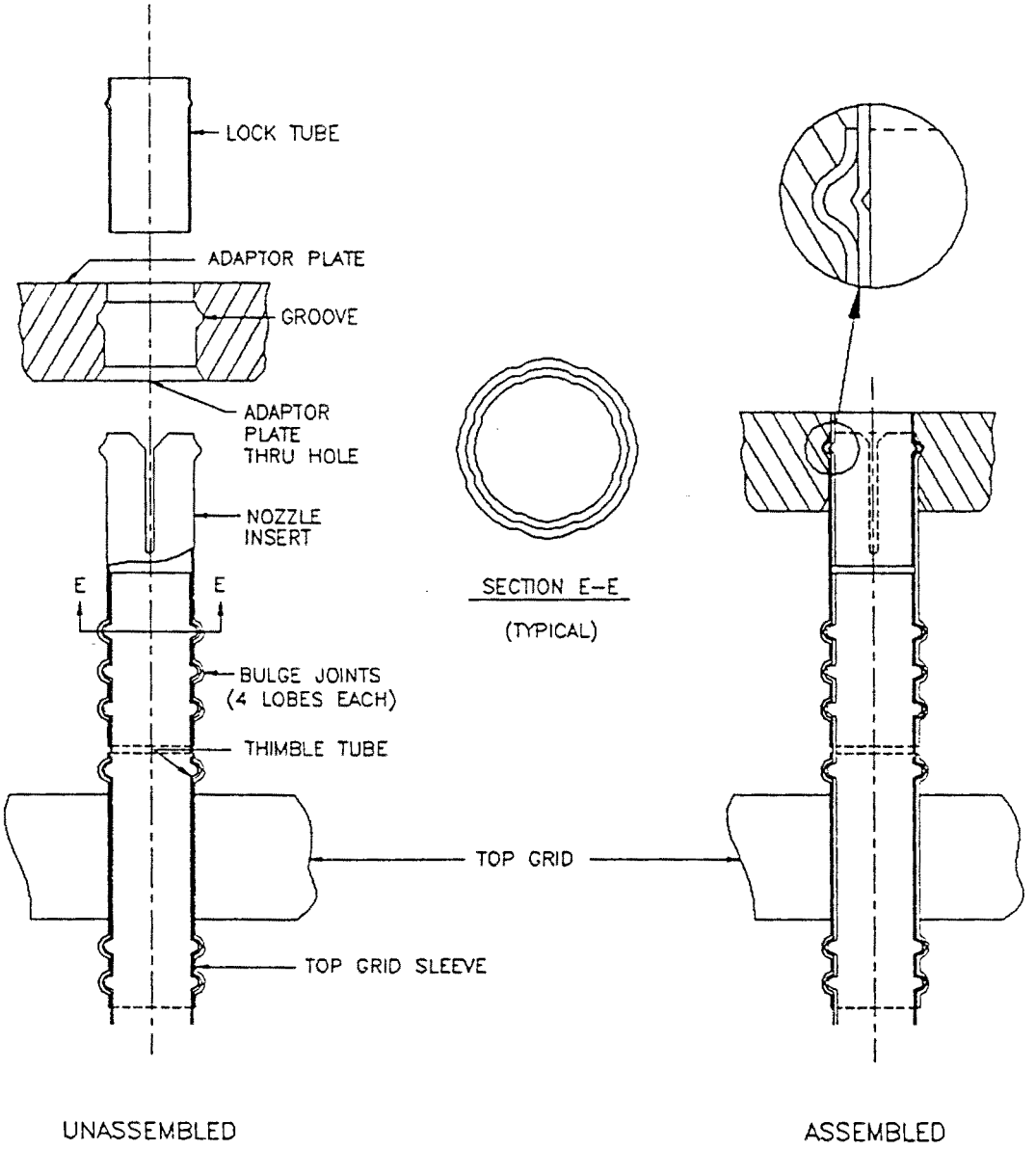
CALLAWAY PLANT
PLAN VIEW FIGURE 4.2-4



DIMENSIONS ARE IN INCHES (NOMINAL)

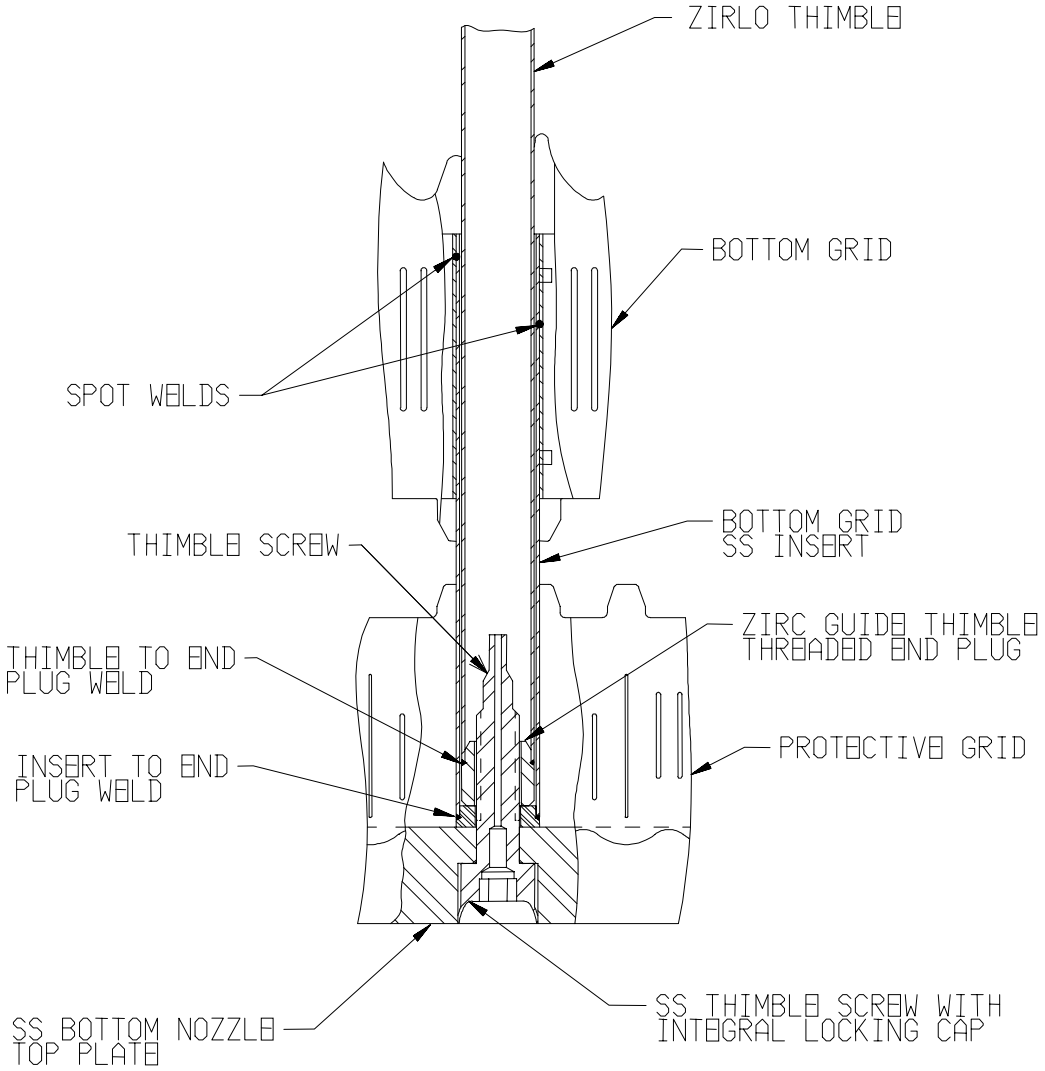
REV. OL-5
6/91

CALLAWAY PLANT
GRID TO THIMBLE ATTACHMENT JOINTS
FIGURE 4.2-5



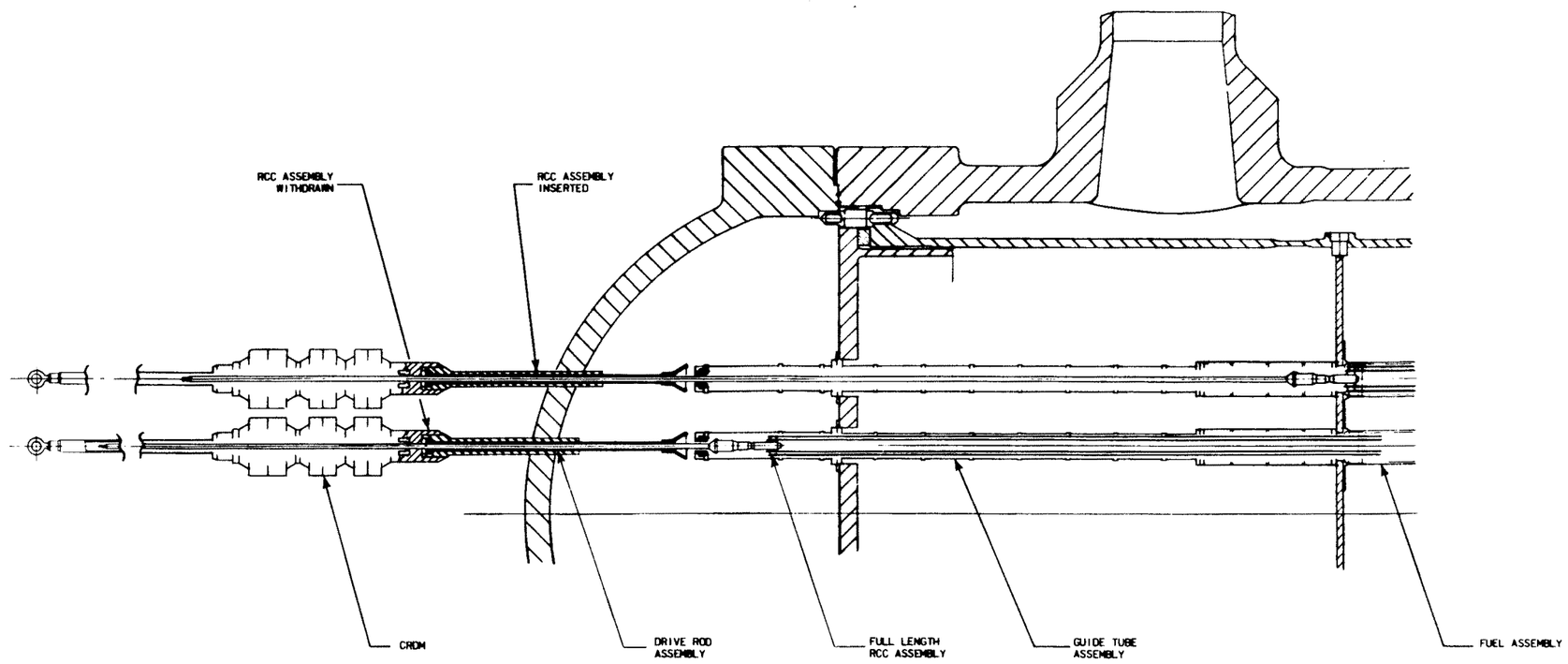
REV. OL-5
6/91

CALLAWAY PLANT
THIMBLE/INSERT/TOP GRID SLEEVE BULGE JOINT GEOMETRY FIGURE 4.2-6



REV OL-13
05/03

CALLAWAY PLANT
GUIDE THIMBLE TO BOTTOM NOZZLE JOINT FIGURE 4.2-7



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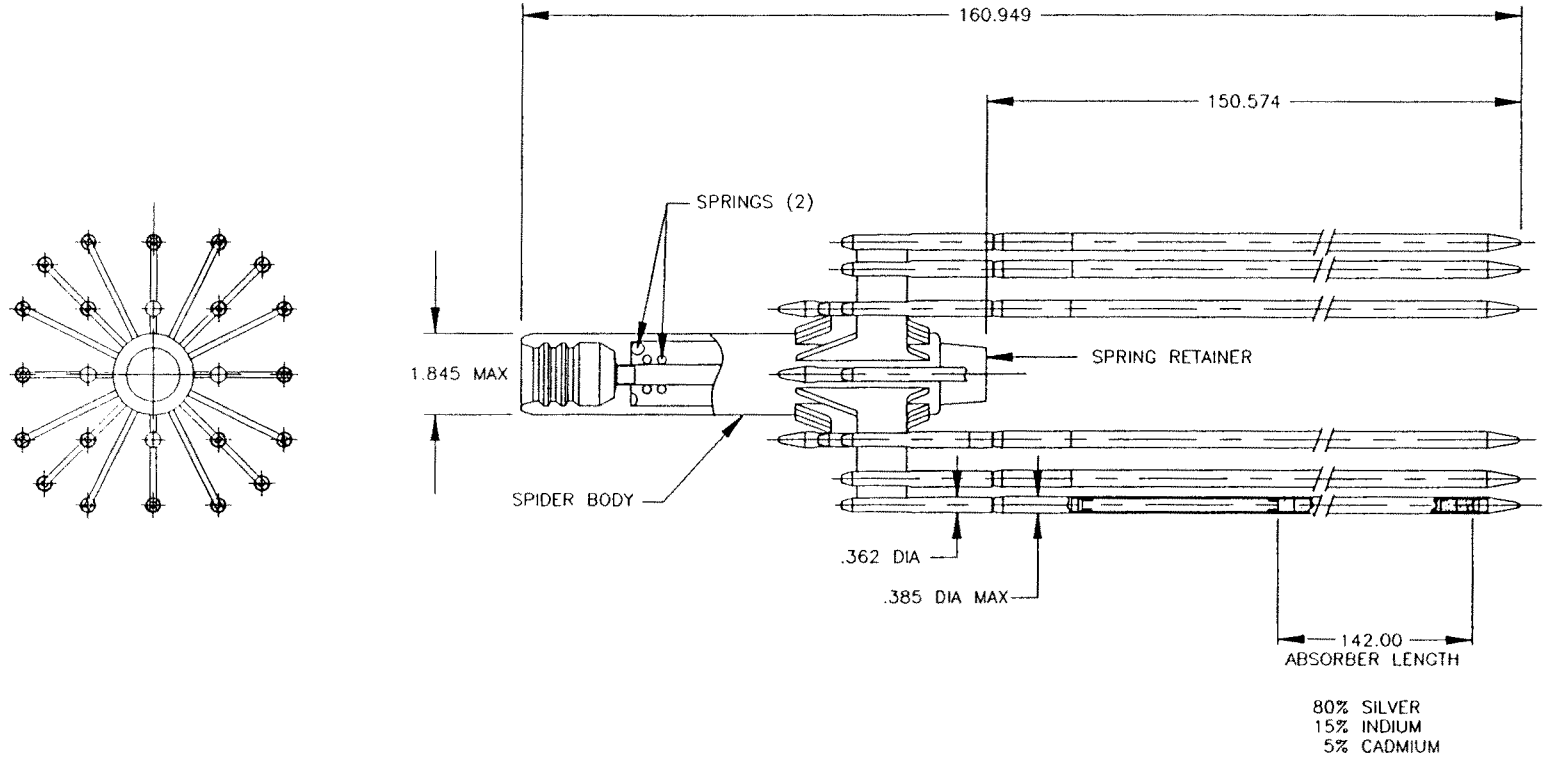
CALLAWAY PLANT

FIGURE 4.2-8

ROD CLUSTER
CONTROL AND DRIVE ROD ASSEMBLY
WITH INTERFACING COMPONENTS



REV. OL-5
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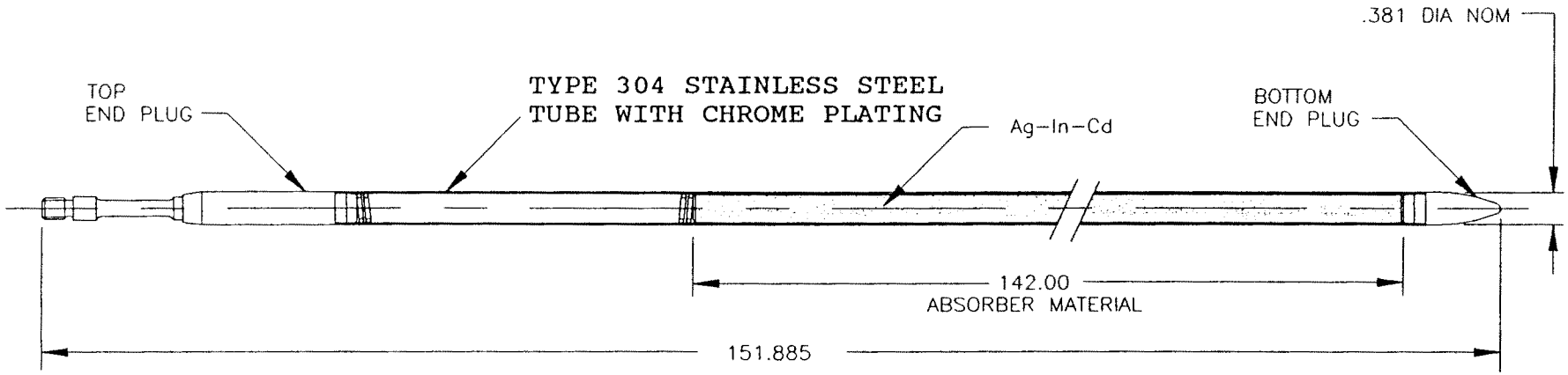
CALLAWAY PLANT

FULL-LENGTH RCCA OUTLINE

FIGURE 4.2-9



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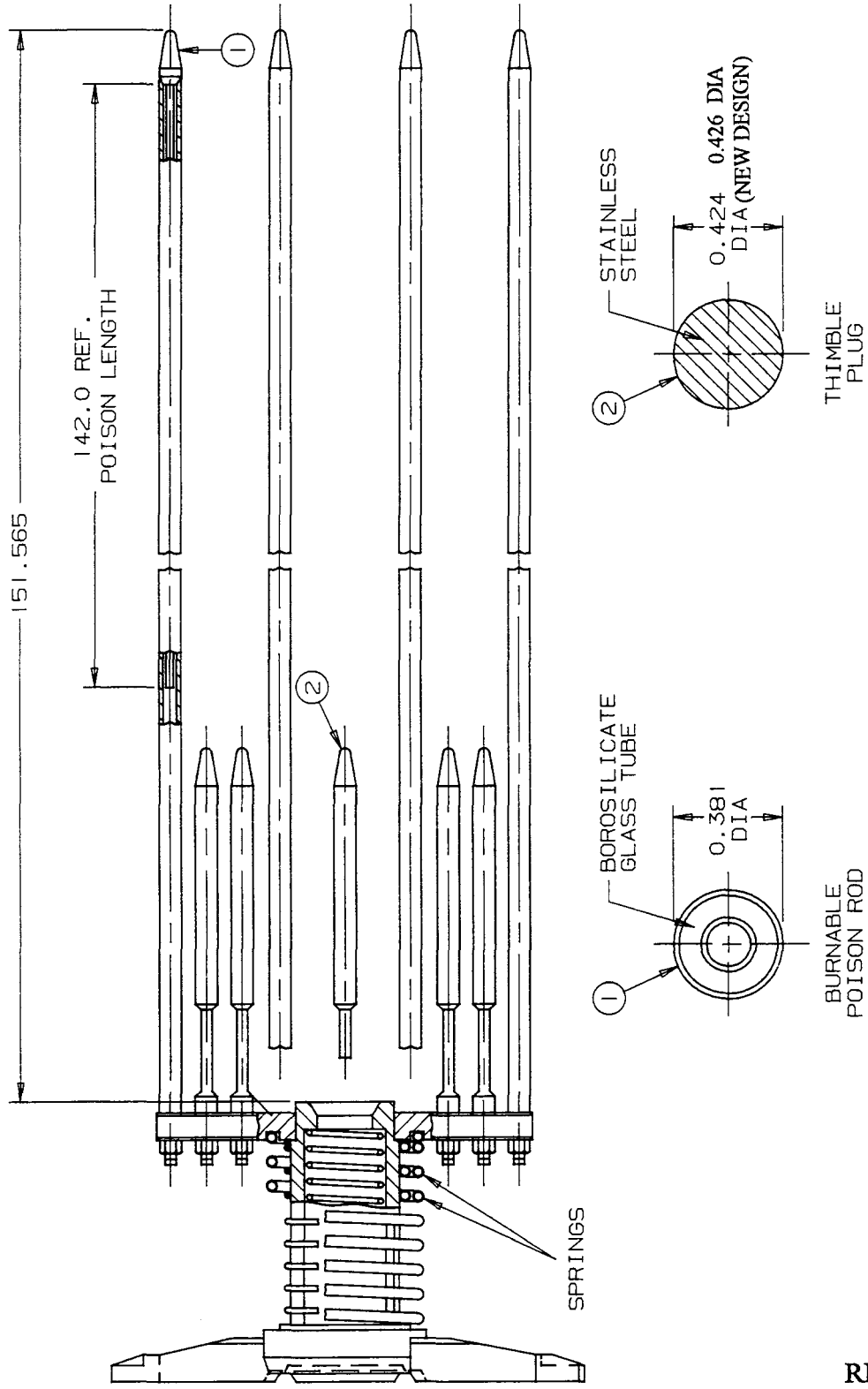
CALLAWAY PLANT
ABSORBER ROD FIGURE 4.2-10

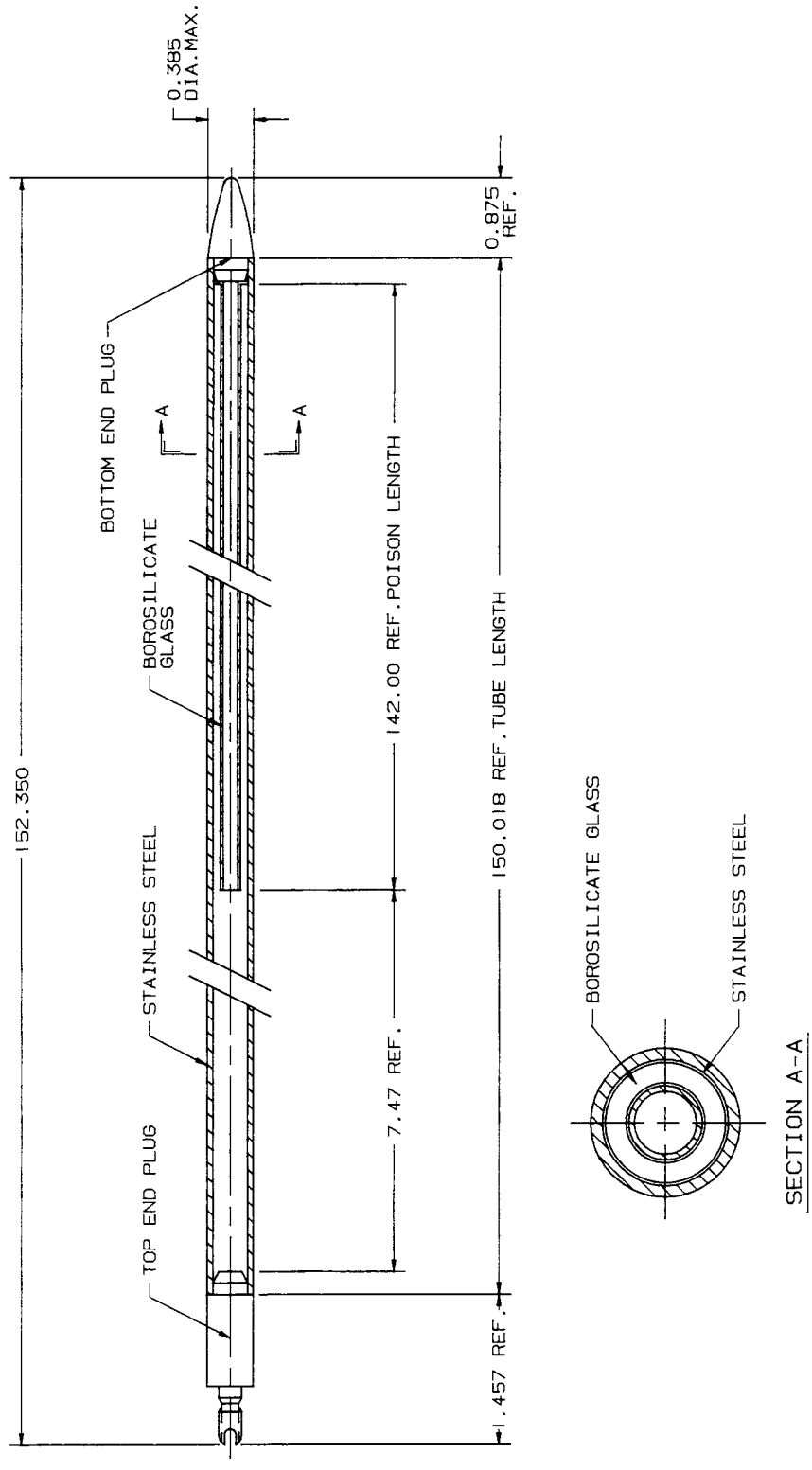


REV. OL-7
5 /94

CALLAWAY PLANT

FIGURE 4.2-11
BURNABLE ABSORBER
ASSEMBLY 17X17

014-A-20766-163



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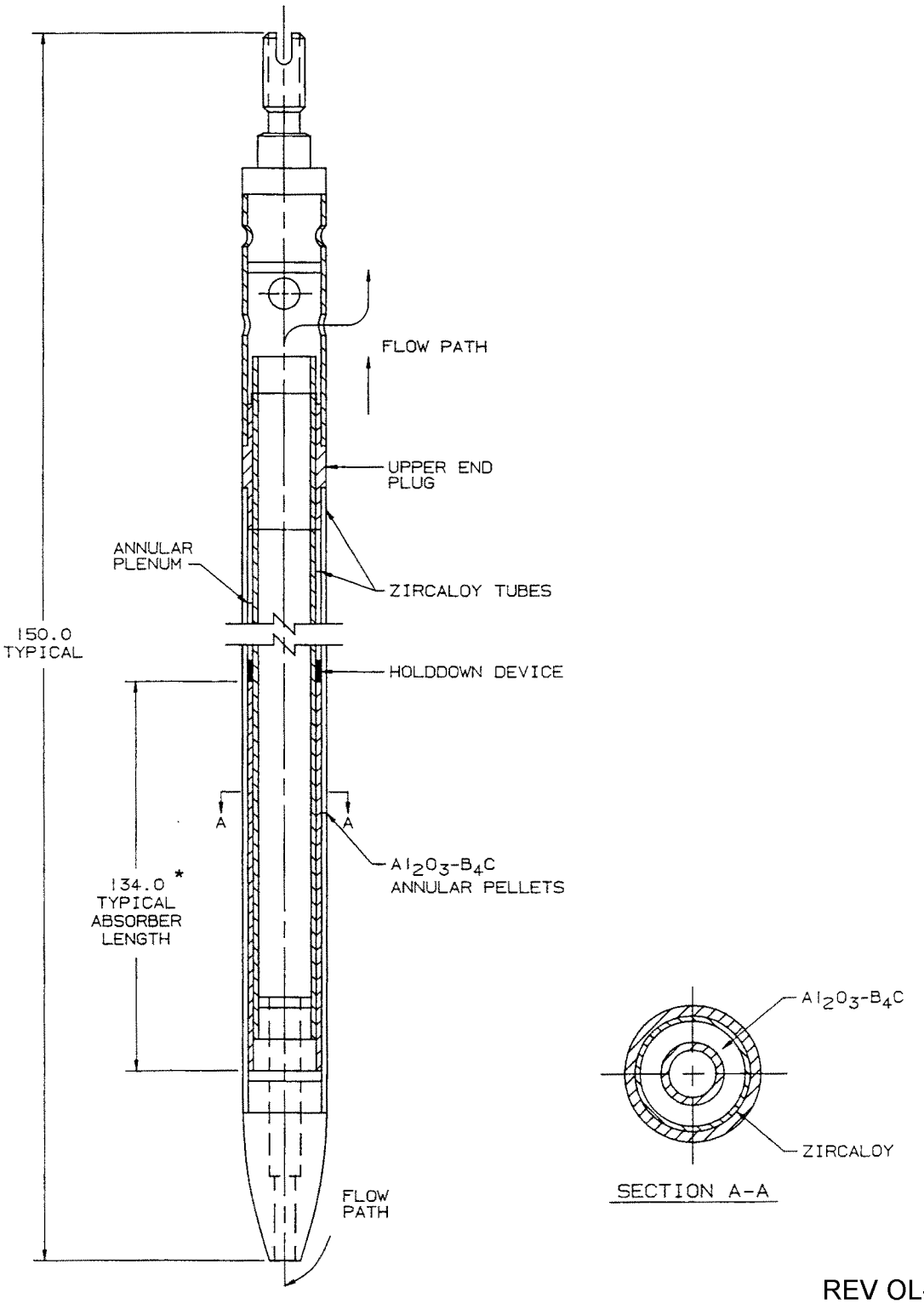
6/87

CALLAWAY PLANT

FIGURE 4.2-12
BURNABLE ABSORBER ROD
CROSS SECTION
17X17

014-A-20766-164



REV OL-13
05/03

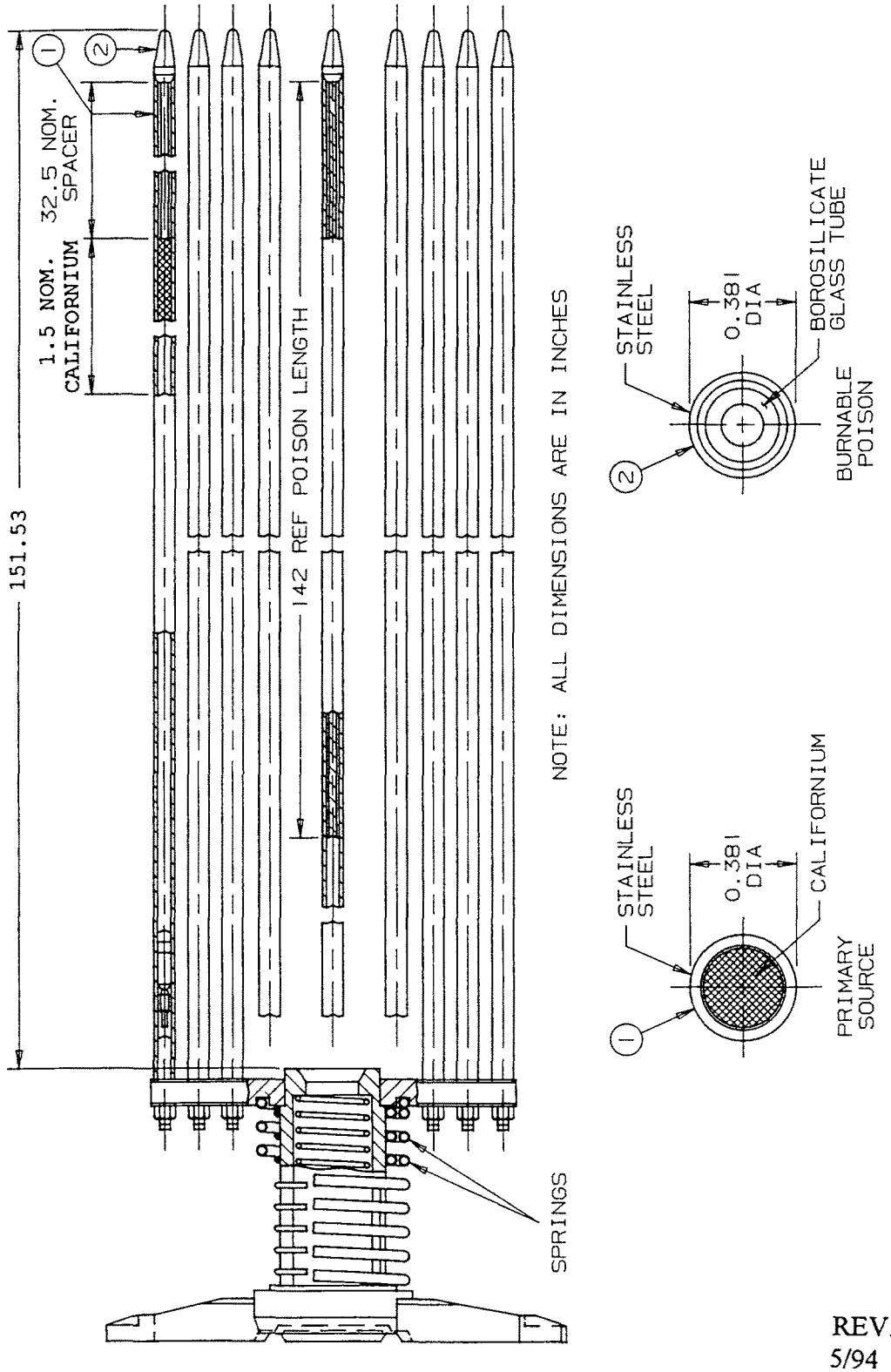
Note: See Figure 4.2-15A for new spring design.

* 132.0 inches in Current feed assemblies

CALLAWAY PLANT

FIGURE 4.2-12a
BURNABLE ABSORBER ROD CROSS-SECTION (ALUMINUM OXIDE BORON CARBIDE ABSORBER)

014-A-20766-165



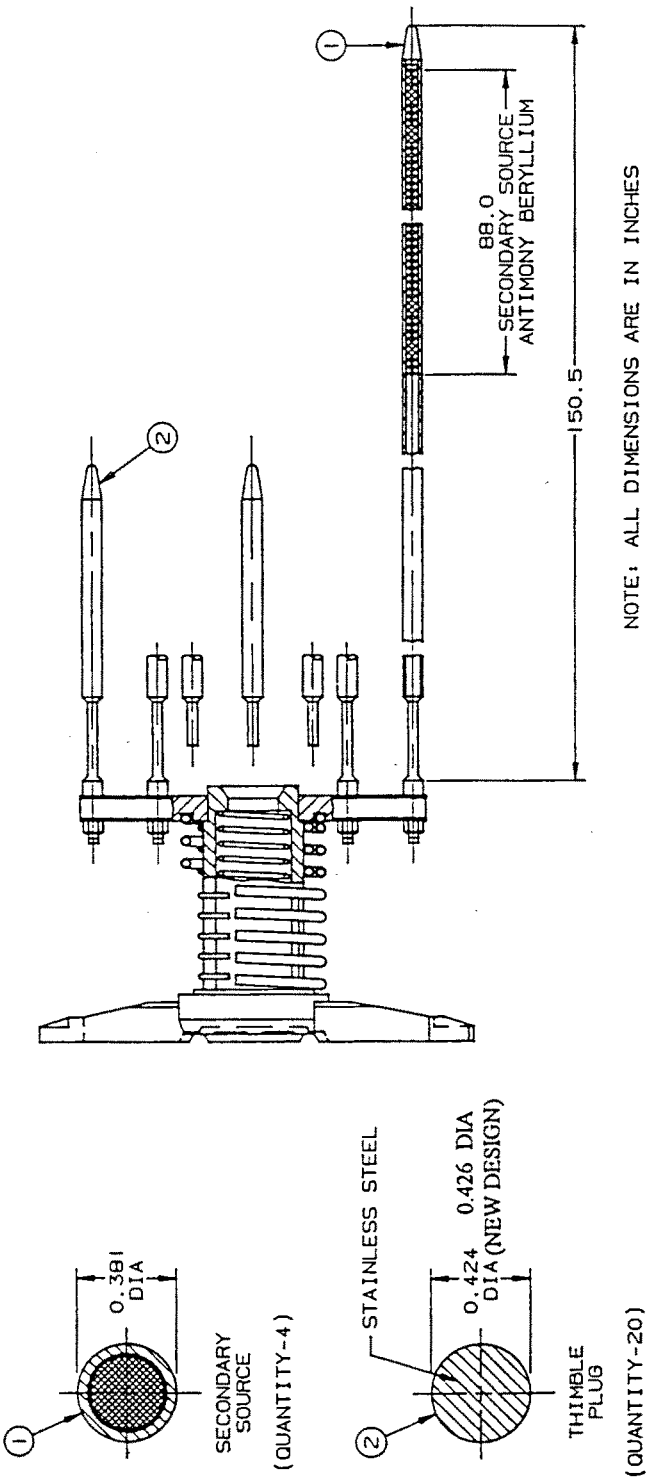
REV. OL-7
5/94

NOTE: See Figure 4.2-15A
for new spring design

CALLAWAY PLANT

FIGURE 4.2-13
PRIMARY SOURCE ASSEMBLY
17X17

014-A-20766-166



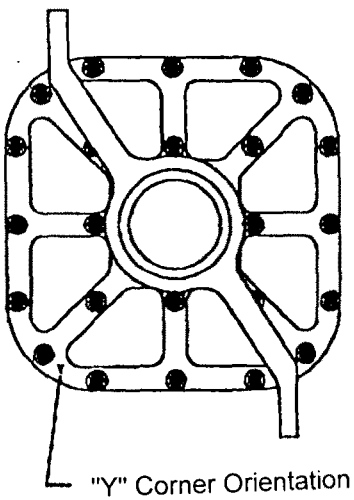
REV. OL-7
5/94

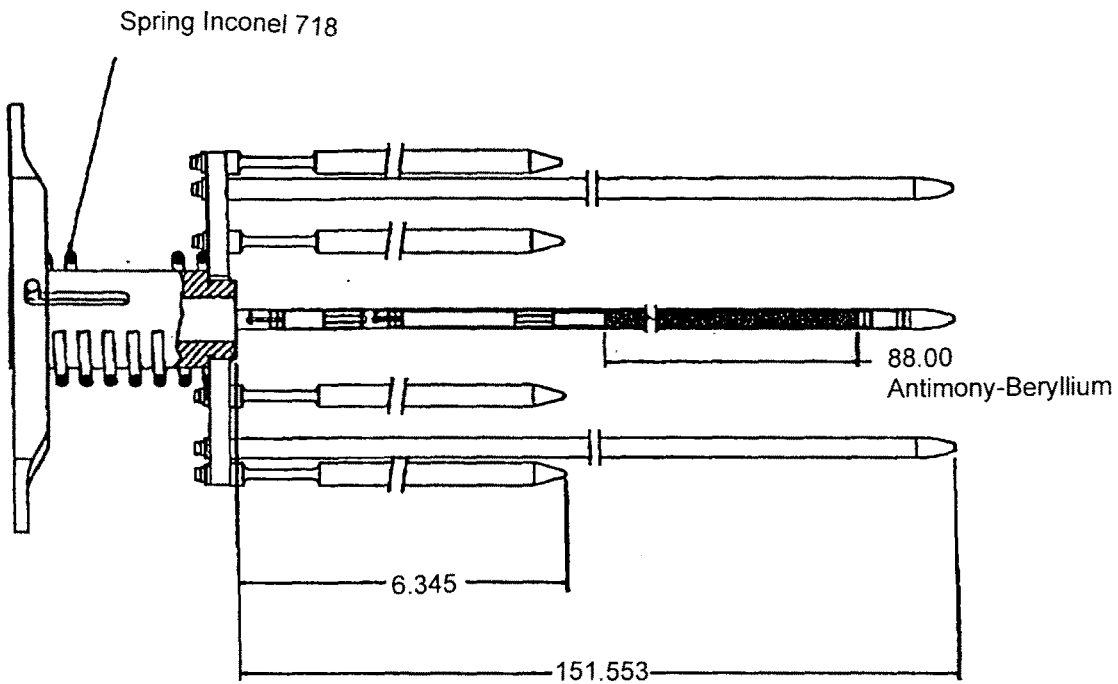
NOTE: See Figure 4.2-15A
for new spring design

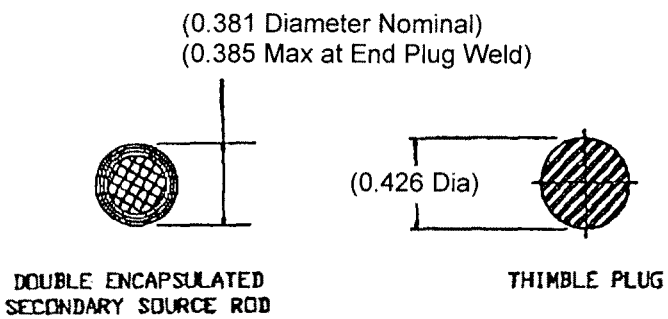
CALLAWAY PLANT

FIGURE 4.2-14
SECONDARY SOURCE ASSEMBLY
17X17

014-A-20766-167



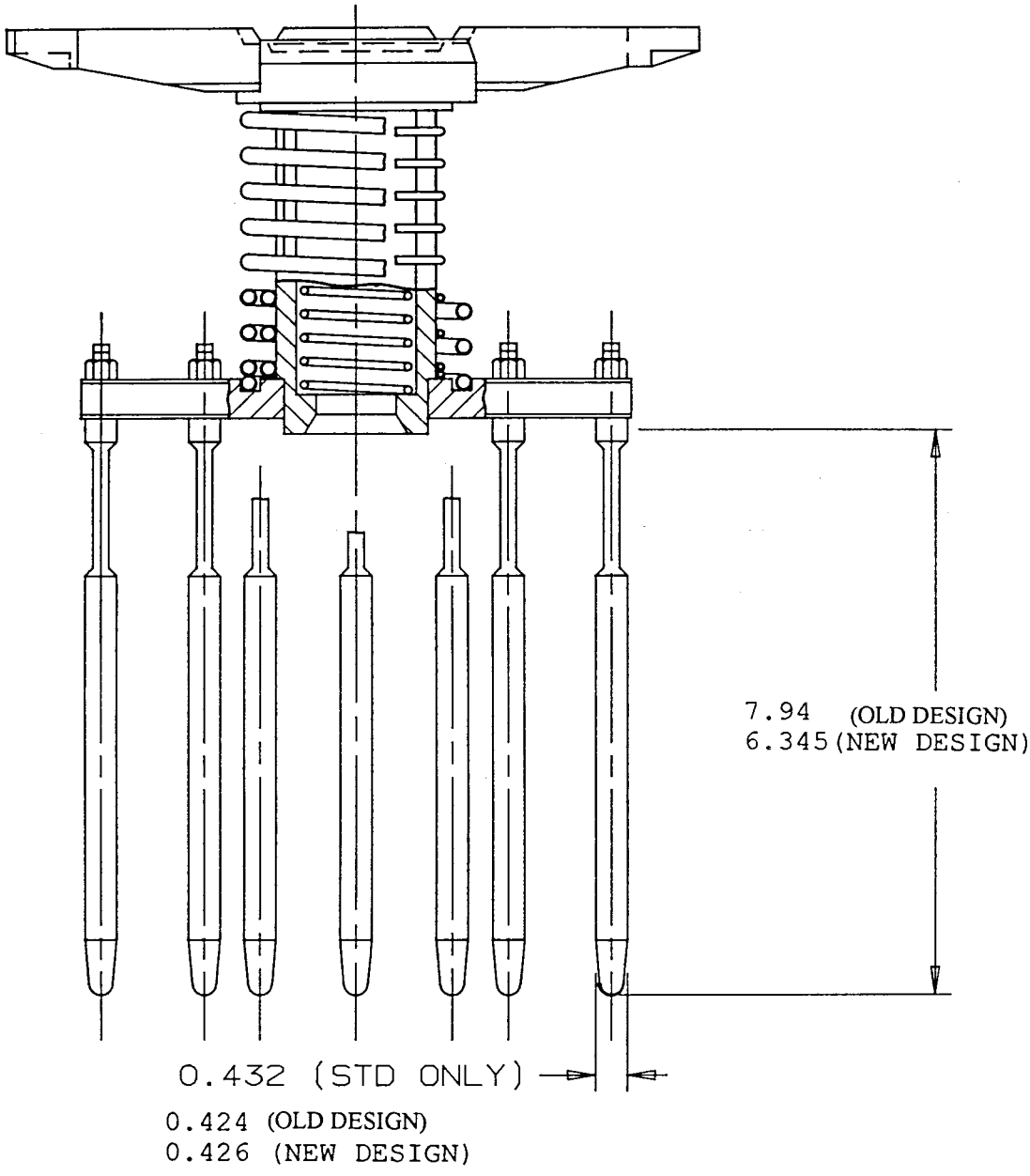




REV OL-11
5/00

CALLAWAY PLANT

FIGURE 4.2-14A
ENCAPSULATED SECONDARY
SOURCE ASSEMBLY 17X17



NOTE: See Figure 4.2-15A
for new spring design

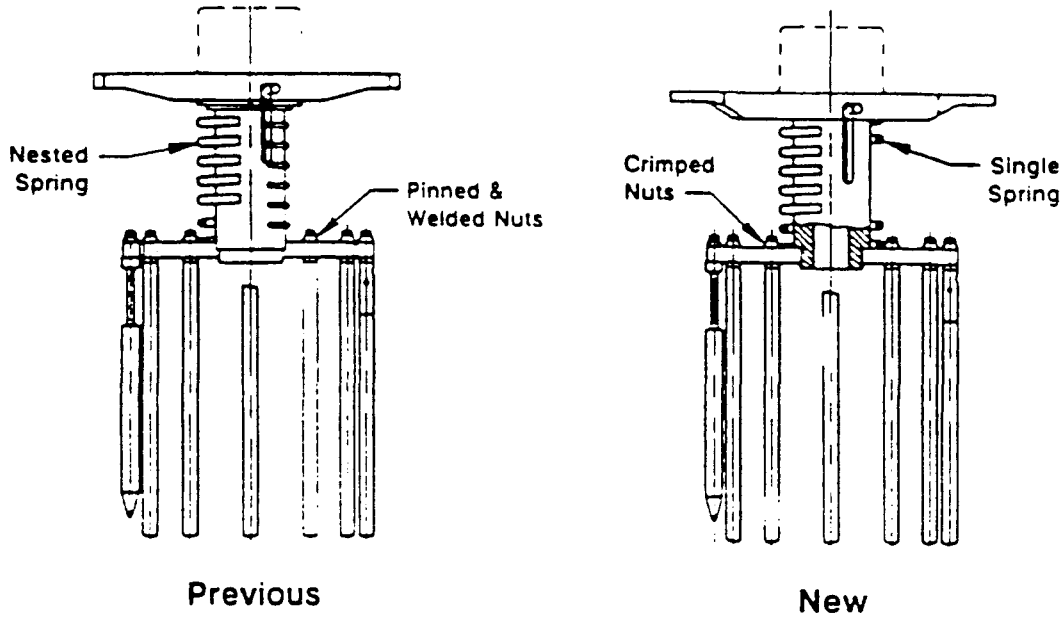
REV. OL-9
5/97

CALLAWAY PLANT

FIGURE 4.2-15
THIMBLE PLUG ASSEMBLY

014-A-20766-168

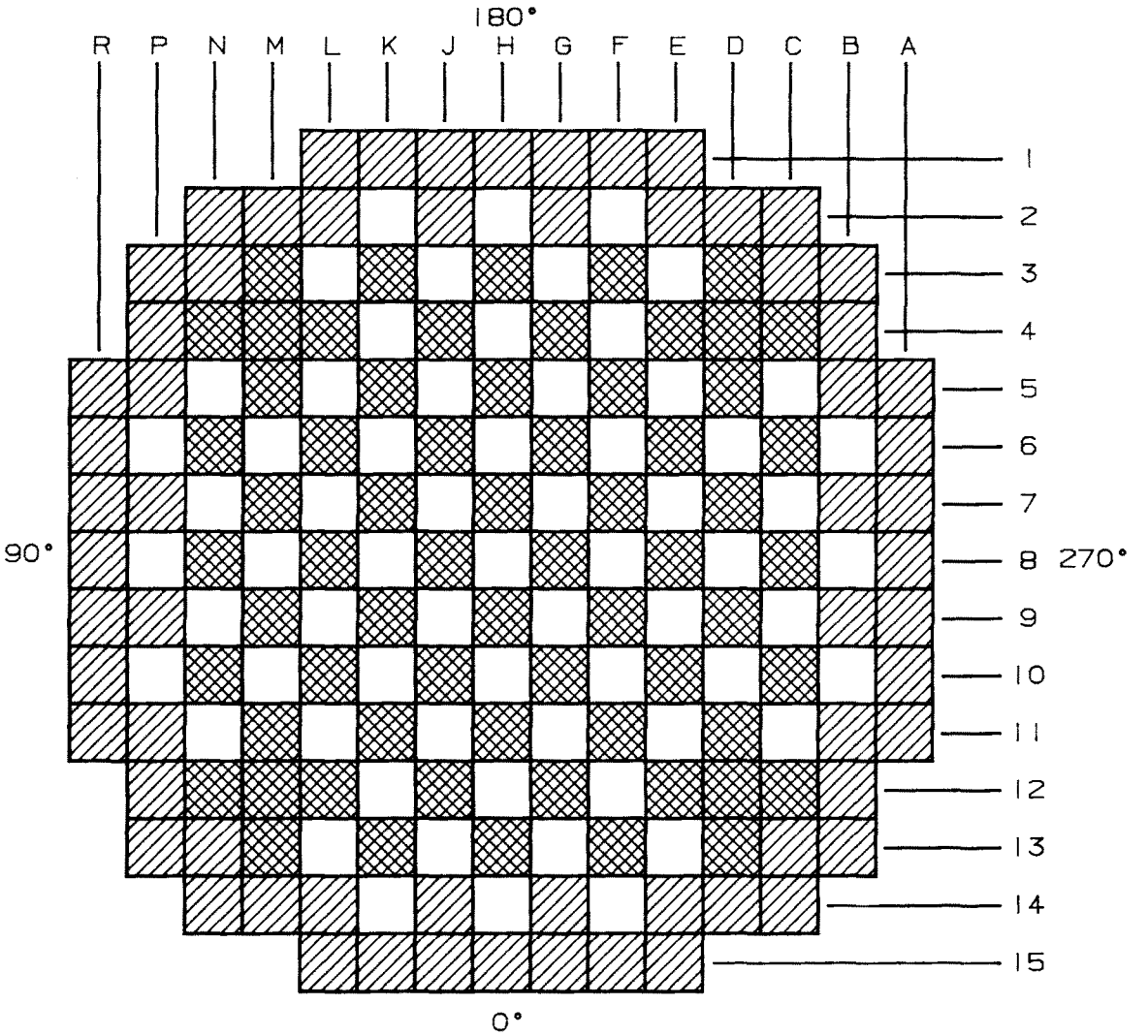
17 X 17



Holddown Assembly Updates - 17 x 17

REV. OL-5
6/91

CALLAWAY PLANT
MODIFIED SPRING DESIGN FIGURE 4.2-15A



FIRST CORE

REGION 1

REGION 2

REGION 3

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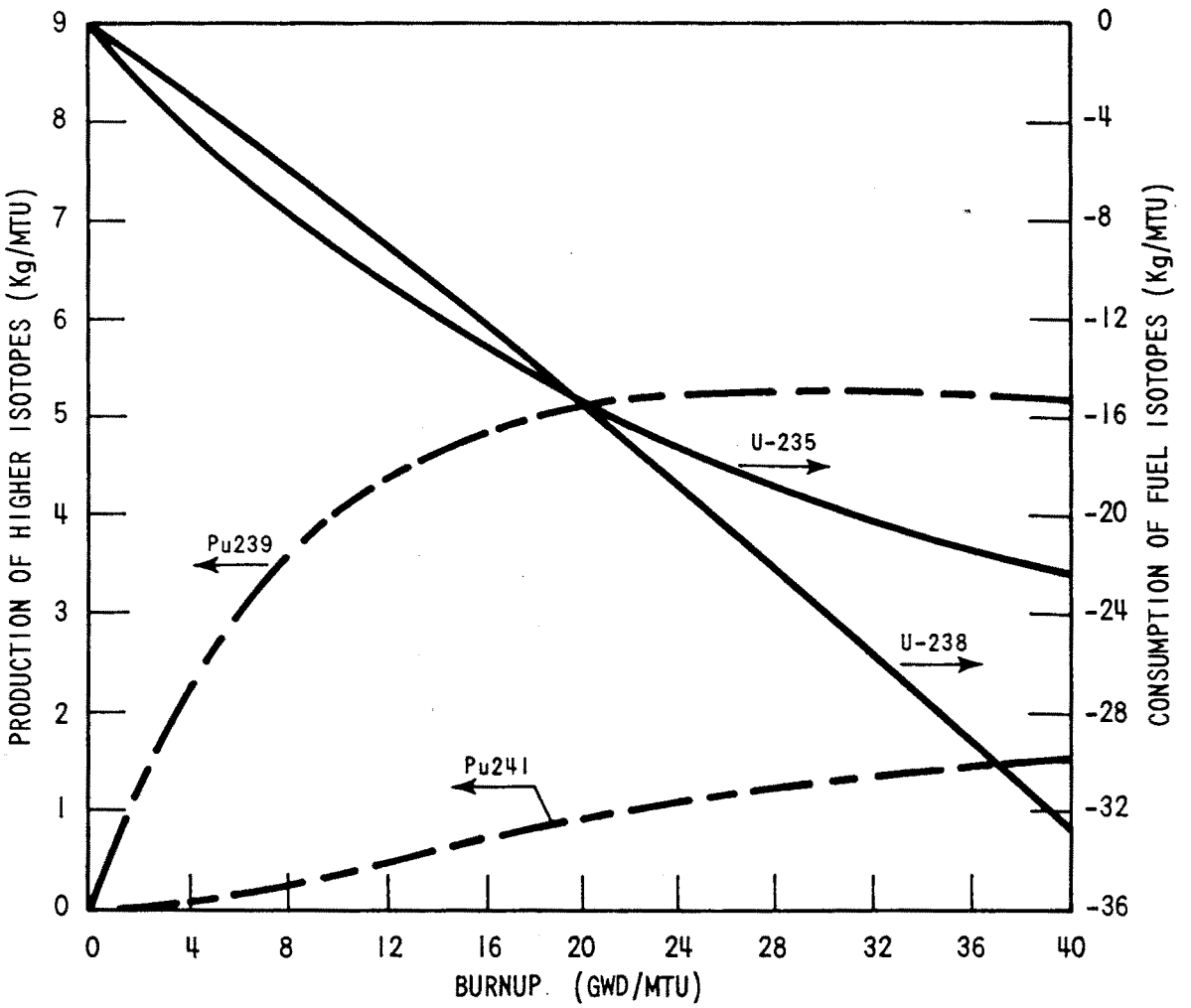
CALLAWAY PLANT

FIGURE 4.3-1
FUEL LOADING ARRANGEMENT

014-A-20766-169



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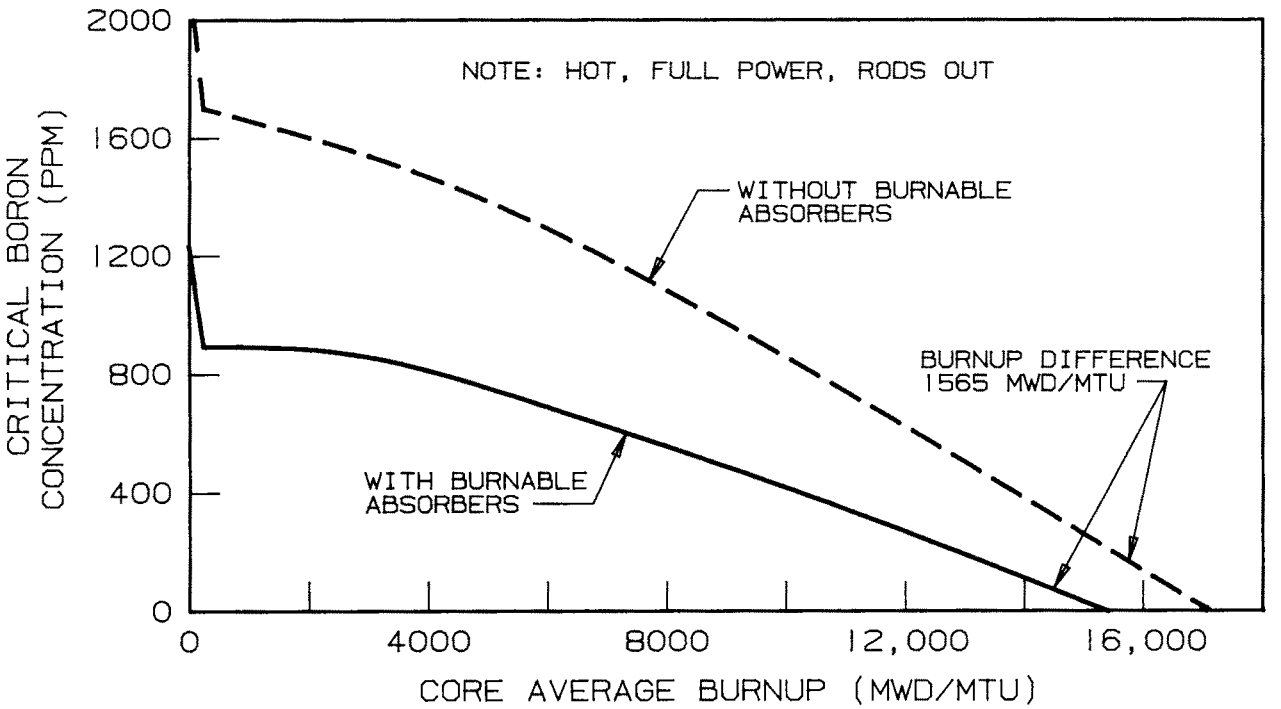
CALLAWAY PLANT

FIGURE 4.3-2

PRODUCTION AND CONSUMPTION OF HIGHER ISOTOPES



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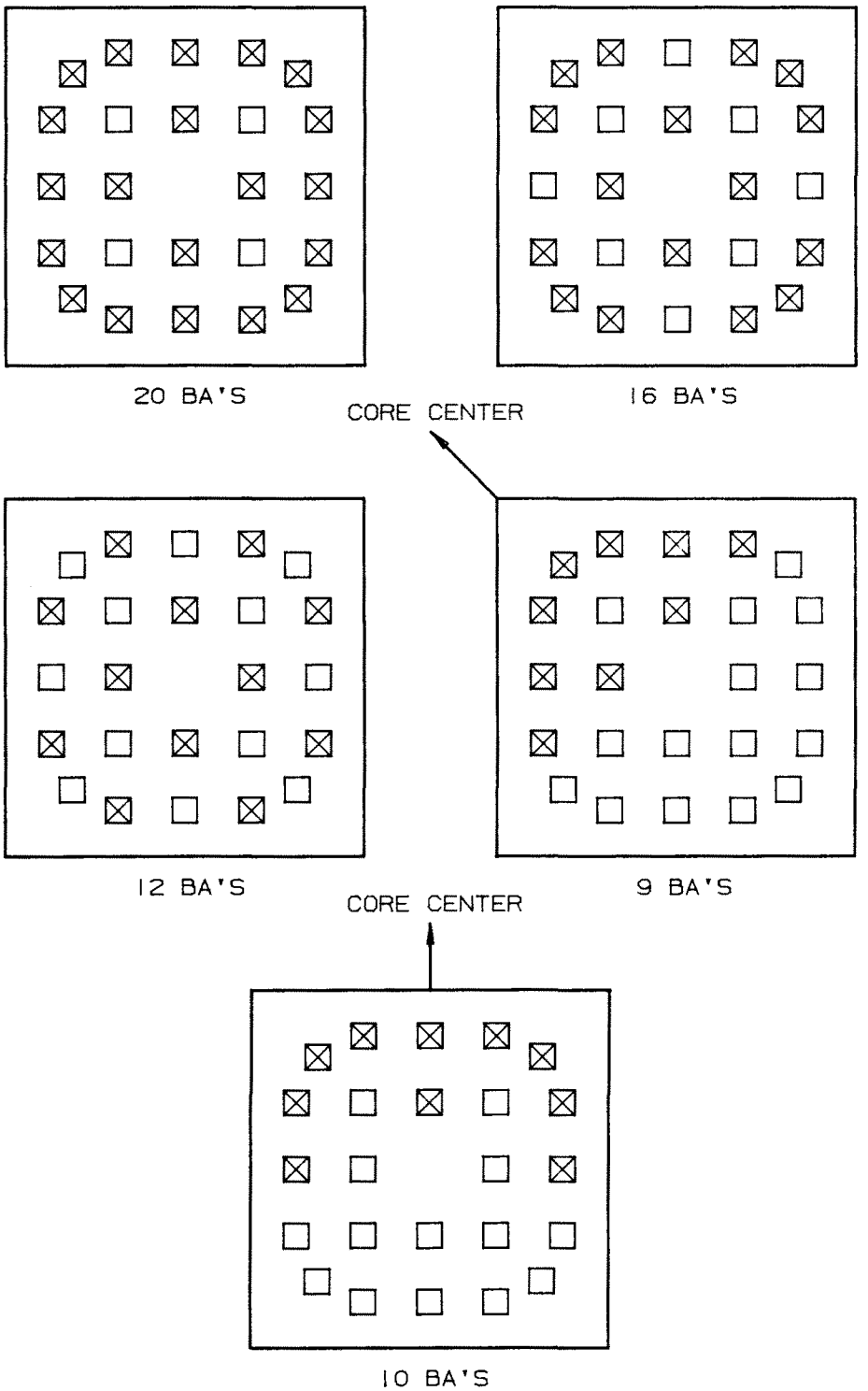
CALLAWAY PLANT

FIGURE 4.3.3A
BORON CONCENTRATION VERSUS FIRST CYCLE BURNUP WITH AND WITHOUT BURNABLE ABSORBER RODS

014-A-20766-170

Figure 4.3-3B Deleted.



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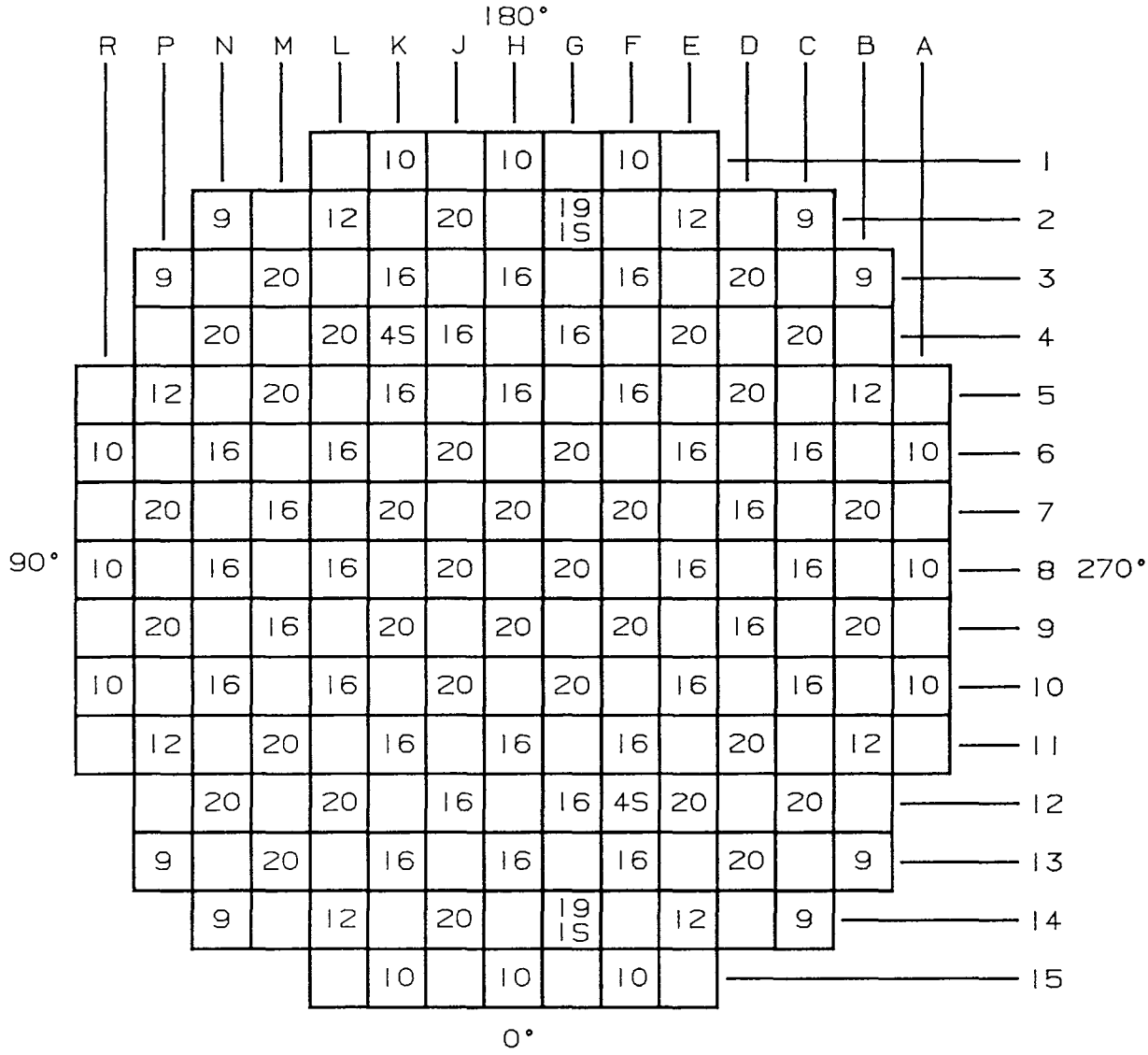
CALLAWAY PLANT

FIGURE 4.3-4A
BURNABLE ABSORBER ROD
ARRANGEMENT WITHIN AN ASSEMBLY

014-A-20766-171

Figure 4.3-4B Deleted.



NUMBER INDICATES NUMBER OF BURNABLE ABSORBER RODS

1S INDICATES PRIMARY SOURCE ROD

4S INDICATES FOUR SECONDARY SOURCE RODS

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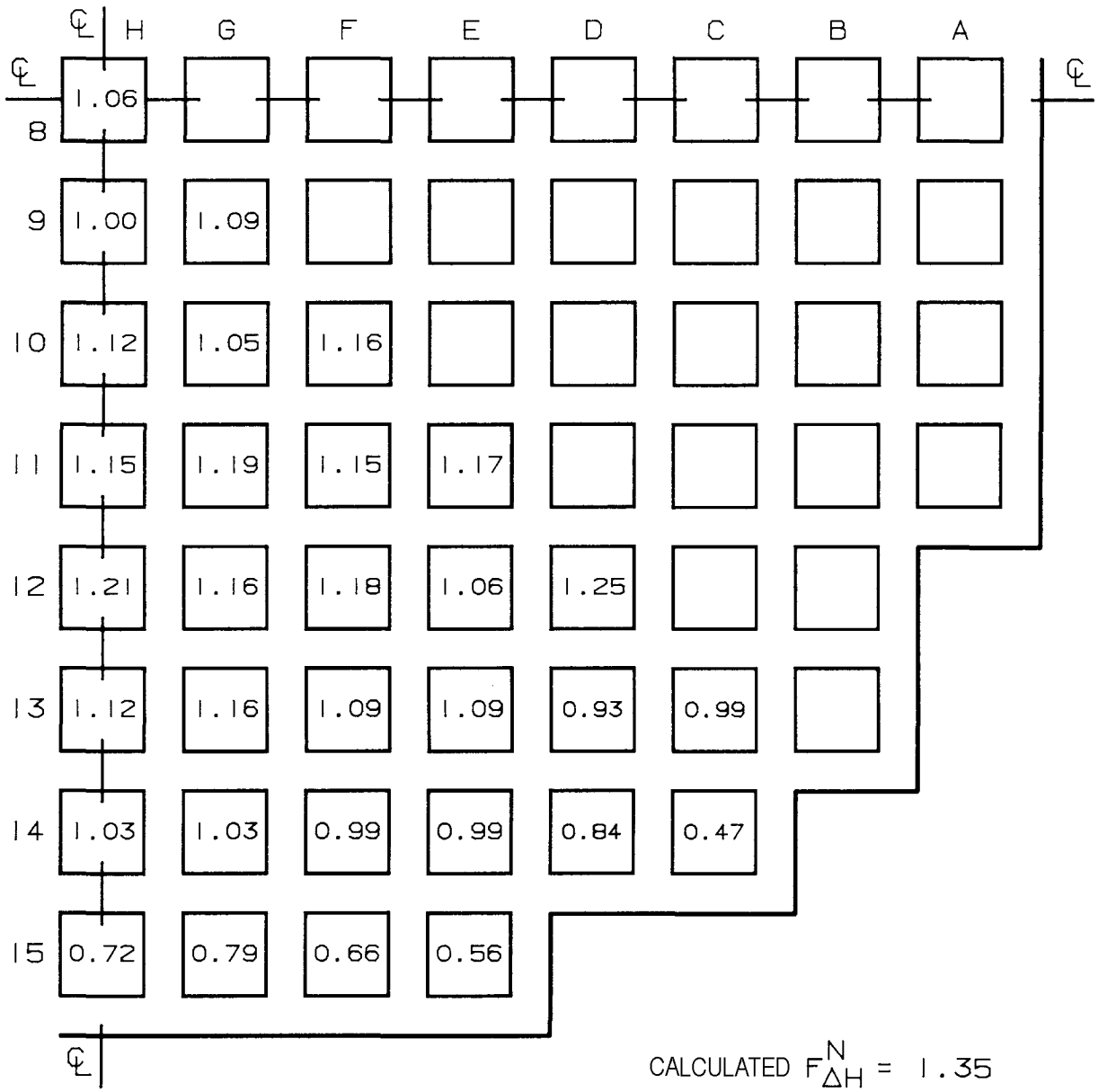
05/03

CALLAWAY PLANT

FIGURE 4.3-5 A
TYPICAL BURNABLE ABSORBER LOADING
PATTERN (CYCLE 1)

014-A-20766-172

Figure 4.3-5B Deleted.



KEY: VALUE REPRESENTS ASSEMBLY RELATIVE POWER

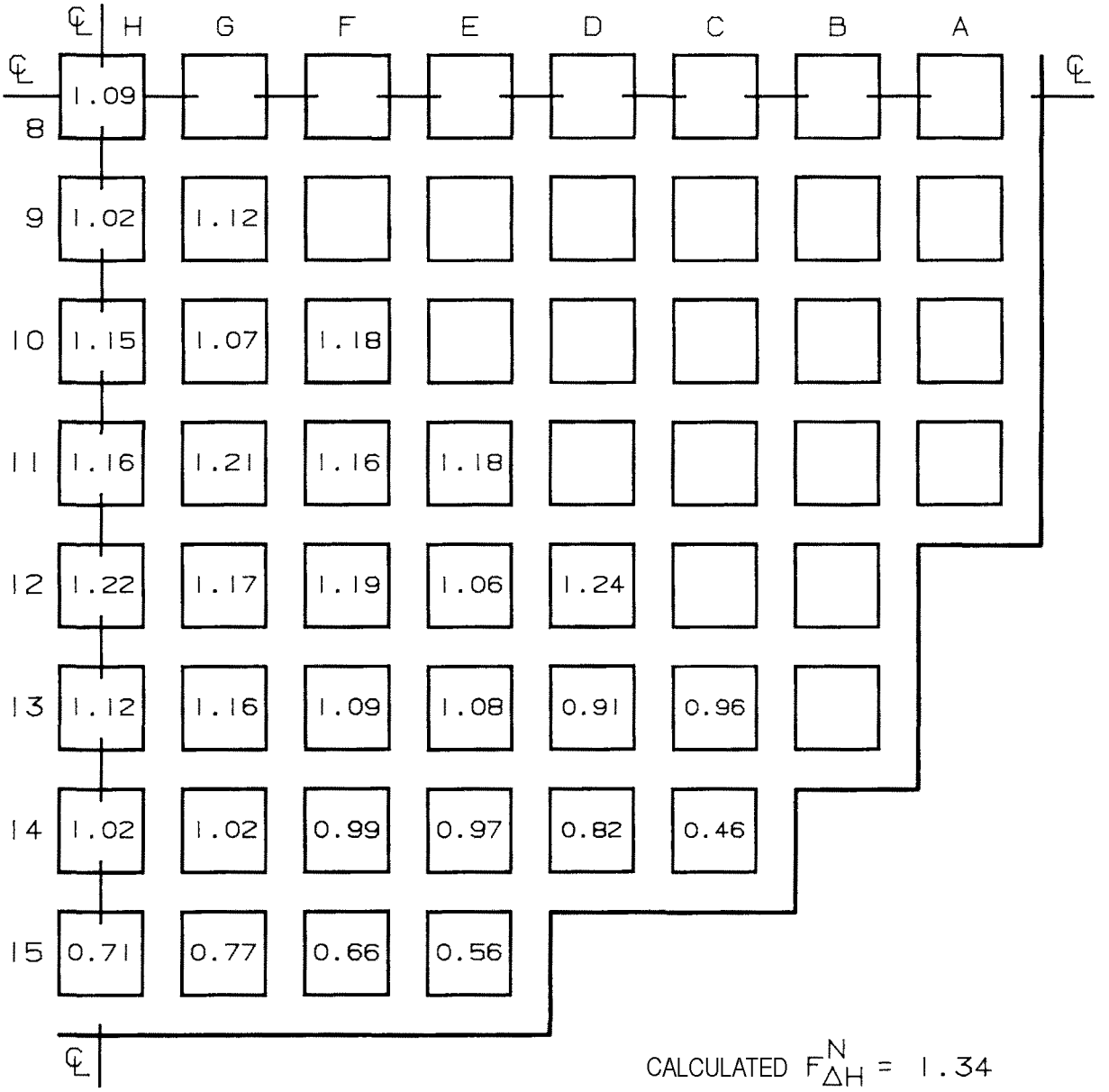
REV OL-13
05/03

CALLAWAY PLANT

FIGURE 4.3-6A
TYPICAL NORMALIZED POWER DENSITY DISTRIBUTION NEAR BEGINNING-OF-LIFE, UNRODDED CORE, HOT FULL POWER, NO XENON (CYCLE 1)

014-A-20766-173

Figure 4.3-6B Deleted.



KEY: VALUE REPRESENTS ASSEMBLY RELATIVE POWER

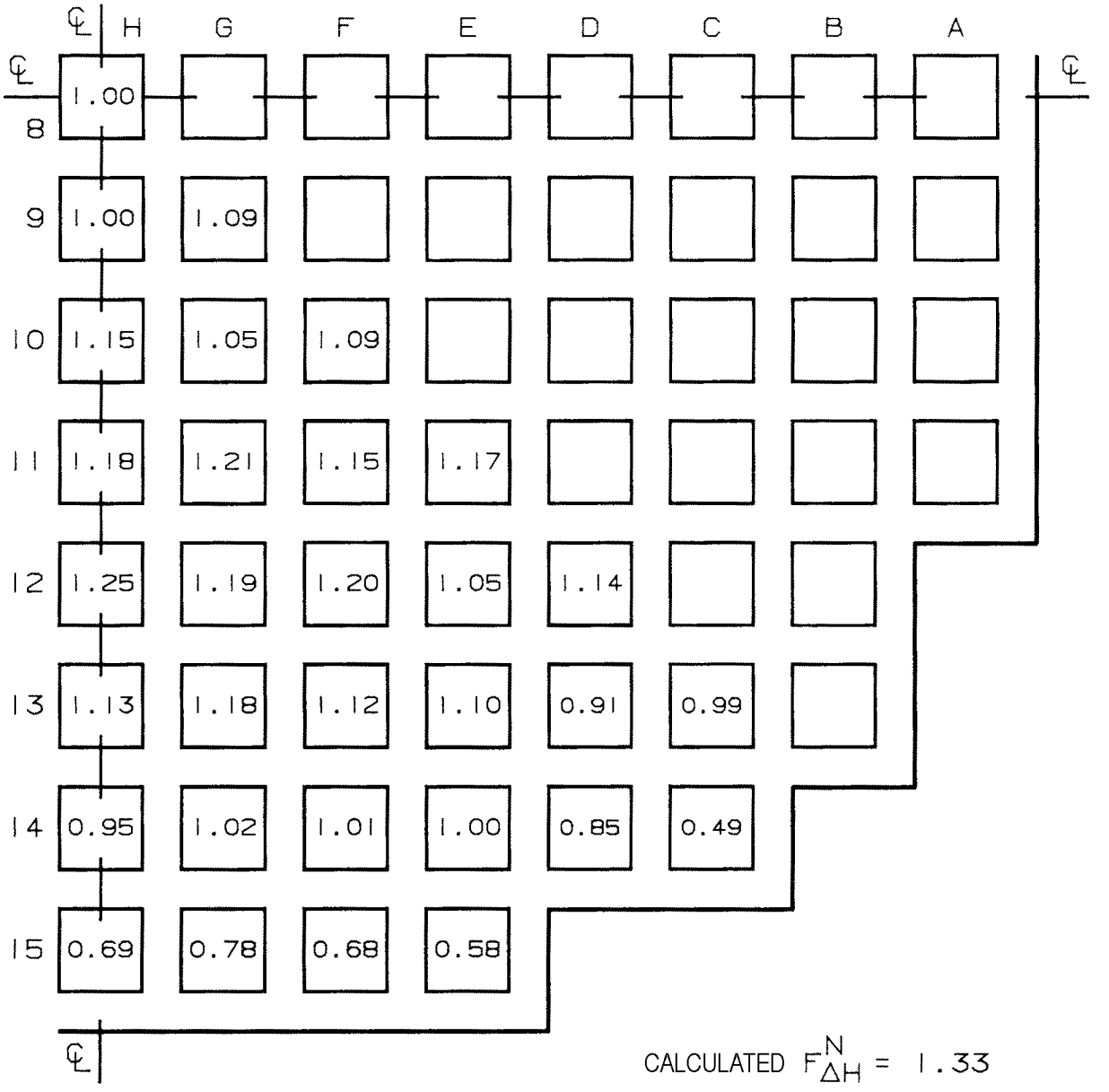
REV OL-13
05/03

CALLAWAY PLANT

FIGURE 4.3-7 A
TYPICAL NORMALIZED POWER DENSITY DISTRIBUTION NEAR BEGINNING-OF-LIFE, UNRODDED CORE, HOT FULL POWER, EQUILIBRIUM XENON (CYCLE 1)

014-A-20766-174

Figure 4.3-7B Deleted.



KEY: VALUE REPRESENTS ASSEMBLY RELATIVE POWER

REV OL-13
05/03

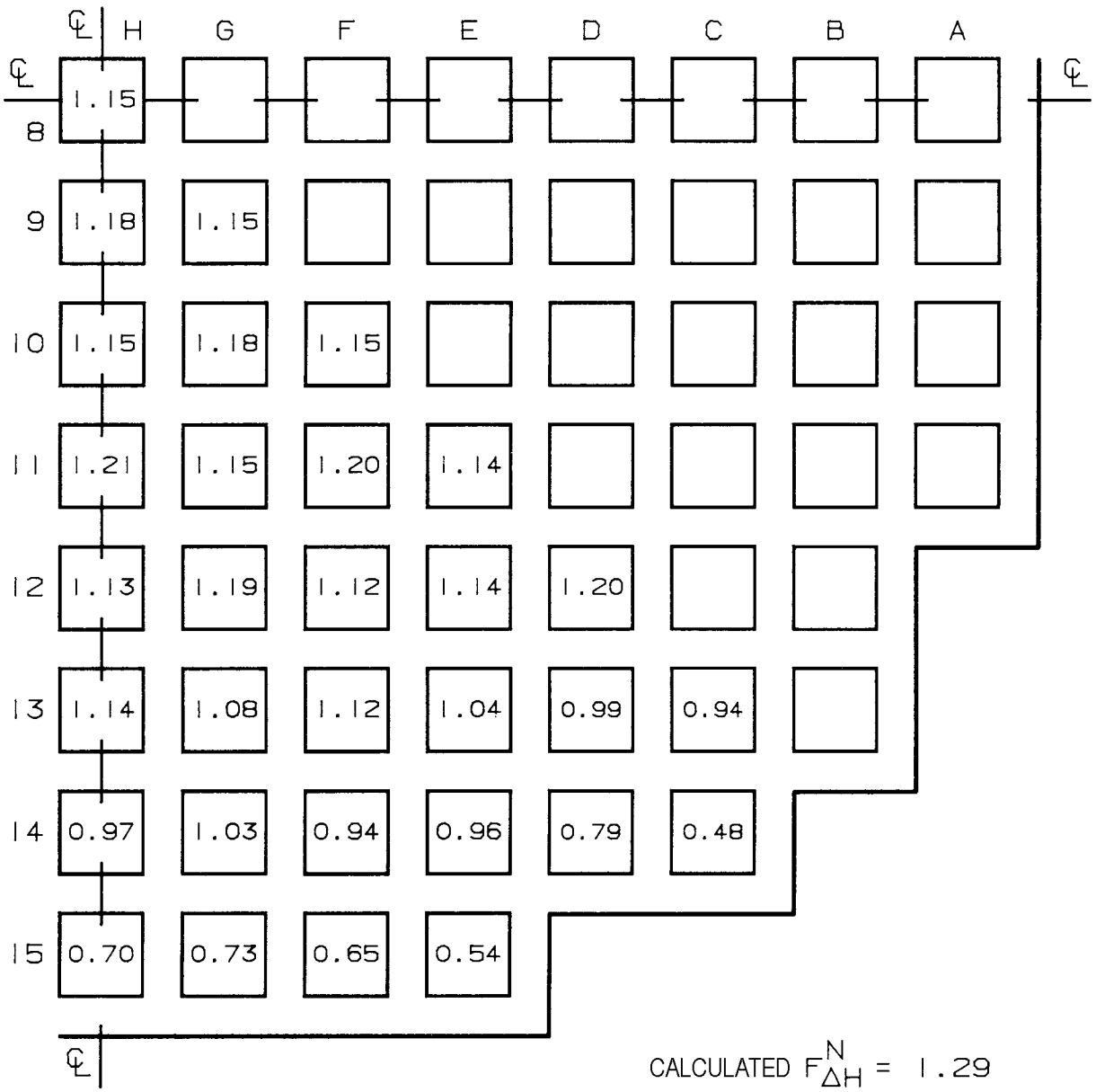
CALLAWAY PLANT

FIGURE 4.3-8 A

TYPICAL NORMALIZED POWER DENSITY DISTRIBUTION NEAR BEGINNING-OF-LIFE, GROUP D AT 28 PERCENT INSERTED, HOT FULL POWER, EQUILIBRIUM XENON (CYCLE 1)

014-A-20766-175

Figure 4.3-8B Deleted.



KEY: VALUE REPRESENTS ASSEMBLY RELATIVE POWER

REV OL-13
05/03

CALLAWAY PLANT

FIGURE 4.3-9A
TYPICAL NORMALIZED POWER DENSITY DISTRIBUTION NEAR MIDDLE-OF-LIFE, UNRODDED CORE, HOT FULL POWER, EQUILIBRIUM XENON (CYCLE 1)

014-A-20766-176

Figure 4.3-9B Deleted.

	H	G	F	E	D	C	B	A
8	1.05							
9	1.11	1.05						
10	1.05	1.11	1.05					
11	1.12	1.05	1.13	1.07				
12	1.06	1.13	1.07	1.14	1.18			
13	1.13	1.06	1.13	1.05	1.07	1.01		
14	1.01	1.12	0.98	1.03	0.86	0.57		
15	0.80	0.81	0.75	0.61				

CALCULATED $F^N_{\Delta H}$ = 1.25

KEY: VALUE REPRESENTS ASSEMBLY RELATIVE POWER

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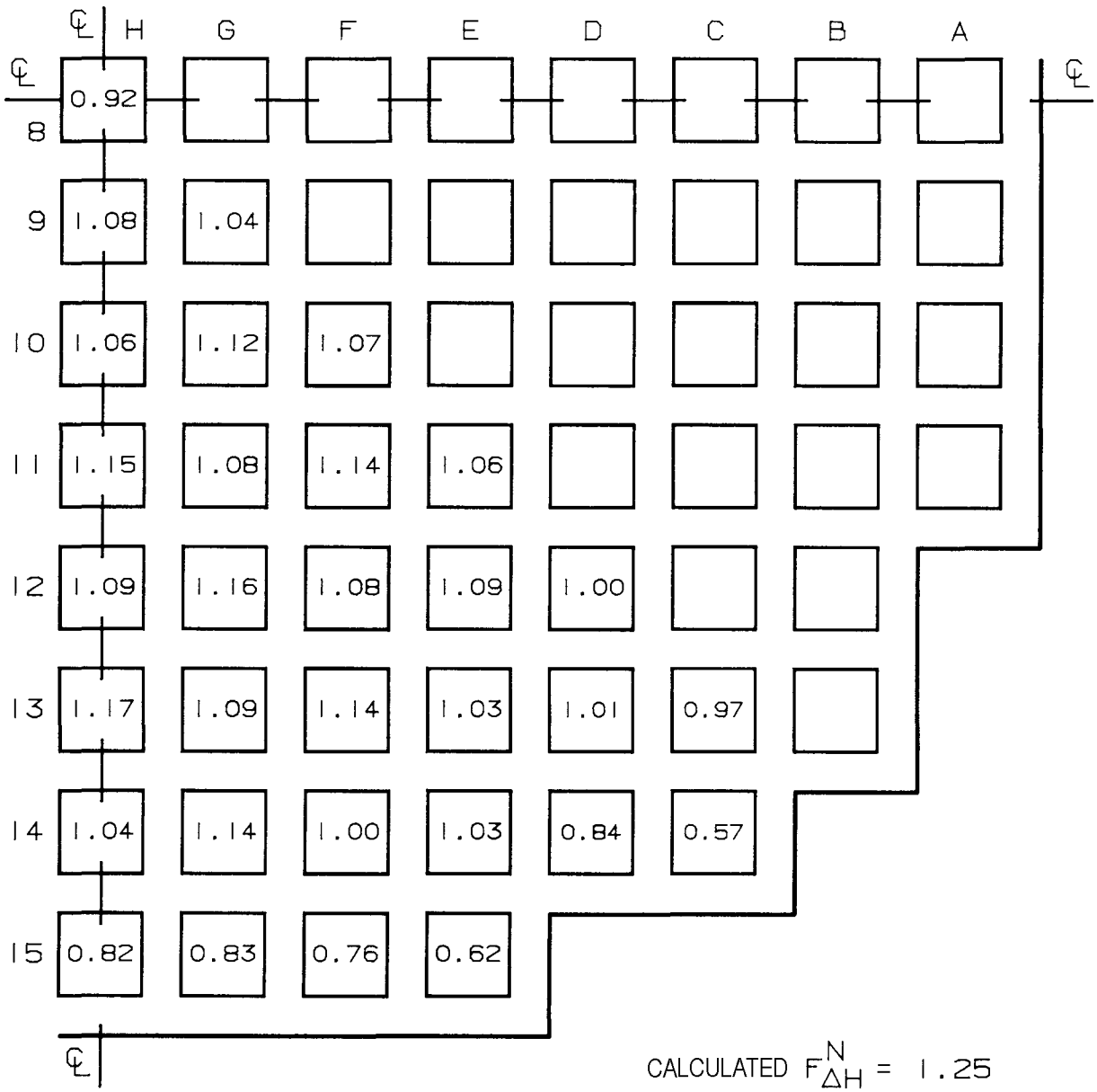
FIGURE 4.3-10A
TYPICAL NORMALIZED POWER DENSITY DISTRIBUTION NEAR END-OF-LIFE, UNRODDED CORE, HOT FULL POWER, EQUILIBRIUM XENON (CYCLE 1)

014-A-20766-177

Figure 4.3-10B Deleted.



KEY: VALUE REPRESENTS ASSEMBLY RELATIVE POWER

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FIGURE 4.3-11 A
TYPICAL NORMALIZED POWER DENSITY DISTRIBUTION NEAR END-OF-LIFE, GROUP D 28 PERCENT INSERTED, HOT FULL POWER, EQUILIBRIUM XENON (CYCLE 1)

014-A-20766-178

Figure 4.3-11B Deleted.

1.02																
1.02	1.03															
1.02	1.05	1.08														
1.02	1.06	1.12	X													
1.03	1.08	1.14	1.17	1.16												
1.03	1.10	X	1.17	1.18	X											
1.03	1.08	1.14	1.14	1.16	1.18	1.17										
1.03	1.08	1.14	1.14	1.16	1.19	1.17	1.17									
1.03	1.10	X	1.16	1.18	X	1.19	1.20	X								
1.03	1.09	1.14	1.14	1.16	1.19	1.17	1.17	1.20	1.18							
1.03	1.09	1.15	1.15	1.16	1.19	1.17	1.17	1.20	1.18	1.18						
1.04	1.11	X	1.18	1.18	X	1.19	1.19	X	1.20	1.20	X					
1.04	1.09	1.15	1.18	1.17	1.19	1.17	1.17	1.19	1.17	1.17	1.20	1.18				
1.04	1.08	1.14	X	1.18	1.18	1.16	1.16	1.18	1.16	1.16	1.19	1.19	X			
1.04	1.06	1.10	1.14	1.16	X	1.16	1.16	X	1.16	1.16	X	1.17	1.15	1.11		
1.04	1.05	1.07	1.08	1.10	1.12	1.10	1.10	1.12	1.10	1.11	1.12	1.11	1.09	1.08	1.07	
1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06

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FIGURE 4.3-12

RODWISE POWER DISTRIBUTION IN A TYPICAL ASSEMBLY NEAR BEGINNING-OF-LIFE, HOT FULL POWER, EQUILIBRIUM XENON; UNRODDED CORE

0.98																
0.98	0.99															
0.98	1.00	1.03														
0.99	1.02	1.07	X													
1.00	1.03	1.09	1.11	1.09												
1.01	1.06	X	1.11	1.11	X											
1.00	1.04	1.08	1.07	1.08	1.10	1.08										
1.00	1.04	1.08	1.07	1.08	1.10	1.08	1.08									
1.01	1.06	X	1.09	1.10	X	1.10	1.10	X								
1.00	1.04	1.08	1.07	1.08	1.10	1.08	1.08	1.10	1.08							
1.00	1.04	1.08	1.07	1.08	1.10	1.08	1.08	1.10	1.08	1.08						
1.01	1.06	X	1.11	1.11	X	1.10	1.10	X	1.10	1.10	X					
1.00	1.03	1.09	1.11	1.09	1.11	1.08	1.08	1.10	1.08	1.08	1.11	1.09				
0.99	1.02	1.07	X	1.11	1.11	1.07	1.07	1.09	1.07	1.07	1.11	1.11	X			
0.98	1.00	1.03	1.07	1.09	X	1.08	1.08	X	1.08	1.08	X	1.09	1.07	1.03		
0.98	0.99	1.00	1.02	1.03	1.06	1.04	1.04	1.06	1.04	1.04	1.06	1.03	1.02	1.00	0.98	
0.98	0.98	0.98	0.99	1.00	1.01	1.00	1.00	1.01	1.00	1.00	1.01	1.00	0.99	0.98	0.98	0.98

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FIGURE 4.3-13

RODWISE POWER DISTRIBUTION IN A TYPICAL ASSEMBLY NEAR END-OF-LIFE, HOT FULL POWER, EQUILIBRIUM XENON; UNRODDED CORE

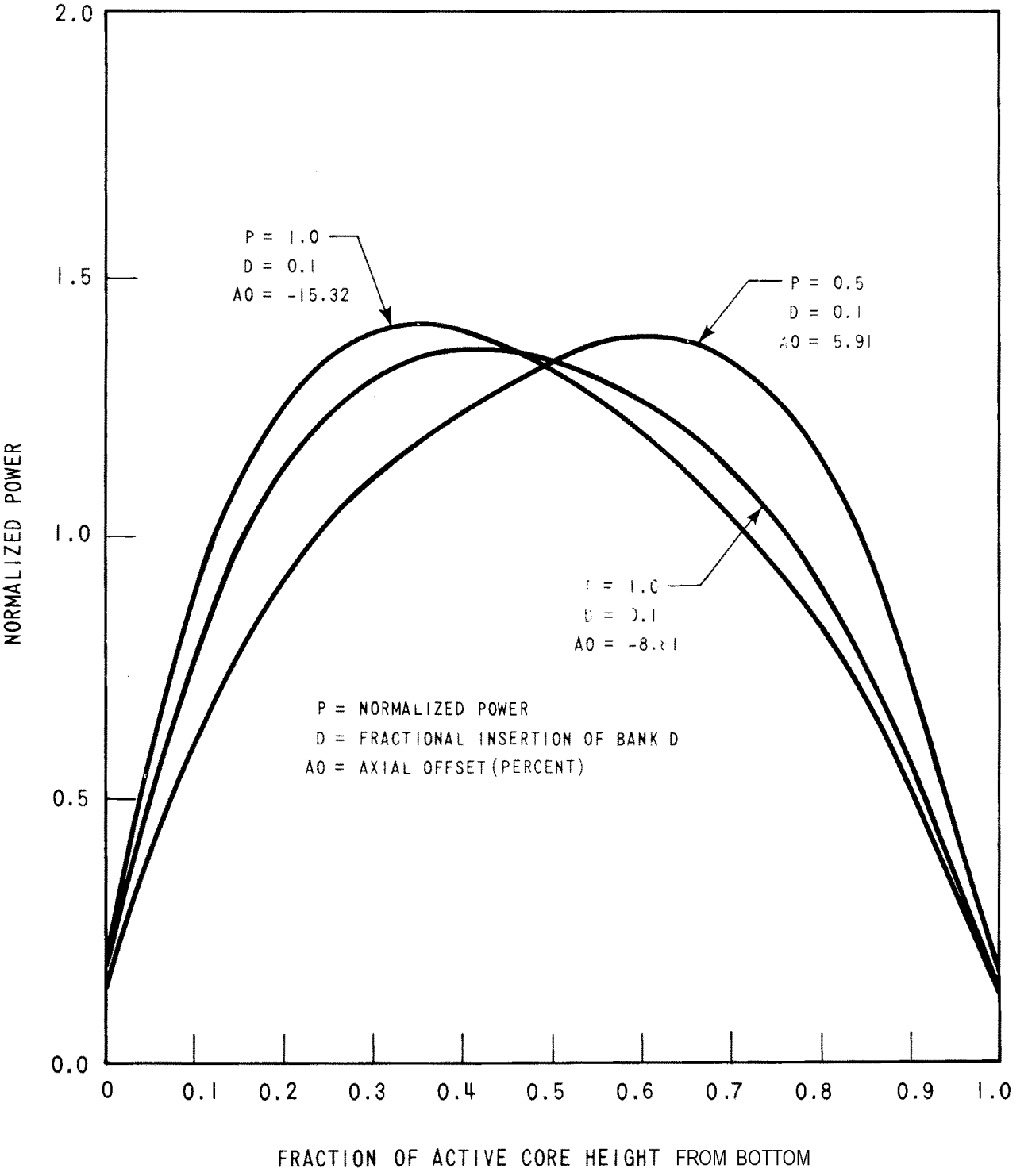

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FIGURE 4.3-14

TYPICAL AXIAL POWER SHAPES
OCCURRING AT BEGINNING-OF-LIFE
(CYCLE 1)

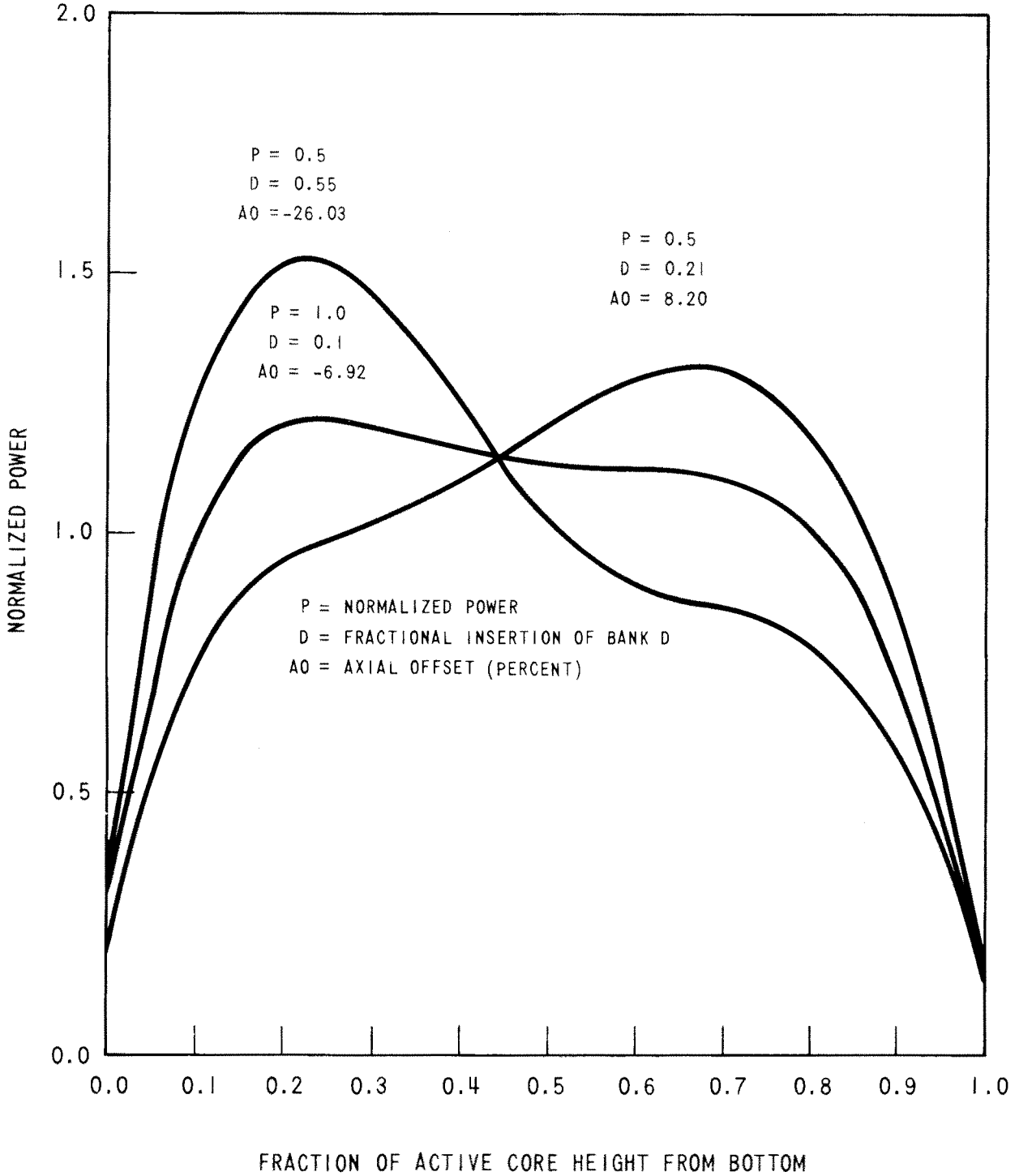

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FIGURE 4.3-15

TYPICAL AXIAL POWER SHAPES
OCCURRING AT MIDDLE-OF-LIFE
(CYCLE 1)

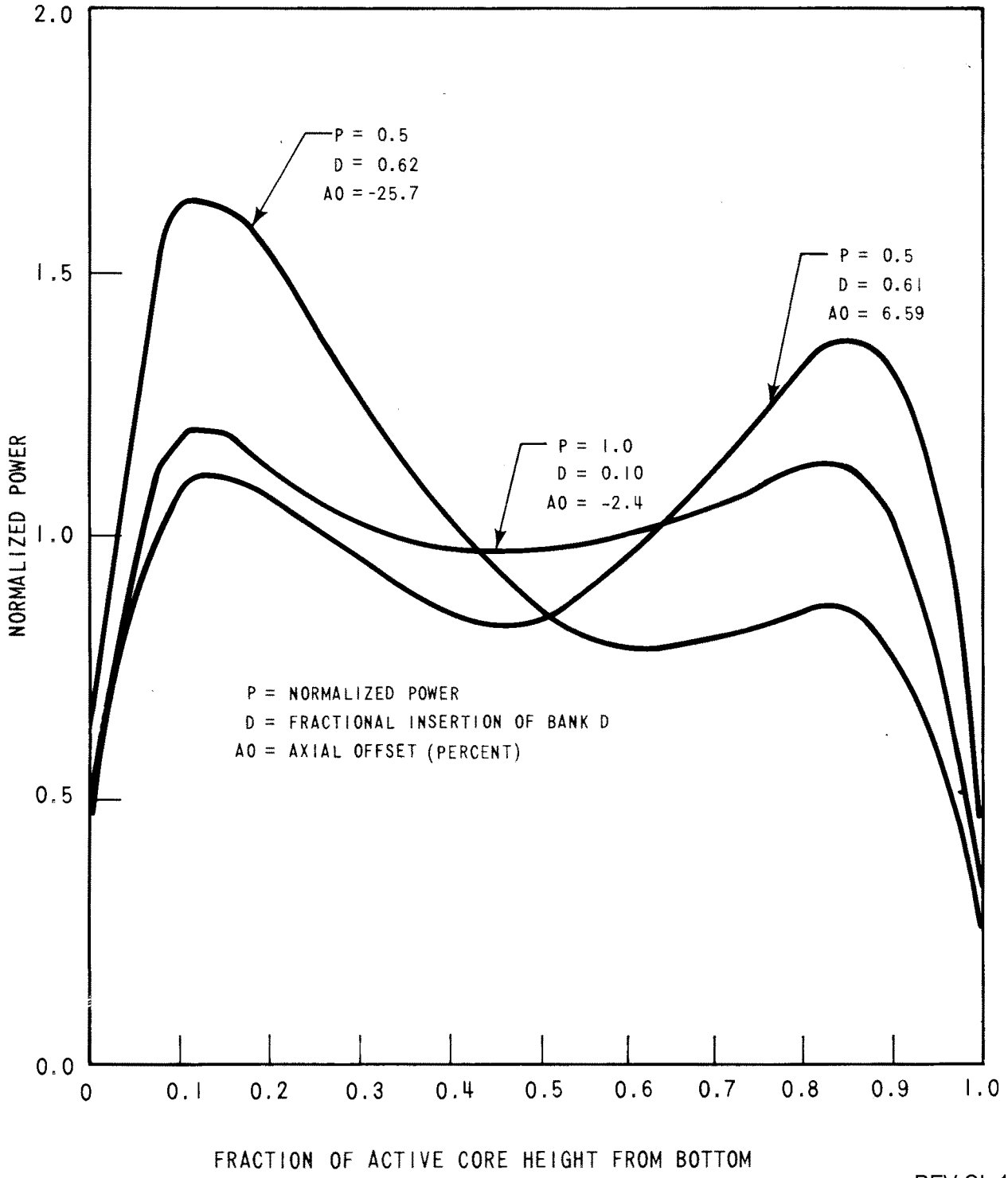

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FIGURE 4.3-16

TYPICAL AXIAL POWER SHAPES OCCURRING AT END-OF-LIFE (CYCLE 1)

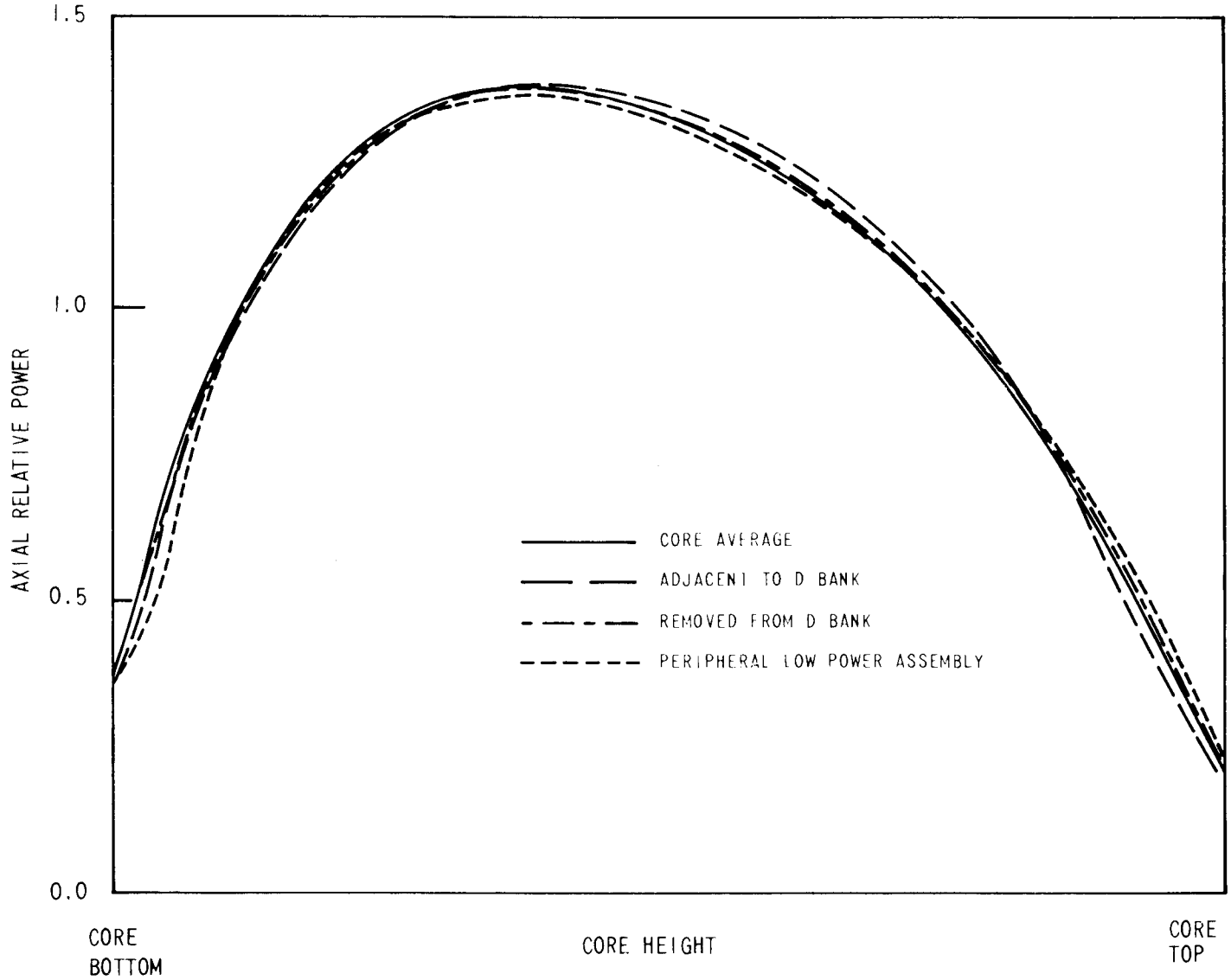

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FIGURE 4.3-17
COMPARISON OF A TYPICAL ASSEMBLY AXIAL POWER DISTRIBUTION WITH CORE AVERAGE AXIAL DISTRIBUTION BANK D SLIGHTLY INSERTED

FIGURE 4.3-18 HAS BEEN DELETED

Figure 4.3-19 has been deleted.

FIGURE 4.3-20 HAS BEEN DELETED

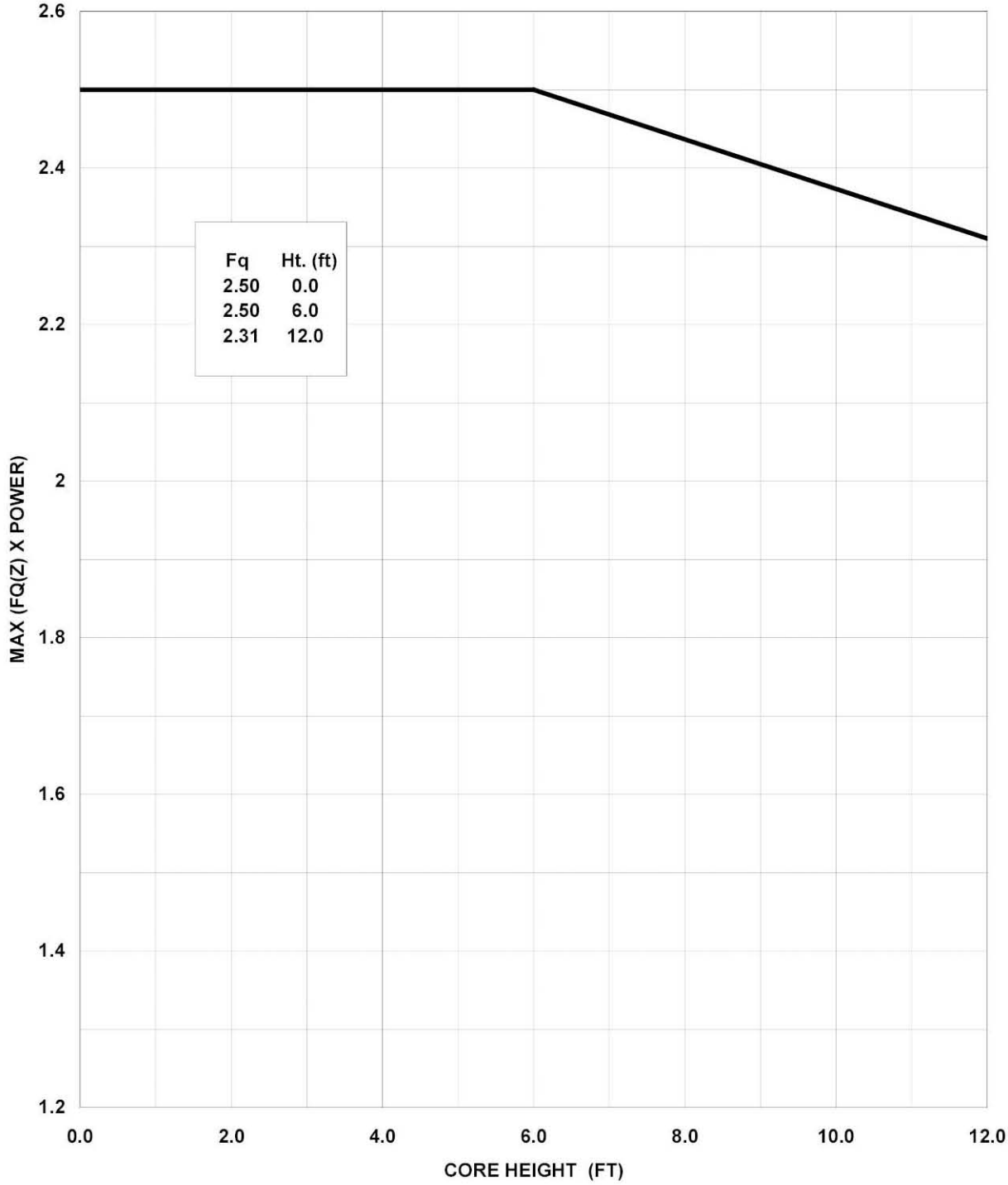

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FIGURE 4.3-21

MAXIMUM F_QX POWER VERSUS AXIAL HEIGHT DURING NORMAL OPERATION

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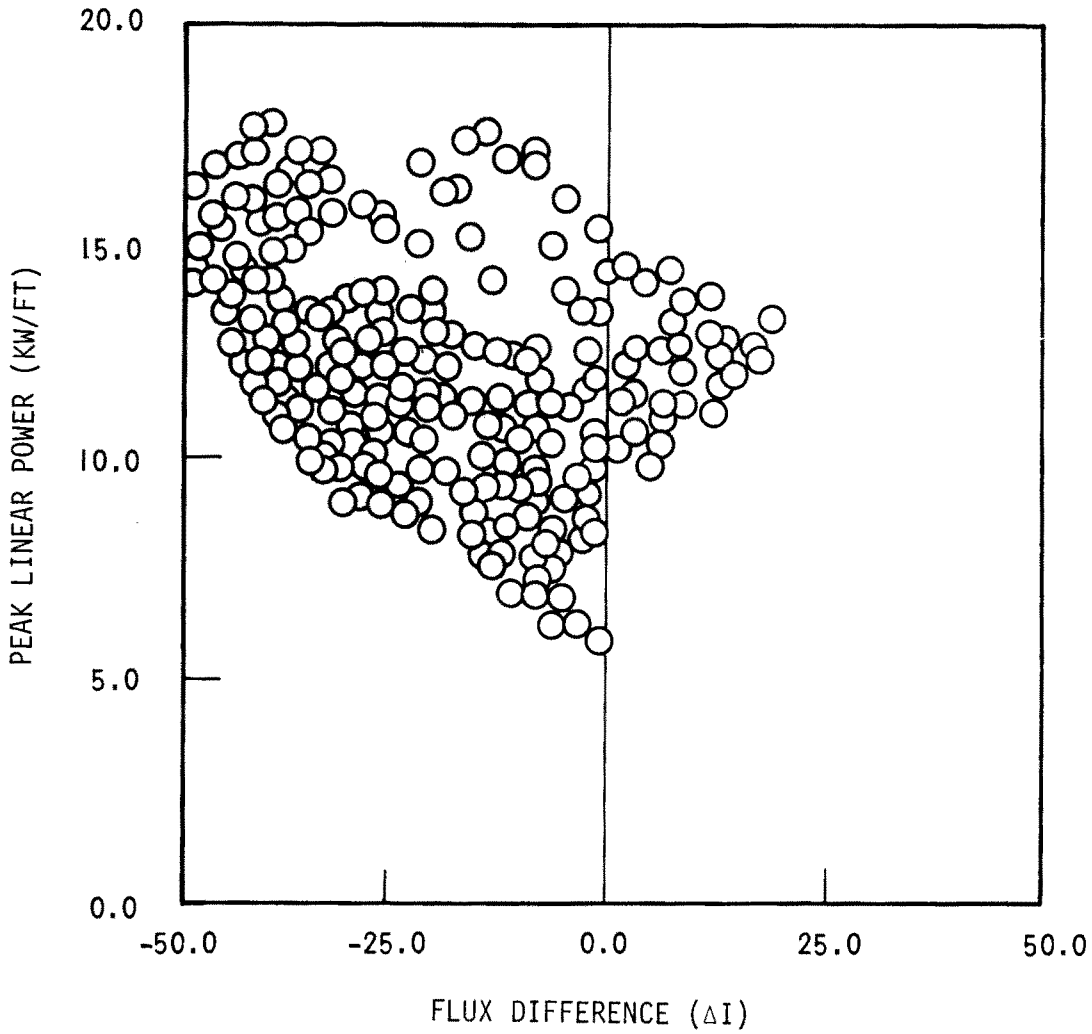

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FIGURE 4.3-22

PEAK LINEAR POWER DURING
CONTROL ROD MALFUNCTION
OVERPOWER TRANSIENTS

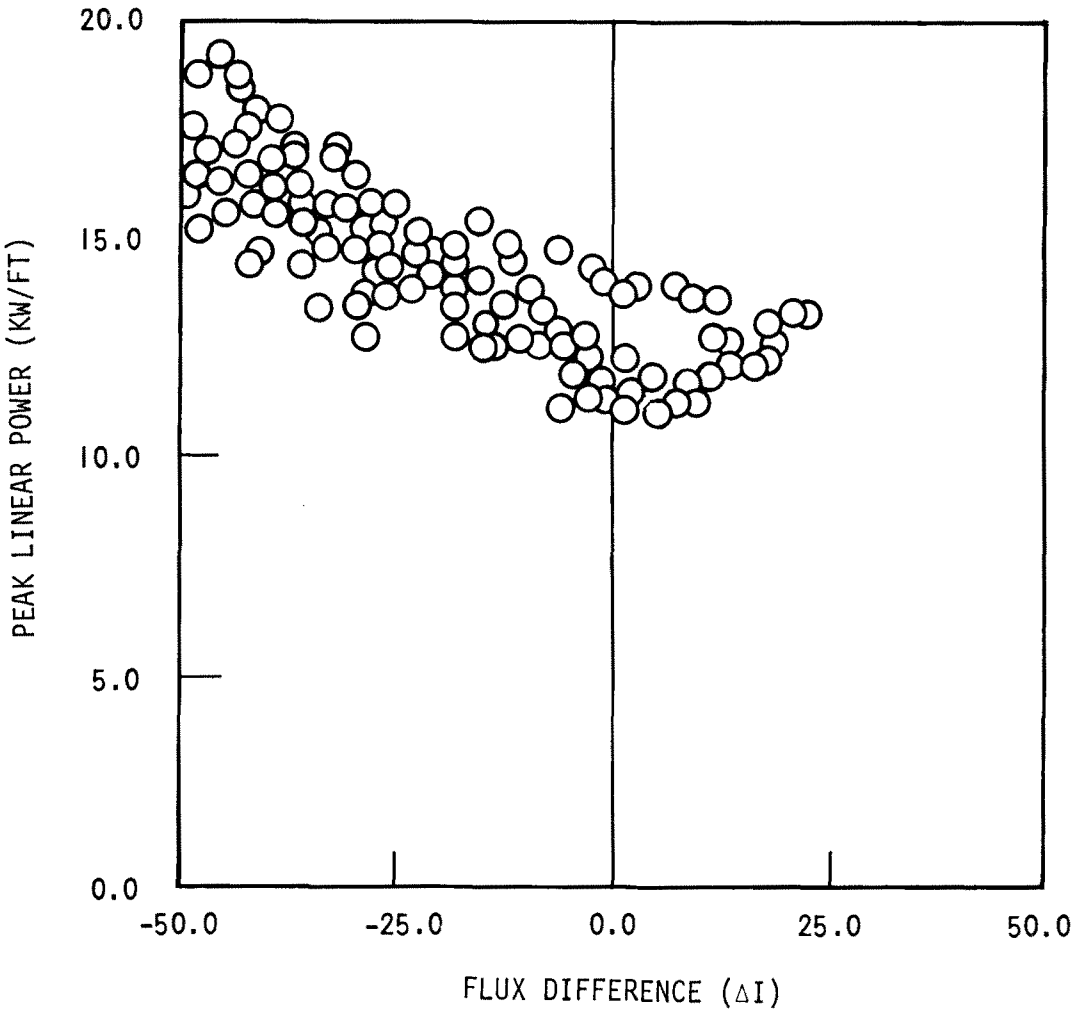

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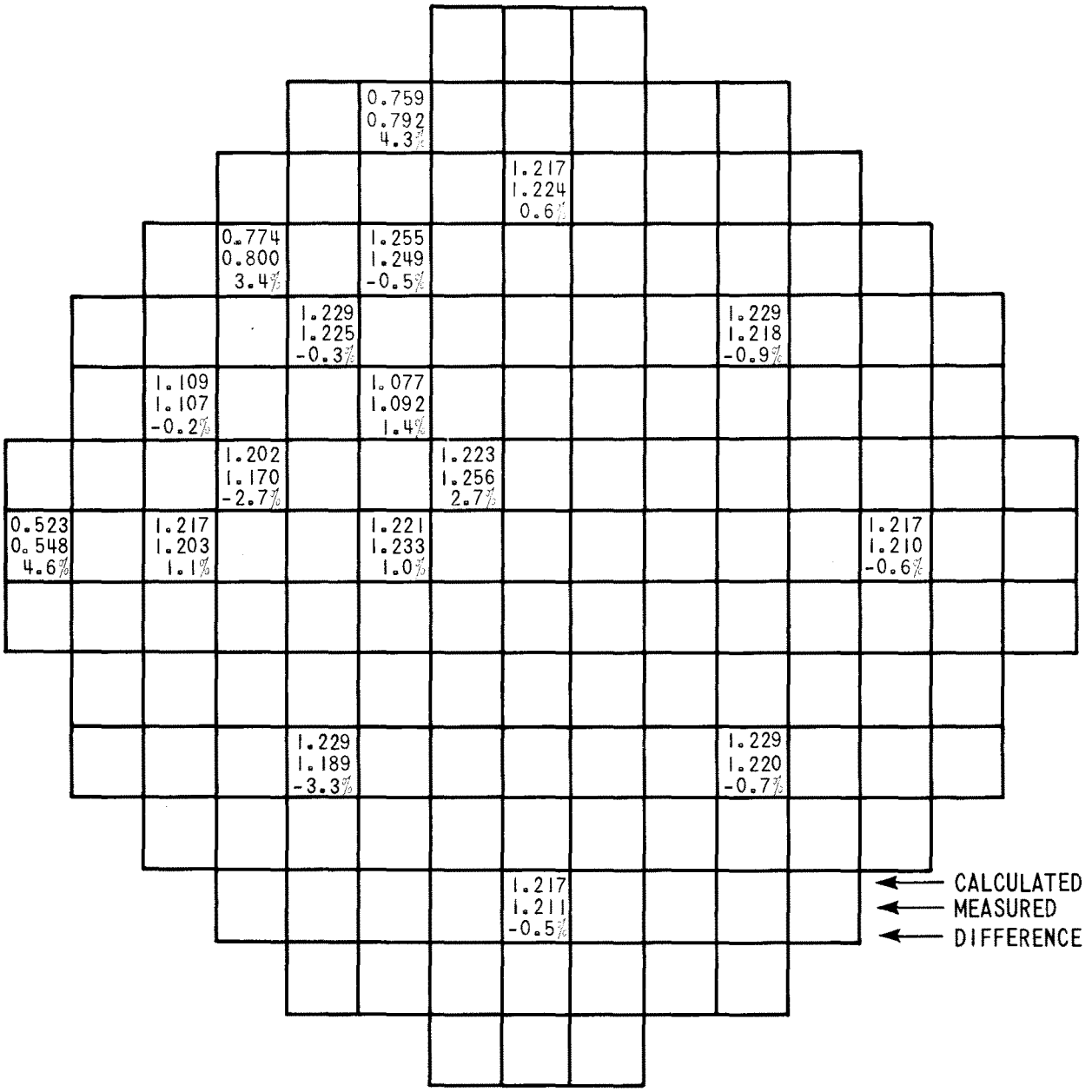
FIGURE 4.3-23

PEAK LINEAR POWER DURING BORATION/DILUTION OVERPOWER TRANSIENTS



PEAKING FACTORS

$\bar{F}_z$ = 1.5

$F^N_{\Delta H}$ = 1.357

F^N_Q = 2.07

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FIGURE 4.3-24

COMPARISON BETWEEN TYPICAL CALCULATED AND MEASURED RELATIVE FUEL ASSEMBLY POWER DISTRIBUTION

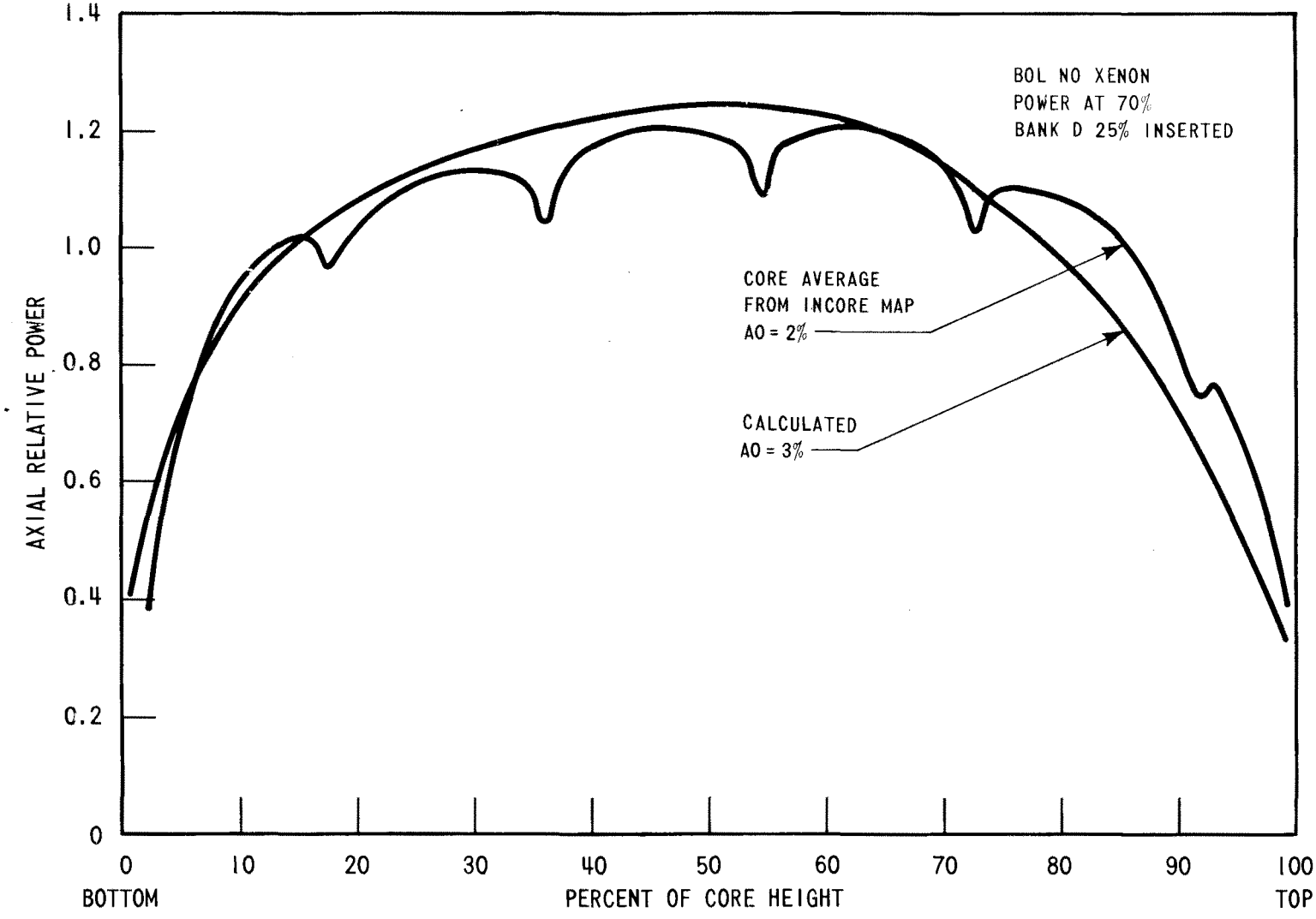

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FIGURE 4.3-25

COMPARISON OF TYPICAL CALCULATED AND MEASURED AXIAL SHAPES

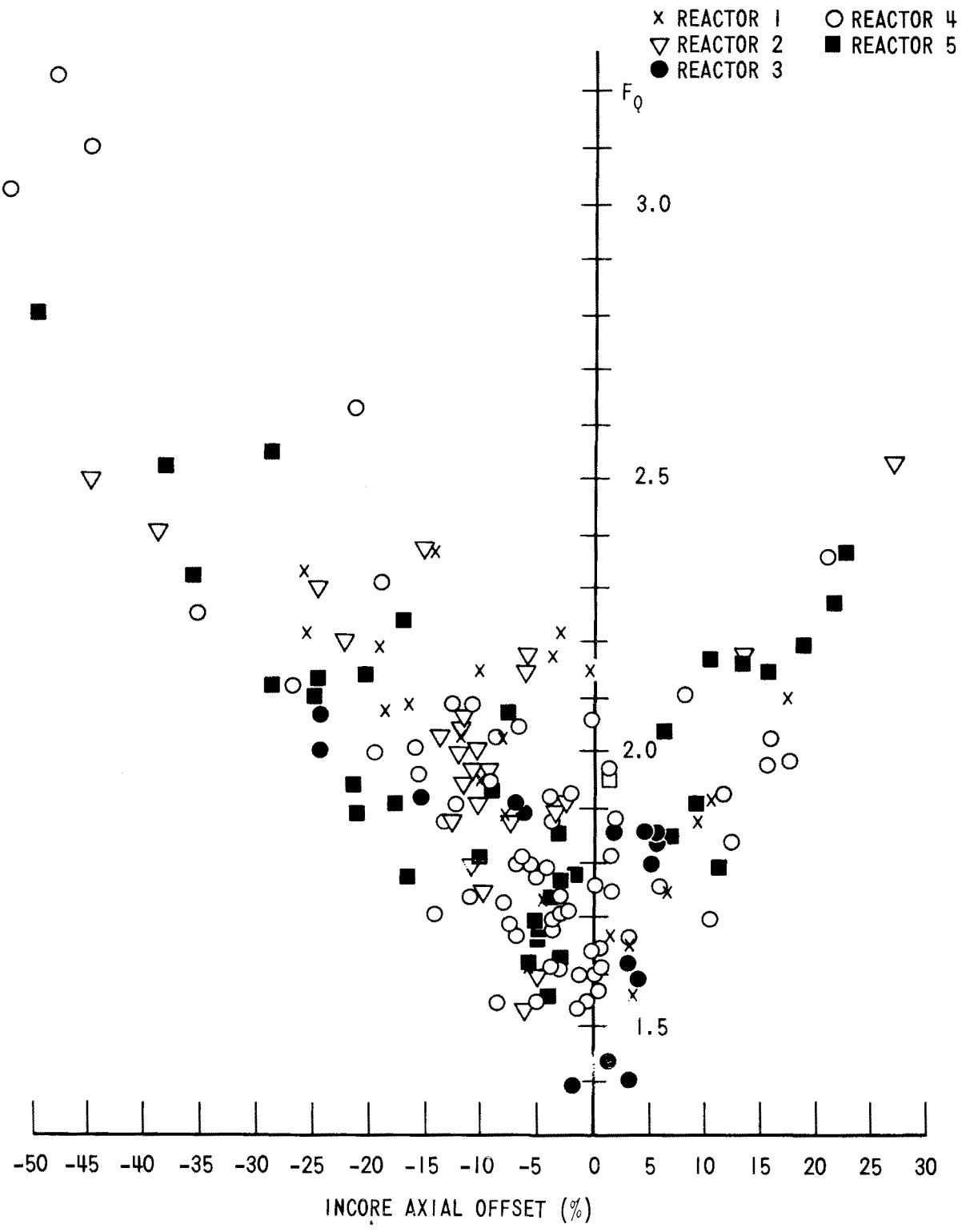

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FIGURE 4.3-26

MEASURED VALUES OF F_Q FOR FULL POWER ROD CONFIGURATIONS

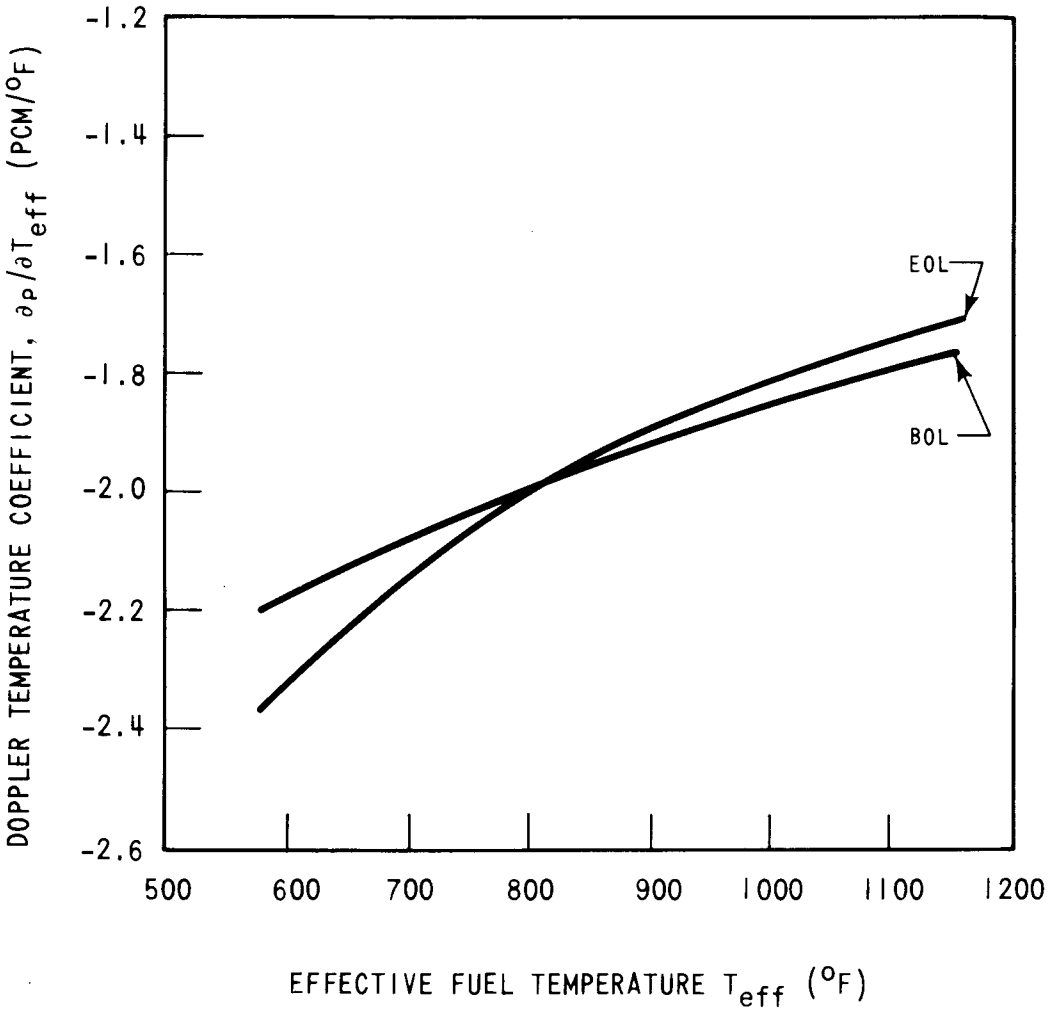

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FIGURE 4.3-27

TYPICAL DOPPLER TEMPERATURE COEFFICIENT AT BOL AND EOL, CYCLE 1

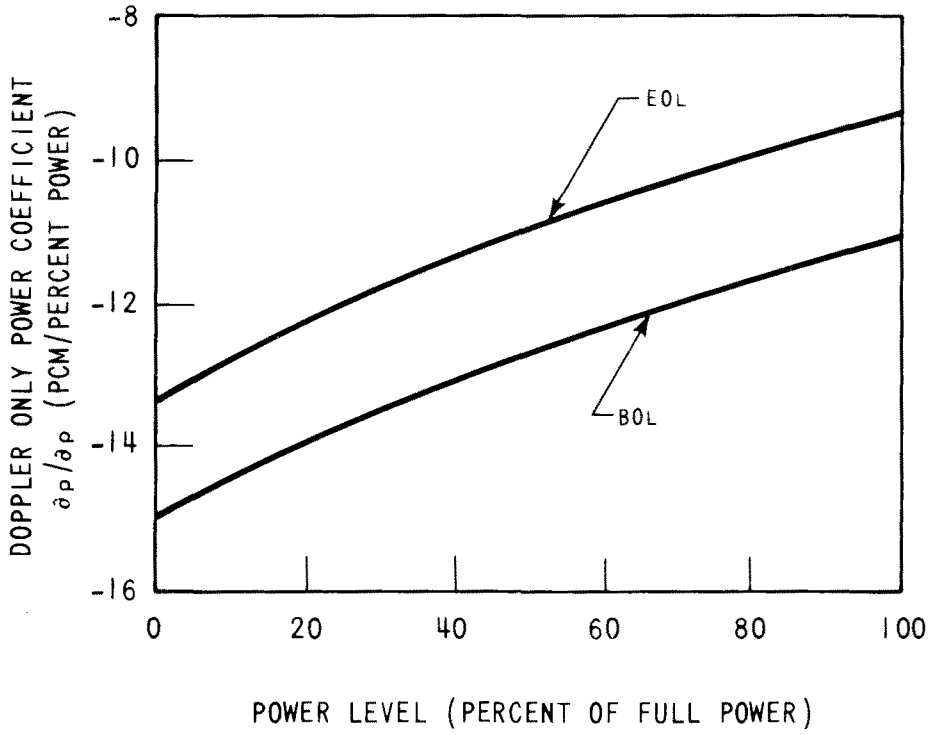

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FIGURE 4.3-28

TYPICAL DOPPLER-ONLY POWER COEFFICIENT AT BOL AND EOL, CYCLE 1

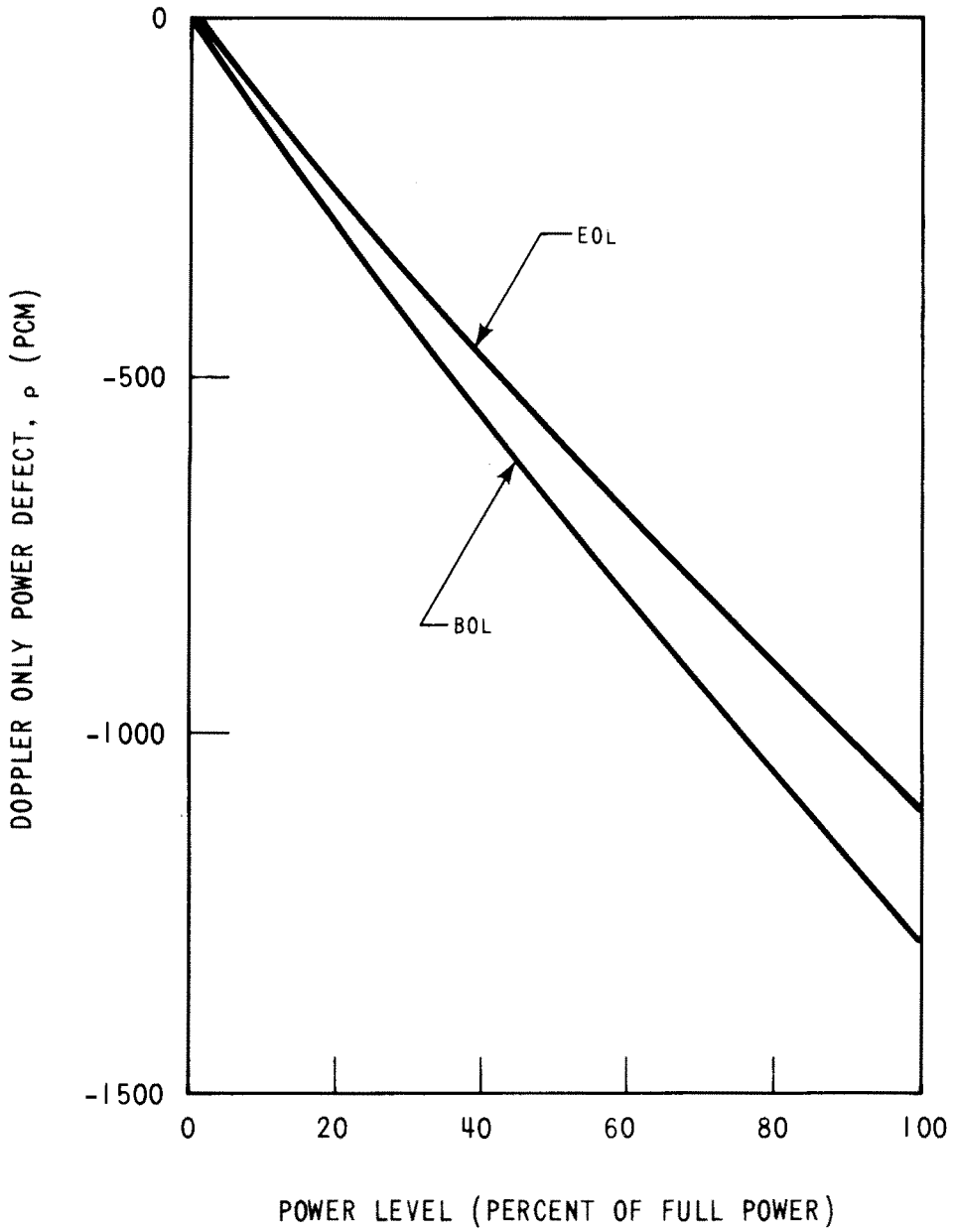

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FIGURE 4.3-29

TYPICAL DOPPLER-ONLY POWER DEFECT AT BOL AND EOL, CYCLE 1

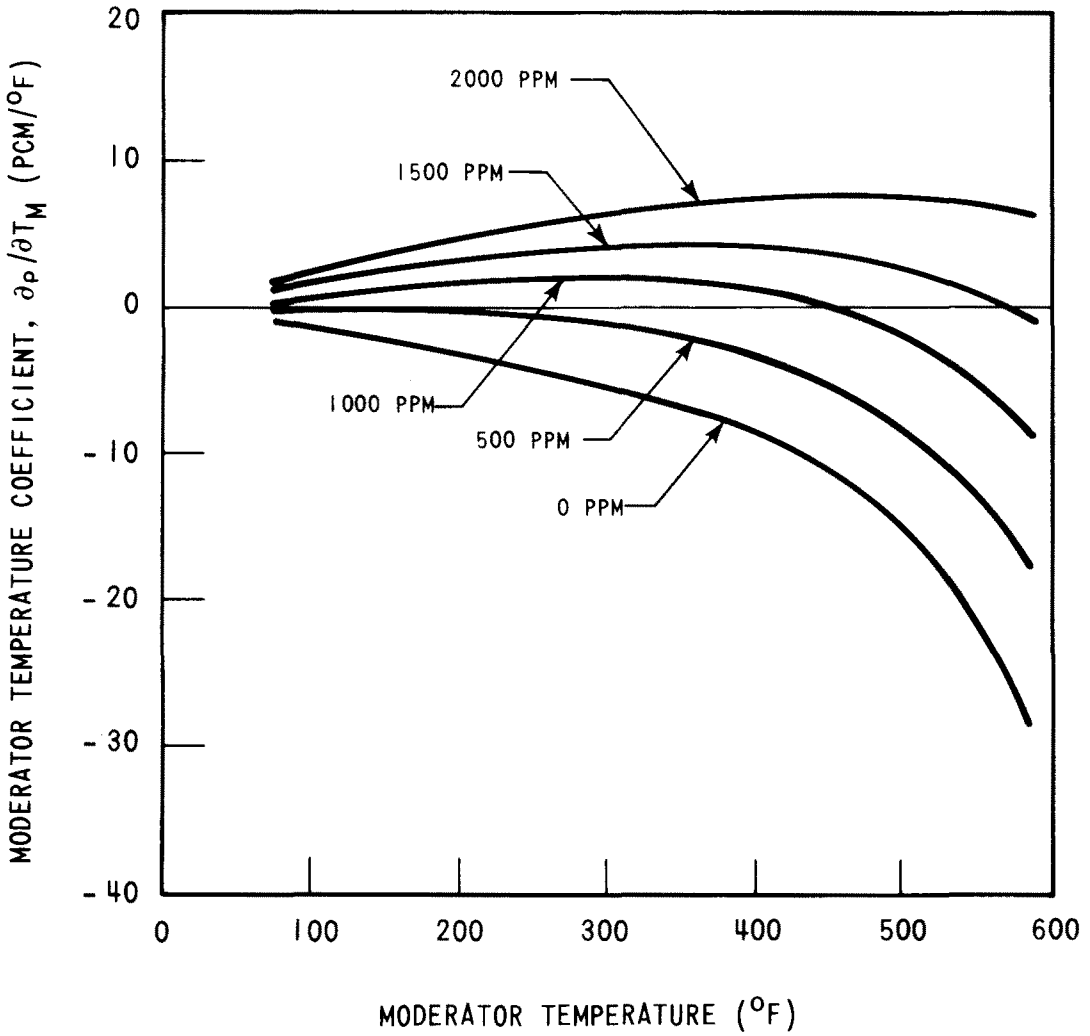

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FIGURE 4.3-30

TYPICAL MODERATOR TEMPERATURE COEFFICIENT AT BOL, CYCLE 1, NO RODS

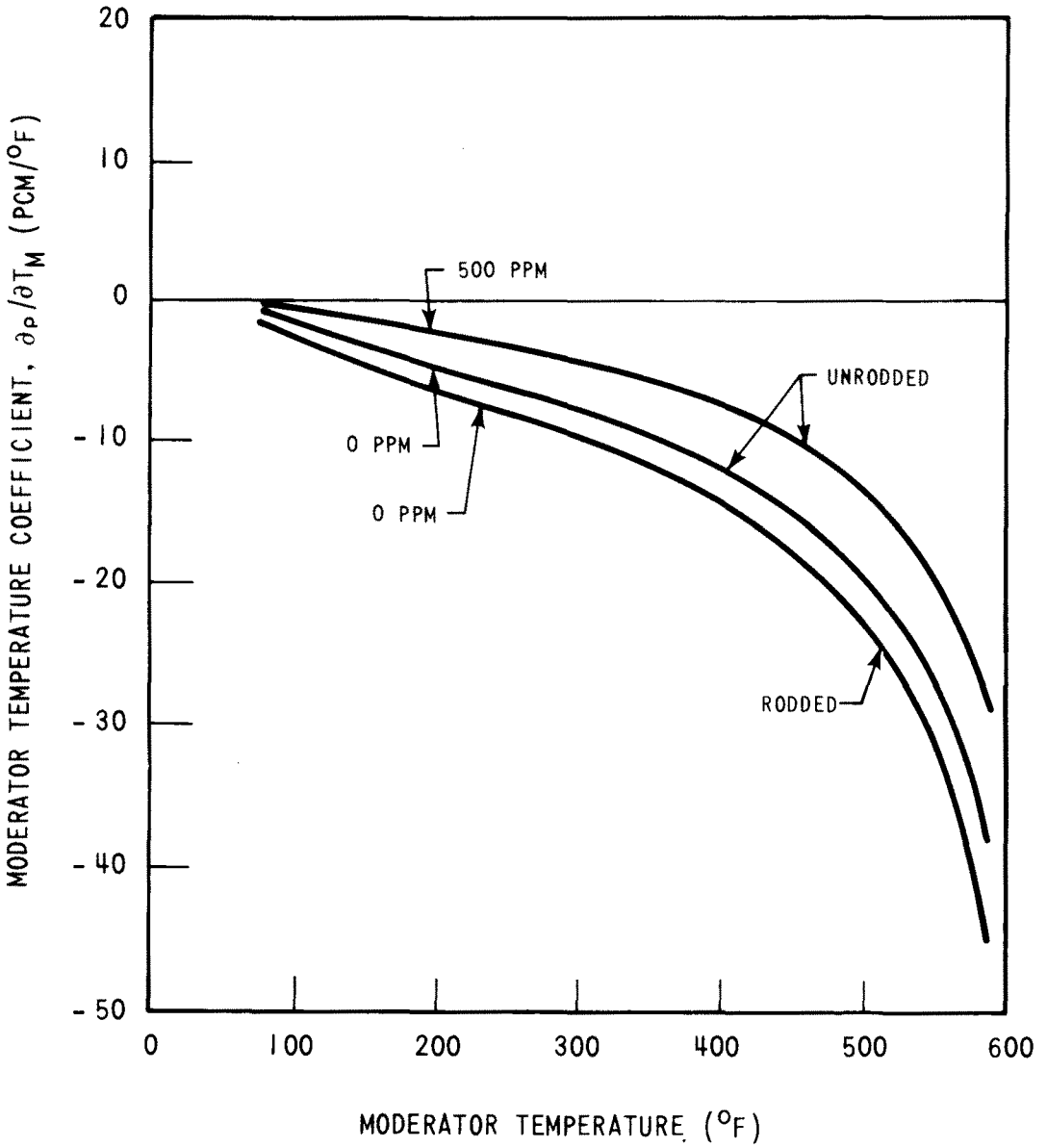

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FIGURE 4.3-31

TYPICAL MODERATOR TEMPERATURE COEFFICIENT AT EOL, CYCLE 1

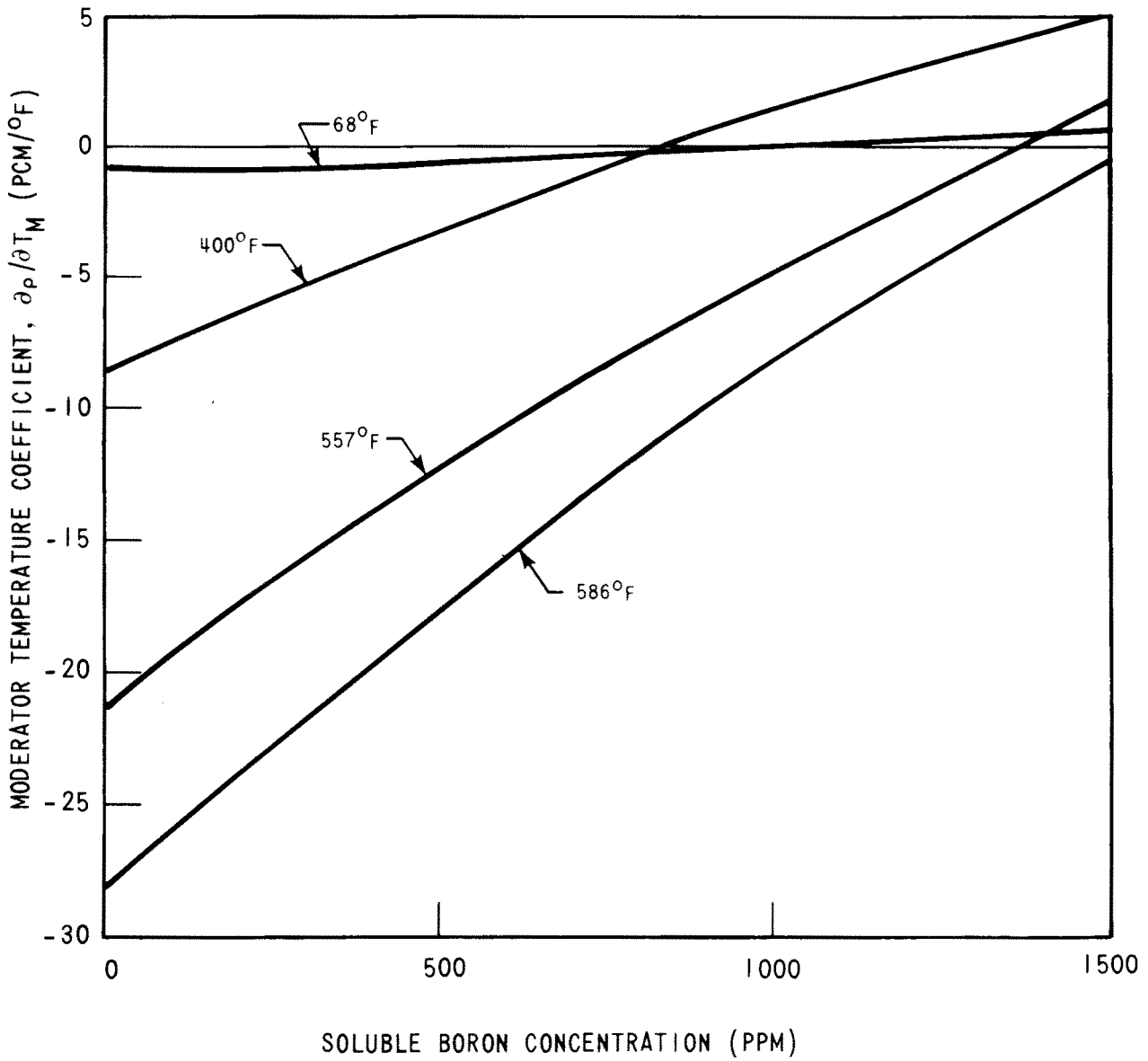

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FIGURE 4.3-32

TYPICAL MODERATOR TEMPERATURE COEFFICIENT AS A FUNCTION OF BORON CONCENTRATION AT BOL, CYCLE 1, NO RODS

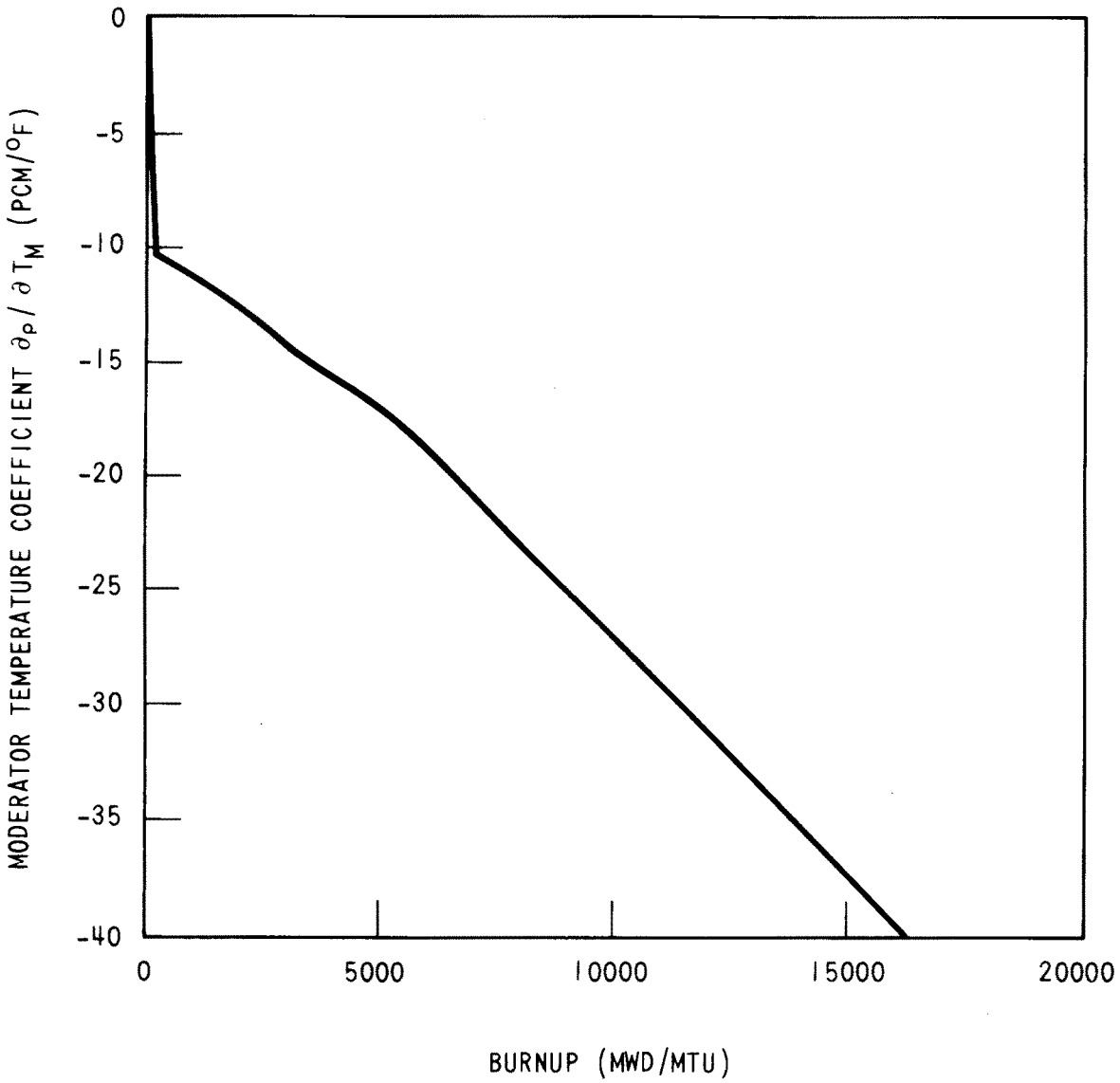

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FIGURE 4.3-33
TYPICAL HOT FULL POWER
TEMPERATURE COEFFICIENT DURING
CYCLE 1 FOR THE CRITICAL BORON
CONCENTRATION

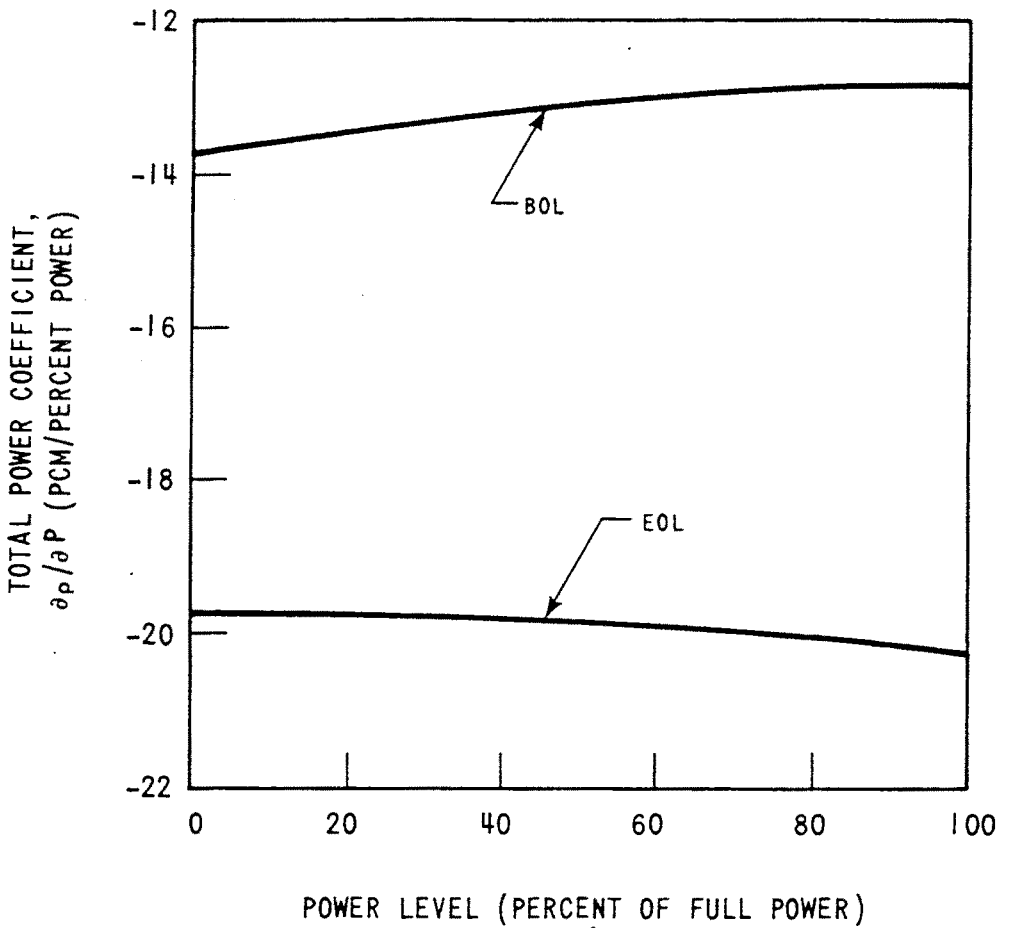

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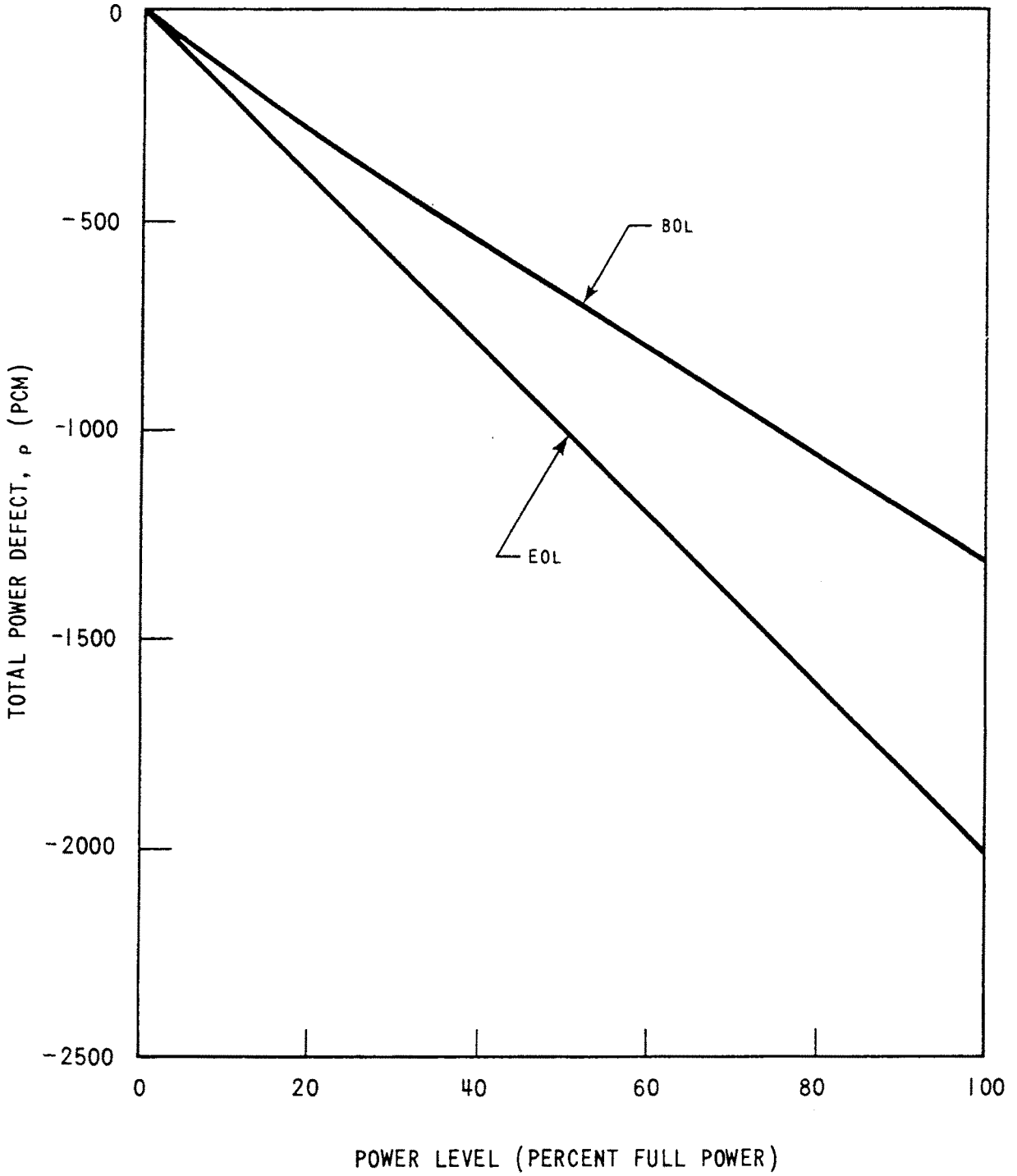
FIGURE 4.3-34

TYPICAL TOTAL POWER COEFFICIENT
AT BOL AND EOL, CYCLE 1



REV. OL-7
5/94

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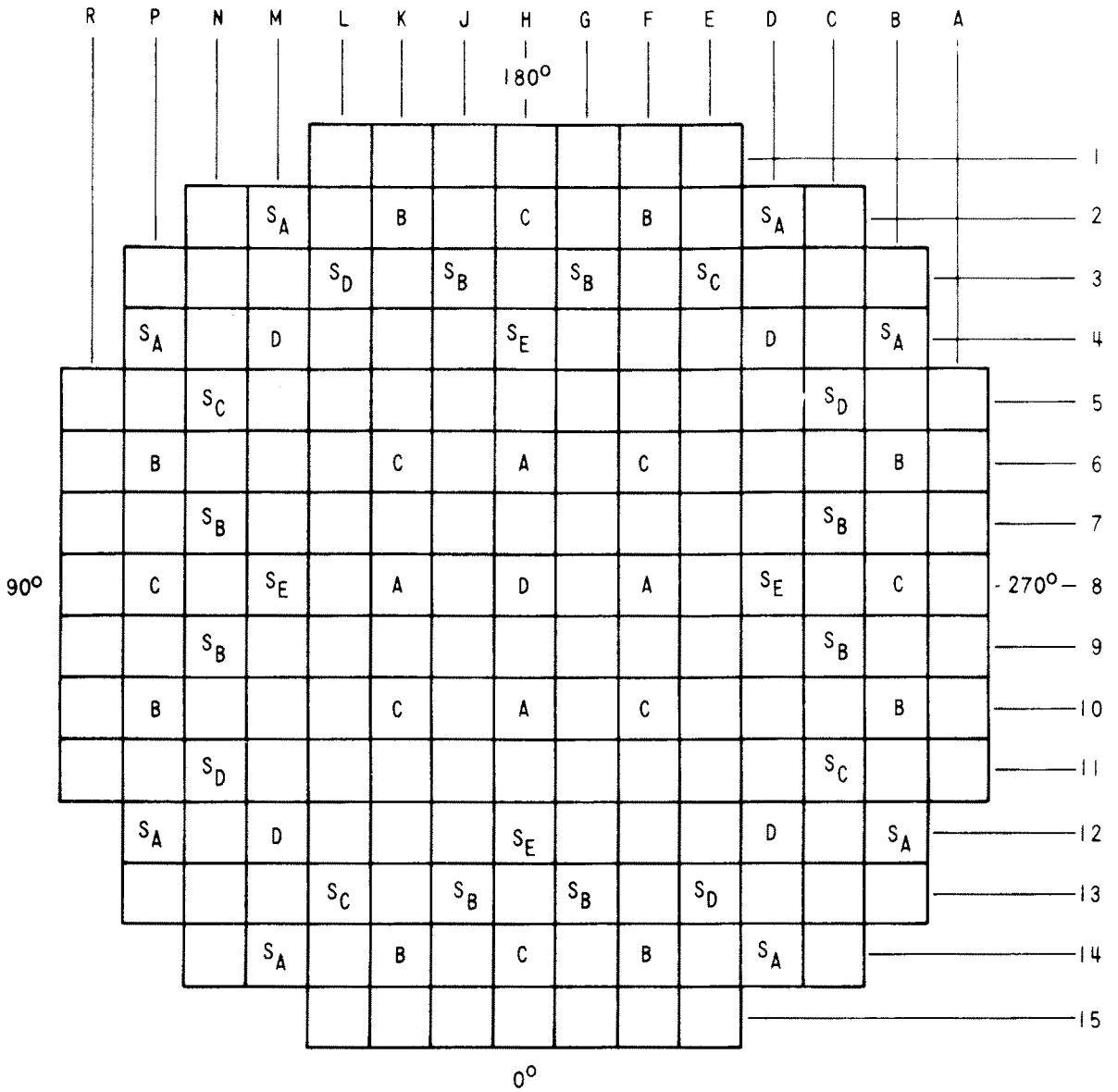
FIGURE 4.3-35

TOTAL POWER DEFECT AT
BOL AND EOL, CYCLE 1



CONTROL BANK	NUMBER OF RODS
A	4
B	8
C	8
D	5
TOTAL	25

SHUTDOWN BANK	NUMBER OF RODS
S_A	8
S_B	8
S_C	4
S_D	4
S_E	4
TOTAL	28

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FIGURE 4.3-36

ROD CLUSTER CONTROL ASSEMBLY PATTERN

FIGURE 4.3-37 HAS BEEN DELETED

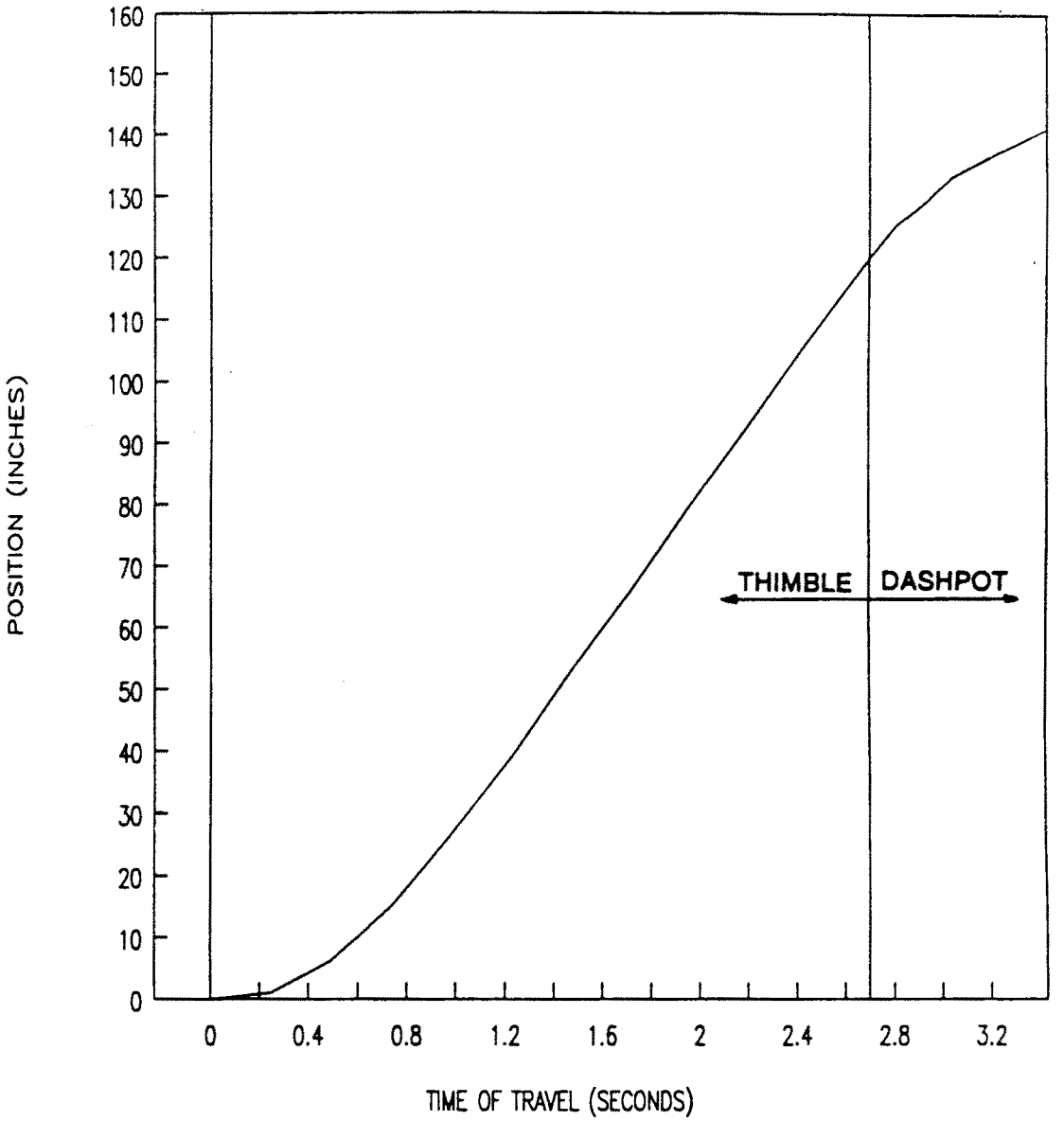

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FIGURE 4.3-38

DESIGN TRIP CURVE

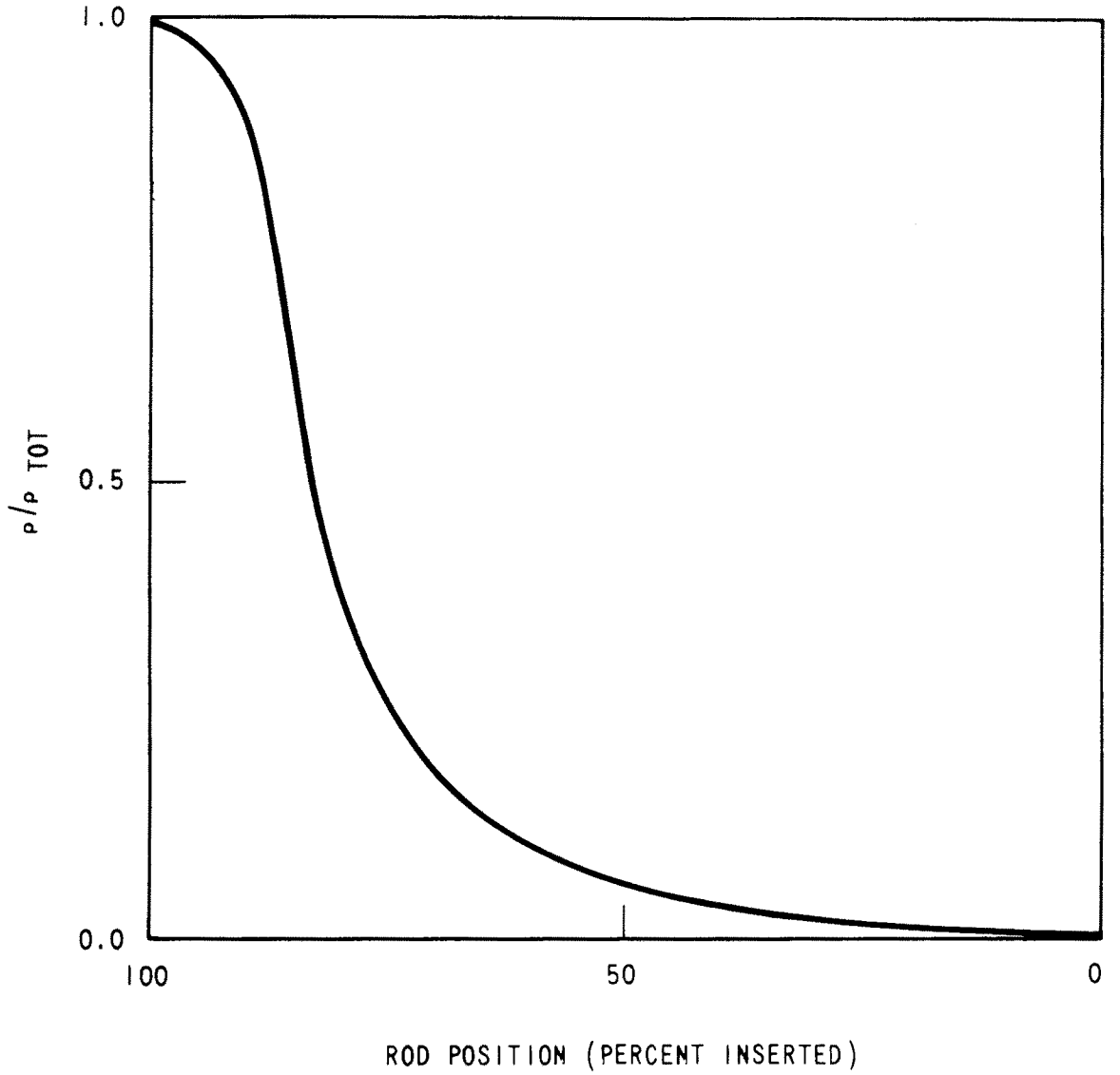

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FIGURE 4.3-39

TYPICAL NORMALIZED ROD WORTH VERSUS PERCENT INSERTION, ALL RODS OUT BUT ONE

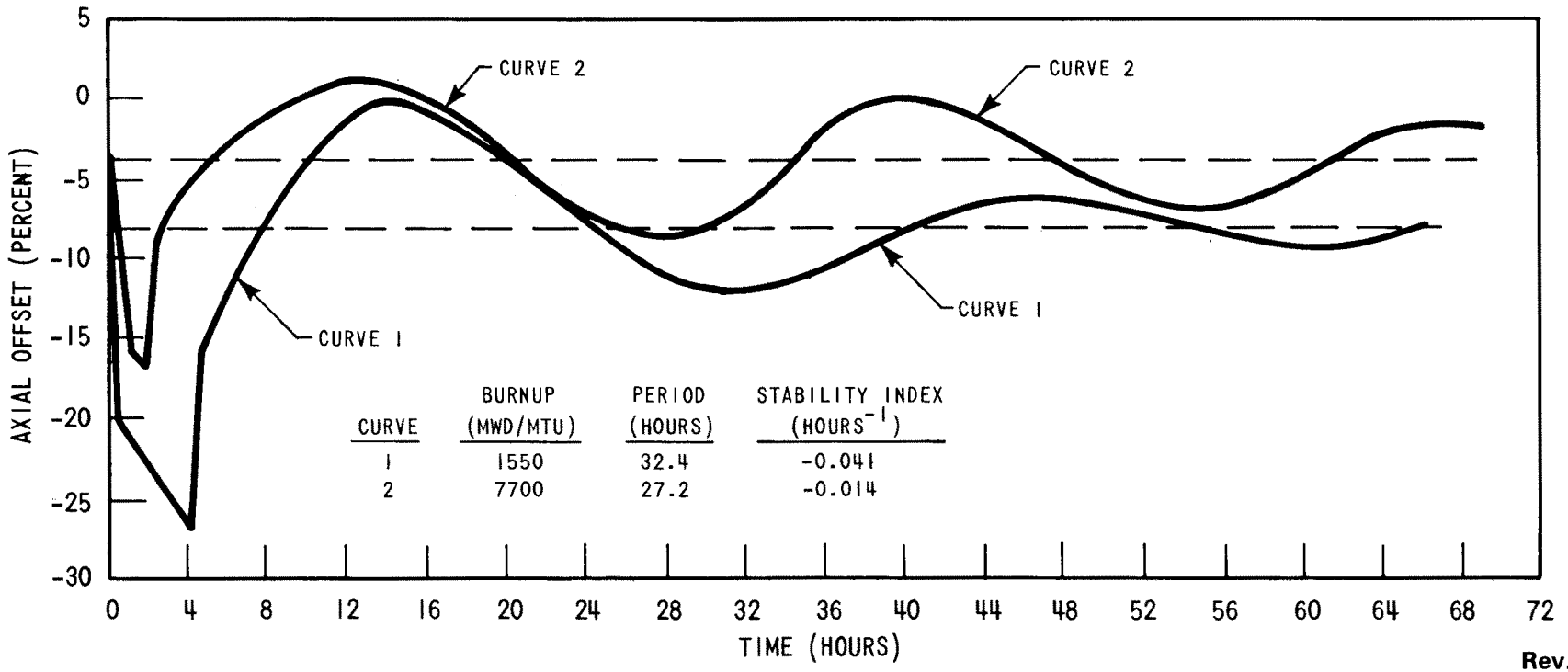

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FIGURE 4.3-40

AXIAL OFFSET VERSUS TIME, PWR CORE WITH A 12 FOOT HEIGHT AND 121 ASSEMBLIES

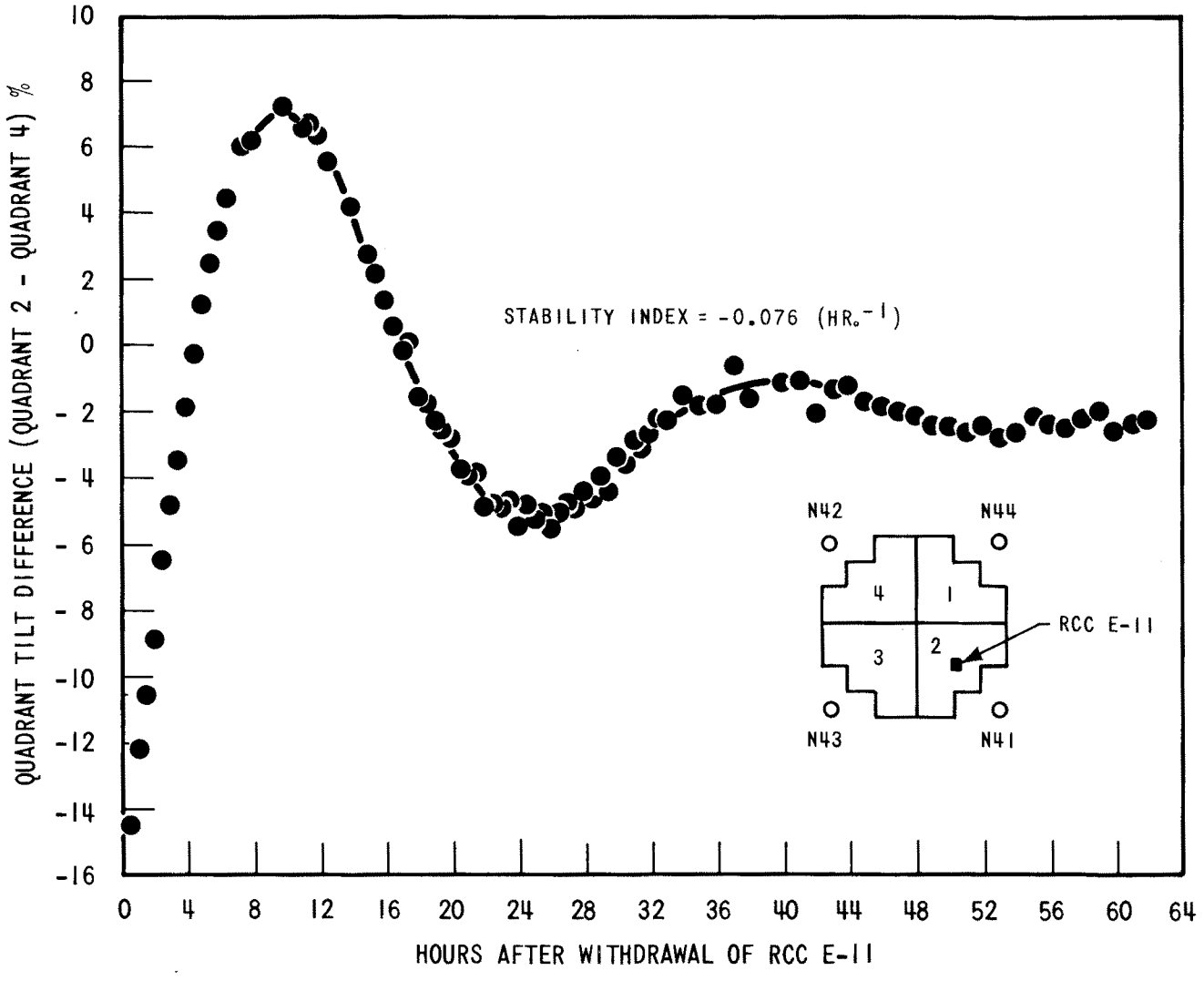

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FIGURE 4.3-41

X-Y XENON TEST THERMOCOUPLE RESPONSE QUADRANT TILT DIFFERENCE VERSUS TIME

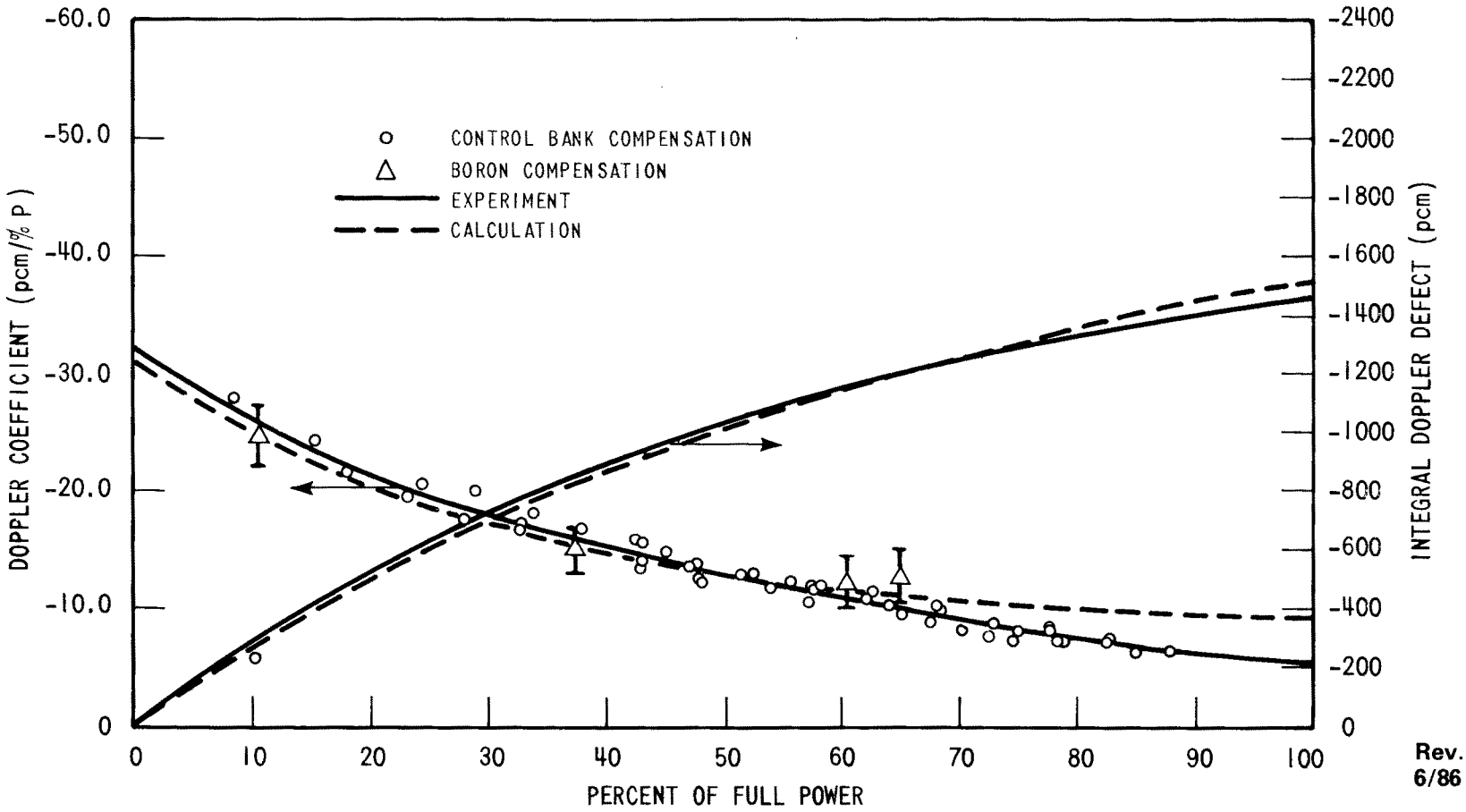

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FIGURE 4.3-42
CALCULATED AND MEASURED DOPPLER DEFECT AND COEFFICIENTS AT BOL, 2-LOOP PLANT, 121 ASSEMBLIES, 12 FOOT CORE

FIGURE 4.3-43 HAS BEEN DELETED

FIGURE 4.3-44 HAS BEEN DELETED

FIGURE 4.3-45 HAS BEEN DELETED

Figure 4.4-1 Deleted.

Figure 4.4-1a Deleted

Figure 4.4-2 Deleted.

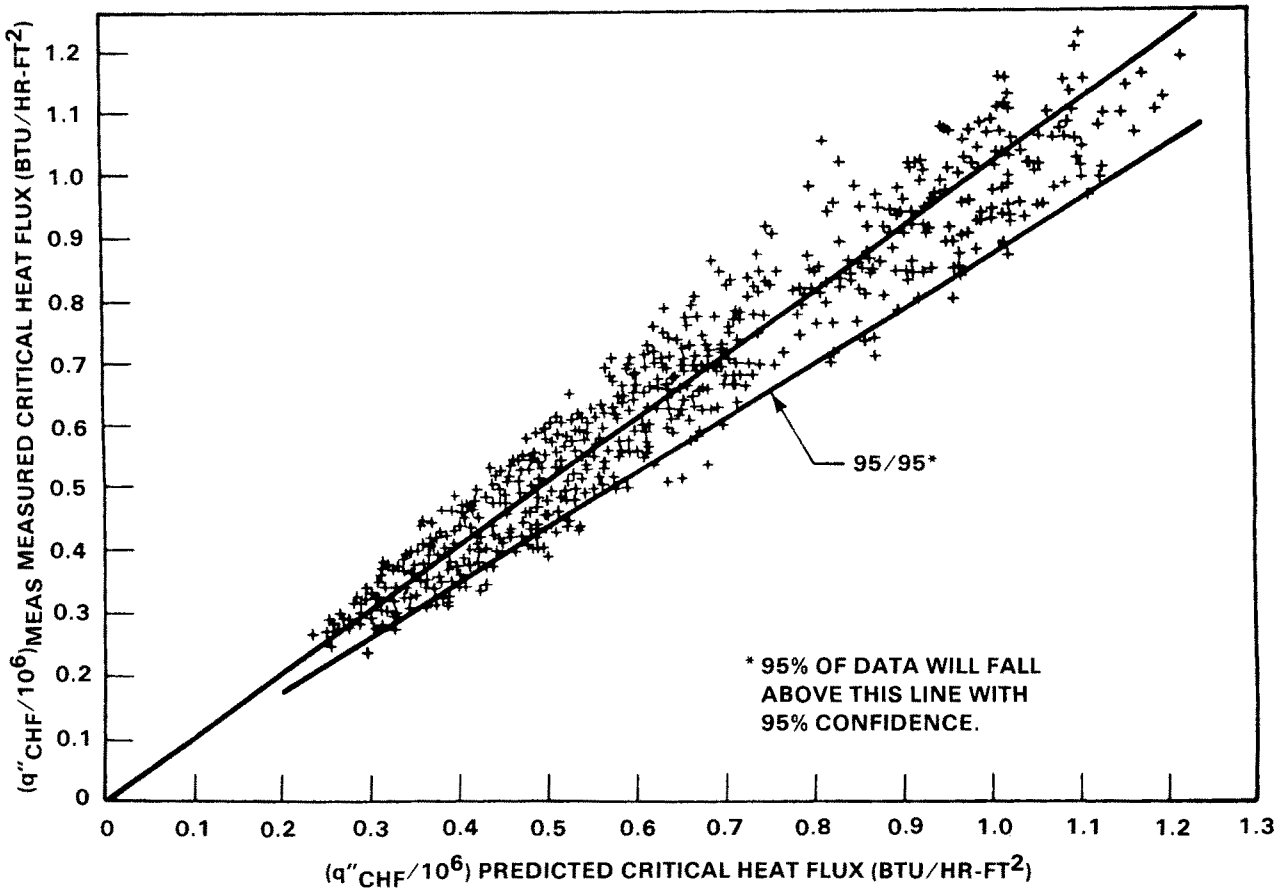

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FIGURE 4.4-2a
MEASURED VERSUS PREDICTED CRITICAL HEAT FLUX - WRB-1 CORRELATION

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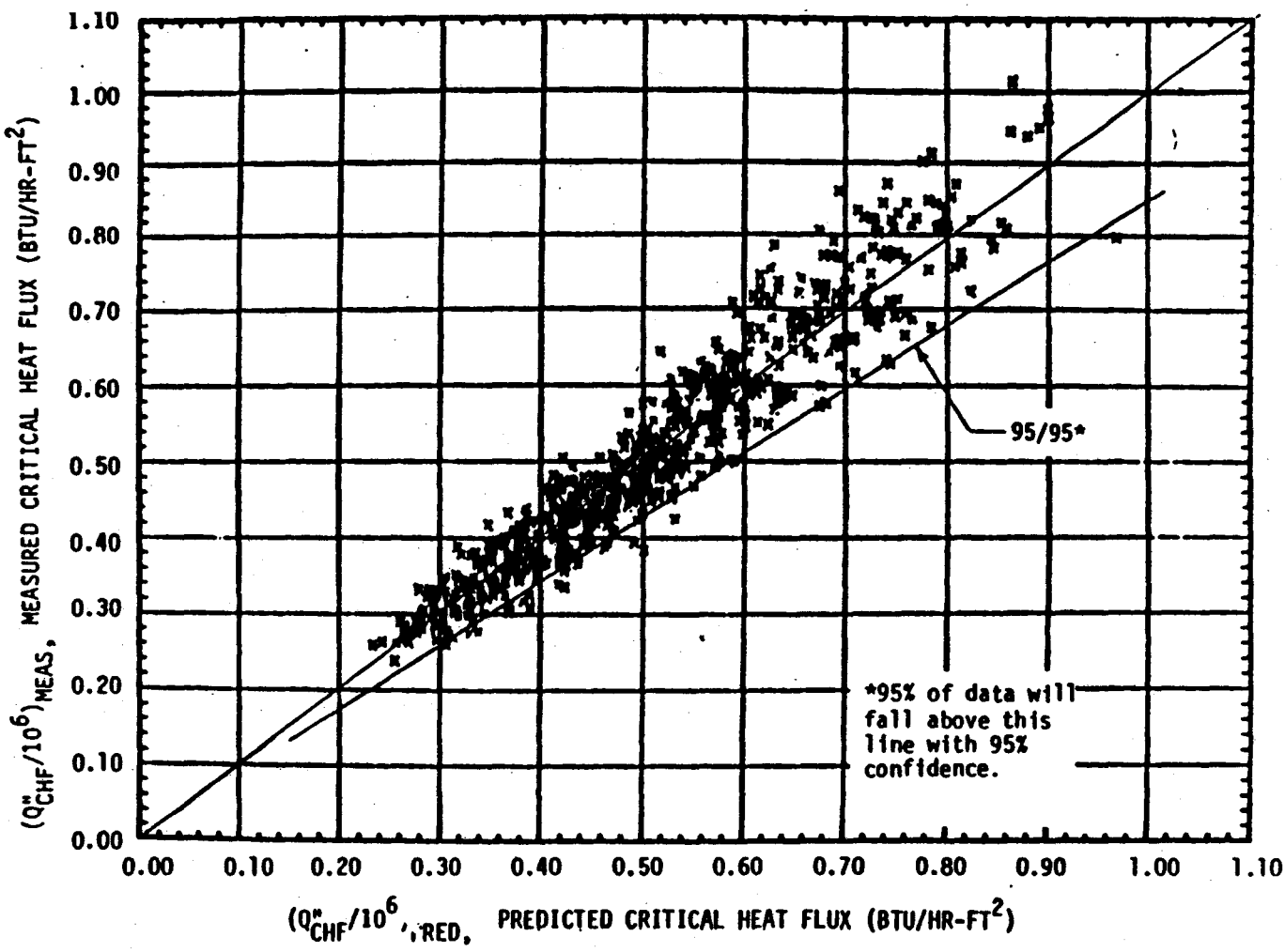

REV. 16
10/06

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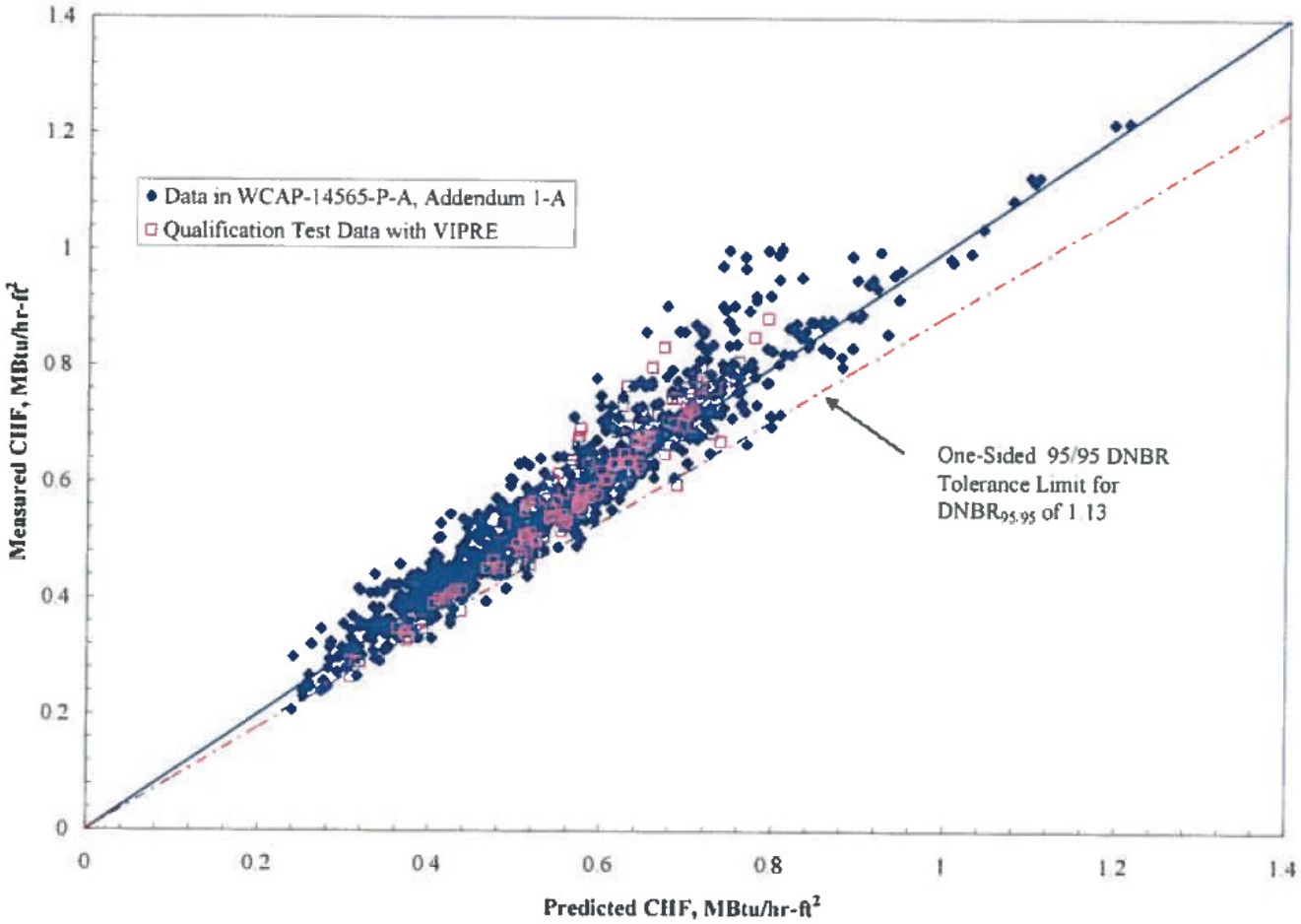
FIGURE 4.4-2b MEASURED VERSUS PREDICTED CRITICAL HEAT FLUX WRB-2 CORRELATION

Figure 4.4-3 Deleted.



Rev. OL-21d
4/16

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FIGURE 4.4-3a MEASURED VERSUS PREDICTED CRITICAL HEAT FLUX – ABB-NV CORRELATION

014-A-20766-180

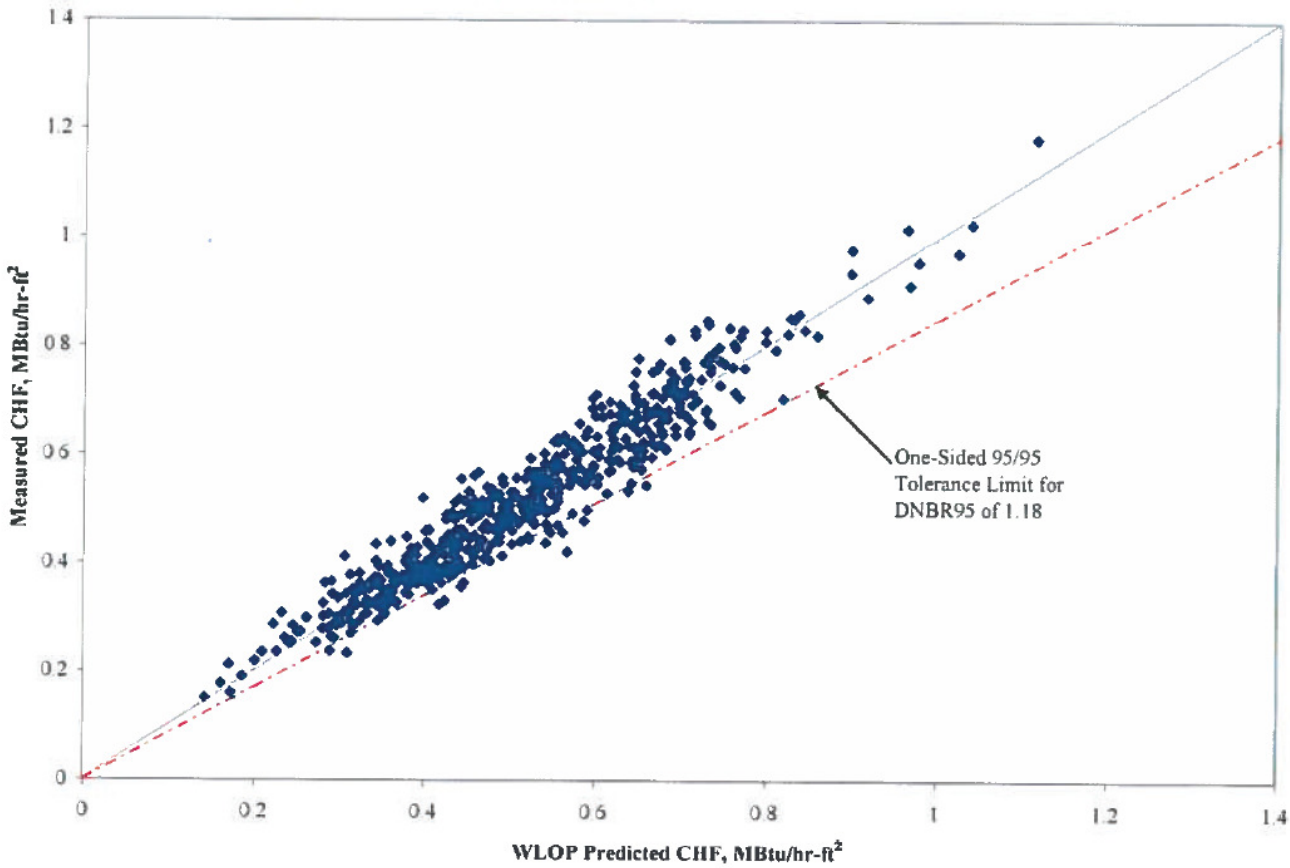

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FIGURE 4.4-3b MEASURED VERSUS PREDICTED CRITICAL HEAT FLUX – WLOP CORRELATION

014-A-20766-180

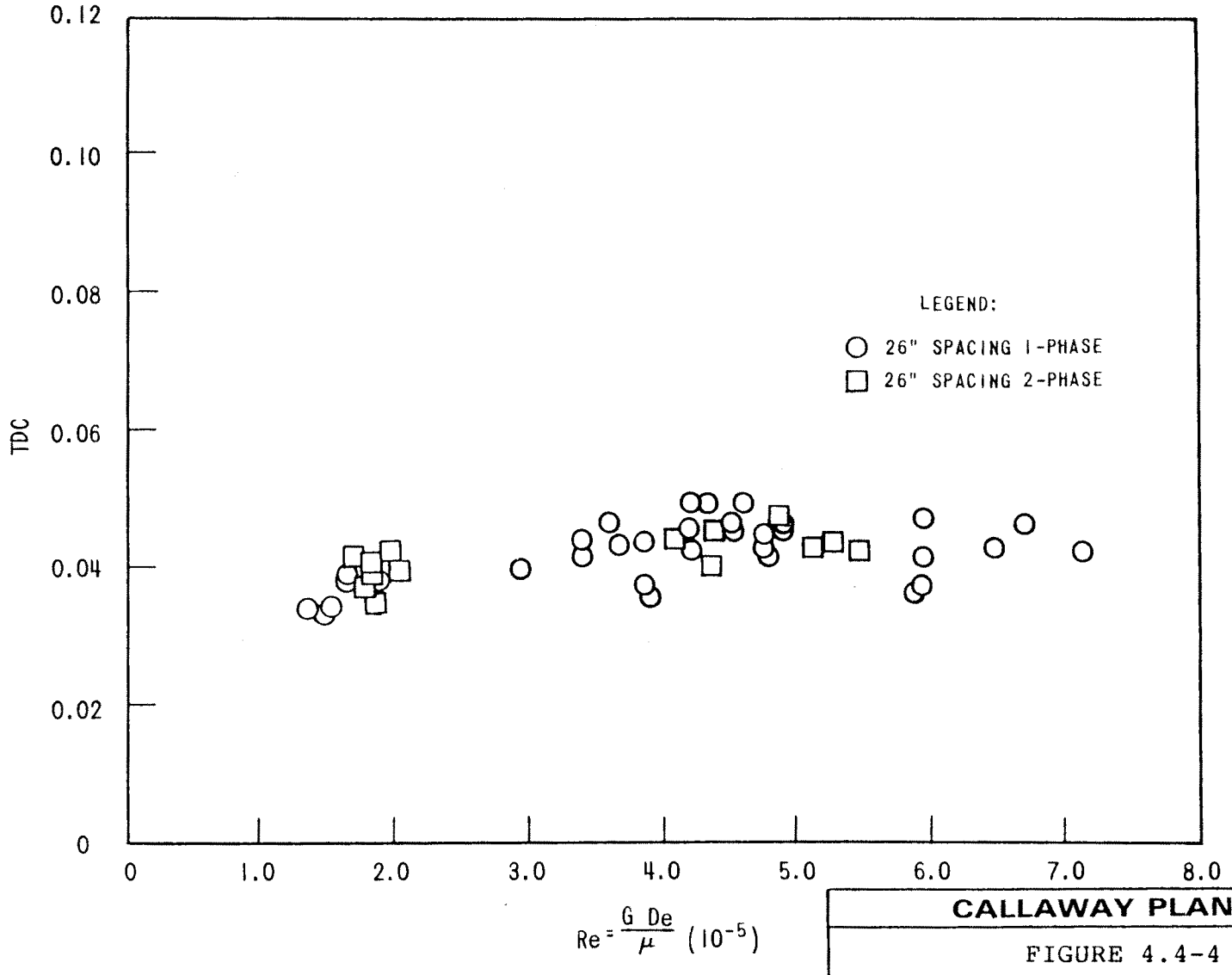

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FIGURE 4.4-4

TDC VERSUS REYNOLDS NUMBER
FOR 26 INCH GRID SPACING

	H	G	F	E	D	C	B	A
8	1.096 1.001							KEY: Δh/Δh G/G
9	1.029 1.001	1.120 1.001						
10	1.153 1.000	1.074 1.001	1.185 1.000					
11	1.166 1.000	1.209 1.000	1.162 1.001	1.185 1.000				
12	1.223 1.000	1.170 1.001	1.188 1.000	1.065 1.002	1.238 1.000			
13	1.126 1.001	1.161 1.001	1.093 1.002	1.086 1.002	0.916 1.001	0.967 1.001		
14	1.025 1.002	1.025 1.002	0.990 1.002	0.975 1.002	0.823 1.000	0.466 0.997		
15	0.717 0.999	0.780 0.999	0.664 0.998	0.563 0.997				

FOR RADIAL POWER DISTRIBUTION NEAR BEGINNING OF LIFE. HOT FULL POWER, EQUILIBRIUM XENON

CALCUALTED $F^N_{\Delta H}$ = 1.34

(CYCLE 1 ONLY)

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FIGURE 4.4-5
NORMALIZED RADIAL FLOW AND ENTHALPY DISTRIBUTION AT 4 FOOT ELEVATION

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	H	G	F	E	D	C	B	A
8	1.096 0.996							KEY: Δh/Δh G/G
9	1.026 1.002	1.120 0.994						
10	1.155 0.991	1.072 0.998	1.188 0.988					
11	1.169 0.990	1.212 0.986	1.165 0.990	1.189 0.998				
12	1.228 0.985	1.173 0.989	1.191 0.988	1.065 0.998	1.242 0.981			
13	1.129 0.992	1.165 0.990	1.095 0.995	1.086 0.996	0.916 1.009	0.963 1.006		
14	1.024 1.000	1.025 1.000	0.989 1.003	0.973 1.004	0.819 1.018	0.468 1.018		
15	0.715 1.022	0.777 1.019	0.663 1.021	0.562 1.019				

FOR RADIAL POWER DISTRIBUTION NEAR BEGINNING OF LIFE. HOT FULL POWER, EQUILIBRIUM XENON

CALCUALTED $F^N_{\Delta H}$ = 1.34

(CYCLE 1 ONLY)

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FIGURE 4.4-6
NORMALIZED RADIAL FLOW AND ENTHALPY DISTRIBUTION AT 8 FOOT ELEVATION

014-A-20766-182

	H	G	F	E	D	C	B	A
8	1.097 0.995							KEY: Δh/Δh G/G
9	1.026 0.999	1.121 0.993						
10	1.157 0.991	1.073 0.996	1.189 0.989					
11	1.170 0.990	1.215 0.980	1.166 0.991	1.190 0.990				
12	1.231 0.987	1.175 0.990	1.193 0.989	1.066 0.997	1.243 0.987			
13	1.130 0.993	1.165 0.991	1.095 0.995	1.087 0.996	0.914 1.005	0.961 1.003		
14	1.023 1.000	1.024 1.000	0.987 1.002	0.971 1.003	0.817 1.011	0.469 1.030		
15	0.711 1.016	0.774 1.013	0.660 1.019	0.560 1.025				

FOR RADIAL POWER DISTRIBUTION NEAR BEGINNING OF LIFE. HOT FULL POWER, EQUILIBRIUM XENON

CALCUALTED $F^N_{\Delta H}$ = 1.34

(CYCLE 1 ONLY)

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FIGURE 4.4-7
NORMALIZED RADIAL FLOW AND ENTHALPY DISTRIBUTION AT 12 FOOT ELEVATION - CORE EXIT

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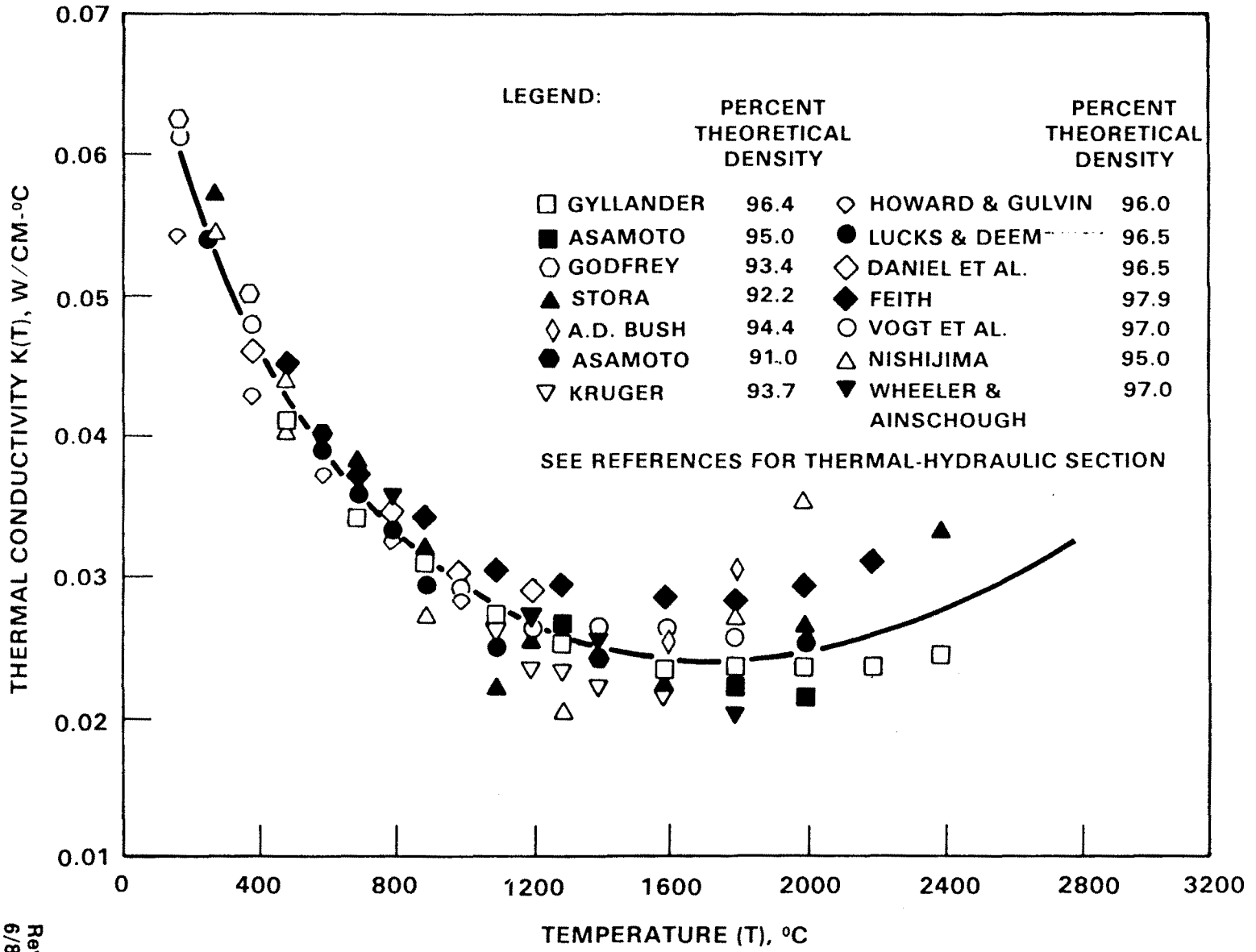
Figure 4.4-8 Deleted



CALLAWAY PLANT

FIGURE 4.4-9

Thermal Conductivity of UO_2
(Data Corrected to 95% Theoretical Density)

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20,343.2

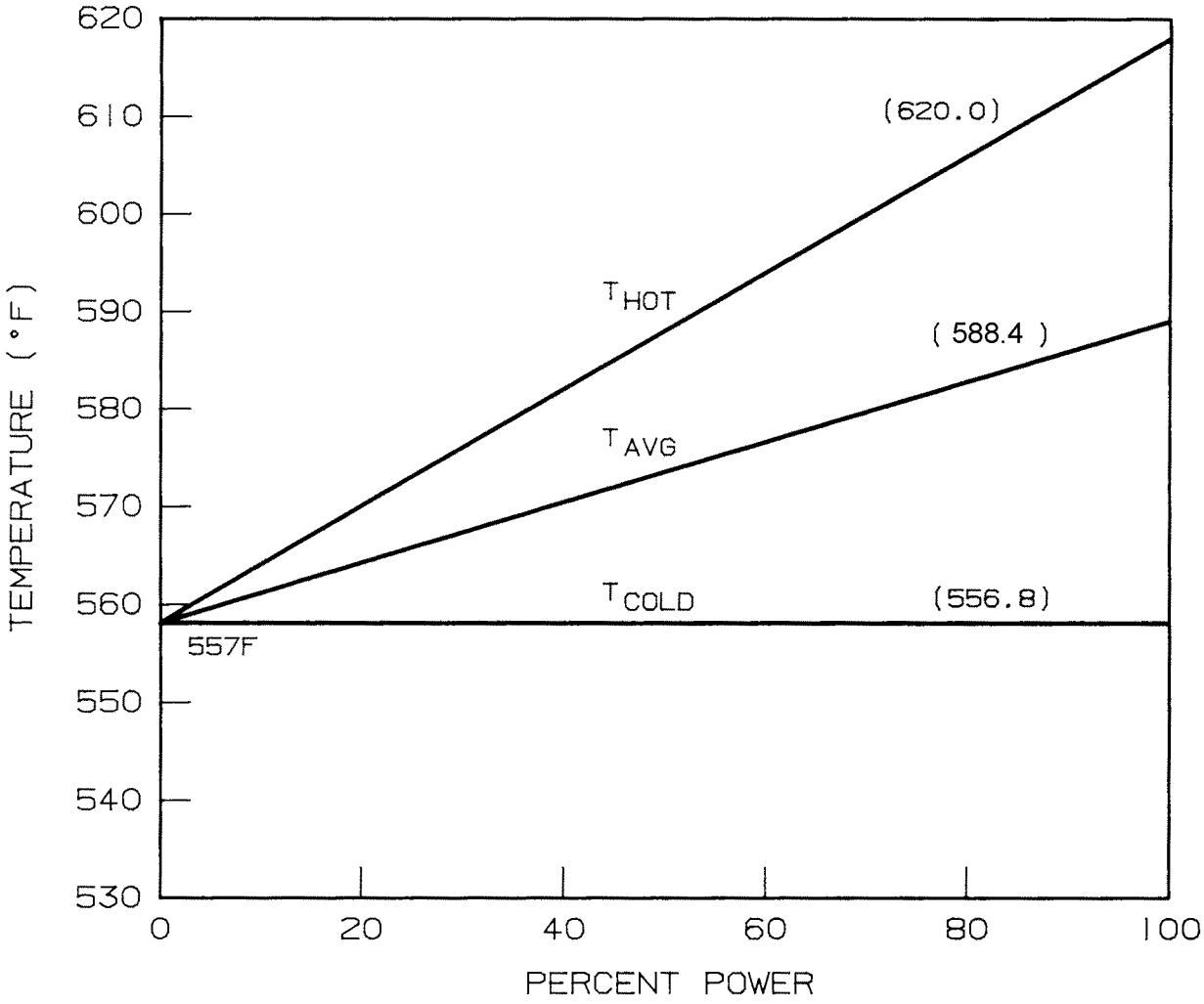

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FIGURE 4.4-10
REACTOR COOLANT SYSTEM
TEMPERATURE-PERCENT POWER MAP

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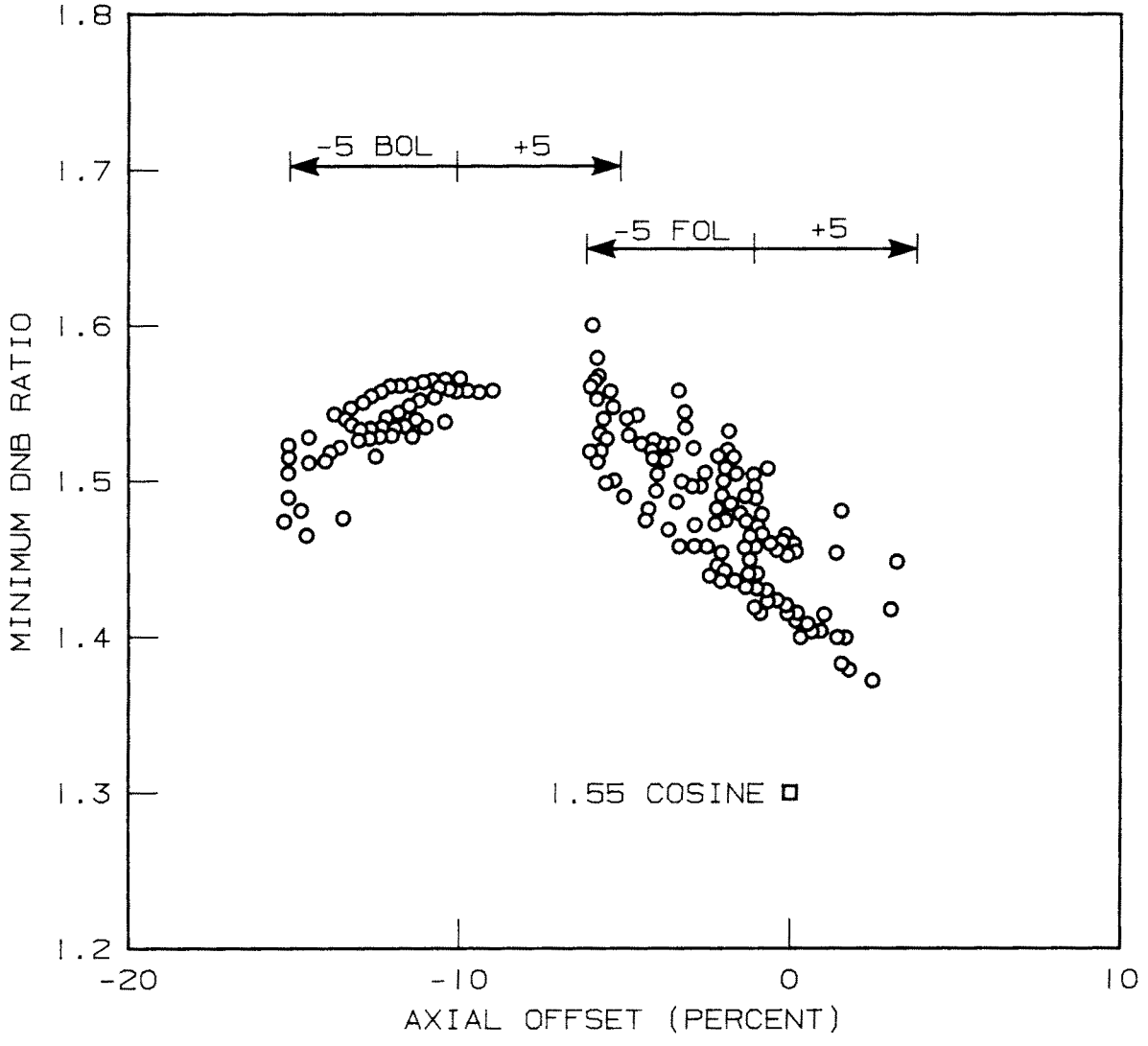

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FIGURE 4.4-11
100% POWER SHAPES EVALUATED AT CONDITIONS REPRESENTATIVE OF LOSS OF FLOW, ALL SHAPES EVALUATED WITH $F^N_{\Delta H}$ = 1.55 (CYLE 1 ONLY)

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Figure 4.4-12 Deleted.

Figure 4.4-13 Deleted.

Figure 4.4-14 Deleted.

Figure 4.4-15 Deleted.

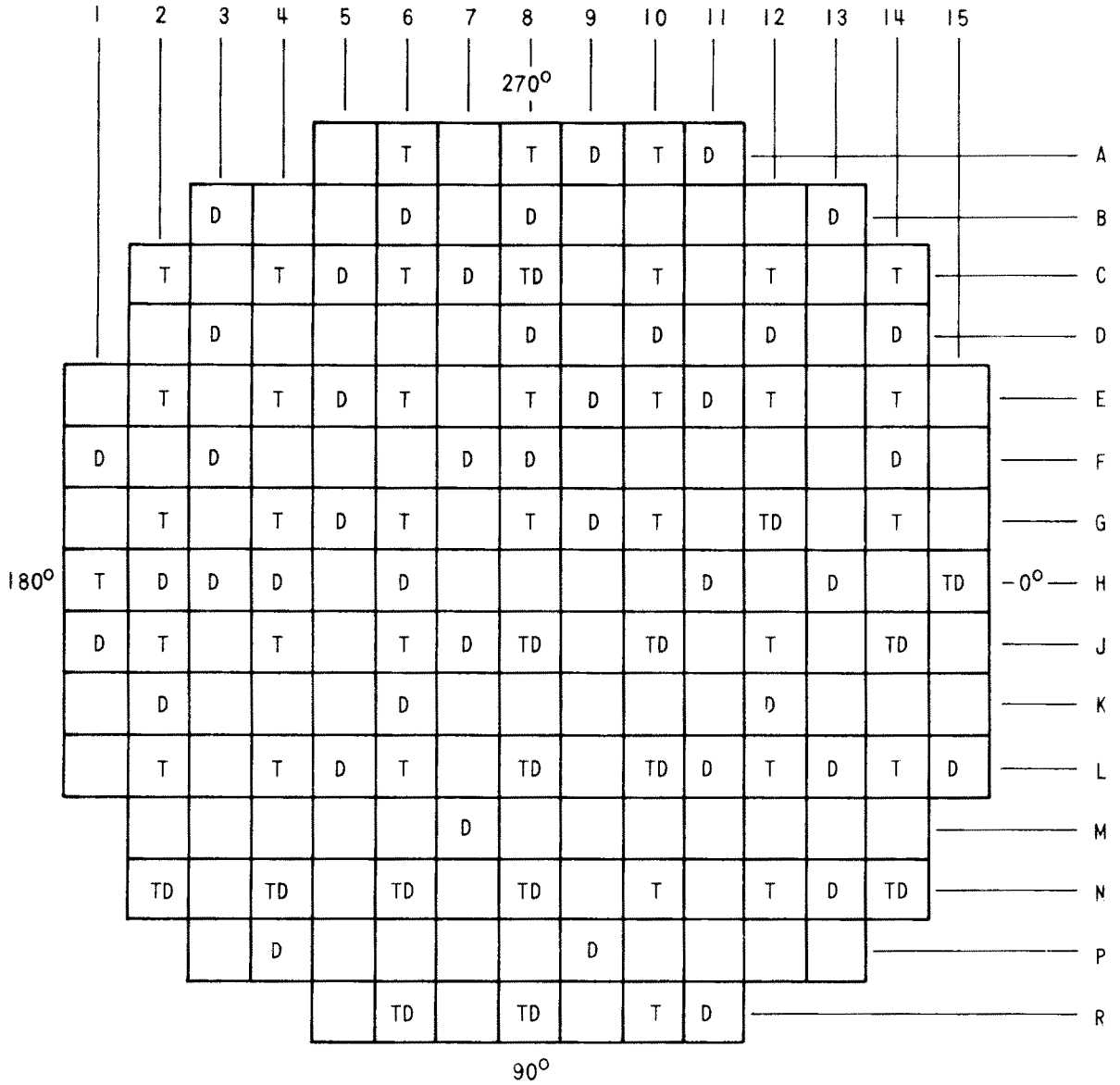
Figure 4.4-16 Deleted.

Figure 4.4-17 Deleted.

Figure 4.4-18 Deleted.

Figure 4.4-19 Deleted.

Figure 4.4-20 Deleted.



T = THERMOCOUPLE (50 LOCATIONS)

D = MOVABLE INCORE DETECTOR (58 LOCATIONS)

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FIGURE 4.4-21

DISTRIBUTION OF INCORE INSTRUMENTATION