12-18-85

GREGORY STEPANEK

URANIUM PLATE TEST STACK: TEST OF CC DESIGN

BACKGROUND:

A TEST NEEDED TO BE SET UP TO DETERMINE IF IT IS POSSIBLE, USING DIFFERENT PRESSURES AND BUTTON SPACINGS, TO SUCESSFULLY FLATEN THE URANIUM PLATES, AND TEST THE CURRENT CC DESIGN.

TO RUN THE TEST A SERIES OF 12 PLATES WAS SET UP IN A CRYOGENIC BATH WITH BELLOWS AT ONE END OF THE BATH TO APPLY PRESSURE TO THE STACK (SEE FIG. 1). EACH PLATE WAS NUMBERED FOR IDENTIFICATION AND THIS CAN BE NOTED ON FIGURE ONE, AND PLATE FLATNESS DATA.

TO DETERMINE THE FLATNESS OF EACH URANIUM PLATE BEFORE STACKING A NUMBER OF MEASUREMENTS WERE TAKEN. THESE INCLUDED:

1) OVERALL DIMENSIONS OF EACH PLATE (FIG 2)

2) THICKNESS OF EACH PLATE AT DIFFERENT LOCATIONS ON THE PLATE

3) ULTRASOUND THICKNESS TEST

4) DIAL GAUGE FRONT CONTOUR

5) DIAL GAUGE BACK CONTOUR

THE PLATES WERE STACKED AS INDICATED IN FIGURE 1. THEY WERE RANDOMLY ORIENTED, AND ORIENTATION OF EACH IS NOTED IN FIGURE 1. THE FERMILAB NUMBER WILL ALWAYS BE LOCATED ON THE FRONT OF THE PLATE,(SEE FIG 2 FOR LOCATION OF FERMI NUMBER). THE LOCATIONS NOTED ON FIGURE 1 ARE THE LOCATIONS OF THE FERMI-NUMBER.

THE PLATES WERE COMPRESSED THEN FLOODED WITH LIQUID NITROGEN. COMPRESSION USING 20 PSI IN THE BELLOWS. GAP MEASUREMENTS COULD NOW BE TAKEN. THIS WAS ACCOMPLISHED BY USING A SET OF RODS OF KNOWN DIAMETERS. A ROD WAS INSERTED INTO THE GAP, IF IT DID NOT FIT THE NEXT SIZE SMALLER ROD WAS INSERTED, THEREBY GIVING A RANGE FOR GAP WIDTH. FOR A ROD TO FIT IN THE GAP IT WAS INSERTED AND MOVED BACK AND FORTH IN THE EAST-WEST DIRECTION. IF THE ROD HUNG UP AT ANY POINT IN THE GAP IT WAS CONSIDERED TO LARGE FOR THE GAP. THE PRESSURE WAS LOWERED TO 1 PSI IN THE BELLOWS AND THE MEASUREMENTS REPEATED; THE PRESSURE WAS BROUGHT BACK TO THE ORIGINAL 20 PSI AND MEASUREMENTS WERE AGAIN TAKEN.

UNDERSTANDING THE DATA

TO BEGIN TO UNDERSTAND THE DATA START WITH THE GAP MEASUREMENT GRAPHS. GRAPHS 1 THROUGH 3 SHOW THE RANGES THAT THE GAPS WILL FALL BETWEEN, AS EXPLAINED EARLIER. THE IDEAL GAP WIDTH IS 0.406" BECAUSE THIS IS THE THICKNESS OF THE G-10 SPACER BUTTONS USED TO MAKE THE GAP.

GRAPH	PSI
1	20
2	1
3	20

BY LOOKING AT THIS DATA FIRST IT CAN BE EASILY SEEN WHICH PLATES MUST BE STUDIED TO DETERMINE WHY THE GAP DID NOT PASS THE TEST. THIS STUDY SHOWS THAT THE LARGEST GAP PROBLEM OCCURS FROM GAPS 6 THROUGH 11, 9 BEING THE WORST AND 11 SHOWING THE MOST CHANGE OVER THE PRESSURE RANGES.

PLATES 6 THROUGH 12 WERE THEN STUDIED INDIVIDUALLY TO TRY TO EXPLAIN GAP FAILURES. THREE DIMENSIONAL (3D) DRAWINGS OF EACH PLATE WERE CONSTRUCTED. TO DO THIS REFER TO THE PLATE DATA CHARTS, MOST OF THE CHART WAS EXPLAINED EARLIER. TO MAKE 3D DRAWINGS A ZERO (OR FLAT) STARTING POINT IS SELECTED. THIS IS DETERMINED BY THE LEFT HAND COLUMN OF PLATE THICKNESS. THE NUMBER USED IS CIRCLED AT THE BOTTOM OF THE COLUMN. A GRID IS SET UP CORRESPONDING TO THE 25 DATA POINTS TAKEN. (SEE FIG 2 AND 3D DRAWINGS) TO DETERMINE WHICH SET OF DATA IS TO BE USED, FRONT OR BACK CONTOUR, THE DEVIATIONS OF EACH ARE COMPUTED AND WRITTEN AT THE BOTTOM OF THE COLUMN. THE LARGER DEVIATION IS THE COLUMN TO USE. THE ORIENTATION OF THE PLATES IS CHECKED FROM FIGURE 1 AND DEVIATIONS ARE MEASURED FROM THE GRID. EACH 1/16" CORRESPONDS TO 0.005" OF PLATE WARP.

BY LOOKING AT THE 3D DRAWINGS IS SEEN THAT THE PLATES ARE NOT STARTING OUT FLAT. WITH THE WORST OF THIS GROUP BEING PLATE 12 WHICH IS APPROXIMATELY 0.173" FROM FLAT.

EXAMPLE CALCULATION

CHOOSING AN ARBITRARY GAP - NUMBER 6

CORESPONDING PLATES - PLATE 6 AND PLATE 7

NODE ON PLATE 6 CLOSEST TO PLATE 7 IS NUMBER 13 (6-13)

NODE ON PLATE 7 CLOSEST TO PLATE 6 IS NUMBER 21 (7-21)

6-13 = 0.157"
0 = 0.160"

0.160 - 0.157 = 0.003"

7-21 = 0.202"

0 = 0.155"

0.202 - 0.155 = 0.047"

THE GAP SHOULD BE 0.406"

0.406 - 0.047 - 0.003 = 0.356"

READING GAP WIDTHS FROM THE GRAPHS FOR GAP NUMBER 6

GRAPH	GAP
1	0.375-0.360
2	0.375-0.360
3	0.375-0.360

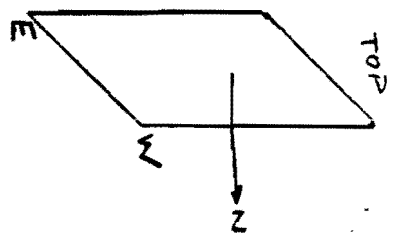
0.356" FALLS JUST OUT OF THE MEASURED RANGE INDICATING A POSSIBLE FLATTENING OF THE PLATES.

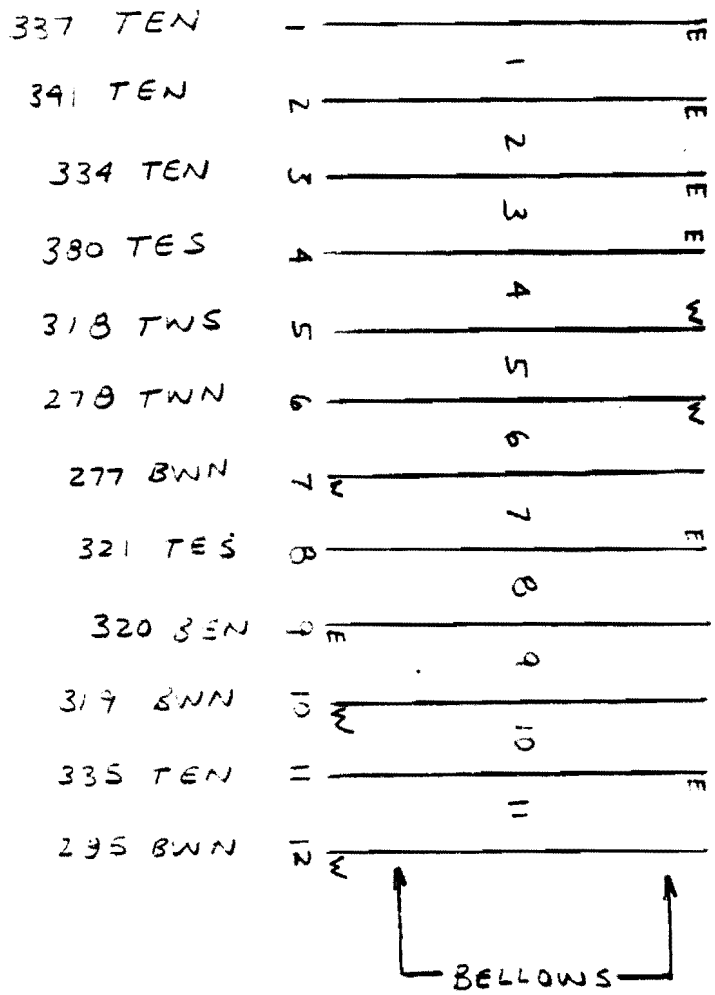
OTHER POINTS WERE CALCULATED AS IN THE ABOVE CASE. IN MANY OF THE CASES THE ABOVE THEORY HOLDS TRUE, IN OTHER CASES, HOWEVER, IT BECOMES EVIDENT THAT WARPAGE OF THE PLATES IS MORE SEVERE, IN TERMS OF PERIODICITY OF THE WARPS, THAN THE 25 DATA POINTS CAN SHOW.

THE MOST EXTREME CASES SEEM TO FALL IN GAPS 11 AND 9. GAP 11 RECEIVES THE MOST HELP FROM THE PRESSURE, CORRECTING THE PLATES OVER A TENTH OF AN INCH. WHEREAS GAP 9 RECEIVES LITTLE HELP FROM THE PRESSURE.

CONCLUSION

FROM REVIEWING THE ABOVE DATA THE CONCLUSION THAT SEEMS TO FOLLOW IS YET ANOTHER TEST. THIS TIME USING THE SAME ARRANGEMENT AS BEFORE, WITH PLATES IN THE SAME ORIENTATION, BUT USING MORE BUTTON SPACERS.





Bottom

TOP

N

Fig 1

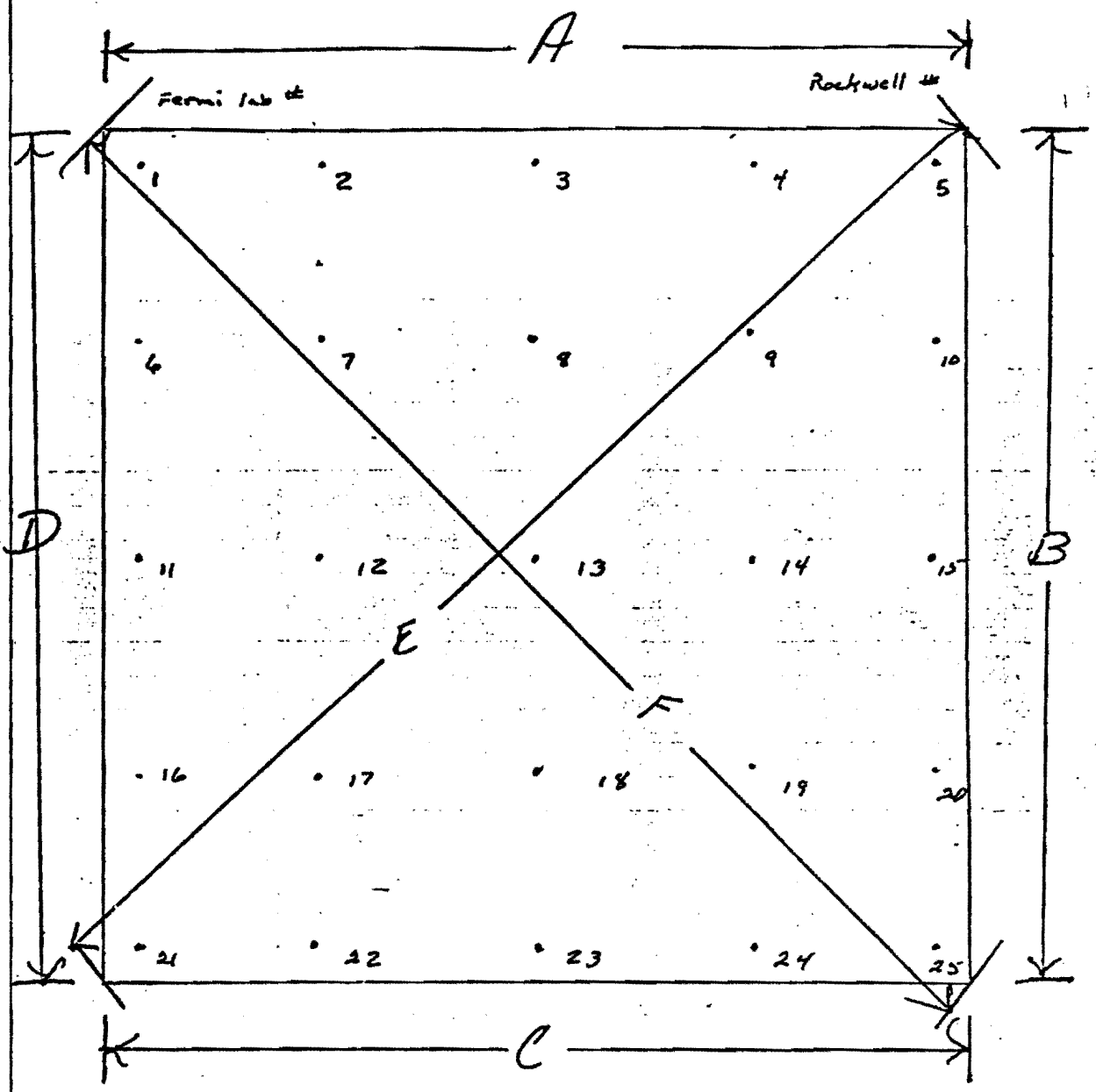
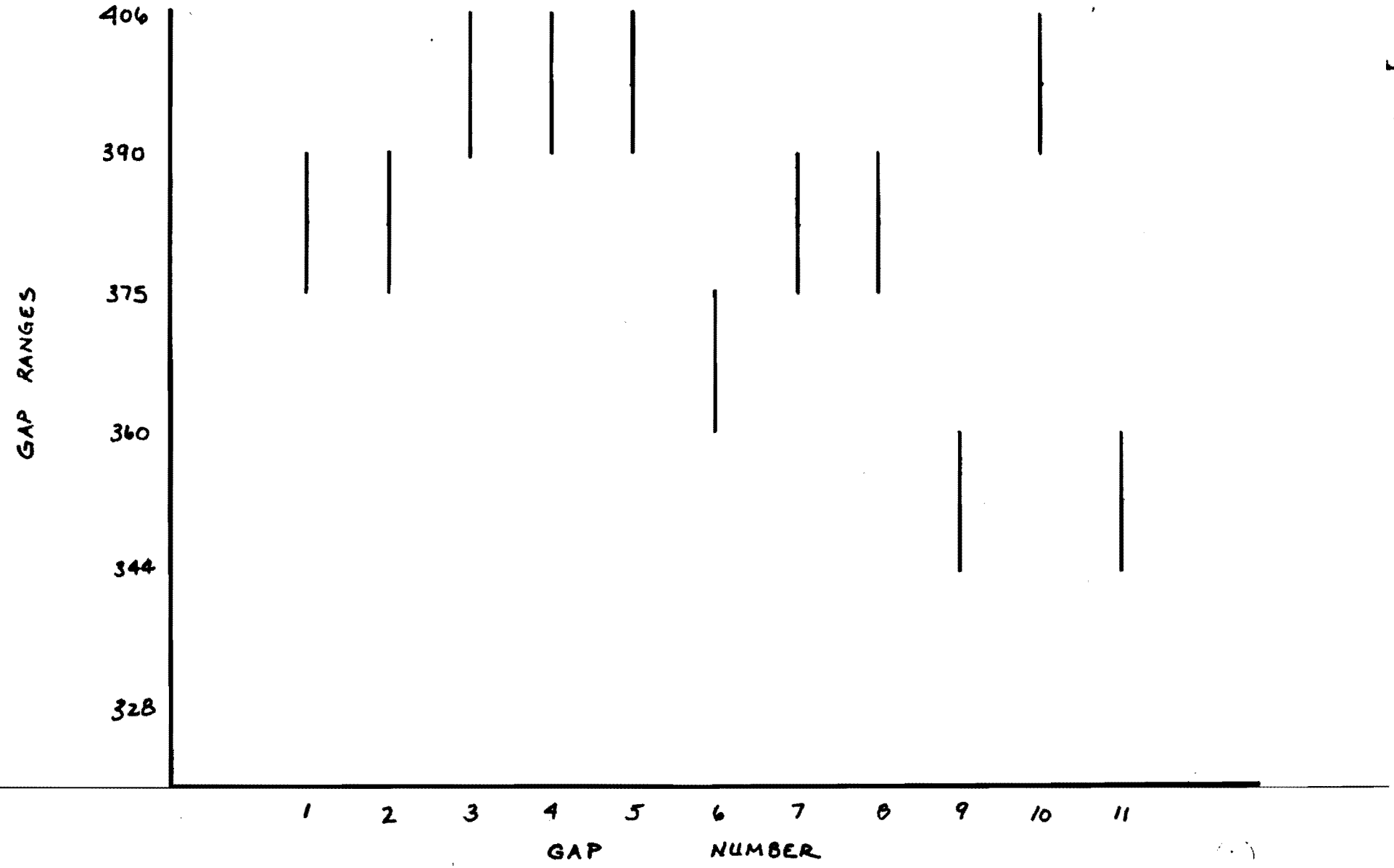

A
Fermi lab
Rockwell
B
C
D
E
F
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

Fig 2

GRAPH = 1

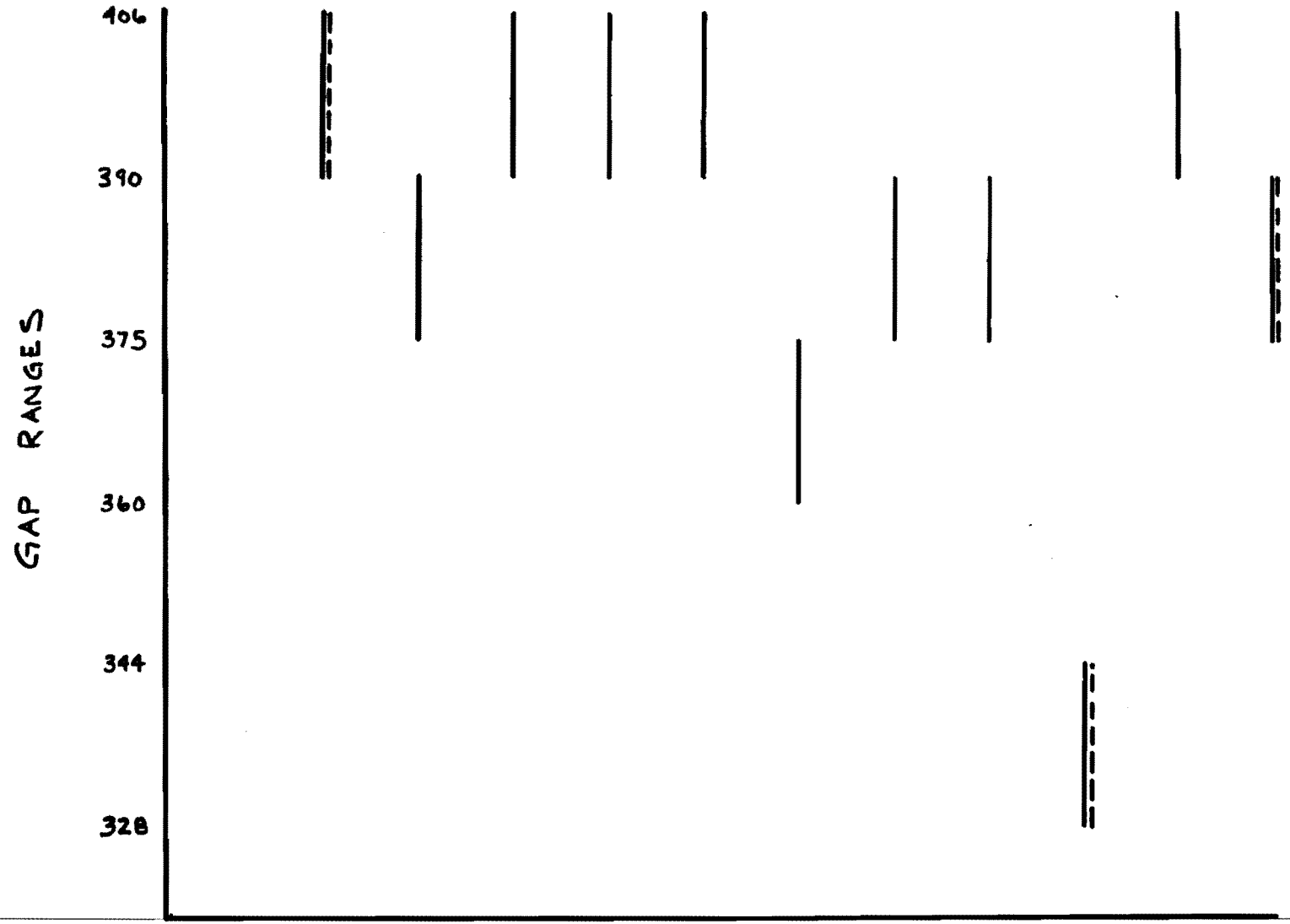
20 PSI



GRAPH #2

1 PSI

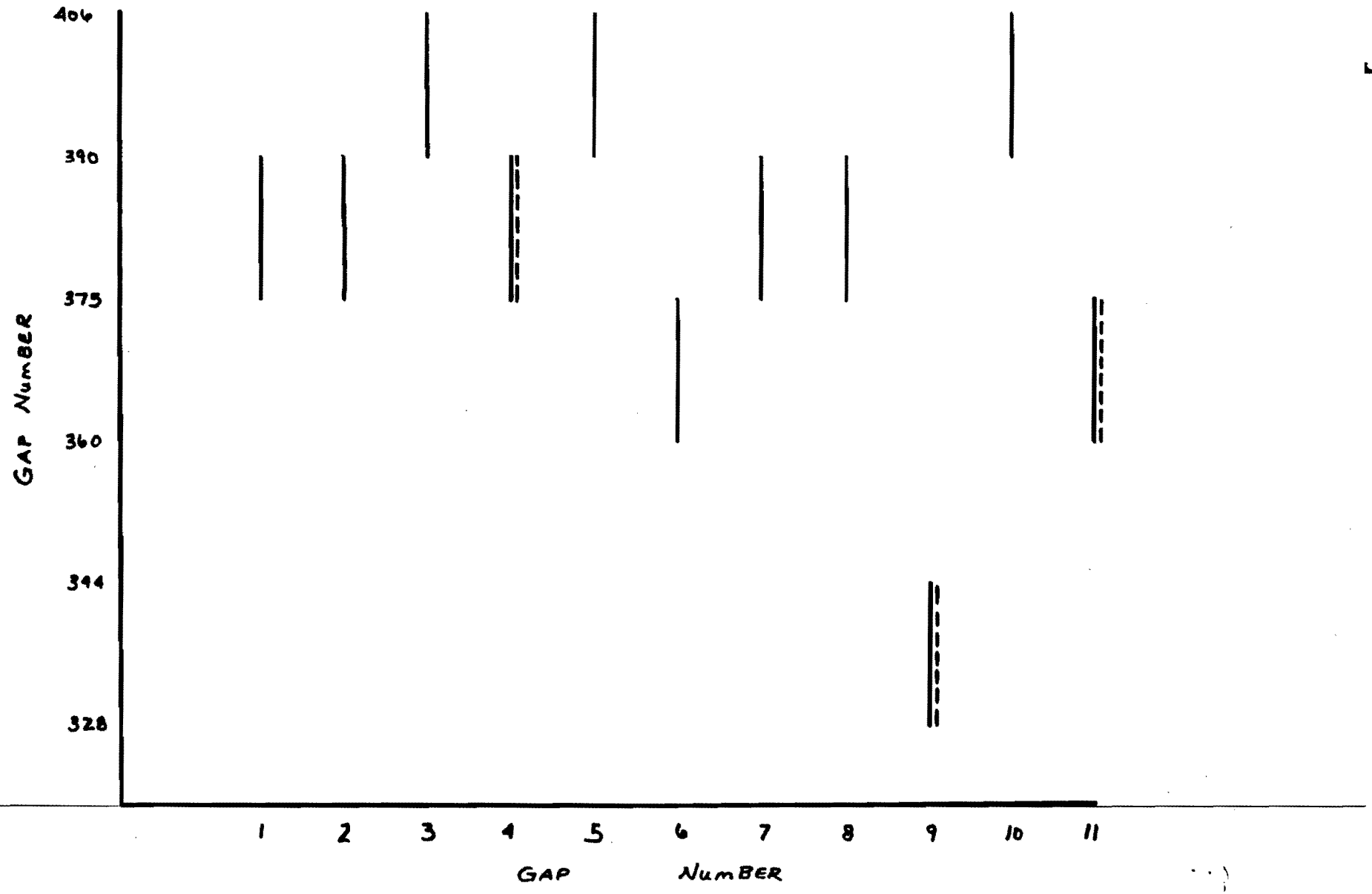
---- INDICATES CHANGE FROM GRAPH NUMBER ONE



GRAPH # 3

20 PSI

INDICATES CHANGE FROM GRAPH NUMBER ONE



Date 11/18/88
INSP by M. Zila

Fermi Number F-337

Rockwell Number 403337-14

Plate 1

		Front Thickness	Front Contour	Back Contour	Surface Zero
A	24.003				
B	24.001				
C	24.016				
D	24.012				
E	33.926				
F	33.956				
1	.157	.157	.162	.170	-0-
2	.157	157	.157	.179	
3	.157	.157	.157	.174	
4	.158	.157	.160	.169	
5	.157	.159	.178	.157	
6	.157	.156	.166	.157	
7		.159	.159	.164	
8		.159	.163	.159	
9		.159	157	.164	
10	.160	.160	.161	.162	
11	.156	.157	.161	.160	
12		.159	156	.164	
13		.160	.162	157	
14		.160	.158	.161	
15	.161	.162	.162	.161	
16	.156	.156	.160	.156	
17		.158	.157	.159	
18		.160	.159	.158	
19		.160	.158	.161	
20	.162	.161	.166	.159	
21	.157	.157	.158	.161	
22	.158	.159	.158	.166	
23	.159	.159	.159	.164	
24	.159	.159	.159	.164	
25	.161	.159	.168	.161	

Φ=.160

.021 .023

Date 1/15/03
Insp by M. Fila

Fermi Number F-341

PLATE —

Rockwell Number 403337-18

A	24.002
B	24.012
C	24.014
D	24.017
E	33.954
F	33.956

		Front Thickness	Front Contour	Back Contour	Surface Zero
1	.162	.161	.178	.165	
2	.162	.162	.162	.170	
3	.162	.161	.162	.175	
4	.163	.162	.163	.172	
5	.162	.161	.168	.162	
6	.160	.158	.160	.180	
7		.159	.159	.180	
8		.160	.160	.180	
9		.159	.158	.179	
10	.159	.159	.159	.175	
11	.160	.158	.162	.187	
12		.160	.179	.178	
13		.161	.182	.163	
14		.159	.173	.167	
15	.160	.158	.161	.174	
16	159	.158	.159	203	
17		.159	.173	.175	
18		.160	.175	.164	
19		.159	.168	.165	
20	.160	.160	.160	.173	
21	.158	.157	.160	.211	
22	.159	.158	.170	.179	
23	.159	.157	.170	.162	
24	.159	.158	.162	.162	
25	.159	.157	.159	.164	

D=160

.049

Date 11/15/85
Insp by M. Fila

Fermi Number F-334

PLATE 2

Rockwell Number 403337-11

		Front Thickness	Front Contour	Back Contour	Surface Zero
A	24.031				
B	24.003				
C	24.011				
D	24.012				
E	33.969				
F	33.942				
1	.154	.156	.164	.158	4.317
2	.154	.155	.157	.156	
3	.154	.154	.157	.155	
4	.153	.154	.171	.156	
5	.154	.154	.205	.152	
6	.153	.156	.156	.157	
7		.155	.154	.160	
8		.154	.153	.153	
9		.156	.158	.154	
10	.154	.157	.191	.153	
11	.153	.153	.154	.159	
12		154	.159	~~.153~~ .167	
13		.154	.155	.166	
14		.155	.157	.165	
15	.155	.157	.184	.157	
16	.153	.154	.154	.162	
17		.154	.155	.172	
18		.155	.151	.171	
19		.155	.157	.169	
20	.154	.155	.190	.159	
21	.152	.152	.165	.156	
22	.153	.151	.156	.156	
23	.152	.151	.157	.157	
24	.152	.152	.162	.154	
25	.152	.153	.189	.154	
		.004	.034	.020	

Date 11/15/85
INSP by M. Nolan

Fermi
Number

PLATE 4

Rockwell
Number

F-280

403332-14

A	24.004				
B	23.989				
C	24.002				
D	24.012				
E	33.951				
F	33.934	Front Thickness	Front Contour	Back Contour	Surface Zero
1	.153	.148	.180	.155	-0-
2	.154	.148	.168	.166	
3	.154	.148	.159	.170	
4	.154	.148	.167	.159	
5	.155	.147	.167	.156	
6	.155	.148	.159	.163	
7		.149	.156	.176	
8		.150	.158	.177	
9		.151	.162	.164	
10	.157	.150	.159	.176	
11	.156	.148	.157	.180	
12		.149	.159	.155	
13		.149	.170	.155	
14		.152	.176	.157	
15	.157	.151	.156	.157	
16	.157	.151	.157	.158	
17		.149	.155	.158	
18		149	.166	.158	
19		.152	.174	.175	
20	.160	.153	.160	.170	
21	.157	.152	.164	.157	
22	.157	.152	.157	.174	
23	.157	.152	.158	.179	
24	.158	.153	.159	.178	
25	.158	.151	.162	.183	

P-155

.022

.023

Date
INSP by M. Pila

Fermi
Number
F-318

PLATE 5

Rockwell
Number
403336-11

A	24.028
B	24.019
C	24.006
D	23.994
E	33.938
F	33.971

		Front Thickness	Front Contour	Back Contour	Surface Zero
1	.158	.152	.158	.169	
2	.157	.152	.157	.164	
3	.157	.153	.161	.158	
4	.158	.153	.159	.158	
5	.158	.152	.158	.158	
6	.156	.152	.156	.173	
7		.153	.163	.160	
8		.153	.157	.162	
9		.153	.157	.163	
10	.157	.153	.159	.164	
11	.154	.149	.154	.168	
12		.149	.155	.164	
13		.149	.154	.167	
14		.151	.154	.167	
15	.154	.149	.154	.165	
16	.155	.149	.155	.176	
17		.151	.160	.158	
18		.149	.157	.151	
19		.151	.160	.162	
20	.156	.149	.158	.163	
21	.153	.148	.155	.175	
22	.153	.149	.163	.160	
23	.153	.147	.162	.156	
24	.154	.148	.159	.158	
25	.153	.149	.155	.162	

F-155

.019

Date 1/10/05
Insp by M. Shila

Fermi Number F-278

PLATE 6

Rockwell Number 403332-12

A	24.014					
B	24.006					
C	24.009					
D	24.021					
E	33.954					
F	33.955	Front Thickness	Front Contour	Back Contour	Surface Zero	
1	.159	.154	.158	.224	4.318	
2	.160	.155	.165	.208		
3	.160	.153	.165	.213		
4	.159	.152	.164	.242		
5	.159	.152	.160	.234		
6	.157	.150	.170	.230		
7		.150	.194	.227		
8		.150	.195	.226		
9		.151	.181	.242		
10	.156	.149	.171	.236		
11	.155	.151	.185	.175		
12		.153	.167	.166		
13		.152	.163	.157		
14		.151	.141	.162		
15	.156	.151	.170	.196		
16	.158	.151	.184	.187		
17		.152	.202	.191		
18		.152	.192	.181		
19		.151	.174	.179		
20	.156	.151	.159	.204		
21	.155	.149	.159	.220		
22	.156	.148	.160	.228		
23	.156	.149	.158	.226		
24	.156	.149	.157	.230		
25	.156	.148	.157	.251		

N=160

Date 11/18/85
Insp by M. Fila

Fermi Number F-277

PLATE 7

Rockwell Number 403332-11

A	24.016					
B	24.008					
C	24.012					
D	24.014					
E	33.967					
F	33.944	Front Thickness	Front Contour	Back Contour	Surface Zero	
1	154	.149	.180	.155	~~3.818~~	3.810
2	156	.150	.157	.166		
3	155	.149	.155	.167		
4	154	.149	.155	.164		
5	154	.148	.160	.158		
6	156	.152	.161	.161		
7		.151	.156	.159		
8		.150	.161	.162		
9		.150	.163	.168		
10	155	.149	.155	.168		
11	155	.150	.156	.168		
12		.152	.167	.156		
13		.150	.181	.152		
14		.149	.186	.162		
15	155	.149	.156	.170		
16	155	.149	.155	.174		
17		.152	.171	.160		
18		.151	.183	.160		
19		.150	.183	.166		
20	156	.149	.165	.177		
21	160	.155	.159	.202		
22	161	.155	.163	.195		
23	161	.155	.167	.189		
24	161	.155	.161	.192		
25	158	.153	.158	.195		

D = 155

.021 (.022)

Date 11/10/05
Insp by M. Sula

Fermi Number F-321

PLATE 9

Rockwell Number 403336-14

A	23.998
B	24.023
C	24.027
D	24.000
E	33963
F	33951

		Front Thickness	Front Contour	Back Contour	Surface Zero
1	146	.146	.150	.182	3.812
2	147	.149	.146	.160	
3	146	.148	.146	.153	
4	147	.149	.154	.152	
5	151	.153	.151	.149	
6	148	.151	.160	.177	
7		.152	.158	.152	
8		.150	.153	.162	
9		.152	.181	.150	
10	152	.154	.174	.176	
11	147	.149	.161	.169	
12		.150	.150	.158	
13		.149	.146	.182	
14		.151	.177	.162	
15	152	.153	.186	.170	
16	148	.151	.160	.161	
17		.152	.153	.154	
18		.150	.146	.180	
19		.152	.174	.160	
20	152	.152	.174	.164	
21	148	.149	.164	.155	
22	149	.150	.155	.152	
23	147	.149	.153	.164	
24	149	.152	.175	.154	
25	153	.153	.180	.196	

D=150

.040 .032

Date 11/18/85
INSP by M. Tila

Fermi Number

PLATE 4

Rockwell Number

F-320

403336-13

A	24.029
B	24.028
C	23.963
D	23.942
E	33924
F	33.927

		Front Thickness	Front Contour	Back Contour	Surface Zero
1	147	.149	.175	.150	3.812
2	148	.150	.148	.171	
3	148	.150	.148	.164	
4	148	.152	.158	.162	
5	146	.155	.205	.147	
6	148	.151	.175	.151	
7		.152	.159	.165	
8		.152	.161	.149	
9		.152	.165	.151	
10	147	.151	.204	.150	
11	148	.151	.170	.148	
12		.154	.154	.171	
13		.152	.154	.158	
14		.151	.159	.154	
15	N7	.149	.210	.140	
16	148	.150	.165	.150	
17		.152	.147	.174	
18		.152	.147	.166	
19		.150	.155	.162	
20	147	.149	.208	.150	
21	152	.154	.173	.149	
22	153	.154	.154	.162	
23	153	.155	.160	.156	
24	152	.154	.169	.161	
25	151	.153	.209	.152	

D-151 .062 .021

Date 11/18/85
INSP by M. Sula

Fermi Number F-319

PLATE ID

Rockwell Number 403336-12

A	24.003
B	24.024
C	23.994
D	24.006
E	33.937
F	33.959

		Front Thickness	Front Contour	Back Contour	Surface Zero
1	153	.155	.177	.163	3.812
2	154	.155	.158	.165	
3	152	.155	.150	.175	
4	153	.156	.174	.165	
5	158	.160	.202	.155	
6	154	.156	.181	.160	
7		.158	.168	.164	
8		.157	.155	.189	
9		.159	.200	.165	
10	159	.160	.234	.156	
11	153	.156	.181	.156	
12		.156	.168	.174	
13		.157	.152	.204	
14		.158	.206	.169	
15	159	.161	.262	.153	
16	153	.155	.171	.155	
17		~~.156~~ .155	.163	.173	
18		.156	.152	.198	
19		.159	.205	.168	
20	158	.159	.261	.154	
21	154	.155	.162	.155	
22	155	.156	.154	.173	
23	155	.158	.156	.181	
24	155	.157	.191	.168	
25	158	.158	.244	.156	
	D=.155		.112	.051	

Date 11/18/85
Insp by M. Jirka

WARPED

PLATE 11

Fermi Number F.335

Rockwell Number 4033337-12 (1)

A	24.014
B	23.994
C	24.011
D	24.007
E	33.951
F	33.949

		Front Thickness	Front Contour	Back Contour	Surface Zero
1	.161	.168	.165	218	-0-
2	.161	.167	.168	.209	
3	.161	.167	.164	.209	
4	.160	.167	.182	.214	
5	.160	.166	.162	.266	
6	.161	.168	.183	.186	
7		.168	191	.165	
8		.169	.179	.181	
9		.166	.214	.166	
10	.160	.167	.175	.234	
11	.162	.169	.176	.168	
12		.169	.184	.161	
13		.169	.175	.174	
14		.166	.206	.158	
15	.160	.168	.172	.214	
16	.162	.169	.176	.162	
17		.169	.171	.168	
18		.168	.166	.172	
19		.166	.183	.161	
20	.159	.166	.176	.186	
21	.161	.166	.171	.168	
22	.160	.166	.160	.181	
23	.160	.166	.160	.175	
24	.158	.164	.165	.165	
25	.158	.163	.182	.161	

Φ=100

.051

.073

Date 11/18/85
INSP by [illegible]

WARPED

PLATE 12

Fermi Number F-285

Rockwell Number 3

403334 03

A	24.009
B	24.017
C	24.029
D	23.989
E	33.957
F	33.961

		Front Thickness	Front Contour	Back Contour	Surface Zero
1	.156	.159	.162	.299	
2	.157	.158	.204	.214	
3	.156	.158	.213	.178	
4	.156	.156	.193	.192	
5	.155	.158	.161	.235	
6	.156	.157	.159	.314	
7		.156	.228	.206	
8		.156	.244	.171	
9		.158	.212	.193	
10	.155	.157	.160	.261	
11	.156	.157	.162	.311	
12		.157	.239	.206	
13		.158	.249	.184	
14		.158	.211	.203	
15	.156	.158	.176	.238	
16	.156	.157	.162	.321	
17		.157	.243	.210	
18		.156	.262	.171	
19		.158	.218	.201	
20	.156	.157	.161	.259	
21	.155	.156	.159	.344	
22	.156	.157	.222	.238	
23	.157	.158	.248	.187	
24	.157	.158	.204	.214	
25	.156	.159	.161	.268	

Φ-155

.210

.173

Date 11/18/85
INSP by M. Irla

Fermi Number F-298

EXTRA PLATE

Rockwell Number 403335-05

A	24.008
B	24.019
C	24.010
D	24.004
E	33.963
F	33.947

		Front Thickness	Front Contour	Back Contour	Surface Zero
1	160	.168	.160	.194	3.812
2	162	.170	.161	.179	
3	159	.165	.163	.161	
4	159	.164	.158	.166	
5	161	.167	.163	.167	
6	.159	.166	.162	.187	
7		.168	.175	.170	
8		.166	.162	.170	
9		.165	.168	.162	
10	160	.169	.164	.182	
11	.159	.166	.166	.168	
12		.171	.184	.159	
13		.168	.167	.168	
14		.165	.175	.163	
15	.160	.169	.171	.188	
16	.159	.166	.165	.165	
17		.167	.180	.159	
18		.166	.161	.172	
19		.164	.169	.168	
20	.161	.168	.162	.197	
21	.159	.168	.159	.160	
22	.161	.169	.167	.164	
23	.159	.167	.159	.173	
24	.158	.164	.159	.181	
25	159	.167	.161	.206	

.021 .040

PLATE #6
(F-278)

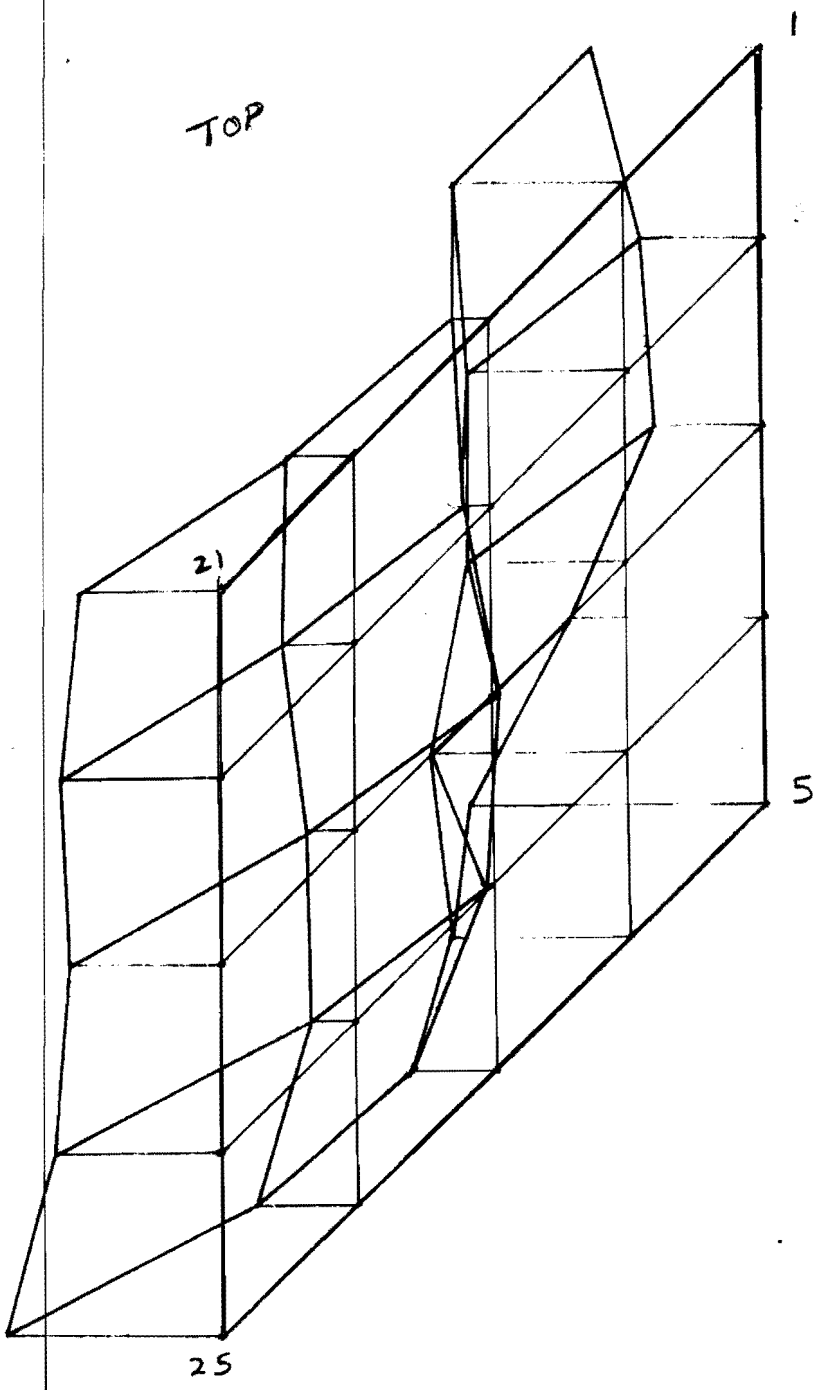
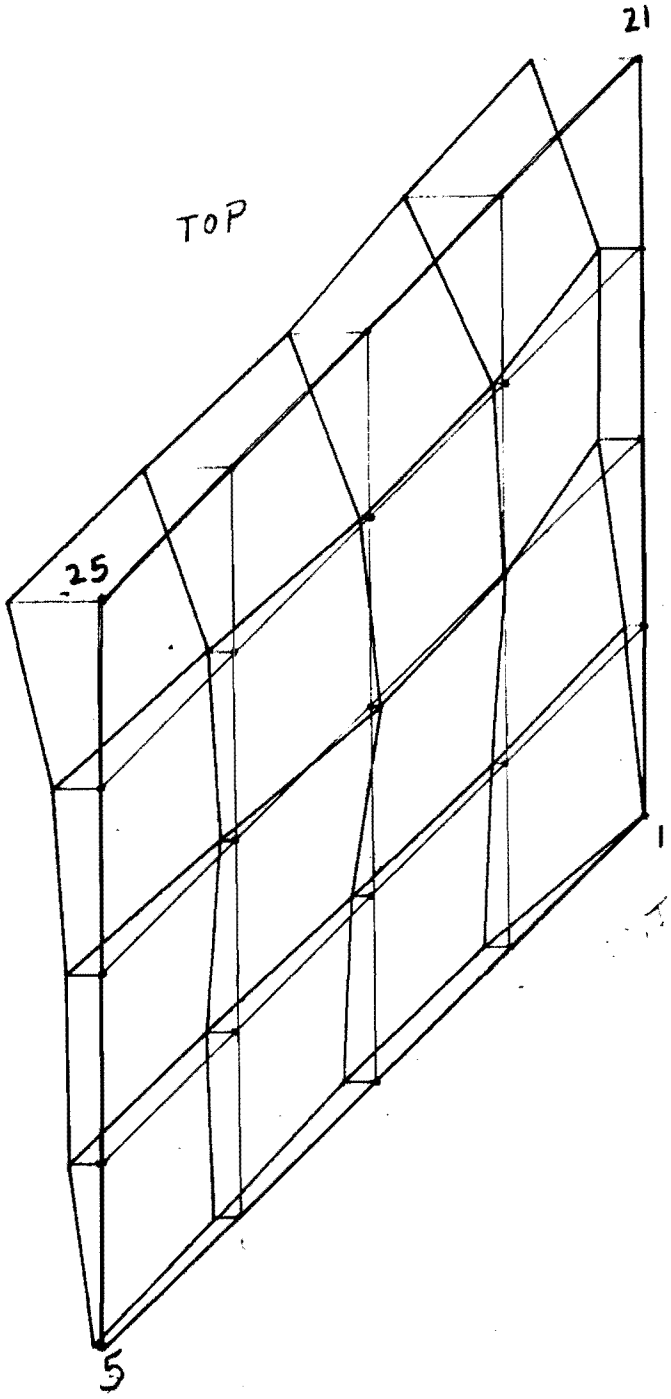


PLATE #7
(F-277)



→N

PLATE # 8
(F-321)

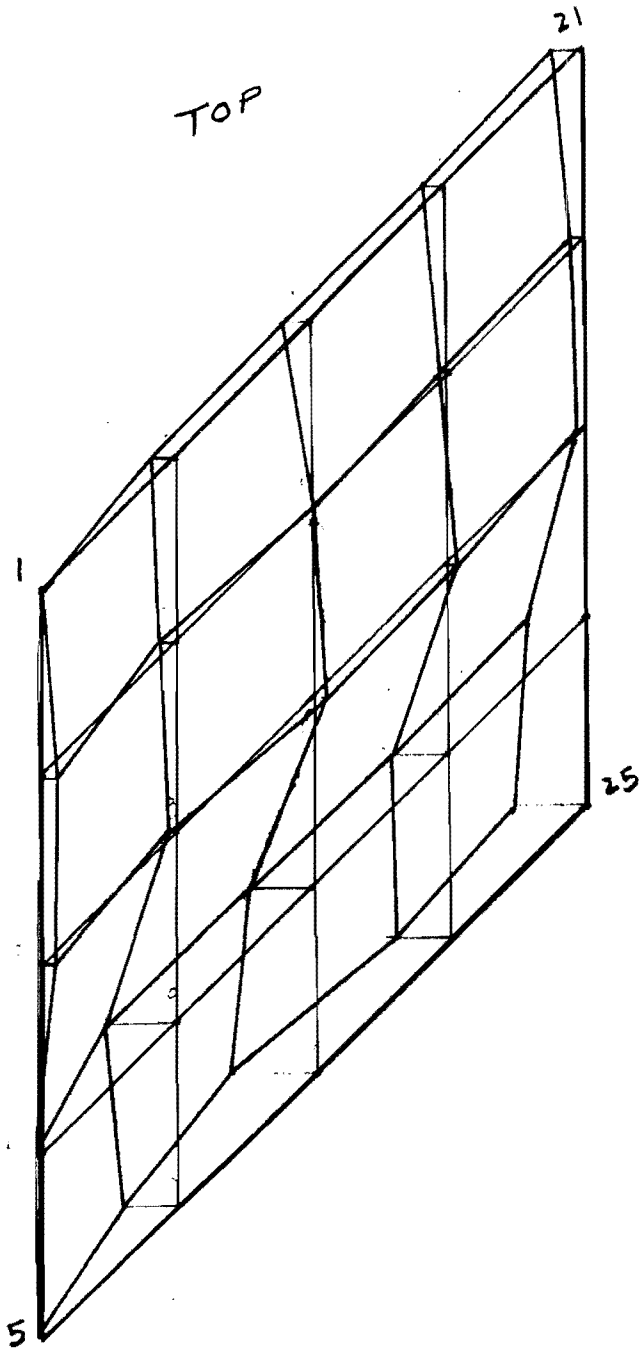


PLATE # 9
(F-320)

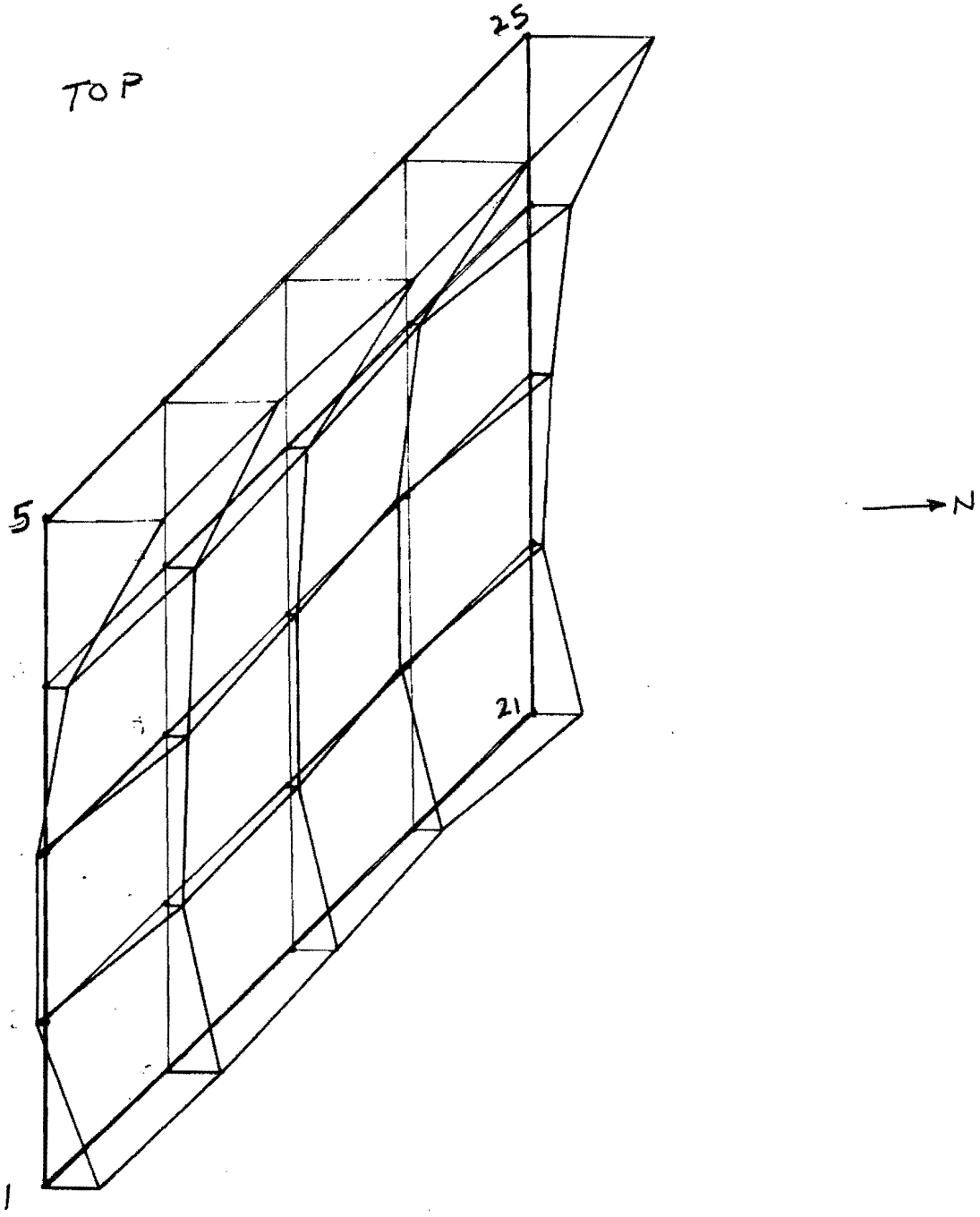


PLATE #10
(F-319)

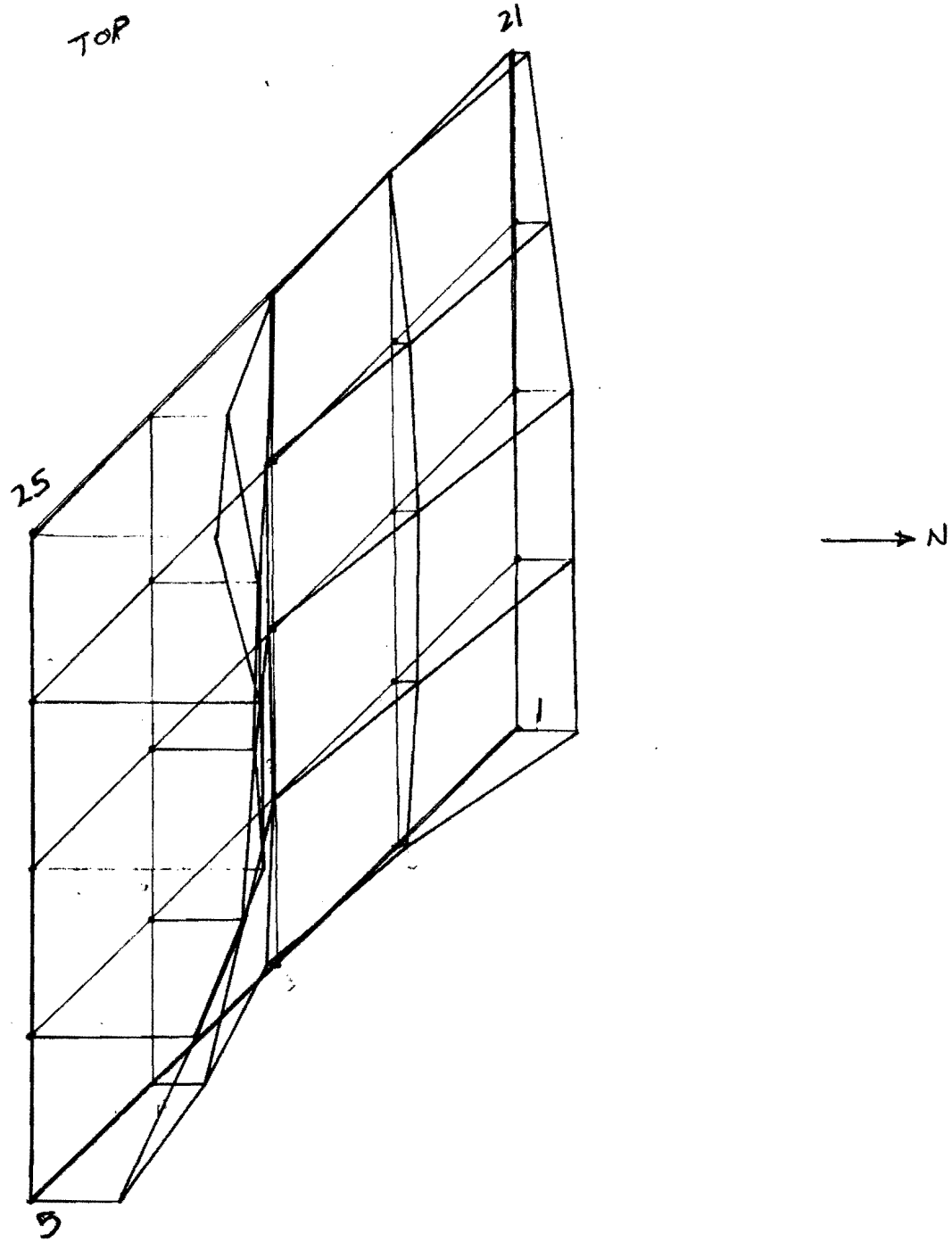
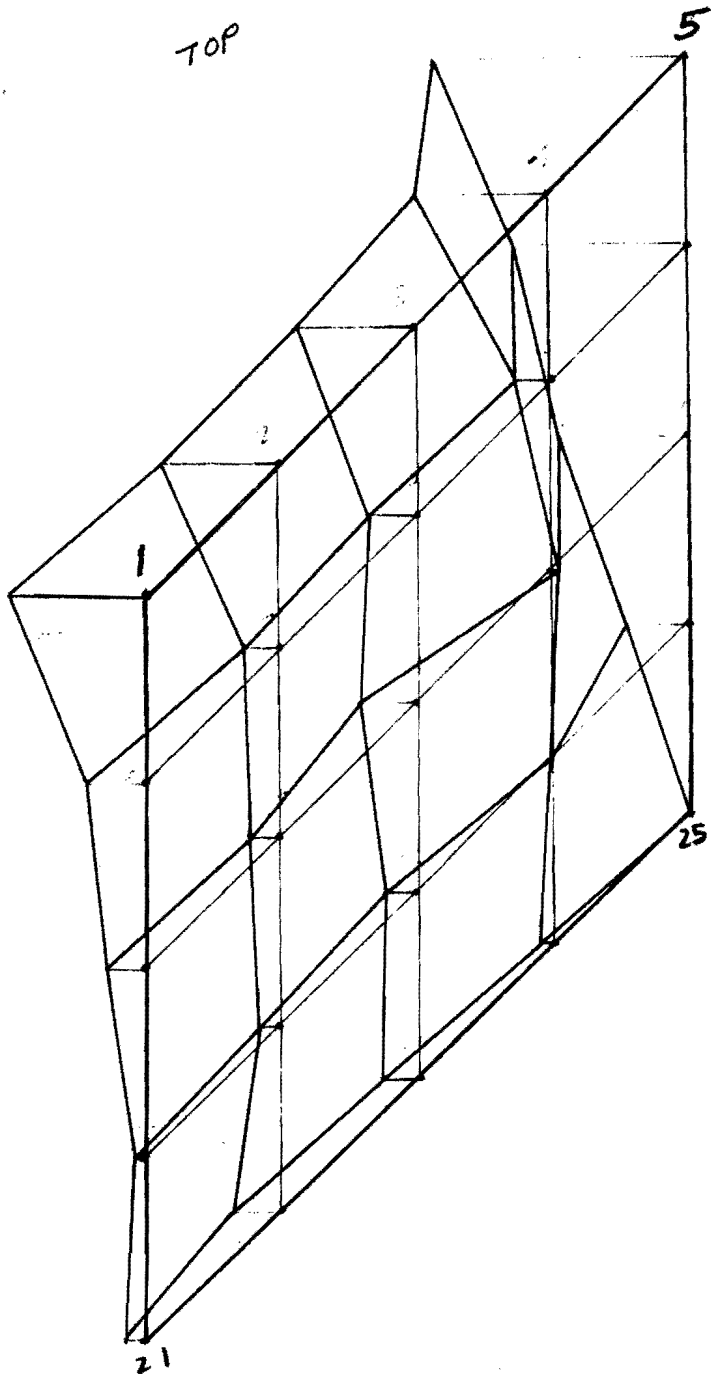
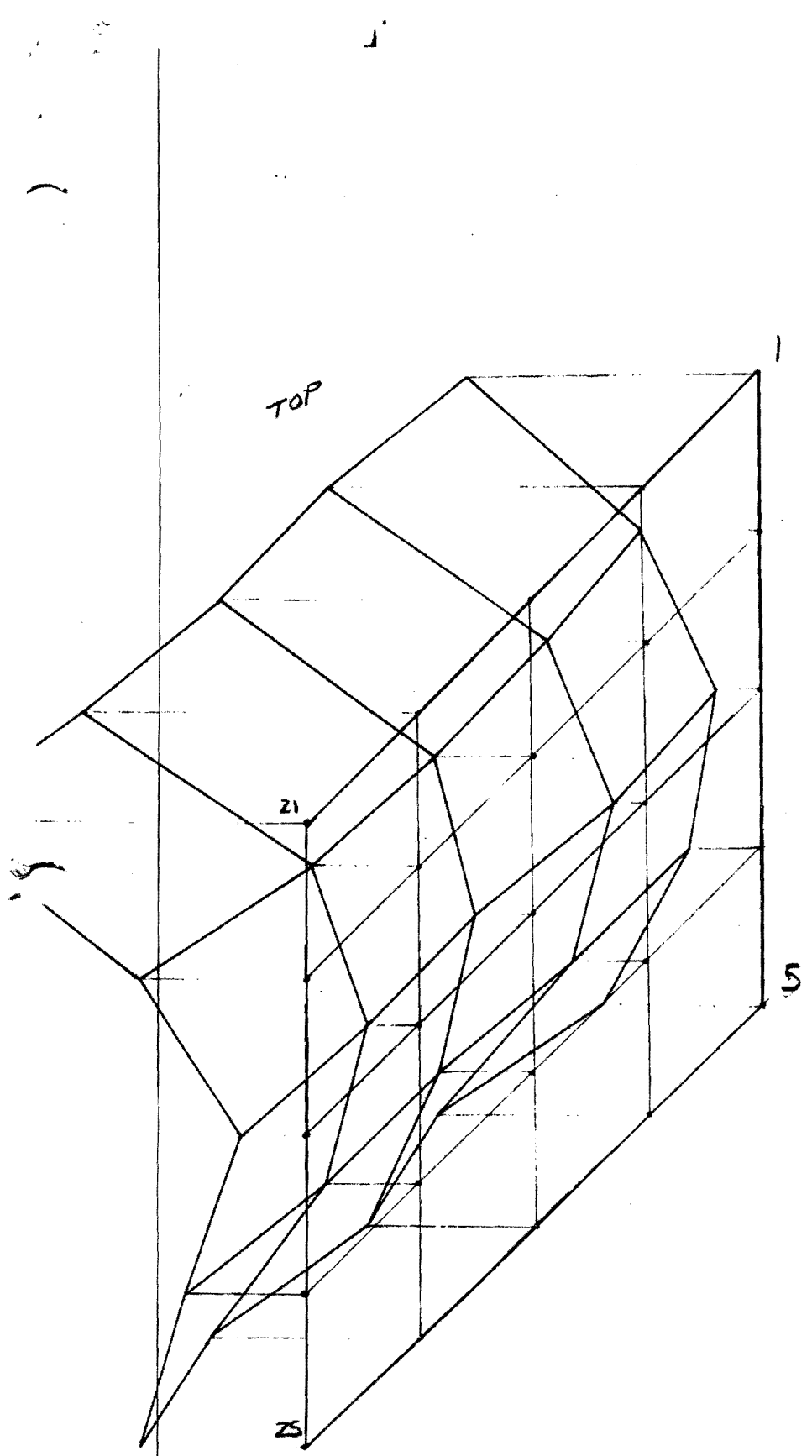


PLATE # 11
(F-335)




TOP
1
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Z1
5
Z5

3740.000-EN-33
34
35