11-17-73

METROPOLITAN EDISON COMPANY

THREE MILE ISLAND NUCLEAR STATION

UNIT NO. 1

REACTOR BUILDING RING GIRDER

SURVEILLANCE REPORT

RETURN TO REGULATORY CENTRAL FILES
ROOM 016

November, 1973

TABLE OF CONTENTS

1.0 SUMMARY AND CONCLUSIONS

Observations for concrete cracking in the designated surveillance areas have shown all cracks to be less than 0.005 inches in width. The cracks are typical for shrinkage cracking in mass concrete as found in the Reactor Containment Building and are acceptable. Data and observations on cracking are contained in Attachment 2.

Strains recorded by the strain gages on pre-selected bars are shown in Tables I, II, III, and IV of Attachment 2. The strains have been converted to stresses which are indicated on Attachment 1. The bar stresses are low and all are acceptable.

It is concluded that the ring girder is fulfilling its function as intended by the original design.

REACTOR BUILDING

RING GIRDER REINFORCING BAR STRESSES

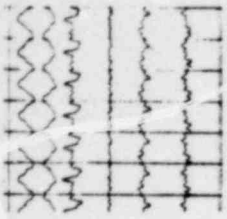
STRAIN GAGE LOCATION	DATE ELEVATION	DATE AZIMUTH	DURING PRESTRESS: FULL VERTICAL	DURING PRESTRESS: VERTICAL PLUS FULL DOME	DURING PRESTRESS: COLUMN 1 FULL PRESTRESS	AFTER ACCEPTANCE TEST: COLUMN 2 6 MONTH	COLUMN 3 DEVIATION COL 2 - COL 1	COLUMN 4 12 MONTH	COLUMN 5 DEVIATION COL 4 - COL 1	COLUMN 6 24 MONTH	COLUMN 7 DEVIATION COL 6 - COL 1	COLUMN 8 36 MONTH	COLUMN 9 DEVIATION COL 8 - COL 1
52 HOOP	435'	108°	0.9	-0.5	4.2								
52 VERT	435'	108°	6.2	3.8	1.5								
53 HOOP	435	245°	0.5	0.6	4.7								
53 VERT	435'	245°	5.7	3.3	0.8								
54 HOOP	435	352°	1.3	-0.3	5.7								
54 VERT	435	352°	7.3	10.6	17.3								
55 HOOP	440	108°	-0.1	1.1	3.2								
55 VERT	440	108°	1.0	0	-0.6								
56 HOOP	440	245°	-0.1	1.0	4.0								
56 VERT	440	245°	0.5	-0.5	-5.1								
57 HOOP	440	352°	1.4	-1.4	3.9								
57 VERT	440	352°	-	-	-								
58 HOOP	446	108°	-	-	-								
58 VERT	446	108°	3.8	4.8	4.7								
59 HOOP	446	245°	0.4	2.6	4.4								
59 VERT	446	245°	-0.8	2.5	1.9								
60 HOOP	446	352°	-0.4	1.9	4.4								
60 VERT	446	352°	4.2	5.4	5.1								
129 HOOP	446	80°	-	-	-								
129 VERT	446	80°	1.2	2.7	3.8								
130 HOOP	446	320°	0.1	2.3	5.0								
130 VERT	446	320°	0.3	2.7	3.0								
61 HOOP	452'	108°	0	2.3	2.6								
61 VERT	452'	108°	1.6	1.4	1.9								
62 HOOP	452'	245°	0.1	1.9	-								
62 VERT	452'	245°	4.2	3.6	3.7								
63 HOOP	452'	352°	0	2.3	2.8								
63 VERT	452	352°	2.3	2.5	3.1								

SPECIAL NOTES,

1. Complete information on strain gage readings is given in Tables I, II, III, and IV of Attachment 2.
2. Conversion of strain to stress assumes E steel = 29,000,000.

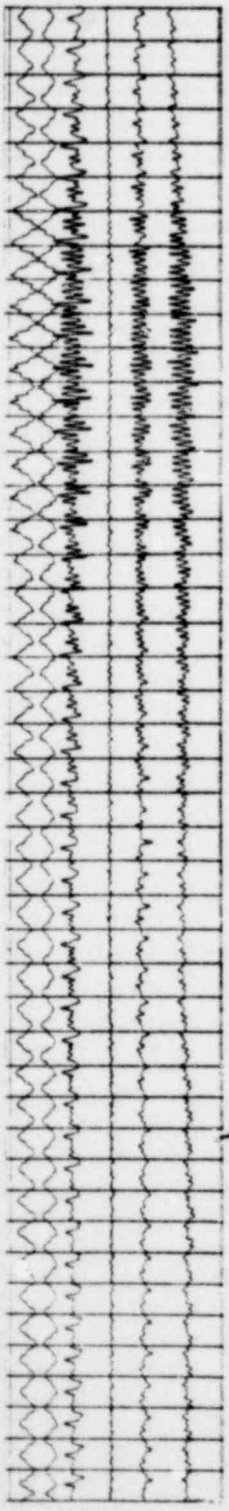
RING GIRDER
SURVEILLANCE
THREE MILE ISLAND NUCLEAR STATION UNIT 1

ATTACHMENT 1



BREWER ENGINEERING LABORATORIES, INCORPORATED

TELEPHONE 617-748-0103
MARION, MASSACHUSETTS
02738



THREE MILE ISLAND NUCLEAR STATION

UNIT 1

RING GIRDER SURVEILLANCE

Written By

Knut Michael Bogh-Henrikssen

Approved By

LaVerne F. Wallace

October 5, 1973

BREWER ENGINEERING LABORATORIES, INCORPORATED

- TABLE OF CONTENTS -

- TABLE OF CONTENTS -

1.0 INTRODUCTION.

1.1 General.

1.1.1 On May 8, 1973, Brewer Engineering Laboratories, Inc., was requested to conduct a long-term (approximately 3½ years) surveillance of the ring girder on Unit 1 of the Three Mile Island Nuclear Power Station in Middletown, Pennsylvania.

1.1.2 This surveillance was to encompass visual inspection of crack patterns, as well as reinforcing bar strain readings.

1.2 Objective.

1.2.1 The objective of this surveillance was to determine the effects of the prestress and the stability of the containment with time.

1.2.2 This was accomplished by taking eight separate sets of readings over the 3½-year period.

2.0 PROCEDURE.

2.1 General.

2.1.1 The surveillance consisted of two phases; one visual and one electrical. The visual phase consisted of crack pattern charting at four selected whitewash areas; and the electrical phase of strain measurements at fourteen locations on both hoop and meridional reinforcing bars. Figure 1 shows the area in detail.

2.1.2 The two phases are being carried out at the following designated reading times:

a. Prior to prestress.

b. After full vertical prestress.

c. After full vertical plus full dome prestress.

d. After full prestress.

e. Six (6) months after acceptance.

f. Twelve (12) months after acceptance.

g. Twenty-four (24) months after acceptance.

h. Thirty-six (36) months after acceptance.

2.1.3 This report is issued after the fourth set of readings and

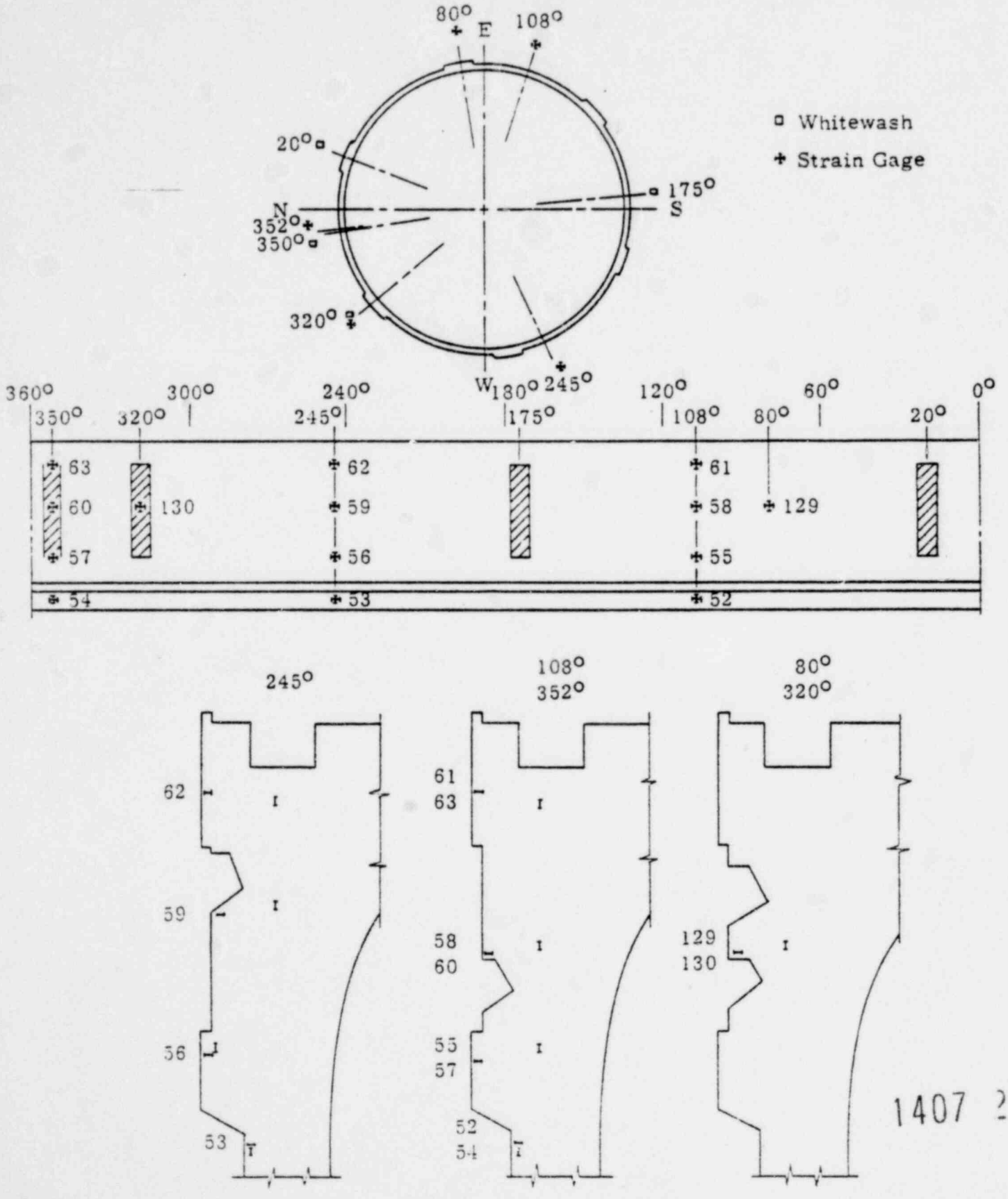


FIGURE 1. RING GIRDER DIAGRAM.

1407 213

will be updated by formal addenda following each of the last four reading times.

2.2 Crack Patterns.

2.2.1 Four 6-foot by 12-foot areas were selected:[1] Three in the north sector and one in the south. The areas run between Elevations 451' and 439' and are centered on Azimuth 20°, 175°, 32[illegible]°, and 350° (see Figures 2 through 5).

2.2.2 Prior to prestressing, all cracks in the four areas were charted, and confirming photographs were taken. Following this, the areas were whitewashed and at each successive reading period the cracks were charted again. This process was used in order to remove hairline surface cracks from the charts.

2.2.3 The detailed procedure for charting the crack patterns is:

a. Trace each crack on the containment with a felt-tip marker.

b. Measure crack width and label any over 0.005 inch.

(Text Continued on Page 9)

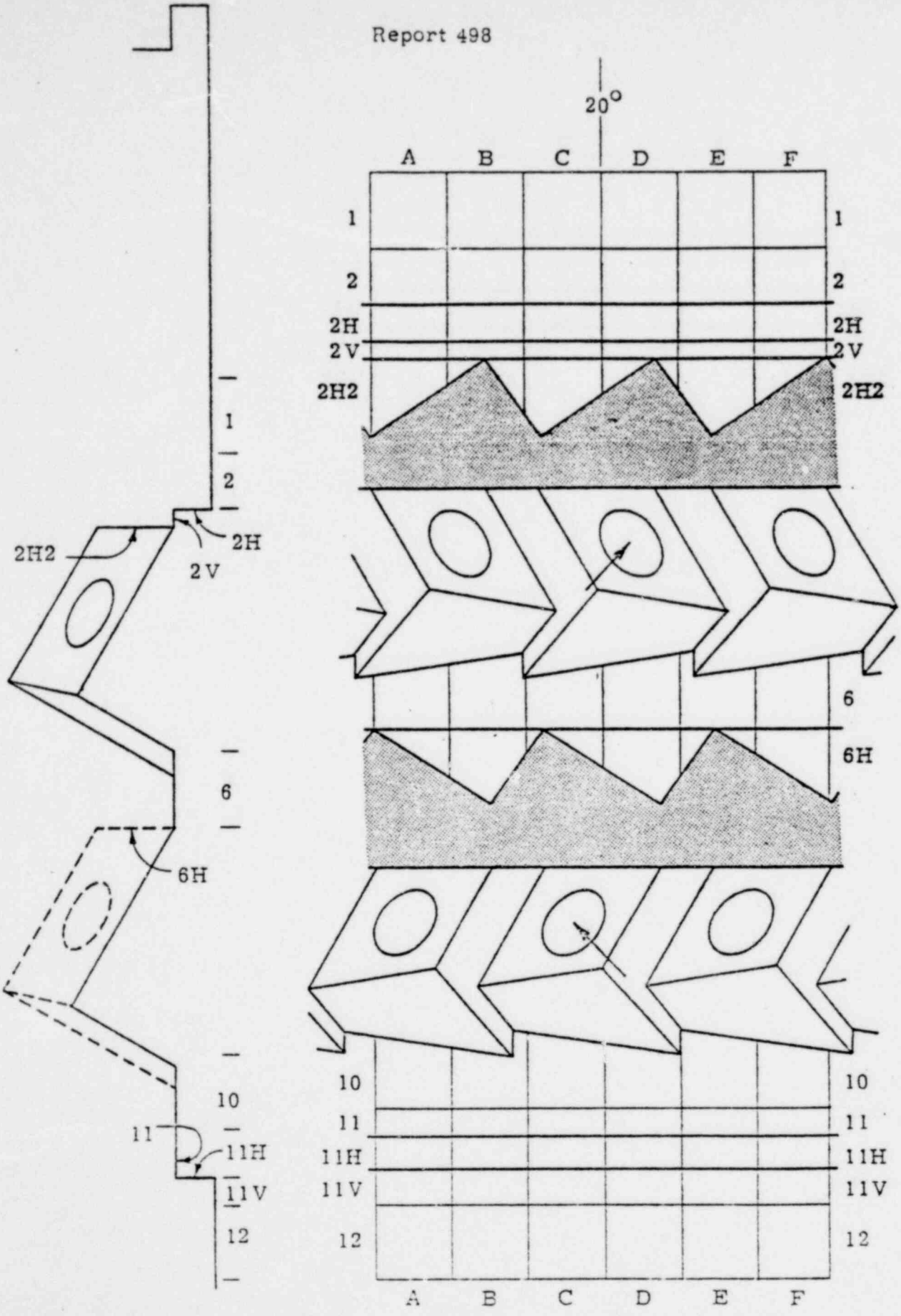


FIGURE 2. CRACK PATTERN AREA AT AZIMUTH 20°.

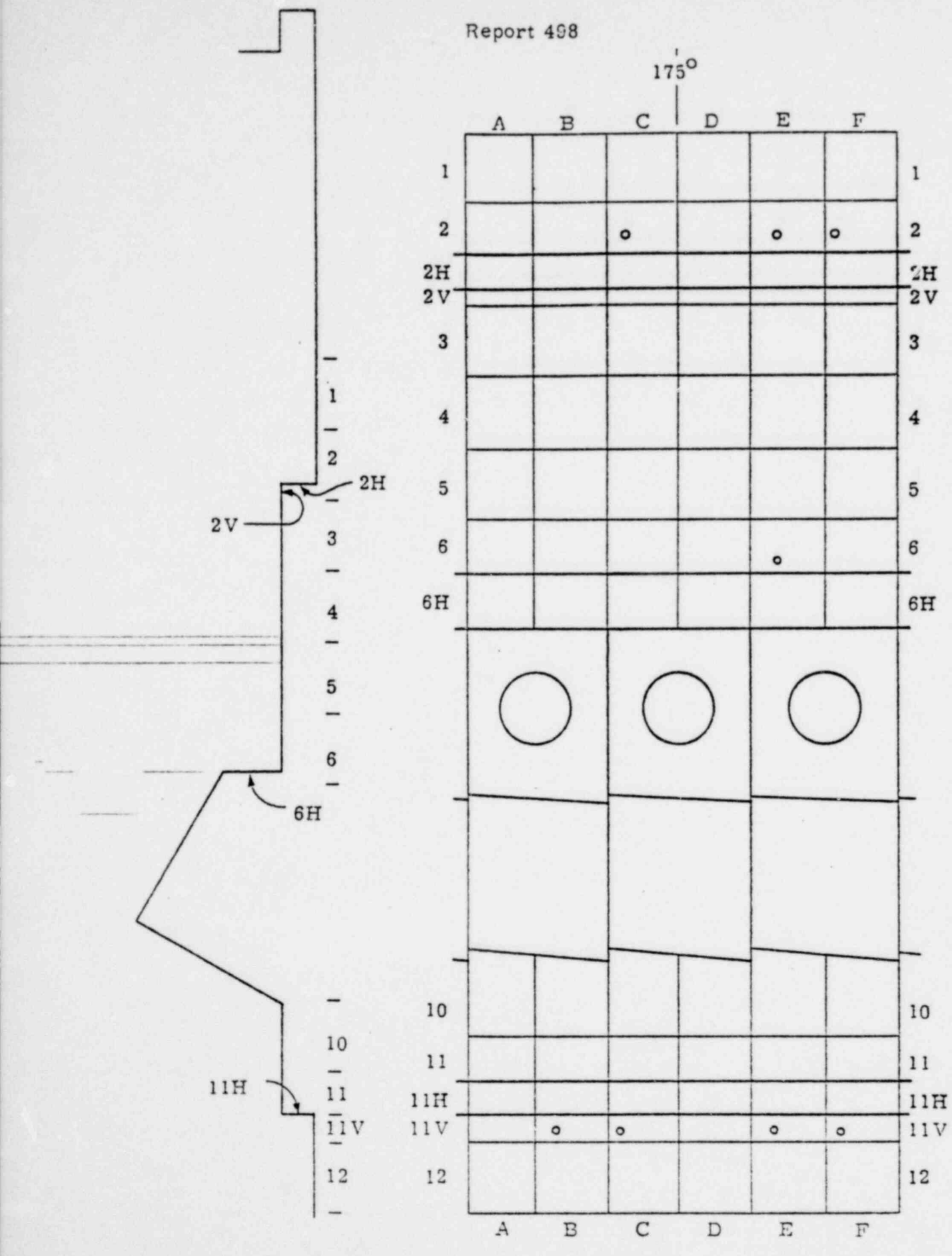


FIGURE 3. CRACK PATTERN AREA AT AZIMUTH 175°.

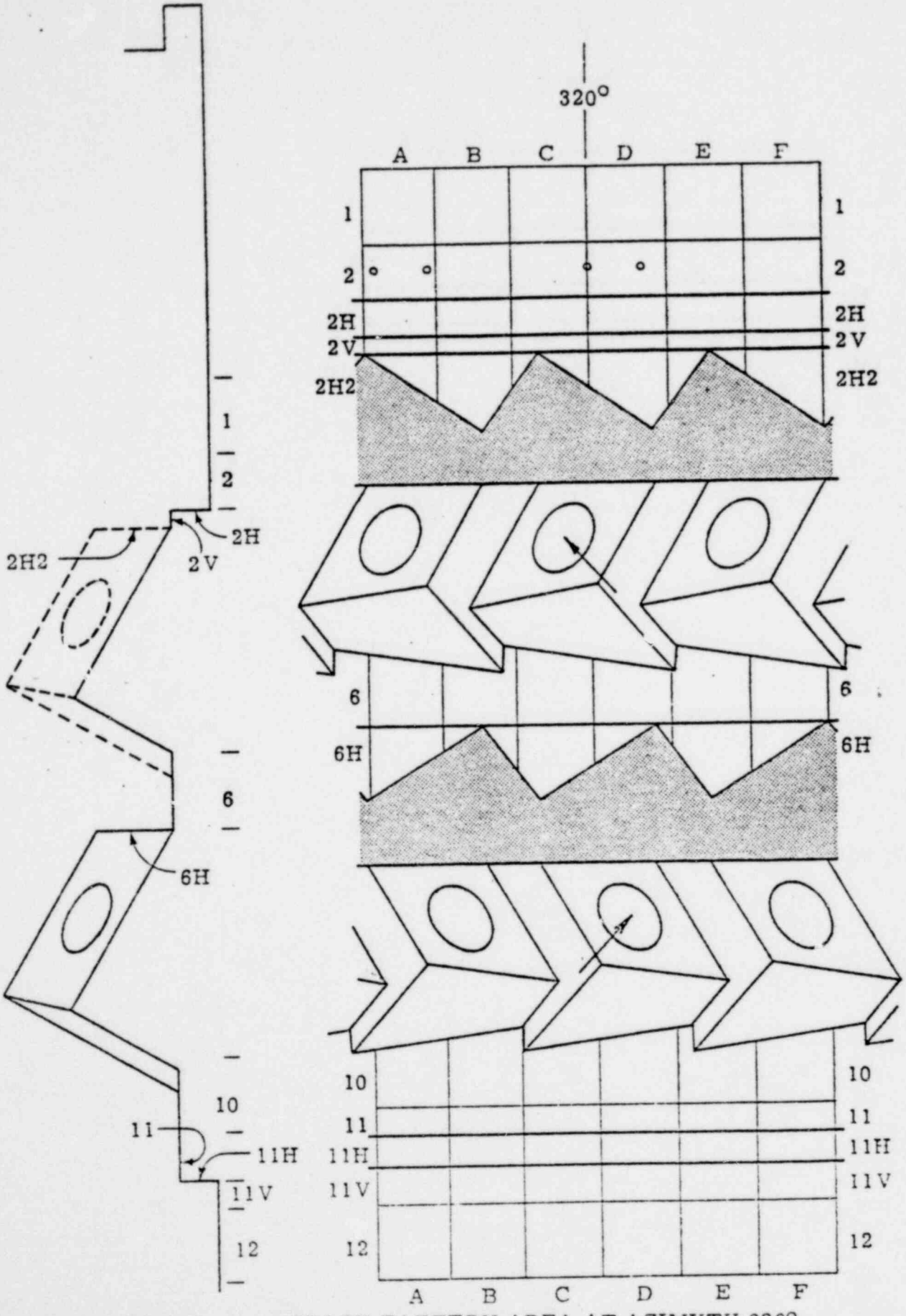


FIGURE 4. CRACK PATTERN AREA AT AZIMUTH 320°.

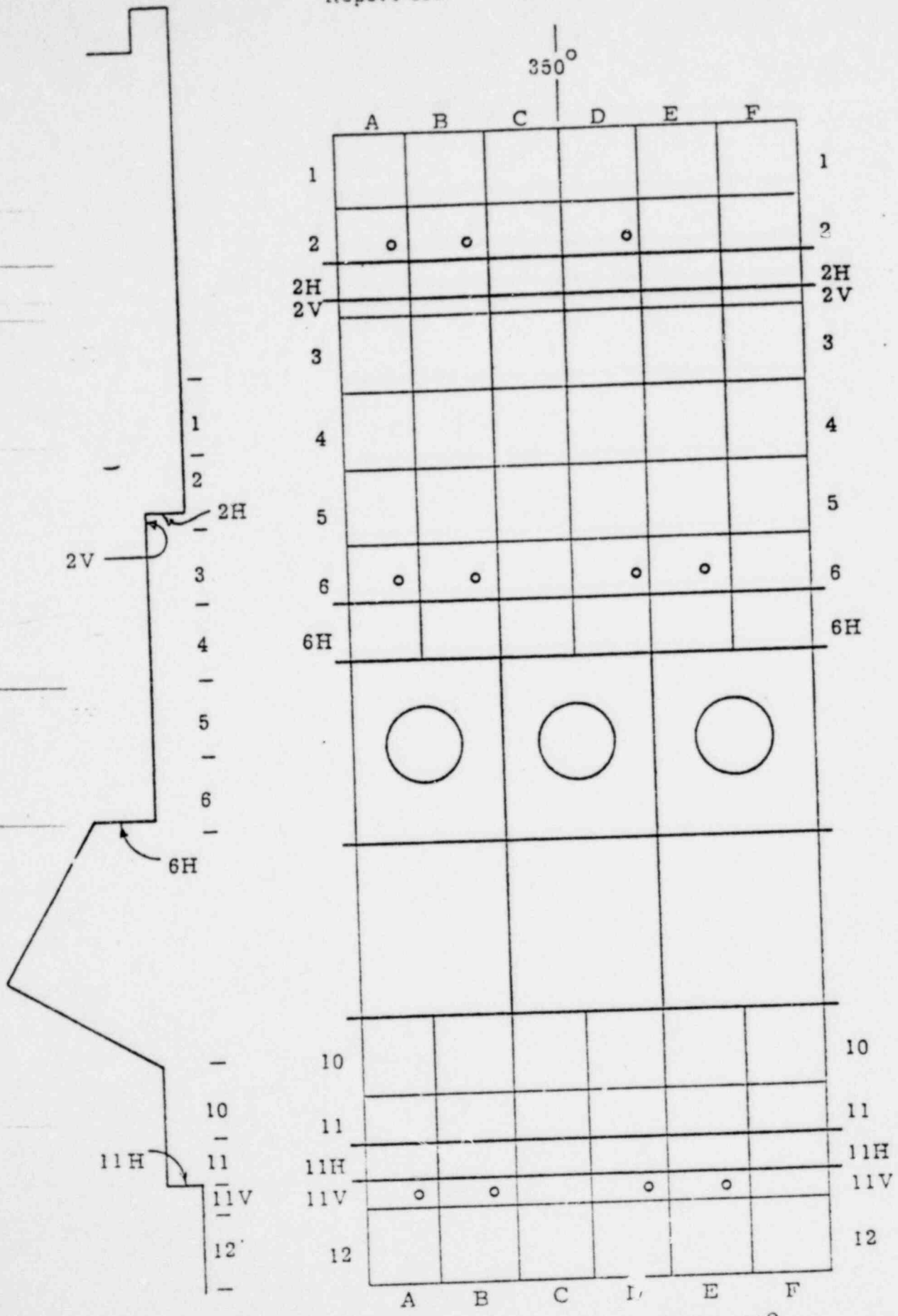


FIGURE 5. CRACK PATTERN AREA AT AZIMUTH 350°.

(Text Continued From Page 4)

c. Chart the cracks on the crack pattern area charts (see Figures 2 through 5).

d. Photograph the four areas.

2.3 Reinforcing Bar Strain Readings.

2.3.1 Gages from Locations 52 through 63, 129, and 130^2 were terminated in four pin connectors in electrical weather-resistant boxes. Available NEMA-4 boxes, inspected monthly and refilled as necessary with desiccant, were used initially and were replaced with a high-quality NEMA-4 box after the dome prestressing. These boxes were inspected at each successive reading and upgraded as necessary. The object of these boxes was to keep the connectors completely dry.

2.3.2 At the designated reading times, strain readings were taken, together with air and containment skin temperature external to the containment and the internal ambient temperature. These readings were recorded and the strain readings adjusted for the initial zero readings of the prior-to-prestress condition (see Figure 6).

2.3.3 The following equipment was used for these readings:

TABLE __

DATE: _____

CONDITION: _____

Strain Gage Location	Elevation (ft)	Azimuth (°)	Microstrain	Temperature (°F) Air	Skin	Time Day	Hour
52 Hoop	435	108					
52 Vert	435	108					
53 Hoop	435	245					
53 Vert	435	245					
54 Hoop	435	352					
54 Vert	435	352					
55 Hoop	440	108					
55 Vert	440	108					
56 Hoop	440	245					
56 Vert	440	245					
57 Hoop	440	352					
57 Vert	440	352					
129 Hoop	446	80					
129 Vert	446	80					
58 Hoop	446	108					
58 Vert	446	108					
59 Hoop	446	245					
59 Vert	446	245					
130 Hoop	446	320					
130 Vert	446	320					
60 Hoop	446	352					
60 Vert	446	352					
61 Hoop	452	108					
61 Vert	452	108					
62 Hoop	452	245					
62 Vert	452	245					
63 Hoop	452	352					
63 Vert	452	352					

Internal Temperature --

FIGURE 6. SAMPLE TABLE FOR STRAIN READINGS.

a. BLH Digital Strain Indicator, Model 1200.

b. Amprobe Fastemp Temperature Indicator, Model T151.

1407 221

3.0 RESULTS.

3.1 Prior to Prestress, May 15, 1973.

3.1.1 Between May 8 and 15, 1973, BEL personnel supervised the layout of the crack pattern areas and the termination of the reinforcing bar strain gage cables.

3.1.2 On May 15, 1973, the cracks were charted and the gage zero readings taken. These efforts are shown in Figures 7 through 10 and Table I.

3.2 After Vertical Prestress, June 6 and 7, 1973.

3.2.1 On June 6, 1973, BEL personnel charted crack patterns and commenced taking the gage readings. Inclement weather precluded finishing the gage readings in one day, and they were concluded on June 7, 1973. The results are shown in Figures 11 through 14 and Table II.

3.3 After Vertical and Dome Prestress, July 5, 1973.

3.3.1 On July 5, 1973, BEL personnel charted crack patterns and took the gage reading. The results are shown in Figures 15 through 18 and Table III.

1407 222

(Text Continued on Page 23)

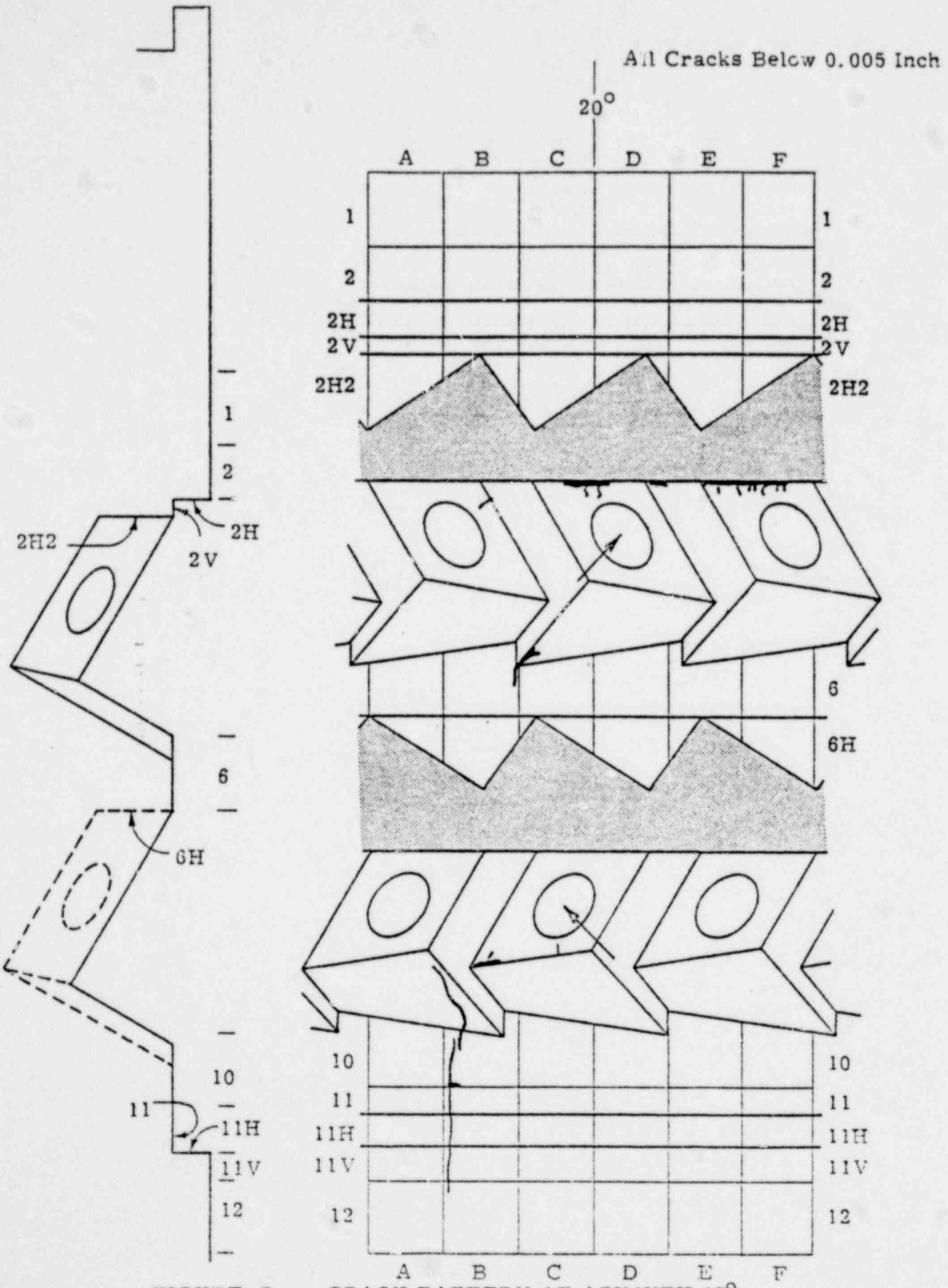


FIGURE 7. CRACK PATTERN AT AZIMUTH 20°
PRIOR TO PRESTRESS, 5-14-73.

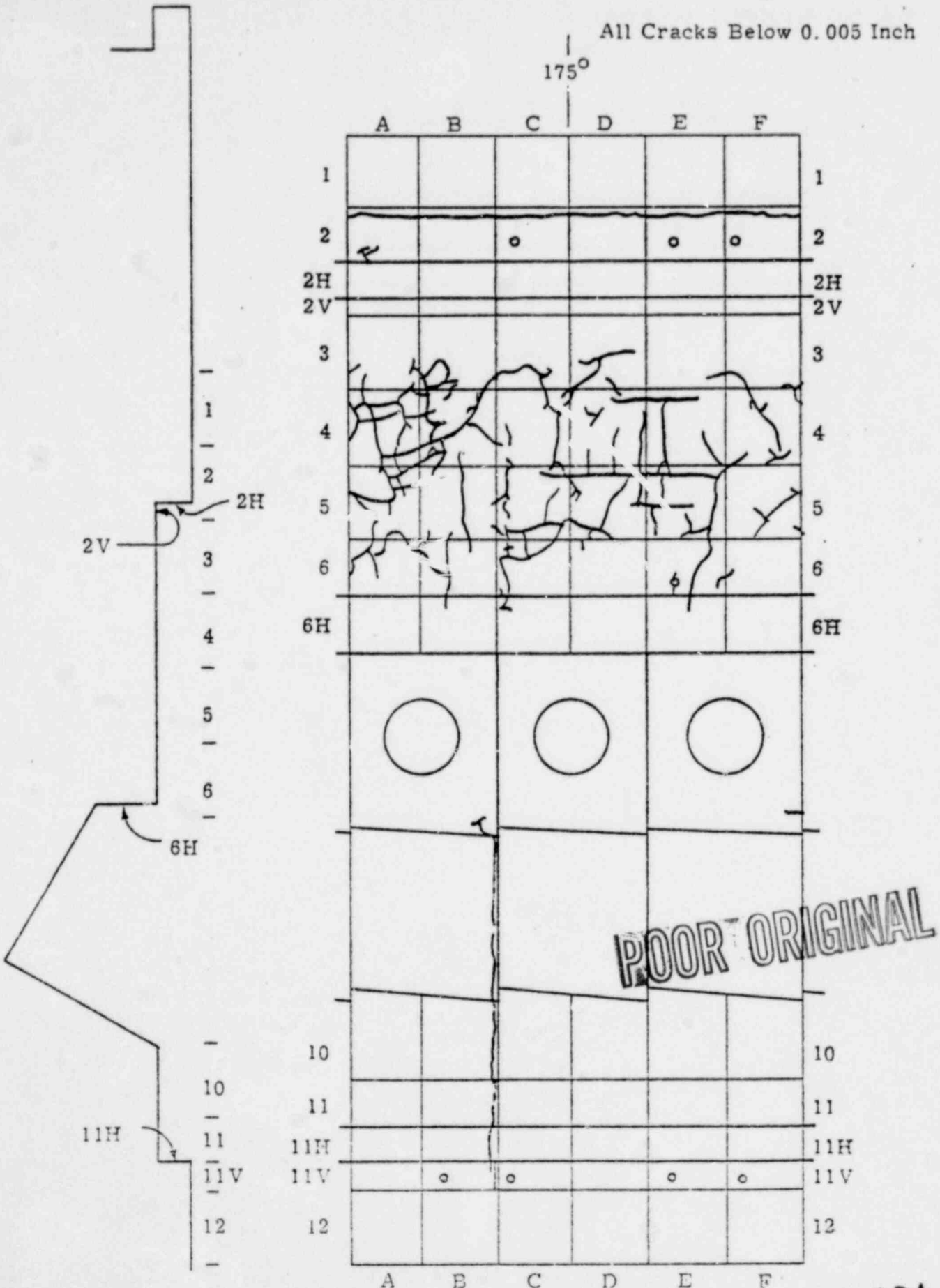


FIGURE 8. CRACK PATTERN AT AZIMUTH 175° PRIOR TO PRESTRESS, 5-14-73.

1407 224

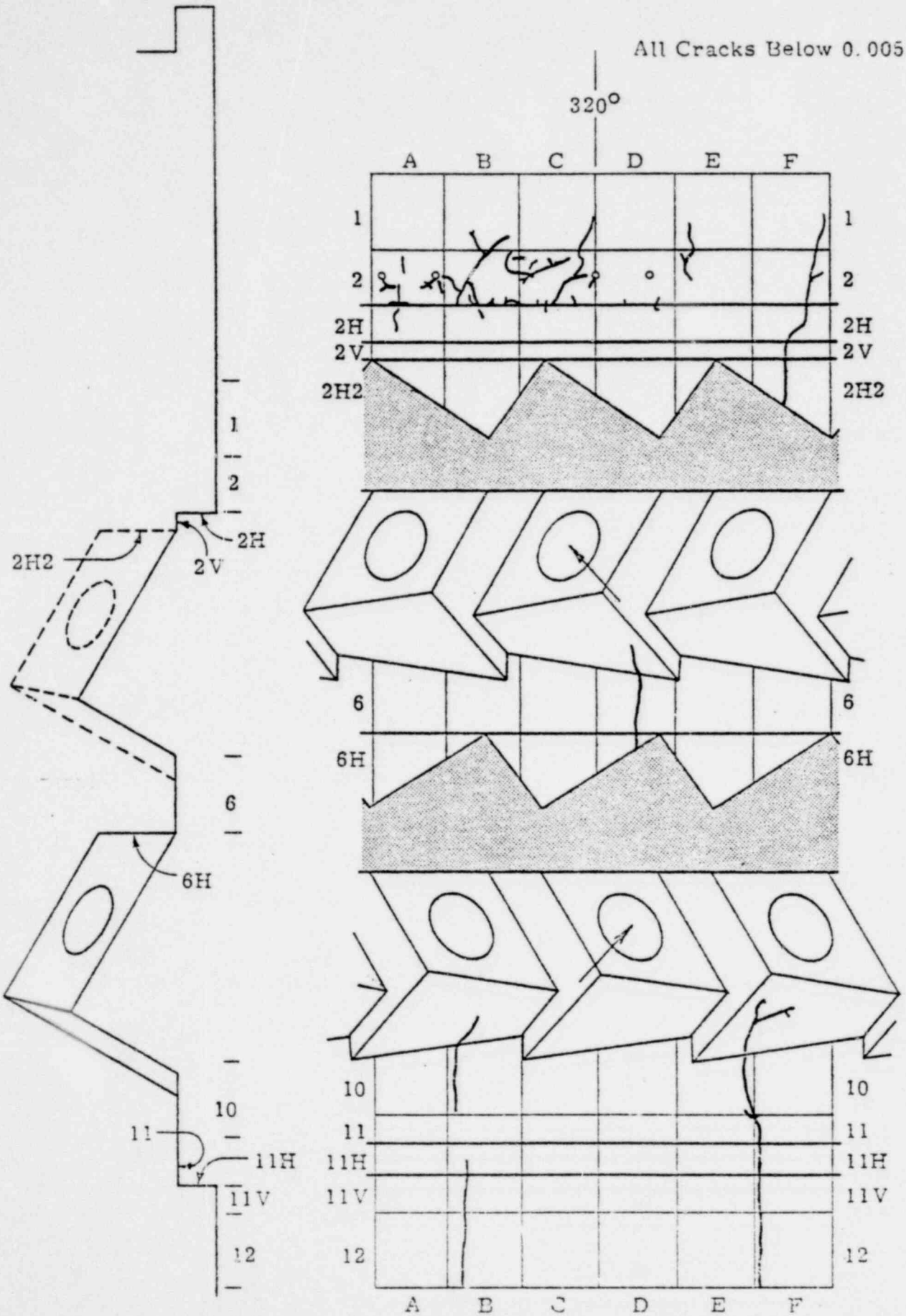


FIGURE 9. CRACK PATTERN AT AZIMUTH 320° PRIOR TO PRESTRESS, 5-14-73.

1407 225

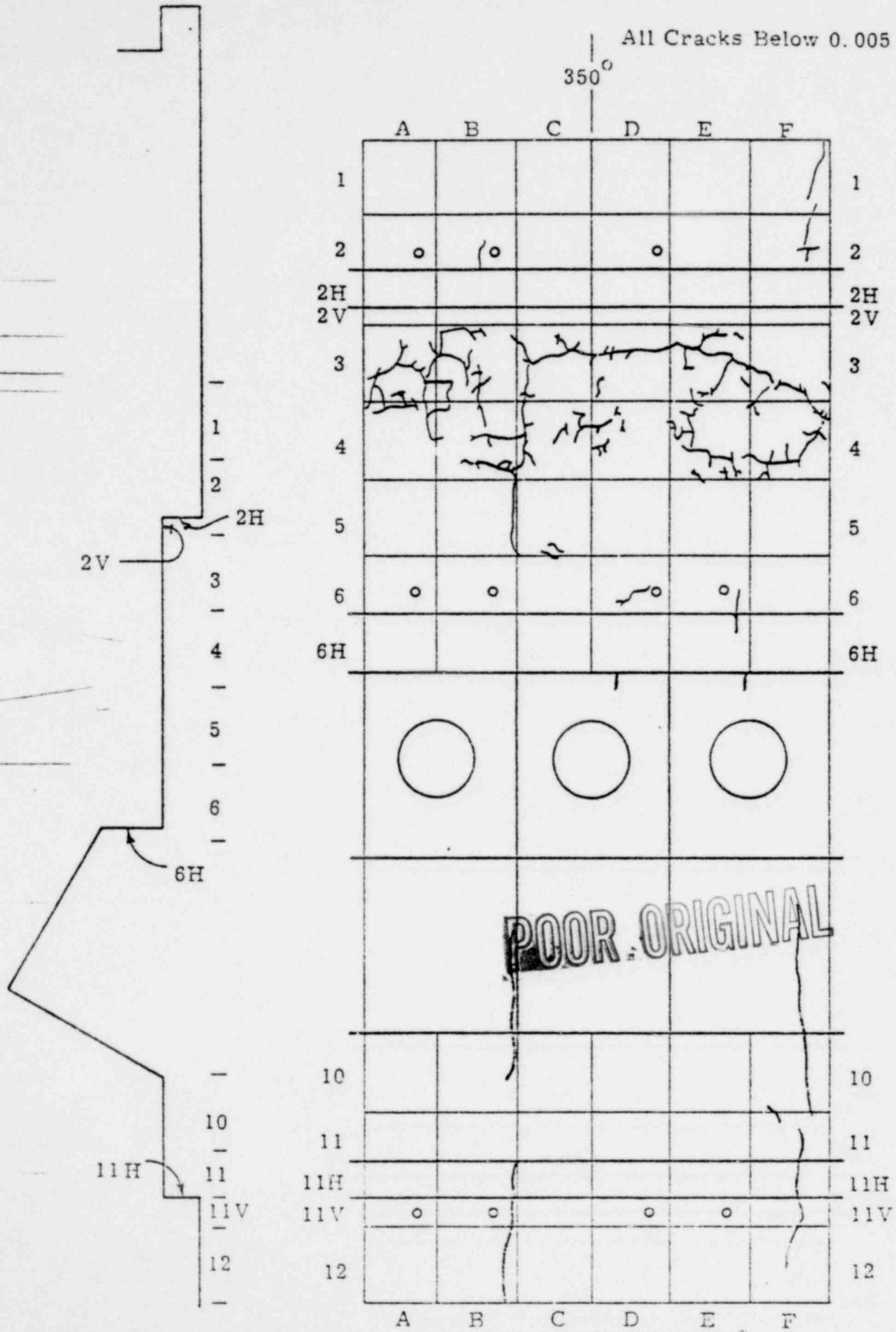


FIGURE 10. CRACK PATTERN AT AZIMUTH 350° PRIOR TO PRESTRESS, 5-14-73.

TABLE I

DATE: MAY 15, 1973
CONDITION: PRIOR TO PRESTRESS

Strain Gage Location	Elevation (ft)	Azimuth (°)	Microstrain[1]	Temperature (°F)		Time	
				Air	Skin	Day	Hour
52 Hoop	435	108	Zero	58	60	15	1730
52 Vert	435	108	Zero	58	60	15	1730
53 Hoop	435	245	Zero	72.5	72	15	1400
53 Vert	435	245	Zero	72.5	72	15	1400
54 Hoop	435	352	Zero	58	58	15	1810
54 Vert	435	352	Zero	58	58	15	1810
55 Hoop	440	108	Zero	58	60	15	1730
55 Vert	440	108	Zero	58	60	15	1730
56 Hoop	440	245	Zero	78	78.5	15	1415
56 Vert	440	245	Zero	78	78.5	15	1415
57 Hoop	440	352	Zero	58	58	15	1810
57 Vert	440	352	--	58	58	15	1810
129 Hoop	446	80	--	54	54	15	1935
129 Vert	446	80	Zero	54	54	15	1935
58 Hoop	446	108	--	58	60	15	1740
58 Vert	446	108	Zero	58	60	15	1740
59 Hoop	446	245	Zero	74	72	15	1430
59 Vert	446	245	Zero	74	72	15	1430
130 Hoop	446	320	Zero	54	56	15	1915
130 Vert	446	320	Zero	54	56	15	1915
60 Hoop	446	352	Zero	58	58	15	1830
60 Vert	446	352	Zero	58	58	15	1830
61 Hoop	452	108	Zero	58	60	15	1750
61 Vert	452	108	Zero	58	60	15	1750
62 Hoop	452	245	Zero	79	72	15	1450
62 Vert	452	245	Zero	74	72	15	1430
63 Hoop	452	352	Zero	56	58	15	1845
63 Vert	452	352	Zero	56	58	15	1845
			Internal Temperature:	64	--	15	1950

NOTE: 1. The three readings not shown (i.e. --) indicate gages that were not installed (two hoop bar gages at Elevation 446) or damaged beyond repair during construction (57 vertical).

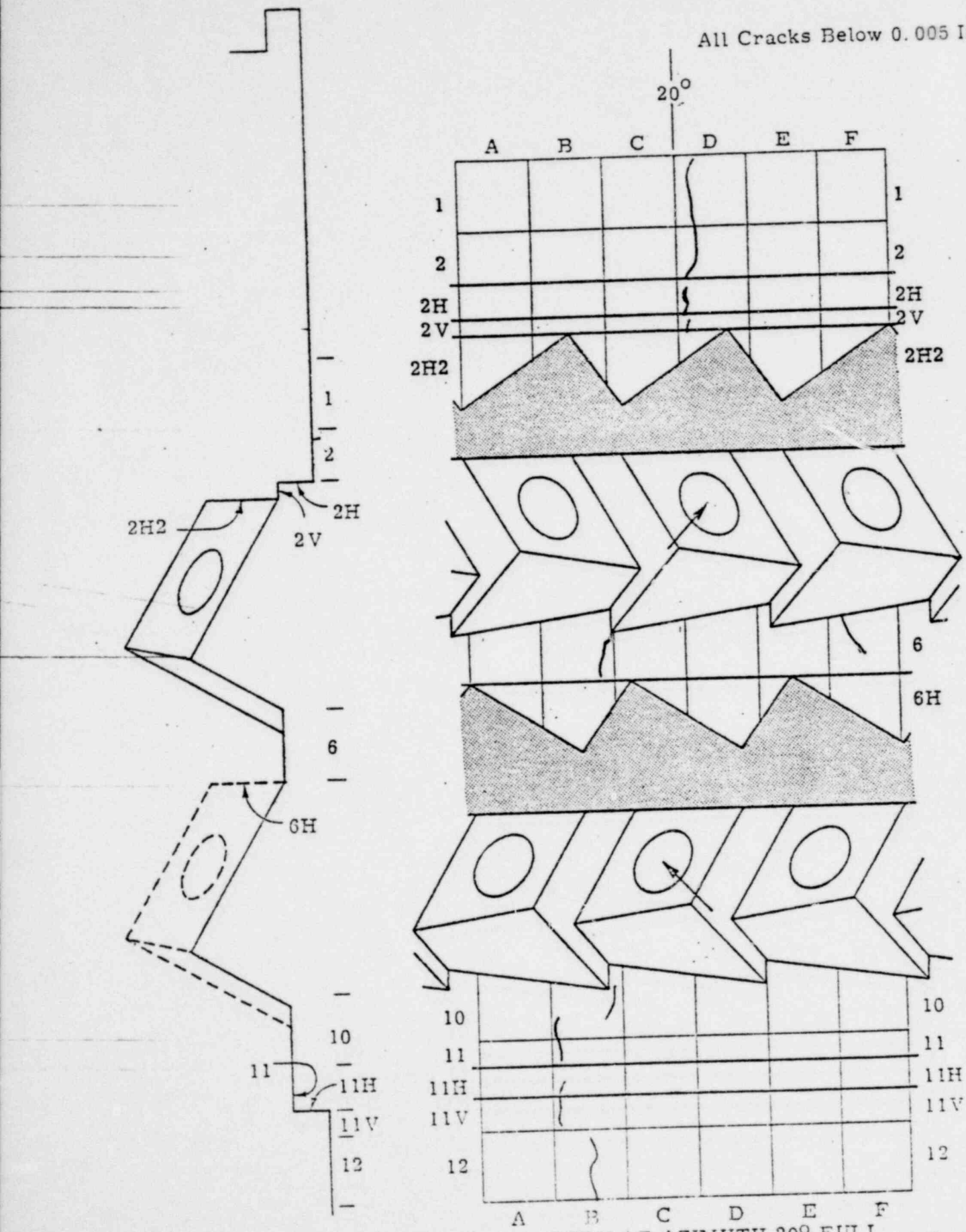


FIGURE 11. CRACK PATTERN AT AZIMUTH 20° FULL VERTICAL PRESTRESS, 6-6-73.

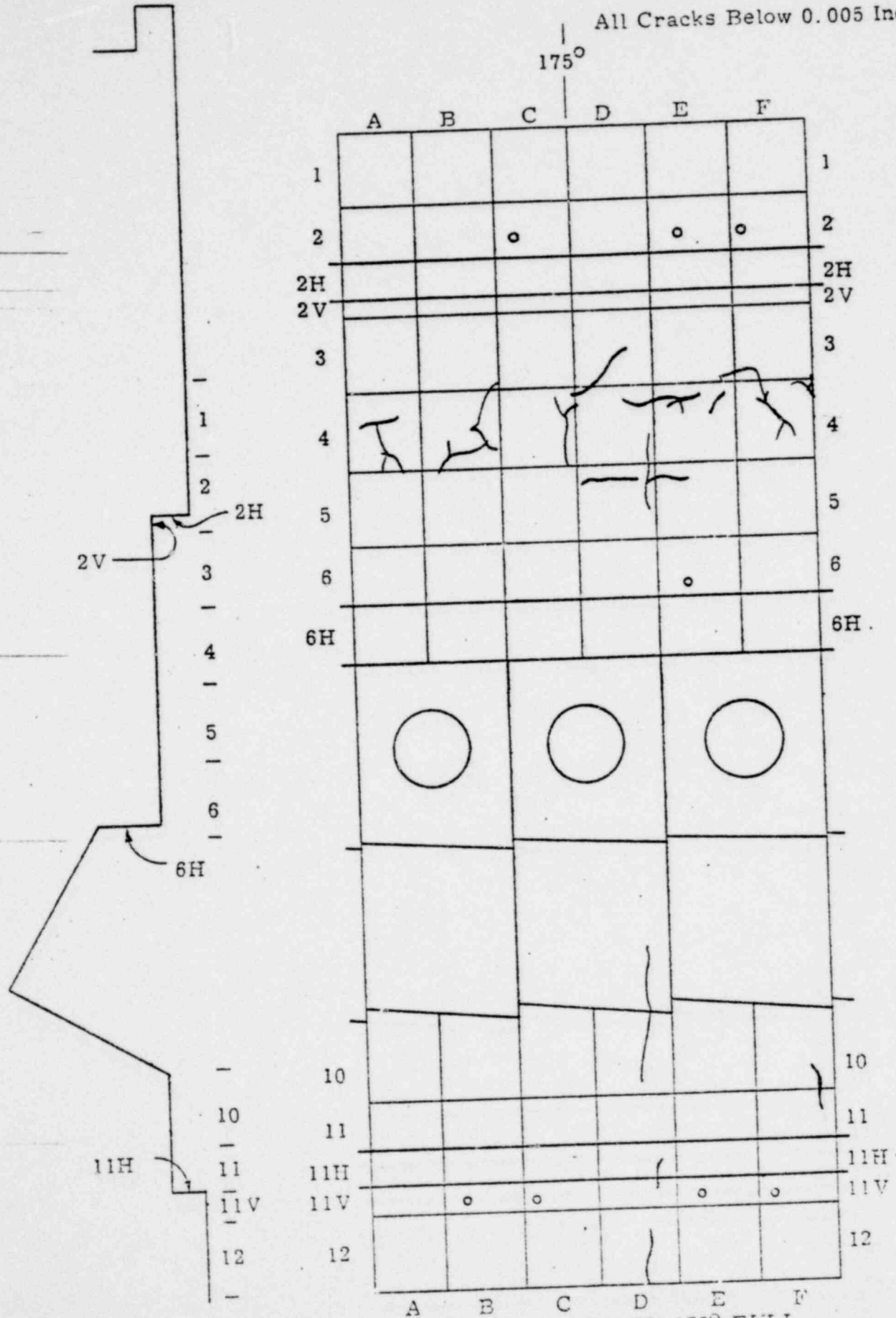


FIGURE 12 CRACK PATTERN AT AZIMUTH 175° FULL VERTICAL PRESTRESS, 6-6-73.

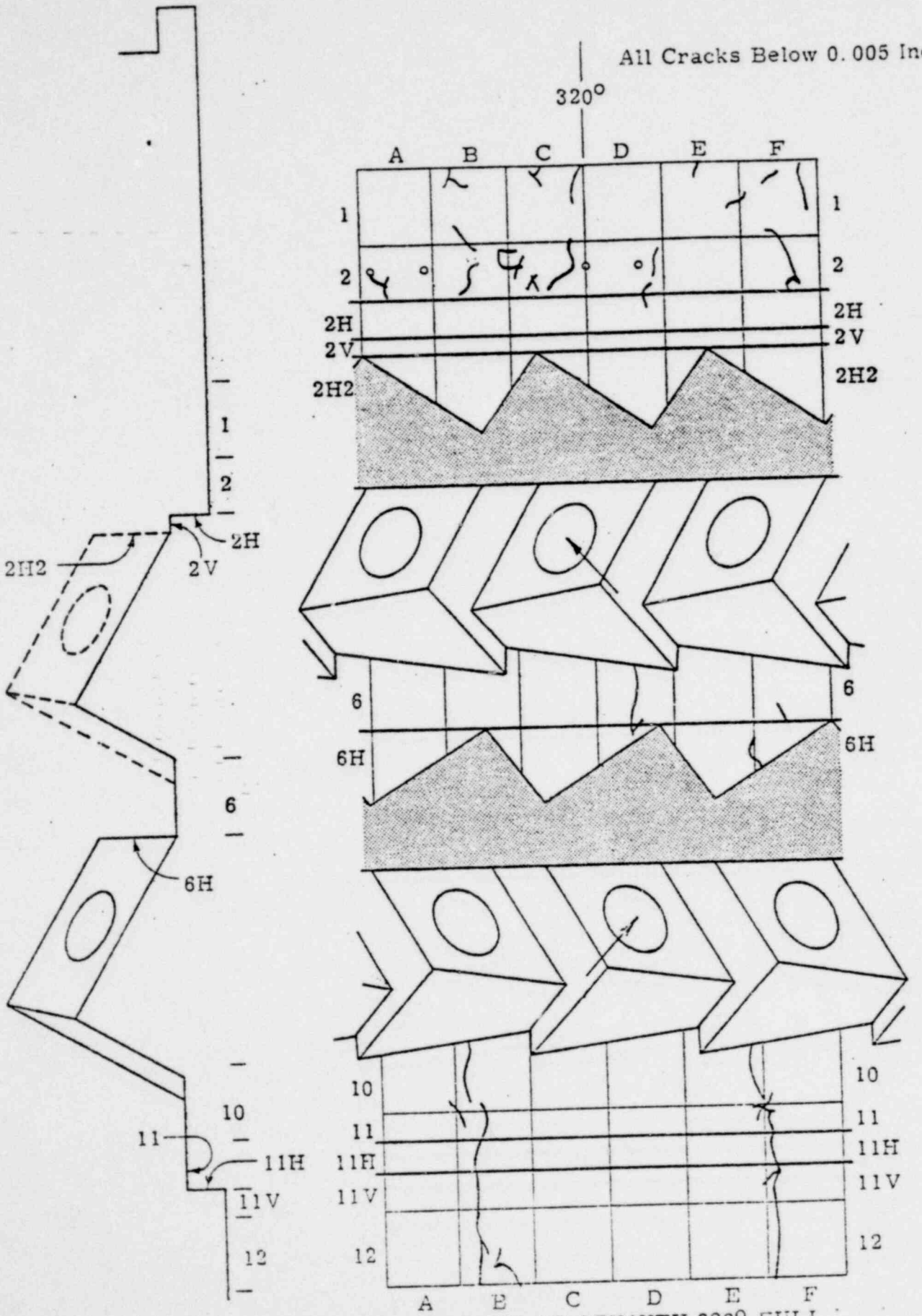


FIGURE 13. CRACK PATTERN AT AZIMUTH 320° FULL VERTICAL PRESTRESS, 6-6-73.

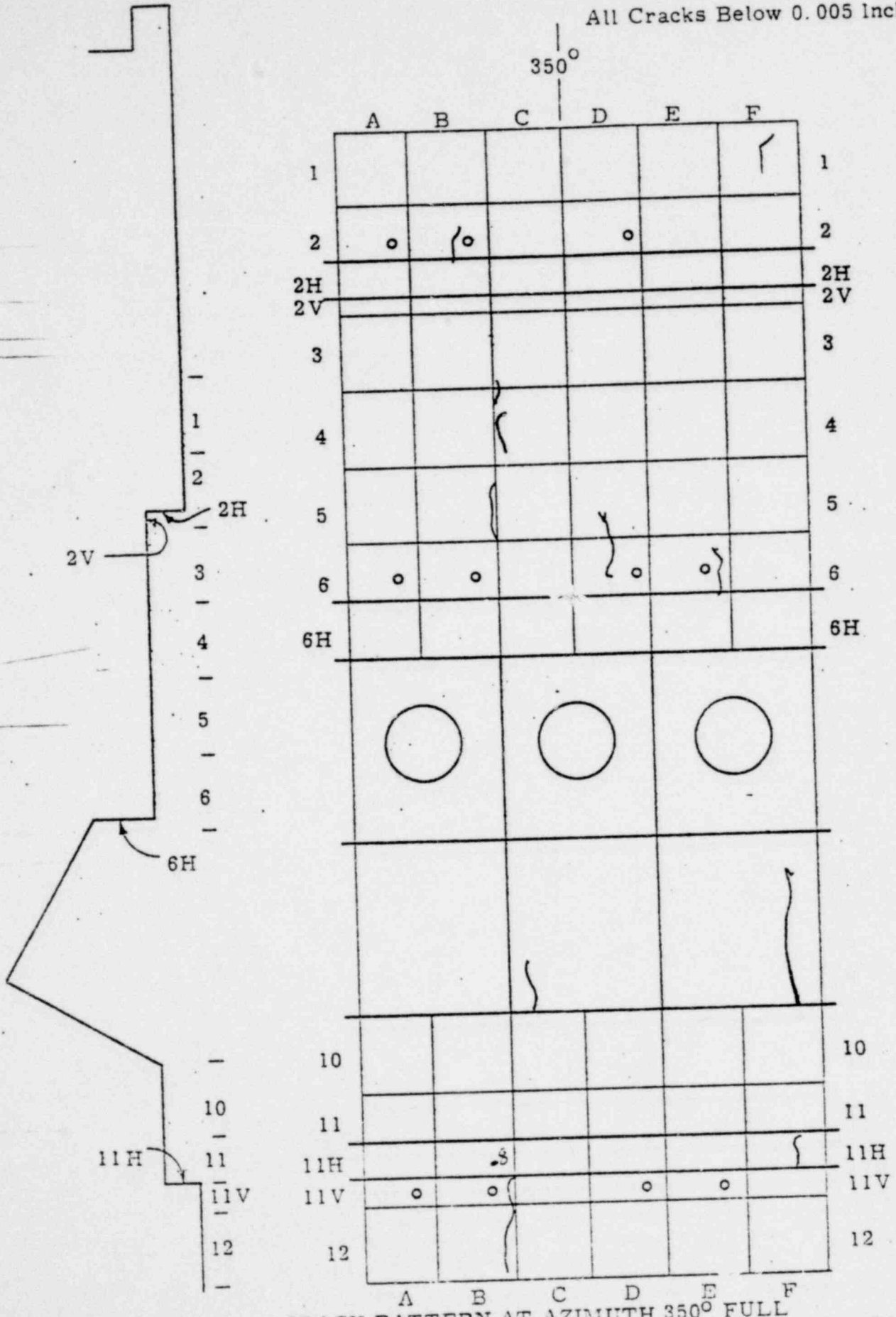


FIGURE 14. CRACK PATTERN AT AZIMUTH 350° FULL VERTICAL PRESTRESS, 6-6-73.

TABLE II

DATE: JUNE 6, 7, 1973
CONDITION: AFTER VERTICAL PRESTRESS

Strain Gage Location	Elevation (ft)	Azimuth (°)	Microstrain	Temperature (°F) Air	Temperature (°F) Skin	Time Day	Time Hour
52 Hoop	435	108	+31	93	92	06	1345
52 Vert	435	108	+213	93	92	06	1345
53 Hoop	435	245	+16	74	72	07	0915
53 Vert	435	245	+197	74	72	07	0915
54 Hoop	435	352	+43	95	93	06	1525
54 Vert	435	352	+251	95	93	06	1525
55 Hoop	440	108	-4	93	92	06	1345
55 Vert	440	108	+33	93	92	06	1345
56 Hoop	440	245	-5	74	72	07	0915
56 Vert	440	245	+18	74	72	07	0915
57 Hoop	440	352	+48	95	93	06	1525
57 Vert	440	352	gage destroyed during construction				
129 Hoop	446	80	no gage installed at this location				
129 Vert	446	80	+41	92	89	06	1315
58 Hoop	446	108	no gage installed at this location				
58 Vert	446	108	+130	80	76	07	1010
59 Hoop	446	245	+12	74	72	07	0855
59 Vert	446	245	-29	74	72	07	0855
130 Hoop	446	320	+5	94	91	06	1445
130 Vert	446	320	+13	98	93	06	1555
60 Hoop	446	352	-12	96	90	06	1555
60 Vert	446	352	+144	96	90	06	1555
61 Hoop	452	108	Zero	90	91	06	1425
61 Vert	452	108	+56	86	84	07	1035
62 Hoop	452	245	+3	72	71	07	0950
62 Vert	452	245	+145	74	72	07	0855
63 Hoop	452	352	+2	96	93	06	1620
63 Vert	452	352	+80	96	93	06	1620
			Internal Temperature:	78	--	06	1745
				81	--	07	1105

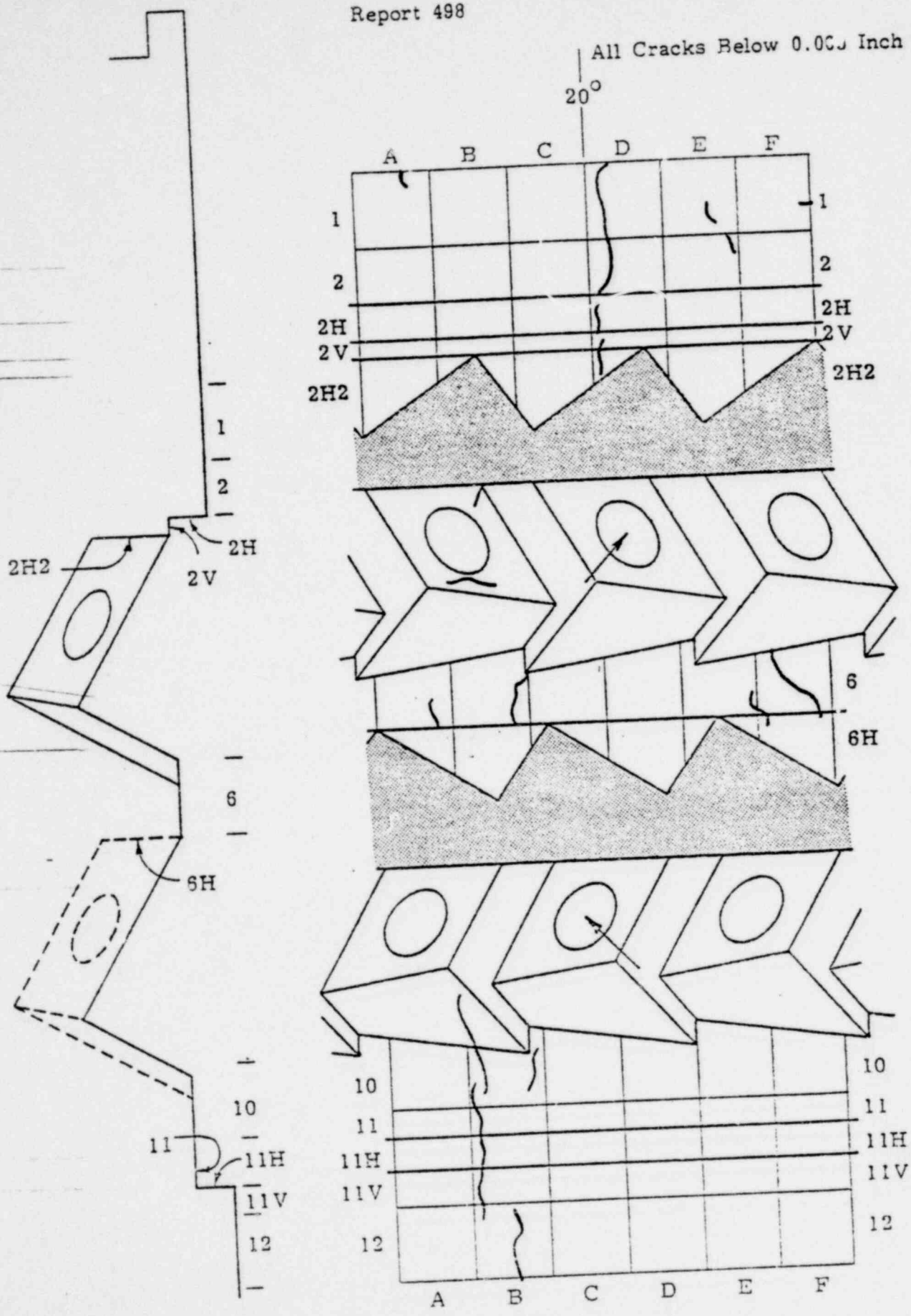


FIGURE 15. CRACK PATTERN AT AZIMUTH 20° FULL VERTICAL AND DOME PRESTRESS, JULY 5, 1973.

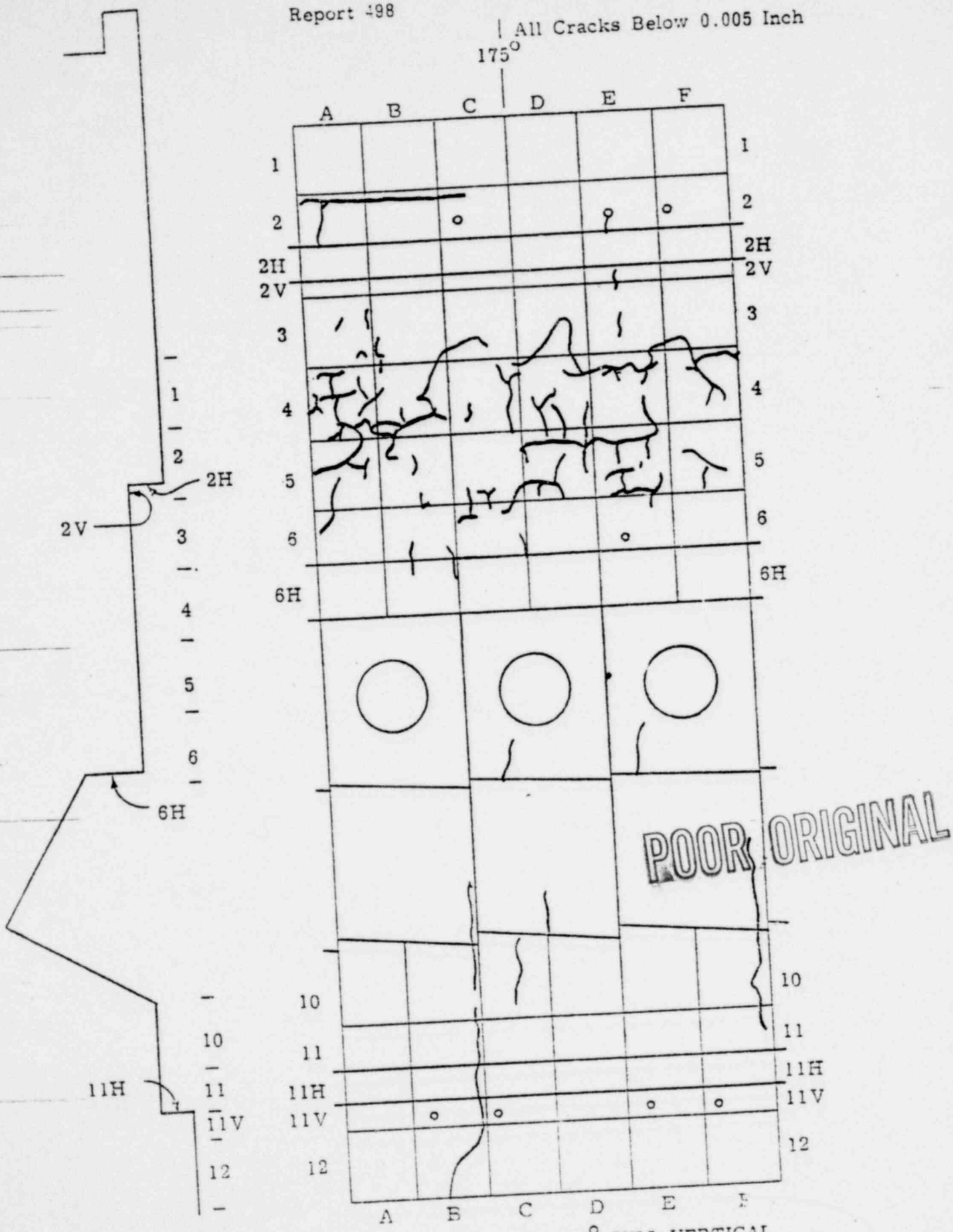


FIGURE 16. CRACK PATTERN AT AZIMUTH 175° FULL VERTICAL AND DOME PRESTRESS, JULY 5, 1973.

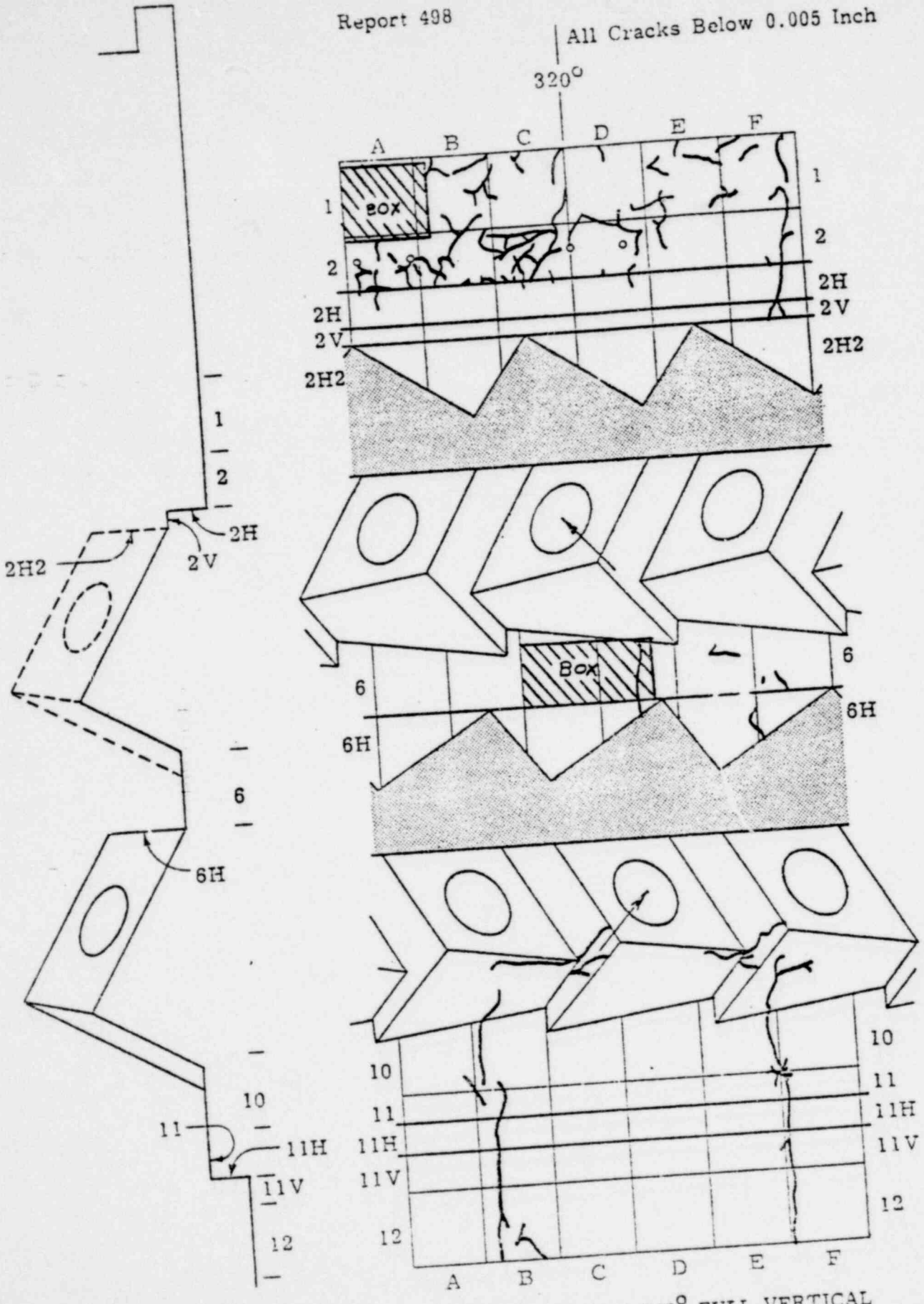


FIGURE 17. CRACK PATTERN AT AZIMUTH 320° FULL VERTICAL AND DOME PRESTRESS, JULY 5, 1973.

All Cracks Below 0.005 Inch

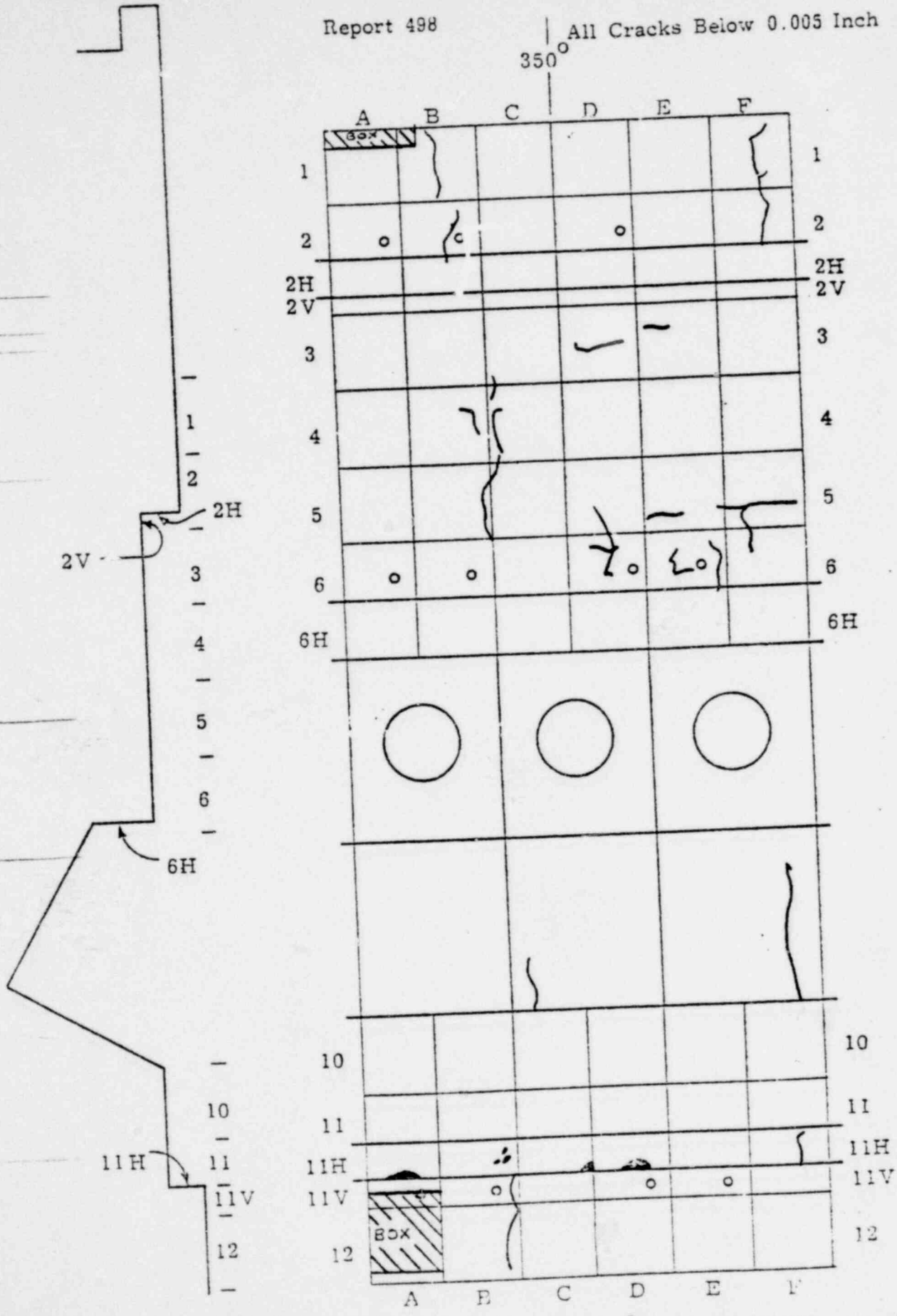


FIGURE 18. CRACK PATTERN AT AZIMUTH 350° FULL VERTICAL AND DOME PRESTRESS, JULY 5, 1973.

TABLE III

DATE: JULY 5, 1973
CONDITION: AFTER VERTICAL AND DOME PRESTRESS

Strain Gage Location	Elevation (ft)	Azimuth (°)	Microstrain	Temperature (°F) Air	Skin	Time Day	Hour
52 Hoop	435	108	-17	68	67	05	1700
52 Vert	435	108	+130	68	67	05	1700
53 Hoop	435	245	+22	78	78	05	1330
53 Vert	435	245	+115	78	78	05	1330
54 Hoop	435	352	-11	76	72	05	1130
54 Vert	435	352	+366 [1]	76	72	05	1130
55 Hoop	440	108	+39	68	67	05	1700
55 Vert	440	108	+1	68	67	05	1700
56 Hoop	440	245	+34	74	78	05	1340
56 Vert	440	245	-17	74	78	05	1340
57 Hoop	440	352	-48	74	72	05	1140
57 Vert	440	352	gage destroyed during construction				
129 Hoop	446	80	no gage installed at this location				
129 Vert	446	80	+94	76	73	05	1410
58 Hoop	446	108	no gage installed at this location				
58 Vert	446	108	+166	67	68	05	1601
59 Hoop	446	245	+91	81	78	05	1350
59 Vert	446	245	+86	72	74	05	1355
130 Hoop	446	320	+81	86	84	05	1315
130 Vert	446	320	+92	86	84	05	1315
60 Hoop	446	352	+66	66	69	05	1150
60 Vert	446	352	+187	66	69	05	1150
61 Hoop	452	108	+81	70	68	05	1556
61 Vert	452	108	+49	70	67	05	1630
62 Hoop	452	245	+67	71	74	05	1400
62 Vert	452	245	+126	81	78	05	1350
63 Hoop	452	352	+78	78	78	05	1156
63 Vert	452	352	+87	78	78	05	1156
			Internal Temperature	76		05	1715

NOTE: 1. Questionable gage - no correlation with corresponding locations.

(Text Continued From Page 12)

3.4 After Full Prestress, September 18, 19, 1973.

3.4.1 On September 18, 1973, BEL personnel commensed crack pattern charting and gage readings. Lack of iron worker personnel and placement of certain scaffolds precluded work at Azimuth 245° and 350°. On September 19, these remaining azimuths were cleared and the surviellance was completed. The results are shown in Figures 19 through 22 and Table IV.

(Text Continued on Page 34)

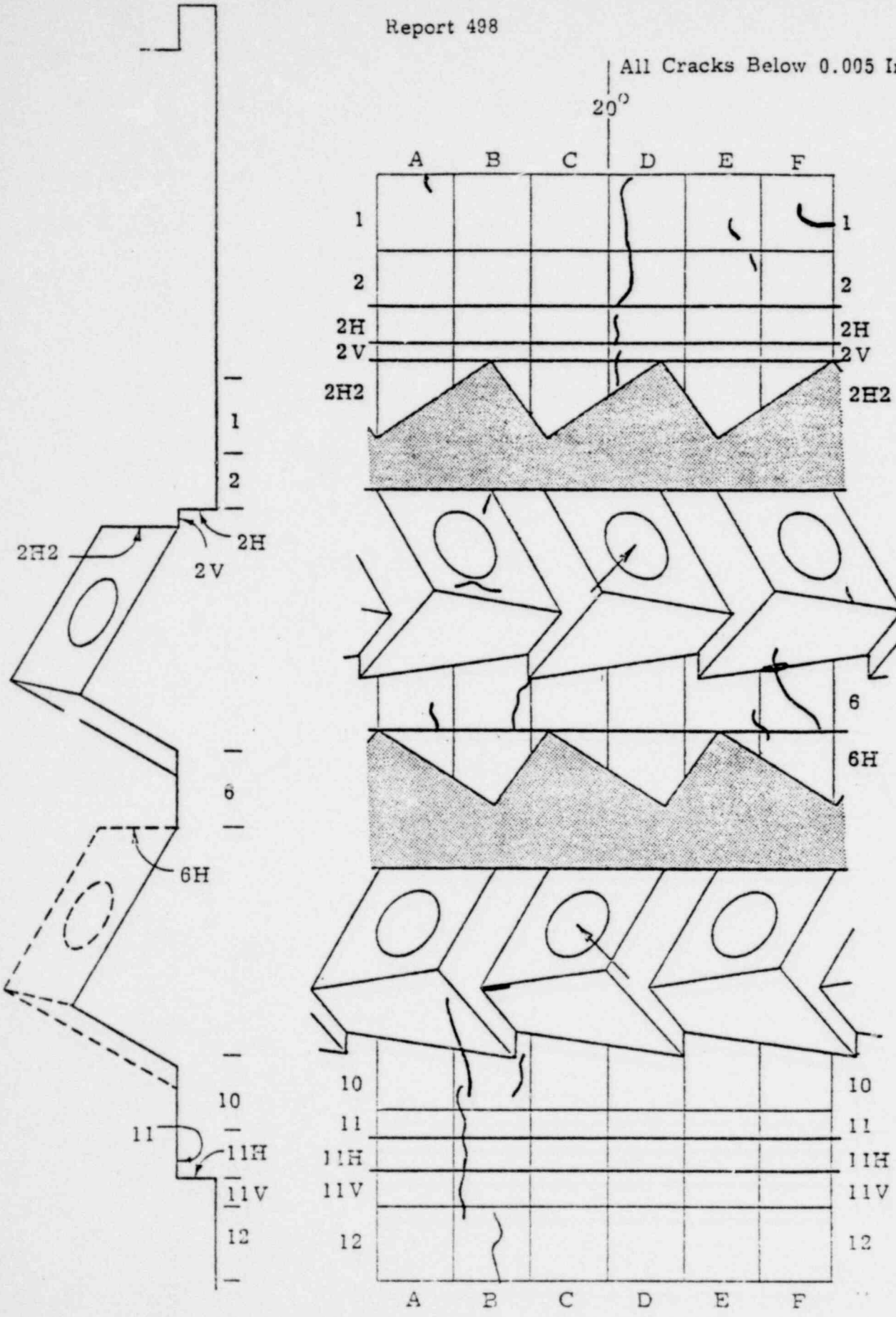


FIGURE 19. CRACK PATTERN AT AZIMUTH 20° AFTER FULL PRESTRESS, SEPTEMBER 18, 1973.

1407 239

All Cracks Below 0.005 Inch

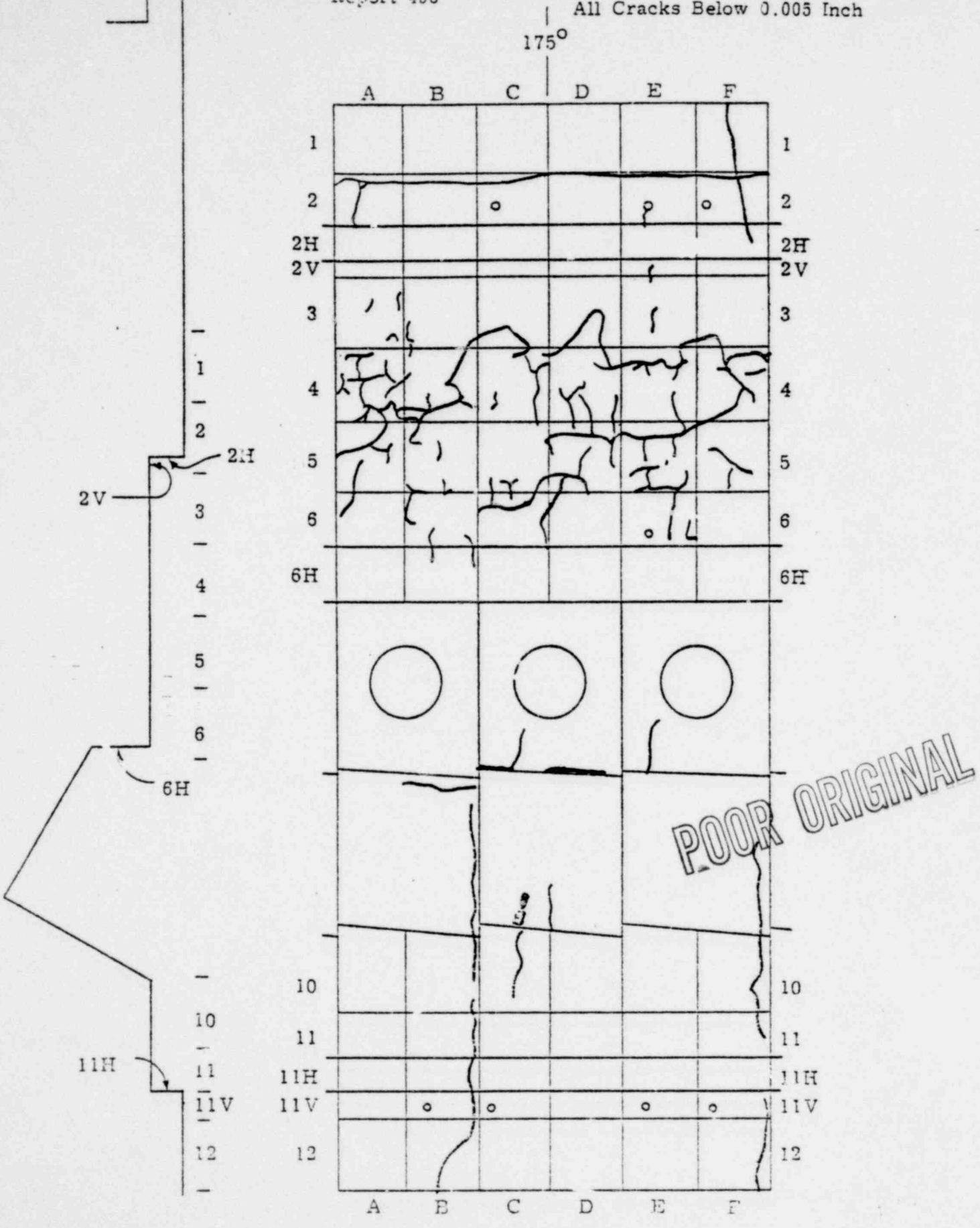


FIGURE 20. CRACK PATTERN AT AZIMUTH 175° AFTER FULL PRESTRESS, SEPTEMBER 18, 1973.

All Cracks Below 0.005 Inch

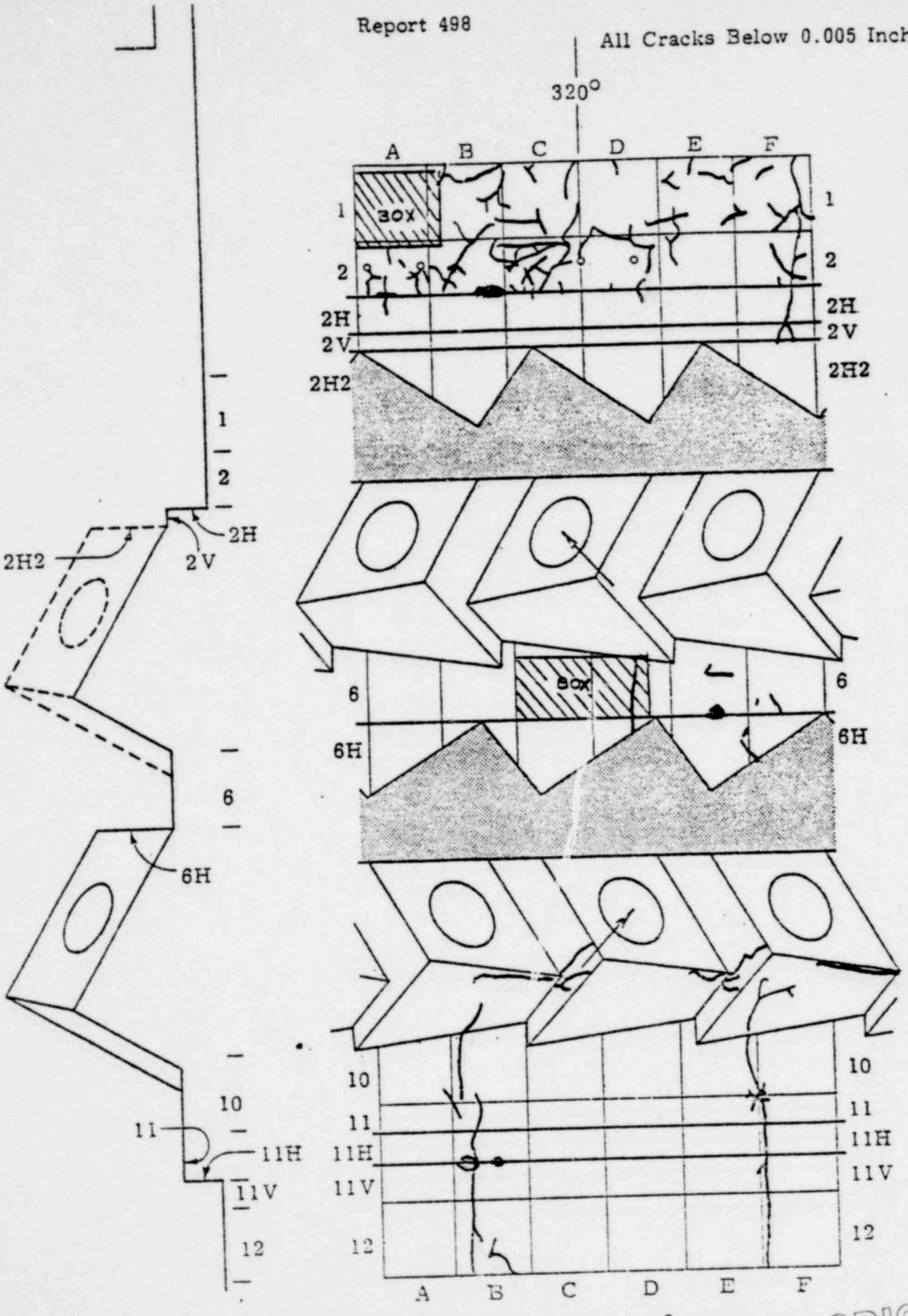


FIGURE 21. CRACK PATTERN AT AZIMUTH 320° AFTER FULL PRESTRESS, SEPTEMBER 18, 1973.

All Cracks Below 0.005 Inch

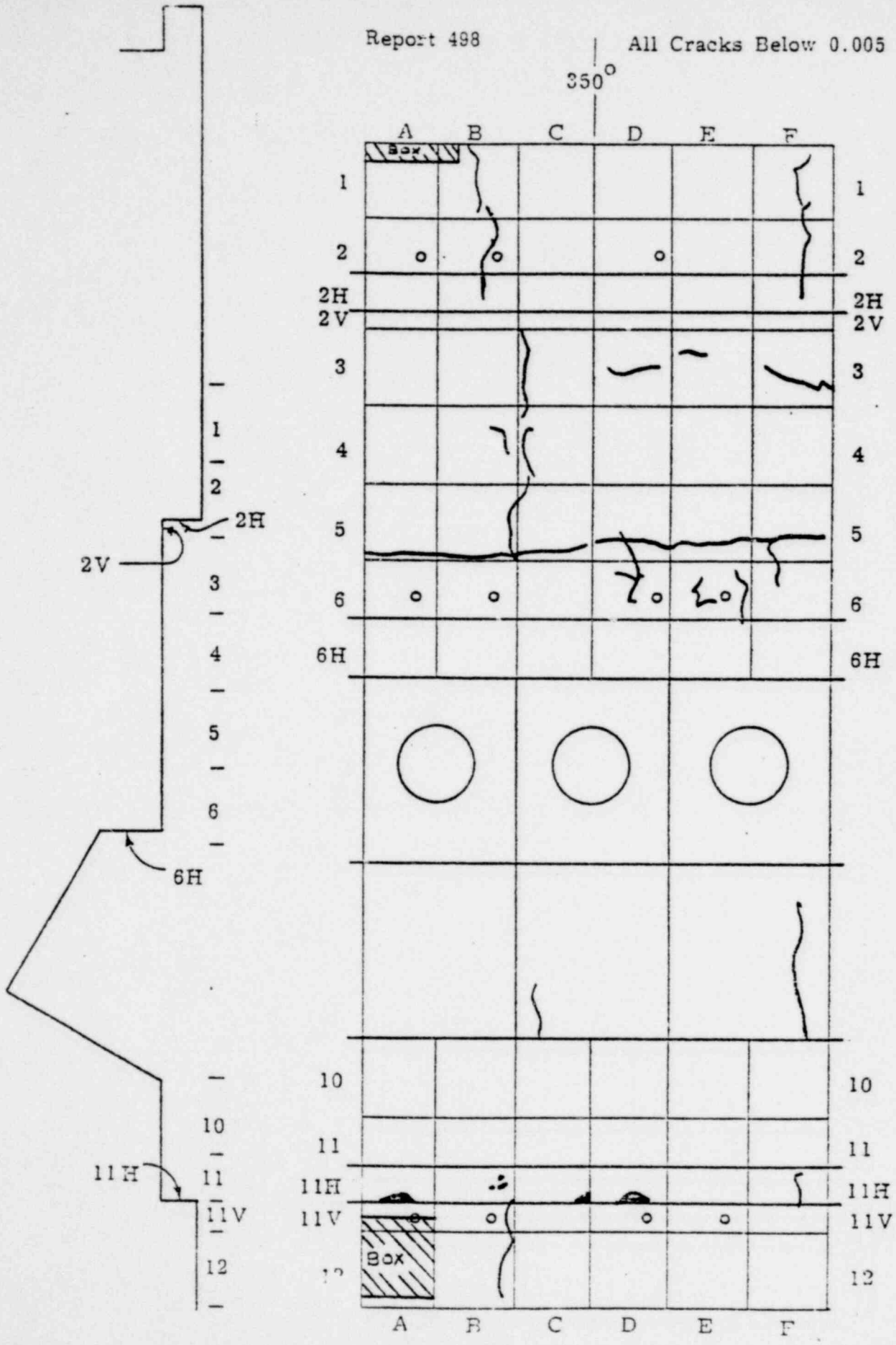


FIGURE 22. CRACK PATTERN AT AZIMUTH 350° AFTER FULL PRESTRESS, SEPTEMBER 19, 1973.

TABLE IV

DATE: SEPTEMBER 18, 19, 1973
CONDITION: AFTER FULL PRESTRESS

Strain Gage Location	Elevation (ft)	Azimuth (°)	Microstrain	Temperature (°F) Air	Skin	Time Day	Hour
52 Hoop	435	108	+146	67	76	18	1400
52 Vert	435	108	+53	67	76	18	1400
53 Hoop	435	245	+162	54	56	19	0937
53 Vert	435	245	+26	54	56	19	0937
54 Hoop	435	352	+198	64	67	18	1330
54 Vert	435	352	+597 [1]	64	67	18	1330
55 Hoop	440	108	+111	67	76	18	1410
55 Vert	440	108	-21	67	76	18	1410
56 Hoop	440	245	+139	54	56	19	0947
56 Vert	440	245	-176	54	56	19	0947
57 Hoop	440	352	+133	64	64	18	1338
57 Vert	440	352	gage destroyed during construction				
129 Hoop	446	80	no gage installed at this location				
129 Vert	446	80	+131	73	72	18	1437
58 Hoop	446	108	no gage installed at this location				
58 Vert	446	108	+162	72	78		1415
59 Hoop	446	245	+152	55	57	19	0957
59 Vert	446	245	+65	55	57	19	0957
130 Hoop	446	320	+171	74	74	18	1310
130 Vert	446	320	+105	70	68	18	1320
60 Hoop	446	352	+152	65	67	18	1345
60 Vert	446	352	+178	65	67	18	1345
61 Hoop	452	108	+89	74	76	18	1417
61 Vert	452	108	+65	74	76	18	1420
62 Hoop	452	245	this gage shorted to ground				
62 Vert	452	245	+129	56	57	19	0957
63 Hoop	452	352	+95	66	66	18	1350
63 Vert	452	352	+106	66	66	18	1350
			Internal Temperature	70	--	18	1610
				68	--	19	1115

NOTE: 1. Questionable gage - no correlation with corresponding locations.

(Text Continued From Page 28)

4.0 REFERENCES.

1. THREE MILE ISLAND NUCLEAR STATION, UNIT #1 RING GIRDER, DRL DOCKET 50-289. Gilbert Associates, Inc., Letter from K. E. Nodland to J. H. Wright of General Public Utilities dated April 6, 1972.

2. PRELIMINARY REPORT ON STRUCTURAL INTEGRITY TESTING OF REACTOR CONTAINMENT STRUCTURE FOR THREE MILE ISLAND NUCLEAR STATION UNIT 1. Metropolitan Edison Company, Gilbert Associates, Inc., Report No. 1710 dated November 5, 1969, Revised December 8, 1972.