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LIC-94-0056

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Gentlemen:

SUBJECT: Fort Calhoun Station (FCS) Steam Generator Eddy Current Test Report - 1993 Refueling Outage

Attached is the FCS Steam Generator Eddy Current Test Report which summarizes testing performed during the Fall 1993 Refueling Outage. This submittal fulfills the reporting requirements of FCS Technical Specifications Section 3.17(5)(ii).

If you should have any questions, please contact me.

Sincerely,

W. G. Gates
Vice President

WGG/mah

Attachment

c: LeBoeuf, Lamb, Greene & MacRae (w/o attachment)
L. J. Callan, NRC Regional Administrator, Region IV
S. D. Bloom, NRC Project Manager
R. P. Mullikin, NRC Senior Resident Inspector

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FORT CALHOUN STATION
STEAM GENERATOR EDDY CURRENT TEST REPORT
1993 REFUELING OUTAGE

INTRODUCTION

This report summarizes steam generator eddy current results obtained during the Fort Calhoun Station (FCS) 1993 Refueling Outage. Summaries of results of the two previous eddy current inspections were submitted to the NRC in the following documents:

- *Fort Calhoun Station Steam Generator Eddy Current Test Report - 1990 Refueling Outage*, dated August 30, 1990 (LIC-90-0669)
- *Fort Calhoun Station Steam Generator Eddy Current Test Report - 1992 Refueling Outage*, dated August 31, 1992 (LIC-92-288R)

DESCRIPTION OF EXAMINATION

ABB/Combustion Engineering conducted an inservice eddy current examination of the steam generator tubing at FCS in October 1993. The examination program was conducted to meet the requirement of Technical Specification Section 3.17. The examination included multi-frequency testing for indications of degradation and dents in Steam Generators A and B.

The test program included:

1. Full length bobbin coil testing of 1229 tubes (25%) in Steam Generator A and 1255 tubes (25%) in Steam Generator B (see Figures 1 and 2). This testing included:
   - An augmented sample of 298 tubes in Steam Generator A and 322 tubes in Steam Generator B. The augmented sample included all tubes identified as degraded tubes (i.e., $\geq$20% wall loss) and one tube adjacent to each of these. Tubes in the areas of the steam generators where experience has indicated potential problems were also inspected.
   - A random sample of 20% of the remaining tubes, or 931 tubes in Steam Generator A and 929 tubes in Steam Generator B.
   - The addition of four (4) tubes in Steam Generator B during the 1993 Outage to test tubes adjacent to newly identified degraded tubes.
2. Motorized Rotating Pancake Coil (MRPC) testing of the top of the inlet tubesheet of 1002 tubes (20%) in Steam Generator A and 850 tubes (17%) in Steam Generator B (see Figures 3 and 4).
3. MRPC testing of previous indications between the hot leg tubesheet and the #1 eggcrate, as well as other hot leg freespan indications for a total of 13 indications in 12 tubes in each of the steam generators (see Figures 5 and 6).

4. MRPC testing in the hot leg U-bends and dented support plate intersections of 25 tubes in Steam Generator B (see Figure 7).

The tubes in the bobbin coil inspection plan were examined at full length. The inspection patterns are shown on Figures 1 and 2. Support notation for each steam generator is shown on Figure 8. Tubes previously determined to have deformation sufficient to restrict the passage of the 0.560" diameter probe were inspected using a 0.540" diameter probe to determine the presence of tube wall degradation or other restrictions.

The recorded multi-frequency eddy current data were analyzed for the presence of defect indications and dents. Tube wall degradation was evaluated using the phase analysis technique for determination of the origin and percentage of tube wall loss represented by the indication. The data were independently analyzed by two groups of certified Level IIA data analysts. Discrepancies between the two sets of evaluation results were reviewed and resolved by a Level III Eddy Current Examiner.

The examination was conducted with a Zetec MIZ-18A digital eddy current acquisition system and analyzed utilizing the Eddynet digital analysis system. The frequencies utilized during the bobbin coil examination were as follows:

400 KHz differential and absolute
100 KHz differential and absolute
600 KHz differential and absolute
10 KHz differential and absolute

400/100 KHz differential mix

The primary frequency of 400 KHz satisfies the requirements of the ASME Boiler and Pressure Vessel Code for the examination of nonferromagnetic steam generator tubing. The 400 KHz absolute is used to measure the radial dent size. The 100 KHz is provided for the confirmation of flaw indications and as a frequency used in the mixes to eliminate support and outside diameter (OD) deposit signals. The 100 KHz absolute detects gradual wall thickness variations. The 600 KHz frequency is provided to assist the analysts with additional mixing capabilities in the event of excessive OD tube deposits. The 10 KHz is provided to facilitate locating the probe position in the steam generator. The 400/100 KHz mix is used to eliminate the tube support signal and OD tube deposits. Other mixes are performed as required by the data analyst.

The tubes in the Top of Tubesheet MRPC Program were inspected in the hot leg expansion transition region of each steam generator. The inspection patterns are shown in Figures 3 and 4. The data were analyzed for the presence of crack-like indications similar to those found in the expansion transition regions at other plants.

The MRPC exams performed on previous indications in the sludge pile region and in the freespan of both steam generators, as well as the MRPC exams at U-bends and at dents in Steam Generator B, were performed to confirm bobbin coil results which show no active stress corrosion cracking in the FCS Steam Generators. The inspection patterns are shown in Figures 5, 6, and 7.

RESULTS OF THE EXAMINATION

Defect Examination:

One tube in Steam Generator B, Line 69, Row 80, was identified as containing a 45% through-wall defect. This indication had been tracked since the 1990 examination, and was called 39% through-wall during the 1992 examination. The indication is located just above the number 7 support on the hot leg side, and was confirmed to be present with MRPC. The MRPC results were inconclusive as to the exact cause of the defect, but did show a volumetric rather than a crack-like indication.

There were no other tubes in either steam generator identified as containing degradation $\geq$40%. Additionally, no crack-like indications were found in the hot leg expansion transition region or any other location of either steam generator during performance of the MRPC exams.

A list of indications and their locations is provided in Table 1 and a list of tubes plugged as a result of this inspection is provided in Table 2.

Dent Examination:

The 400 KHz absolute data from the bobbin coil exams were used to evaluate average radial dents for a sample of the most severely dented tubes in the steam generators. Though the bobbin coil probe is not extremely accurate in determining actual dent size, it can be used as an indicator of change. Results of the bobbin coil dent measurements indicate that there has been no significant increase in the overall average size of the dents in either steam generator since the last inspection.

Tubes determined to have deformation sufficient to restrict the passage of the 0.560" diameter probe in past inspections were reinspected with a 0.540" diameter probe to determine the presence of tube wall degradation or the presence of other restrictions in the entire length of the tube. During the 1993 examination, there were no new tubes that restricted passage of a 0.560" diameter probe due to denting, and no tubes that restricted passage of a 0.540" diameter probe.

CONCLUSIONS

One tube required plugging in Steam Generator B during the 1993 Refueling Outage because it contained a defect which exceeded the 40% through-wall plugging criteria as defined in Technical Specification 3.17. This indication had been tracked since 1990, and was reported as 39% through-wall in 1992. MRPC testing confirmed the existence of the defect and showed it to be volumetric rather than crack-like in nature. There are currently 55 tubes plugged (1.1%) in each steam generator. The number of indications below the 40% plugging limit increased over that found during the previous inspection. It is concluded, however, that this is more indicative of heightened sensitivity of the analysts in the evaluation and documentation of small amplitude indications rather than denoting the onset of further degradation. No cracks were found in the expansion transition region or any other region of either steam generator during performance of the MRPC exams.

The results of bobbin coil dent measurements indicate no significant dent growth since the last outage. This conclusion is further supported by the fact that no new tubes restricted passage of the 0.560" diameter probe due to denting, and no tubes restricted passage of the 0.540" diameter probe.

TABLE 1

LIST OF INDICATIONS

STEAM GENERATOR A					
Line/Row	Indication	Location	Line/Row	Indication	Location
9/7	19%	HTS + 0.9"	56/37	6%	HTS + 5.5"
15/44	5%	HTS + 0.9"	71/42	23%	HTS + 1.0"
20/41	16%	HTS + 17.1"	73/42	23%	HTS + 6.4"
23/20	9%	H1 + 28.8"	76/73	2%	HTS + 0.8"
25/66	3%	H3 + 13.7"	87/78	19%	H4 + 17.2"
40/31	9%	HTS + 5.7"	91/74	5%	H3 + 13.7"
40/87	7%	CTS + 35.2"	92/23	5%	HTS + 1.2"
41/66	15%	HTS + 1.0"	95/82	5%	H2 + 29.7"
43/94	18%	HTS + 2.5"	98/55	10%	HTS + 1.0"
47/6	9%	HTS + 0.8"	104/27	16%	HTS + 2.4"
50/35	19%	HTS + 0.9"	125/8	17%	CTS + 3.4"
50/35	17%	HTS + 1.9"	125/8	15%	H1 + 0.5"
50/35	4%	HTS + 1.2"	125/8	27%	HTS + 3.5"
52/39	14%	HTS + 1.9"			
STEAM GENERATOR B					
Line/Row	Indication	Location	Line/Row	Indication	Location
8/11	6%	H1 + 21.1"	38/37	19%	HTS + 3.9"
10/45	8%	HTS + 36.8"	38/37	12%	HTS + 10.2"
18/25	27%	HTS + 1.8"	44/61	6%	H4 + 20.3"
21/28	6%	HTS + 2.1"	46/27	24%	HTS + 9.6"
22/35	8%	HTS + 1.6"	46/33	10%	HTS + 5.7"
27/84	24%	CTS + 0.9"	48/39	16%	HTS + 1.2"
30/87	14%	V1 + 15.4	52/83	25%	HTS + 8.0"
31/36	16%	HTS + 1.4"	55/66	8%	HTS + 3.2"
32/83	12%	H4 + 13.1"	55/84	9%	HTS + 0.7"
33/84	21%	C3 + 22.6"	56/15	18%	H1 - 0.9"
35/78	14%	C2 + 20.0"	56/49	4%	H2 + 2.2"
36/69	24%	HTS + 1.1"	56/89	16%	HTS + 5.4"

TABLE 1 (Continued)

STEAM GENERATOR B					
Line/Row	Indication	Location	Line/Row	Indication	Location
57/64	23%	HTS + 18.0"	83/70	23%	H2 + 0.4"
57/64	19%	C3 + 5.2"	83/88	19%	H7 + 2.8"
59/68	16%	HTS + 3.0"	83/88	4%	H7 + 3.0"
62/57	31%	C1 + 14.9"	84/31	11%	HTS + 4.0"
62/57	14%	HTS + 3.6"	88/31	17%	HTS + 2.8"
67/38	10%	HTS + 5.5"	88/31	16%	HTS + 3.2"
68/51	3%	HTS + 4.2"	88/81	5%	H3 + 1.8"
68/69	15%	H3 + 6.1"	97/28	12%	H3 + 22.3"
68/75	7%	HTS + 2.1"	97/28	4%	H2 + 28.0"
69/52	14%	HTS + 3.5"	97/28	5%	H2 + 29.1"
69/80	45%	H7 + 1.9"	97/28	8%	H3 + 19.0"
69/80	37%	H7 + 2.2"	97/28	7%	H3 + 25.6"
69/80	15%	H7 + 2.6"	97/28	5%	H2 + 29.2"
70/59	20%	HTS + 3.9"	97/78	11%	HTS + 2.5"
72/81	26%	HTS + 3.4"	101/28	9%	H3 + 23.8"
73/80	5%	CTS + 0.7"	101/28	7%	H3 + 28.6"
73/82	15%	HTS + 3.1"	101/28	16%	H3 + 8.3"
76/19	7%	HTS + 4.0"	101/28	2%	H3 + 29.7"
78/35	13%	HTS + 7.1"	102/39	7%	HTS + 1.2"
78/47	5%	HTS + 3.1"	104/33	4%	HTS + 0.9"
78/47	4%	HTS + 3.8"	108/41	8%	H2 + 6.2"
79/36	11%	HTS + 1.0"	110/15	17%	HTS + 1.0"
79/78	18%	CTS + 12.6"	112/5	4%	H2 + 12.5"
80/29	7%	HTS + 16.2"	112/63	2%	H4 + 15.2"
80/51	1%	HTS + 1.5"	114/5	11%	H2 + 6.3"
80/79	6%	H2 + 12.6"	114/5	11%	H2 + 6.8"

TABLE 2

LIST OF TUBES PLUGGED

DURING 1993 REFUELING OUTAGE

STEAM GENERATOR A

No Tubes Plugged

STEAM GENERATOR B

Line/Row	Reason
69/80	45% at H7 + 1.9"

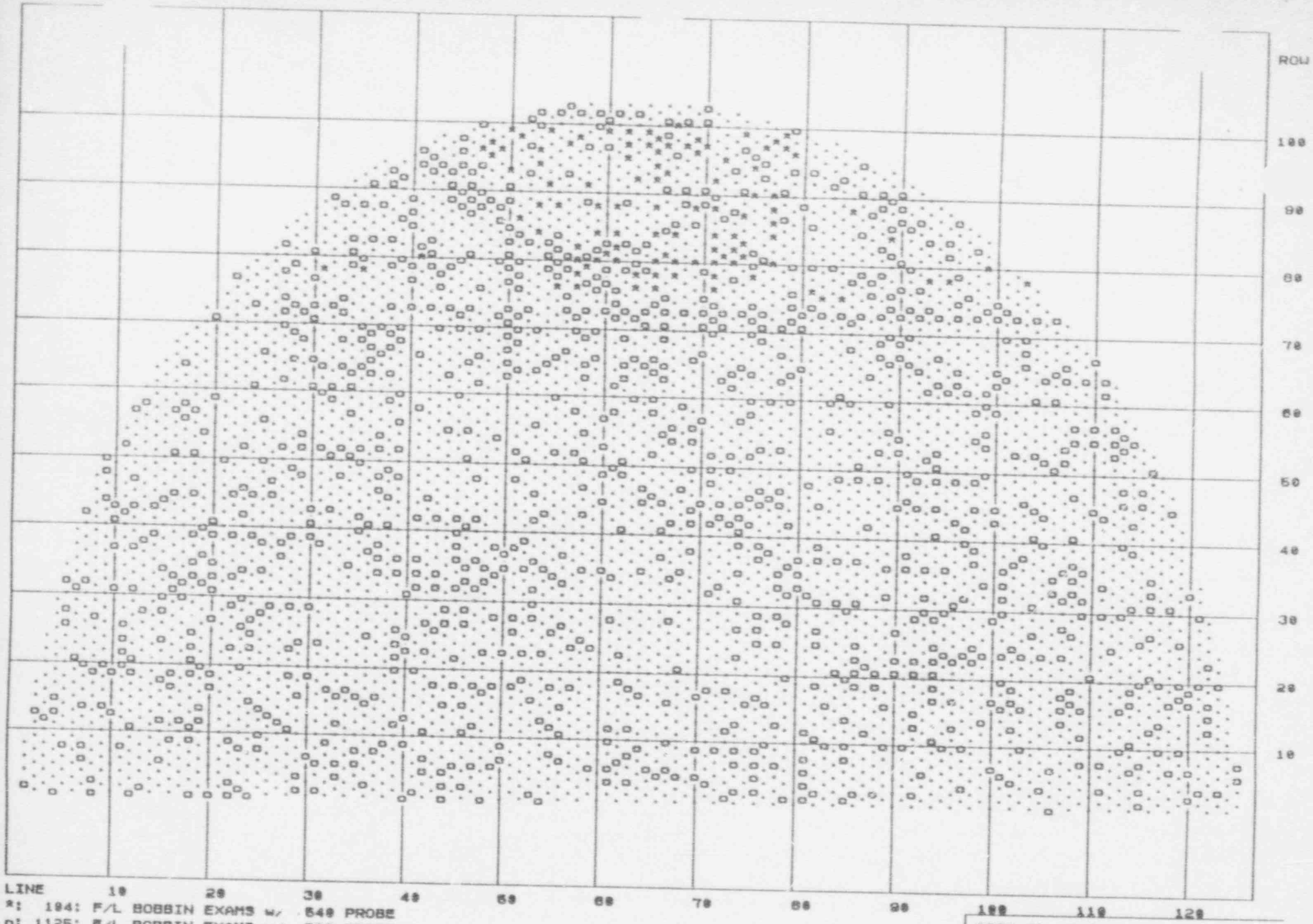

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FIGURE 1

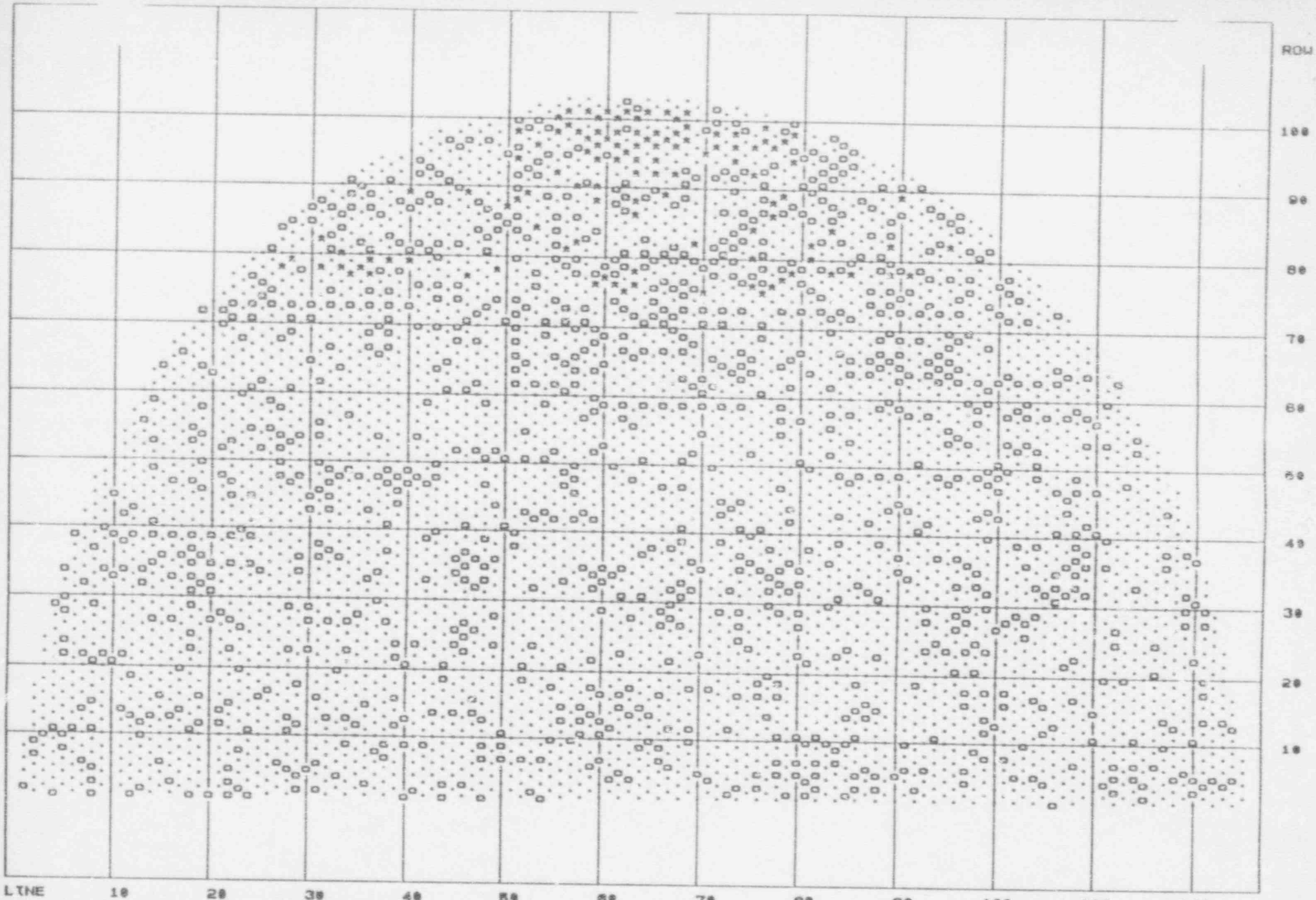

FIGURE 2

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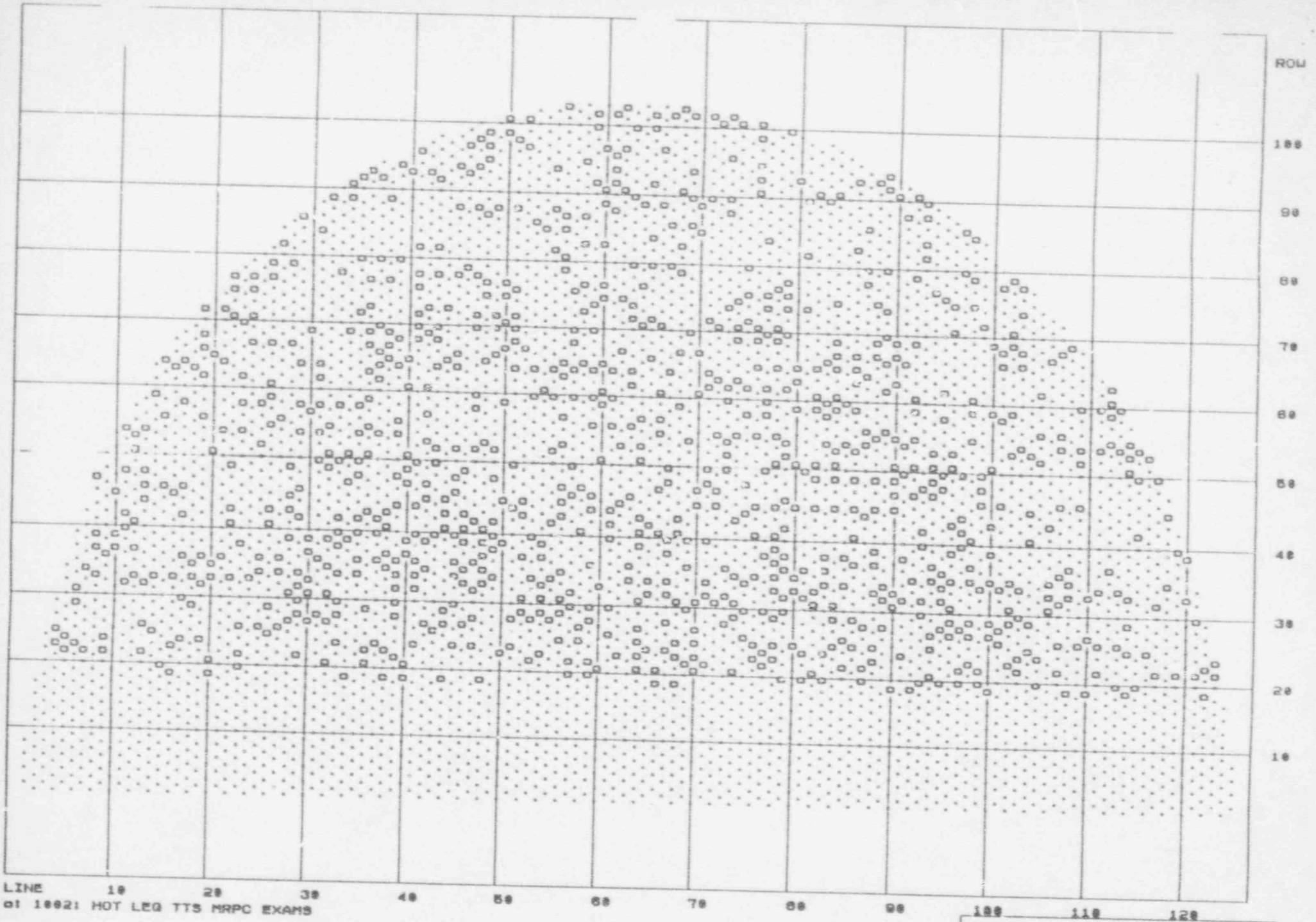
ROW
100
90
80
70
60
50
40
30
20
10
LINE
10
20
30
40
50
60
70
80
90
100
110
120
01 1002: HOT LEG TTS MRPC EXAMS
OPPD Ft. Calhoun Unit 1
Steam Generator A
ABB/CE Data Management 11/29/93
ACRI 1313 Tubes

FIGURE 3

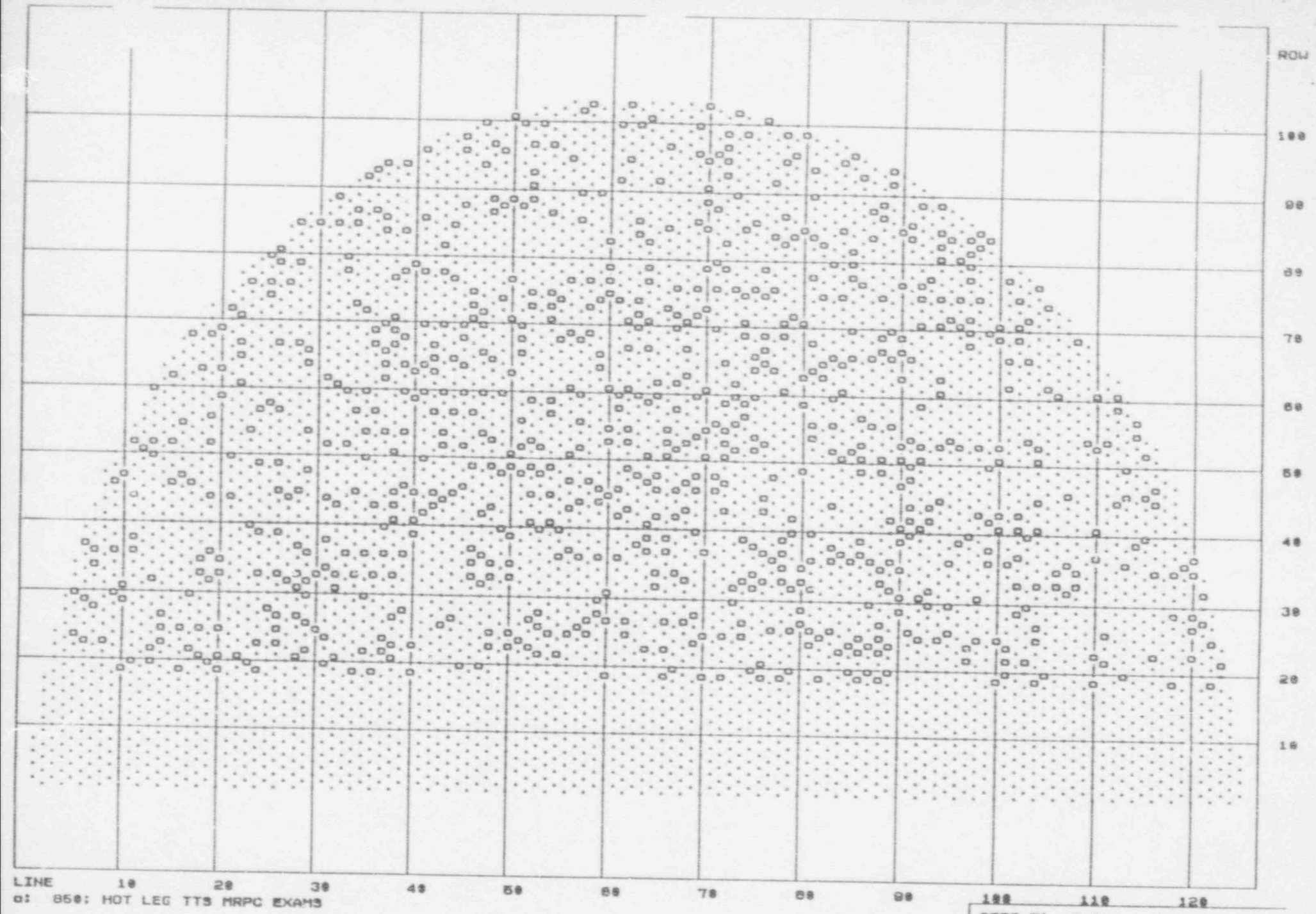
ROW
100
90
80
70
60
50
40
30
20
10
LINE
10
20
30
40
50
60
70
80
90
100
110
120
o: 850: HOT LEG TTS MRPC EXAMS
OPPD Ft. Calhoun Unit 1
Steam Generator B
ABB/CE Data Management 11/30/93
ACRI ISIS Tubes

FIGURE 4

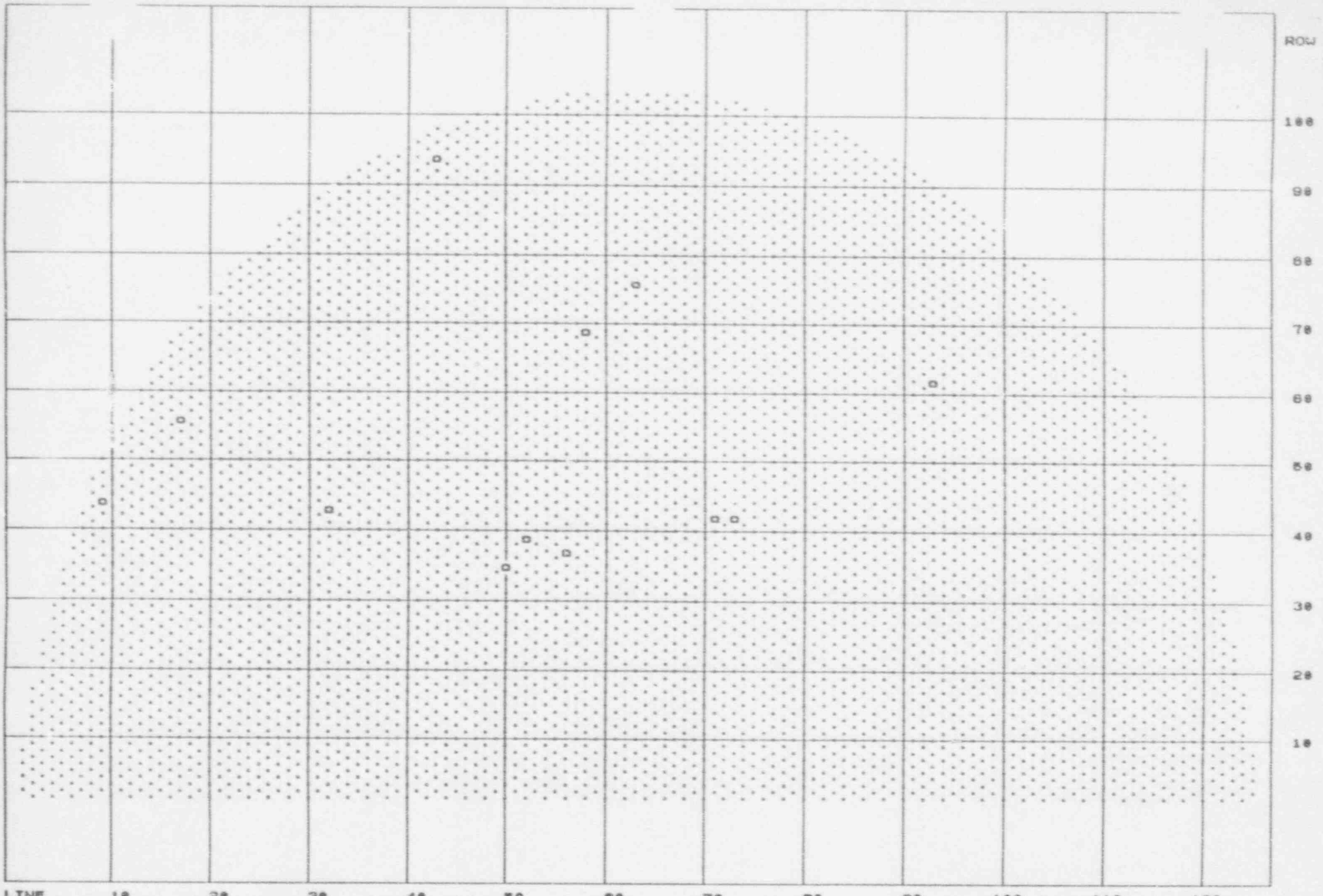

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FIGURE 5

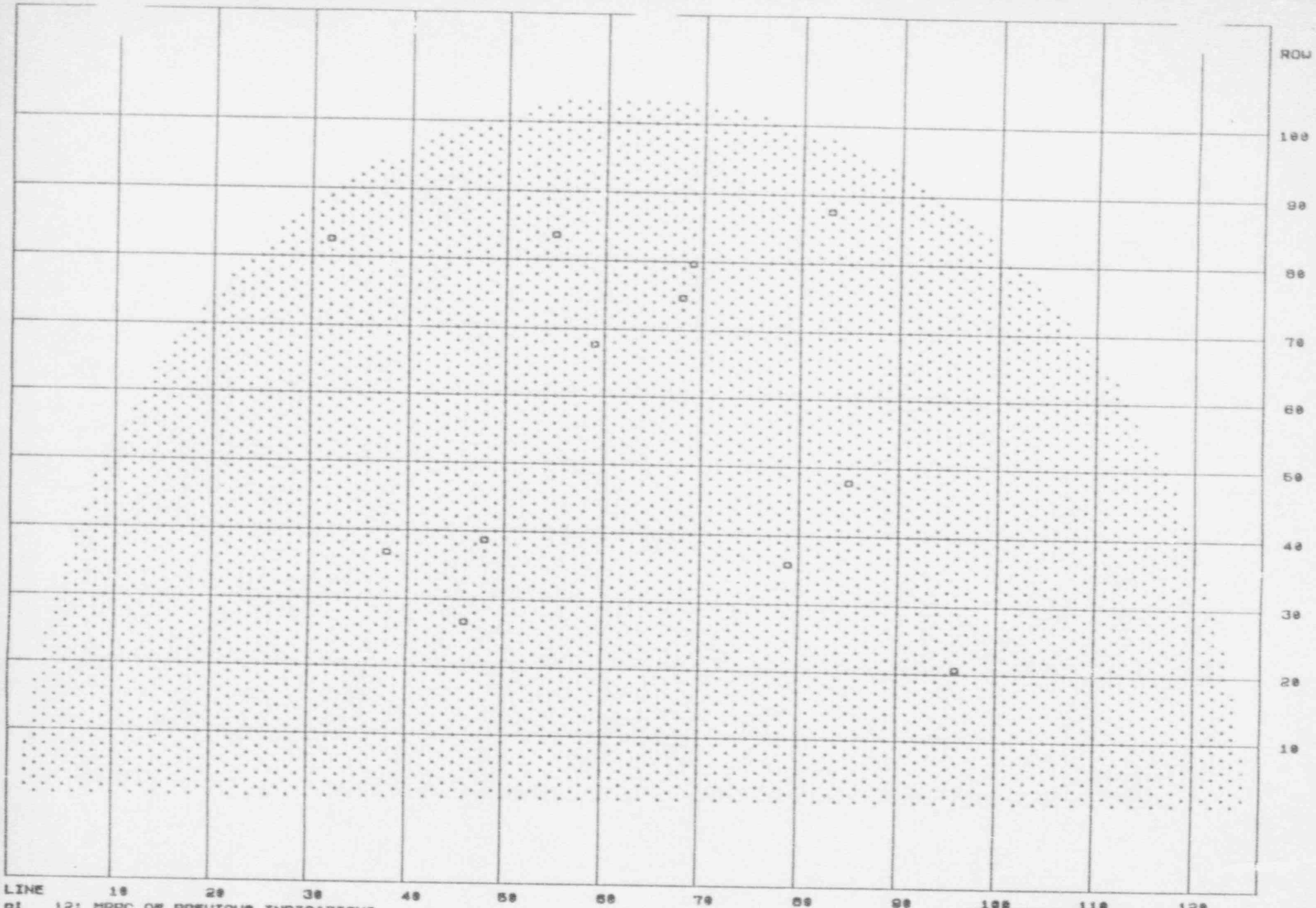

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FIGURE 6

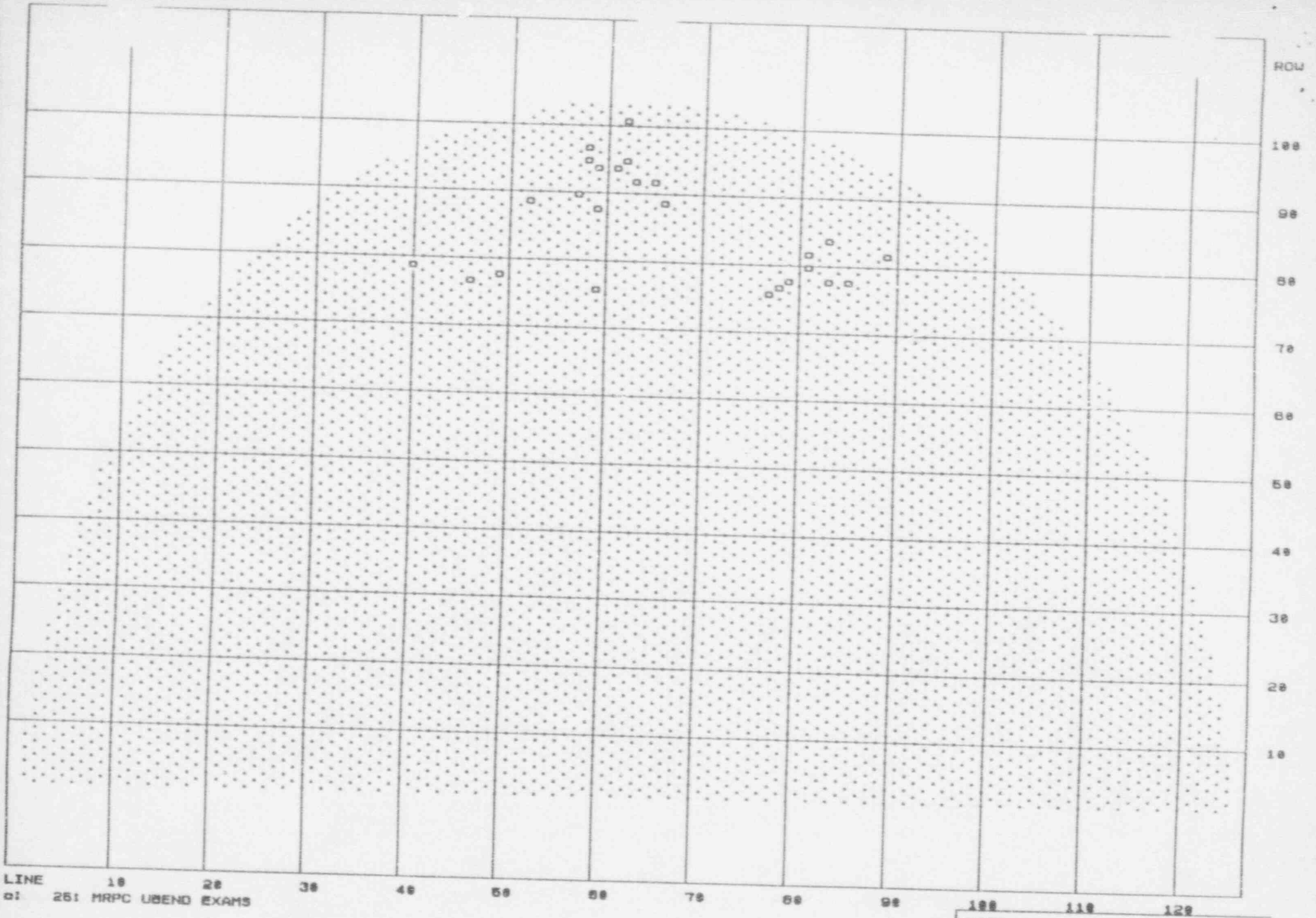

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FIGURE 7

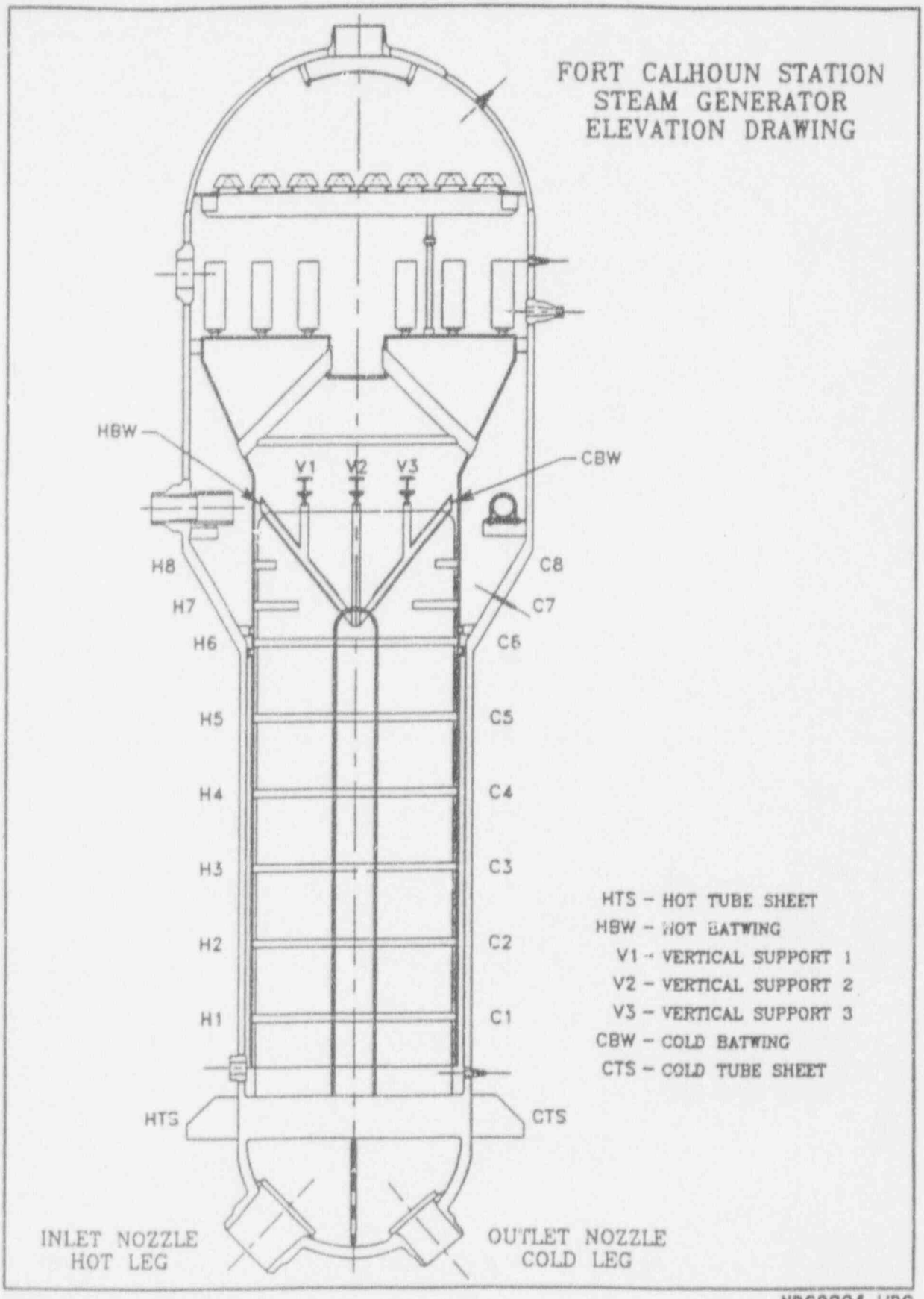
FORT CALHOUN STATION
STEAM GENERATOR
ELEVATION DRAWING
HBW
CBW
V1
V2
V3
H8
H7
H6
H5
H4
H3
H2
H1
C8
C7
C6
C5
C4
C3
C2
C1
HTS
CTS
HTS - HOT TUBE SHEET
HBW - HOT BATWING
V1 - VERTICAL SUPPORT 1
V2 - VERTICAL SUPPORT 2
V3 - VERTICAL SUPPORT 3
CBW - COLD BATWING
CTS - COLD TUBE SHEET
INLET NOZZLE
HOT LEG
OUTLET NOZZLE
COLD LEG
NRC9204.WPG

FIGURE 8