

TURKEY POINT 3 STEAM GENERATOR
INSPECTION PROGRAM

I. Introduction

An extensive inspection program for the Turkey Point Unit 3 steam generators was conducted in October, 1980. The following items were accomplished:

1. gauging of steam generator hot legs and cold legs - all steam generators
2. measurements of #1 tube support plate flow slots in all steam generators
3. eddy current inspection of small radius U-bends in steam generator A
4. Regulatory Guide 1.83 eddy current measurements in the hot legs and cold legs of all steam generators
5. preventive plugging

Table 1 is a summary of the approximate number of steam generator tubes inspected in each category and in each steam generator.

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Table 1: Summary of Total Steam Generator Tubes Inspected

	<u>A Hot Leg</u>	<u>A Cold Leg</u>	<u>B Hot Leg</u>	<u>B Cold Leg</u>	<u>C Hot Leg</u>	<u>C Cold</u>
Gauging	1170	144	1342	210	1273	231
U-Bend Rows						
2-5	--	141	--	--	--	--
R.G.	155	428	199	42	260	150

This report summarizes the inspections conducted, the results of these inspections and preventive plugging programs accomplished.

II. Inspection Programs

A. Gauging Program

The tube gauging program in the tubelane area is based on previously defined regions where significant tube deformation has occurred.

These regions were formerly determined using finite element analysis techniques which yield tube hoop strain contours as a function of plate deformation. The boundary in the peripheral tubelane areas near the three and nine o'clock wedge locations is modified to take into account the greater extent of deformation in this region of the plate determined by previous experience. After four reinspections since the first gauging inspection at Turkey Point 3, it became apparent that the finite element model no longer gave reasonable

expectations as to the position of a strain boundary which might be linked to location of the most severely restricted tubes. The 17.5% strain contour utilized in the 12/79 inspection would encompass most of the hot leg tube bundle at 24 effective full power months beyond closure of the support plate flow slots, which is regarded as having occurred as of the 12/77 inspection. (The tube hoop strain at 24 effective full power months beyond full closure is given for reference purposes in Figure 1). Therefore, the gauging program, based on the program used in 12/79, has been adjusted to reflect prior experience at the Surry and Turkey Point plants. Additional inspection programs were defined for the periphery, wedge, and patch plate regions. These programs were based on previous tube leakage histories at the Turkey Point and Surry plant sites, as well as previous gauging results at the Surry and Turkey Point sites, as deemed appropriate. Due to the current awareness of the potential for tube deformation on the cold leg side, inspections of all three steam generator cold legs were performed.

The inspection boundary for the December 1979 inspection (Figure 2) is included for reference. The gauging inspection boundaries for the October 1980 inspection are indicated in Figure 3 (typical hot leg) and Figure 4 (typical cold leg).



The following conservatisms were utilized in determining the Turkey Point 3 inspection boundary:

1. If a restricted tube was found close to the inspection boundary, the inspection was expanded in that area.
2. In addition to the specific gauging inspection program, it should be noted that tubes in the central portion of the tube bundles from Row 13 upward were tested with 700 mil probes, providing early indications on any new deformation which might exist away from the regions usually regarded as active, i.e. the tubelane, patch plate, wedges, and periphery.
3. Tubes restricted in previous inspections, but not adjacent to the areas of predominant activity were incorporated into the gauging program laid out generally for the three steam generators.

B.. Flow Slot Measurements

Photographs were taken in each steam generator through the secondary handholes. These photographs were then utilized to measure the openings in the #1 tube support plate flow slots. Results are discussed in Section III. Flow slot measurements are utilized in the finite element analysis work and are an indicator of the present status of denting in the steam generators.

C. Other Denting Related Inspections

The U-bends of unplugged tubes in Rows 3 thru 5 in steam generator A were examined with 100 KHz. These inspections are performed to confirm the integrity of the small radius U-bends in low number rows.

In the January 1979 inspection, annulus measurements were taken in steam generator B. These measurements provide a qualitative indicator of the upper plate expansion trends in the most affected steam generator. That had been the second such measurement of this type for steam generator B. No obvious trends had been noted in this unit or in three such measurements in Turkey Point Unit 4. Therefore, this measurement was not made at this inspection and is not planned for future inspections.

D. Regulatory Guide 1.83 (R.G. 1.83) Inspection

The types and extent of inspections required in this area are specified in R.G. 1.83. Typical inspection plans are included (Figures 5 and 6). During the inspections, expansions of the program in steam generators A and C were accomplished as required by R.G. 1.83. Results of the inspection are discussed later in this report.

III. Inspection Results

A. Gauging Program

Results of the gauging inspections are indicated in Figures 7, 8, 9, 10, 11 and 12 and are summarized in Table 2. It should be noted that the tubes inspected included tubes R22 C13 (S/G3A) and R12 C80 (S/G3B). These tubes were previously reported to have been inadvertently omitted from the last inspection program and were committed to be inspected during this outage (letter L-80-26, January 18, 1980). The inspection results confirmed that neither tube required plugging nor were they located in areas of generalized denting.

TABLE 2: Tube Restriction Summary

Number of Tubes Restricting Passage of Gauge

S/G Gauge <u>Diameter</u>	Tubelane		Periphery and Wedge		Patch Plate
	<u>Hot Leg</u>	<u>Cold Leg</u>	<u>Hot Leg</u>	<u>Cold Leg</u>	<u>Hot Leg</u>
SG A					
.650"	22	0	22	0	25
.610"	4	0	1	1	0
.540"	9	0	2	0	0
SG B					
.650"	14	0	7	0	3
.610"	1	1	1	0	0
.540"	0	0	0	0	0
SG C					
.650"	25	0	8	0	5
.610"	4	0	0	2	1
.540"	2	0	0	0	0



Summary comments resulting from the review of this and other data are as follows:

1. In steam generators A, B, and C, restricted tubes generally developed adjacent to previous activity or clustered together with other new activity. This was particularly true of tubes that restricted the 0.610" and 0.540" probes. Areas of activity were consistent with past historical data for this and other plants.
2. Tube restrictions were noted in some of the inspected wedge areas (in the hot legs) of all steam generators and this activity appears consistent with previous experience at this and other units.
3. In this inspection of the cold leg areas, only one tube restriction was noted in the tubelane regions (SGB). No activity was noted in four of the six cold leg wedge areas inspected. Slight activity was noted adjacent to one of the inspected wedge areas in each of SG/A and SG/C. The level of activity is consistent with that noted in previous Turkey Point inspections. The overall level of activity continues to indicate a very low growth rate as compared to the hot leg.
4. During the last approximately 8.5 EFPM of operations, no shutdowns due to leakage events occurred.

5. Review of the gauging results for this period shown that 82 tubes were reported restricted in the tubelane region, this compares with 75 observed in December, 1979 after 6 EFPM and 214 in 1/79 after 9.5 EFPM. A restricted tube is defined as a tube not passing a 650 mil probe. The apparent limitation in the number of restrictions reflects the fact that plugging in December, 1979 was performed for a 10 month period, but less than 3.5 months operation actually ensued.

8. Flow Slot Measurements

The results of the flow slot measurements are indicated in Figure 16. Only the lower support plates are clearly visible in each S/G. The results are consistent with previous behavior.

C. Other Denting Related Inspections

The U-bends of unplugged tubes in rows 3 thru 5 in steam generator A were examined at 100 kHz. No indications were noted in these small radius U-bends.

D. Regulatory Guide 1.83 Inspection Results and Evaluation

The results of the Regulatory Guide 1.83 Inspection are summarized in Table 3. As a result of this inspection, a total of fourteen tubes will be plugged for indications equal to or greater than 40% wall penetration. An additional tube (R4-C46) in steam generator A is pluggable on this basis, but is also pluggable due to a .540 inch

restriction. The pluggable tubes are generally located in rows 5 to 8, inclusive, with only a few in higher rows, as shown in Figures 13 and 15.

Evaluation of the results suggests probable thinning in the region of the sludge pile in the cold leg.

Comparison of the eddy current signals from the affected tubes with corresponding signals from previous inspections indicates that no major change in depth of penetration has occurred. Therefore, it is concluded that the rate of thinning has not increased substantially.

TABLE 3

Regulatory Guide 1.83

Inspection Results

Size of Indication

(%Wall Penetration)

	<u>SG A</u>		<u>SG B</u>		<u>SG C</u>	
	<u>Inlet</u>	<u>Outlet</u>	<u>Inlet</u>	<u>Outlet</u>	<u>Inlet</u>	<u>Outlet</u>
<20	8	140	4	32	5	45
20-29	2	74	1	20	3	88
30-39	0	29	0	11	1	24
>40	0	14	0	0	1	0

IV. Plugging Criteria

A. Gauging Program

Although experience has shown that advance of the predicated strain contours from the finite element model no longer is an appropriate basis for tube plugging, the plugging criteria which were developed using the model have been retained, since their application has generally been conservative and effective in reducing the frequency of tube leakage events resulting from denting. As in the May, 1980 inspection of Turkey Point 4, a program which incorporates all previously observed activity with several rows margin beyond is considered appropriate; again a sampling of central area tubes provided by the Reg. Guide 1.83 inspection permits detection of new areas of activity (should any occur).

The criterion established for plugging tubes in the region of the patch-plate differs from that used for other regions of the bundle. All leaks in the patchplate region have occurred at the perimeter of the plate or near to the patchplate boundary, where plug welds connect the patchplate to the main body of the tube support plate. All observed data indicate that the phenomenon at the patchplate is local in nature and is not consistent with the general strained state of the plate, nor can the phenomenon be represented by the finite element model. Due to these factors, the region of the patchplate is inspected and a specific set of plugging criteria applied. Because

of the fact that leakers in this region have not always restricted 0.540 inch probes, leakers and tubes that restrict the 0.540 inch probe should be treated alike, and the surrounding tubes about both should be plugged. In addition, tubes that restrict the 0.610 inch probe should be plugged and tubes on either side of the patchplate boundary (plate perimeter on one side the plug welds on the other three sides) that restrict the 0.650 inch probe should be plugged.

Due to the local plate cracking that is believed to occur at the periphery and near wedge locations, tube leaks may occur here at lower levels of tube restriction than in the tubelane. Thus, the wedge areas should have their own inspection program and plugging criteria. The plugging criteria at hot leg wedge locations calls for treating leakers and tubes that restrict the 0.540 inch probe in a similar manner. In addition, tubes that restrict the 0.610 inch probe and peripheral tubes that restrict the 0.650 inch probe should be plugged. Cold leg plugging will be based on the degree of activity noted and rates of progression observed from gauging.

The plugging criteria which support at least six months of operation are:

1. All tubes which do not pass the 0.540 inch probe will be plugged.
2. Additionally, two (2) tubes beyond (i.e., higher row numbers) any tube in columns 1-92 which did not pass the 0.540 inch probe in the tubelane region will be plugged.

3. All tubes which do not pass the 0.610 inch probe will be plugged.
4. The tubes in any column for which plugging under criteria (1), (2), or (3) above is implemented in the tubelane region will also be plugged in the lower row numbered tubes back to the tubelane if not already plugged.
5. As a conservative measure, tubes completely surrounding any known leaking tubes including the diagonally next tube will be plugged if not already covered by the foregoing criteria. Since no leaking tubes were discovered, application of this criterion is not required.
6. In any given column which is surrounded by columns containing tubes with significant tube restrictions or prior plugging, (thereby creating a "plugging valley" in the pattern) engineering judgement will be used to fill the bottom of the valley.
7. Additional preventive plugging will be implemented at the hot leg wedge locations. This plugging will include all tubes that:
 - a. restrict the 0.540 inch probe.
 - b. restrict the 0.610 inch probe.
 - c. restrict the 0.650 inch probe at the periphery

- d. surround leakers and tubes that restrict the 0.540 inch probe including the diagonally next tube
- 8. Application of the criteria specified in 7. above, will be made on the basis of engineering judgement. for cold leg wedge locations.
- 9. Additional preventive plugging will be implemented in the patchplate region. This plugging will include all tubes that:
 - a. restrict the 0.540 inch probe
 - b. restrict the 0.610 inch probe
 - c. surround leakers and tubes that restrict the 0.540 inch probe including the diagonally next tube
 - d. lie on either sides of the patchplate boundary (plate perimeter on one side, the plug welds on the other three) and restrict the 0.650 inch probe.

The six month operating period was also evaluated relative to a postulated main steam line break accident (MSLB). In doing this, it was conservatively assumed that each unplugged tube in the two rows beyond the present tubelane

plugging boundary would leak at a rate of 0.05 gpm/tube during a postulated main steam line break. Using the fact that there are 92 tubes in a row, the total number of unplugged tubes in the tubelane region lying adjacent to the current plugging boundary at the end of the next six months is less than:

$$2 \times 92 \text{ tubes per row} = 184 \text{ tubes}$$

The total resulting leakage from these tubes would be:

$$184 \text{ tubes} \times \frac{0.05 \text{ GPM}}{\text{tube}} = 9.2 \text{ GPM}$$

This added to the 0.3 GPM leakage assumed to be present at the start of a postulated main steam line break (which would increase to approximately 0.7GPM due to MSLB differential pressures) yield a total leakage less than 10 GPM, which has been determined in previous submittals to be an acceptable level of leakage during a postulated MSLB.

B. Regulatory Guide 1.83

The criteria for plugging tubes in this area are established in the regulatory guide.

C. Preventive Plugging Accomplished

The preventive plugging programs that were implemented are indicated in Figures 13, 14 and 15. Both gauging and Regulatory Guide 1.83 program plugging are indicated. Table 4 summarizes this plugging.

TABLE 4 Summary of Tubes Plugged

	<u>Gauging</u>	<u>R.G 183</u>
SG A	57	13
SG B	7	0
SG C	22	1
	<hr/>	<hr/>
TOTAL	86	14

025000 140300Z

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100

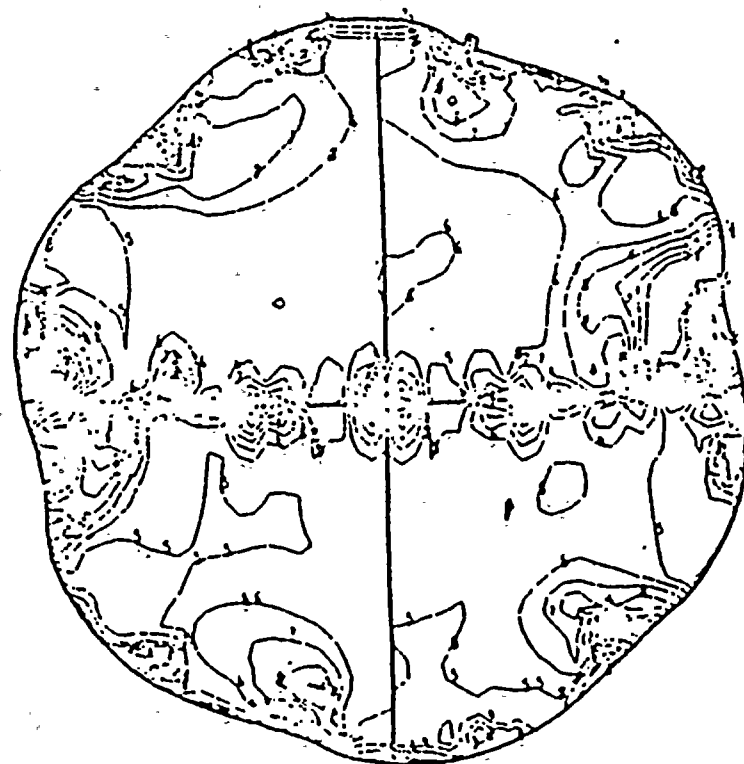
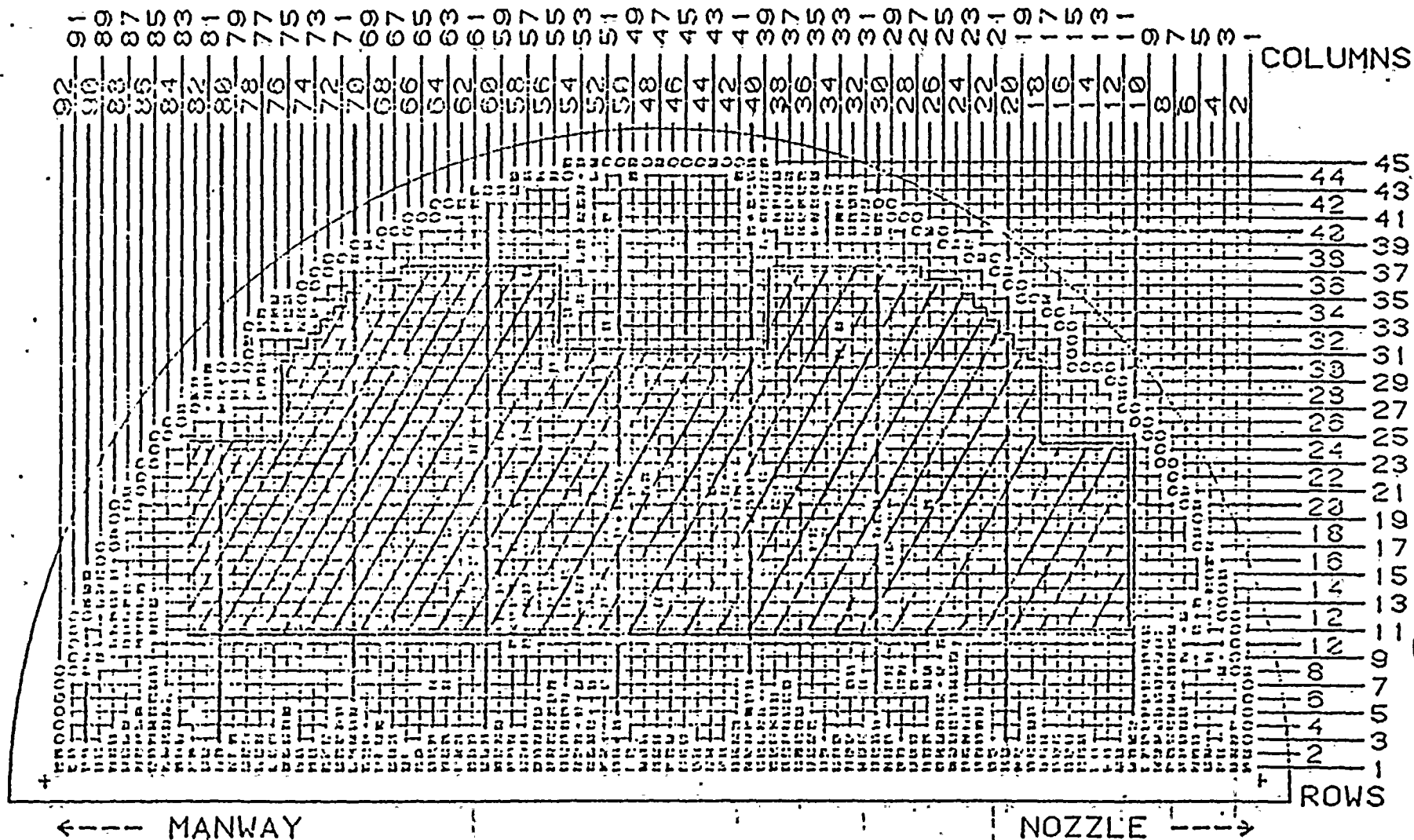


FIGURE 1 - TUBE HOOP STRAIN AT
24 EFPM's BEYOND FULL CLOSURE

OCTOBER 1980

FPL-A



FPL-A

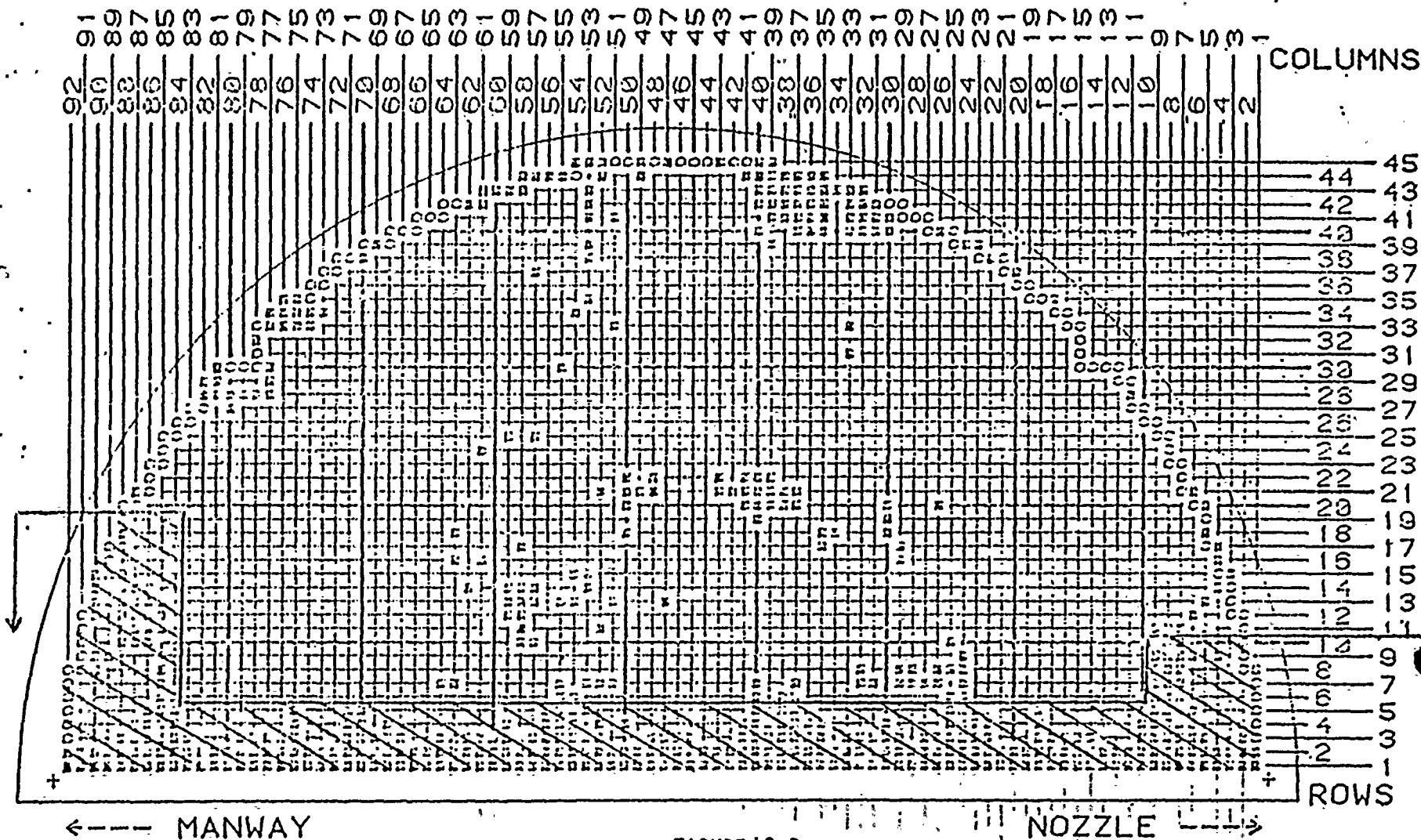


FIGURE 2 B
TYPICAL GAUGING INSPECTION
BOUNDARY - COLD LEG
DECEMBER 1979 INSPECTION
Test Blocked-In Region

FIGURE 3

GAUGING PROGRAM (TYPICAL) INLET

SERIES 44

GAUGE ALL TUBES OUTSIDE BOUNDED AREA, OCTOBER, 1980

FPL-A

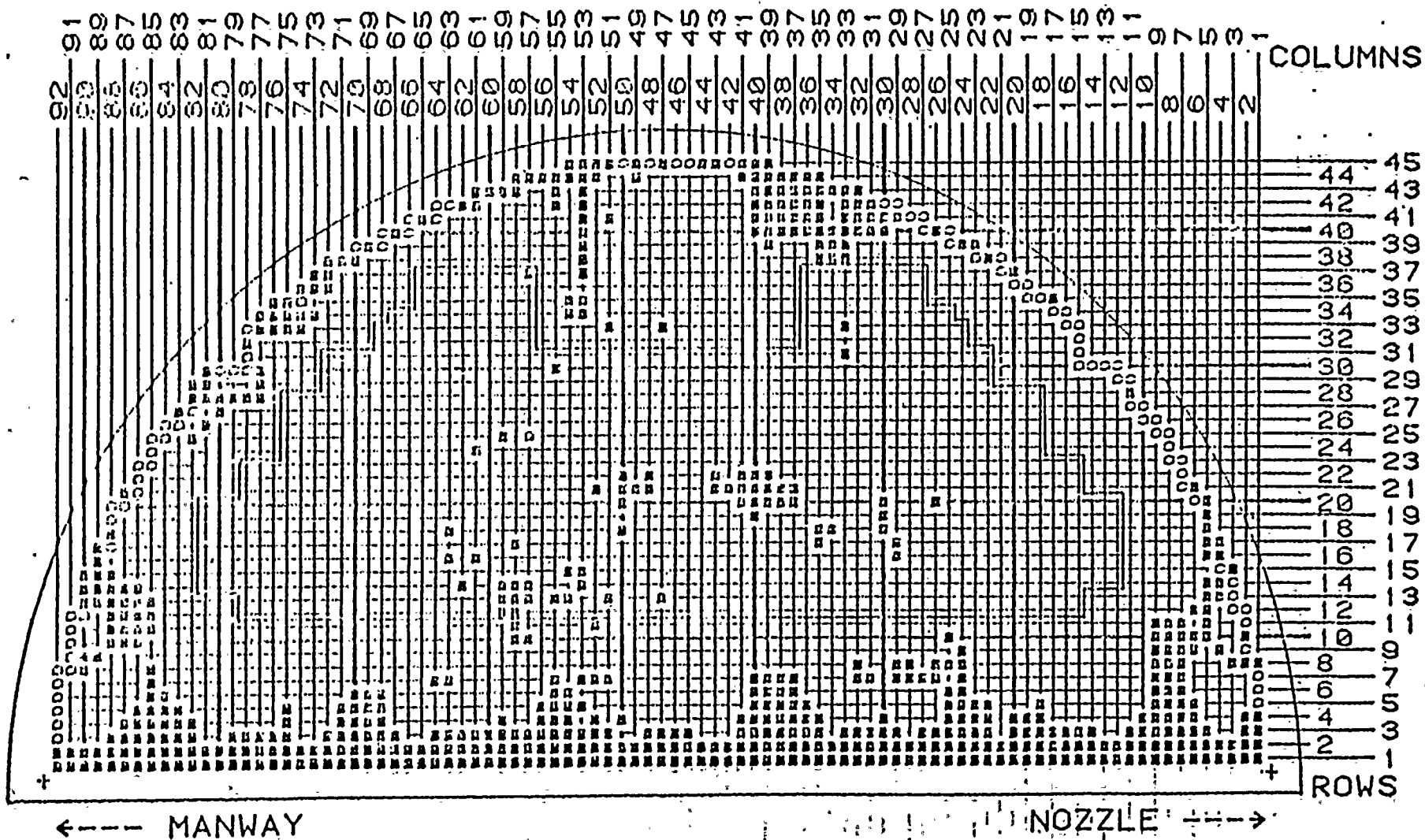


FIGURE 4

GAUGING PROGRAM (TYPICAL) OUTLET
GAUGE ALL TUBES WITHIN BOUNDED AREA
OCTOBER, 1980

SERIES 44

FPL-A

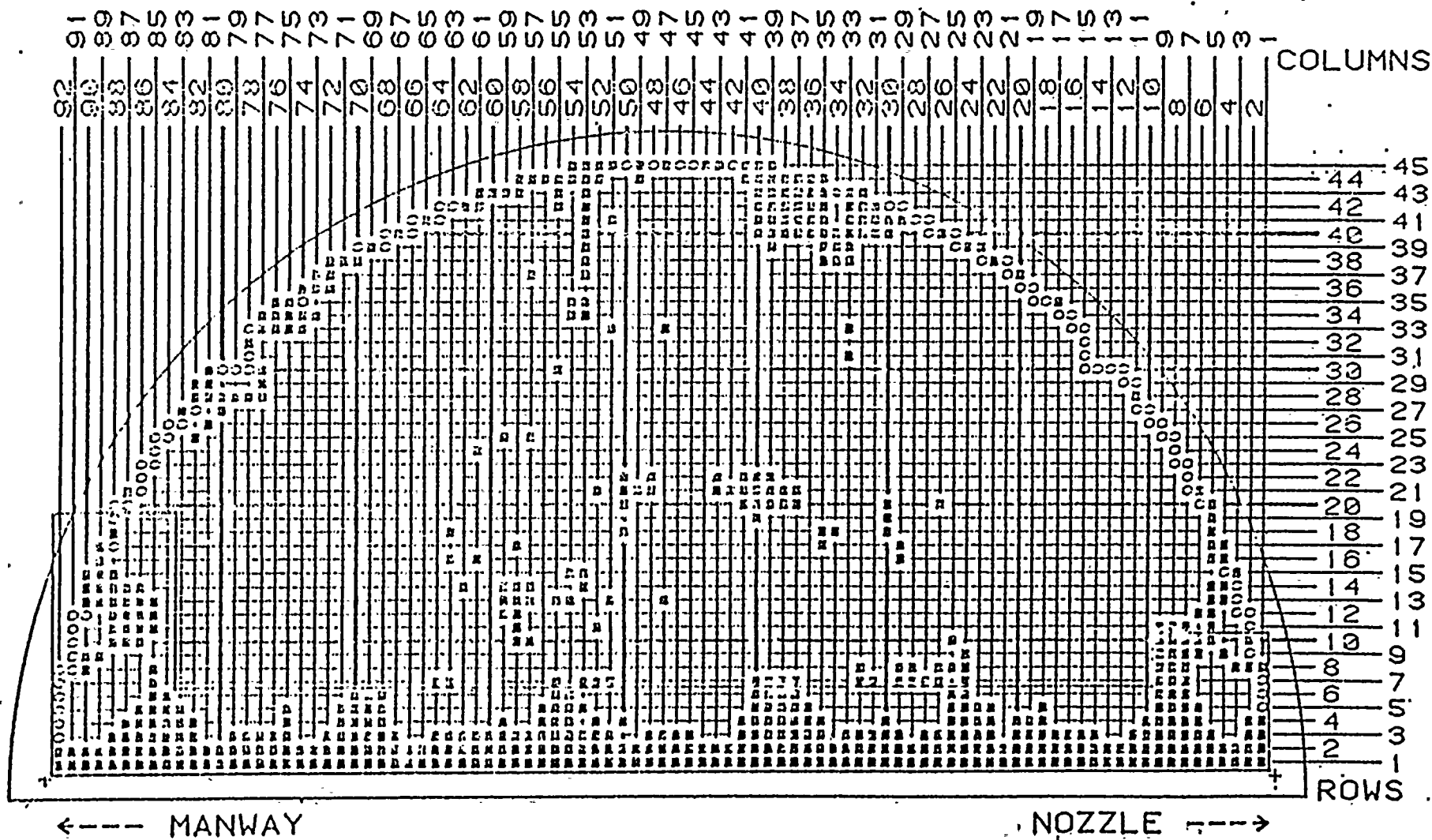



FIGURE 5

Regulatory Guide 1.83 Inspection
Program (Typical) - Inlet Leg

- X. REG. GUIDE - INSPECT THRU URBEND W/ 720-SF (ALT 700F) - 151 TUBES (PROGRAM LISTING SHEETS Identify these Tubes by RG IN EXTENT COLUMN ALONG W/ EXTENT OF IMPACT.)
- ALL TUBES OUTSIDE  AREA - GAUGE STARTING W/ 650 ϕ , followed by 610 ϕ and 540 ϕ Probes for those restricted. - 1150 TUBES (Program Listing Sheets Identify these tubes by EXTENT ENTRY - 6" Support - ONLY)
- FOR THOSE REG. GUIDE TUBES (X) RESTRICTED TO 720 or 700F, Gauge W/ 650 ϕ - IF RESTRICTED TO 650, Gauge (Thru Top Support) WITH 610 & 540 ϕ AS REQD. WHEN THE X TUBE IS IDENTIFIED AS BEING RESTRICTED TO 650 ϕ , box that tube in by doing the adjacent B tubes Thru 6" Support with 650 ϕ probe. Any found restricted must have adjacent tubes gauged w/ 650 (w/ 610 in) as well as that tube being gauged thru.
- FOR THOSE TUBES OUTSIDE of Gauging Program that are restricted, insure that adjacent tubes are gauged w/ 650 ϕ etc. If an adjacent tube had been inspected (or gauged) during REG. GUIDE IT IS NOT NECESSARY TO RE-GAUGE.

SERIES 44

FPL-A
INLET

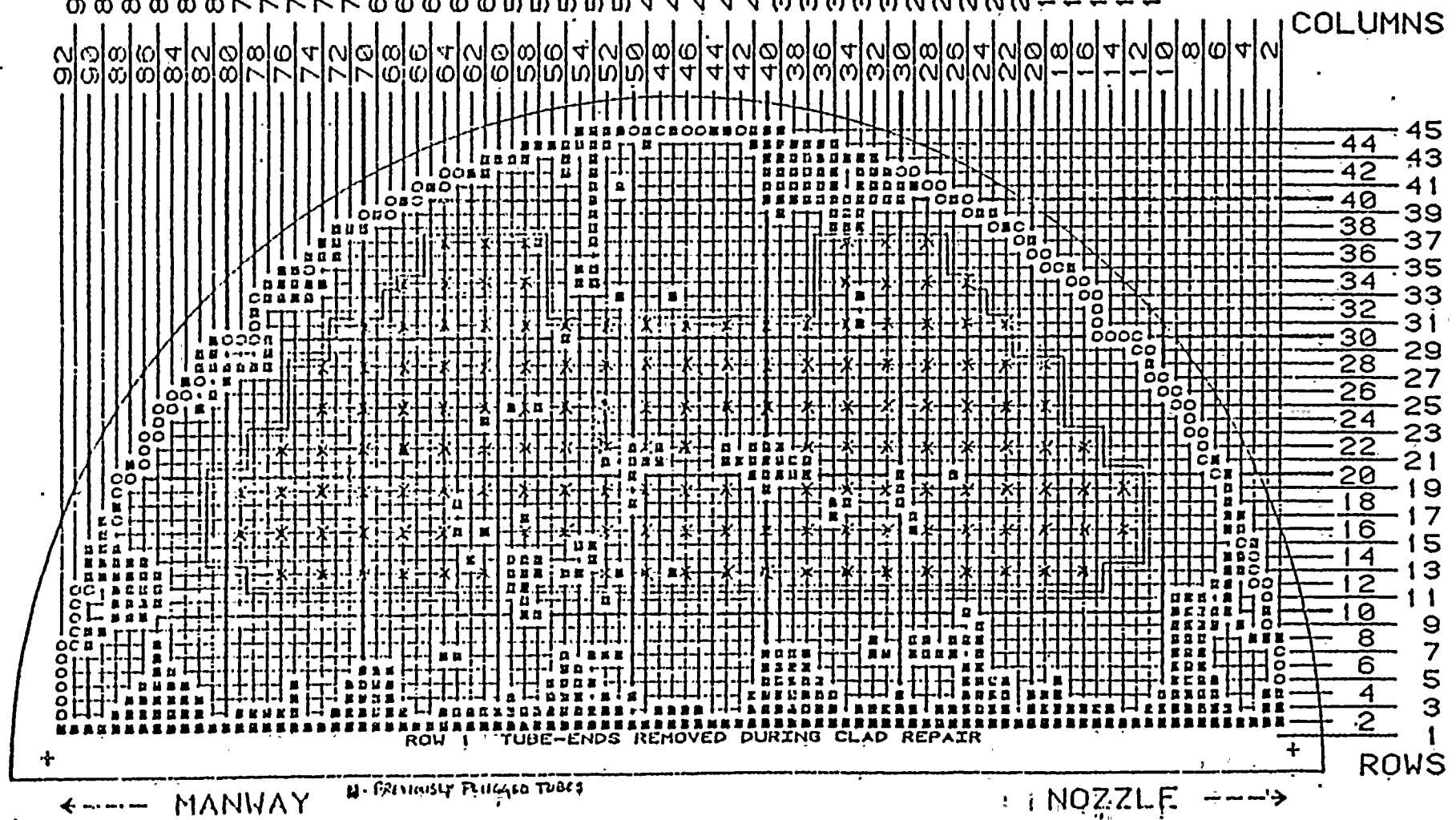



FIGURE 6

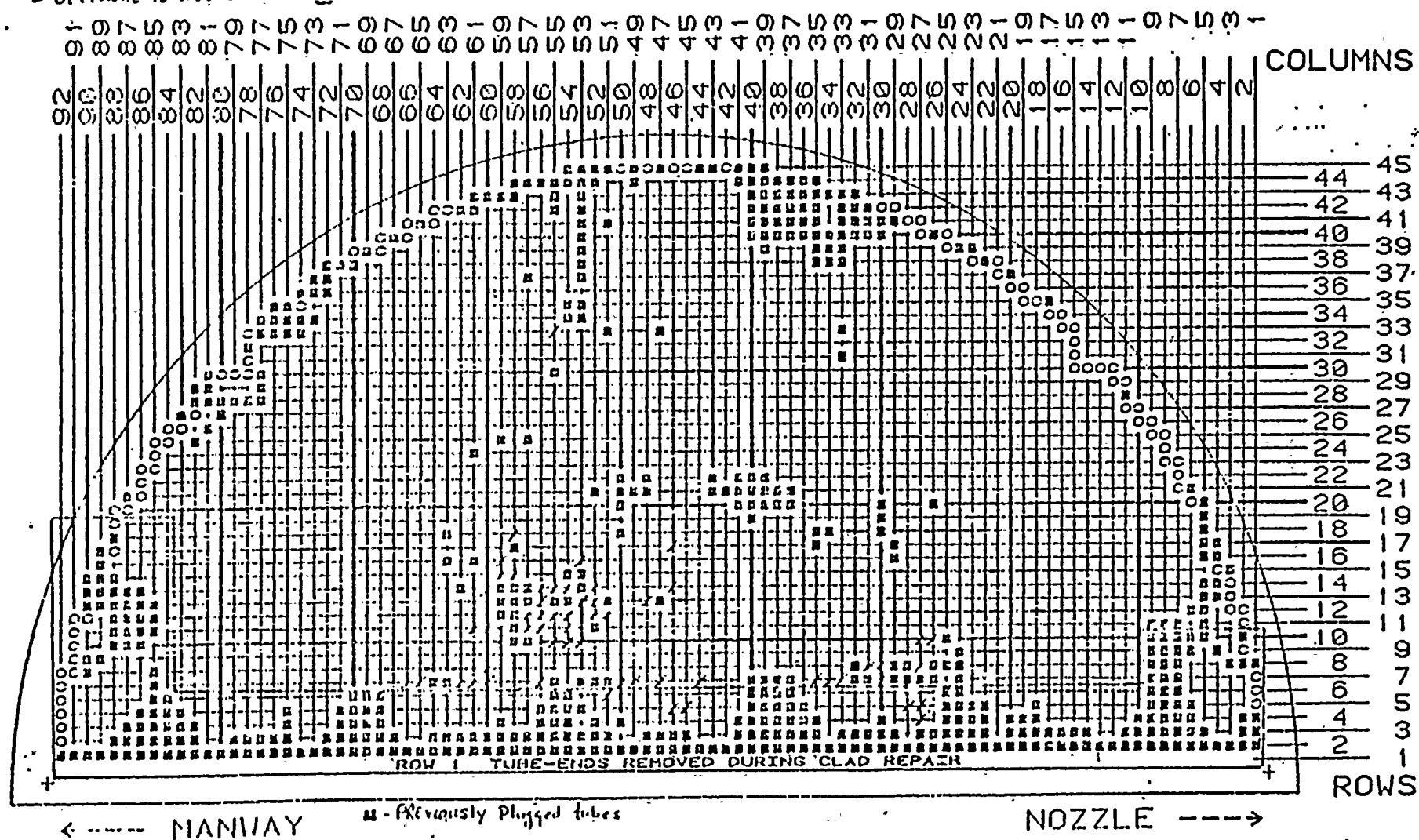
Regulatory Guide 1.83 Inspection
Program (Typical) - Outlet Leg

- REG. GUIDE - 1 - INSPECT 59 TUBES THRU 1ST SUPPORT W/ 726SF (726FAU) - IF ANY TUBES ARE FOUND TO BE restricted, Gauge w/ 610 ϕ probe to 6th support, Gauge adjacent tubes w/ 610, & any \geq 610 ϕ restrictions WITH 540 ϕ . CONTINUE ADJACENT TUBE 'BOX IN' UNTIL ALL ADJACENT TUBES PASS 610 ϕ RESTRICTIONS WITH 540 ϕ . CONTINUE LISTING SHEET EXTENT COLUMN BY 'RA' AND EXTENT
- REG GUIDE TUBES ARE IDENTIFIED IN PROGRAM LISTING SHEET EXTENT COLUMN BY 'RA' AND EXTENT
 - GAUGE 289 TUBES INSIDE  THRU 6th SUPPORT W/ 610 F (OR L OR BF) FOLLOWED BY 540 F (OR BF) IF RESTRICTED TO 610
 - 'BOX IN' ALL RESTRICTED TUBES ON EDGE OF PATTERN UNTIL ALL ADJACENT TUBES PASS 610 ϕ
 - OF 289 TUBES ARE GAUGING, ALL OPEN TUBES IN ROWS 3 THRU 5 ARE TO BE INSPECTED THRU UREND - USE 610 BF W/ TUBER (and mol) followed by 540 BF IF 610s ARE RESTRICTED. REFER TO JOB DATA SHEET FOR BRUSH CHART SETUP
 - OPTIONAL TO USE 610 & 540 BF'S IN ENTIRE PROGRAM IN LIEU OF F OR L TYPE PROBES.

SERIES 44

FPL-A

OUTLET



Turkey Point Unit 3
 Steam Generator A - Inlet
 Gauging Results - October, 1980

Restrictions

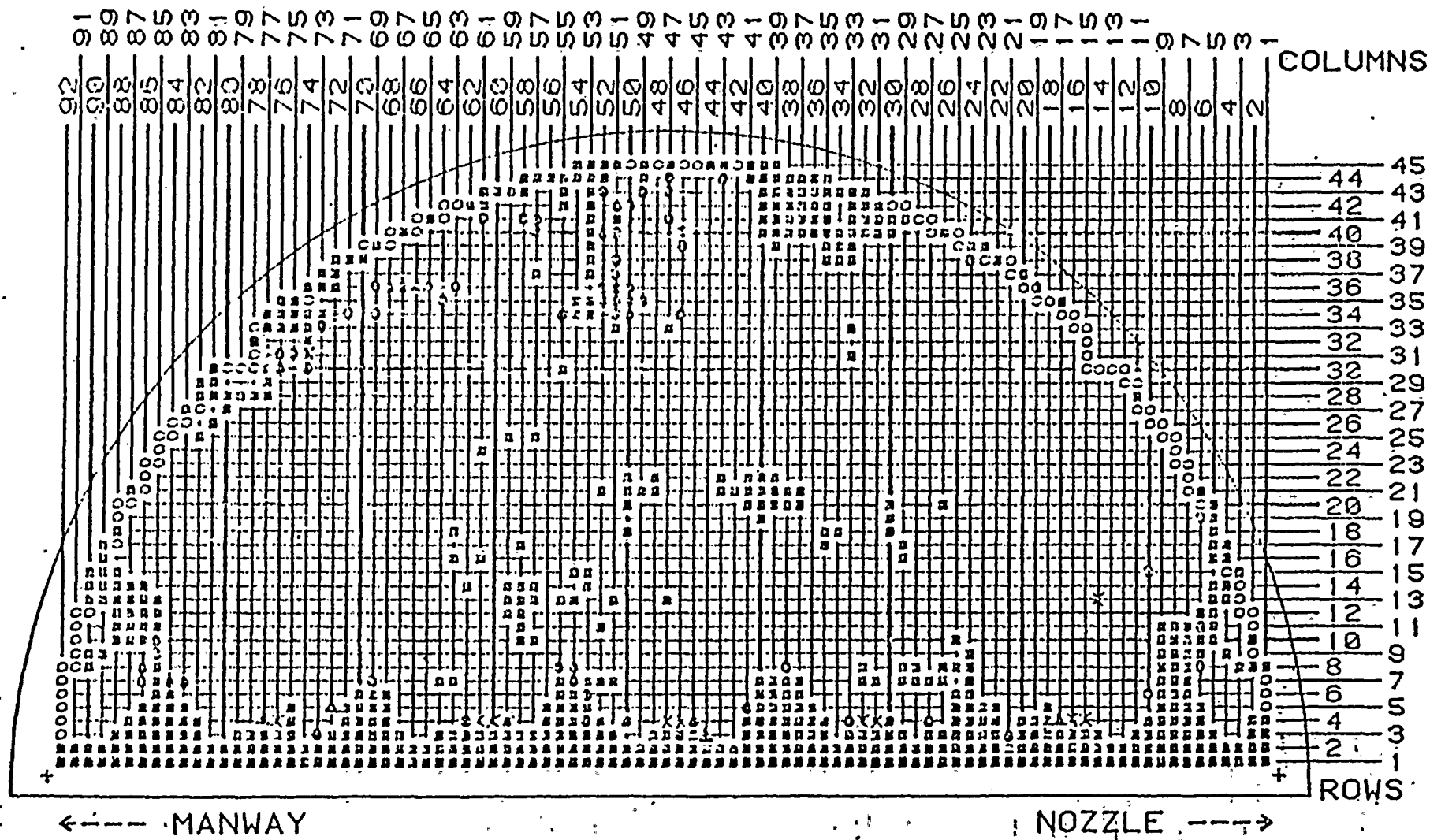
○ = .650"
 ▲ = .610"
 X = .540"

No. of
 Tubes

69
 5
 12

SERIES 44

FPL-A



Turkey Point Unit 3
 Steam Generator A - Outlet
 Gauging Results - October, 1980

Restrictions

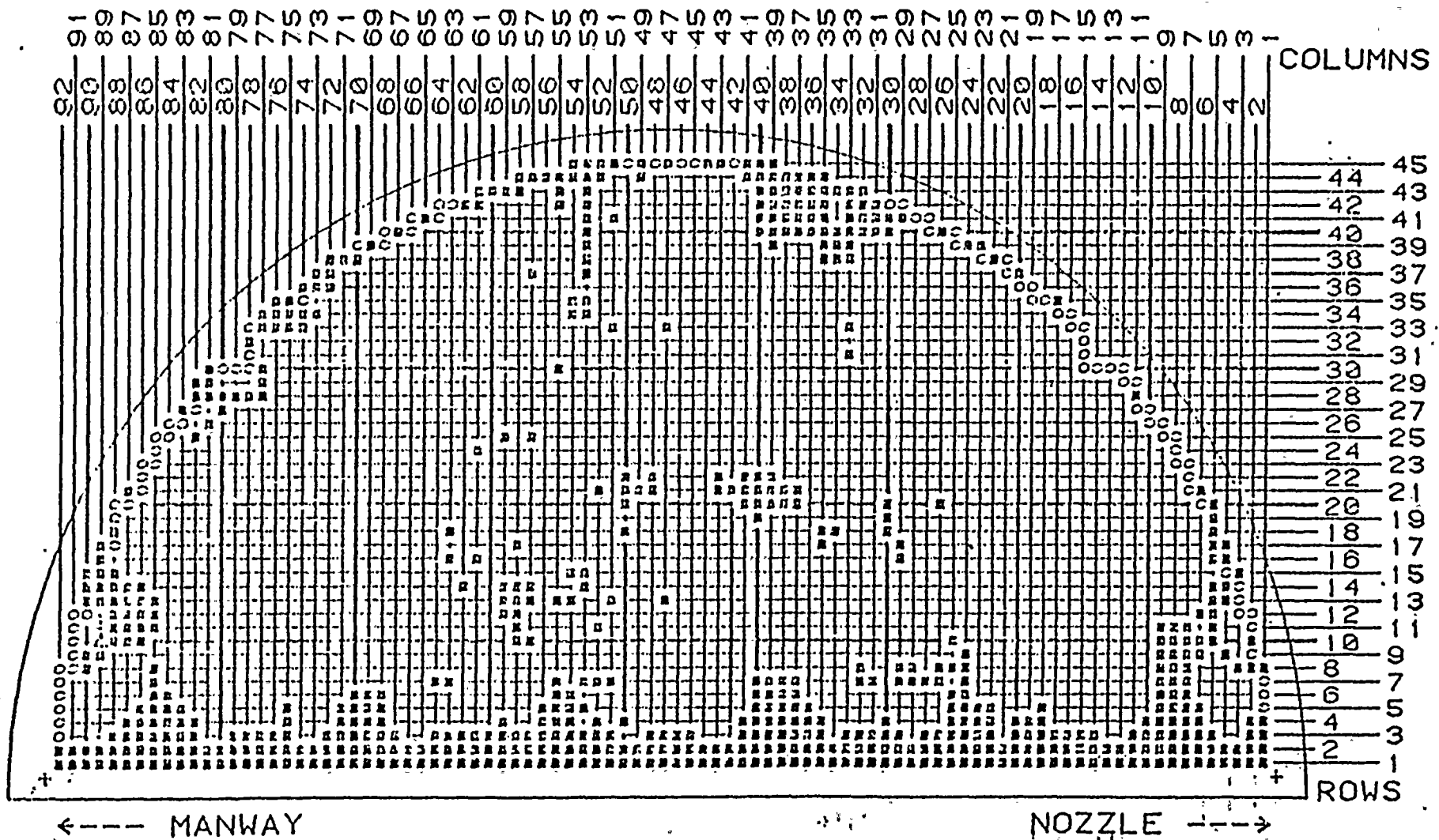
○ = .650"
 ▲ = .610"
 X = .540"

No. of
Tubes

0
 1
 0

SERIES 44

FPL-A



Turkey Point Unit 3
 Steam Generator B - Inlet
 Gauging Results - October, 1980

FIGURE 9

Restrictions

No. of
Tubes

○ = .650"

24

▲ = .610"

2

X = .540"

0

SERIES 44

FPL-B

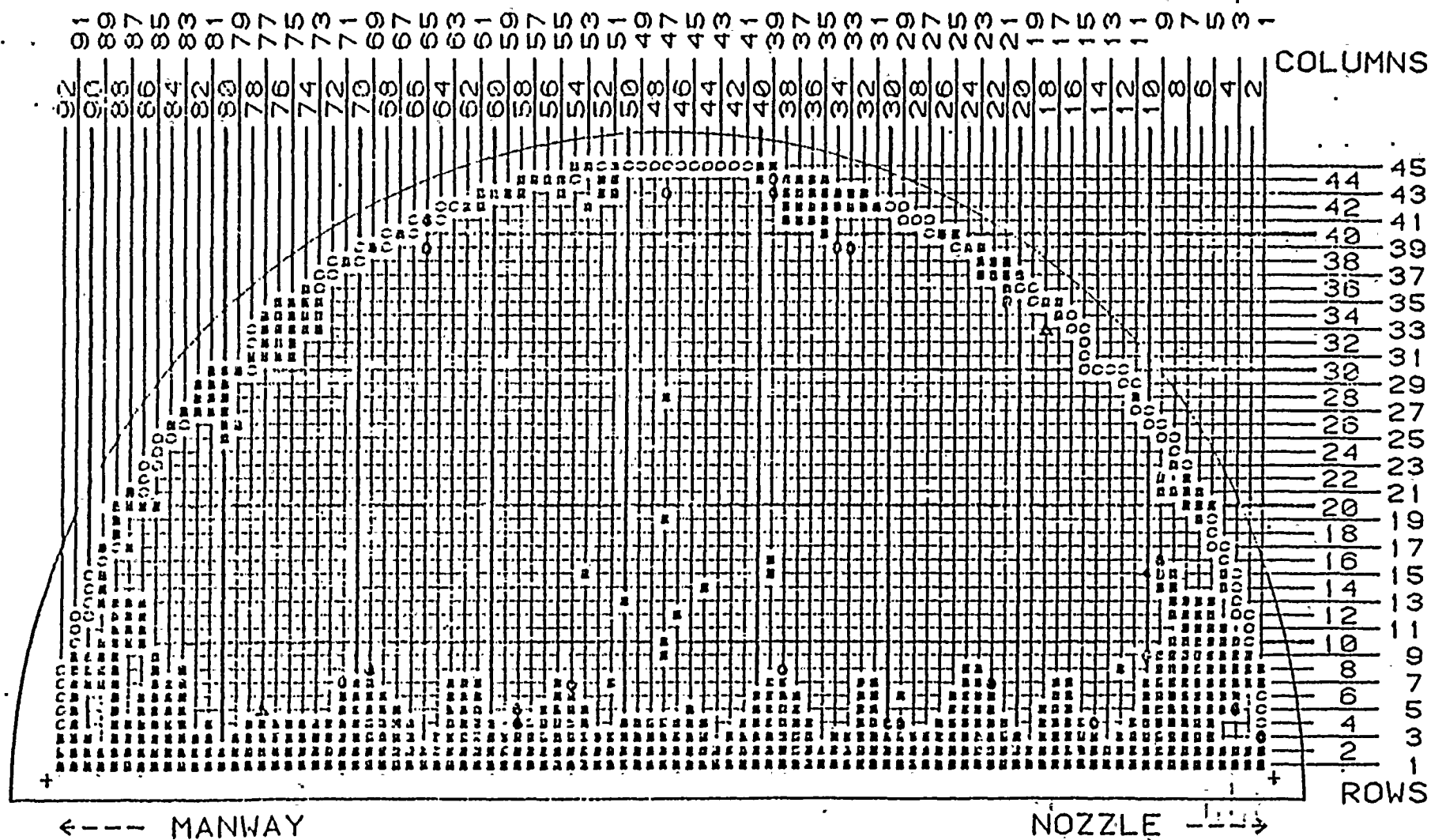


FIGURE 10

Turkey Point Unit 3
Steam Generator B - Outlet
Gauging Results - October, 1980

Restrictions

○ = .650"
△ = .610"
X = .540"

No. of
Tubes

0
1
0

SERIES 44

FPL-B

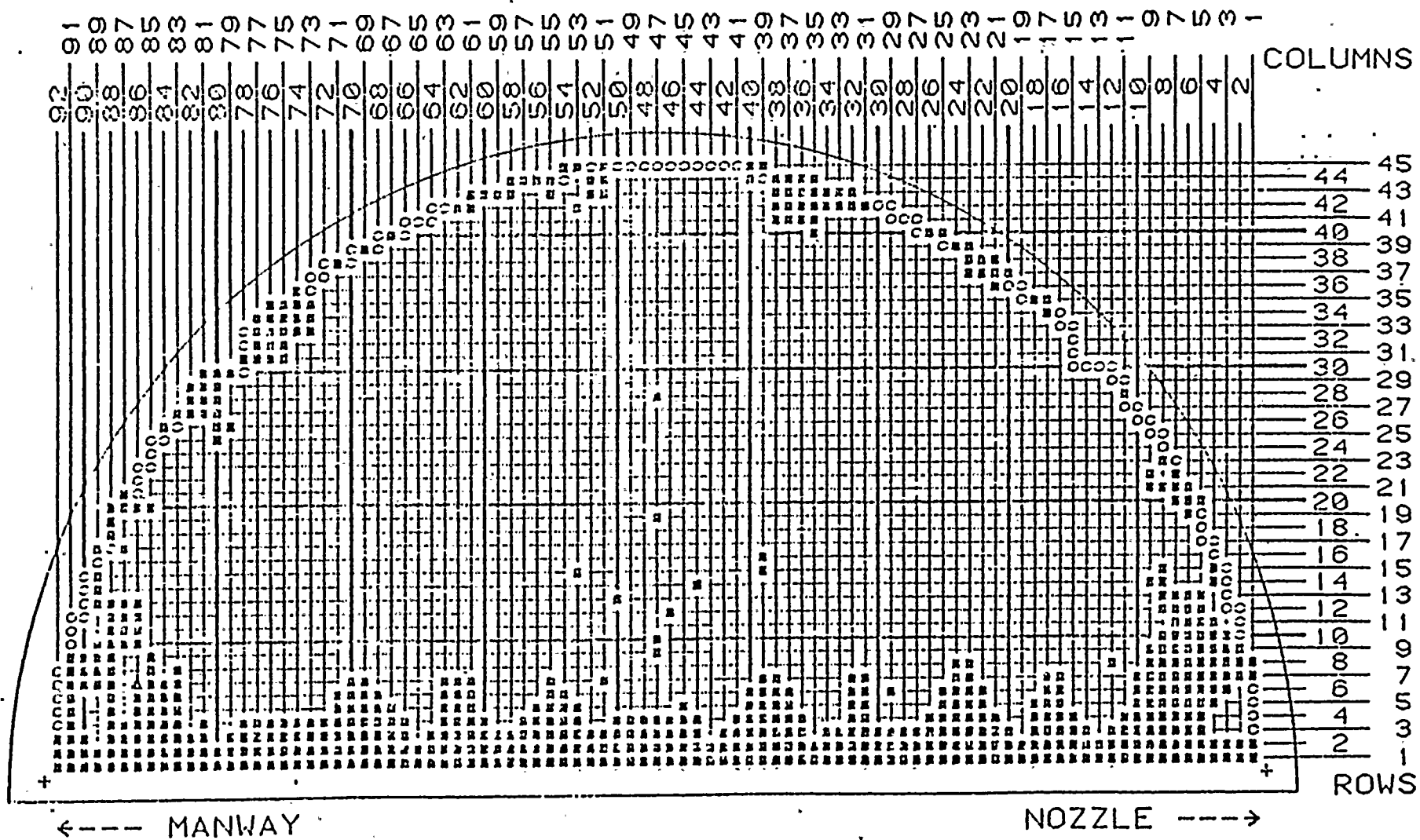


FIGURE 11

Turkey Point Unit B
Steam Generator C - Inlet
Gauging Results - October, 1980

Restrictions

No. of
Tubes

● = .650"
▲ = .610"
X = .548"

38
5
2

SERIES 44

FPL-C

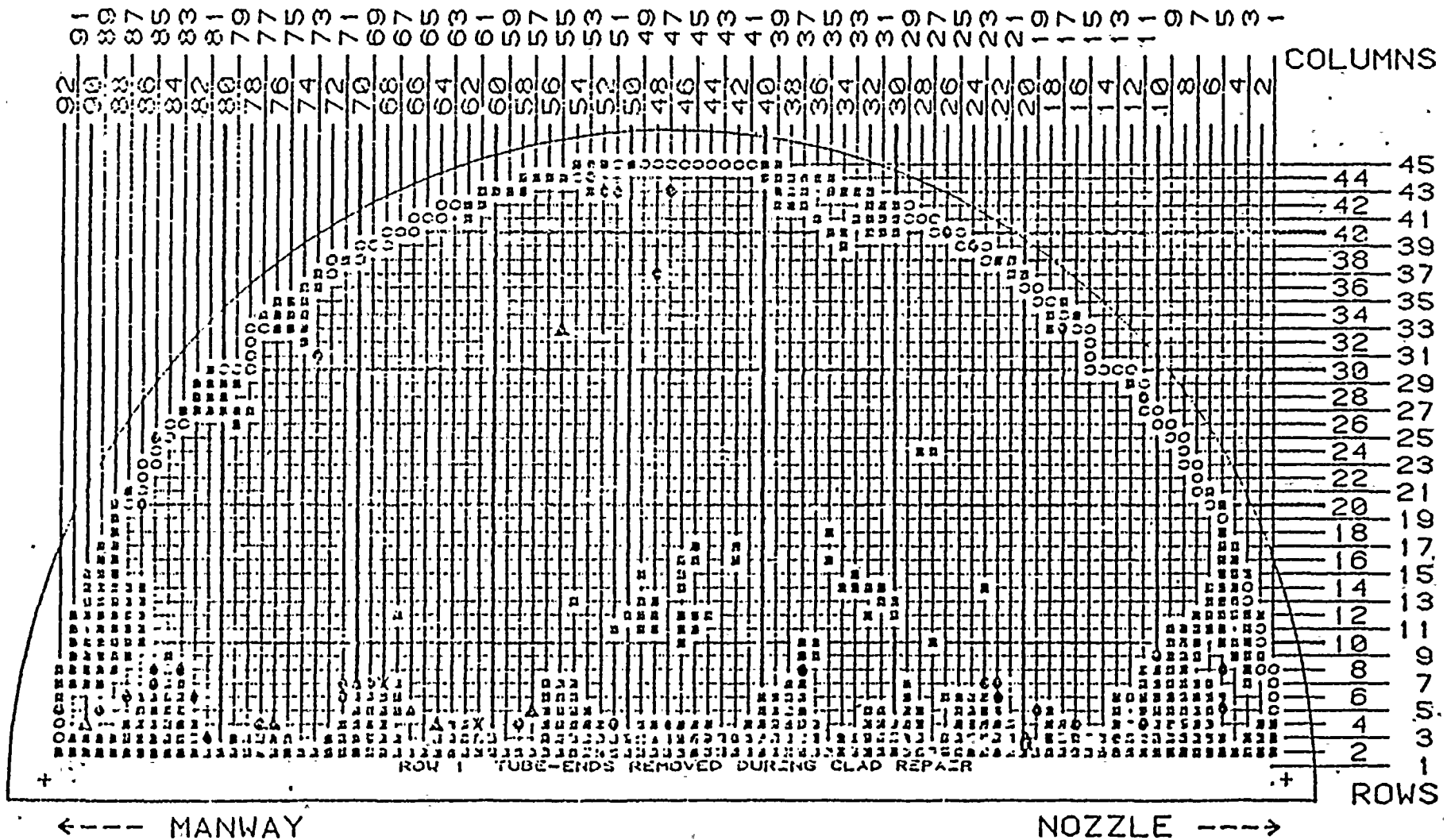


FIGURE 12

Turkey Point Unit 3
Steam Generator C - Outlet
Gauging Results - October, 1980

Restrictions

No. of
Tubes

● = .650"
▲ = .610"
X = .540"

0
2
0

SERIES 44

FPL-C

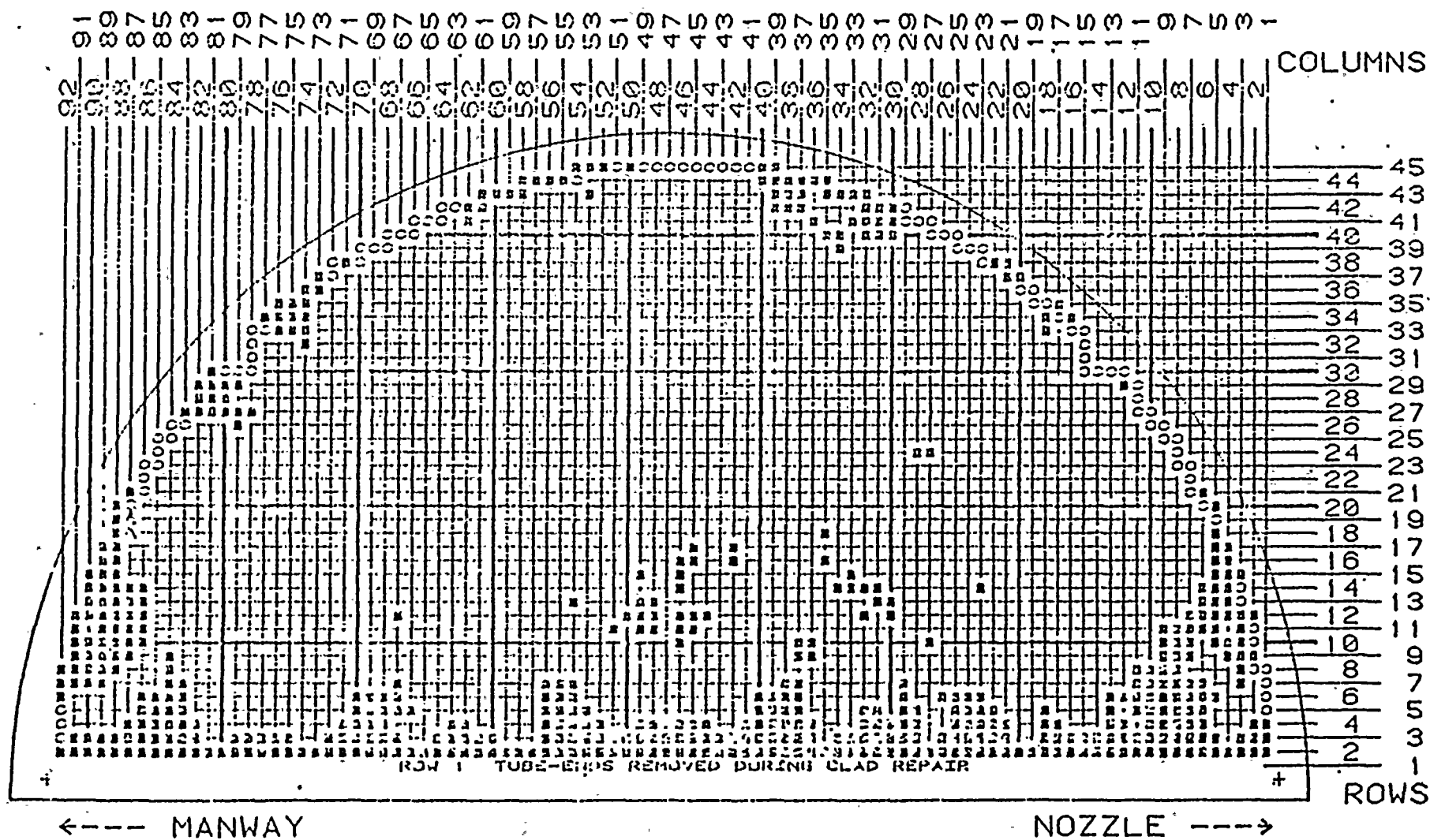


FIGURE 13

TURKEY POINT Unit #3
STEAM GENERATOR A
October, 1980

RECOMMENDED
PLUGGING PER:

○ = Gauging Results
X = Reg. Guide 1.83
■ = Previous Plugging

NO. OF
TUBES

57
13

SERIES 44

FPL-A

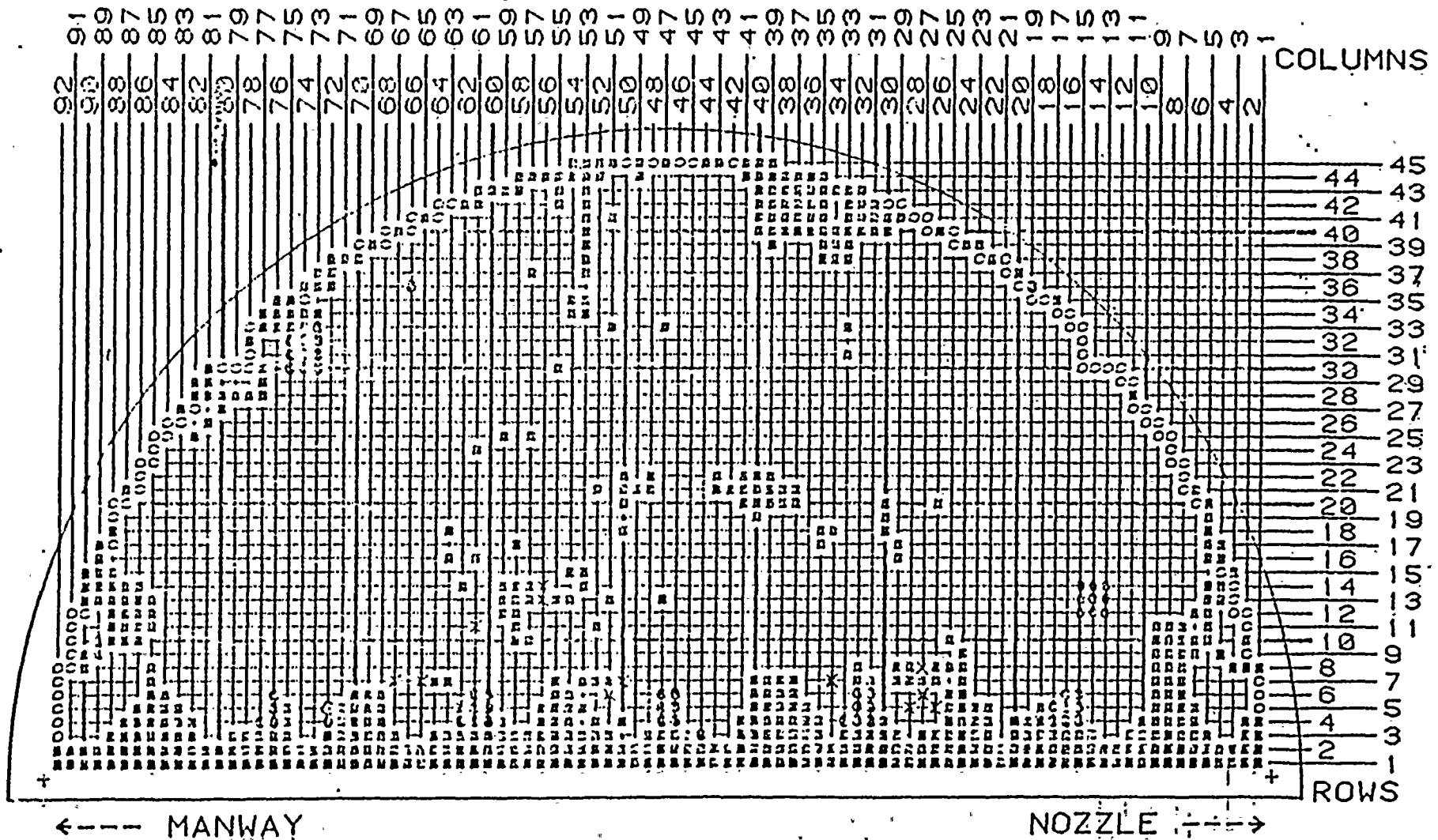


FIGURE 14

TURKEY POINT UNIT #3
STEAM GENERATOR B
October, 1980

RECOMMENDED
PLUGGING PER:

○=Gauging Results
X=Reg. Guide 1.83
■=Previous Plugging

NO. OF
TUBES

7
0

SERIES 44

FPL-B

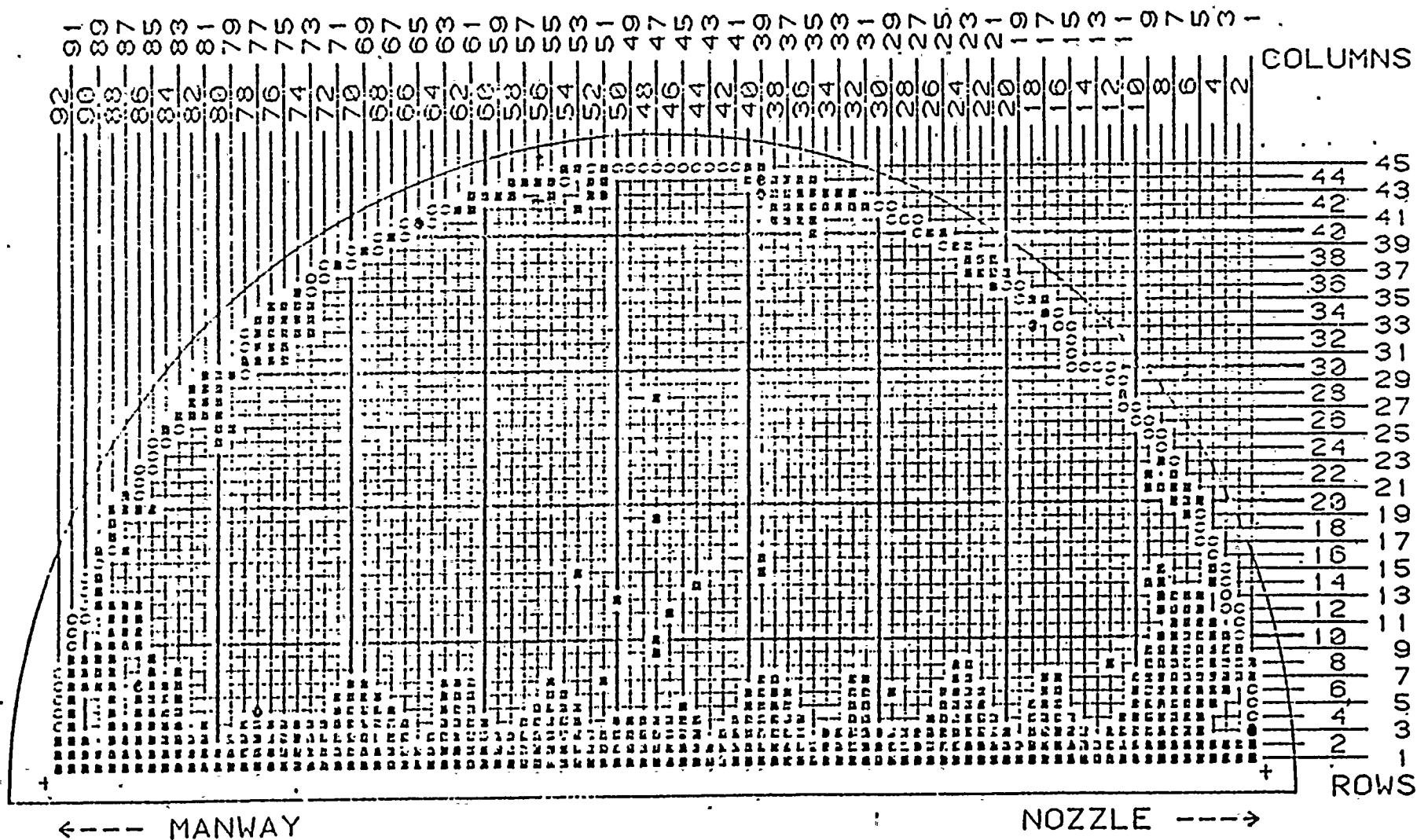


FIGURE 16

