

VIRGINIA ELECTRIC AND POWER COMPANY  
RICHMOND, VIRGINIA 23261

December 29, 1978

Mr. Harold R. Denton, Director  
Office of Nuclear Reactor Regulation  
Attn: Mr. Albert Schwencer, Chief  
Operating Reactors Branch 1  
Division of Operating Reactors  
U. S. Nuclear Regulatory Commission  
Washington, D. C. 20555

Serial No. 703B  
PO/DLB:scj  
Docket No. 50-280  
License No. DPR-32

Dear Mr. Denton:

REGULATORY DOCKET FILE COPY

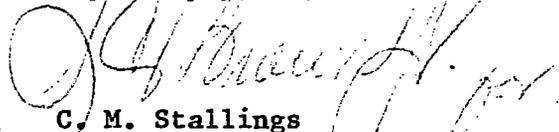
Subject: Steam Generator Inspection  
Surry Power Station Unit No. 1

The results of a recently completed Surry Power Station Unit No. 1 steam generator inspection and preventive plugging program are presented in the attachment.

The total number of tubes plugged in Surry Unit No. 1 is now 2471, or approximately 24.3%. Therefore existing analyses regarding safe operation under normal and accident conditions are applicable.

In our submittal of December 12, 1978 (Serial No. 703) we requested an amendment to Operating License DPR-32 for Surry Unit No. 1. The proposed change was to extend operation for nine months of equivalent full power operation with the same conditions and modifications as issued in the June 23, 1978 Order for Modification of License. We wish to modify our initial admendment proposal and now request that operation be extended for six months of equivalent full power operation from the completion of this inspection. Based on (1) confidence developed in the preventive plugging program; (2) total tube plugging remaining less than the allowable 25% and (3) the acceptable results of the inspection and plugging program, we have concluded that operation of Unit No. 1 for an additional six months of equivalent full power operation would in no way endanger the health and safety of the general public. Based on our current schedule, reactor coolant system heat-up beyond 350°F is expected at approximately midnight on January 1, 1978. Accordingly, we request your prompt approval of the proposed amendment.

Very truly yours,



C. M. Stallings  
Vice President-Power Supply  
and Production Operations

7901020150

Attachment

cc: Mr. James P. O'Reilly

A001  
5  
40/40

Steam Generator Tube Inspection  
Program and Plugging Criteria  
Surry Power Station - Unit No. 1  
December, 1978

1. Inspection Program

The tube gauging program is intended to encompass those regions where significant degrees of tube deformation may have occurred. The regions are determined by the finite element analysis which, when combined with tube strain tests, yields tube hoop strains versus tube location and extent of plate deformation. Additional inspections are defined for certain areas, particularly the wedge and patch plate regions. The inspection programs in the wedge and patch plate regions are based on previous leaker history at the Turkey Point and Surry sites, as well as previous gauging results at the Surry and Turkey Point sites. The basic inspection program was submitted in our letters of December 11 and 20, 1978 (Serial Nos. 703 and 703A). Additional inspections have been made on the basis of the visual inspection performed at the beginning of the inspection program. A summary of all inspections is included in Figure 1, Table 1 and Figures 3, 4, and 5.

The bases for the inspection boundary are as follows:

- 1) The hot leg inspection boundary encompasses the 15% strain boundary as determined by finite element analysis. Since full closure was observed in Surry Unit 1 during the April 1977 inspection, Surry 1 is regarded as being beyond full closure by approximately 15 EFPM's. The tube hoop strain contours calculated for 15 EFPM's were utilized to determine the 15% boundary for this inspection. Figure 2, "Tube Hoop Strain at 18 EFPM's", conservatively represents the approximate current condition of Surry Unit No. 1 steam generators.
- 2) The cold leg inspection boundary was based on the 17.5% strain boundary and on past experience. The use of the 17.5% strain boundary is based on the minimal number of denting indications found in previous inspections. As explained in our letter of December 20, 1978, the results of this inspection confirm the validity of this approach.
- 3) When a restricted tube was found close to the inspection boundary, the inspection was expanded in that area.
- 4) During the visual inspection of steam generators at the beginning of the outage, two (2) tubes in the center area of the tube bundle on steam generator C were found dripping. An expanded inspection was performed in the area of these two tubes in steam generator C. Since leakage in these tubes was attributed to O.D. Wastage additional inspections were made in all steam generators of all tubes that showed wastage of 20% or greater during the May, 1978 inspection and all tubes 1 and 2 tubes beyond the previous inspection boundary. These additional inspections were performed in order to determine if a) tubes exhibiting moderate wastage in May had deteriorated rapidly during the subsequent 6 months operation, or if b) the area of significant tube wastage had expanded beyond previous inspection boundaries.

Based on these criteria and on inspection results, it appears that the inspection boundaries were adequate and conservative.

## 2. Visual Inspection Results

A visual inspection of all steam generator tube sheets was performed at the beginning of the inspection outage. To identify leaking tubes or tube plugs, the steam generator secondary side is pressurized to approximate 200 psig and the primary side of the tube sheet is inspected for evidence of leakage. Results of the visual inspection are as follows (additional details were provided in our December 20, 1978 letter):

Steam Generator A  
8 leaking plugs  
0 leaking tubes

Steam Generator B  
0 leaking plugs  
0 leaking tubes

Steam Generator C  
0 leaking plugs  
5 leaking tubes

The leaking tubes in C steam generator were:

- 1) Row 5, Column 69
- 2) Row 3, Column 76
- 3) Row 17, Column 8
- 4) Row 25, Column 64
- 5) Row 29, Column 61

The first three leaking tubes were in areas expected to have denting activity. Tube R5-C69 was the only tube which exhibited steady leakage and was therefore considered the cause of the .3 gpm leak which led to the early shutdown. This tube restricted a .650" probe and was determined to have a dent at the second support plate. The last two leaking tubes are in the central area of the tube bundle, and were found to have leaked due to OD wastage. Additional discussion of these two tubes and related inspections is included following a discussion of the results of the basic inspection program.

## 3. Evaluation of Inspection Results

The results of the inspection program are presented in Figures 6, 7, and 8. These results support the adequacy of the inspection program and the plugging criteria.

A. Tubes in the tubelance region that restrict the .650" probe lie within the 15% strain boundary. All tubes that restrict either the .610" or the .650" probe are adjacent to areas of previous activity.

B. There were no tubes in steam generators A, B, or C that restricted the .540" probe.

C. All activity appears to be moving in a stable manner, adjacent to previous activity.

D. Activity in the wedge areas appears consistent with previous experience at Surry and other sites. Based on the behavior of these areas at Surry and other sites, application of the plugging criteria should stabilize these regions.

E. On the cold leg side, all tubes in all steam generators met the gauging criteria with a .610" probe and all tubes were satisfactorily U-bend inspected. The only problem identified in the cold leg inspection was in the U-Bend inspection of tube R4-C12 where the .610" would not pass over the U-Bend. A .510 probe was used and the U-Bend inspection was satisfactorily completed. Tube R4-C12 will be plugged. These results indicate that cold leg activity continues to grow at a very slow rate as compared to hot leg activity.

F. In those areas where additional inspections were performed to identify areas of significant wastage, all tubes with significant wastage and all tubes where wastage measurement could not be considered accurate due to masking effects were plugged.

#### 4. Inspections for O.D. Wastage

Among the tubes suspected of leaking in steam generator "C" were two tubes located in the central area of the tube bundle. These were tube R25-C64, and tube R29-C61. Both tubes were inspected with a .720" probe and found to have OD wastage in excess of 80%. In both cases accurate determination of the extent of wastage was difficult due to the presence of masking signals which have been attributed to the presence of minor denting.

Tube R29-C61 had not been previously inspected. Tube R25-C64 was inspected in May of 1978 at which time OD wastage was estimated to be approximately 30%. The apparent rapid wastage of this tube prompted a review of the data from the May inspection. The tape of eddy current data for tube R25-C64 from May indicated a minor dent which was, to some degree, masking the wastage measurement signal. Based on the masking effects of minor dents, and on past experience with growth rates of OD wastage, we have concluded that due to the masking effect of the dent present at the May inspection the extent of wastage was underestimated at that time. We have also concluded that existing methods of OD wastage measurement may not be reliably interpreted in close proximity to small dents due to masking effects. Accordingly for this inspection we have assumed that determination of significant wastage in close proximity to a dent is not reliable and we have plugged any tube where a dent is detected sufficient to affect wastage measurement.

Recognizing that the above conclusions bring into question previous inspection results, extensive additional inspections were made in the wastage prone areas. Specifically, all tubes in all steam generators which indicated moderate (> 20%) wastage at the previous inspection were reinspected. Additionally 2 tubes in all directions beyond the boundary of the previous Regulatory Guide 1.83 inspection were inspected. This

was to detect any expansion in the area of significant wastage. The inspection areas are shown in Figures 3, 4, and 5. Note that on Figure 3 for steam generator "A", the inner enclosed area represents the boundary of the previous inspection. All tubes in the inner area which showed wastage of 20% or greater in the previous inspection were reinspected. This area is surrounded by a two tube boundary in which all tubes were inspected. The same applies to Figures 4 and 5 for steam generators "B" and "C". Additionally, in steam generator "C" a ten by ten area designated by the small square was completely inspected. This was the localized inspection in the area of the two suspected leaking tubes. The supplementary inspections for tube OD wastage included a total of 918 tubes. All tubes with either significant wastage or some wastage in proximity to a dent of sufficient size to mask the defect were plugged. This resulted in the plugging of a total of 63 tubes including all steam generators. While this is a large number of tubes, this indicates the application of an extremely conservative plugging approach more so than any increase in wastage activity. Almost all tubes plugged had indications of only minor wastage and were plugged due to masking. Only 16 tubes were judged as near or exceeding the 40% plugging limit, and in each case these were tubes which were close to the limit, i.e. 35-39% wastage, at the previous inspection. This indicates that there has been no rapid growth in wastage activity. The recognition of the masking effects of minor dents and the corrective action as implemented should ensure the integrity of the central bundle region during the next operating period.

#### 5. Plugging Criteria

The plugging rationale and criteria as defined below are consistent with those applied in previous inspections. Note that extensive additional plugging has been done in all steam generators.

The plugging criteria applied to support six months of operation are:

A. All tubes which do not pass the 0.540 inch probe will be plugged.

B. Additionally, for in excess of six months operation, two tubes beyond (i.e., higher row numbers) any tube in columns 15-79 which does not pass the 0.540 inch probe will be plugged; for such tubes in column 1-14 and 80-94 five tubes beyond will be plugged on the hotleg side and four tubes beyond will be plugged on the coldleg side.

C. All tubes which do not pass the 0.610 inch probe will be plugged.

D. The tubes in any column for which plugging under criteria (A), (B), or (c) above is implemented will also be plugged in the lower row number tubes back to the tubelane if not already plugged.

E. As a conservative measure, tubes completely surrounding any known leaky tubes including the diagonally next tube will be plugged if not already covered by the foregoing criteria.

F. In any given column which is surrounded by columns containing tubes with significant tube restriction or prior plugging, (thereby creating a "plugging valley" in the pattern) engineering judgement will be used to fill the bottom of the valley. In the peripheral tubelane areas near the three and nine o'clock wedges, tubes surrounded previously plugged tubes or tubes exhibiting high deformation activity will be plugged based on engineering judgement.

G. Additional preventive plugging will be implemented at the hot leg wedge locations. This plugging will include all tubes that:

1. Restrict the 0.540 inch probe
2. Restrict the 0.610 inch probe
3. Restrict the 0.650 inch probe at the periphery
4. Surround leakers and tubes that restrict the 0.540 inch probe including the diagonally next tube.

H. Application of the criteria specified in G, above, will be made on the basis of engineering judgement for cold leg wedge locations.

#### 6. Actual Plugging Pattern

Figures 9, 10, and 11 indicate the plugging patterns for Surry 1 steam generators based on the plugging criteria described above.

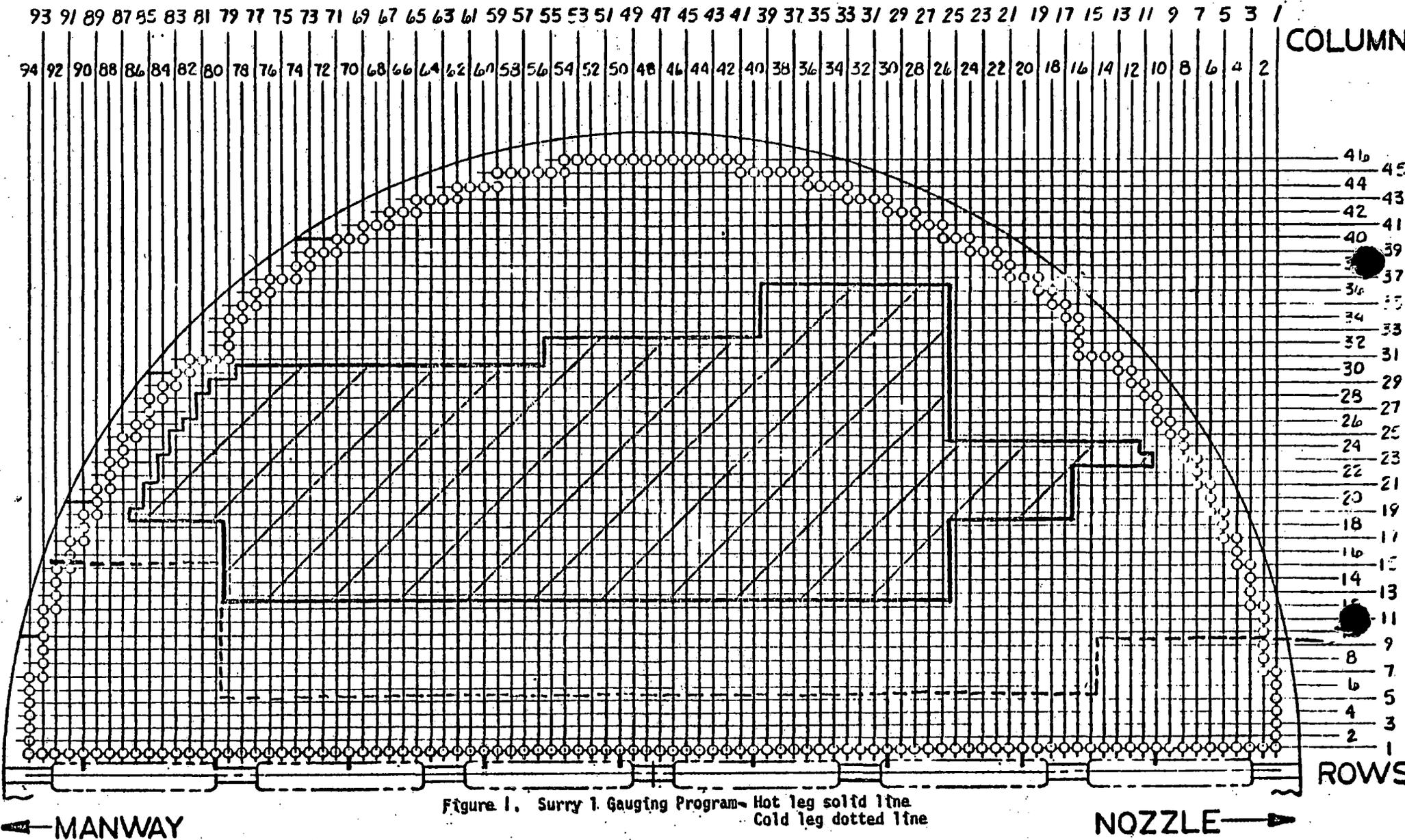
#### 7. Handhole Inspections

Handhole inspection using photographs were performed in all steam generators. This inspection was to verify that the support plates had undergone no further degradation since the last inspection and that no new phenomena had developed. Inspection revealed that the condition of the visible support plates had not changed since the previous inspection and that no new phenomena were observed. The photographs will be available for inspection at the site.

#### 8. Annulus Measurement

Wrapper to shell annulus measurements were performed in steam generator C as part of a continuing program to monitor plate growth.

# SERIES 51



(SEE ALSO TABLE 1)

TABLE 1

In addition to the inspection program outlined in Figure 1, the following tubes were inspected in all steam generator.

Row 13, Column 79  
Row 14, Column 79  
Row 19, Columns 17 through 24  
Row 20, Columns 17 through 24  
Row 21, Columns 17 through 24  
Row 23, Column 11  
Row 30, Columns 77 and 78

The additions were made on the basis of past experience at Surry and other sites.

.025000 INCREMENT

MIN	.03285
1	.04000
3	.10000
5	.15000
7	.20000
9	.24000
11	.30000
13	.35000
15	.40000
17	.45000
MAX	.496352

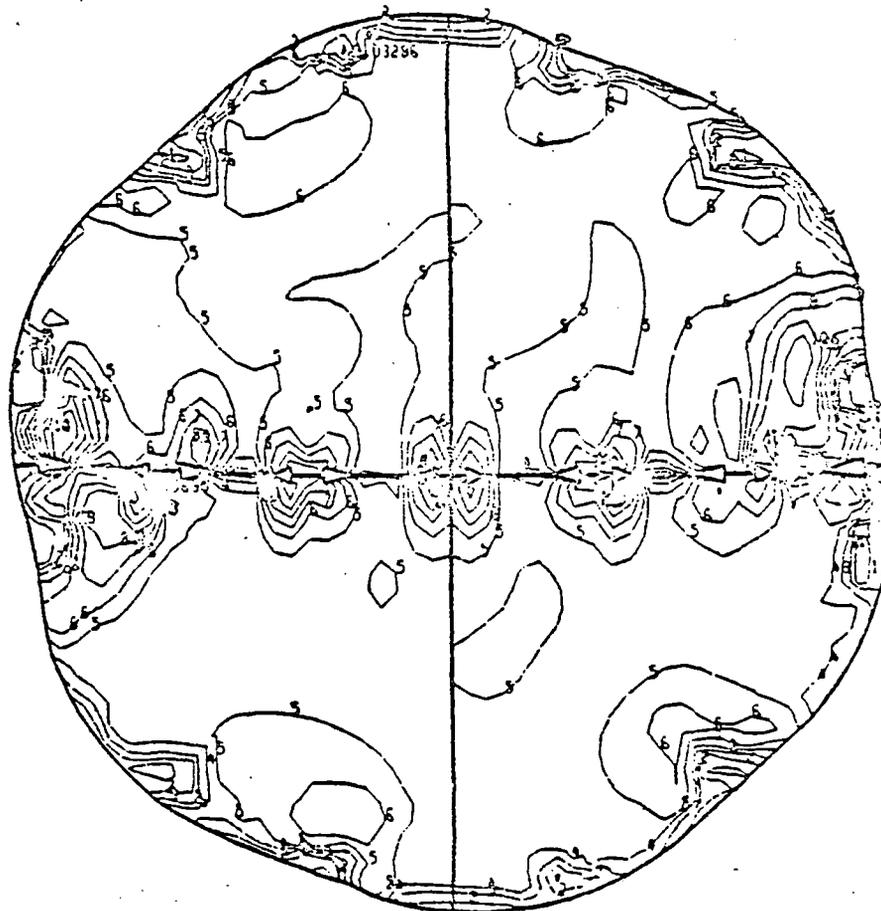


Figure 2 Tube Hoop Strain at 18 EFPM's  
Beyond Full Closure

SERIES 51

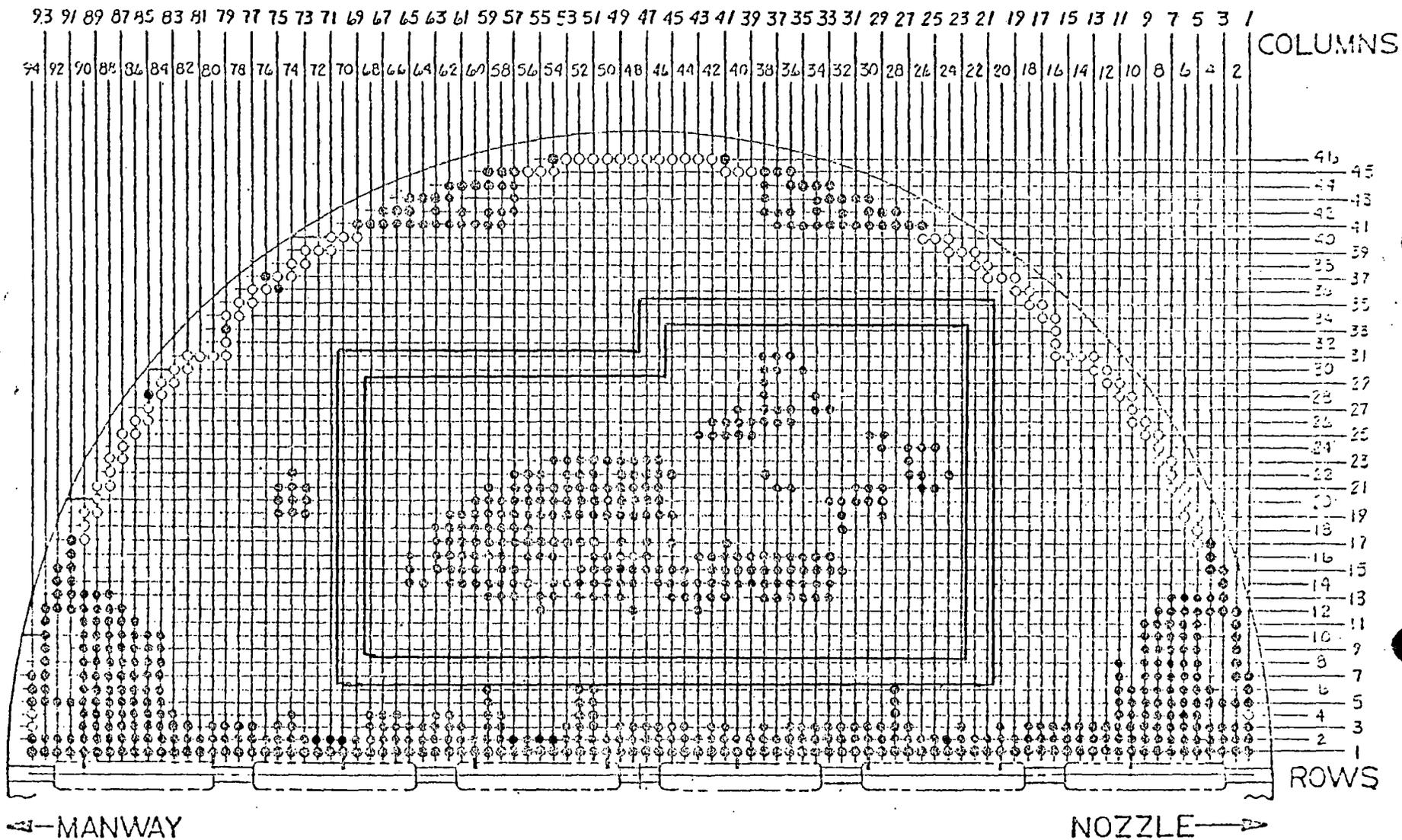
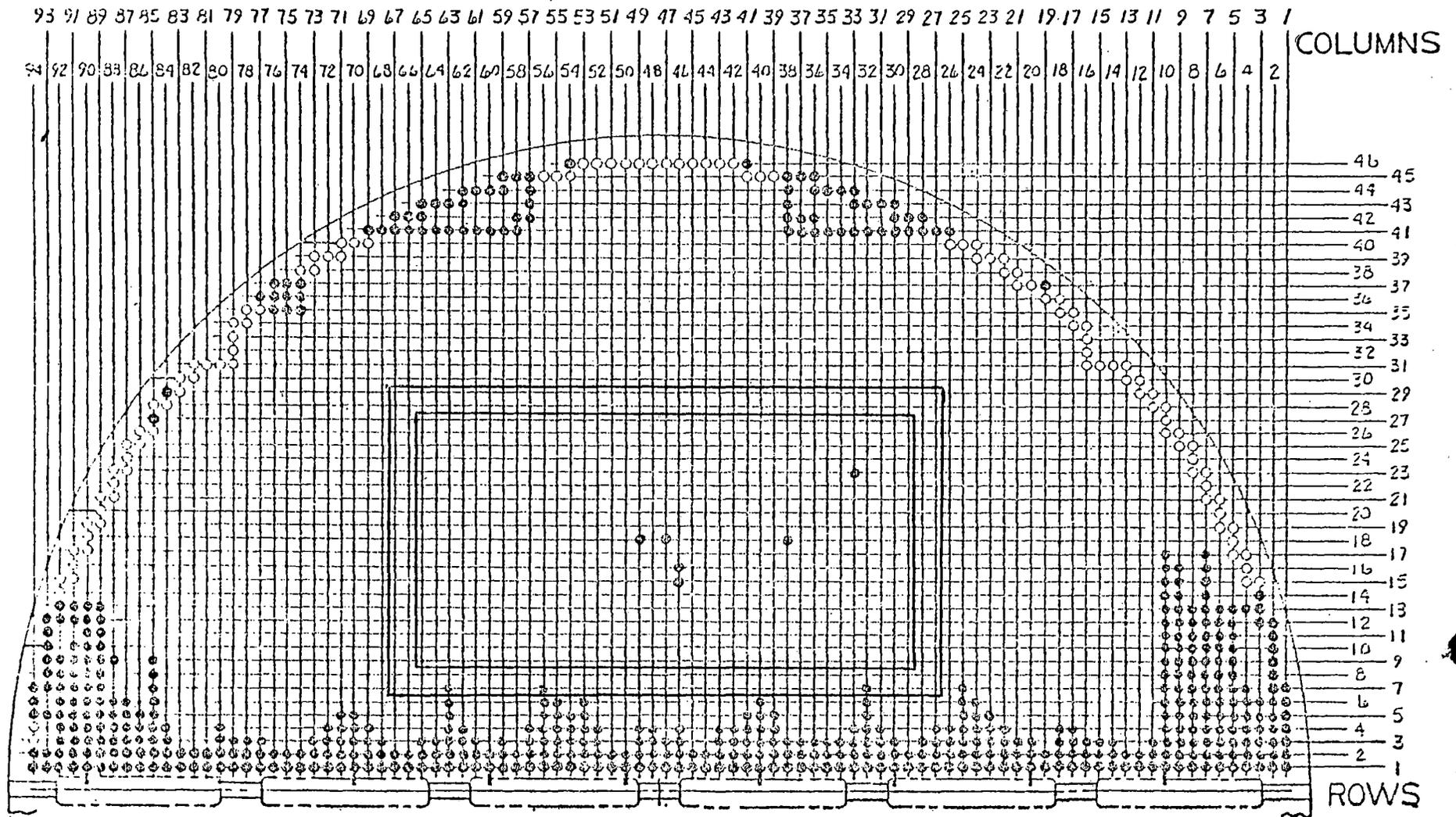


Figure 3

STEAM GENERATOR 1A  
SUPPLEMENTARY INSPECTION AREAS

SERIES 51



MANWAY

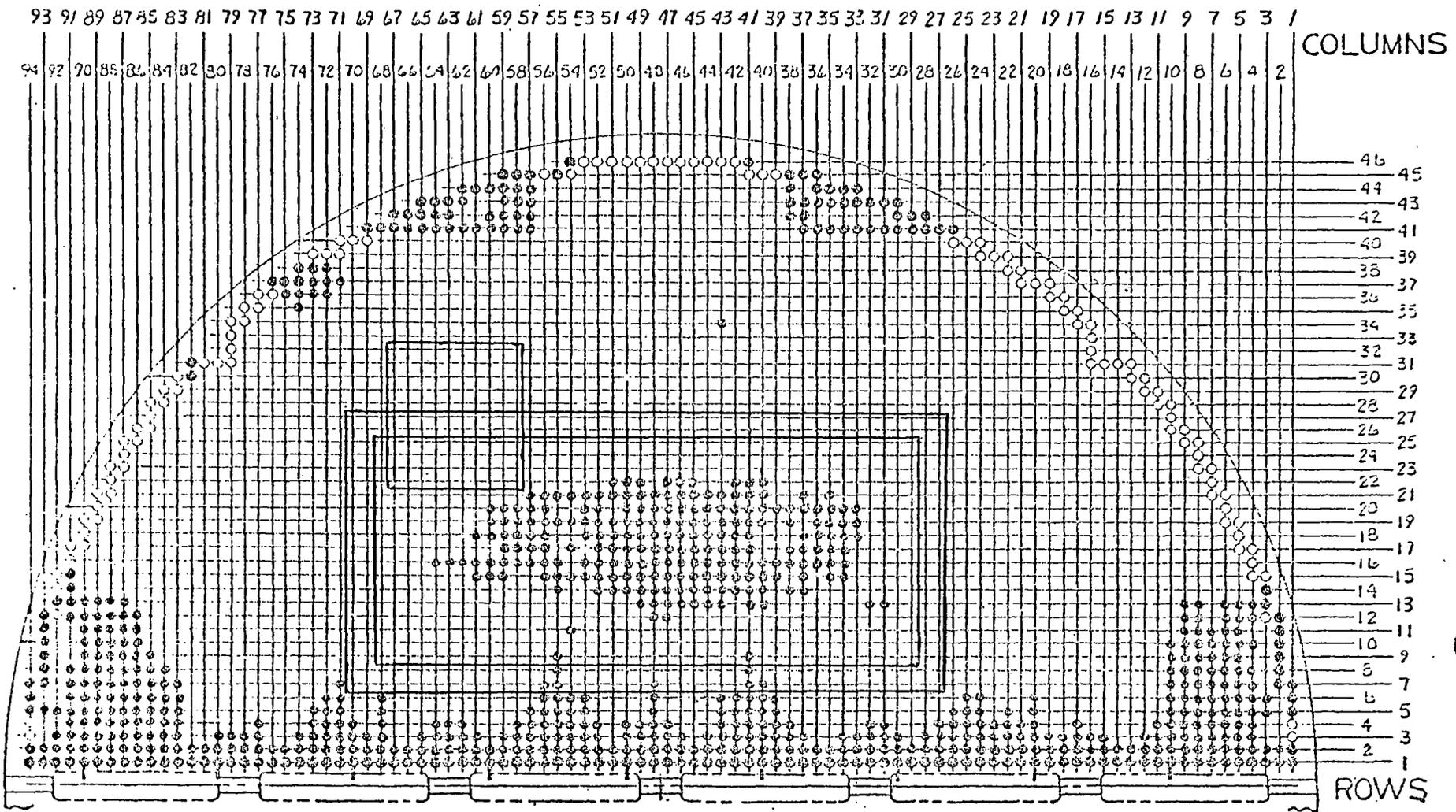
NOZZLE →

STEAM GENERATOR IB

SUPPLEMENTARY INSPECTION AREAS

Figure 4

SERIES 51



MANWAY

NOZZLE

STEAM GENERATOR IC  
SUPPLEMENTARY INSPECTION AREAS

Figure 5

SERIES 51

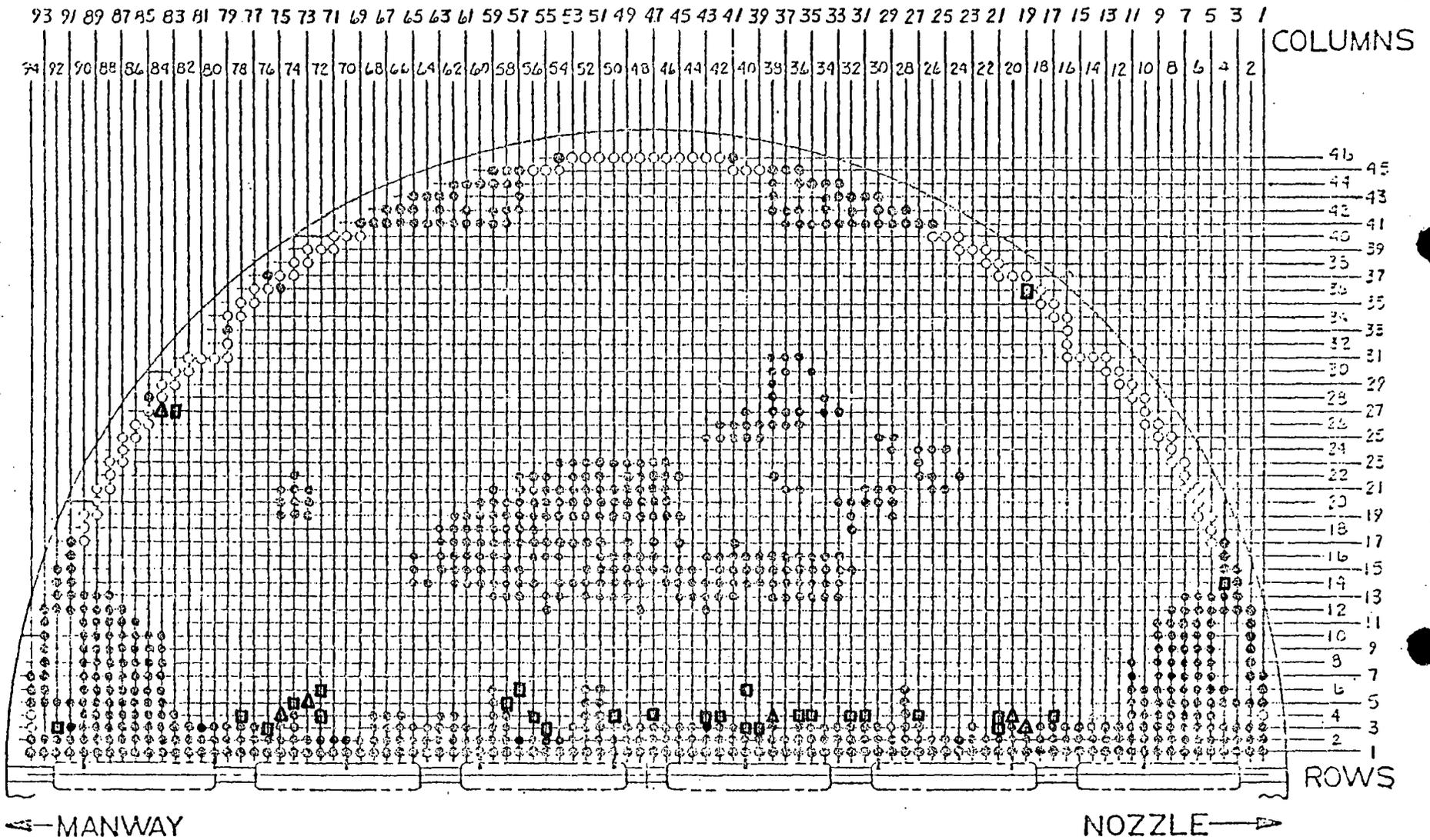


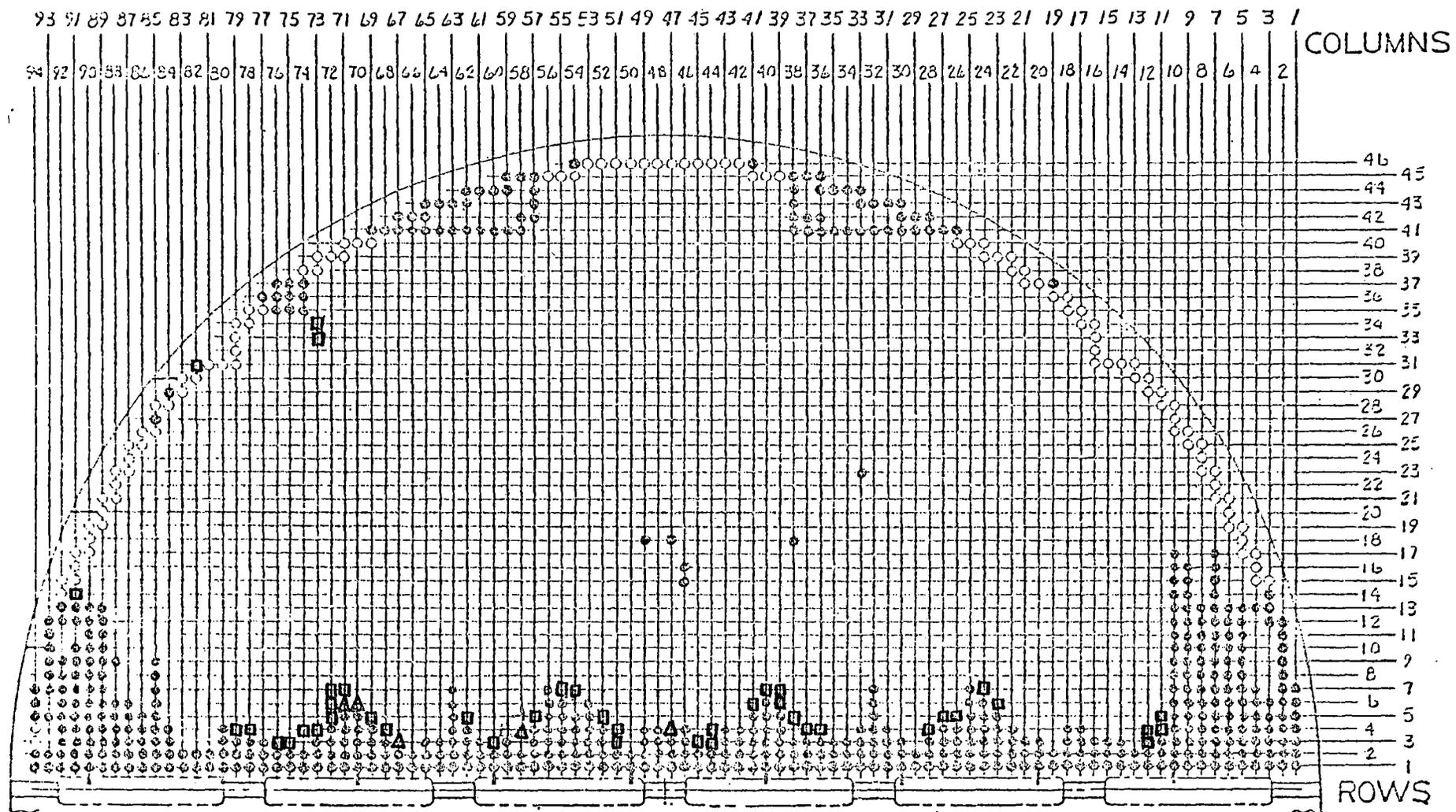
Figure 6.

GAUGING RESULTS

SURRY 1, S.G. "A"

X = .540" PROBE  
 Δ = .610" PROBE  
 □ = .650" PROBE

SERIES 51



MANWAY

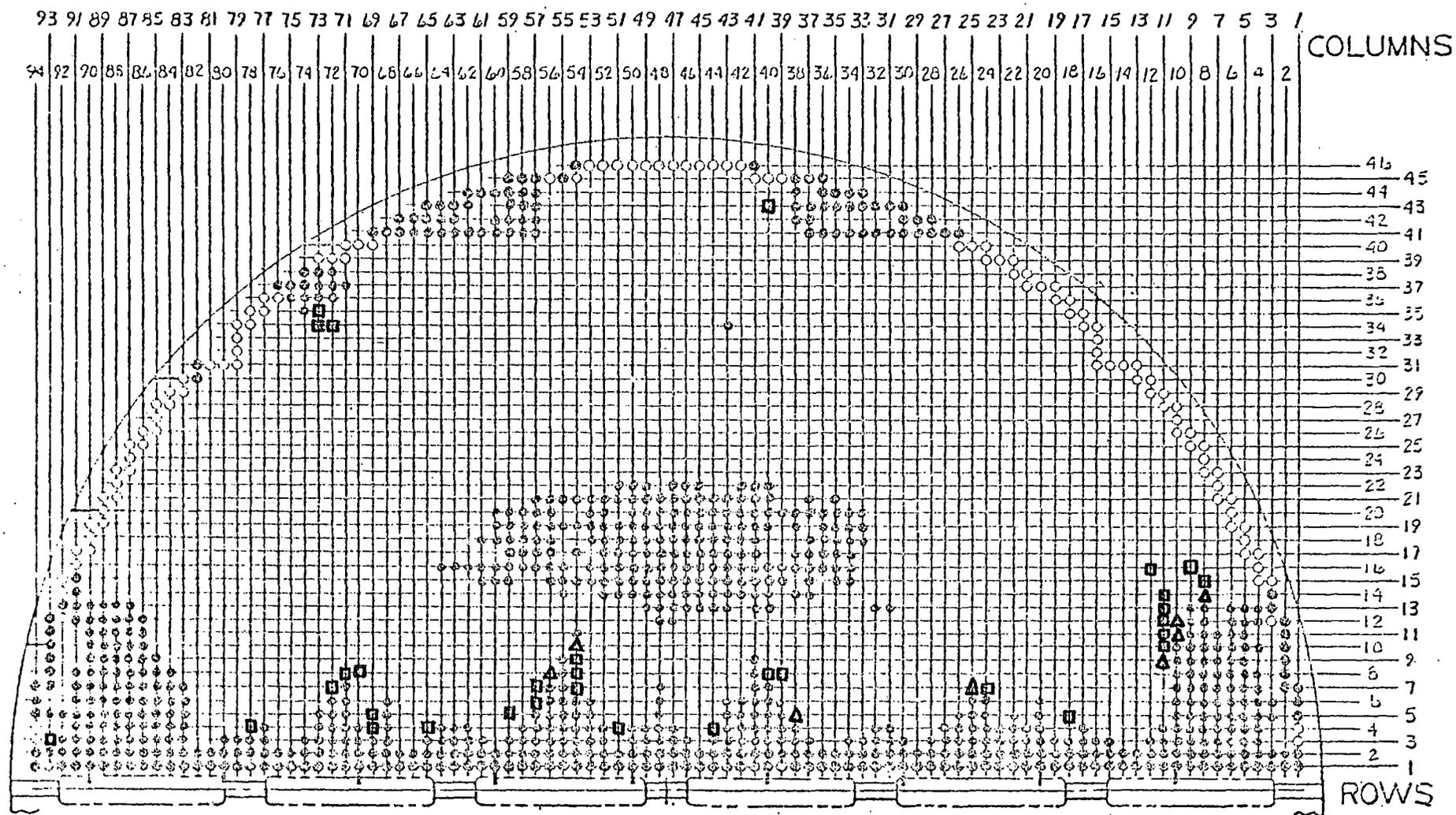
NOZZLE →

GAUGING RESULTS  
SURRY 1, S.G. "B"

X = .540 PROBE  
 Δ = .610 PROBE  
 □ = .650 PROBE

Figure 7

SERIES 51



COLUMNS

45  
44  
43  
42  
41  
40  
39  
38  
37  
36  
35  
34  
33  
32  
31  
30  
29  
28  
27  
26  
25  
24  
23  
22  
21  
20  
19  
18  
17  
16  
15  
14  
13  
12  
11  
10  
9  
8  
7  
6  
5  
4  
3  
2  
1

ROWS

MANWAY

NOZZLE →

GAUGING RESULTS  
SURRY 1, S.G. "C"

X = .540" PROBE  
 Δ = .610" PROBE  
 □ = .650" PROBE

Figure 8

SERIES 51

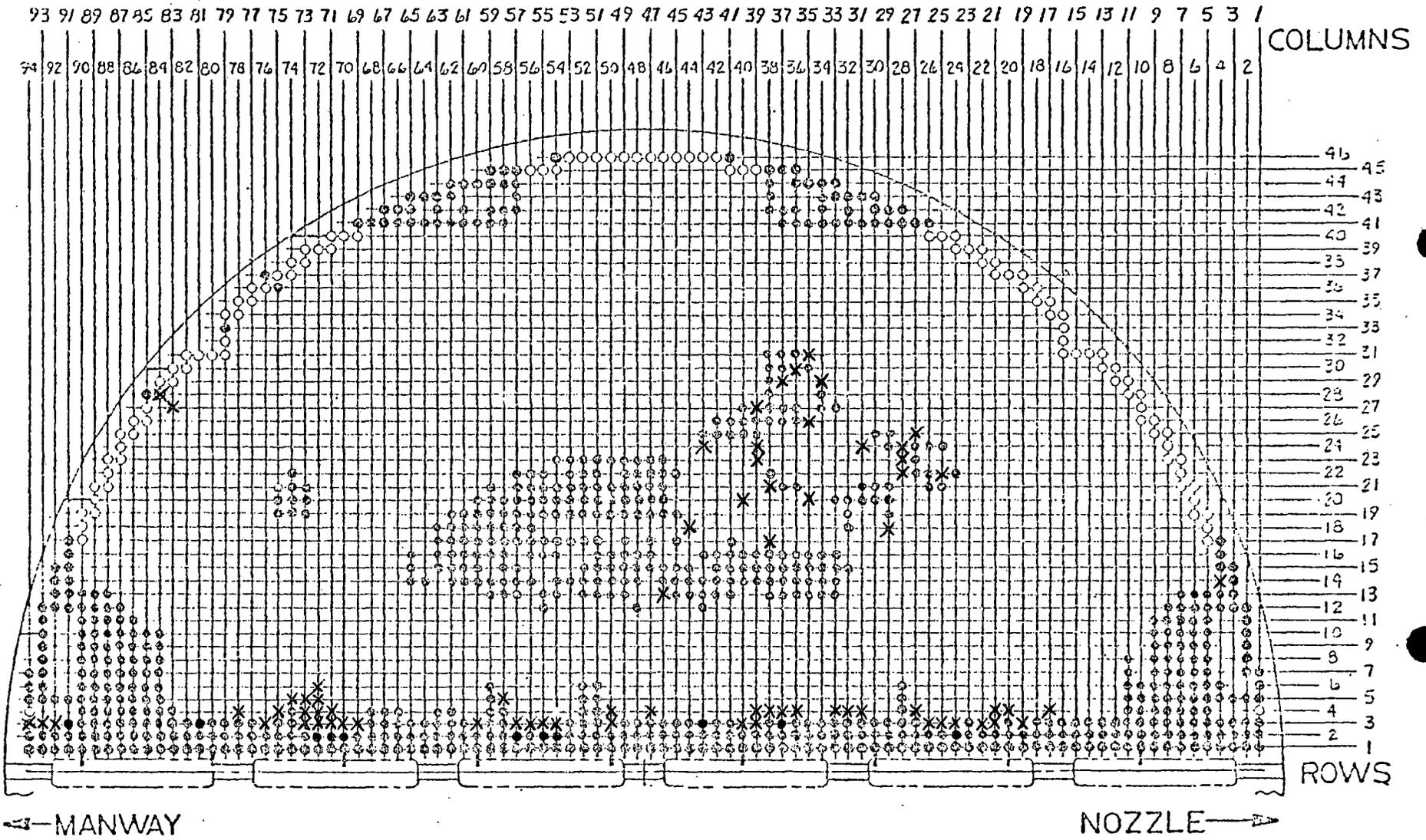


Figure 9

SURRY 1 STEAM GENERATOR A  
PREVENTIVE PLUGGING PATTERN

X = TUBES TO BE PLUGGED  
● = TUBES PREVIOUSLY PLUGGED

SERIES 51

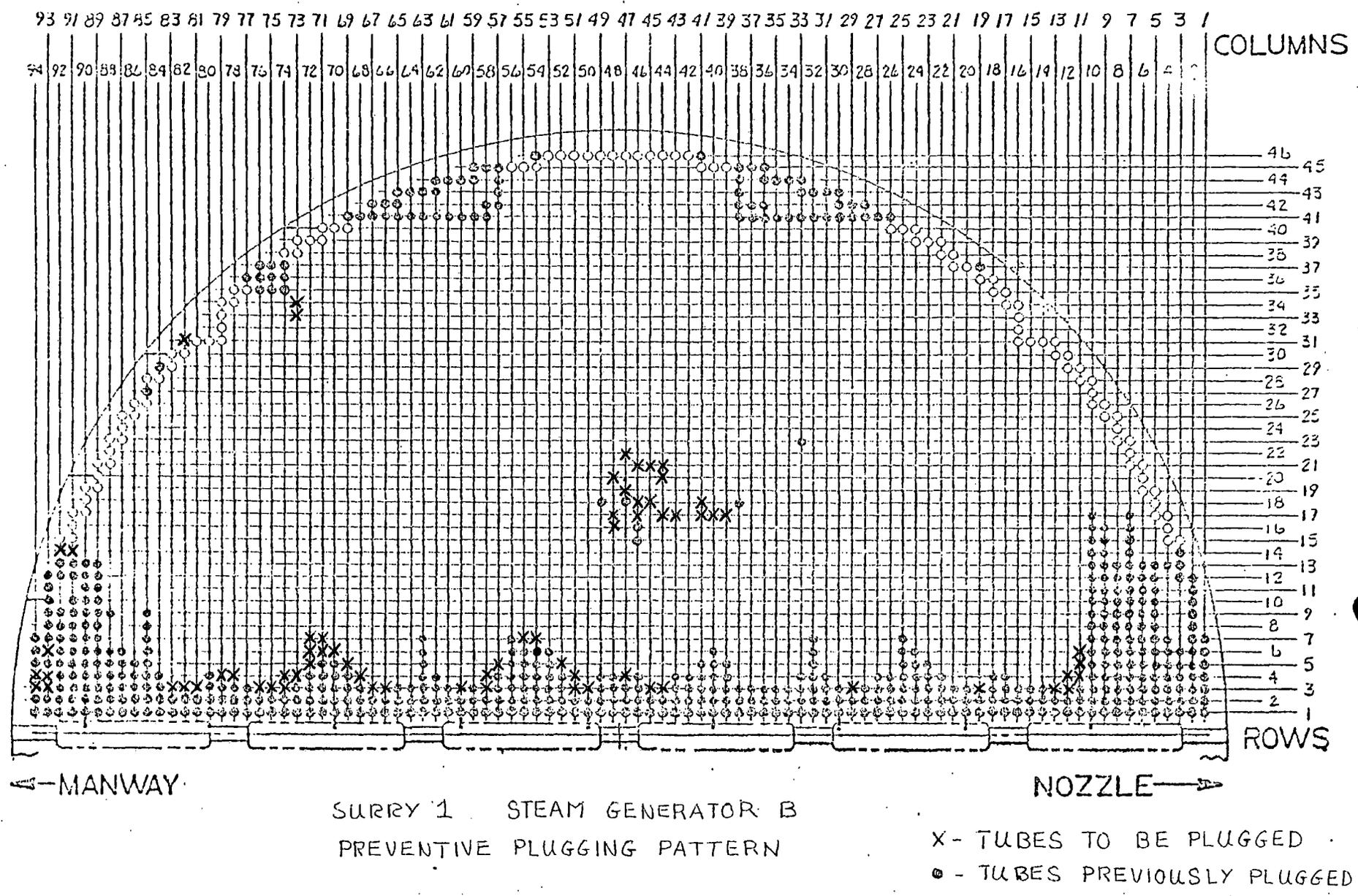
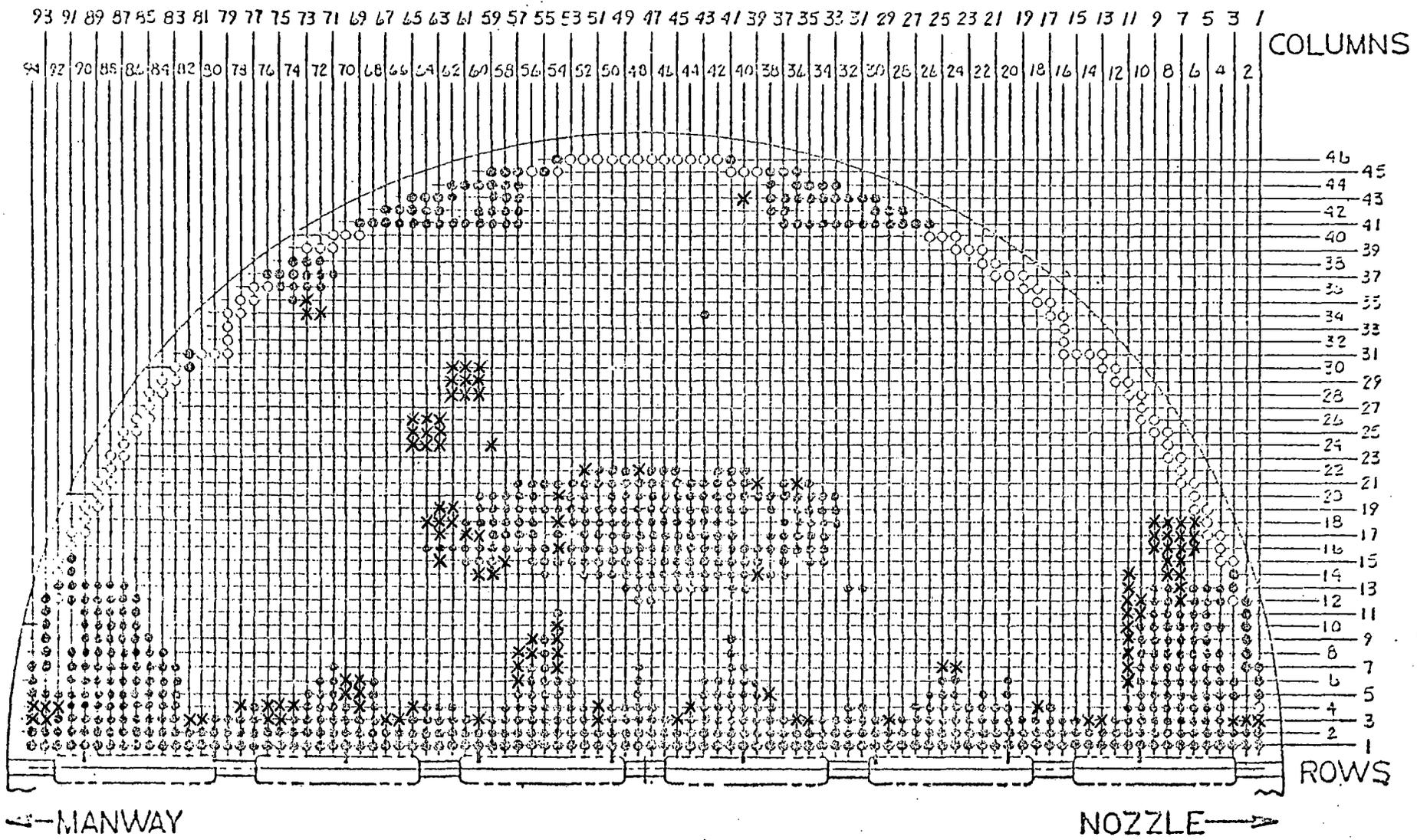


Figure 10

SERIES 51



SURRY 1 STEAM GENERATOR C

PREVENTIVE PLUGGING PATTERN

X- TUBES TO BE PLUGGED

● - TUBES PREVIOUSLY PLUGGED

Figure 11