NORTH ANNA POWER STATION
UNIT NO. 2
STEAM GENERATOR INSERVICE INSPECTION
SPECIAL REPORT

I. Introduction

North Anna Unit 2 began commercial operation on December 14, 1980, and operated at a capacity factor of 75.4 percent until shutdown for the first refueling on March 7, 1982. No primary to secondary tube leakage has been experienced during the first cycle of operation.

II. Steam Generator (S/G) Inspection Program

An extensive S/G inspection program was planned for North Anna Unit 2 Cycle 1-2 refueling. This recently completed inspection program exceeded the requirements of the North Anna Unit 2 Technical Specifications.

A. Technical Specification Program

Technical Specification 4.4.5.0 requires that a sampling program inspection be conducted which includes a minimum of 3% of the tubes (total) in all steam generators selected on a random basis. Since approximately 98% of all tubes in A steam generator were inspected, 99% in B steam generator, and 92% in "C" steam generator, this inspection far exceeded the requirements specified in Technical Specifications and R.G. 1.83.

B. Visual inspections

In addition to the full eddy current (EC) examination of all three steam generators, a visual examination of the internals was conducted through the existing 6" inspection ports and the 2 1/2 inch ports recently installed. A portion of the tubes was inspected from tubesheet, through the u-bend and to the opposite-end tubesheet to insure all tube areas were scanned. This examination revealed no indication of flow slot obstruction or closure. No other visual evidence of degradation was observed during the course of this inspection. Photographic prints have been taken of the internals and of the bundles and are on file at the site.

III. Inspection Results

A. 'A' & 'B' Steam Generators

Evidence of minor corrosion in the tube to support plate intersections was observed during the review of the EC data received from the inspection on 'A' and 'B' steam generators. This has been previously observed in North Anna steam generators as was discussed in our report of Unit 1 inspection results dated December 10, 1979. No evidence exists at this time to indicate that these two steam generators have experienced denting similar to that found in the 'C' steam generator.

B. 'C' Steam Generator

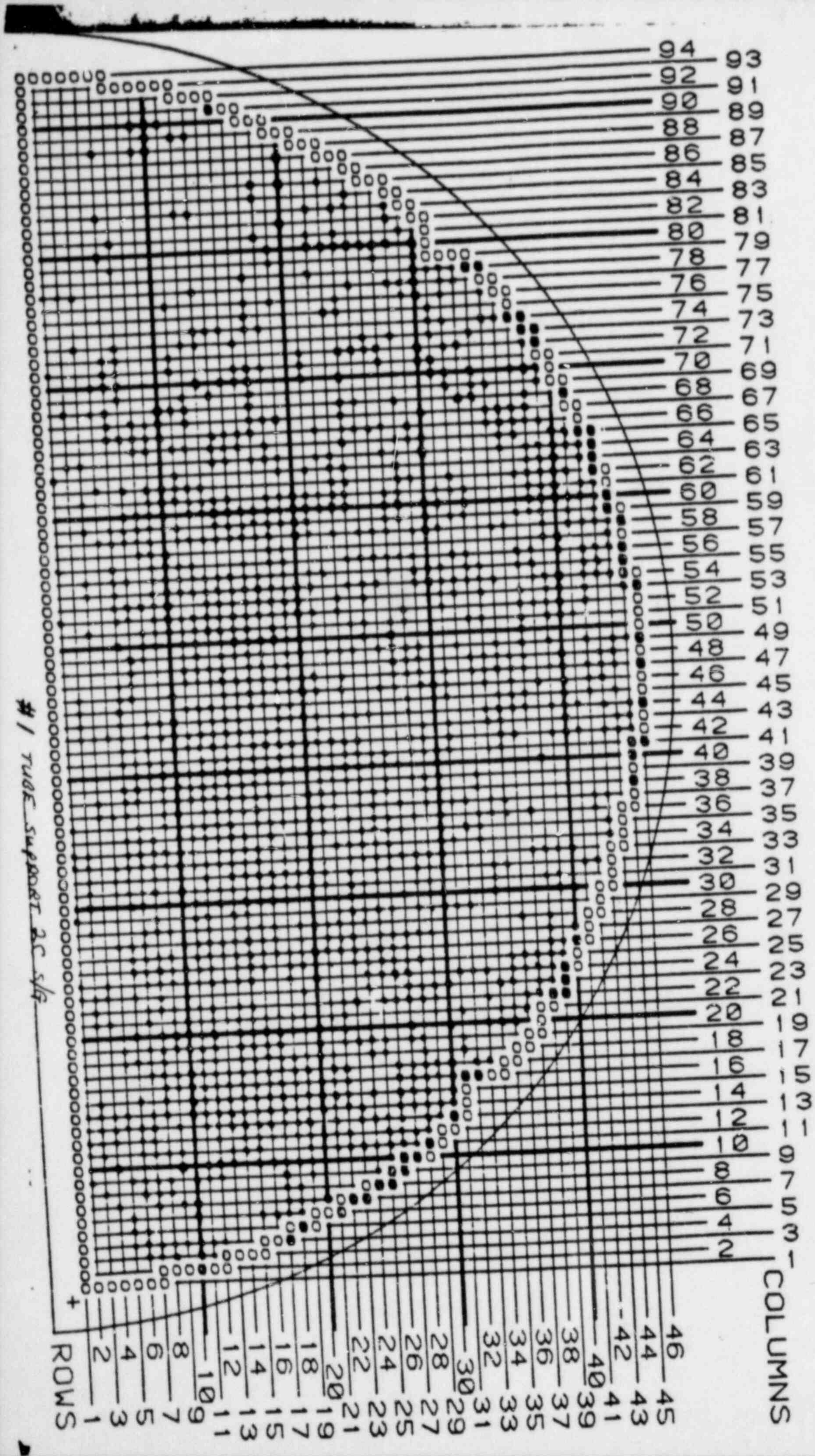
Of the 3,388 tubes contained in the tube bundle, 92% of the tubes were examined. Since the row 1 tubes had been previously plugged, they were excluded. Two different size probes were utilized during this inspection, 0.610" and 0.700". Approximately 95% of the tubes on the hot leg side showed evidence of minor denting at approximately 35% of the tube and tube support plate intersections. The denting is estimated to be less than one mil at all locations. Tube support plate maps are attached which identify the locations of the observed denting.

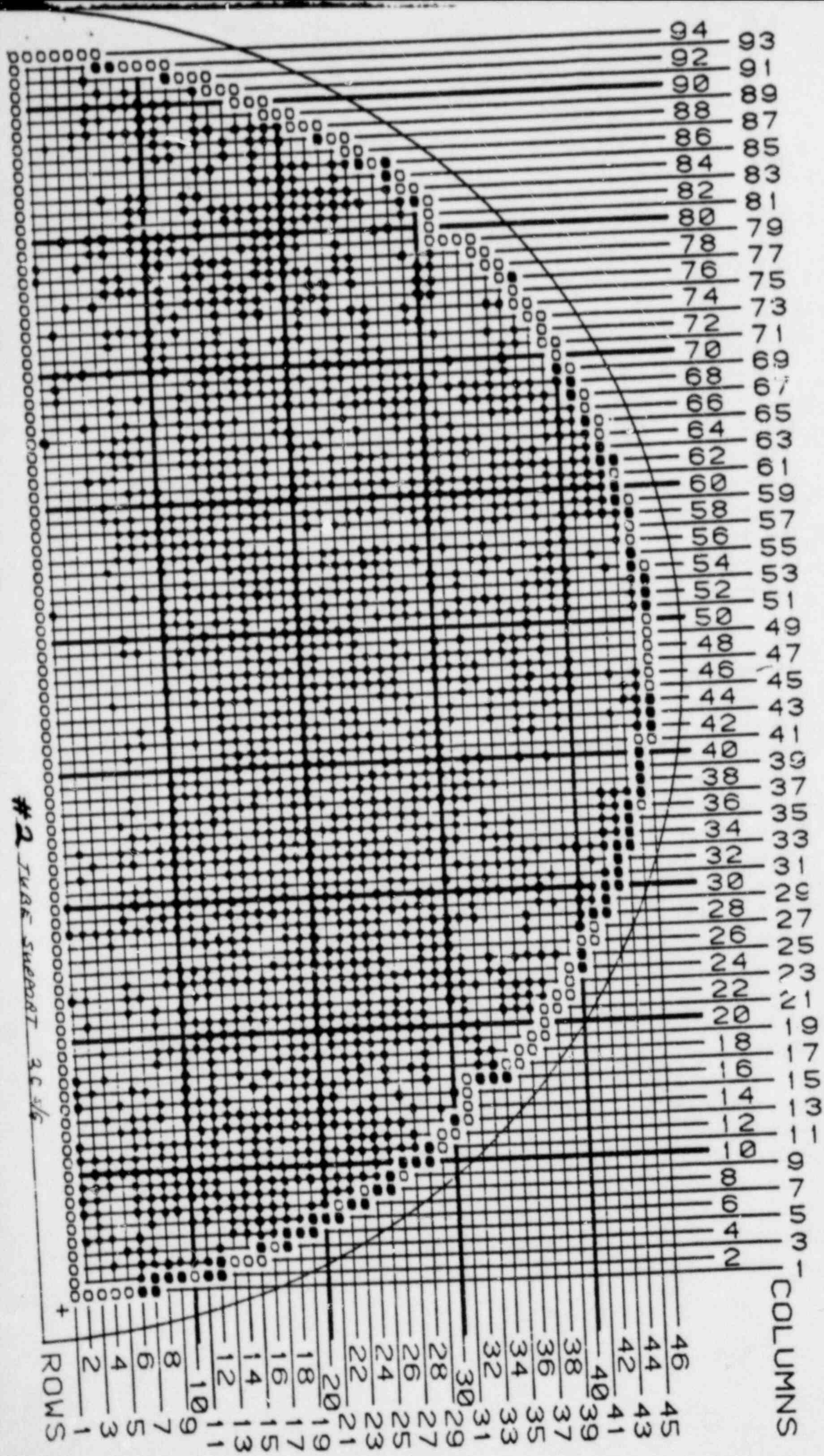
IV. Boric Acid Conditioning Program

The eddy current inspection has indicated that a significant portion of the "C" steam generator tubes are dented. The principal concerns are the rapid rate at which the denting has occurred and the localization of the activity.

In a joint effort with Westinghouse, VEPCO intends to conduct a boric acid conditioning program on the Unit 2 steam generators similar to that conducted on Unit 1. The intent of this program is to stop the support plate corrosion and inhibit further deterioration. A boric acid soak at reduced power followed by intermittent boric acid treatment during power operation will be implemented. The process of introducing boric acid into the steam generators inhibits corrosion by chemically combining with magnetite, a corrosion product, to form borasite which is a less permeable compound. The borasite is a dense, stable compound less subject to corrosion activity. This effectively seals the corrosion site and prevents transport of corrosives into the annular region which inhibits the formation of additional magnetite. Follow-up treatments amend the process by maintaining the borasite seal. A copy of the program utilized for Unit 1 is attached and will be modified as appropriate for Unit 2.

ATTACHMENT A





ROWS
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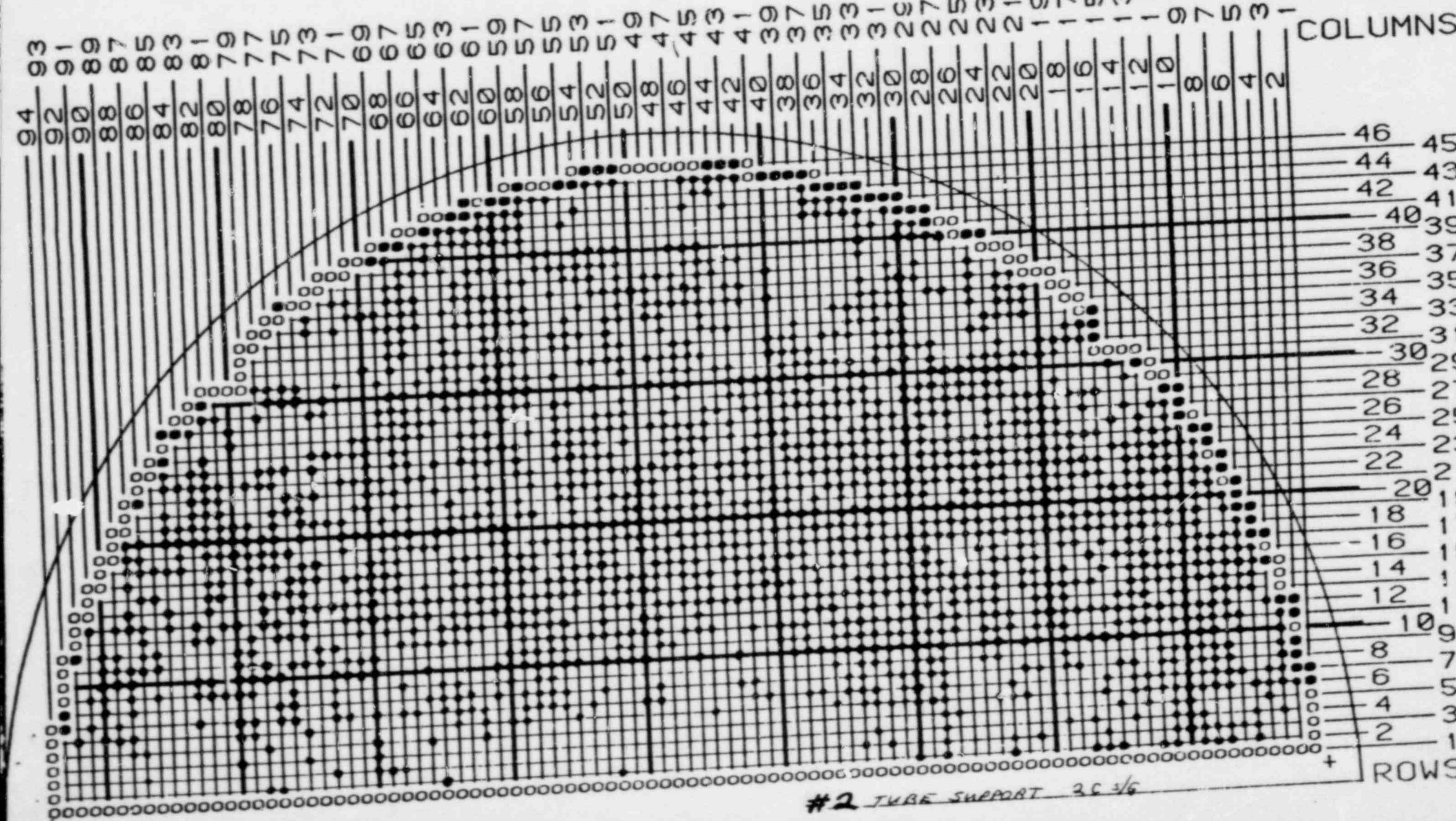
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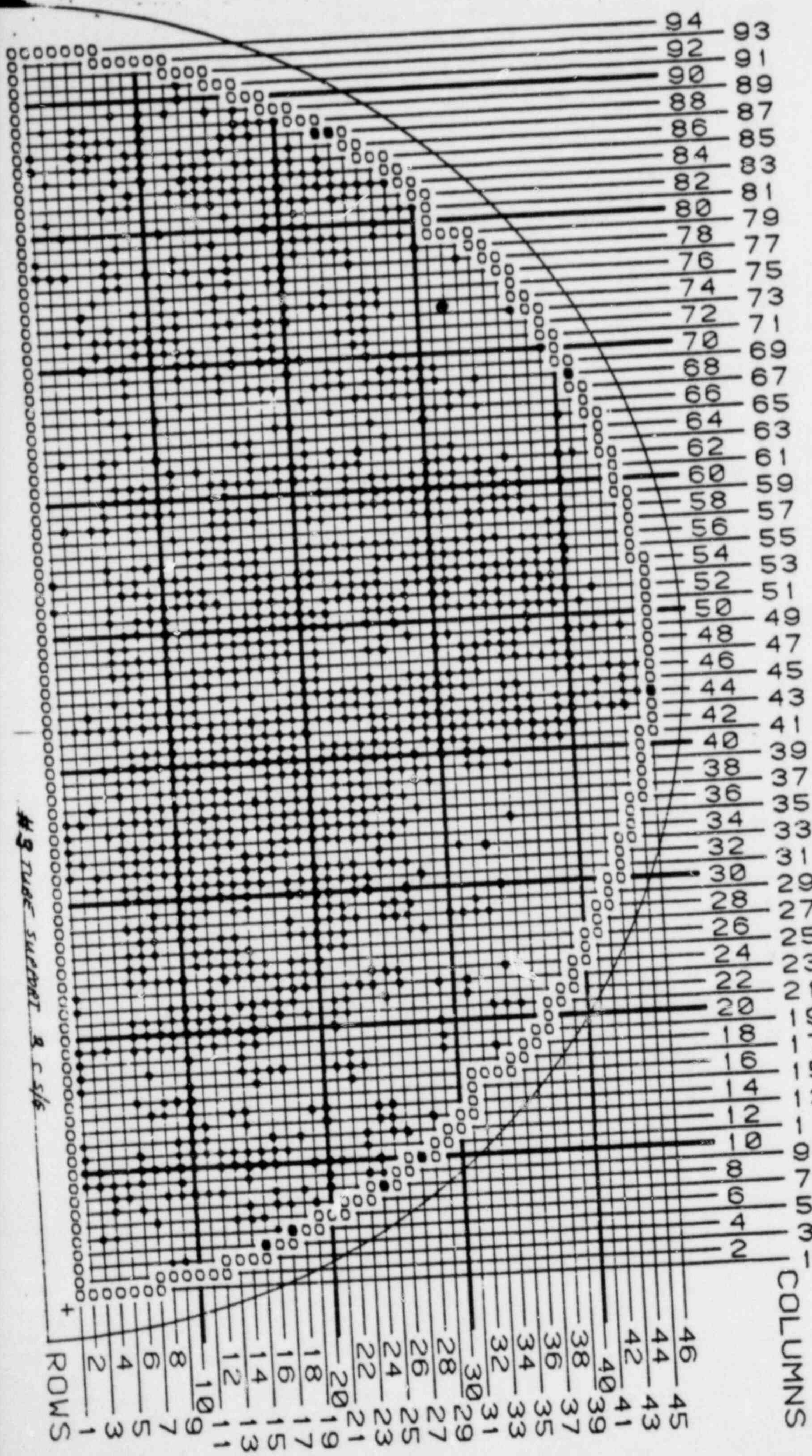

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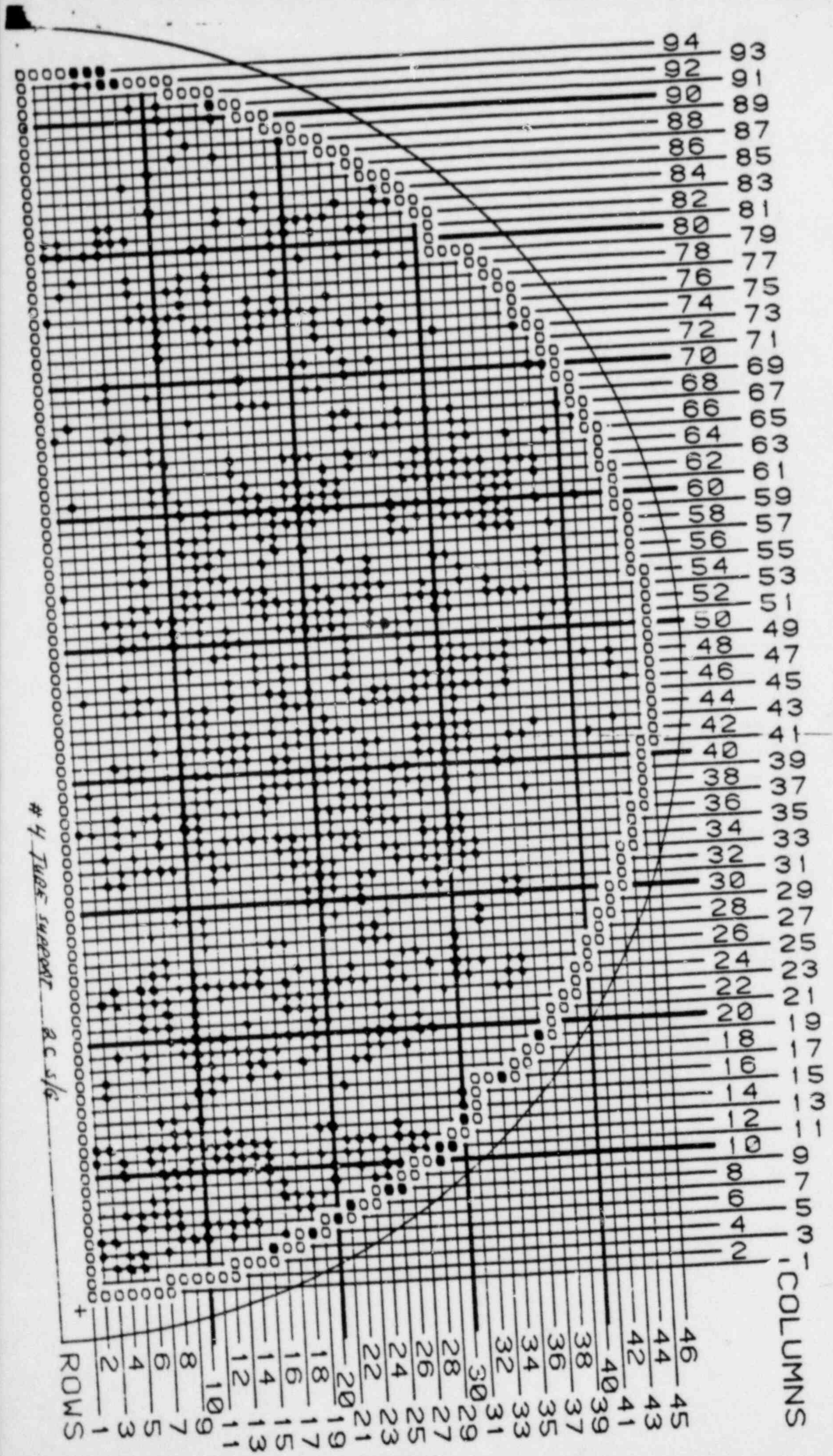
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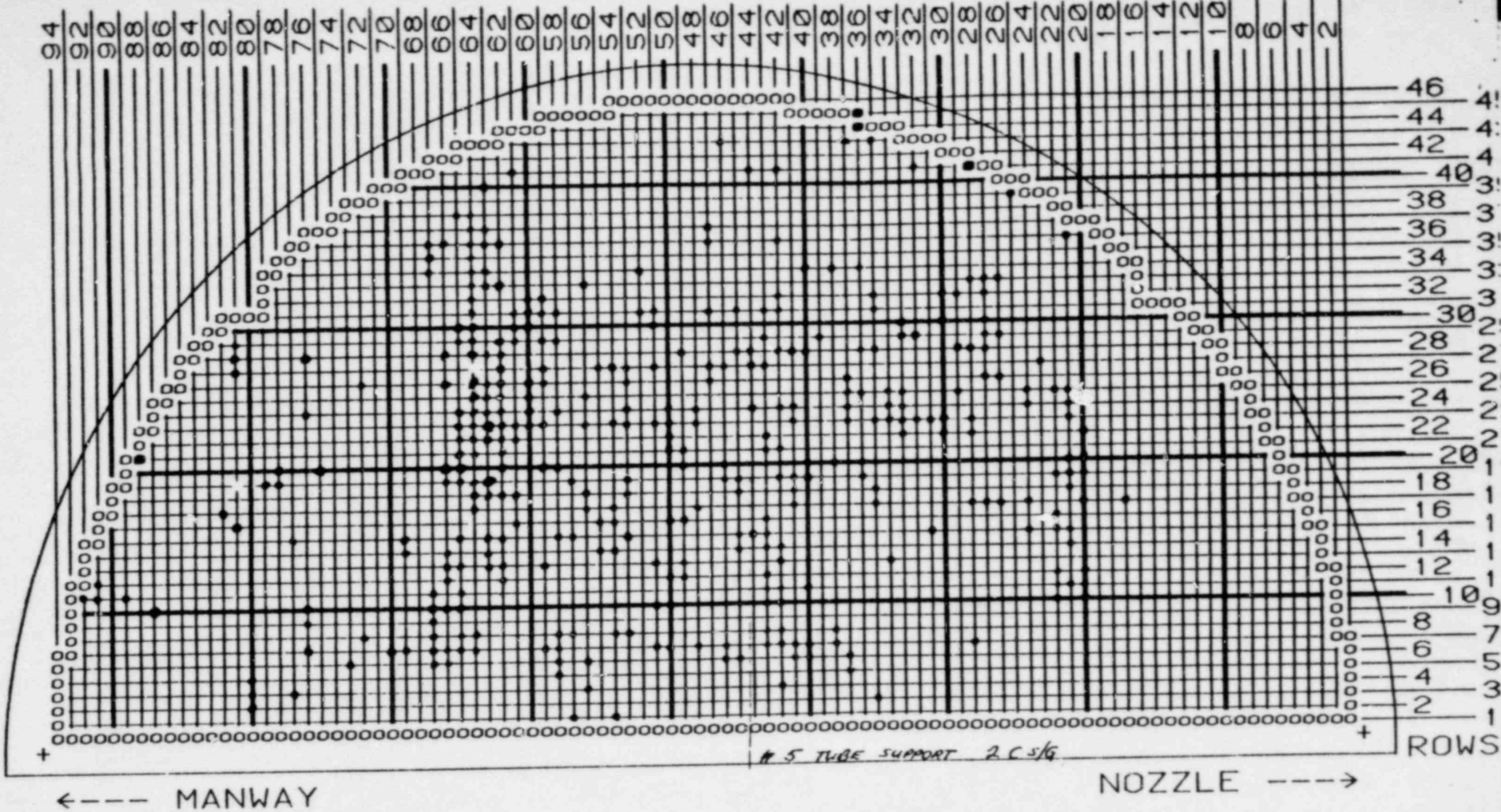
#4 TUBE SUPPORT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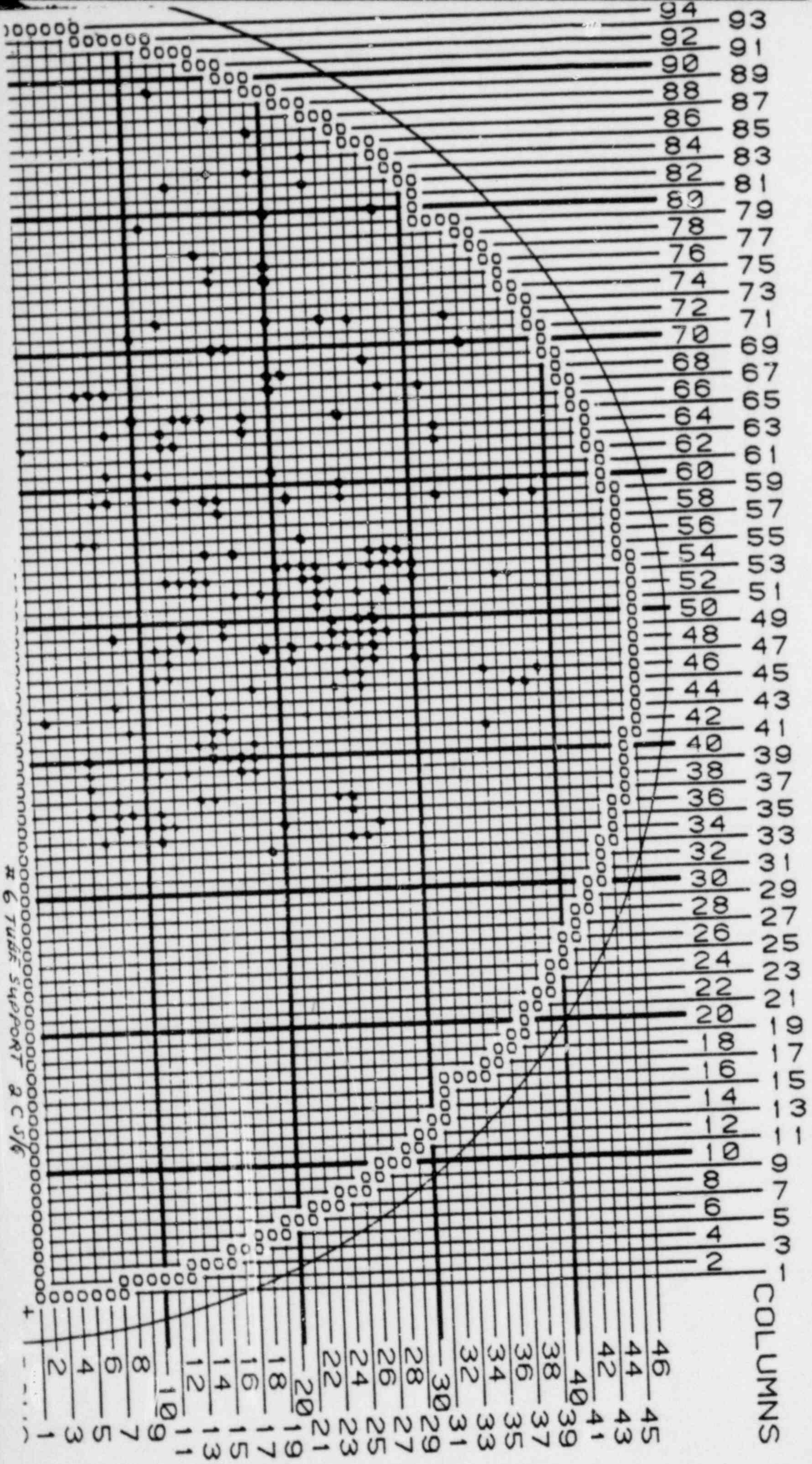
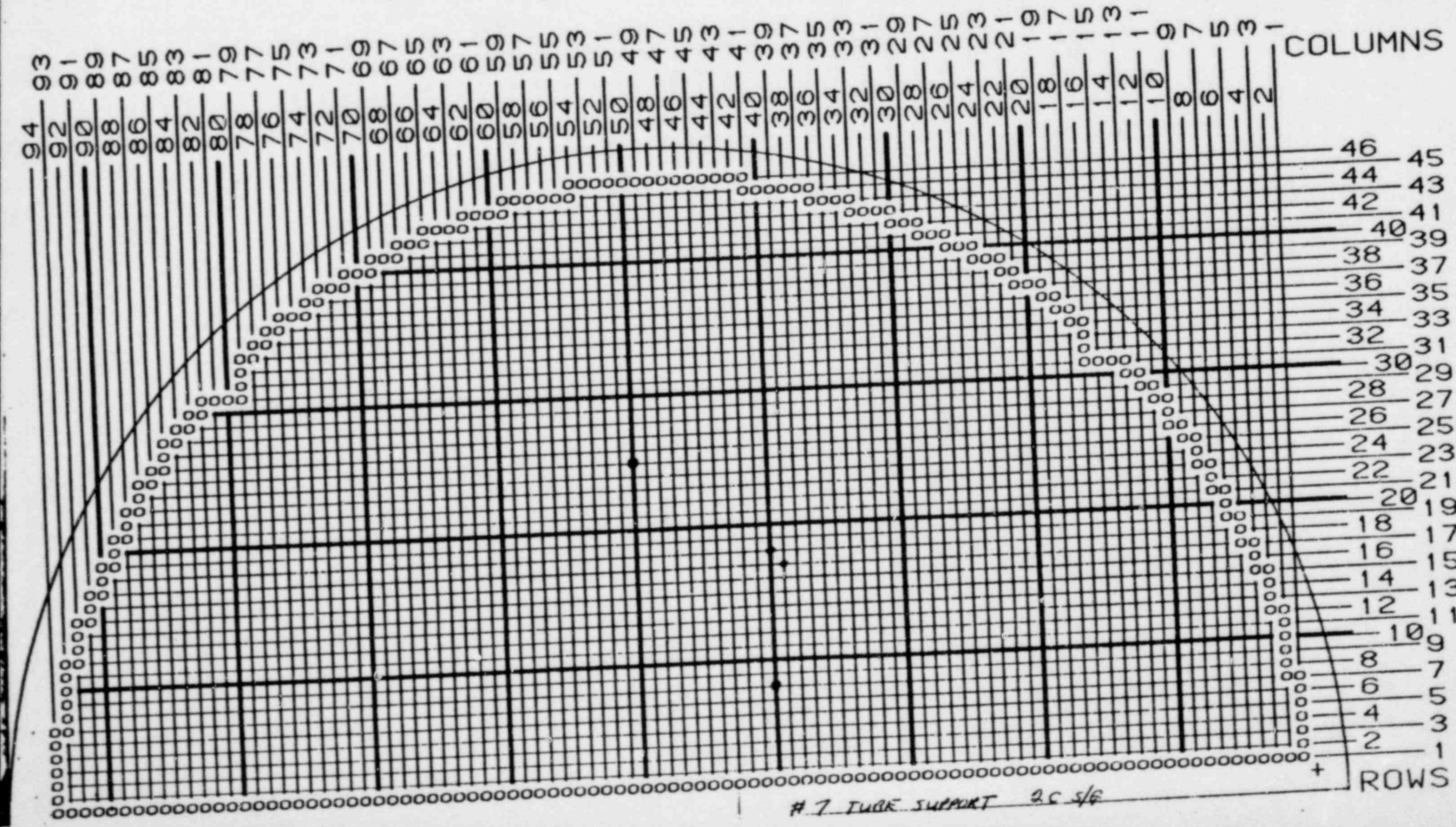
46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2
ROWS
5 TUBE SUPPORT 2 C S/G
←--- MANWAY
NOZZLE ---→



COLUMNS



COLUMNS
ROWS
#7 TUBE SUPPORT 2C S/G

ATTACHMENT B

Procedure for Boric Acid Conditioning of Steam Generators and Boric Acid Effect on Chemistry Parameters and Operating Guidelines

1.0 PURPOSE

To condition the North Anna Unit 1 steam generators with boric acid during startup and subsequent plant operation.

2.0 OBJECTIVES

To inhibit the corrosion process responsible for the steam generator tube denting. Measurements of the hydrogen produced in situ will be the criteria for determining the effectiveness of the steam generator boric acid conditioning.

3.0 GENERAL CONSIDERATIONS OF STEAM GENERATOR BORIC ACID CONDITIONING

3.1 No radioactive material will be injected to the secondary side during any phase of this test.

3.2 Sampling will be conducted by using secondary system sampling points and local sampling points for liquid samples.

3.3 The operation and safety of the plant should not be affected by sampling activities described in 3.2 and 5.0.

3.4 Chemical additions to the steam generators will be made using the existing steam generator wet layup chemical addition system.

3.5 The blowdown concentrations of boron during the test will be comparable to those that have been experienced during periods of primary-to-secondary leakage.

4.0 PROCEDURE

4.1 Test Conditions

4.1.1 Steam generators should be drained and then refilled from the condensate storage tank (CST). Add sufficient boric acid to maintain a concentration of 50 ppm boron.

4.1.2 Maintain a low power (25%) boric acid soak (50 ppm as boron) for a period of at least 4 days, followed by continuous addition of boric acid (5 - 10 ppm as boron) to the steam generators during power escalation and 100% power.

4.1.3 Hydrogen monitoring should continue during the low power soak.

4.1.4 Establish a new corrosion hydrogen baseline after returning to 100% power to determine the effectiveness of the low power boric acid soak.

4.1.5 All chemistry and operating parameters must be closely monitored during each conditioning phase. The secondary side chemistry is to be within the specified guidelines.

4.1.6 All chemical additions should be continuous and at a constant rate.

4.1.7 During the low power soak treatment, blowdown should be secured except when sampling or when blowdown is needed to control chemistry.

4.1.8 The chemical and volume control tank should be maintained at a nearly constant pressure (±3 psi).

4.2 Test Preparations

4.2.1 Scavenging of Oxygen from Condensate Storage Tank (CST)

4.2.1.1 Add 35% hydrazine to the CST, promote mixing when possible, until a concentration of 2 ppm hydrazine is obtained in CST.

4.2.1.2 Allow at least 24 hours for oxygen scavenging.

4.2.2 Preparation for the Injection of Boric Acid

4.2.2.1 Prepare a boric acid solution in the chemical addition tank using approximately 80 pounds of boric acid to approximately 200 gallons of condensate makeup.

4.2.2.2 Analyze final tank solution for boron and record result (approximately 8000 ppm); record volume of additive contained in tank.

4.2.2.3 Adjust steam generator blowdown to a nominal yet sufficient rate (not less than 5 gpm for a minimum of 1 hour) prior to sampling. Flush sample line, at a rate of not less than 500 ml/minute, prior to sampling according to schedule below (ASTM Procedure D3370, 1975).

Pipe Size (inside diameter), in.	Purging Period Per Foot of Line, sec.
1/8	5
1/4	10
3/8	15
1/2	25
3/4	40
1	60

4.2.2.4 Align the chemical addition system (auxiliary feed) to inject the boric acid solution to the steam generators.

4.2.3 Preparation for Boron Accountability Program

4.2.3.1 Boron analyses should be performed on condensate, feedwater, blowdown, main steam and heater drain samples, verifying boron concentration levels in the secondary plant prior to low power boric acid conditioning.

4.2.3.2 Certify the sample points included in the boron accountability program (Section 4.2.3.1 and 5.0). If necessary, additional sample points may be included as directed by the lead engineer.

4.2.4 Assemble hydrogen measurement apparatus (Kent-Cambridge Mark IV Hydrogen Analyzer) as described in Section 7.1.

4.3 Test Sequence

4.3.1 Phase I - Draining and Filling of Steam Generators

4.3.1.1 Drain steam generators per operating procedures.

4.3.1.2 Fill steam generators, drawing feedwater from condensate storage tank through auxiliary feed system.

4.3.1.3 Upon initiating the steam generator fill, the oxygen concentration in the auxiliary feed inlet should be determined. If greater than 500 ppb oxygen is detected, additional hydrazine should be added to condensate storage tank.

4.3.1.4 Add hydrazine into the auxiliary feed pump suction continuously to provide a minimum residual in the initial fill of 2 ppm.

4.3.1.5 Boric acid addition should be started upon initiation of the steam generator fill. A 50 ppm boron solution will require an addition rate of about 185 gph of a 4% boric acid solution assuming the use of the motor driven auxiliary feed pump. A fill time of about 45 minutes per generator would be required based on the capacity of the motor driven auxiliary feed pump.

4.3.2 Phase II - Heatup (Prior to Hot Standby)

4.3.2.1 Heatup to 180^{o}F for reactor coolant system chemistry hold of 8 hours; confirm boron concentration and adjust it using layup chemistry addition system.

4.3.2.2 Heat up to approximately 400°F, hold to draw a pressurizer bubble.

4.3.2.3 Steam generator blowdown should continue at the maximum permissible rate during any transient period, as determined by plant conditions.

4.3.2.4 Frequent analyses should be performed to identify the occurrence of any chemical return phenomena. If chemical return is detected, heatup should be suspended until cleanup is effected.

4.3.2.5 Makeup water to the steam generators during this period should be identical to that used in the initial fill, i.e., 50 ppm boron and 2 ppm hydrazine in steam generator.

4.3.2.6 Adjust boron addition rate as required to maintain approximately 50 ppm in the steam generator blowdown.

4.3.2.7 As heatup progresses, hydrazine thermal decomposition will result in the production of ammonia. The 2 ppm excess hydrazine is expected to produce as much as 1.1 ppm ammonia. This will be reduced to some extent by blowdown.

4.3.3 Phase III - Heatup (Hot Standby)

4.3.3.1 Continue heatup until hot standby (547°F) condition is reached.

4.3.3.2 Continue hydrazine addition to condensate storage tank per Section 4.2.1.

4.3.3.3 Maintain 100 ppm hydrazine residual in steam generator blowdown. To achieve this level an auxiliary feed hydrazine concentration of about 1.25 ppm will be required. This is expected to result in an ammonia content in the steam of about 0.7 ppm. The corresponding steam generator ammonia concentration will be about 0.4 ppm, or somewhat higher than the recommended range for normal operation.

4.3.3.4 Maintain a boron concentration of 50 ppm in steam generator blowdown. This can be accomplished by addition either to the auxiliary feedwater pump suction or through the layup chemistry addition system.

Note: Some difficulty in accurate control is anticipated. While feedwater additions to all four generators can be expected to be equal over the long term, large variations are possible at any given moment.

4.3.3.5 Perform zero power physics testing as required.

4.3.3.6 During this period, steam dump will normally be to atmosphere and this is recommended to avoid potential ammonia attack of the condenser. The steam will contain about 0.7 ppm ammonia, 5 ppm boron and less than 50 ppb hydrazine. Thus, assuming a typical 4-day hold at hot standby, a total discharge of about 7.5 pounds of ammonia and about 50 pounds of boron (300 pounds of boric acid) is anticipated.

4.3.3.7 If necessary, blowdown at maximum rate until chlorides are less than detectable.

4.3.4 Phase IV - Power Escalation

4.3.4.1 Initiation of power operation in the unit can proceed at any point according to normal procedures.

4.3.4.2 Draw condenser vacuum and initiate steam dump to condenser per normal procedure. The expected ammonia content of the steam (0.7 ppm) exceeds the recommended level for normal operation; it does not exceed levels which have been commonly experienced in the past.

4.3.4.3 Establish 10 - 20 ppb minimum hydrazine residual in feedwater using normal addition system to ensure oxygen control.

Note: If pH requirements are not met (>8.0 in feedwater), the addition of ammonium hydroxide may be necessary.

4.3.4.4 Boron concentrations should be maintained at 50 ppm by using the layup chemistry addition system. Major boric acid additions can be made to the condensate pump suction if the boron concentration drops below 30 ppm. Approximately 175 gallons of 4% boric acid solution (10 pounds boron) will be required to effect a 20 ppm increase in concentration.

4.3.4.5 With the moisture separator reheater out of service, escalate power to approximately 30% and, if not previously done, put in automatic feedwater control system.

4.3.5 Phase V - Low Power (25%) Hold

4.3.5.1 Reduce power to 25% and leave in automatic feedwater control system.

4.3.5.2 Commence monitoring corrosion hydrogen.

4.3.5.3 Boron distribution and accountability in the secondary plant (sample points are given in Sections 4.2.3 and 5.0) should be determined.

4.3.5.4 Maintain 10 - 20 ppb minimum hydrazihe residual in feedwater using normal addition system.

4.3.5.5 The steam generator blowdown boron concentration will be maintained within 45 ± 5 ppm by adjusting the feedwater inlet addition to the steam generator.

4.3.5.6 Maintain these conditions for a minimum of 96 hours, monitoring the chemical and operating parameters throughout.

4.3.5.7 Establish the steam generator boron demand (hideout) after 48 hours into the soak as outlined in the following steps:

1. Determine boron concentration in the steam generator blowdown. Then, secure steam generator boron addition and blowdown.
2. After a minimum of 6 additional hours (54 hours cumulative), determine boron concentration in the steam generator blowdown. (Prior to sampling, blowdown should be flushed according to Section 4.2.2.3)
3. If $\frac{\text{boron @ t = 6}}{\text{boron @ t = 0}}$ is greater than 90%, demand is satisfied.

   Where, t = 6 is 6 hours after securing addition, and
   t = 0 is time of securing addition.
4. Resume addition required to maintain 45 - 50 ppm boron.
5. After 30 additional hours (84 cumulative hours into soak), repeat Steps 1 thru 3. If boron accountability is greater than 90%, resume addition for 6 more hours to complete treatment. However, if boron accountability is less than 90%, proceed to Step 6.
6. Resume boron addition until demand is satisfied (greater than 90% accountability), repeating Steps 1 thru 3 as determined by lead engineer.

4.3.5.8 Monitor the volume of additive in the chemical addition tank to determine the boric acid addition rate. Repeat Sections 4.2.2.1 and 4.2.2.2 as required to prevent tank from going dry.

4.3.6 <u>Phase VI - Boric Acid Continuous Addition at 100% Power</u>

4.3.6.1 At the conclusion of the low power soak, terminate boric acid addition.

4.3.6.2 Allow the steam generator blowdown boron concentration to decrease to 5 - 10 ppm, then increase power to 100%.

4.3.6.3 Resume boric acid addition, adjusting the boric acid feed rate as required to maintain the 5 - 10 ppm boron concentration.

4.3.6.4 Maintain these conditions monitoring chemical and operating parameters throughout.

4.3.6.5 Monitor the volume of additive in the chemical addition tank to determine the boric acid addition rate. Replenish the tank as required and as defined in Sections 4.2.2.1 and 4.2.2.2.

4.3.6.6 Establish the corrosion hydrogen generation rate after confirming that all chemical parameters are stabilized.

5.0 SAMPLING

5.1 Sampling of secondary system water and condensed steam will be from the (1) condensate pump discharge, (2) main feedwater, (3) steam generator blowdown, and (4) main steam sample points.

5.2 Reactor coolant sampling will be performed at the normal reactor coolant sample point.

5.3 The main steam and feedwater sample points must be flushed prior to sampling as determined by lead engineer.

6.0 ANALYSES

6.1 Secondary Side Liquid Samples

6.1.1 All samples identified in Section 5.0 are to be analyzed for hydrazine and boron. Dissolved oxygen, pH, and ammonia will be measured in the condensate, feedwater, and blowdown samples.

6.1.2 Hydrogen analyses will be performed on the main steam and feedwater samples using Kent-Cambridge Mark IV Hydrogen Analyzers in accordance with the instrument instruction manual.

6.2 Reactor Coolant Samples

6.2.1 Reactor coolant samples will be analyzed for hydrogen content using the standard site analysis procedure and apparatus.

7.0 ANALYSIS SCHEDULE

7.1 Kent-Cambridge Dissolved Hydrogen Analyzer

7.1.1 Kent-Cambridge Analyzers will be connected to the main steam sample points.

7.1.2 One Kent-Cambridge Analyzer will be connected to the feedwater sample point.

7.1.3 Recorders will be connected to the Kent-Cambridge Analyzers to provide continuous monitoring of dissolved hydrogen.

7.1.4 Adjust total flow (approximately 550 cc/min bypassing sampling cup) to 800 cc/min ± 30 cc/min while maintaining active sample flow at 250 cc/min ± 15 cc/min.

7.1.5 Sample temperature is to be maintained at 85°F ± 15°F.

7.1.6 E'ectrical zero is to be checked for drift once each day.

7.1.7 Each instrument is to be calibrated according to operating instructions at least once each week.

7.2 On-Site Secondary Side Liquid Analyses

7.2.1 Hydrazine analyses are to be performed twice daily for all samples identified in Section 5.1.

7.2.2 Dissolved oxygen, ammonia, and pH analyses are to be performed daily on condensate, feedwater, and blowdown samples.

7.2.3 Boron analyses are to be performed at least 3 times per day on all samples outlined in Sections 4.2.3 and 5.0.

7.3 Primary Side Hydrogen Analyses

7.3.1 Reactor coolant hydrogen analyses are to be performed in accordance with the site sampling schedule.

8.0 RECORDING OF DATA

8.1 All analytical data and results will be recorded in a permanent Westinghouse Engineering Workbook.

8.2 Plant data required during the test period include the following at least once each day; where unavailable, conditions will be estimated from heat balance drawings.

1. Unit power level.
2. Feedwater flowrate.
3. Main steam flowrate, temperature and pressure.
4. Steam generator blowdown rate.
5. Net amount of boric acid feed as established from feed tank makeup and the feed rates.
6. Routine secondary system chemistry data generated during testing.
7. Latest condenser leak rate measurement.
8. Reactor coolant flowrate, pressure and temperature (T_{ave}, T_H or T_C).
9. Volume control tank pressure.

9.0 DATA EVALUATION

The data will be evaluated to establish effects of boric acid on the steam generator net corrosion hydrogen generation rate and concentrations in other secondary system components.

10.0 REPORTING TEST RESULTS

A Westinghouse report will be issued to North Anna Unit 1.

11.0 MANPOWER AND FACILITIES REQUIREMENTS

11.1 Westinghouse engineering and chemistry technician personnel from the Chemistry Operations Group will participate in this program. The engineer will assume lead responsibility and will provide overall program direction. The Westinghouse chemistry technicians will perform the hydrogen and hydrazine analyses specified in Sections 5.0, 6.0 and 7.0. Additional analyses will be performed as required.

11.2 If needed, and as available, Westinghouse will provide the Kent-Cambridge Mark IV Hydrogen Analyzers. Westinghouse equipment will require access to electrical supply (110 V).

11.3 The customer will provide the technician manpower and laboratory facilities required for on-site analyses identified in Sections 7.2.2 and 7.2.3 (blowdown boron analyses only).

11.4 Westinghouse will perform any off-site analyses deemed necessary to fulfill the test objectives.

12.0 IMPLEMENTATION OF PROGRAM

The Westinghouse lead engineer will coordinate on-site testing activities with the cognizant customer representative(s) at the site and may modify the sampling and/or analyses as required to fulfill the test objectives.

TABLE 1

Revised Secondary System Chemistry AVT Operating Guidelines

	Without Boric Acid	With Boric Acid
Condensate[1]		
Oxygen, ppb	<10	<10
Feedwater		
pH, @ 25°C	8.8 - 9.2	>8.0
Conductivity, µmhos	1.8 - 5.0	≤5
Oxygen, ppb	<5	<5
Hydrazine, ppb	$[O_2]$ + ≥10	$[O_2]$ + ≥10
Ammonia, ppm	≤0.5	≤0.5

Steam Generator AVT Chemistry Guidelines

	In the Absence of Locatable Condenser Leakage		In the Presence of Locatable Condenser Leakage	
Parameter	Without Boric Acid	With Boric Acid	Without Boric Acid[2]	With Boric Acid[2]
pH @ 25°C	>8.5	>7.0	>8.5	>7.0
Cation Conductivity µmhos/cm @ 25°C	<2.0	<2.0	2.0	2.0
Boron, ppm	N/A	5 - 10	N/A	5 - 10
Sodium, ppm	<0.04	<0.04	0.1	0.1
Chloride, ppm	<0.05	<0.05	0.15	0.15
Oxygen, ppb	<5	<5	<5	<5
Hydrazine, ppb	$[O_2]$ + ≥20	$[O_2]$ + ≥20	$[O_2]$ + ≥20	$[O_2]$ + ≥20
Ammonia, ppm	>0.06	>0.06	>0.06	>0.06
Silica, ppm	<0.05	<0.05	0.05	0.05
Blowdown, gpm	Continuous[3]	Continuous[3]	Continuous[4]	Continuous[4]

[1] Continuous overboard at air ejector drains.

[2] Continued operation with locatable contaminant ingress is not recommended.

[3] Operate at the minimum continuous blowdown rate required to maintain continuous monitoring capability, approximately 5 gpm/SG.

[4] Blowdown continuously at a rate required to maintain chemistry parameters.

TABLE 2

Steam Side Laboratory Analysis Frequency

Analysis[1]	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
Steam Generator Blowdown							
pH	X	X	X	X	X	X	X
Cation Cond.	X	X	X	X	X	X	X
Boron	X	X	X	X	X	X	X
Sodium	X	X	X	X	X	X	X
Chloride	X	X	X	X	X		
Suspended Solids			X				
Silica	X	X	X	X	X		
Ammonia	X	X	X	X	X	X	X
Hydrazine	X	X	X	X	X	X	X
Oxygen	X	X	X	X	X	X	X
Feedwater							
pH	X	X	X	X	X	X	X
Conductivity	X	X	X	X	X	X	X
Amine	X	X	X	X	X		
Ammonia	X	X	X	X	X		
Hydrazine	X	X	X	X	X	X	X
Fe/Cu	X		X		X		
Oxygen	X	X	X	X	X	X	X
Condensate and Main Steam							
pH	X	X	X	X	X	X	X
Cation Cond.	X	X	X	X	X	X	X
Sodium	X	X	X	X	X	X	X
Ammonia	X		X		X		

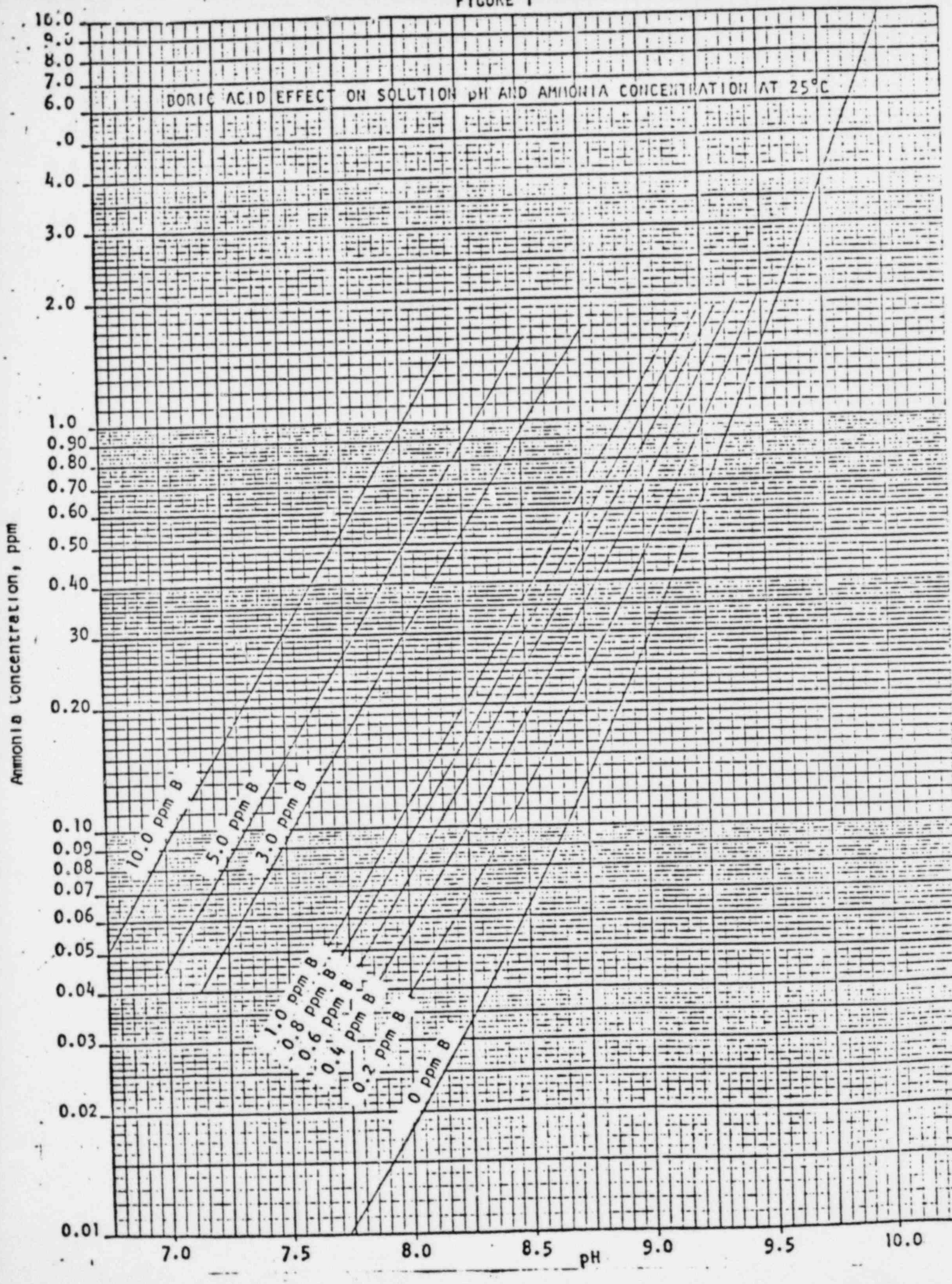
[1]Analytical methods are presented in WCAP-7333, "Chemical Analysis Procedures for Westinghouse Pressurized Water Reactors."

TABLE 3

BORIC ACID EFFECT ON SOLUTION pH AND AMMONIA CONCENTRATION AT 25°C

ppm B	ppm Ammonia 0	0.05	0.10	0.25	0.50	1.0
0	7.00	8.40	8.65	8.97	9.18	9.38
0.1	6.90	8.24	8.52	8.86	9.10	9.32
0.2	6.84	8.12	8.41	8.77	9.02	9.26
0.3	6.79	8.03	8.32	8.69	8.96	9.21
0.4	6.75	7.95	8.24	8.62	8.90	9.15
0.5	6.72	7.89	8.18	8.56	8.84	9.11
0.6	6.69	7.83	8.12	8.51	8.79	9.07
0.7	6.66	7.78	8.07	8.46	8.75	9.03
0.8	6.64	7.73	8.03	8.42	8.71	8.99
0.9	6.62	7.69	7.99	8.38	8.67	8.95
1.0	6.62	7.65	7.95	8.34	8.63	8.92
3.0	6.38	7.23	7.53	7.92	8.22	8.52
5.0	6.28	7.03	7.32	7.71	8.01	8.31
6.0	6.24	6.96	7.24	7.63	7.93	8.23
7.0	6.21	6.90	7.18	7.57	7.87	8.17
8.0	6.18	6.84	7.12	7.51	7.81	8.11
9.0	6.15	6.80	7.07	7.46	7.76	8.06
10.0	6.13	6.75	7.03	7.42	7.72	8.01
15.0	6.04	6.59	6.86	7.24	7.54	7.84
20.0	5.98	6.48	6.74	--	7.42	7.72
25.0	5.93	6.39	6.65	7.02	7.32	7.62
30.0	5.89	6.32	6.57	6.95	7.24	7.54
35.0	5.86	6.26	6.51	6.89	7.18	7.47
40.0	5.83	6.21	6.45	6.83	7.12	7.42
45.0	5.81	6.17	6.41	6.78	7.07	7.36
50.0	5.78	6.13	6.36	6.73	7.02	7.32
75.0	5.69	5.99	6.20	6.56	6.85	7.14
100.0	5.63	5.88	6.08	6.43	6.72	7.01

FIGURE 1



BORIC ACID EFFECT ON SOLUTION pH AND AMMONIA CONCENTRATION AT 25°C
Ammonia Concentration, ppm
10.0
9.0
8.0
7.0
6.0
4.0
3.0
2.0
1.0
0.90
0.80
0.70
0.60
0.50
0.40
0.20
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
10.0 ppm B
5.0 ppm B
3.0 ppm B
1.0 ppm B
0.8 ppm B
0.6 ppm B
0.4 ppm B
0.2 ppm B
0 ppm B
7.0
7.5
8.0
8.5
9.0
9.5
10.0
pH