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SUBJECT: Forwards Apr 1980 steam generator insp rept & evaluation of results,in response to NRC request.

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April 29, 1980

Director of Nuclear Reactor Regulation
Attention: Mr. Dennis L. Ziemann, Chief
Operating Reactors Branch No. 2
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Steam Generator Inspection Results and Analysis
R. E. Ginna Nuclear Power Plant, Unit No. 1
Docket No. 50-244

Dear Mr. Ziemann:

In response to a request of Dr. B. D. Liau of your staff we are submitting for your information a report on the 1980 Steam Generator Inspection and an evaluation of the results. Please find attached one copy of each.

Attachment A - April 1980 Steam Generator Inspection
Attachment B - Evaluation of Results

Very truly yours,

L D White, Jr.

L. D. White, Jr.

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Attachment A

April 1980 Steam Generator Inspection

A program of planned eddy current examinations was conducted on both loop "A" and "B" steam generators at R. E. Ginna Nuclear Power Plant from April 3-8, 1980 during the scheduled refueling and maintenance outage. The purpose of these examinations was to assess the integrity of the steam generator tubing and take corrective actions to assure reliable and safe operation during the next operating fuel cycle.

These examinations consisted of a multifrequency eddy current examination to detect and measure potential tube defects. This is the third year of multifrequency eddy current examinations at the Ginna plant. The four frequencies chosen were as follows:

a. 400 KHz Differential,
b. 200 KHz Differential,
c. 100 KHz Differential,
d. 100 KHz Absolute.

Along with the four frequencies, a support plate and tube sheet mix was utilized by combining the inputs from the 400 KHz and 200 KHz differential frequencies. This mix allowed for more accurate interpretation of signals from areas of the steam generator where the signal from support structures interfere with signals generated from tubing flaws.

The examinations consisted of a 100 percent inspection of both steam generators inlets and the outlets receiving approximately a 25 percent inspection. Minimum tube length examined was from the first support plate down through the tube sheet crevice. Tubes were also examined over the U-bend region and to the sixth support plate. With the exception of indications which will be discussed in the text,

there were not any subtle changes noted over previous years data. The steam generator outlets did not show any reportable indications. In the "A" steam generator inlet only one tube (R 16 C 88) requiring plugging was found. It displayed a 50% small volume indication 2 inches above the top of the tube sheet.

The "B" steam generator, which had two (2) crevice indications in April of 1979 and eleven (11) crevice indications in the December 1979 showed thirty one (31) crevice indications at this time. These indications fall into two categories, the first being 13 indications which were identified at all examination frequencies and are as follows:

R17C35 - 38%, 15" above tube end
R18C35 - <20%, 15" above tube end
R18C36 - 48%, 18" above tube end
R14C38 - 58%, 15" above tube end
R17C40 - 60%, 18" above tube end
R17C41 - 60%, 18" above tube end
R15C41 - 67%, 18" above tube end
R15C42 - 75%, 15" above tube end
R14C43 - 77%, 12" above tube end
R19C44 - 67%, 10" above tube end
R24C45 - 85%, 15" above tube end
R24C46 - 95%, 15" above tube end
R21C54 - 60%, 15" above tube end

The second category included 18 indications that were detected with the 100 KHz absolute frequency only. These indications were an abnormal vertical channel signal on the brush strip chart recorder that resembled the signals at 100 KHz absolute of the 13 tubes found at the other frequencies. Therefore, the following tubes are considered to be under crevice attack:

| | | |
|---|---|---|
| R14C32 | R16C35 | R13C39 |
| R15C34 | R17C36 | R18C41 |
| R16C34 | R16C37 | R15C44 |
| R17C34 | R19C37 | R14C46 |
| R18C34 | R18C38 | R18C46 |
| R15C35 | R19C38 | R18C48 |

These 31 tubes with crevice indications, with the exception, of three R24C45, R24C46 and R21C54, all fit into a pattern with the previous 13 tubes found in the two examination in 1979, as shown

in Figures I and II. In addition to these, three tubes in the "B" inlet were found with defects above the tube sheet as follows:

R32C16 - 41%, small volume indication, 2" above tube sheet
R45C48 - 46%, 24" above tube sheet
R45C47 - 36%, 24" above tube sheet.

After eddy current data analysis was complete crevice indications were identified only in the "B" steam generator inlet and not in the "A" steam generator. Two tubes from the "B" steam generator inlet and one tube from the outlet were chosen for tube pulling. These tubes, R17C41 - 60% indication 18" above the tube end, R15C44 - smallest 100 KHz absolute signal, and R17C40 - outlet (cold leg) tube with no indication, but the opposite end of an inlet tube with an indicator, were determined as tubes that would potentially give valuable information concerning the damage mechanism and also allow for three different crevices to have deposits removed for chemical analysis.

The tube pulling operations went as follows:

1. R17C41 - 60% indication 18" above tube end

   a. marked ID at 14", 24" and 26" from tube end
   b. tube started pulling at a force of 4500 psi then dropped to 2500 psi for short period of time, average remainder pulled at 1500 psi.
   c. total length cut 69.5", total pulled length 72" giving approximately 2.5" elongation or 3.5%.
   d. honed sample from crevice.

2. R15C44 - small 100 KHz absolute signal in crevice region

   a. marked ID at 14", 24" and 26" from tube end
   b. tube started pulling at a force of 2400 psi dropped to 1800 then increased for an average pull of 2100 psi
   c. total length cut was 69.5", total pulled length 72.06"
   d. honed sample from crevice.

3. R17C40 - No indication from outlet

   a. marked ID at top of tube sheet.
   b. tube started pulling at a force of 3200 dropped to approximately 1100 for the remainder of the pull

c. total length cut was 69.5", total pulled length 69.875".
d. honed sample from crevice.

The proposed hypothesis for the crevice cracking mechanism is a general intergranular corrosion attack (IGA) that takes place down in the tube sheet crevice area. After the intergranular corrosion attack has penetrated deep enough into the tube wall the remaining wall cracks due to stress caused either by pressure and/or thermal loads on the tube. The active species involved in this attack is postulated to be a caustic solution of NaOH, however, $Na_2SO_4$, or $NaSiO_3$ may also be involved. Crevice deposit analysis and the pulled tube surface deposit analysis should help identify the actual species involved in this attack. This concentration of caustic is believed to be from previous phosphate chemistry operation (prior to November 1974) and not to be from the all volatile treatment (AVT) operating chemistry that Ginna has used the last five and one half years. It is postulated that the molar ratio between $Na^+$ and $PO_4^=$ in the crevice has been increasing in the crevice as $PO_4$ has been slowly removed during wettings and subsequent dryouts. This action leaves behind free $Na^+$ and $OH^-$, which would raise the pH and produce caustic crevice conditions.

A number of actions have been taken to gain additional information concerning the cause of crevice intergranular corrosion attack and to reduce the propensity for crevice attack. These actions include a more sophisticated eddy current inspection, tube pulling, tube sheet water lancing, crevice flushing boil out, continued close control of secondary chemistry, and a mid-cycle Fall steam generator inspection.

Our use of multifrequency eddy current inspection including a 100 KHz absolute examination has allowed the identification and plugging of otherwise undetected attack within the crevice region. Tubes which might otherwise be susceptible to crack growth and result in primary to secondary leakage are plugged.

The three tubes which have been pulled and are being examined by Westinghouse Electric Corporation should yield valuable information concerning damage mechanism and chemical species.

As in all previous steam generator inspections, an extensive program of water lancing on the secondary side has been carried out. Thus, the quantity of sludge in the secondary side is minimized.

A crevice flushing boil out procedure will be employed to further reduce the potentially detrimental material in the tube sheet crevice. The program to be employed at Ginna is based, in part, on programs previously employed at Kansai Electric Power Company at Mehama Unit 2 and by Wisconsin Electric Power Company at Point Beach Unit 1. The program at Ginna will involve approximately twenty-two cycles. Boric acid will be added during a number of these cycles with the objective of neutralizing the caustic solution in the crevices.

During startup and plant operation, the full flow condensate demineralizers will continue to be used and careful control of secondary chemistry will be maintained. Operating experience has demonstrated our ability to maintain excellent chemistry conditions on the secondary side.

Finally, we plan to shut down Ginna Station in the Fall of 1980 to reexamine the steam generators. This inspection should aid in establishing the effectiveness of corrective actions being applied now and to planning any future corrective actions.

Figure I

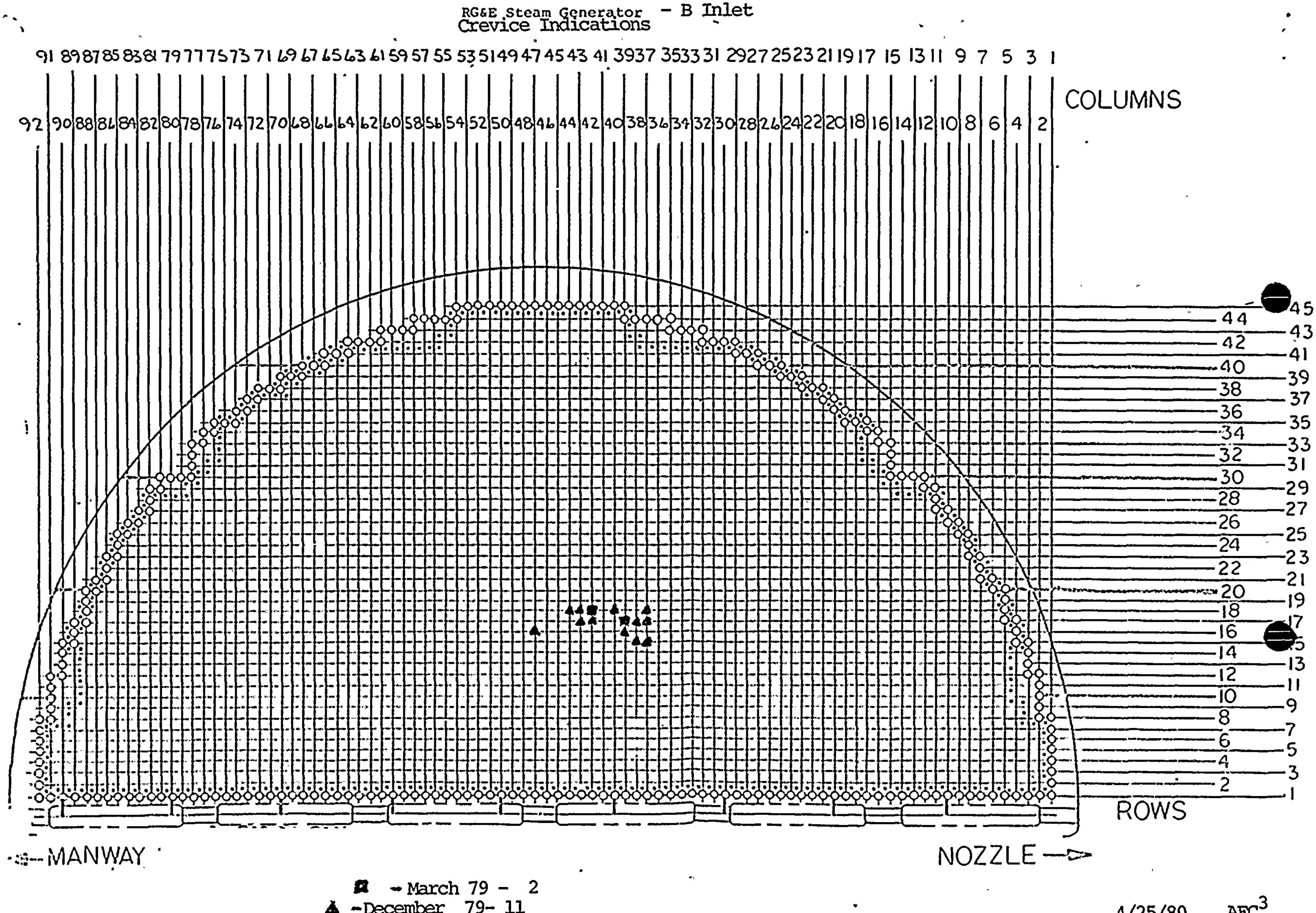


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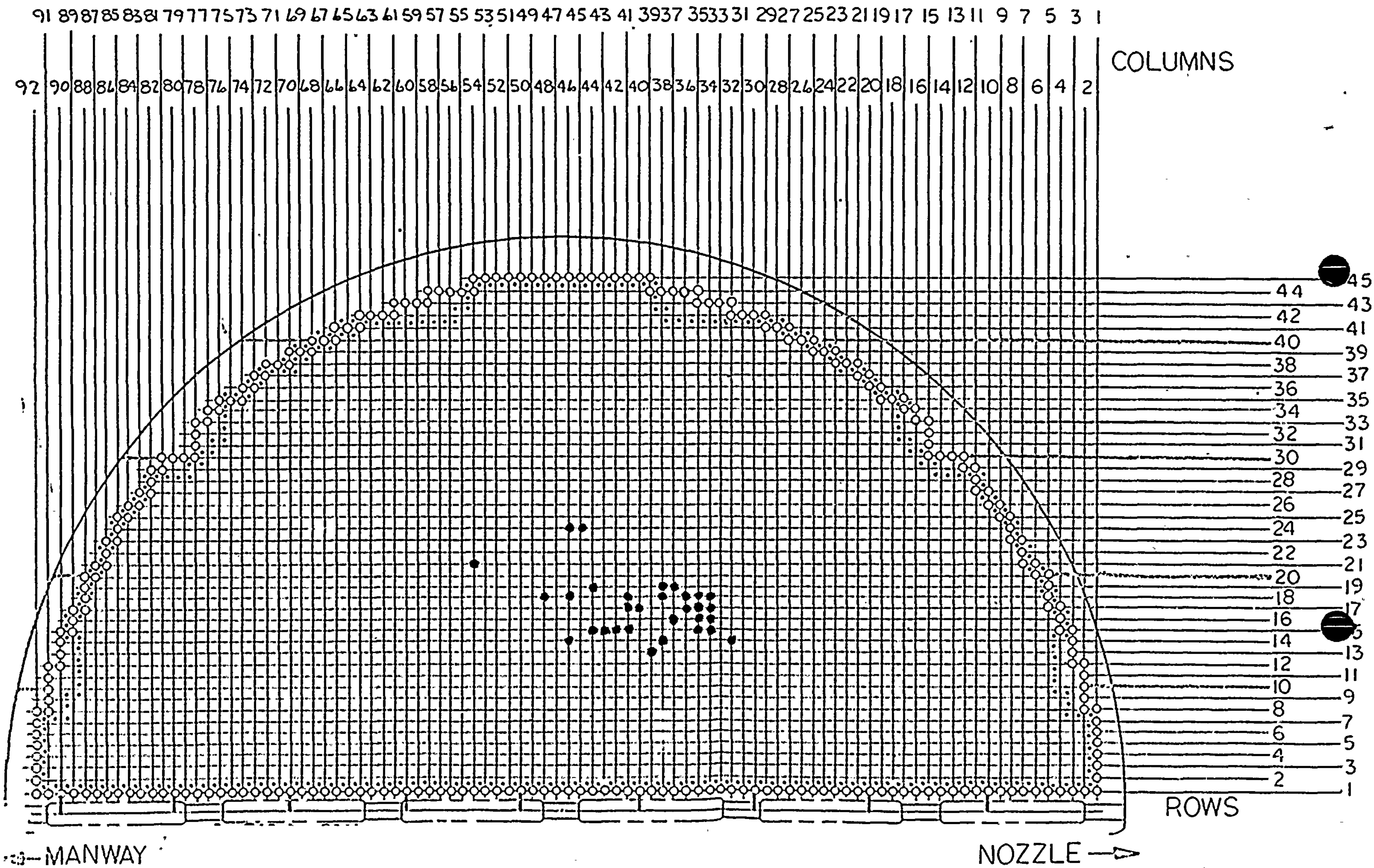
Figure II

RG&E Steam Generator - B Inlet
Crevice Indications

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Attachment B

Evaluation of Results

The results of the steam generator inspection have been reviewed to determine whether there are any unreviewed safety questions or whether a change in the Technical Specifications is required. The conclusion has been reached that there are no unreviewed safety questions and that no change in Technical Specifications is required.

The current safety analysis assumes that 10% of the steam generator tubes are plugged. Current plugged levels are well below 10%, 3.74% in the A and 3.44% in the B. Therefore, the current analysis remains valid.

The current Technical Specification limit is 0.1 gpm in either steam generator when averaged over 24 hours. This limit was proposed on April 25, 1975 and was reviewed and approved by the NRC in license amendment no. 7 dated May 14, 1975. This limit was established to ensure tube integrity following design basis events under the condition of tube cracking superimposed upon thinning of the tube to 60% of the wall remaining. Tests and analyses performed and approved in 1975 demonstrated that if leakage was limited to 0.1 gpm, then the maximum possible crack size was limited. Even assuming that the maximum length crack occurred on a previously thinned area when 50% tube wall remained, tubes did not fail during design basis transients. A 40% plugging limit was, therefore, established to provide a level of conservatism.

Whereas the Technical Specification were established based on defects occurring above the tube sheet, crevice cracks seen this outage and in the previous two outages are below the surface of the tube sheet. The tube in the vicinity of the crevice crack is provided support by the tube sheet and the previous safety analysis of tube integrity may be conservatively applied. Tube clearances within the tube sheet may vary from manufacturing tolerances from .016 inches to .022 inches on the diameter. These clearances are further reduced in operation by the deposits and corrosion products in the crevices. Therefore, the tubes in the crevice area are tightly confined within the tube sheet, which provides reinforcement to the tube wall material in the area of the crevices where the intergranular corrosion attack has been found. This would reduce tube distress under abnormal loadings prohibiting significant cracking or rupture.

Further, thinning in the crevice region has not been observed, thus providing significant additional margin.

Based on these considerations, there is no unreviewed safety question and no change in the Technical Specifications is required. Plant operation may, therefore, resume.