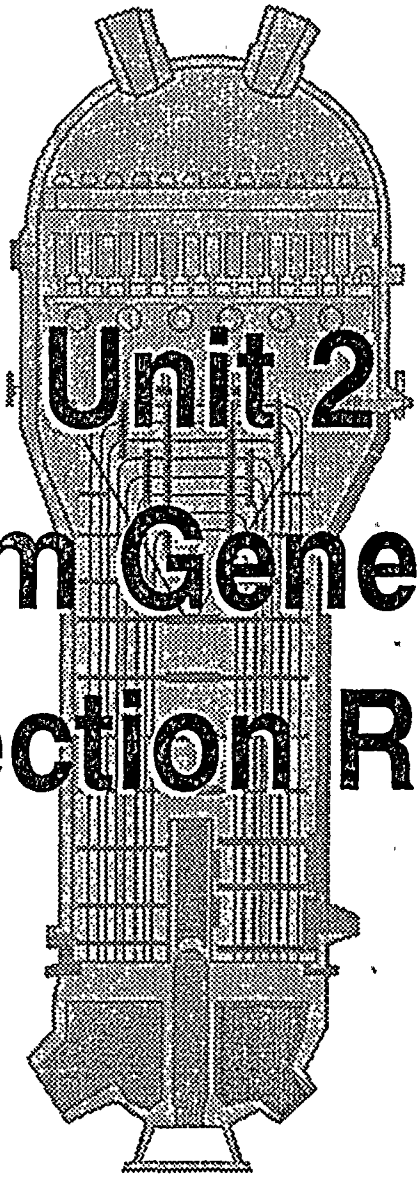
Palo Verde Nuclear Generating Station



Unit 2 Steam Generator Inspection Report

Mid-Cycle Outage
March 1994

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I. EXECUTIVE SUMMARY

In March 1993, PVNGS Unit 2 experienced a steam generator (SG) tube rupture subsequently determined to be due to a free span axial crack in the upper elevation of the tube bundle caused by intergranular stress corrosion cracking (IGSCC) on the outer tube wall. Extensive eddy current testing (ECT) in the refueling outage following the rupture identified an arc shaped area of tubes in the upper elevation of the bundle where 104 tubes had axial crack indications in the number 2 SG (SG 22). The number 1 SG (SG 21) exhibited the same pattern of cracks, but had approximately 18 tubes with axial indications. This empirical data led to an analysis that identified the arc shaped region as an area susceptible to dryout and deposit formation which could concentrate corroding species and lead to bridging deposits that form crevice environments.

From this thermal-hydraulic model a number of corrective actions were developed drawing on the accepted industry methods to combat IGSCC. These centered on reducing the area susceptible to deposit formation, reduction of corrosion product ingress, reduction of primary temperature and improvement of chemical environment. Defense in depth was implemented by augmenting these preventive measures with enhanced leak rate detection and mitigation efforts as well as establishing administrative limits on primary dose equivalent iodine, the source term for offsite dose in a tube rupture event.

The ECT data from the fourth refueling outage (U2R4) was used to develop a model of the cracking mechanism, and both deterministic and statistical models supported a safe operating period of six months.

These analyses were presented to the NRC Staff for review, and after obtaining concurrence for six effective full power months of operation Unit 2 was restarted. APS elected to operate at reduced temperature and power for a period of approximately four and one half months prior to shutdown for SG inspection and chemical cleaning. During this outage (U2M5), free span axial crack indications in SG tubes were identified using ECT. As was the case during the previous inspection, these indications were largely located in the upper bundle area, principally at or near the 90° square bend on the hot leg side of the SG. Additionally, four circumferential crack indications were discovered at the hotleg tubesheet for the first time in Unit 2 SGs. Finally, ECT inspection results for SG 22 tubes were different when pre-chemical cleaning data was compared to post-chemical cleaning data.

Appendix A to this document contains tubesheet maps illustrating those tubes with indications, along with a detailed report on these indications. A total of 22 and 308 tubes were identified as having axial crack indications in SG 21 and SG 22 respectively. An additional 2 tubes are indicated in the SG 22 report and tubesheet map (Appendix A) due to plug removal and reexamination of 1993 axial indication. The four tubes with tubesheet circumferential cracks were located in SG 22.

The ECT results were used to develop a cycle growth rate for the interim operating period. The crack growth was determined to be approximately one-half the rate conservatively estimated previously. The reduced crack growth is consistent with a temperature reduction and enhanced thermal-hydraulic conditions resulting from operation at reduced power. As a result, the previous estimates of crack growth rate are considered conservative and the assumptions forming the basis for six months of safe operation are still valid.

The circumferential cracking mechanism is considered less aggressive than the axial cracking, and therefore, bounded by the operating period determined for axial cracking. A detailed analysis of the circumferential cracking mechanism is being developed with the NSSS vendor based on industry and PVNGS specific information. This analysis is based on PVNGS Unit 1 data, which was observed to be the most aggressive and therefore represents the worst case observed at PVNGS and will envelope Units 2 and 3.

Although the inspection results from U2M5 support the continued use of the six month operating cycle, APS will present the final RG 1.121 evaluation, incorporating tube pull results and a statistical treatment of all uncertainties, within four and one-half months of breaker closure. During this period Unit 2 will continue to be operated at reduced power and temperature conditions.

Additional topics discussed in this report include the apparent change in ECT detectability in SG 22 but not in SG 21 following chemical cleaning, tube removal activities underway in SG 22 and future actions.

II. PROBLEM DESCRIPTION AND SAFETY ASSESSMENT

Two corrosion mechanisms are addressed in this report: free span axial cracking (first observed in the U2R4 outage following a tube rupture in March 1993) and circumferential cracking at the top of the tubesheet due to primary water stress corrosion cracking (PWSCC) and outer diameter stress corrosion cracking (ODSCC) in the sludge pile area.

A. Free Span Axial Cracking

Free span axial cracking between the 08H and vertical supports was again observed in PVNGS Unit 2 steam generators during the January 1994 mid-cycle outage (U2M5) which began approximately four and one half months after initial startup in Cycle 5. The locations and physical characteristics of the cracks are similar to those observed in the U2R4 outage, and the cause is attributed to IGSCC accelerated by environmental factors on the secondary side of the steam generator. The individual factors contributing to this phenomenon are discussed in detail in Reference 1.

Reference 1 also discussed the implications this corrosion mechanism has on the ability to comply with RG 1.121 requirements for minimum tube wall thickness. Both deterministic and statistical analyses predicted that given the observed crack growth rates and threshold of detection, the plant could be operated for six effective full power months without exceeding the Regulatory Guide limits on wall thickness. ECT inspection, ultrasonic testing (UT) and in-situ pressure testing conducted in the U2M5 outage confirm the expected result that no cracks challenge the RG 1.121 limits. Therefore, the inspection and test results support the continued validity of these analyses.

It should be noted that two major corrective actions designed to retard ODSCC were not implemented until the U2M5 outage. These are the implementation of boric acid treatment to buffer crevice environments and the completion of chemical cleaning to remove bridging deposits which form crevice-like conditions in the free span area. Although both these actions should favorably impact the corrosion rate, no credit is being taken for the effects of further reduction in the crack growth rates.

PVNGS has performed the analyses which predict that a run time of six months produces no challenges to RG 1.121 limits based on the inspection results following four and one half months of operation. A review of crack growth rates is underway to complete a revised calculation of operating time. Environmental conditions following the U2M5 outage are expected to improve due to boric acid treatment and chemical cleaning. Therefore, there is no safety significance for operation of PVNGS Unit 2 up to six months.

B. Circumferential Cracking

The circumferential cracking phenomenon was first observed in PVNGS Unit 1 during the fourth refueling outage (U1R4) which took place in the Fall of 1993. The phenomenon has since been observed in Units 2 and 3, and is associated with the sludge pile as was described in depth in Reference 2, "Unit 1 Steam Generator Inspection Report" dated October 1993.

As stated in Reference 2 the mechanisms causing circumferential cracking are not new and have been identified in industry experience reports at other plants. The location of these cracks in Unit 2 follows the sludge pile pattern observed in Units 1 and 3. No cracks challenged the RG 1.121 limits. Sludge lancing was conducted following chemical cleaning to reduce the sludge pile. This position is strengthened by the fact that reduced temperature/power operation, as was practiced following startup from U2R4, will again be implemented during the next operating period. It can be determined qualitatively that these cracks do not have an adverse safety significance because they have not grown to unacceptable size since the last inspection, and therefore, are bounded by the run time limits determined from axial cracking. Finally, multiple rupture of SG tubes during a main steam line break accident was analyzed (Reference 12) and has predicted dose consequences well within 10CFR100 limits.

III. STEAM GENERATOR CYCLE 5 OPERATION

In Reference 1, APS identified existing and planned actions to address the control and mitigation of secondary corrosion attack within the arc region of the Unit 2 SGs. The evaluation performed by APS concluded that the form of attack was caustic induced IGSCC in a region of increased contaminant concentration due to dryout or steam blanketing. Consequently, mitigating actions were focused on reduced introduction of contaminants and corrosion products, reducing electrochemical potential (ECP), neutral crevice chemistry and the elimination of dryout conditions. Defect management was implemented via administrative and equipment improvements in leakage monitoring and a reduced operating interval. The following information describes the specific actions implemented or in-place during Cycle 5 for Unit 2.

A. Secondary Water Chemistry

PVNGS implemented a secondary water chemistry control plan in December 1992 to reduce the potential for steam generator related power generation losses and to extend steam generator life. The scope of the plan was to address the concern for IGSCC, due to caustic crevice conditions, elevated corrosion product transport and elevated ECP. Unit 2 began implementation of these actions following restart from the U2R4 outage in August 1993. Preliminary indications of those control parameters that are measurable, demonstrate relative success during Cycle 5 as compared to prior to the tube rupture event. A summary of the chemistry changes is as follows:

1. Feedwater Hydrazine

During Cycle 5 the feedwater hydrazine concentration was maintained at levels greater than 100 ppb. The purpose for increasing the hydrazine concentration is to promote a reduction in the ECP, thereby reducing the driving force for tube crack growth rate. No adverse effects have been noted with condensate or blowdown demineralizer operations with the elevated concentrations of hydrazine, and therefore no problems were encountered with the elevated hydrazine levels during Cycle 5.

2. Molar Ratio Control

Beginning in late 1992, PVNGS implemented a control range for blowdown molar ratio. Molar ratio, as currently defined, is the ratio of sodium divided by chloride, expressed in equivalents. The PVNGS target range for molar ratio has been 0.5 to 1.2. As identified in Reference 1, prior to Cycle 5 Unit 2 bulk water chemistry, while within industry guidelines, had operated with a caustic molar ratio, a fact which is known to contribute to accelerated IGSCC. During Cycle 5 operation, the molar ratio was reduced by a considerable margin compared to previous operating history. The average molar ratio of the Unit 2 SGs during Cycle 5 operation was 1.4 with a decreasing trend. This average is still above the target range, but below the 2.3 average for the eight months prior to the tube rupture event. The reduction in molar ratio was accomplished by bypassing the condensate polishers during the cycle.

In addition to the positive trend in daily monitored molar ratio control, the hideout return data collected during the shutdown of Unit 2 (January 7, 1994) indicated a significant reduction in caustic chemistry conditions as compared to the historical hideout return data collected from 1991 - 1993. A summary of the hideout return data is presented in Table III-1.

TABLE III-1: HIDEOUT RETURN DATA

Parameter	1991-1993 Average	January 1994 Average
Chloride (ave grams)	2	4
Sulfate (ave grams)	84	172
Sodium (ave grams)	97	8
Molar Ratio	19	3
MULTEQ pH	10.2	8.4

The significant reduction in sodium return is consistent with condensate polisher bypass operations, and has resulted in both a decrease in MULTEQ predicted pH as well as the molar ratio observed during the shutdown. Both the decrease in sodium, and the increase in chloride hideout return are consistent with the goals of the chemistry control program. The increase in sulfate is being reviewed however, based upon hideout return rate trends, the sulfate appears to be desorbing from SG surfaces external to the crevice regions and is not expected to adversely impact crevice chemistry.

As increased data is available from operating and shutdown cycles, the molar ratio target will be adjusted to obtain a near neutral crevice pH indication.

3. Decreased Secondary System Iron Transport

Bypassing the condensate polishers during Cycle 5 allowed the unit to increase secondary system pH by a considerable amount. Unit 2 has historically operated with full flow polishers, and the highest pH obtainable was 9.15. If the pH was allowed to increase above 9.15, the condensate polishers could not be regenerated quickly enough to operate in the hydroxide cycle. The associated feedwater iron concentration at a pH of 9.15 was approximately 10 ppb. During the current cycle, pH was increased to approximately 9.8, and the average feedwater iron concentration was reduced to less than 5 ppb. The operating specification was reduced during 1993 to 5 ppb from the previous 10 ppb to reflect revision 3 of the EPRI PWR Secondary Water Chemistry Guidelines issued in May 1993.

Following the startup from U2M5, operation with ammonia/hydrazine/boric acid secondary chemistry will continue until operations stabilize. Ethanolamine (ETA) injection will then be implemented in order to reduce iron transport further. Unit 1, which is currently operating with ETA/hydrazine/boric acid, is maintaining feedwater iron concentrations in the 2 - 3 ppb range.

4. Scheduled Power Reductions

During Cycle 5, Unit 2 performed scheduled downpowers in order to optimize crevice contaminant removal. A total of four downpowers were conducted during the cycle (not all scheduled). Hideout return chemistry data obtained during a downpower to zero percent power November 1, 1993 indicated the crevice chemistry was very close to neutral.

The scheduled downpowers ranged from a decrease in reactor power of 5% to 20% in order to obtain data relative to optimum frequency, duration and percent power reduction. Based upon the results from data collected at all units, subsequent downpowers may be less frequent but of a larger magnitude to maximize the benefit of contaminant removal mechanisms. The initial downpower following a unit startup will occur 1 - 2 months later. The frequency and duration of downpowers will be evaluated and adjusted on an ongoing basis as new data is evaluated.

5. Modified SG Sample Point

In order to reduce the statistical errors associated with controlling molar ratio while operating with reduced contaminant levels, all units commenced controlling steam generator chemistry from the downcomer sample point rather than the hotleg blowdown sample point, which has been historically utilized. Unit 2 recently observed a concentration factor of 3 for contaminants in the downcomer sample point when compared to the hot leg blowdown sample point. Monitoring this elevated concentration enhances the ability to determine molar ratio since the sample is less sensitive to statistical error.

6. Resin Intrusion Control

As indicated in Reference 1, corrective actions have been implemented to reduce resin intrusion to the SGs. Chemistry procedure 74DP-9ZZ05, Abnormal Occurrence Checklist, has been revised to include actions to be taken whenever a resin intrusion is suspected and/or confirmed in the secondary system. This procedure provides direction for sampling and outlines actions to be taken if a resin intrusion is confirmed. In addition to increased monitoring of resin ingress, a revision to the inspection criteria of retention elements, resin traps and screens has been completed. All damaged retention elements have been replaced with an improved design (24 internal support rods as opposed to 18 in the damaged elements), and damaged resin trap baskets have been replaced.

B. Leakage Monitoring

Per Reference 1, several enhancements in leakage monitoring have been implemented during Cycle 5 operation in Unit 2. Both procedural and equipment design improvements were incorporated. The following summarizes these enhancements and a current status.

1. Equipment Enhancements

<u>Steam Generator Blowdown Radiation Monitors (RU-4 & RU-5)</u>

The blowdown monitors currently monitor the downcomer flow streams to provide greater sensitivity to detect primary to secondary leakage.

<u>Condenser Vacuum Exhaust Monitor (RU-141)</u>

The alert setpoints for the condenser vacuum exhaust monitor were decreased to provide earlier alarms to plant operators in the event of increasing primary leakage.

<u>N-16 Monitors</u>

N-16 monitoring systems have been permanently installed in all three units to provide an additional diagnostic tool for primary-to-secondary leakage detection. The design incorporates sodium iodide crystal detectors connected to the existing radiation monitoring system. The detectors are located on the main steam lines (4 per unit) in the Turbine Building and are connected to the condenser exhaust high-range effluent monitor (RU-142), which had been abandoned in place when the condenser vacuum exhaust was routed to the plant vent. Existing control room alarm and indication capabilities were utilized.

2. Procedural Improvements

A leak rate hierarchy, as well as an administrative primary-to-secondary leakage limit have been in place during Cycle 5 operation in Unit 2. Depending on the trended leakrate, the monitoring frequency will be increased. A formal evaluation for continued operation will be conducted when a 10 gpd leak rate increases by more than 50% in a 24 hour period, or if a stable leak rate of 25 gpd is reached. At 50 gpd, the Shift Supervisor initiates an orderly plant shutdown, and then informs plant management.

3. Leakage History Cycle 5

Prior to the shutdown of Unit 2 for U2M5 inspections, a small tritium concentration was detected however, there was no evidence of leakage from other monitoring methods. Several steps were taken to determine if any evidence of primary-to-secondary leakage existed. Two sets of blowdown filter samples were collected and counted to determine if any level of iodine was present. None was detected. RU-141 iodine cartridges were also counted and again no indication of iodine was found. Based on these results, it was recommended that a pressure test be conducted post shutdown to determine if a possible cause for the tritium indication could be found. In SG 22, a small leak was observed in a CE welded plug in tube R1C10. This plug was removed and replaced with a BWNT mechanical plug.

C. **Effects of Reduced Power and Temperature**

As indicated in Reference 1, APS developed an analytical model to confirm the presence of a concentrating deposition effect which occurs in an arc-like region defined both vertically and radially in the SGs at PVNGS. The empirical deposit or dryout parameter was defined as a function of mass flux (ρv), and a concentration factor for non-volatile impurities (1-X). The defects found during U2R4 correlated with a deposit parameter of 180 lb/hr/ft^2. The studies performed by APS also found that the hot side circulation ratio significantly influences the deposit parameter. The hot side circulation ratio is defined as the total flow divided by the mass of steam exiting the hot side or the inverse of the average hot side exit steam quality. The current design circulation ratio is 1.74 which is less than typical industry values of 2. An increase is being evaluated which would result in the secondary bulk water being less concentrated in the upper region of the tube bundle.

Although APS is continuing to investigate measures to reduce the deposit parameter, the most immediate and effective means of increasing the hot side circulation ratio is a decrease in thermal power. APS found that decreasing power below 87% raised the circulation ratio above 2.18, thereby reducing the deposit parameter below the threshold for dryout. The additional benefit of operating at reduced power levels is a corresponding reduction in primary inlet temperature. The benefits in temperature reduction in reducing defect growth rate are analyzed using an Arrhenius relationship typical of industry SG degradation models. Assuming an activation energy of 54 kcal/mole, a 50% reduction in a relative damage ratio is accomplished with a temperature reduction from 621°F to 605°F.

As a result, APS elected to operate Unit 2 during Cycle 5 at approximately 85% power to obtain a maximized benefit in eliminating the dryout region. This, in combination with a 10°F reduction in T_{COLD}, produced a 16°F primary (T_{HOT}) temperature reduction.

D. **Summary**

The control and mitigation strategies implemented by PVNGS during Cycle 5 are considered to be the most effective measures available based on the current industry information regarding IGSCC damage mechanisms. Published literature indicates that improvements in secondary water chemistry control, a reduction in primary temperature and elimination of the analytically defined arc region should reduce defect growth rate. While the benefits in reducing overall plugging rates may not be realized in the short term, the immediate impact on defect growth rates which challenge RG 1.121 limits appears to have been confirmed in the U2M5 inspection results.

IV. CHEMICAL CLEANING

A. Process Objectives

A full bundle chemical cleaning effort was conducted on both Unit 2 SGs during the outage. The primary objectives of the project were:

1. To remove bridged deposits in the upper bundle regions which were identified by eddy current analysis and may have aggravated the axial cracking condition in that area.

2. To remove tube scale deposits which interfere with heat transfer and may contain undesirable contaminants.

3. To remove deposits from the surface of the tubesheet and the flow distribution plate (FDP).

A secondary objective was to attempt to remove deposits from the drilled hole crevices in the flow distribution plate.

The EPRI/SGOG low temperature process, modified to include "crevice cleaning" and "passivation" steps, was selected as the best method.

B. Sludge Estimates and Material Evaluation

The NSSS vendor was contracted to perform the following evaluations to assist in the chemical cleaning process:

1. Sludge (deposit) loading estimation.

2. Materials of construction evaluation.

3. Material corrosion allowances.

4. Limits and precautions guidelines.

The deposit loading estimation was based upon two independent methods of calculation. The first method utilized empirical data collected during destructive and non-destructive examinations performed for SG 22 and the non-destructive examination of SG 21. This method predicted a deposit mass of 6,000 pounds in SG 21 and 9,100 pounds in SG 22. The second calculation employed a study of secondary iron transport performed by APS and predicted that a maximum of 13,000 pounds could be in each SG, discounting blowdown effects. The actual number

predicted by APS Chemistry was significantly lower (about 6,000 pounds in each SG). BWNT forecast the values to be 4,500-6,500 pounds per SG (based upon past applications). To ensure an effective process, all operations were based upon the "high" estimate. This ensured that all qualification testing, corrosion estimates, and chemicals purchased for application were conservatively high and that all deposits would be removed from the SGs.

The review of materials of construction included only those components, materials, and weldments located below the level of the down-comer feedwater nozzle penetration. Materials above this elevation were not exposed to chemical cleaning solvents. Note that the downcomer feedwater nozzle is approximately one foot higher than the maximum chemical cleaning solvent level.

The corrosion allowance evaluation determined the most critical material (that material with the least corrosion allowance) and the most susceptible material (that material which was expected to undergo the most corrosion). The table below was developed to assist in real time monitoring of the corrosion rates during the chemical cleaning process and to ensure corrosion was maintained within acceptable limits.

TABLE IV-1: CORROSION ALLOWANCES

Material	Location	Allowable Lifetime Corrosion	Expected Corrosion	Alert Limit	Admin Limit
Critical Materials					
409 SS	Eggcrate Support	15 mils *	< 1 mil	N/A	N/A
SA-106 Gr B	Cone Nozzle	28 mils	< 3 mils	5 mils	7 mils
Susceptible Materials					
SA-533 Gr A	Shell	62.5 mils	< 5 mils	11 mils	15.6 mils
SMAW (E7018)	Weld Filler	62.5 mils	< 5 mils	11 mils	15.6 mils
AISI- 1018 CS	Scalloped Bar	62.5 mils	< 5 mils	11 mils	15.6 mils

* BWNT prescribed an allowable lifetime corrosion of 8.5 mils to 409 SS.

C. Qualification Program

A review of the materials of construction produced a list of several metals and welds in the SGs which were initially considered untested or of high interest. These materials were tested during phase one of the qualification programs. The results of this testing justified their qualification for exposure to the chemical cleaning solvents. The predicted corrosion for all metals and welds was less than the established corrosion allowances.

Three separate tests were performed to assess the dissolution characteristics of PVNGS deposits and the corrosion expected during the deposit dissolutions. These tests are summarized below:

Test 1: Since about 97% of the PVNGS SG deposit inventory is on the tubing, the dissolution kinetics tend to be controlled by the tube deposit. Nearly all of the tube deposit are rapidly removed by the 200°F iron solvent. Test 1 exposed two tube sections to the 200°F iron solvent followed by the copper solvent. The tubes used were tubes pulled from the PVNGS SG 22. The test showed that nearly 100% of the tube deposit dissolved in 8 to 10 hours in the iron solvent. The iron removed equated to a deposit thickness of 1.7 mils. No copper removal could be detected from the copper solvent exposure. This is due to a combination of the lower level of copper in the tube deposit (<1%) and the small amount of deposit present on the tubes.

Test 2: Test 2 was primarily a corrosion test. The secondary objectives were deposit dissolution characteristics and passivation testing. Test 2 exposed many PVNGS materials (welds and base metals) to the full process proposed for application at PVNGS. Corrosion results from this test were intentionally made conservative by the following actions:

- Deposit loading was set to simulate 12,000 pounds in the SGs.
- The 200 and 250°F iron solvents were applied in the test autoclave for longer than expected at PVNGS.
- The 250°F crevice solvent was applied with more deposit left in the autoclave than will be left in the PVNGS SGs.

Despite the conservatism, all corrosion results were lower than the corrosion allowances established for the chemical cleaning. There was no localized corrosion of any material or weld. Corrosion of the ferritic stainless steel tube support materials (A-240 Type 405 and A-176 Type 409) was less than 0.01 mils. Corrosion of the Alloy 600 tubing was higher than expected, but still less than 0.5 mils (some of the weight loss that produced the Alloy 600 corrosion measurement was certainly due to dissolution of residual deposit on the pulled tubes). These results documented that the chemical cleaning corrosion would be acceptable and that the process can be safely applied.

All of the corrosion specimens passivated in this test, using the copper passivation solvent, were visually inspected and found to have a dull gray finish. This is typical of the passivation film achieved by the solvent and the previously used EPRI/SGOG hydrazine based passivation solvent. One of the corrosion specimens passivated in this test was analyzed by X-ray diffraction. The passive film was determined to be predominately magnetite. This test data supports the use of the copper passivation solvent at PVNGS.

Deposit dissolution rate was slower than expected in this test. Since the deposits used were not PVNGS deposits and the autoclave geometry was suspected to have slowed dissolution, the dissolution results from this test have limited use; however, dissolution results from Test 3, which used PVNGS deposits, are applicable.

Test 3: The objective of this test was to determine how much iron could be chelated by an iron solvent containing 200 grams/liter of Ethylene-diamine-tetra-acetic acid (EDTA). The results from this test would determine if more than one batch of iron solvent would be needed to dissolve the 12,000 pounds (upper limit) of deposit in SG 22. This test used deposit material from PVNGS. The iron solvent chelated about 38 grams/liter of iron. Note that this is the theoretical limit of the solvent. Previous tests on deposits from other plants have shown that dissolution rates slowed significantly when EDTA concentration dropped below 30 grams/liter. Therefore, in previous chemical cleanings, EDTA was always maintained above 40 grams/liter. In this test, the dissolution did not slow even as EDTA concentration fell to 0 grams/liter. Since 12,000 pounds of deposit dissolving into 34,000 gallons of solvent is equal to 28 grams/liter of iron, one batch of iron solvent (34,000 gallons) was shown to be sufficient to dissolve even the highest estimated deposit loading. Solvent spiking and use of a second batch of solvent would not be needed. Note that the stirring conditions used in this test make dissolution ideal. It was not expected that the solvent could achieve an iron loading of 38 grams/liter in the field however, 28 grams/liter is realistic.

The results of all testing and other qualification tasks were incorporated into the standard EPRI/SGOG chemical cleaning application scenario to develop the PVNGS chemical cleaning process specifications and all associated field application procedures.

D. Process Application

The process, as applied to each SG in series, involved:

- A full volume rinse at ambient temperature. The solution contained 50-200 ppm hydrazine and enough ammonium hydroxide to adjust the pH to 10.
- A full volume magnetite solvent application at 200°F (for 40 hours in SG 21 and 60 hours in SG 22) to remove bridged, tube, and tubesheet deposits. The magnetite solvent contained 200 g/l EDTA, 10 g/l hydrazine, 10 ml/l CCI-801 (as a corrosion inhibitor), and ammonium hydroxide (to a pH of 7).
- A low volume (just above the flow distribution plate) magnetite ("crevice") solvent application at 250°F (for about 24 hours) to clean out flow distribution plate crevices. This step involved localized boiling to mechanically assist in the crevice cleanup. The crevice solvent contained 200 g/l EDTA, 10 g/l hydrazine, 10 ml/l CCI-801 (as a corrosion inhibitor), and ammonium hydroxide (to a pH of 6).
- A low volume and full volume rinse and cooldown.
- A full volume copper solvent application at 80°F (for 10 hours in SG 21 and 6 hours in SG 22) to remove copper deposits. The copper solvent contained EDTA, hydrogen peroxide, and Ethylene-diamine (to a pH of 9.5).
- A full volume passivation (hydrogen peroxide) step at 100-120°F to develop a thin oxide layer to protect carbon steel surfaces from corrosion after the chemical cleaning process.
- A low volume and full volume rinse.

During the iron step, the quantity of iron entrained in the solvent is monitored (via periodic sample analysis) to determine the continued effectiveness of the process. The corresponding rate of iron dissolution is monitoring via iron dissolution curves (see Figures IV-1 and IV-2). The effective end of the iron step is reached when the curve flattens out (and the quantity of free EDTA in the solvent remains adequate).

Mixing was provided via 500 gpm recirculation from handhole to handhole and periodic drain and refill evolutions.

During process application, two incidents of interest occurred during the SG 22 application which required the implementation of contingency actions. These are summarized below:

1. Level indication problems were experienced during the first 20 hours of the iron solvent step. During this time, level was maintained two feet below the top of the tube bundle. Level indication problems were corrected and the level was raised to cover the tube bundle at about hour 25. The iron solvent step was extended to 60 hours (the maximum time allowed by procedure). This provided the same 35 hours of exposure to the top of the SG 22 tube bundle as the SG 21 bundle. The 60 hour exposure limit is a conservatively safe exposure time derived from associated qualification testing work.

2. The SG 22 passivation step was aborted twice due to high temperature within the SG upper sections. The copper passivation solvent is the spent copper solvent with a lower concentration of EDTA and is applied at 100 to 120°F. During these first two attempts at passivating SG 22, general corrosion increased above that normally seen. Although the increase was minor, and caused little change to the total corrosion, it was obvious that the SG carbon steel was not passivating, and the solvent was drained. It was subsequently confirmed that the higher corrosion was caused by a higher upper shell temperature. After cooling the upper shell a third time, successful passivation step using the same solvent was completed. The passivation step is designed to start at a temperature of 95 to 105°F. For SG 22, the lower shell temperature was approximately 104°F and the upper was >110°F. This was determined to meet the procedural requirements and the solvent was injected. Rapid peroxide breakdown, caused by the higher initial upper shell temperature, resulted in a quick rise in temperature and corrosion rates. On the second attempt, the lower shell temperature was about 95°F and upper was >110°F. The same reaction occurred on this attempt. After additional cooldown, the upper shell temperature was lowered to less than 100°F and the passivation step was successfully applied.

E. Corrosion Monitoring

Corrosion monitoring during process application was accomplished through the utilization of the computer-based corrosion monitoring system (CMS) and weight loss coupons. CMS electrodes provided on-line free and galvanic corrosion data (the sum of these is provided under "CMS" in Table IV-2). Electrodes were weighed before and after the process to provide a weight loss comparison to the on-line predicted data. Coupons were not monitored on-line; they were used to prove weight loss corrosion data only. Corrosion data for the electrodes and coupons is also provided in Table IV-2.

TABLE IV-2: CORROSION SUMMARY					
Material	Type	Lower Probe SG 21	Upper Probe SG 21	Lower Probe SG 22	Upper Probe SG 22
SA-533	CMS	1.362	1.901	1.722	1.111
	Electrode	1.370	1.5561	2.113	1.257
	Coupon	1.390	Note 3	1.917	Note 3
AISI-1018	CMS	1.352	1.538	2.421	0.791
	Electrode	1.447	1.450	2.986	0.982
	Coupon	1.972	Note 3	2.677	0.855
SMAW (E7018)	CMS	2.172	2.233	2.771	1.606
	Electrode	2.675	2.212	3.489	1.946
	Coupon	2.570	Note 3	3.214	1.417
SA-106B	Coupon	0.846	Note 3	1.370	0.645
SA-240 (Type 405)	Coupon	Note 3	Note 3	Note 3	0.003

Note: 1. All values in mils penetration.
2. Values are the higher of duplicate specimens.
3. A coupon of this material was not installed at this location.

Base metal and weld electrodes and coupons were manufactured to duplicate the materials of interest as closely as possible. All materials were manufactured using the same procedures as were used during fabrication of the SGs. Electrodes were cut from the weld metal, the base metal or the heat affected zone, as appropriate, for the material of interest. Electrodes and coupons were fully measured, cleaned, weighed and identified prior to and after the cleaning. Material identification and traceability was monitored throughout the entire cleaning program.

The CMS consisted of a computer system, a data acquisition system (DAS), an interface box, and the connective cabling. The computer system allowed for data acquisition at a high rate of speed, with multi-tasking capabilities. Thus, the acquisition of data was not slowed down by computer processing of previously gathered data. The DAS contained a zero resistance ammeter (ZRA) drawer and a linear polarization (LP) drawer. ZRA probes measure corrosion in the range of 0-22,400 mils per year (mpy) and LP probes monitored free corrosion in the range of 0-2,000 mpy. Maximum corrosion rates experienced during chemical cleaning were 12,500 mpy galvanic and 1090 mpy free corrosion. Both corrosion instruments provided a large margin of excess capability. The CMS predicted corrosion correlated well with the actual corrosion as determined by electrode weight loss measurements, as shown in the table above.

All corrosion monitoring was accomplished in accordance with an operating instruction which included directions for handling and monitoring traceability of electrodes and coupons as well as installation of probe holders into the SGs. During the cleaning process, corrosion was measured at two different elevations within each SG, utilizing the 6" handholes (just above the FDP).

F. Sludge Lancing

Sludge lancing of the SG tubesheets was performed following completion of chemical cleaning operations. The methodology employed lancing of the tubesheet through two separate nozzle configurations. Each nozzle was inserted through the two 7" handholes (just above the tubesheet), directing water flow from the "no tube" lane (between the divider plate and the first row of tubes) towards the SG annulus. One of the nozzle blocks had orifices perpendicular to the plane of the divider plate and the other orifices 30° from the plane of the divider plate. An independent water flow, through the periphery of each SG, moved sludge to the suction point (located across from the 7" handholes that housed the lancing nozzle block).

A total of 6 passes were performed in SG 21 and 9 passes in SG 22. Note that post-lancing inspections in SG 22 necessitated the performance of 3 passes to further clean some areas which were identified to have tubesheet deposits exceeding acceptance criteria. A "pass" is defined as the insertion or withdrawal of the lancing mechanisms to spray the tubesheet in the 90 or 30° lanes. The amount of sludge removed through this process is indicated in the Section IV.H.

G. Secondary Side Inspection / FOSAR

Secondary side inspections were conducted on both SGs. These inspections were performed in order to document chemical cleaning results as well as evaluate the condition of lodged foreign objects previously located in both SGs and retrieve any loose objects discovered in the SG annulus or divider lane section.

The inspections were performed utilizing the two 7" diameter handholes on either side of the divider lane and one of the 6" diameter handholes located above the FDP on the hotleg side of the bundle. Inspection activities consisted of the following:

1. Prior to chemical cleaning (SG 22 only): FDP crevice, eggcrate and tube surface inspections through the 6" hotleg handhole. Sludge pile, tube surface inner bundle and brief annulus inspections through one of the 7" handholes.

2. After chemical cleaning and sludge lancing (SG 21): Tube sheet, tube surface, inner tube bundle and detailed annulus and divider lane inspections through both of the 7" handholes.

3. After chemical cleaning and sludge lancing (SG 22): FDP crevice, eggcrate and tube surface inspections through the 6" hotleg handhole. Tube sheet, tube surface, inner tube bundle and detailed annulus and divider lane inspections through both of the 7" handholes.

All inspections were videotaped. A final report with all significant video information in still photographs is under development. The review of inspection video tapes indicates that:

1. The FDP crevices and 02H eggcrate areas are free of any previously identified deposits.

2. The tube surfaces are very clean, with a dull shine. Some hard scale still remains on some of the lower tube periphery (was not dissolved by the chemical cleaning process).

3. The tubesheet is free of any major deposits.

4. The following loose parts were identified during the annulus inspections and were removed:

   - SG 21 cold leg annulus: ½" X ½" piece of crumpled metal.
   - SG 21 hot leg annulus: 3" X ¼" thin strip of gasket material.
   - SG 22 cold leg annulus: 4" X ½" X ¼" ceramic or plastic bar.
   - SG 22 cold leg divider lane: ¼" C-shaped ring.
   - SG 22 cold leg annulus: 3" long "garlock" gasket material.
   - SG 22 cold leg annulus: 6" long "weld rod."

H. Results of Chemical Cleaning

ECT analysis of the upper tube bundle, following chemical cleaning, indicate removal of tube deposits in this area. A total of 6,093 pounds of deposit was removed from SG 21 (including sludge lance) and 5,568 pounds were removed from SG 22. Tables IV-3 and IV-4 provide a breakdown of the various species removed during each step of the cleaning process. Note that these numbers are preliminary until a final report from BWNT has been received. As expected, the amount of copper removed from each SG was minimal (less than 10 pounds). This is consistent with a nearly copper-free facility (the condenser tubesheets are composed of aluminum-bronze).

TABLE IV-3: DEPOSIT REMOVED DURING CLEANING OF SG 21							
Step	Amount Removed (lb)						
	Fe_3O_4	Cu	NiO	ZnO	MnO_2	Cr_2O_3	Total
Iron	4852	0.4	145	2.9	48.6	3.5	5052
Crevice	519	0.1	8	0.3	2.7	0.4	531
Copper	4.0	8.8	0.5	0	0	0.7	14
Sludge	N/A	N/A	N/A	N/A	N/A	N/A	496
Total	5375	9.3	153.5	3.2	51.3	4.6	6093

TABLE IV-4: DEPOSIT REMOVED DURING CLEANING OF SG 22							
Step	Amount Removed (lb)						
	Fe_3O_4	Cu	NiO	ZnO	MnO_2	Cr_2O_3	Total
Iron	4396	0.1	146.4	2.0	43.7	3.6	4592
Crevice	396.5	0.1	7.3	0.2	2.3	0.4	407
Copper	34.2	9.1	1.0	0	0	0.5	45
Sludge	N/A	N/A	N/A	N/A	N/A	N/A	≈524
Total	4827	9.3	154.7	2.2	46	4.5	5568

V. STEAM GENERATOR INSPECTION

A. Original Scope

An examination plan was prepared and submitted to the NRC (Reference 16, dated December 6, 1993) to address the original scope and expansion plans. To summarize, the original scope of the eddy current (ECT) examinations planned for the U2M5 outage was largely based on the examination results of the U2R4 outage for axial indications, and U1R4 for circumferential indications. The scope included 100% full length bobbin coil examination of the bobbin arc area and approximately a 400 tube full length bobbin coil sample throughout the bundle (Figure V-1 and V-2). In addition, a 20% rotating pancake coil (MRPC) examination of the hotleg tubesheet area (Figure V-3 and V-4), and a 100% MRPC examination of the MRPC arc area (Figure V-5 and V-6) was planned. This is illustrated in the following table:

TABLE V-1: ORIGINAL EDDY CURRENT SCOPE

Original Plan	ECT Method	Extent	SG 21	SG 22
Bobbin Arc	Bobbin	Full Length	4018	3869
MRPC Arc	MRPC	08H to 1st VS	1904	1778
Tubesheet Hotleg	MRPC	TSH	2270	2245
Checkerboard Sample	Bobbin	Full Length	400	400

Note: The numerical differences between SG 21 and SG 22 is largely due to the number of existing plugged tubes.

B. Chemical Cleaning Expansion Scope

An examination plan was also prepared and submitted to the NRC (Reference 17, dated January 27, 1994) to address the examinations associated with the chemical cleaning schedule and related scope. This plan was prepared with the purpose of verifying the effectiveness of the chemical cleaning process to remove the ridge deposits and also to determine if a significant detectability shift occurred. The plan included expansion criteria based on the PVNGS Technical Specifications using the 1800 MRPC arc as the total population.

To summarize the plan; tubes with axial indications detected prior to chemical cleaning were to be reexamined after cleaning. An additional 60 tubes were also to be reexamined that contained deposit indications. For SG 21 the plan required a number of the arc tubes to be examined after cleaning for comparing the distribution of tubes with axial defects with the tubes with axial defects detected prior to cleaning. Table V-2 illustrates the overall plan. Based on the results in SG 22, further examinations were conducted in both SGs. A detailed discussion is contained in the next section.

TABLE V-2: CHEMICAL CLEANING EXAMINATION SCOPE				
Post-Cleaning Plan	ECT Method	Extent	SG 21	SG 22
SAI/MAI	Bobbin	Full Length	11	86
SAI/MAI	MRPC	08H to 1st VS	11	86
Tubes with PDP	MRPC	08H to 1st VS	62	62
MRPC Arc	MRPC	08H to 1st VS	≈570	N/A

C. **Expansions**

Several expansions were performed during this outage in each SG. The expansions can be categorized into three areas. The first based on the circumferential indications at the hotleg tubesheet area, the second based on the bobbin arc axial indications, and the third based on the effects of the chemical cleaning. This is illustrated in Table V-3.

The first expansion area was for circumferential indications. While performing the MRPC examinations in SG 21 and 22, four circumferential indications were detected in the highest sludge pile area in SG 22. These all appeared to be originated from the inside diameter, were short (0.35" maximum MRPC length), and also appeared to be essentially 100% through wall. The scope of SG 22 was then expanded to include 100% of the hotleg tubesheet area.

The second area of expansion was for axial indications detected in the bobbin arc. Several axial indications were detected, prior to chemical cleaning in both steam generators. As a result, an area surrounding the MRPC arc was added. The expansion included 980 tubes in SG 21 and 949 tubes in SG 22. The tubesheet maps shown in Figures V-7 and V-8 are provided to illustrate this expansion area. The examinations included MRPC from the BW1 through the 1st VS in SG 21 and 08H through the 1st VS in SG 22. Additional indications were found in this expansion in SG 22 and an additional 49 tubes were added to bound the indications by 5 tubes (Figure V-9).

The third area is based on an evaluation of the chemical cleaning plan. The results appear to vary significantly in each SG. For SG 21, 11 axial indications were detected prior to chemical cleaning and were reexamined after the cleaning process. When the data was compared, no significant change was identified. The initial plan of 62, plus an additional 6% sample (108 tubes), was also examined after chemical cleaning. No new axial indications were detected. The distribution of axial indications on each side of SG 21 was reviewed and it was noted to be similar to the 1993 outage distribution. The overall evaluation concluded that the indications were essentially identical with no detectability or size shift.

In SG 22, 86 tubes with axial indications were identified prior to chemical cleaning and were reexamined after cleaning. It was noted that a significant change had occurred in a number of the axial indications, and that several additional indications were identified in those tubes. In addition, 6 of the 62 tubes with deposits examined were now identified to have axial indications. The overall evaluation for this SG concluded that a significant detectability shift had occurred. Based on these evaluations and the expansion plan, additional tubes were examined as identified in Table V-3.

TABLE V-3: ECT EXPANSION SCOPE				
Expansion Cause	**ECT Method**	**Extent**	**SG 21**	**SG 22**
Circumferential Indications				
Tubesheet Hotleg	MRPC	TSH	0	8391
Axial Indications				
Bobbin Arc	MRPC	BW1 to 1st VS	980	0
	MRPC	08H to 1st VS	0	951
	Bobbin	Full Length	0	951
Post Chemical Cleaning Examination				
Tubesheet Hotleg	MRPC	TSH	0	325
Sludge	Bobbin	Full Length	97	174
MRPC Arc	MRPC	08H to 1st VS	108	1628
	Bobbin	Full Length	0	220
Bounding Axial	MRPC	08H to 1st VS	0	49

D. NDE Techniques

The original eddy current scope as well as subsequent expansions were conducted with bobbin coil or rotating pancake coil techniques. The eddy current examination methods are the primary method used to identify and define SG tube degradation. Several changes were incorporated into the eddy current methods during this outage to enhance detectability and to incorporate improved technology.

The bobbin coil examinations are typically performed full length from the cold leg side. Both the absolute mode and differential modes are used to detect and classify degradation. Based on the evaluation of data from the U2R4 outage, the frequencies were changed slightly and a medium frequency probe is now used. The ASME prime frequency was decreased from 550 KHz to 500 KHz and a 300 KHz frequency replaced the 990 KHz previously used. The combination of these lower frequencies and the medium frequency probe appeared to slightly enhance detection of outside diameter degradation.

The MRPC technique utilizes a three coil probe in both the straight and bend sections of the tubing. The probe includes a 0.115" diameter pancake coil, and a 0.080" axial and circumferential coil. Based on the evaluation of the data from the U2R4 outage, the pancake coil diameter was changed from the standard 0.080" to the 0.115" (identified as the big coil probe). In addition, to this coil diameter change, the use of low loss cable from the probe pusher to the MIZ-30 was utilized to provide a better signal to noise ratio.

In addition to the above, a ZETEC MIZ-30 is now utilized instead of the MIZ-18A. This change was evaluated and does not effect detectability, but does allow a faster sample rate and for the use of two probes on one eddy current instrument.

Ultrasonic examinations were utilized to augment the eddy current examinations. These examinations were performed with techniques similar to those used in the U1R4 in the straight sections of the tubing. The number of each type of indication is identified in Table V-4. The examinations appeared to provide consistent results in the tubesheet area for the circumferential indications, but results in the bobbin arc (upper hotleg area) were less consistent. The goal of these examinations was to provide feedback from depth, length, and origin of the axial indication. A detailed comparison is included in Table V-5.

TABLE V-4: ULTRASONIC EXAMINATION SCOPE

Type	SG 21	SG 22
Circumferential (TSH)	0	3
Axial (Arc)	5	25
Chemical Cleaning	0	5

TABLE V-5: ULTRASONIC EXAMINATION DETAILS								
Row	Col	Location	ECT			UT		
			ID/OD	Length	Bobbin Depth	ID/OD	Length	Depth
Circumferential Indications in SG 22								
59	116	TSH	ID	0.31	NDD	-	-	-
56	117	TSH	ID	0.22	NDD	ID	0.41	34%
54	119	TSH	ID	0.35	NDD	ID	0.65	46%
Axial Indications in SG 21								
140	111	09H+25	OD	1.95	NQI	OD	2.63	28%
147	116	09H	OD	0.52	NBI	OD	0.81	23%
133	122	BW1	OD	0.48	NQI	OD	0.47	23%
129	134	08H	OD	0.26	NQI	OD	0.18	35%
118	141	BW1	OD	2.23	NQI	OD	3.14	25%
Axial Indications in SG 22								
111	36	08H+35	OD	7.5	NQI	OD	9.17	32%
117	44	09H	OD	0.25	61%	OD	0.26	32%
120	45	BW1	OD	0.85	NBI	-	-	-
139	68	09H+23	OD	3.01	NBI	-	-	-
134	99	09H+19	OD	0.50	NQI	-	-	-
136	103	09H+19	OD	0.57	NQI	-	-	-
135	106	09H+20	OD	4.34	NBI	OD	0.56	20%
132	111	09H+15	OD	1.73	NBI	OD	1.65	37%
142	113	BW1	OD	0.92	NQI	OD	1.17	24%
147	114	09H+33	OD	0.51	NBI	-	-	-
137	130	08H 09H BW1	OD OD OD	0.52 0.38 0.51	DSI DSI NBI	- OD -	- 0.20 -	- 34% -
133	136	09H+16	OD	1.00	NBI	OD	1.20	37%
118	147	08H+38	OD	1.25	ADR	OD	0.60	17%
117	148	09H BW1	OD OD	0.50 1.05	DSI NQI	-	-	-
118	149	08H+39	OD	2.35	NQI	OD	0.64	15%

TABLE V-5: ULTRASONIC EXAMINATION DETAILS (cont'd)								
Row	Col	Location	ECT			UT		
			ID/OD	Length	Bobbin Depth	ID/OD	Length	Depth
Axial Indications in SG 22 Bends								
110	39	BW1+8	OD	1.23	NBI	-	-	-
133	92	BW1+7	OD	1.38	NQI	-	-	-
128	97	BW1+2	OD	1.97	NQI	-	-	-
145	98	BW1+12	OD	2.39	NBI	OD	2.54	35%
142	101	BW1+5	OD	1.05	NQI	OD	1.70	29%
133	134	BW1+4	OD	1.40	NBI	OD	2.00	24%
Volumetric Indications in SG 22								
125	96	BW1	OD	N/A	NBI	OD	0.12	20%
148	125	08H	OD	N/A	NQI	OD	0.20	37%
142	135	09H+21	OD	N/A	NBI	OD	2.45	7%
110	143	BW1	OD	N/A	68%	OD	0.21	44%

E. New NDE Techniques

1. Square Bend UT

Based on the number of axial indications detected above the batwing location in the square bend region, BWNT developed a UT probe that would examine the tubing up to the horizontal region. A separate probe was developed for the longitudinal wave examination and for the circumferentially oriented shear wave examinations. The probe was utilized in the APS square bend mock-up to verify detectability of electric discharge machining notches in the bend and at the lower tangent. Both probes were successfully utilized in SG 22. The results are tabulated in Table V-5.

2. MRPC Probes

In addition to the big coil (0.115") pancake MRPC probe, a new 0.180" saddle shaped coil was evaluated. This coil size was chosen to provide broader coverage and enhanced detectability and was contoured to fit the tubing inside diameter to provide a longer life. Examinations were performed in the APS mock-up and in SG 21. The results are being evaluated in detail, but preliminary review indicates that the coil has a slightly better signal to noise ratio and therefore may show promise for future use.

3. MRPC Motor Units

Several styles and combinations of MRPC motor units were evaluated during this outage in both SGs. The evaluation process is ongoing. The goal is to reduce actual examination times by rotating the probes at a higher rate. Several of the combinations presently being evaluated are listed below:

TABLE V-6: MRPC MOTOR UNITS UNDER EVALUATION					
Coil	Motor Unit	RPM	Speed	Samples	Remarks
0.115	High Speed	1250	1.0"/S	1500 SS	Straight sections
0.180 SS	High Speed	1250	1.0"/S	1500 SS	Straight sections
0.180 SS	High Speed	933	0.6"/S	949 SS	Motor stalled/bends
0.115	High Speed	600	0.4"/S	711 SS	High noise in data
0.115 IL	High Speed	600	0.4"/S	711 SS	Extensive horiz noise

F. Effects of Chemical Cleaning

In Reference 17, APS proposed a post chemical cleaning ECT program designed to determine the effectiveness of chemical cleaning, and if the process would impact ECT results. EPRI Report NP-4597 reported that Millstone Unit 2 had identified a significant change in ECT after chemical cleaning was performed. Based on review of the Millstone 2 results, APS concluded that the same issue was not applicable to PVNGS. The change in signals at Millstone 2, was a result of significant copper levels (20-40% at Millstone verses 1-2% at PVNGS) resulting in overcompensation of copper masking. No concerns were identified regarding possible physical effects on cracks due to chemical cleaning, as the data at Millstone 2 and qualification testing performed for Indian Point 2 (Reference 24) demonstrated that chemical cleaning does not result in a increase in crack size.

Due to the apparent change in indication size for a number of indications in SG 22, ultrasonic testing was conducted on five indications (which had shown post-cleaning change) to compare with pre-cleaning conditions. The results of this sample showed no physical growth of the crack indication leading to the conclusion that the ECT changes reflect the removal of ECT interfering deposits in SG 22 vice actual crack growth.

As discussed previously, PVNGS did detect a significant shift in ECT detection after the chemical cleaning in SG 22. Several theories are being pursued to determine the cause. Although there was indication of clearer signals, the change was not observed during the after-cleaning examinations in SG 21. The information presented below summarizes the post cleaning inspection results for both SGs.

Steam Generator 21 Summary

1. Eleven tubes with axial indications were detected in SG 21 prior to chemical cleaning

   - Approximately 1400 tubes in the MRPC ARC were examined prior to cleaning with a total of 11 axial indications identified. The inspections were concentrated in the high column area of the ARC (column 90 and above).

2. Eleven additional tubes with axial indications were detected in SG 21 after cleaning (these 11 tubes had not been examined prior to chemical cleaning).

   - Approximately 500 tubes were examined post-chemical cleaning to complete the MRPC ARC.

   - No additional axial indications were detected in the 62 tubes with deposits examined after chemical cleaning. 108 additional tubes were inspected in a random pattern per the commitments in Reference 17. No evidence of a change was detected.

3. ECT voltage and length measurements appeared consistent before and after chemical cleaning.

   - Voltage averaged 0.74 volts prior to cleaning, and 0.76 volts post cleaning

   - Lengths averaged 0.82" prior to cleaning and 0.80" post cleaning

Steam Generator 22 Summary

1. 86 tubes with axial indications were detected in SG 22 prior to cleaning and essentially all of the MRPC arc was examined prior to chemical cleaning.

2. The post cleaning inspection sample as specified in Reference 17 identified a change in existing defects, as well as the identification of new defects. PVNGS elected to re-perform all MRPC arc inspections.

   - Approximately 32 additional axial indications were detected in the original 86 tubes when reexamined.

   - Six of the 62 tube post cleaning sample with deposit indications were identified as having axial indications.

   - Several of the 86 pre-cleaning axial indications appeared larger post cleaning.

   - A total of 309 axial indications were compared and the ECT voltage and length measurements changed as follows:

     - Volts averaged 0.62 volts pre-cleaning, 0.87 volts post-cleaning.

     - Length averaged 0.90" pre-cleaning, 1.16" post-cleaning.

- A small percentage of the pre-cleaning ECT indications went down in volts and length.

- On average, the larger the voltage reading prior to chemical cleaning, the larger the change in reading post cleaning.

3. A total of 308 tubes with axial indications were identified after all inspections were completed.

From the eddy current analysts perspective, the change observed in SG 22 appeared to be a shift in the detectability of the defects. The new axial indications identified post cleaning were found in a subsequent review of previous data, but were less conspicuous and typically smaller in voltage and length. The impact of this shift with respect to ECT detectability, RG 1.121 evaluations, and continued operation has been considered. Under any likely scenario, this inspection shift is expected to be short term. All postulated theories are affected by a return to service with either a re-deposition of magnetite or change in crack conductivity. As a result, no credit is taken for an increase in crack detectability. All tubes with crack indications have been removed from service. Detectability thresholds for the deterministic evaluation of acceptable operating interval are based on information from tube pulls conducted in U2R4.

Based on the current information available, two theories have been developed in an effort to explain the change in ECT signals after chemical cleaning. Tubes pulled from SG 22 post chemical cleaning are expected to provide additional information and may resolve unknowns for either supposition.

1. Deposit Interference Theory

   A possible explanation for a change in ECT signals as a result of chemical cleaning may be due to a reduction in an interfering, or opposite acting, signal associated with the tube deposits. Detailed examination of the MRPC eddy current presentation of the defects which experienced a change due to chemical cleaning indicates that the defect signal now stands out greater or clearer against the tube's background signal. It can be postulated that this could be due to either an increase in the defect signal or to a decrease in an interfering or opposite acting signal. For the latter case, it is postulated that the composition or magnitude of the tube deposit is such that the eddy current signal is pulled in an opposite direction than the defect signal. The net result would be an apparent reduced defect signal in that all or a portion of the defect signal is canceled out by the deposit signal. Upon removal of the deposit, the opposite acting interfering signal would be eliminated, causing the defect signal to appear larger or more clear than prior to chemical cleaning. This would then result in an apparent change in defect signal strength.

   Similarly, defects that did not stand out sufficiently from background prior to chemical cleaning would, upon removal of the opposite acting deposit signal, now stand out sufficiently to be detected by the eddy current analysts. This would result in new defects being detected following chemical cleaning. It is noted that many of the defects in SG 22 and all of the defects in SG 21 detected prior to chemical cleaning did not experience a change in the ECT signals. Whether a particular defect experiences a change in signal would probably depend on the nature of the actual defect (e.g. tightness of the crack,

degree of associated IGA, etc.) and of the deposit (e.g. composition and thickness of the deposit). Evaluation of the population of change calls indicates that the larger the original defect signal, the more likely the signal experienced a change.

Evidence that this phenomena may be occurring is supported by the apparent increase in the strength of tube bowing signals after chemical cleaning. Since there is no conceivable mechanism by which tubes can be bowed further or brought closer together by chemical cleaning, the change in the tube bowing signal is directly a result of the elimination of the deposit signal. Detailed examination of the MRPC eddy current presentation of the bowing signal indicates that the signal now stands out greater or clearer against the tube's background signal. Removal of an opposite acting signal would cause this affect.

The net result of elimination of an opposite acting signal associated with deposits is an increase in eddy current detectability. It is reasonable to expect that the change in SG 22 should have been observed in SG 21 assuming a similar effect of deposit removal. A possible explanation is the apparent difference in crack population. Based on the sample sizes, performed in both SGs pre- and post-chemical cleaning, a significant difference in defect quantities is obvious. The fact that the impact in reducing signal interference was not observed in SG 21, may simply be due to a much smaller population of defects to detect.

As stated previously, the detectability thresholds used in the RG 1.121 analyses were established by comparison of field eddy current calls, prior to any chemical cleaning, with actual crack profiles from the U2R4 pulled tubes. An increase in detectability resulting from chemical cleaning is not taken credit for in the RG 1.121 analyses.

2. Oxidation Theory

A second explanation for the change in ECT signals, may be the oxidation of metallic species within the crack face, such as nickel, copper or chromium. It has been postulated that during the passivation sequence for the SG 22 chemical cleaning, that a higher solvent temperature (120-140°F) in the upper region of the SG, resulted in a subsequent liberation of oxygen due to rapid decomposition of hydrogen peroxide. If this condition resulted in the oxidation of parent metals, an increase in crack resistivity may have occurred resulting in a change (increase) in the eddy current voltage signal. An additional indication of the plausibility of this theory is the lack of change in the circumferential defects at the tubesheet transition. No change in ECT signal was identified in these defects post chemical cleaning. Since these defects are considered to be ID, the influence of passivation step oxidation would be negated.

As stated previously, either an increase in defect detectability or a signal increase due to crack oxidation is not credited in the deterministic evaluation performed in support of RG 1.121. If in fact the crack face conductivity has been affected as indicated, it would have the effect of over-calling defect size. Therefore, the assumptions contained within the structural analysis would be conservative. However, some concern has been raised regarding future crack growth rate if certain metal species, primarily copper, have been oxidized. Literature data (References 25 and 26) generally concludes that the effects of copper oxides are an increase in ECP. Generally, an increase in ECP in the presence of caustic can accelerate stress corrosion cracking. Conversely, elevated ECP should result in the suppression of intergranular attack.

The Unit 2 tube failure analysis performed in support of Reference 1, indicated that low amounts of copper (2 atomic % average) were present in the OD surface films and crack surfaces for freespan and support defects. Since the mode of degradation was predominantly IGA, even at the crack tips, it was concluded at that time that the effects of copper were minimal. Therefore, it is unlikely that oxidation of copper at these levels would have any impact on increasing crack growth rates in the Unit 2 steam generators. However, without an established threshold for the relationship of copper concentration and ECP effects in caustic, it is prudent to consider a possible aggravated effect on defect growth rate. Consequently, APS intends to increase hydrazine levels (~600 ppb) during the boric acid crevice flushing and boric acid high temperature soaks in order to establish a reducing environment prior to start-up. These steps should ensure that any oxides developed during chemical cleaning are reduced to the metallic state. Unit 2 will continue to operate at hydrazine levels of 100 ppb throughout the remainder of Cycle 5 operation to promote reduced electrochemical potential.

G. Tube Harvest

In order to gain information pertaining to eddy current detectability issues, a portion of 21 tubes were removed from the hotleg bend region on the secondary side of SG 22. These tubes were cut above the 09H tube support and on the hot leg side of the first vertical support to facilitate removal of the tube sections via the secondary manway of the generator.

The primary purpose of laboratory examinations on these tubing sections is to provide information to support SG tube integrity analyses. Table V-7 provides a detailed summary of the field eddy current data. The pulled tubes provide a diverse cross section of the different types of eddy current indications seen. The tube samples include NBIs and NQIs in both the bends and straight sections of the tubing, indications that have changed since the U2R4 inspections, and indications that changed pre- to post-chemical cleaning. Comparison of this field data with actual crack profiles as determined from metallography will provide information regarding NDE thresholds, effectiveness, and probability of detection. Crack morphology will also be evaluated and microanalytical examination of crack oxide films will also be performed to assess the crevice chemical conditions.

Laboratory NDE and destructive analyses will be performed on the tube sections to evaluate flaw profilometry, maximum and average flaw depth, correlation between NDE and destructive analysis, and possible root cause/chemical attack information. The scope of tube examinations will include: Visual examinations, diametrical measurements, eddy current (bobbin and MRPC) testing in containment after removal and again in a laboratory environment, ultrasonic testing, burst testing to show structural compliance with RG 1.121, fractography, metallography (radial and cross-section), auger and x-ray photoelectron spectroscopy, tensile and bulk chemistry testing, and modified Huey testing. Laboratory work will be conducted with APS direct supervision and communication with the APS steam generator project team.

1. Summary of Non-Destructive Examinations:

Table V-7 provides the ECT data for the tubes which were removed from SG 22. Table V-8 contains the results of the ultrasonic testing performed on the tube pull candidates.

TABLE V-7: STEAM GENERATOR 22 AXIAL INDICATIONS (TUBE PULL CANDIDATES)									
Row	Col	Elevation	MRPC AC	Bobbin AC	MRPC BC	Bobbin BC	'93-'94 Change	Chem Cleaning Change	Length
133	134	BW1-3.83 BW1-2.13 BW1-1.30 BW1+1.49 BW1+2.53 BW1+3.95 BW1+6.44	BOW SAI SAI SAI NDD SAI SAI	N/A NQI NQI NBI N/A NBI NQI	BOW NDD NDD NDD PDP SAI NDD	N/A NBI NBI NBI N/A NBI NQI	Large	Small	6.83" 0.75" 0.26" 0.49" 1.24" 1.38" 0.51"
135	134	BW1-2.79	BOW	N/A	BOW	N/A	N/A	N/A	4.55"
137	134	BW1+16.00	SAI	NBI	SAI	NQI	Small	Large	2.03"
134	135	BW1+8.62	SAI	NQI	SAI	NQI	Small	Small	0.42"
136	135	BW1+1.97	PRC	PBC	20%	17%	N/A	N/A	WEAR
138	135	BW1+1.88	PRC	PBC	24%	27%	N/A	N/A	WEAR
140	135	BW1-3.65 BW1-1.75 BW1+1.14 BW1+16.40	NDD BOW 11% SAI	N/A N/A NDD NQI	PDP BOW NDD SAI	N/A N/A NDD NQI	Small	Small	6.25" 2.60" WEAR 3.73"
142	135	09H+13.0 09H+13.0 09H+21.4 BW1-22.36 BW1+1.22	NDD BOW PRC BOW 8%	N/A N/A NQI N/A NDD	PDP BOW SVI BOW NDD	N/A N/A NDD N/A NDD	Large	Large	13.00" 10.00" 1.19" 24.89" WEAR
144	135	09H+10.74 09H+12.81 BW1+1.05	NDD PRC 6%	N/A N/A 16%	PDP BOW 5%	N/A N/A NDD	N/A	N/A	12.60" 10.61" N/A
133	136	09H+11.10 09H+14.64 09H+14.99 09H+16.91	BOW NDD SAI SAI	N/A N/A NQI NQI	BOW PDP SAI SAI	N/A N/A NBI NBI	Small	Small	7.27" 3.77" 1.00" 1.91"
135	136	BW1+1.72	PRC	PBC	27%	19%	N/A	N/A	WEAR
137	136	BW1+14.66 BW1+17.45	SAI SAI	NBI NBI	PLG PLG	PLG PLG	Small	N/A	0.74" 2.53"
139	136	BW1-1.81 BW1+18.03	22% SAI	N/A NBI	PLG PLG	PLG PLG	Small	N/A	WEAR 2.35"
141	136	BW1-14.98 BW1+2.00	BOW 6%	N/A NDD	BOW NDD	N/A NDD	N/A	N/A	17.76" WEAR
143	136	09H+12.17 BW1-20.01 BW1+1.12	NDD BOW 10%	N/A N/A NDD	PDP BOW NDD	N/A N/A NDD	N/A	N/A	18.07" 22.23" N/A
134	137	BW1+2.03 BW1+16.62	NDD SAI	23% NBI	NDD SAI	NDD NBI	Large	Large	WEAR 1.12"
136	137	BW1+16.60	SAI	NBI	NDD	NDD	Small	Small	0.94"

TABLE V-7: STEAM GENERATOR 22 AXIAL INDICATIONS (TUBE PULL CANDIDATES - cont'd)									
Row	Col	Elevation	MRPC AC	Bobbin AC	MRPC BC	Bobbin BC	'93-'94 Change	Chem Cleaning Change	Length
138	137	BW1-4.23 BW1+5.88 BW1+16.30	BOW NDD SAI	N/A N/A NQI	BOW PDP SAI	N/A N/A NBI	Large	Large	3.93" 4.12 2.67"
140	137	09H+23.54 09H+24.16 BW1-1.84 BW1+17.37	NDD BOW PRC SAI	N/A N/A PBC NBI	PDP BOW 13% NDD	N/A N/A 8% NBI	Small	Small	2.08 3.14" WEAR 2.35"
142	137	BW1+14.45	NDD	DNT	NDD	DNT	N/A	N/A	N/A
135	138	BW1-6.17 BW1+0.02 BW1+1.51	BOW NDD SAI	NDD N/A NQI	NDD PDP SAI	NDD N/A NQI	Small	Small	7.46" 2.40" 1.01"

TABLE V-8: Ultrasonic Inspection Summary (Tube Pull Candidates)						
Row	Column	Location	Defect Type	Length	Width	Depth
133	134	09H+23.5 09H+24.0 09H+24.5 09H+24.6 09H+25.0 09H+26.0	Axial Indication,OD Surface Scratch,ID Axial Indication,OD Axial Indication,OD IGA Axial Indication,OD	0.620" 1.000" 0.850" 0.810" 0.444" 2.000"	N/A N/A N/A N/A 0.147" N/A	14% N/A 12% 17% N/A 24%
142	135	09H+16.3	Volumetric Indication,OD	2.450"	0.400"	7%
133	136	09H+13.9 09H+14.8	Axial Indication,OD IGA	1.200" 3.000"	N/A 0.200"	37% N/A

2. Summary of Removal Process:

A total of 21 tubes have been removed from SG 22. Figure V-10 provides a tube map showing locations of removal candidates. All tubes were cut approximately 3" above the 09H eggcrate support and approximately 3" away from the vertical support (VS1).

For each tube cut at 09H and VS1, the remaining tube sections are:

- A vertical tube section from the hot side primary tubesheet face up to 3" above 09H
- A tube section extending from the cold side primary tubesheet face to 3" past VS1.

The cut above 09H was made using a whip-cutter inserted from the hotleg primary plenum. Once all hotleg cuts were verified, parallel coldleg plenum whip-cuts (above the coldleg bend to the first vertical support) and secondary entries for tube section removal were performed. A clamping fixture was secured to three tube sections at a time from the secondary side. This restrained the tubes cut at 09H to facilitate the second cut at VS1. Once these three whip-cuts were verified, the tube sections were be removed from the SG and the clamping fixture was re-installed on the next three tubes of interest.

Secondary platforms were installed in the SGs utilizing the VS3 and VS5 I-beams and the VS1 crescent plate for support. This insured protection of the secondary bundle and provided an efficient working platform to minimize worker exposure. All materials to be used in the secondary side were secured by lanyard to ensure foreign material exclusion. All tube sections were positively identified via identification plugs and marked tube sheaths. The tube sections were removed through the secondary manway and taken to an eddy current tent for inspection.

3. Flow Induced Vibration (FIV) Stability of Remaining Tube Sections

The original tubes and the remaining tube sections have been evaluated for stability to FIV. The worst case tube in the tube removal region is tube R145C134 (this location is not in the base removal scope, however, as a contingency may need to be removed) since it has the longest vertical and horizontal spans. The highest cross flow force on the original SG tube acts against the hot side square bend. Since the hotleg bend region is to be removed, the largest forcing function will be removed from the structural model for the remaining tube section.

a. Tube Section Remaining from Cold Side Primary Face to VS1

Conservative flow velocities were used to evaluate the flow stability margin (FSM) for tube R145C134. The FSM for the virgin tube is greater than 2.0. Due to the removal of the hotleg elbow, the FSM for the altered tube condition is 2.6. Thus, the tube section remains in a stable configuration and no additional hardware or modification is required for this tube section for continued operation of the SG.

Additionally, since a large flow stability margin exists (FSM of 2.0 versus an allowed FSM of 1.0) the flow velocity increase as a result of the void region can be accommodated without the need for any flow blocking mechanism.

b. Vertical Tube Section Remaining from Hot Side Primary Face to 09H

As previously mentioned, the highest cross flow force on the original SG tube acts on the hotleg square bend. Since the bend region was removed, the largest forcing function was removed from the remaining vertical tube section. The FSM for the remaining section was not calculated since there are no significant cross flow velocities identified in the region below eggcrate support 09H. Thus, the vertical tube section is acceptable "as-is".

c. Unrestrained Batwing Supports

Removal of tube sections in columns 135, 136 and 137 will cause sections of the batwing supports to be unsupported for up to 20". In order to evaluate the consequences of this configuration, an evaluation is being performed similar to that performed on the relatively long unsupported batwing lengths in the stay cylinder void region. The increased cross-flow component due to the void region will be evaluated to determined the induced vibratory motion of the unsupported batwing sections. Due to the pinned-pinned configuration of the batwing in this area, the torsional deflection of the batwing will be assumed negligible, and the in-plane harmonic motion of the batwing will be evaluated based on the new bundle configuration.

4. Final Inspection Requirements:

All tubes cut at VS1 will be visually inspected to determine that sufficient engagement length exists. All of the tubes adjacent to those removed from service will be inspected by bobbin and/or MRPC to verify no damage occurred to the tube (e.g., dings, scratches) as a result of the tube removal process.

Once all tube sections have been removed, a secondary side video inspection will be performed in the newly created void region of the bundle. The inspection will be performed to obtain the following information:

- Relative tube spacing with sufficient definition to determine less than nominal gaps between tubes. This inspection will be made with the camera angle perpendicular to the vertical section of the tubes near the 90° bend region.
- General condition of outer tube surface (i.e., scratches and/or deposits).
- General condition of VS1 and batwings.

Tube samples will be visually examined and photographed upon laboratory receipt and tube surface characteristics noted. Deposit samples are not expected to be available since the SG was recently chemically cleaned. Each tube sample will be tensile tested and bulk chemistry tested. Microstructure examinations to characterize carbide distribution will also be performed for each tube section. The tube bend section axial indications will be analyzed using the following methods:

- Bobbin, MRPC, UT, UTEC, RFEC and Cecco probe analysis
- Burst testing of selected defect(s)
- Stereo-microscopic examination and high magnification photography of burst openings
- Scanning electron microscopy examination to obtain crack morphology and burst crack profiles
- Radial metallography of selected IGA areas

- Cross-sectional metallography of selected areas
- Auger and X-ray photoelectric spectroscopy examination of selected fracture faces (possibly two samples)
- Surface examination of selected tubes

These tube examinations will provide additional vital information to support the following engineering analysis:

- Field bobbin/MRPC ECT correlation to actual defect length/depth data
- Validation of field ECT detectability thresholds
- Characterization of various vendor ECT probe capability in bend samples
- Burst test data correlation for defect integrity analyses
- Provide data for future POD database development
- Identification of mode of degradation (IGA/IGSCC)

VI. REGULATORY GUIDE 1.121 EVALUATION

NRC RG 1.121 provides the requirements for evaluating the structural integrity of degraded SG tubing. The requirements are designed to maintain specific margins for degraded tubing against rupture. In this evaluation, compliance with the Regulatory Guide requirements over the past operating interval is first demonstrated. This determination verifies that the evaluation performed following the last SG inspection, to determine the length of the operating interval, was appropriate and conservative. Next, analyses will be performed, considering crack growth rate and eddy current detection thresholds, to determine the length of the next operating interval such that the safety margins specified in RG 1.121 will continue to be maintained. The methodology being used in an on-going statistical analysis is described in this report. The statistical analysis results, upon completion, will be provided in a supplemental report. Finally, the preliminary results of a deterministic analysis are presented to provide support for an interim operating interval until the statistical analysis is complete.

A. Regulatory Guide 1.121 Compliance

1. Structural Evaluation

To determine whether the safety margins specified in Regulatory Guide 1.121 were maintained over the past operating cycle, a structural analysis is performed to determine the maximum allowable crack size. APS has previously performed this structural evaluation, which utilizes a burst correlation developed for EPRI by Framatone described in EPRI report NP-6865-L "Steam Generator Tube Integrity, Volume 1". Using this correlation, the maximum allowable crack depth as a function of crack length can be determined as illustrated in Figure VI-1. This figure is reproduced from Figure X-h in Reference 1, but has been adjusted downward slightly to account for the increased primary to secondary pressure differential associated with the 10 degree T-cold reduction and operation at 85% power. The curve has also been adjusted to address the structural limit for short cracks. Since many of the cracks in the upper bundle are located in the free-span, some of the cracks tend to be long. The Framatone correlation was selected since it has been shown to provide the best comparison with available burst test data for long cracks. However, the correlation has been shown to be overly conservative for short cracks less than approximately 0.75 inches long that approach through-wall depth. Therefore, APS uses an EPRI correlation developed in EPRI report NP-6864/L "PWR Steam Generator Tube Repair Limits" for determining RG 1.121 compliance for short flaws. This correlation indicates a through wall flaw less than 0.698 inches long will maintain the required safety margins against rupture.

2. Eddy Current Results

The preferred approach to demonstrating RG compliance would be to simply take the largest defects, in terms of depth as called by bobbin and length as called by MRPC and compare to the RG limit curve. There were a total of four axial defects with measurable bobbin depth calls. All of these defects are located in SG 22. Two of these indications are short and, therefore would meet RG limits if they are less than 0.689 inches long (since the defects could be 100% through-wall and still maintain the required structural safety margins). The percent through wall depths of the remaining two defects are below the corresponding RG 1.121 depth limit considering the measured length of the defects. Based on their measured depth and length, all four meet RG 1.121 requirements as shown in Table VI-1.

TABLE VI-1: SG 22 TUBES WITH MEASURABLE CRACK DEPTHS

Row	Column	Bobbin Depth (%)	MRPC Length (In)	RG 1.121 Limit
117	44	61	0.25	0.689" long
136	116	48	1.04	67% thruwall depth
142	117	52	2.21	65% thruwall depth
136	127	40	0.22	0.689" long

It should be noted that the RG 1.121 limits as described in the above table are conservative in that it is assumed that the measured bobbin depth call is an indication of the average crack depth. The results of the pulled tube examinations (from U2R4) demonstrated that the bobbin coil consistently over-calls the average crack depth.

In addition to the axial indications, four circumferential indications at the top of the tubesheet transition were detected. The longest of these defects was measured by MRPC to be 0.35 inches circumferential extent. Based on a structural analysis described in the Unit 1 Steam Generator Inspection Report (Reference 2), a 100% throughwall circumferential defect of up to 1.6 inches long would be expected to maintain the required structural margins. Therefore it is concluded that the circumferential defects do not approach RG 1.121 limits. Similarly, the largest wear defect has a depth of 52% as measured by bobbin coil, which is well below the allowable for wear-type defects.

The very large majority of the axial defects identified in the Unit 2 SGs are either not detectable with the bobbin coil technique (NBI) or are detected by bobbin coil but an accurate depth cannot be obtained (NQI). Therefore all defects classified as NBI or NQI are implicitly small and meet RG 1.121 requirements. This position was verified by the tube pull laboratory results performed following the U2R4 outage. As described in detail in Section VII.B.2 of Reference 1, crack profiles were generated in the laboratory by destructive examination for each crack location from the sample of 8 tubes pulled from SG 22 to allow direct comparison with eddy current results. Table VI-3 provides a compilation of actual measured crack depths/lengths; corresponding field bobbin, lab bobbin and field MRPC indications; measured burst pressure, and calculated burst pressures based on actual measured average crack depth and length. Cracks that were detected by field bobbin are indicated by an NQI, DSI (distorted support indication), or numerical entry in the "Field Bobbin" column. An NBI entry in this column indicates the crack was not detected by bobbin coil inspection. Cracks detected by MRPC are indicated by an SAI (single axial indication) or MAI (multiple axial indication) in the MRPC column. An NDD entry indicates the crack was not detected.From this data, it can be seen that all cracks designated NBI had an average through wall depth well below RG requirements. Although there were no NQIs in the pulled tube samples, it can be seen that any of the cracks that approached or exceeded the approximate 65% RG 1.121 limit were measurable by bobbin techniques. Thus, all NQIs and NBIs should be well below the RG limit. However, the entire set of pulled tube samples consisted of cracks located in the vertical straight leg portion of the tubes. Many of the defects designated NQI or NBI are located in the bend section of the tube. Since it is believed that bobbin detectability, and probably bobbin measurability, for defects located in the bends is less than in the straight legs, there is a concern that NBI or NQI defects located in the bends may approach RG 1.121 limits. To address this concern, the largest defects as indicated by MRPC were in-situ pressure tested for final determination that the required safety margins had been maintained.

TABLE VI-3: DEFECT BURST STRENGTH SUMMARY

Row	Col	Defect Location/ Section	Actual Maximum Depth(%)	Actual Average Depth(%)	Field Bobbin Call	Field MRPC Call	MRPC Length (in)	Burst Length (in)	Burst Pressure (psig)	Calculated Burst (ave)	Calculated Burst (max)
127	140	07H/13	100	40	74	SAI	0.3	0.58	5330	7491	1455
127	140	08H/15	89.3	58	64	SAI	0.4	1.0	6119	5346	2026
105	156										
	270°	Midspan/16	98	77	85	MAI	1.6	1.38	3200	2656-3171	725-866
	90°	Midspan/16	40	25	NBI	SAI	N/A	N/A	N/A		
	0°	Midspan/16	38	35	NDD	NDD	NDD	N/A	N/A		
	0°	Midspan/16	32	32	NDD	NDD	NDD	N/A	N/A		
	0°	Midspan/16	38	31	NDD	NDD	NDD	N/A	N/A		
103	156	Midspan/17	57	45	NBI	MAI	0.29	0.325	6968	6983-7171	5923-6082
			42	27	NBI	MAI	N/A	N/A	N/A		
117	40	Midspan/17	61	27	NBI	SAI	N/A	N/A	N/A		
116	41	Midspan/19	12	N/A	NDD	NDD	NDD	N/A	N/A		
22	13	01H/2	56	31	52	SAI	0.25	0.325	8948	8011-8688	6412-5913
29	24	01H/2	40	21	DSI	SAI	0.33	0.275	9662	9354-9605	7742-7950

3. In-Situ Pressure Tests

In order to select the largest defects for in-situ pressure testing, a method for assessing the apparent magnitude or depth of defects using the MRPC signal was developed. Using the Unit 2 pulled tube samples, a comparison has been made between the actual average depth of defects to the maximum vertical voltage amplitude of the MRPC signal. From this data sample, the correlation provided in Figure VI-2 was obtained. This correlation verifies the intuitive impression that deeper defects will produce a greater MRPC voltage signal. Based on this observation, all tubes with axial defects with a maximum vertical voltage amplitude signal of greater than 3 volts were selected to be pressure tested. Additionally, the MRPC presentation of all defects with vertical voltage amplitudes greater than 2 volts were reviewed to assess whether, based on the MRPC presentation, the defect could potentially have an average through wall depth greater than the defects with greater than 3 volts signals. Two tubes were selected in this manner. The tube with the largest measurable defect depth was also selected, as were all tubes with single volumetric indications greater than 63%. All tubes were pressurized to 4260 psia. This test criteria is based on 3 times the operating differential pressure of 1290 psid, adjusted for room temperature and application of an approximately 50 psi test margin. All tubes, as tabulated below, were successfully pressurized to a minimum of 4260 psi, indicating the required safety margins against bursting were maintained. All defects were subsequently reexamined by MRPC and no change in the eddy current presentation was observed.

TABLE VI-2: IN-SITU PRESSURE TEST RESULTS

SG	Row	Column	Selection Criteria	Pass/Fail
21	118	95	>3 Volts axial indication	Pass
21	99	39	SVI >63% (66% measured)	Pass
22	149	120	>3 Volts indication	Pass
22	146	121	>3 Volts indication	Pass
22	105	138	>3 Volts indication	Pass
22	144	105	>2 Volts axial, MRPC presentation	Pass
22	130	95	>2 Volts axial, MRPC presentation	Pass
22	110	143	SVI >63% (73% measured)	Pass
22	117	44	61% Axial indication	Pass

B. Statistical Analysis To Determine Next Operating Interval

As required by RG 1.121, an analysis is being performed to demonstrate that the required safety margins will be maintained over the length of the next operating interval. A statistical approach is being used for evaluating uncertainties and for providing a more realistic assessment of tube integrity margins than can sometimes be achieved through a deterministic approach. A deterministic approach was used by APS to determine the length of the last operating interval. This statistical analysis is scheduled for completion by May 30, 1994, at which time the length of the next operating interval will be finalized.

The following sections describe the basic methodology being used in this analysis. When the statistical analysis is completed, a detailed report will be prepared.

1. Crack Distribution and Crack Growth Rate Determination

The distribution of cracks (i.e. the number of cracks at any given depth or length) that exists in a SG can be determined by statistically combining the as-detected crack distribution, in terms of depth and length, with the probability of detection (POD). This statistical distribution describes the number of "real" cracks, at any given depth or length, both detected and undetected. If distributions are determined for successive inspections, the crack growth rate distribution and the rate at which new cracks are being initiated can be determined from the two real crack distributions.

The length distribution of the as-detected cracks is formed by obtaining the length, as measured by MRPC, of each bobbin detected crack. The depth distribution is formed by first obtaining the depth information for all cracks in which bobbin depth calls can be made. These depth calls are then converted to average crack depths using a correlation developed from the U2R4 pulled tube samples. However, the large majority of cracks detected by bobbin are not measurable (NQI). The NQIs within each discrete length interval are then distributed amongst the discrete depth intervals. APS is currently evaluating several assumed NQI depth distributions. The distribution chosen will be described in the final analysis report.

Having determined the length and depth distributions of the as-detected cracks in this manner, the real cracks distributions are determined by combining with the appropriate bobbin POD curve. The real crack distribution, thus, consists of both the detected and undetected by bobbin crack populations. This analysis will use a POD curve derived from Fig. 3.39 in NUREG/CR-5117.

This process of forming the length and depth crack distributions is performed using the results of the U2R4 and the current U2M5 inspection. The U2R4 distribution is then updated by removing from the distribution those tubes that have been plugged, including the large population of tubes which have defects detected by the more sensitive MRPC technique.

We now have developed sufficient information to be able to estimate the initiation rate (cracks/month) at which new crack sites are being produced on the SG 22 tubes. This is done by comparing the number of estimated "real" cracks at successive inspection. For example, comparing the number of real cracks at U2M5 to the number of real cracks at U2R4 following plugging provides an estimate of the number of new cracks that initiated during the operating interval. Dividing the number of new cracks initiated by the duration of the operating interval results in an estimate of the rate at which new cracks are formed. The new crack sites initially start at essentially zero depth and subsequently grow in depth and length based on the operating time and the through-wall depth and axial length crack propagation rates.

The Monte-Carlo technique is then used for calculating the depth and length propagation rate probability distributions. The length and depth real crack distributions for U2R4 after plugging and U2M5 before plugging are arranged in a cumulative distribution function (CDF). The U2R4 distributions are adjusted by adding additional "real" cracks to the first axial crack length and/or depth intervals as necessary. This adjustment effectively amounts to adding cracks of zero length or depth, in order to equalize the total "real" crack count between U2R4 (following tube plugging) and U2M5 (before plugging). A Monte-Carlo simulation consisting of 50,000 histories samples the cumulative distribution functions. As an outcome of this simulation the depth and length crack propagation rate probability distributions are generated.

2. Determination of Next Operating Interval

To determine the length of the next operating cycle, Monte-Carlo simulations are performed to propagate the "average depth real" cracks which remain following U2M5 tube plugging. In addition to these cracks, new crack sites of essentially zero depth are simulated to occur at the rate determined previously. All cracks are propagated both depth-wise and length-wise by using the crack propagation rate probability distributions previously developed. In order to compile the required key results at each postulated Cycle 5 operating time, 50,000 Monte-Carlo histories are collected during each simulation. This large number of simulations minimizes the statistical uncertainty resulting from finite sampling. In this manner, the probability of a crack exceeding specific critical combinations of crack depth and length, based on the Framatone burst correlation used to determine the Unit 2 maximum allowable crack size, is determined. All results are determined at 50%, 95%, and 99% statistical confidence levels; the resulting mean (expected value) is also determined.

3. Defect Population Considered in the Analysis

As can be seen by the above discussion, the process of determining the distribution of real cracks, both detected and undetected, is dependent somewhat on the applicability of the POD curve. However, a large percentage of the defects detected in the Unit 2 SGs are located in the 90° square bends of the tubing. Industry experience indicates that bobbin coil detectability levels in the bend sections may be much less than the corresponding detectability levels for defects located in the vertical straight leg section of the tubing, therefore the POD curve is probably not applicable for defects located in the bends. Therefore, combining the as-detected distribution of defects, which contains the population of defects located in the bends, with a POD that is not applicable for a large percentage of the population would not be statistically correct.

To ensure that the population of defects included in the as-detected distribution is applicable to the POD curve used, only the defects located in the vertical straight leg sections of the tubing is utilized in the statistical analysis. This approach is considered acceptable if two important considerations can be addressed. Will the beginning of cycle condition of the undetected defects in the bends be consistent with the straight legs and will the growth rates of defects located in the bends be consistent with the statistically derived growth rates of defects located in the straight legs?

The beginning of cycle condition of the bends should be consistent with the straight legs. Both the straight legs and the bends are inspected by MRPC techniques. It is believed that there is not an appreciable difference between MRPC detectability levels in the straight leg sections and the bend sections due to the mechanics of the rotating pancake coil. Therefore, undetected (by MRPC) defects left in service at the start of the cycle in the bends should not be any deeper than the undetected (by MRPC) defects left in the straight sections.

Observation and field experience indicates that crack growth rates are not appreciably greater for defects located in the bends. The largest defects observed during the U2R4 outage, including the tube rupture, were located in the straight section of the tubing. Although this does not give a direct growth rate comparison between cracks located in the bend versus in the straight leg, if growth rates were appreciably greater in the tube bends it would be expected that there would be larger defects in the bend. From the current inspection results, it is noted that the majority of defects identified exhibit detectable or precursor MRPC signals upon re-evaluation of the previous outage ECT tapes. This allows for a more direct determination of the apparent growth rates of the defects by evaluating the change in MRPC voltage signal. Review of this data indicates no appreciable difference in the magnitude of change of the MRPC voltage signal between defects in the bends versus in the straight legs. Thus it can be concluded that the derived crack growth rates of the population of defects, using only the data from cracks located in the straight legs, is representative of the crack growth rates for defects located in the tube bends.

C. Deterministic Analysis

Although a statistical analysis is considered to be the more appropriate methodology for performing an assessment of crack growth rates and determining the length of the next operating cycle, a deterministic analysis is also being performed. This analysis allows for a more direct comparison with the results of the analysis performed following U2R4. A preliminary analysis has been completed using a deterministically derived apparent crack growth rate observed over the last operating interval. When combined with the eddy current detectability threshold determined previously (Reference 1) and the maximum allowable crack size as illustrated in Figure VI-1, a maximum operating interval length can be determined. The results of this preliminary analysis support an interim operating interval until the final statistical and deterministic analyses can be completed.

1. Crack Growth Rate Analysis

In the previous Unit 2 outage, no precursor eddy current signals were observed for either free span or eggcrate crevices indications. In the present outage, after a run time of 4.5 months, additional indications have been found. However, at least 59 of these indications clearly show precursor signals, indicating their presence at startup. Indeed, voltage levels can be assigned to these precursor MRPC signals. With the knowledged gained from previous cycle tube pulls, these precursor signals now would be considered as flaw indications. Evaluation of fractographic data for the previous Unit 2 tube examinations has led to an empirical correlation of maximum (vertical) MRPC voltage with average crack depth. Hence, in 59 cases, comparison of beginning of cycle and mid cycle MRPC voltages can be used to infer crack growth rates. In this analysis it is assumed that the 59 data points are representative of the crack growth rates for the entire defect population. This assumption will be validated in the final deterministic analysis.

The correlation of average crack depth with MRPC voltage is illustrated in figure VI-2. the average crack depth was obtained essentially from measurements of fractographic montages of the crack faces. Average crack depth is of interest, since it is this parameter, combined with crack length, that determines structural integrity. Only one of the pulled tubes exhibited an average crack depth that was a challenge to Reg. guide 1.121 burst strength requirements. This average depth was 77% of the wall thickness over a distance of about 1.38 inches. The corresponding burst pressure was 3200 psi. the MRPC trace for this flaw exhibited three distinct voltage peaks. All three peaks are plotted in Figure VI-2 to provide some idea of data scatter. All other points reflect a single voltage for single average crack depth. An independent analysis of a similar but not totally equivalent data set led to essentially the same correlation curve. APS is continuing to evaluate and refine this correlation.

Figures VI-3 and 4 illustrate the magnitudes of the beginning of cycle and mid cycle MRPC voltages. All of these indications were found with the same size MRPC coil and were found prior to chemical cleaning. Thus, the voltages are directly comparable. Figure VI-3 shows that most signal amplitudes increased. Figure VI-4 illustrates a maximum voltage change on the order of 1.1 volts. Figure VI-4 also illustrates that voltage growth is not correlated with starting signal amplitude. The largest mid cycle voltage was 2.84 volts but this signal also had the largest beginning of cycle voltage, 2.41 volts. Almost all beginning of cycles voltages were less than 1.0 volt and the spread of voltage changes is nearly uniform

For any given voltage pair, beginning versus mid cycle, the spread in possible crack depths is large. However, the large number of data points makes it reasonable to compute most likely crack growth rates and then examine the range of these values. Figure VI-5 provides a schematic illustration of the calculation of the most likely crack growth rate for each voltage pair. Without prior knowledge, the most likely crack depth is the mid scatter band value. The beginning of cycle crack depth was set at this point. The range of possible mid cycle depths was then set from the upper scatterband limit to either the beginning of cycle depth or the lower scatterband edge. This choice eliminated the possibility of negative crack growth rates in all but one case. The most likely mid cycle depth was then taken as the midpoint of the possible range.

Dividing the change in average crack depth by the run time of 4.5 months leads to a crack growth rate express in terms of percent of wall per month. Crack growth rates from all 59 voltage pairs are plotted on Weibull probability paper in figure VI-6. This data represents free span, eggcrate and batwing crevices and bend region location. More than 10 voltages pairs are available for each region. About 95% of the calculated crack growth rates are less than 2.5% per month (1.0 mils/month). This is somewhat better than the last outage 95% estimate of 4.8% per month (2.0 mils/month). The calculated crack growth rates are consistent with a temperature reduction and better thermal hydraulic conditions brought about by the reduction to 85% power. In the most conservative interpretation, previous estimates of crack growth rates are shown to be prudent and conservative. With the advent of additional pulled tube data, it is likely that a strong case can be made that remedial actions have reduced the operative crack growth rates by a factor of two.

2. Maximum Operating Interval

The tube pull examinations performed following the U2R4 outage established an MRPC detectability threshold of at least 40% average through wall depth. The results of the tube pull examinations are summarized in Table VI-3. Based on the results of the U2R4 inspections and the current U2M5 inspections, it is extremely unlikely that there exists axial defects in tubes which were not inspected with MRPC. Therefore, for the purpose of this evaluation, a 40% average through wall defect will be considered to be the largest defect that could be left in-service at the start of the next operating interval.

As described earlier in this report, APS has previously performed a structural evaluation to determine the maximum allowable crack depth as a function of crack length as illustrated in Figure VI-1. Based on an assumed 40% largest crack left in service and a crack growth rate of 1 mil/month, the time to meet this structural limit can be determined. However, the determination of a maximum allowable crack depth requires consideration of crack length. The most conservative consideration would be to assume an infinitely long crack which, based on Figure VI-1, would result in a maximum crack depth of 64% (RG 1.121 Limit curve asymptotically approaches 64%). However, it is extremely unlikely that the deepest crack left in service would grow at the 95% crack growth rate and also be a very long crack at the same time. A more reasonable approach was presented in Section X.B of Reference 1 which resulted in the use of 1.4 inches as a reasonably conservative, structurally significant crack length for use in the deterministic analysis. This approach did not imply that there will not be any cracks longer than 1.4 inches. This approach does imply that it would be extremely conservative to assume that the occasional deep crack left in service will team up with the occasional fast growth rate and result in a long, deep crack with a structurally significant length of greater than 1.4 inches. Using this approach is this analysis results in a maximum allowable crack depth of 66%.

Figure VI-7 graphically illustrates the determination of the maximum operating interval such that RG 1.121 safety factors are maintained. As can be seen, this deterministic analysis indicates a maximum operating interval of approximately 10 months.

D. Conclusion

A RG 1.121 analysis using a deterministic approach was previously performed following eddy current inspections performed during U2R4. This analysis estimated that 95% of the cracks detected during that outage had experienced a crack growth rate of 2 mils/month or less. Determination of this crack growth rate required several assumptions to be made due to the lack of detectable eddy current signals or precursors at the prior inspection (U2R3). Based on this crack growth rate and on eddy current detectability thresholds determined from tube pull examination results, APS determined that an operating interval of 6 months should result in all tubes maintaining the required structural safety margins specified by RG 1.121.

After an operating interval of approximately 4.5 months, SG inspection and test results indicates the previous deterministic analysis assumptions and inputs were conservative in that no axial defects were found which approach or exceed the Regulatory Guide limits. This indicates that an operating interval of at least six months is justified.

A statistical analysis is being performed to determine the apparent crack growth rates being experienced by the population of defects and, hence, the appropriate length of the next operating interval. A statistical approach is being taken as suggested by the NRC in their Safety Evaluation Report of the Unit 2 Steam Generator Tube Rupture Evaluation Report. The basic methodology of this analysis is described herein. This analysis requires a statistical treatment of all the final eddy current data as well as the development of uncertainties for various analysis assumptions and inputs. Upon completion of this analysis, a final determination of the appropriate operating interval can be made.

A preliminary deterministic analysis has been performed in a similar manner as performed previously to allow for a more direct comparison with the results of the previous analysis. Contrary to the situation that existed at that time, the large majority of the defects identified during this inspection have detectable or precursor MRPC signals upon re-evaluation of the previous outage inspection eddy current tapes. This allows for a more direct determination of the apparent growth rates of the defects, with the development of an MRPC voltage to average crack depth correlation. This evaluation indicates that apparent crack growth rates over this past operating interval are approximately one-half the growth rates estimated to have occurred between U2R3 and U2R4. This growth rate would indicate an operating interval of 10 months is justified. Although APS intends to determine the length of the next operating interval based on the results of the statistical analysis, the deterministic analysis provides further justification for an interim operating interval until the final statistical and deterministic analyses are completed.

VII. OPERATING PLAN/FUTURE ACTIONS

A. Plugging Margin Analysis

The Unit 2 Cycle 5 safety analyses assume the following amount of plugged SG tubes: LOCA analyses 800 total plugged tubes (500/300 asymmetric split) and Non-LOCA analyses 600 tubes per generator. As a result of the number of plugged SG tubes during the U2M5 outage, the LOCA and Non LOCA plugged tube assumptions were exceeded.

An evaluation of the impact of an increased number of plugged SG tubes on the results of the LOCA analyses is being performed to allow Unit 2 to return to power operation. ABB-CE is tasked with completing the LOCA evaluation. The evaluation assumes 1,100 total plugged SG tubes and the ability to reduce the linear heat rate value from 13.5 kw/ft to a value required to bound the current Cycle 5 analyses results. The evaluation requires re-performing the Refill/Reflood Hydraulics Code and the Hot Rod Heatup Code to determine the impact additional plugged tubes would have on the calculated peak clad temperature obtained for the limiting large break LOCA.

The Non LOCA peak pressure events are also adversely impacted by the increased number of plugged tubes. The peak pressure events safety analyses are being re-performed conservatively assuming 1,000 plugged tubes per SG, 100% reactor power and a 555°F nominal inlet temperature. The non peak pressure events were determined to be unaffected by the increased tube plugging, therefore the existing Cycle 5 analyses are still bounding.

All analyses are currently in progress and are expected to be completed by March 20, 1994.

B. Post Chemical Cleaning

As discussed earlier, a change in ECT indications occurred after SG chemical cleaning. The same phenomenon was not seen in SG 21. One task currently underway is the analysis of various chemical cleaning waste streams from the two SGs to determine if there is a component present in one set of solvents which does not exist in the other set. The following samples will be analyzed:

TABLE VII-1: CHEMICAL CLEANING WASTE SAMPLES

Sample	Source	Comment
Iron Tank	SG 22	Iron Solvent
F-1 Tank	SG 22	Crevice Solvent
F-3 Tank	SG 21	Iron Solvent
F-4 Tank	SG 21	Iron & Crevice Solvent
Sludge	SG 22	Sludge Lance Sample
Sludge	SG 21	Sludge Lance Sample

A qualitative analysis of each sample will be performed via inductively coupled plasma analysis, with special consideration to aluminum, chromium, nickel, copper, sulfur, lead, phosphorus, and silicon. Additionally, a full spectrum organic analysis (GC Mass Spectrophotometer) will be conducted. The intent will be to identify the various constituents of each sample and the relative differences between SG 21 and SG 22 samples.

C. Chemistry Control

Additional corrective actions to address caustic crevice conditions, elevated corrosion product transport and elevated electrochemical potential are currently under review. These include:

1. Boric acid treatment will be implemented upon unit startup. The implementation plan has not been finalized but may include an ambient soak with a low concentration of boron, a series of 300°F crevice flushes with a high concentration of boron, a low power soak with 300 ppm boron and online addition.

2. An ECP monitor is being obtained through an agreement with EPRI. The monitor will be installed on the final feedwater system of one of the units and be will utilized to further expand the industry's knowledge of the relationships between hydrazine, dissolved oxygen and ECP.

3. Procedural guidance is being drafted to implement a hideout (tracer injection) test to determine the hideout fractions of major analytes. The data obtained from the tracer tests will be utilized in conjunction with chemistry trend data and hideout return data to optimize molar ratio control. A decision matrix for ammonium chloride injection has been developed. Ammonium chloride injection is being considered to control molar ratio if determined necessary.

4. Additional corrective actions are being taken to reduce resin ingress to the SGs. Actions currently under review for possible implementation include replacing the resin traps and retention elements with new designs, quantifying the resin fine ingress to the SGs, upgrading resin purchase specifications and storage methods, and establish procedures for conditioning new resin prior to use.

5. Corrective actions are being taken to improve condensate polisher operations. Actions currently under review for possible implementation include upgrades to the regeneration equipment and processes, preventative maintenance activities and establishment of training requirements.

6. Longer term actions include evaluating the use of alternate amines and/or carbohydrazide for SG layup, optimization of temperature holds during shutdowns and implementing startup limits for iron (determine when it is permissible to bypass polishers).

VIII. OPERATING INTERVAL / BASIS FOR RESTART

APS has determined that PVNGS Unit 2 is safe to operate for a period of at least six months. This conclusion is based on the results of a comprehensive ECT inspection program which included MRPC inspection of the arc of interest from the 08H to VS in each SG, MRPC inspection from 08H to VS (BW to VS in SG 21) in an area of approximately 900 tubes surrounding this arc and bobbin inspection of an arc of approximately 4000 tubes centered on the arc of 1800 tubes. The top of tubesheet area was also inspected using MRPC techniques to identify circumferential cracks. This scope ensures the areas susceptible to free span cracking or circumferential cracking were thoroughly inspected.

Axial crack indications for the most part were too small to size with bobbin coil inspection. The threshold of detection for the bobbin coil was established at 50% throughwall based on pulled tube analysis from the U2R4 outage, and the MRPC threshold was placed at 40% throughwall. Cracks which could not be sized by bobbin were evaluated by the MRPC voltage associated with the indication. A correlation of voltage to actual depth was developed from the U2R4 pulled tube laboratory data to support this methodology.

Circumferential cracks were evaluated using the same methodology described in Reference 2 assuming 100% throughwall for the length of the indication.

The results of this inspection did not identify any axial cracks whose size would challenge RG 1.121 limits, and this was further verified by conducting in-situ pressure testing of 9 tubes (7 with axial crack indications, 1 in SG 21 and 6 in SG 22). The fact that no RG 1.121 challenges were present confirms the predictions of the axial crack growth which form the basis for a six month operating interval presented in Reference 1. The U2M5 inspection results indicate that reduced power and temperature resulted in lower crack growth rates and lead to the conclusion that an allowed run time of six months is still applicable to PVNGS Unit 2. However, pending completion of a revised RG 1.121 analysis using U2M5 inspection results APS will continue to operate Unit 2 at reduced power and temperature conditions.

The inspection did not identify any circumferential cracks whose size would challenge RG 1.121 limits based on an assumed 100% throughwall depth over the length of the crack. The circumferential cracking phenomenon was reported in Reference 2, and pending the completion of the quantitative analysis based on industry and PVNGS specific data, it is reasonable to treat the circumferential cracking issue as being bounded by the more aggressive axial cracking mechanism. Therefore, circumferential cracking does not restrict the calculated allowed run time which is based on the free span axial cracking mechanism. The bounding argument is supported by the number and size of axial cracks as opposed to circumferential cracks.

Two important corrective actions were implemented in the U2M5 outage. Boric acid treatment to address the caustic crevice environment and chemical cleaning to remove the bridging deposits between tubes which are responsible for the formation of crevices in the free span area. The existing prediction of run time takes no credit for the benefits of these actions adding an unquantified margin of conservatism.

The multi-tier approach to tube rupture prevention and mitigation described in References 1, 2, 12 and 13 is still in place:

- Increased scope and better resolution in eddy current inspection for crack indications
- Implementation of industry recognized corrective actions to retard accelerated corrosion
- Enhanced leak rate monitoring methods
- Improved operator diagnostic methods for primary-to-secondary leakage
- Revised mitigating actions for tube rupture events
- Analysis verifies actions limit tube rupture consequences within 10CFR100 criteria

This defense in depth approach supports the conclusion that operation of PVNGS Unit 2 for at least six months does not constitute a safety concern. Upon completion of analysis using U2M5 data a longer period of operation may be justified.

IX. REFERENCES

1. "Unit 2 Steam Generator Tube Rupture Analysis Report", submitted to the NRC staff as enclosure 2 to William Conway's letter 102-02569-WFC/JRP, dated July 18, 1993

2. "Unit 1 Steam Generator Inspection Report" dated October 1993

3. MCC-93-495, "Task 2.1 Report: Steam Generator Sludge Loading Estimation Engineering Services for Steam Generator Chemical Cleanup for PVNGS Unit 2", ABB Combustion Engineering Nuclear Operations, December 1, 1993.

4. MCC-93-483, "Task 2.2 Report: Materials Evaluation for PVNGS Unit 2 Steam Generators", ABB Combustion Engineering Nuclear Operations, December 1, 1993.

5. MCC-93-492, "Task 2.3 Report: Corrosion Allowances Chemical Cleanup for PVNGS Unit 2", ABB Combustion Engineering Nuclear Operations, December 1, 1993.

6. MCC-93-484, "Task 2.4 Report: Limits and Precautions Guideline for Engineering Services for Steam Generator Chemical Cleanup at PVNGS Unit 2", ABB Combustion Engineering Nuclear Operations, October 25, 1993.

7. 13-N001-6.03-529-1, "Palo Verde Chemical Cleaning Dissolution Testing", B&W Nuclear Technologies, January 28, 1994.

8. 13-N001-6.03-528-1, "PVNGS Chemical Cleaning Materials Evaluation/Corrosion Estimates", B&W Nuclear Technologies, January 28, 1994.

9. 13-N001-6.03-530-1, "PVNGS Chemical Cleaning Qualification - Final Report", B&W Nuclear Technologies, January 28, 1994.

10. 13-N001-6.03-526-1, "PV Chemical Cleaning Process Specification", B&W Nuclear Technologies, December 29, 1993.

11. USNRC Regulatory Guide 1.121, "Basis for Plugging Degraded PWR Steam Generator Tubes", For Comment, August 1976.

12. Letter 102-02585, dated July 25, 1993, from W.F. Conway, Executive VP, Nuclear, APS, to NRC, "Steam Generator Tube Evaluation".

13. Letter 102-02593, dated July 30, 1993, from W.F. Conway, Executive VP, Nuclear, APS, to NRC, "Steam Generator Tube Rupture Analysis".

14. EPRI NP-6865/L, "Steam Generator Tube Integrity, Volume 1", June, 1991.

15. EPRI NP-6864/L, "PWR Steam Generator Tube Repair Limits", December, 1991.

16. Letter 102-02751, dated December 6, 1993, from J. M. Levine, VP Nuclear Production, APS, to USNRC, "Steam Generator Tube Inspection Plan".

17. Letter 102-02803, dated January 27, 1994, from J. M. Levine, VP Nuclear Production, APS, to USNRC, "Steam Generator Tube Inspection Plan Addendum".

18. Letter dated February 25, 1994, from Gary Henry, EPRI NDE Center, to Doug Hansen, APS, "Review of Unit 2 S/G 22 Eddy Current Data Before and After Chemical Cleaning".

19. Letter dated February 28, 1994, from Tom Bipes, ABB-CE, to Jack Lareau, ABB/AMDATA, "Voltage & Length Measurements for Palo Verdi (sic) Tube SAI Indications".

20. EPRI TR-102134, PWR Secondary Water Chemistry Guidelines", Revision 3, May, 1993.

21. Letter dated August 19, 1993, from T.E. Murley, Director. Office of NRR, USNRC, to W.F. Conway, Executive VP, Nuclear, APS, "Restart of Palo Verde Unit 2" (Enclosure 1).

22. NUREG/CR-5117, "Steam Generator Tube Integrity Program / Steam Generator Group Project", R.J. Kurtz, et.al., USNRC, May 1990.

23. EPRI NP-4597, "Chemical Cleaning of Millstone Unit 2", May 1986.

24. EPRI NP-6356-M, "Qualification of PWR Steam Generator Chemical Cleaning For Indian Point-2", May 1989.

25. EPRI NP-6721-SD, "Corrosion Evaluation of Thermally Treated Alloy 600 Tubing in Primary and Faulted Secondary Water Environments", EPRI Research Project 1708-2 Final Report, June 1990.

26. EPRI NP-3040, "Neutralization of Tubesheet Crevice Corrosion", EPRI-SGOG Research Project S-183-2 Final Report, May 1983.

APPENDIX A SUMMARY OF AXIAL AND CIRCUMFERENTIAL CRACKS

Appendix A contains tubesheet maps which illustrate those tubes with axial and circumferential indications. Additionally, the associated ECT reports are included.

The following figures and tables are included in this Appendix:

Figure A-1	SG 21 Axial Indication Tubesheet Map
Table A-1	SG 21 Axial Indication ECT Report
Figure A-2	SG 22 Axial Indication Tubesheet Map
Table A-2	SG 22 Axial Indication ECT Report
Figure A-3	SG 22 Circumferential Indication Tubesheet Map
Table A-3	SG 22 Circumferential Indication ECT Report

LEGEND

The following is a legend for Tables A-1, A-2, and A-3:

ROW: Indicates the row number of a given tube.

LIN: Indicates the column number of a given tube.

LEG: Indicates the tube leg from which examination was performed (C is from coldleg, H is from hotleg).

EXAM EXTENT PROGRAM: Indicates the tube length initially required to be examined (i.e., F/L=full length, 07H=seventh support on hotleg side).

EXAM EXTENT ACTUAL: Indicates the tube length actually examined.

EXP: Expansion column used for identifying the expansion number in which the indication was detected.

CAL: Indicates calibration number on which the data was recorded.

PROBE: Indicates probe diameter in first three digits and type in last two digits.

- 580 would identify a 0.580" diameter probe
- BC = MRPC big coil
- AC = MRPC after chemical cleaning
- MF = MidFrequency bobbin coil
- MC = MidFrequency bobbin coil after chemical cleaning

LOCATION: Gives indication location relative to known landmarks such as supports, vertical straps, and batwings. Typical locations codes:

- VS1 = #1 Vertical Strap
- BW1 = #1 Batwing
- 01H = #1 Support plate on hotleg side
- TSC = Top of tubesheet coldleg side
- TEC = Tube end coldleg side

VOLTS: Indicates the voltage of a given indication response. For SAI, MAI, SCI, MCI indications, this column indicates length.

DEG: The measured phase angle of a given indication response.

%: The percent throughwall of a given indication based on the measured angle/amplitude and the calibration curve established for that particular channel, or analysis comment codes (e.g., PLP=Possible Loose Parts).

CH: Indicates the channel used to measure and evaluate a given indication.

FIGURE A-1

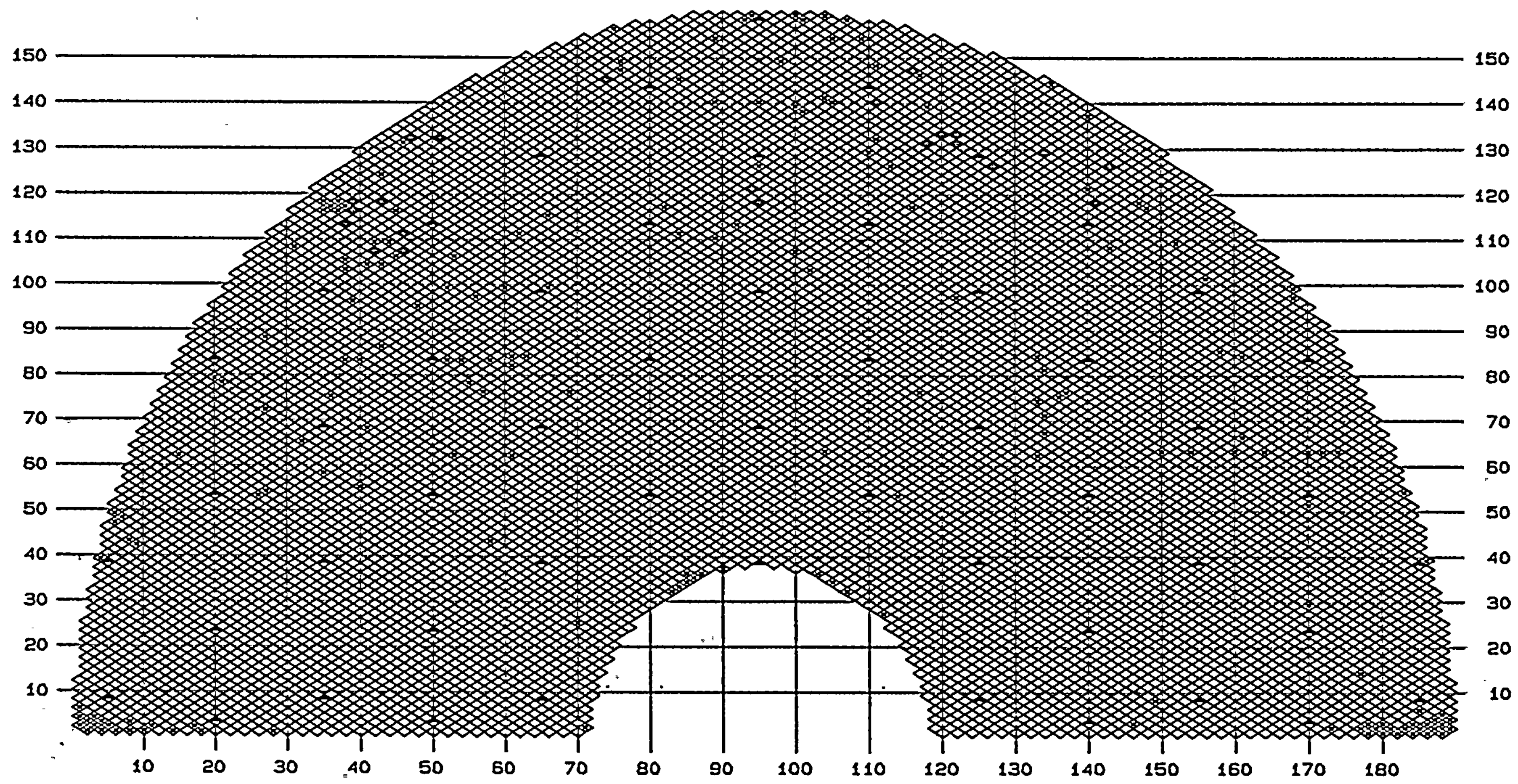
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR: 21
MAP: SAI MAI
Percent: MAI, SAI

DATE: 03/03/94
TIME: 12:38:40

STAYS ▲

PLUGGED 188 X   MAI 0 ◆   SAI 22 ◆



CONAM NUCLEAR, INC. BW

FIGURE A-2

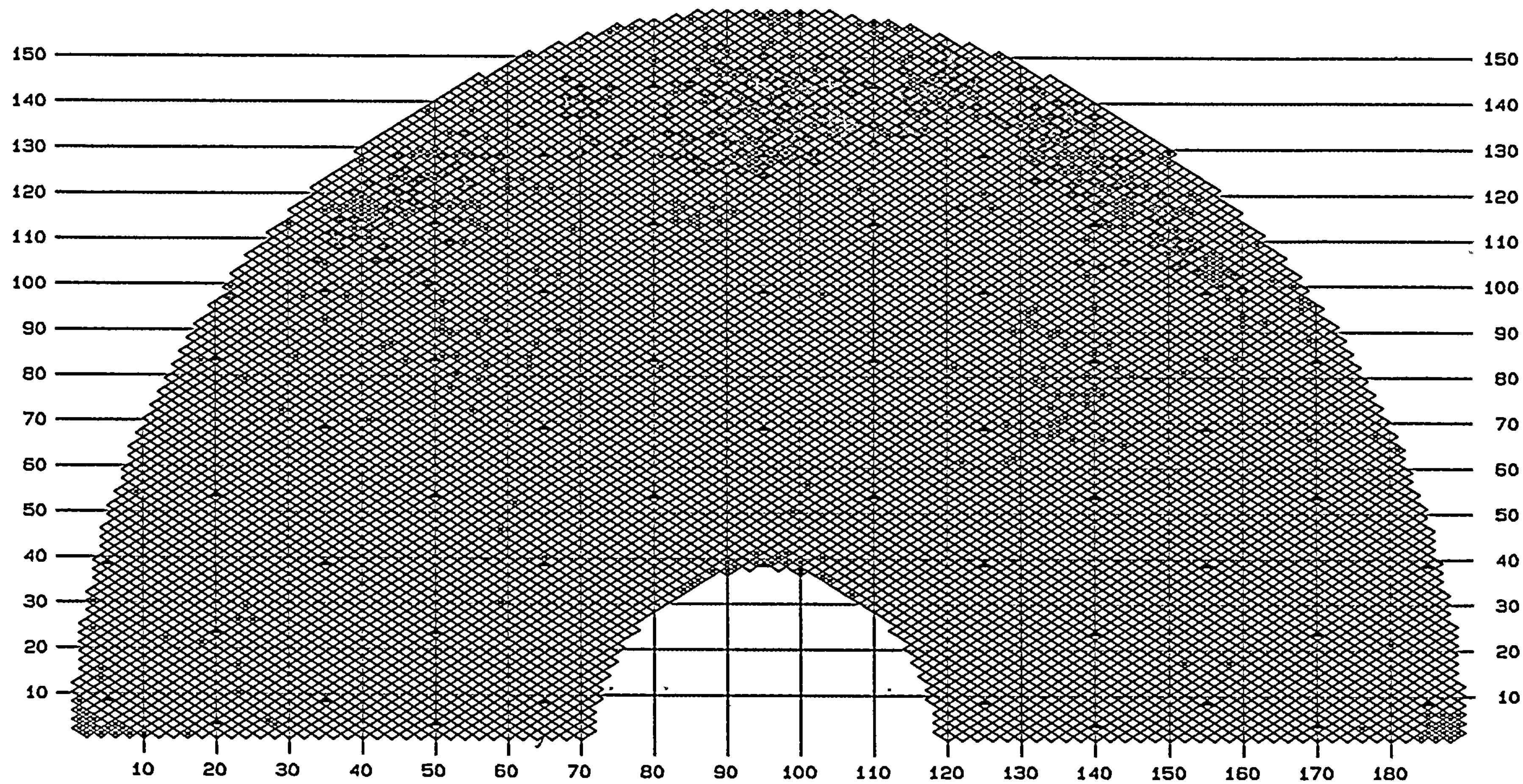
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR: 22
MAP: SAI MAI
Percent: MAI, SAI

DATE: 03/03/94
TIME: 10: 51: 19

STAYS ▲

PLUGGED 368 X MAI 13 ◆ SAI 297 ◆



CONAM NUCLEAR, INC. BW

FIGURE A-3

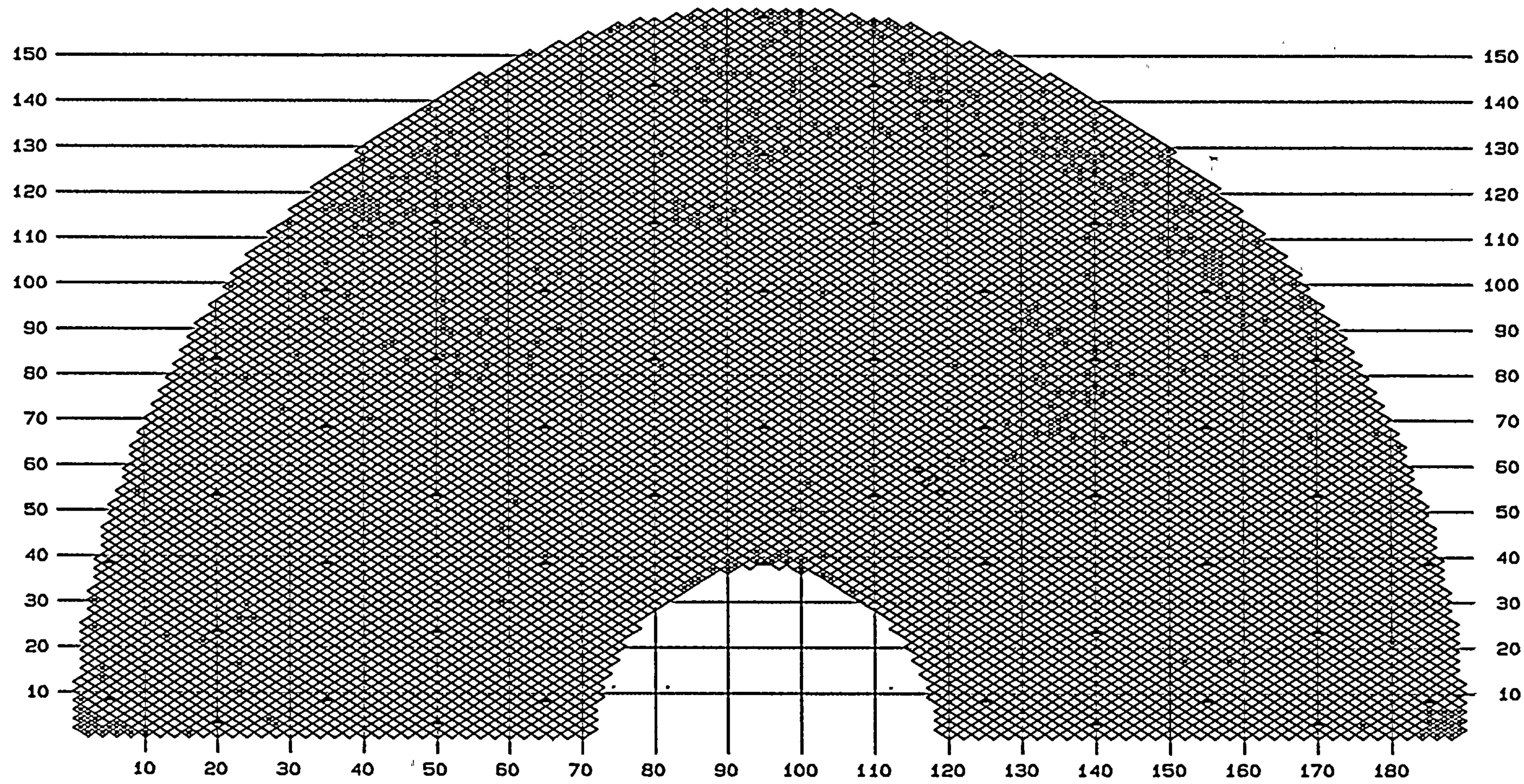
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR: 22
MAP: SCI MCI
Percent: MCI, SCI

DATE: 03/03/94
TIME: 12:25:03

· STAYS ▲

PLUGGED 368 X MCI 0 ◆ SCI 4 ◆



CONAM NUCLEAR, INC. BW

TABLE A-1

CUMULATIVE REPORT

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 21
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:49:34

				EXAM EXTENT						CURRENT				
ROW	LIN	HEAT#	LEG	PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	VOLTS	MIL	DEG	%	CH
113	38		H	08H-VS2	08H-VS2		00303	580BC	BW1+ 14.15	0.22		0	SAI	P 2
116	39		H	08H-VS2	08H-VS2		00306	580BC	BW1+ 15.04	0.35		0	SAI	P 2
			H	08H-VS2	08H-VS2		00306	580BC	BW1+ 19.00	1.10		0	SAI	P 2
118	39		H	08H-VS2	08H-VS2		00307	580BC	BW1+ 16.20	2.55		0	SAI	P 2
107	42		H	08H-VS2	08H-VS2		00366	580BC	08H+ 34.84	0.55		0	SAI	P 2
			H	08H-VS2	08H-VS2		00366	580BC	08H+ 35.96	0.60		0	SAI	P 2
			H	08H-VS2	08H-VS2		00366	580BC	08H+ 37.17	0.46		0	SAI	P 2
			H	08H-VS2	08H-VS2		00366	580BC	08H+ 38.56	0.48		0	SAI	P 2
			H	08H-VS2	08H-VS2		00366	580BC	08H+ 40.05	0.49		0	SAI	P 2
			H	08H-VS2	08H-VS2		00366	580BC	BW1- 1.55	0.26		0	SAI	P 2
118	43		H	08H-VS2	08H-VS2		00366	580BC	08H+ 0.29	0.24		0	SAI	P 2
107	46		H	08H-VS2	08H-VS2		00332	580BC	BW1+ 0.71	1.26		0	SAI	P 2
111	46		H	08H-VS2	08H-VS2		00366	580BC	BW1+ 3.55	1.06		0	SAI	P 2
132	47		H	08H-VS1	08H-VS1		00341	580BC	BW1+ 17.93	0.18		0	SAI	P 2
132	51		H	08H-VS1	08H-VS1		00377	580BC	BW1+ 3.63	1.39		0	SAI	P 2
			H	08H-VS1	08H-VS1		00377	580BC	BW1+ 18.03	0.33		0	SAI	P 2
145	74		H	08H-VS1	08H-VS1		00244	580BC	BW1+ 4.12	0.39		0	SAI	P 2
121	94		H	08H-VS2	08H-VS2		00150	580BC	BW1+ 3.55	0.63		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00226	580AC	BW1+ 3.78	0.66		0	SAI	P 2
118	95		H	08H-VS2	08H-VS2		00437	580AI	BW1+ 4.04	2.44		0	SAI	P 2
			H	BW1-VS2	BW1-VS2	1	00247	580BC	BW1+ 4.21	2.35		0	SAI	P 2
140	111		H	08H-VS1	08H-VS1		00168	580BC	09H+ 25.91	1.95		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00226	580AC	09H+ 25.91	1.90		0	SAI	P 2
147	116		H	08H-VS1	08H-VS1	4	00226	580AC	09H+ 0.42	0.40		0	SAI	P 2
			H	08H-VS1	08H-VS1		00153	580BC	09H+ 0.48	0.52		0	SAI	P 2
131	118		H	08H-VS1	08H-VS1		00147	580BC	BW1+ 3.00	1.12		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00226	580AC	BW1+ 3.18	0.78		0	SAI	P 2
133	120		H	08H-VS1	08H-VS1	4	00226	580AC	BW1+ 6.40	0.99		0	SAI	P 2
			H	08H-VS1	08H-VS1		00144	580BC	BW1+ 6.48	0.96		0	SAI	P 2
131	122		H	08H-VS1	08H-VS1		00139	580BC	BW1+ 3.01	0.40		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00226	580AC	BW1+ 3.25	0.38		0	SAI	P 2
133	122		H	08H-VS1	08H-VS1	4	00226	580AC	BW1+ 0.29	0.35		0	SAI	P 2
			H	08H-VS1	08H-VS1		00137	580BC	BW1+ 0.43	0.48		0	SAI	P 2
126	127		H	08H-VS1	08H-VS1		00196	580BC	BW1+ 3.86	0.78		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00226	580AC	BW1+ 4.08	0.79		0	SAI	P 2
129	134		H	08H-VS1	08H-VS1	4	00226	580AC	08H+ 0.56	0.24		0	SAI	P 2
			H	08H-VS1	08H-VS1		00107	580BC	08H+ 0.57	0.26		0	SAI	P 2
118	141		H	08H-VS2	08H-VS2	4	00226	580AC	BW1+ 0.17	2.57		0	SAI	P 2
			H	08H-VS2	08H-VS2		00082	580BC	BW1+ 0.28	2.23		0	SAI	P 2
126	143		H	08H-VS1	08H-VS1		00232	580AC	BW1+ 19.22	1.02		0	SAI	P 2
			H	08H-VS1	08H-VS1		00080	580BC	BW1+ 19.68	1.07		0	SAI	P 2

TABLE A-1
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 21
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:49:34

NUMBER OF TUBES SELECTED FROM CURRENT OUTAGE: 22
NUMBER OF DATA RECORDS SELECTED FROM CURRENT OUTAGE: 41

NO TREND ANALYSIS REQUESTED

DATA SELECTION CRITERIA:
Percent: MAI,SAI

REPORT OPTIONS:
Only examination results matching criteria are included

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

PAGE: 1 OF 14
DATE: 03/03/94
TIME: 12:14:35

ROW	COL	DATE	LEG	EXAM EXTENT PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	CURRENT VOLTS	MIL	DEG	%	CH
97	22		H	01H-01H	01H-01H	1	00485	600AC	01H- 0.14	0.22		0	SAI	P 2
105	34		H	08H-VS2	08H-VS2	8	00430	580AC	BW1+ 8.36	0.93		0	SAI	P 2
109	36		H	08H-VS2	08H-VS2	8	00430	580AC	08H+ 35.58	0.76		0	SAI	P 2
111	36		H	08H-VS2	08H-VS2	4	00322	580AC	08H+ 32.07	7.65		0	MAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	08H+ 32.09	8.03		0	MAI	P 2
			H	08H-VS2	08H-VS2		00029	580BC	08H+ 32.21	7.50		0	MAI	1
			H	08H-VS2	08H-VS2		00029	580BC	08H+ 32.21	7.00		0	MAI	1
108	37		H	08H-VS2	08H-VS2	8	00422	580AC	08H+ 30.21	1.19		0	SAI	P 2
110	37		H	08H-VS2	08H-VS2	8	00429	580AC	08H+ 33.01	0.67		0	SAI	1
			H	08H-VS2	08H-VS2	8	00429	580AC	08H+ 35.85	2.21		0	SAI	1
114	37		H	08H-VS2	08H-VS2	8	00425	580AC	08H+ 19.16	0.29		0	SAI	1
			H	08H-VS2	08H-VS2	8	00425	580AC	08H+ 20.56	1.22		0	SAI	1
110	39		H	08H-VS2	08H-VS2	4	00322	580AC	BW1+ 8.47	1.23		0	SAI	P 2
			H	08H-VS2	08H-VS2		00023	580BC	BW1+ 8.63	0.68		0	SAI	P 2
114	39		H	08H-VS2	08H-VS2		00037	580BC	08H+ 30.91	0.20		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	08H+ 31.95	0.50		0	SAI	P 2
			H	08H-VS2	08H-VS2		00037	580BC	BW1+ 8.02	0.29		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	BW1+ 8.62	0.73		0	SAI	P 2
120	39		H	08H-VS2	08H-BW1	6	00640	580AC	08H+ 33.85	0.77		0	SAI	P 2
112	41		H	08H-VS2	08H-VS2	8	00444	580AC	BW1+ 9.64	1.41		0	SAI	P 2
			H	08H-VS2	08H-VS2	8	00444	580AC	BW1+ 12.78	0.58		0	SAI	P 2
122	41		H	08H-VS1	08H-VS1	8	00447	580AC	08H+ 25.64	0.40		0	SAI	1
105	42		H	08H-VS2	08H-VS2	8	00447	580AC	BW1+ 8.64	0.44		0	SAI	P 2
113	42		H	08H-VS2	08H-VS2	8	00581	580AC	BW1+ 7.51	0.99		0	SAI	P 2
108	43		H	08H-VS2	08H-VS2	8	00452	580AC	BW1+ 8.24	0.59		0	SAI	P 2
114	43		H	08H-VS2	08H-VS2	8	00455	580AC	BW1+ 7.75	0.49		0	SAI	P 2
116	43		H	08H-VS2	08H-VS2	8	00452	580AC	BW1+ 7.43	1.41		0	SAI	P 2
105	44		H	08H-VS2	08H-VS2	8	00458	580AC	BW1+ 9.31	0.90		0	SAI	P 2
117	44		H	08H-VS2	08H-VS2	4	00322	580AC	09H- 1.29	0.21		0	SAI	P 2
			H	08H-VS2	08H-VS2		00048	580BC	09H- 1.25	0.25		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	09H- 0.00	0.28		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	BW1+ 7.35	0.43		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	BW1+ 8.71	0.46		0	SAI	P 2
121	44		H	08H-VS2	08H-VS2	8	00458	580AC	BW1+ 8.81	0.20		0	SAI	P 2
116	45		H	08H-VS2	08H-VS2	8	00462	580AC	BW1+ 8.26	0.60		0	SAI	P 2
120	45		H	01H-01H	01H-01H	1	00485	600AC	01H+ 0.20	0.17		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	09H- 0.61	0.58		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	09H+ 0.55	0.58		0	SAI	P 2
			H	08H-VS2	08H-VS2		00054	580BC	BW1+ 1.13	0.85		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00322	580AC	BW1+ 1.29	1.07		0	SAI	P 2
124	45		H	08H-VS1	08H-VS1	8	00457	580AC	BW1+ 12.28	0.68		0	SAI	P 2
128	45		H	08H-VS1	08H-VS1	8	00457	580AC	BW1+ 17.52	1.29		0	SAI	P 2
125	46		H	08H-VS1	08H-VS1	8	00461	580AC	BW1+ 12.12	0.72		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00461	580AC	BW1+ 13.47	0.73		0	SAI	P 2
102	47		H	08H-VS2	08H-VS2	6	00668	580AC	BW1+ 7.95	0.50		0	SAI	P 2
118	47		H	08H-VS2	08H-VS2	8	00467	580AC	BW1+ 8.15	0.18		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

ROW	COL	DATE	LEG	EXAM EXTENT PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	CURRENT VOLTS	MIL	DEG	%	CH
120	47		H	08H-VS2	08H-VS2	8	00466	580AC	09H+ 0.01	0.74		0	SAI	P 2
122	47		H	08H-VS1	08H-VS1	8	00462	580AC	BW1+ 10.93	0.54		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00462	580AC	BW1+ 12.06	0.81		0	SAI	P 2
103	48		H	08H-VS2	08H-VS2	6	00669	580AC	BW1+ 2.03	0.97		0	SAI	P 2
117	48		H	08H-VS2	08H-VS2	8	00466	580AC	BW1+ 9.59	0.77		0	SAI	P 2
123	48		H	08H-VS1	08H-VS1	8	00467	580AC	BW1+ 9.25	0.56		0	SAI	P 2
100	49		H	08H-VS2	08H-VS2	6	00489	580AC	BW1+ 2.40	0.30		0	SAI	P 2
			H	08H-VS2	08H-VS2	6	00489	580AC	BW1+ 9.06	0.43		0	SAI	P 2
			H	08H-VS2	08H-VS2	6	00489	580AC	BW1+ 9.49	0.31		0	SAI	P 2
118	51		H	08H-VS2	08H-VS1	8	00478	580AC	BW1+ 9.01	1.33		0	SAI	P 2
124	51		H	08H-VS1	08H-VS1	8	00478	580AC	BW1+ 8.81	0.26		0	SAI	P 2
128	51		H	08H-VS1	08H-VS1	8	00478	580AC	09H- 0.54	0.55		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00478	580AC	09H+ 0.68	0.43		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00478	580AC	BW1- 1.35	1.63		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00478	580AC	BW1+ 7.08	1.41		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00478	580AC	BW1+ 12.81	1.26		0	SAI	P 2
109	52		H	08H-VS2	08H-VS2	6	00666	580AC	BW1+ 4.30	0.77		0	SAI	P 2
119	52		H	08H-VS2	08H-VS2	8	00478	580AC	BW1+ 8.83	0.45		0	SAI	P 2
125	52		H	08H-VS1	08H-VS1	8	00484	580AC	09H+ 9.09	0.29		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00484	580AC	BW1+ 8.39	1.06		0	SAI	P 2
114	53		H	08H-VS2	08H-VS2	8	00497	580AC	08H+ 46.11	1.26		0	SAI	P 2
118	53		H	08H-VS2	08H-VS2	8	00497	580AC	BW1+ 7.73	0.70		0	SAI	P 2
126	53		H	08H-VS1	08H-VS1	8	00497	580AC	BW1+ 0.74	0.58		0	SAI	P 2
121	54		H	08H-VS2	08H-VS2	8	00497	580AC	BW1+ 7.60	1.17		0	SAI	P 2
123	54		H	08H-VS1	08H-VS1		00075	580BC	BW1+ 7.29	0.28		0	SAI	P 2
			H	08H-VS1	08H-VS2	4	00322	580AC	BW1+ 7.98	0.92		0	SAI	P 2
129	54		H	08H-VS1	08H-VS1	8	00498	580AC	BW1- 0.50	1.36		0	SAI	P 2
133	54		H	08H-VS1	08H-VS1	8	00498	580AC	09H- 0.72	0.26		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00498	580AC	09H+ 0.04	0.35		0	SAI	P 2
122	55		H	08H-VS1	08H-VS1	8	00502	580AC	08H+ 39.81	1.08		0	SAI	P 2
128	55		H	08H-VS1	08H-VS1	8	00501	580AC	BW1+ 8.47	1.37		0	SAI	P 2
128	57		H	08H-VS1	08H-VS1	8	00506	580AC	09H+ 0.31	1.25		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00506	580AC	BW1+ 6.94	1.38		0	SAI	P 2
128	59		H	08H-VS1	08H-VS1	8	00514	580AC	BW1+ 8.02	0.47		0	SAI	P 2
135	62		H	08H-VS1	08H-VS1	4	00322	580AC	BW1+ 1.00	0.33		0	SAI	P 2
			H	08H-VS1	08H-VS1		00208	580BC	BW1+ 1.03	0.32		0	SAI	P 2
137	68		H	08H-VS1	08H-VS1	4	00322	580AC	09H+ 0.00	1.03		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00322	580AC	BW1+ 9.10	0.58		0	SAI	P 2
			H	08H-VS1	08H-VS1		00111	580BC	BW1+ 9.18	0.58		0	SAI	P 2
139	68		H	08H-VS1	08H-VS1	4	00322	580AC	09H+ 23.18	2.75		0	SAI	P 2
			H	08H-VS1	08H-VS1		00111	580BC	09H+ 23.31	3.01		0	SAI	P 2
141	68		H	08H-VS1	08H-VS1	8	00541	580AC	09H+ 22.46	0.89		0	SAI	P 2
145	68		H	08H-VS1	08H-VS1	4	00322	580AC	09H+ 19.96	0.37		0	SAI	P 2
			H	08H-VS1	08H-VS1		00113	580BC	09H+ 20.16	0.40		0	SAI	P 2
128	69		H	08H-VS1	08H-VS1		00121	580BC	BW1+ 5.44	0.25		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00322	580AC	BW1+ 6.44	0.16		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

ROW	COL	DATE	LEG	EXAM EXTENT PROGRAM	EXAM EXTENT ACTUAL	EXP	CAL	PROBE	LOCATION	CURRENT VOLTS	MIL	DEG	%	CH
140	69		H	08H-VS1	08H-VS1		00116	580BC	BW1- 1.46	0.67		0	SAI	P 2
			H	09H-VS1	09H-VS1	4	00322	580AC	BW1- 1.34	0.34		0	SAI	P 2
			H	09H-VS1	09H-VS1	4	00322	580AC	BW1+ 6.98	0.21		0	SAI	P 2
			H	09H-VS1	09H-VS1	4	00322	580AC	BW1+ 8.83	0.33		0	SAI	P 2
129	70		H	08H-VS1	08H-VS1	8	00544	580AC	BW1+ 8.60	0.51		0	SAI	P 2
137	70		H	08H-VS1	08H-VS1		00121	580BC	BW1+ 2.03	0.29		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00544	580AC	BW1+ 2.08	0.37		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00544	580AC	BW1+ 8.43	0.42		0	SAI	P 2
141	70		H	08H-VS1	08H-VS1	8	00544	580AC	09H+ 25.01	1.63		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00544	580AC	BW1+ 0.27	1.03		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00544	580AC	BW1+ 0.29	2.50		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00544	580AC	BW1+ 0.30	0.67		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00544	580AC	BW1+ 6.91	1.24		0	SAI	P 2
143	70		H	08H-VS1	08H-VS1		00121	580BC	BW1+ 4.02	0.41		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 4.14	0.58		0	SAI	P 2
132	71		H	08H-VS1	08H-VS1		00121	580BC	BW1+ 4.11	0.41		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 4.45	0.22		0	SAI	P 2
138	71		H	08H-VS1	08H-VS1	8	00545	580AC	BW1+ 8.05	0.40		0	SAI	P 2
140	71		H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 1.24	1.00		0	SAI	P 2
			H	08H-VS1	08H-VS1		00121	580BC	BW1+ 7.68	0.69		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 7.96	1.00		0	SAI	P 2
131	72		H	08H-VS1	08H-VS1	8	00551	580AC	BW1+ 9.88	1.12		0	SAI	P 2
137	72		H	08H-VS1	08H-VS1	8	00550	580AC	BW1+ 8.35	0.65		0	SAI	P 2
140	73		H	08H-VS1	08H-VS1	8	00553	580AC	BW1+ 8.96	1.24		0	SAI	P 2
143	74		H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 5.78	1.00		0	SAI	P 2
			H	08H-VS1	09H-VS1		00131	580BC	BW1+ 5.86	0.27		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 15.97	0.80		0	SAI	P 2
128	75		H	08H-VS1	08H-VS1	8	00561	580AC	BW1+ 8.00	0.78		0	SAI	P 2
131	76		H	08H-VS1	08H-VS1	8	00558	580AC	BW1+ 7.87	0.55		0	SAI	P 2
132	77		H	08H-VS1	08H-VS1	8	00562	580AC	BW1+ 8.21	0.97		0	SAI	P 2
133	82		H	08H-VS1	08H-VS1	8	00597	580AC	BW1+ 18.61	0.70		0	SAI	P 2
137	82		H	08H-VS1	08H-VS1	8	00597	580AC	BW1+ 7.99	0.65		0	SAI	P 2
139	82		H	08H-VS1	08H-VS1	8	00598	580AC	BW1+ 20.10	1.26		0	SAI	P 2
128	83		H	08H-VS1	08H-VS1	8	00602	580AC	BW1+ 4.86	0.89		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00602	580AC	BW1+ 6.45	1.13		0	SAI	P 2
144	83		H	08H-VS1	08H-VS1	8	00602	580AC	BW1+ 1.53	0.27		0	SAI	P 2
129	84		H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 4.21	4.10		0	SAI	P 2
			H	08H-VS1	08H-VS1		00157	580BC	BW1+ 4.41	0.39		0	SAI	P 2
131	84		H	08H-VS1	08H-VS1	8	00605	580AC	BW1+ 6.24	1.41		0	SAI	P 2
133	84		H	08H-VS1	08H-VS1		00157	580BC	BW1+ 4.93	0.93		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 5.15	1.26		0	SAI	P 2
143	84		H	08H-VS1	08H-VS1	8	00605	580AC	BW1+ 7.22	0.42		0	SAI	P 2
128	85		H	08H-VS1	08H-VS1	8	00612	580AC	BW1+ 7.83	1.81		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00612	580AC	BW1+ 8.58	1.75		0	SAI	P 2
132	85		H	08H-VS1	BW1-VS1	8	00653	580AC	BW1+ 7.06	0.37		0	SAI	P 2
			H	08H-VS1	BW1-VS1	8	00653	580AC	BW1+ 7.70	0.37		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

				EXAM EXTENT						CURRENT				
ROW	COL	DATE	LEG	PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	VOLTS	MIL	DEG	%	CH
132	85		H	08H-VS1	BW1-VS1	8	00653	580AC	BW1+ 8.76	0.42		0	SAI	P 2
144	85		H	08H-VS1	08H-VS1	8	00612	580AC	BW1+ 8.28	0.91		0	SAI	P 2
125	86		H	08H-VS1	08H-VS1	8	00613	580AC	BW1+ 7.72	0.60		0	SAI	P 2
127	86		H	08H-VS1	BW1-VS1	8	00655	580AC	BW1+ 2.57	0.47		0	SAI	P 2
126	87		H	08H-VS1	08H-VS1	8	00617	580AC	BW1+ 3.58	0.71		0	SAI	P 2
142	87		H	08H-VS1	08H-VS1	8	00617	580AC	BW1+ 3.74	0.71		0	SAI	P 2
125	88		H	08H-VS1	08H-VS1	8	00621	580AC	BW1+ 7.66	1.01		0	SAI	P 2
133	88		H	08H-VS1	08H-VS1	8	00621	580AC	BW1+ 17.71	1.06		0	SAI	P 2
141	88		H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 4.81	0.54		0	SAI	P 2
			H	08H-VS1	08H-VS1		00172	580BC	BW1+ 5.07	0.56		0	SAI	P 2
126	89		H	08H-VS1	08H-VS1	8	00624	580AC	BW1+ 2.79	0.26		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00624	580AC	BW1+ 7.48	0.97		0	SAI	P 2
138	89		H	08H-VS1	08H-VS1		00172	580BC	BW1+ 7.13	0.77		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 7.88	1.11		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 20.31	0.71		0	SAI	P 2
144	89		H	08H-VS1	08H-VS1	8	00625	580AC	BW1+ 0.00	1.72		0	SAI	P 2
148	89		H	08H-VS1	08H-VS1	8	00621	580AC	BW1+ 1.43	0.17		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00621	580AC	BW1+ 1.69	0.17		0	SAI	P 2
152	89		H	08H-VS1	08H-VS1	6	00688	580AC	BW1+ 24.74	1.50		0	MAI	P 2
			H	08H-VS1	08H-VS1	6	00688	580AC	BW1+ 24.90	3.80		0	MAI	P 2
125	90		H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 2.62	0.55		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 7.33	0.63		0	SAI	P 2
			H	08H-VS1	08H-VS1		00172	580BC	BW1+ 7.37	0.54		0	SAI	P 2
127	90		H	08H-VS1	08H-VS1	8	00624	580AC	BW1+ 7.25	1.42		0	SAI	P 2
131	90		H	08H-VS1	08H-VS1		00172	580BC	BW1+ 7.39	0.59		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00325	580AC	BW1+ 7.73	0.71		0	SAI	P 2
133	90		H	08H-VS1	08H-VS1	8	00628	580AC	BW1+ 1.10	0.19		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00628	580AC	BW1+ 7.47	0.58		0	SAI	P 2
137	90		H	08H-VS1	08H-VS1	8	00628	580AC	BW1+ 19.24	1.49		0	SAI	P 2
139	90		H	08H-VS1	08H-VS1	8	00629	580AC	BW1+ 7.10	1.53		0	SAI	P 2
147	90		H	08H-VS1	08H-VS1	8	00629	580AC	BW1+ 1.44	0.64		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00629	580AC	BW1+ 1.46	0.83		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00629	580AC	BW1+ 6.95	0.43		0	SAI	P 2
126	91		H	08H-VS1	08H-VS1	8	00632	580AC	BW1+ 7.44	1.29		0	SAI	P 2
132	91		H	08H-VS1	08H-VS1	8	00632	580AC	BW1+ 7.60	0.64		0	SAI	P 2
134	91		H	08H-VS1	08H-VS1	8	00628	580AC	BW1+ 7.57	1.12		0	SAI	P 2
138	91		H	08H-VS1	08H-VS1	8	00628	580AC	BW1+ 5.07	0.70		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00628	580AC	BW1+ 19.60	1.38		0	SAI	P 2
142	91		H	08H-VS1	08H-VS1	8	00628	580AC	BW1+ 7.46	0.99		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00628	580AC	BW1+ 8.84	0.68		0	SAI	P 2
125	92		H	08H-VS1	08H-VS1	8	00632	580AC	BW1+ 8.92	1.49		0	SAI	P 2
129	92		H	08H-VS1	08H-VS1	8	00632	580AC	BW1+ 8.17	0.40		63	SAI	P 2
133	92		H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 5.25	0.76		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 6.89	1.22		0	SAI	P 2
			H	08H-VS1	08H-VS1		00179	580BC	BW1+ 7.05	1.38		0	SAI	P 2
139	92		H	08H-VS1	08H-VS1	8	00635	580AC	BW1+ 8.04	0.49		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

ROW	COL	DATE	LEG	EXAM EXTENT PROGRAM	EXAM EXTENT ACTUAL	EXP	CAL	PROBE	LOCATION	CURRENT VOLTS	MIL	DEG	%	CH
141	92		H	08H-VS1	08H-VS1	8	00632	580AC	BW1+ 8.21	0.31		0	SAI	P 2
147	92		H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 18.83	1.59		0	SAI	P 2
			H	08H-VS1	08H-VS1		00181	580BC	BW1+ 19.83	0.71		0	SAI	P 2
140	93		H	08H-VS1	08H-VS1	8	00635	580AC	BW1+ 9.65	0.96		0	SAI	P 2
144	93		H	08H-VS1	08H-VS1	8	00636	580AC	BW1+ 8.68	0.29		0	SAI	P 2
139	94		H	08H-VS1	08H-VS1	8	00637	580AC	BW1+ 5.19	1.26		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00637	580AC	BW1+ 7.11	0.96		0	SAI	P 2
143	94		H	08H-VS1	BW1-VS1	8	00654	580AC	BW1+ 2.48	0.85		0	SAI	P 2
145	94		H	08H-VS1	BW1-VS1	8	00654	580AC	BW1+ 1.12	0.54		0	SAI	P 2
			H	08H-VS1	BW1-VS1	8	00654	580AC	BW1+ 6.31	0.36		0	SAI	P 2
124	95		H	08H-VS1	08H-VS1	8	00460	580AC	BW1+ 2.83	0.95		0	SAI	P 2
126	95		H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 7.26	0.70		0	SAI	P 2
130	95		H	08H-VS1	08H-VS1	8	00460	580AC	08H+ 35.30	0.18		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00460	580AC	BW1+ 2.00	0.86		0	SAI	P 2
			H	08H-VS1	08H-VS1		00198	580BC	BW1+ 6.54	2.09		0	SAI	P 2
132	95		H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 1.89	0.31		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 2.29	0.89		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 6.58	0.99		0	SAI	P 2
134	95		H	08H-VS1	08H-VS1	8	00460	580AC	BW1- 1.20	2.23		0	SAI	P 2
138	95		H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 4.53	1.33		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 6.19	0.45		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 17.84	0.67		0	SAI	P 2
142	95		H	08H-VS1	08H-VS1		00201	580BC	BW1+ 4.17	0.71		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 4.41	1.54		0	SAI	P 2
			H	08H-VS1	08H-VS1		00201	580BC	BW1+ 7.20	0.50		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 7.83	1.15		0	SAI	P 2
144	95		H	08H-VS1	08H-VS1	8	00460	580AC	BW1+ 6.23	0.85		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00460	580AC	BW1+ 8.64	0.40		0	SAI	P 2
150	95		H	08H-VS1	08H-VS1	8	00463	580AC	BW1+ 18.15	1.23		0	SAI	P 2
133	96		H	08H-VS1	08H-VS1	4	00326	580AC	BW1- 0.75	0.75		0	SAI	P 2
			H	08H-VS1	08H-VS1		00260	580BC	BW1+ 4.25	0.51		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 5.07	0.59		0	SAI	P 2
139	96		H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 5.76	0.91		0	SAI	P 2
			H	08H-VS1	08H-VS1		00200	580BC	BW1+ 6.11	0.80		0	SAI	P 2
141	96		H	08H-VS1	08H-VS1		00260	580BC	BW1+ 3.56	1.31		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 3.81	0.67		0	SAI	P 2
143	96		H	08H-VS1	08H-VS1	8	00464	580AC	09H+ 27.87	0.36		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00464	580AC	09H+ 28.68	0.42		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00464	580AC	BW1+ 3.66	1.25		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00464	580AC	BW1+ 5.33	0.63		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00464	580AC	BW1+ 7.17	0.87		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00464	580AC	BW1+ 17.74	1.47		0	SAI	P 2
145	96		H	08H-VS1	08H-VS1	4	00326	580AC	09H+ 26.42	3.57		0	SAI	P 2
			H	08H-VS1	08H-VS1		00260	580BC	BW1+ 6.48	0.90		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 6.50	0.90		0	SAI	P 2
147	96		H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 3.85	0.26		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

				EXAM EXTENT						CURRENT				
ROW	COL	DATE	LEG	PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	VOLTS	MIL	DEG	%	CH
147	96		H	08H-VS1	09H-VS1		00201	580BC	BW1+ 3.90	1.19		0	SAI	P 2
128	97		H	08H-VS1	08H-VS1	4	00326	580AC	08H+ 41.47	0.61		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	09H+ 14.54	0.79		0	SAI	P 2
			H	08H-VS1	08H-VS1		00199	580BC	BW1+ 6.16	1.15		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 6.81	1.13		0	SAI	P 2
130	97		H	08H-VS1	08H-VS1	4	00326	580AC	08H+ 34.25	0.50		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 0.72	0.79		0	SAI	P 2
			H	08H-VS1	08H-VS1		00199	580BC	BW1+ 1.12	0.60		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 3.27	0.55		0	SAI	P 2
136	97		H	08H-VS1	08H-VS1	4	00326	580AC	09H+ 22.60	1.02		0	SAI	1
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1- 1.83	0.37		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 1.24	0.33		0	SAI	P 2
			H	08H-VS1	07H-VS1		00199	580BC	BW1+ 1.60	0.18		0	SAI	P 2
138	97		H	08H-VS1	08H-VS1	8	00463	580AC	BW1+ 3.34	0.49		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00463	580AC	BW1+ 18.68	1.53		0	SAI	P 2
142	97		H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 11.62	1.82		0	SAI	P 2
			H	08H-VS1	08H-VS1		00196	580BC	BW1+ 11.68	0.83		0	SAI	P 2
			H	08H-VS1	08H-VS1		00196	580BC	BW1+ 12.44	0.63		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 12.79	1.71		0	SAI	P 2
146	97		H	08H-VS1	08H-VS1		00197	580BC	BW1+ 3.39	0.56		0	SAI	P 2
			H	08H-VS1	08H-VS2	4	00326	580AC	BW1+ 3.61	0.26		0	SAI	P 2
127	98		H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 6.78	0.95		0	SAI	P 2
			H	08H-VS1	08H-VS1		00197	580BC	BW1+ 7.35	0.56		0	SAI	P 2
131	98		H	08H-VS1	08H-VS1	8	00464	580AC	BW1+ 7.61	0.50		0	SAI	P 2
135	98		H	08H-VS1	08H-VS1	8	00464	580AC	BW1+ 2.01	0.55		0	SAI	P 2
139	98		H	08H-VS1	08H-VS1	8	00468	580AC	BW1+ 4.89	1.98		0	SAI	1
143	98		H	08H-VS1	08H-VS1		00196	580BC	BW1+ 18.59	1.33		0	SAI	1
			H	08H-VS1	08H-VS1	4	00326	580AC	BW1+ 18.64	1.32		0	SAI	P 2
145	98		H	08H-VS1	08H-VS1	4	00324	580AC	BW1- 1.74	0.38		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1- 0.15	0.44		0	SAI	P 2
			H	08H-VS1	08H-VS1		00197	580BC	BW1+ 12.89	2.39		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 13.93	1.09		0	SAI	P 2
			H	08H-VS1	08H-VS1		00197	580BC	BW1+ 17.92	1.87		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 18.94	1.87		0	SAI	P 2
128	99		H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 10.84	0.84		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 13.91	0.73		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 0.56	2.31		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 2.72	1.17		0	SAI	P 2
			H	08H-VS1	08H-VS1		00197	580BC	BW1+ 4.44	0.33		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 4.76	0.45		0	SAI	P 2
130	99		H	08H-VS1	08H-VS1	8	00469	580AC	BW1+ 2.39	0.58		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00469	580AC	BW1+ 5.37	0.78		0	SAI	P 2
132	99		H	08H-VS1	08H-VS1	8	00468	580AC	08H+ 41.07	0.37		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00468	580AC	08H+ 43.49	0.45		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00468	580AC	BW1+ 2.23	0.61		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00468	580AC	BW1+ 5.75	0.55		0	SAI	P 2

TABLE A-2

CUMULATIVE REPORT

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

ROW	COL	DATE	LEG	EXAM EXTENT PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	CURRENT VOLTS	MIL	DEG	%	CH
132	99		H	08H-VS1	08H-VS1	8	00468	580AC	BW1+ 8.10	0.71		0	SAI	P 2
134	99		H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 15.80	0.39		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 19.57	1.63		0	SAI	P 2
			H	08H-VS1	08H-VS1		00194	580BC	09H+ 19.60	0.50		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 2.71	0.88		0	SAI	P 2
136	99		H	08H-VS1	08H-VS1	8	00469	580AC	09H+ 22.40	0.55		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00469	580AC	BW1+ 1.41	0.32		0	SAI	P 2
138	99		H	08H-VS1	08H-VS1	8	00468	580AC	BW1+ 18.98	2.22		0	SAI	P 2
146	99		H	08H-VS1	08H-VS1	8	00463	580AC	BW1+ 6.23	1.43		0	SAI	P 2
129	100		H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 6.58	1.45		0	SAI	P 2
133	100		H	08H-VS1	08H-VS1	8	00472	580AC	09H+ 17.71	2.20		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 1.09	0.79		0	SAI	P 2
137	100		H	08H-VS1	08H-VS1	8	00468	580AC	BW1+ 8.58	0.80		0	SAI	P 2
139	100		H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 8.20	0.57		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 19.59	0.49		0	SAI	P 2
143	100		H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 1.25	0.28		0	SAI	P 2
145	100		H	08H-VS1	08H-VS1		00334	580BC	BW1+ 0.38	0.45		0	SAI	P 2
			H	08H-VS1	08H-VS1		00334	580BC	BW1+ 1.14	0.30		0	SAI	P 2
			H	08H-VS1	08H-VS1		00334	580BC	BW1+ 6.88	10.23		0	SAI	P 2
128	101		H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 1.16	0.32		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 6.27	0.85		0	SAI	P 2
132	101		H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 5.56	0.37		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00472	580AC	BW1+ 6.99	0.42		0	SAI	P 2
138	101		H	08H-VS1	08H-VS1		00191	580BC	BW1+ 4.52	0.91		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 4.99	0.97		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 18.33	1.91		0	SAI	P 2
142	101		H	08H-VS1	08H-VS1		00191	580BC	BW1+ 4.61	1.67		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 5.29	1.05		0	SAI	P 2
144	101		H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 28.55	1.06		0	SAI	P 2
			H	08H-VS1	08H-VS1		00191	580BC	BW1+ 1.24	0.45		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 1.45	0.58		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 12.14	1.05		0	SAI	P 2
127	102		H	08H-VS1	08H-VS1	8	00477	580AC	BW1+ 2.86	1.12		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00477	580AC	BW1+ 3.72	0.25		0	SAI	1
129	102		H	08H-VS1	08H-VS1	8	00474	580AC	BW1+ 4.12	0.34		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00474	580AC	BW1+ 6.57	0.67		0	SAI	P 2
137	102		H	08H-VS1	08H-VS1	8	00477	580AC	BW1+ 4.32	0.66		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00477	580AC	BW1+ 6.01	0.94		0	SAI	P 2
139	102		H	08H-VS1	08H-VS1	8	00474	580AC	BW1+ 4.52	0.80		0	SAI	P 2
143	102		H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 3.34	0.44		0	SAI	P 2
			H	08H-VS1	08H-VS1		00188	580BC	BW1+ 3.39	0.34		0	SAI	P 2
136	103		H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 18.92	0.35		0	SAI	1
			H	08H-VS1	08H-VS1		00183	580BC	09H+ 19.68	0.57		0	SAI	1
			H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 20.17	0.59		0	SAI	P 2
			H	08H-VS1	08H-VS1		00183	580BC	09H+ 21.01	0.19		0	SAI	1
			H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 21.55	0.29		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

				EXAM EXTENT						CURRENT				
ROW	COL	DATE	LEG	PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	VOLTS	MIL	DEG	%	CH
144	103		H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 3.76	0.64		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 4.77	0.90		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 7.92	1.16		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 11.73	1.27		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 16.99	2.13		0	SAI	P 2
150	103		H	08H-VS1	08H-VS1		00184	580BC	BW1+ 18.84	0.50		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 19.02	0.70		0	SAI	P 2
135	104		H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 1.63	0.30		0	SAI	P 2
			H	08H-VS1	08H-VS1		00183	580BC	BW1+ 1.72	0.22		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 2.26	0.50		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 5.70	0.92		0	SAI	P 2
137	104		H	08H-VS1	08H-VS1	4	00324	580AC	BW1- 0.02	3.50		0	MAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 0.20	2.46		0	MAI	P 2
			H	BW1-BW1	BW1-BW1		00261	580BC	BW1+ 1.97	2.24		0	MAI	1
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 5.33	1.15		0	SAI	P 2
139	104		H	08H-VS1	08H-VS1		00183	580BC	BW1+ 3.52	0.67		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00331	580AC	BW1+ 3.66	0.35		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00331	580AC	BW1+ 7.50	0.88		0	SAI	P 2
			H	08H-VS1	08H-VS1		00183	580BC	BW1+ 7.72	0.75		0	SAI	P 2
143	104		H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 3.46	0.83		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 5.11	0.80		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00480	580AC	BW1+ 6.34	1.02		0	SAI	P 2
145	104		H	BW1-BW1	BW1-BW1		00334	580BC	BW1+ 0.73	0.25		0	SAI	P 2
132	105		H	08H-VS1	08H-VS1	8	00481	580AC	BW1+ 7.28	0.95		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00481	580AC	BW1+ 9.83	0.80		0	SAI	P 2
136	105		H	08H-VS1	08H-VS1	8	00481	580AC	BW1+ 1.79	0.20		0	SAI	P 2
138	105		H	08H-VS1	08H-VS1	8	00482	580AC	BW1+ 0.00	0.83		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00482	580AC	BW1+ 6.43	1.00		0	SAI	P 2
144	105		H	08H-VS1	08H-VS1	8	00481	580AC	BW1+ 6.93	5.30		0	SAI	P 2
131	106		H	08H-VS1	08H-VS1		00261	580BC	BW1+ 3.74	0.66		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 3.95	1.06		0	SAI	P 2
133	106		H	08H-VS1	08H-VS1	8	00482	580AC	BW1+ 6.15	0.29		0	SAI	P 2
135	106		H	08H-VS1	08H-VS1	4	00324	580AC	09H+ 20.96	4.50		0	SAI	P 2
			H	08H-VS1	08H-VS1		00178	580BC	09H+ 20.97	4.34		0	SAI	P 2
137	106		H	08H-VS1	08H-VS1	8	00483	580AC	BW1+ 5.95	0.98		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00483	580AC	BW1+ 7.24	0.32		0	SAI	P 2
143	106		H	08H-VS1	08H-VS1	8	00482	580AC	BW1+ 6.54	0.83		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00482	580AC	BW1+ 7.72	0.62		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00482	580AC	BW1+ 10.66	0.53		0	SAI	P 2
145	106		H	08H-VS1	08H-VS1	8	00482	580AC	BW1+ 9.92	1.38		0	SAI	P 2
147	106		H	08H-VS1	BW1-VS1	8	00535	580AC	BW1+ 8.28	0.97		0	SAI	P 2
134	107		H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 6.40	0.42		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 7.35	0.61		0	SAI	P 2
			H	BW1-VS1	BW1-VS1		00261	580BC	BW1+ 7.53	0.68		0	SAI	P 2
136	107		H	08H-VS1	08H-VS1	8	00483	580AC	BW1+ 1.52	0.42		0	SAI	P 2
142	107		H	08H-VS1	08H-VS1		00261	580BC	BW1+ 6.78	1.41		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

				EXAM EXTENT						CURRENT				
ROW	COL	DATE	LEG	PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	VOLTS	MIL	DEG	%	CH
142	107		H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 6.80	0.63		0	SAI	P 2
135	108		H	08H-VS1	08H-VS1	8	00490	580AC	BW1+ 6.90	0.51		0	SAI	P 2
144	109		H	08H-VS1	08H-VS1	8	00495	580AC	BW1+ 5.42	0.56		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00495	580AC	BW1+ 7.02	0.77		0	SAI	P 2
131	110		H	08H-VS1	08H-VS1	4	00324	580AC	BW1+ 3.46	1.22		0	SAI	P 2
			H	08H-VS1	08H-VS1		00170	580BC	BW1+ 3.48	1.51		0	SAI	P 2
135	110		H	08H-VS1	08H-VS1	8	00496	580AC	BW1+ 3.43	1.12		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00496	580AC	BW1+ 5.93	0.72		0	SAI	P 2
142	113		H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 2.62	0.53		0	SAI	P 2
			H	08H-VS1	08H-VS1		00158	580BC	BW1+ 2.69	0.92		0	SAI	P 2
133	114		H	08H-VS1	08H-VS1	8	00504	580AC	BW1+ 9.37	1.51		0	SAI	P 2
135	114		H	08H-VS1	08H-VS1	8	00503	580AC	BW1- 1.28	0.76		0	SAI	P 2
141	114		H	08H-VS1	08H-VS1	8	00504	580AC	BW1+ 0.68	0.30		0	SAI	P 2
143	114		H	08H-VS1	08H-VS1	8	00503	580AC	BW1+ 5.59	1.24		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00503	580AC	BW1+ 6.85	0.68		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00503	580AC	BW1+ 7.66	0.59		0	SAI	P 2
147	114		H	08H-VS1	08H-VS1	4	00323	580AC	09H+ 32.88	0.58		0	SAI	P 2
			H	08H-VS1	08H-VS1		00155	580BC	09H+ 33.18	0.51		0	SAI	P 2
134	115		H	BW1-VS1	BW1-VS1	8	00503	580AC	BW1+ 4.87	0.53		0	SAI	P 2
138	115		H	08H-VS1	08H-VS1	8	00504	580AC	BW1+ 5.75	0.79		0	SAI	P 2
140	115		H	08H-VS1	08H-VS1	8	00507	580AC	BW1+ 5.48	1.38		0	SAI	P 2
133	116		H	08H-VS1	08H-VS1	8	00507	580AC	BW1+ 6.08	1.04		0	SAI	P 2
141	116		H	08H-VS1	08H-VS1	8	00508	580AC	BW1+ 5.54	0.44		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00508	580AC	BW1+ 6.84	0.71		0	SAI	P 2
138	117		H	09H-VS1	09H-VS1	8	00510	580AC	BW1+ 5.99	1.24		0	SAI	P 2
142	117		H	08H-VS1	08H-VS1	8	00510	580AC	BW1+ 5.90	2.21		0	SAI	P 2
144	117		H	08H-VS1	08H-VS1	4	00323	580AC	BW1- 1.68	0.61		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 5.97	0.50		0	SAI	P 2
			H	08H-VS1	08H-VS1		00150	580BC	BW1+ 5.98	0.46		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 8.03	1.01		0	SAI	P 2
141	118		H	08H-VS1	08H-VS1	8	00516	580AC	BW1+ 7.14	1.81		0	SAI	P 2
143	118		H	08H-VS1	08H-VS1	8	00510	580AC	BW1+ 3.54	0.32		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00510	580AC	BW1+ 10.59	0.86		0	SAI	P 2
149	118		H	08H-VS1	08H-VS1	4	00331	580AC	09H+ 26.90	0.67		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00331	580AC	09H+ 29.65	0.67		0	SAI	P 2
144	119		H	08H-VS1	08H-VS1	4	00323	580AC	09H+ 0.73	0.24		0	SAI	P 2
			H	08H-VS1	08H-VS1		00147	580BC	09H+ 0.85	0.26		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 8.40	1.10		0	SAI	P 2
146	119		H	08H-VS1	08H-VS1	8	00517	580AC	09H+ 26.81	0.89		0	SAI	P 2
152	119		H	08H-VS1	08H-VS1	6	00642	580AC	BW1+ 17.34	0.61		0	SAI	P 2
139	120		H	08H-VS1	08H-VS1	8	00460	580AC	BW1+ 2.71	0.42		0	SAI	P 2
141	120		H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 6.62	1.57		0	SAI	P 2
143	120		H	08H-VS1	08H-VS1		00143	580BC	BW1+ 6.46	1.27		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 7.00	1.28		0	SAI	P 2
145	120		H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 6.85	0.49		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 7.59	0.49		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

ROW	COL	DATE	LEG	EXAM EXTENT PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	CURRENT VOLTS	MIL	DEG	%	CH
145	120		H	08H-VS1	08H-VS1		00145	580BC	BW1+ 8.77	0.60		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 10.02	1.33		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 14.98	0.87		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 18.14	1.21		0	SAI	P 2
147	120		H	08H-VS1	08H-VS1	8	00460	580AC	BW1+ 14.05	1.77		0	SAI	P 2
149	120		H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 17.44	2.70		0	SAI	P 2
151	120		H	08H-VS1	08H-VS1	6	00642	580AC	BW1+ 15.52	1.97		0	SAI	P 2
142	121		H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 0.47	0.51		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 5.41	0.73		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 6.65	1.02		0	SAI	P 2
146	121		H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 16.06	1.87		0	SAI	P 2
148	121		H	08H-VS1	08H-VS1	8	00460	580AC	BW1+ 17.17	1.70		0	SAI	P 2
150	121		H	08H-VS1	08H-VS1	8	00459	580AC	BW1+ 17.43	1.56		0	SAI	P 2
117	122		H	01H-01H	01H-01H	1	00487	600AC	01H- 0.18	0.45		0	SAI	P 2
143	122		H	08H-VS1	08H-VS1	8	00453	580AC	BW1+ 10.75	0.84		0	SAI	P 2
144	123		H	08H-VS1	07H-VS1	8	00450	580AC	BW1+ 17.28	1.57		0	SAI	1
139	124		H	08H-VS1	08H-VS1	8	00448	580AC	BW1+ 0.43	0.70		0	SAI	P 2
143	124		H	08H-VS1	08H-VS1	8	00448	580AC	BW1+ 10.56	0.74		0	SAI	P 2
145	124		H	08H-VS1	08H-VS1		00207	580BC	BW1+ 16.72	1.38		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00323	580AC	BW1+ 17.22	2.18		0	SAI	P 2
137	126		H	08H-VS1	08H-VS1	8	00446	580AC	BW1- 1.34	0.42		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00446	580AC	BW1+ 0.85	0.99		0	SAI	P 2
136	127		H	08H-VS1	08H-VS1	4	00323	580AC	09H+ 0.33	0.22		0	SAI	P 2
			H	09H-09H	09H-09H		00213	580BC	09H+ 0.46	0.21		0	SAI	P 2
135	128		H	08H-VS1	08H-VS1	4	00323	580AC	BW1- 1.83	0.46		0	SAI	P 2
			H	08H-VS1	08H-VS1		00118	580BC	BW1- 1.69	0.53		0	SAI	P 2
133	130		H	BW1-BW1	BW1-BW1		00334	580BC	BW1+ 0.54	0.38		0	SAI	P 2
137	130		H	08H-VS1	08H-VS1		00213	580BC	08H+ 0.52	0.52		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	08H+ 0.52	0.55		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	09H+ 0.81	0.41		0	SAI	P 2
			H	08H-VS1	08H-VS1		00213	580BC	09H+ 0.85	0.38		0	SAI	P 2
			H	08H-VS1	08H-VS1		00213	580BC	BW1+ 1.74	0.51		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 1.74	0.47		0	MAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 1.76	0.56		0	MAI	P 2
143	130		H	08H-VS1	08H-VS1	8	00527	580AC	BW1+ 15.76	1.07		0	SAI	P 2
128	131		H	08H-VS1	08H-VS1	8	00431	580AC	BW1+ 0.62	0.83		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00431	580AC	BW1+ 6.45	2.30		0	SAI	P 2
130	131		H	08H-VS1	08H-VS1	8	00427	580AC	BW1+ 6.03	0.80		0	SAI	P 2
132	131		H	08H-VS1	08H-VS1	8	00431	580AC	BW1+ 6.00	0.62		0	SAI	P 2
134	131		H	08H-VS1	08H-VS1	8	00427	580AC	BW1+ 0.75	1.38		0	SAI	P 2
136	131		H	08H-VS1	08H-VS1	8	00431	580AC	09H+ 0.64	0.20		0	SAI	P 2
			H	08H-VS1	08H-VS1		00110	580BC	09H+ 0.81	0.40		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00431	580AC	BW1+ 0.27	1.01		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00431	580AC	BW1+ 1.93	0.30		0	SAI	P 2
123	132		H	08H-VS1	08H-VS1	8	00431	580AC	BW1+ 7.15	1.63		0	SAI	P 2
127	132		H	08H-VS1	08H-VS1	8	00427	580AC	BW1+ 1.22	0.32		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

				EXAM EXTENT						CURRENT				
ROW	COL	DATE	LEG	PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	VOLTS	MIL	DEG	%	CH
137	132		H	08H-VS1	08H-09H	4	00319	580AC	08H- 0.94	0.34		0	SAI	P 2
			H	08H-VS1	08H-VS1		00216	580BC	09H- 0.61	0.44		0	SAI	P 2
			H	09H-VS1	09H-VS1	4	00319	580AC	09H+ 0.01	1.50		0	SAI	P 2
			H	08H-VS1	08H-VS1		00216	580BC	09H+ 0.61	0.15		0	SAI	P 2
			H	09H-VS1	09H-VS1	4	00319	580AC	BW1+ 0.26	1.91		0	SAI	P 2
			H	08H-VS1	08H-VS1		00216	580BC	BW1+ 1.39	0.34		0	SAI	P 2
139	132		H	08H-VS1	08H-VS1	8	00427	580AC	BW1+ 15.58	0.50		0	SAI	P 2
143	132		H	08H-VS1	08H-VS1	8	00428	580AC	BW1+ 16.07	0.70		0	SAI	P 2
130	133		H	08H-VS1	08H-VS1	8	00424	580AC	BW1+ 6.73	0.42		0	SAI	P 2
123	134		H	08H-VS1	08H-VS1		00098	580BC	BW1+ 7.59	0.29		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 7.75	0.58		0	SAI	P 2
131	134		H	08H-VS1	08H-VS1	8	00424	580AC	09H- 0.45	0.71		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00424	580AC	09H+ 0.25	1.52		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00424	580AC	BW1+ 6.95	1.15		0	SAI	P 2
133	134		H	08H-VS1	08H-VS1	4	00319	580AC	BW1- 2.13	0.75		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1- 1.30	0.26		0	SAI	P 2
			H	08H-VS1	08H-VS1		00319	580AC	BW1+ 1.49	0.49		0	SAI	P 2
			H	08H-VS1	08H-VS1		00099	580BC	BW1+ 3.78	1.40		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 3.95	1.38		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 6.44	0.51		0	SAI	P 2
135	134		H	09H-09H	09H-09H		00529	580AC	09H- 1.19	0.15		0	SAI	P 2
137	134		H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 16.00	2.03		0	SAI	P 2
			H	08H-VS1	08H-VS1		00099	580BC	BW1+ 16.12	0.92		0	SAI	P 2
126	135		H	08H-VS1	08H-VS1		00216	580BC	BW1+ 0.56	0.18		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 0.62	0.18		0	SAI	P 2
134	135		H	08H-VS1	08H-VS1		00091	580BC	BW1+ 7.65	0.26		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 8.62	0.42		0	SAI	P 2
140	135		H	08H-VS1	08H-VS1		00094	580BC	BW1+ 16.23	0.16		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 16.40	3.73		0	SAI	P 2
			H	08H-VS1	08H-VS1		00094	580BC	BW1+ 16.84	0.17		0	SAI	P 2
			H	08H-VS1	08H-VS1		00094	580BC	BW1+ 17.49	0.54		0	SAI	P 2
133	136		H	08H-VS1	08H-VS1	4	00319	580AC	09H+ 14.99	1.00		0	SAI	P 2
			H	08H-VS1	08H-VS1		00091	580BC	09H+ 15.03	0.87		0	SAI	P 2
			H	08H-VS1	08H-VS1		00091	580BC	09H+ 16.60	1.00		0	SAI	P 2
			H	08H-VS1	08H-VS1	4	00319	580AC	09H+ 16.91	1.91		0	SAI	P 2
137	136		H	08H-VS1	08H-VS1	1	00700	580AC	BW1+ 14.66	0.74		0	SAI	P 2
			H	08H-VS1	08H-VS1	1	00700	580AC	BW1+ 17.45	2.53		0	SAI	P 2
139	136		H	08H-VS1	08H-VS1	1	00700	580AC	BW1+ 18.03	2.35		0	SAI	P 2
120	137		H	08H-VS2	08H-VS2		00086	580BC	BW1+ 6.27	1.02		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00319	580AC	BW1+ 6.78	2.14		0	SAI	P 2
122	137		H	08H-VS1	08H-VS1	8	00420	580AC	BW1+ 0.44	0.23		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00420	580AC	BW1+ 0.81	0.23		0	SAI	P 2
134	137		H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 16.62	1.12		0	SAI	P 2
			H	08H-VS1	08H-VS1		00086	580BC	BW1+ 16.82	0.60		0	SAI	P 2
136	137		H	08H-VS1	08H-VS1	8	00419	580AC	BW1+ 16.60	0.94		0	SAI	P 2
138	137		H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 16.30	1.32		0	SAI	P 2

TABLE A-2

CUMULATIVE REPORT

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

ROW	COL	DATE	LEG	EXAM EXTENT PROGRAM	EXAM EXTENT ACTUAL	EXP	CAL	PROBE	LOCATION	CURRENT VOLTS	CURRENT MIL	CURRENT DEG	%	CH
138	137		H	08H-VS1	08H-VS1		00089	580BC	BW1+ 17.89	1.27		0	SAI	P 2
140	137		H	08H-VS1	08H-VS1	4	00330	580AC	BW1+ 17.37	2.35		0	SAI	P 2
105	138		H	08H-VS2	08H-VS2	6	00488	580AC	BW1+ 1.59	1.29		0	SAI	P 2
			H	08H-VS2	08H-VS2	6	00488	580AC	BW1+ 3.50	0.84		0	SAI	P 2
117	138		H	08H-VS2	08H-VS2	8	00414	580AC	BW1+ 7.86	0.72		0	SAI	P 2
135	138		H	08H-VS1	08H-VS1	4	00319	580AC	BW1+ 1.51	1.01		0	SAI	P 2
			H	08H-VS1	08H-VS1		00206	580BC	BW1+ 1.69	0.66		0	SAI	P 2
			H	08H-VS1	08H-VS1		00206	580BC	BW1+ 1.85	0.28		0	SAI	P 2
120	139		H	08H-VS2	08H-VS2	8	00414	580AC	BW1+ 8.32	1.72		0	SAI	P 2
130	139		H	08H-VS1	08H-VS1	8	00413	580AC	BW1+ 6.11	0.59		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00413	580AC	BW1+ 9.15	1.03		0	SAI	P 2
134	139		H	08H-VS1	08H-VS1	8	00413	580AC	BW1+ 18.91	0.83		0	SAI	P 2
123	140		H	08H-VS1	08H-VS1	8	00367	580AC	BW1+ 6.97	0.83		0	SAI	P 2
137	140		H	08H-VS1	08H-VS1	8	00366	580AC	BW1+ 13.80	0.84		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00366	580AC	BW1+ 15.93	0.40		0	SAI	P 2
104	141		H	08H-VS2	08H-VS2	6	00488	580AC	BW1+ 1.72	1.47		0	SAI	P 2
			H	08H-VS2	08H-VS2	6	00488	580AC	BW1+ 4.16	0.49		0	SAI	P 2
114	141		H	08H-VS2	08H-VS2		00079	580BC	BW1+ 2.75	0.20		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1+ 3.37	0.75		0	SAI	P 2
118	141		H	08H-VS2	08H-VS2	8	00371	580AC	BW1+ 8.14	1.19		0	SAI	P 2
126	141		H	08H-VS1	08H-VS1	8	00367	580AC	BW1+ 7.77	0.68		0	SAI	P 2
125	142		H	08H-VS1	08H-VS1	8	00371	580AC	08H+ 40.11	0.37		0	SAI	P 2
122	143		H	08H-VS1	08H-VS1	8	00371	580AC	BW1- 1.23	0.50		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00371	580AC	BW1+ 1.62	0.43		0	SAI	P 2
124	143		H	08H-VS1	08H-VS1	8	00370	580AC	08H+ 35.96	0.33		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00370	580AC	BW1- 1.84	0.44		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00370	580AC	BW1- 0.46	0.26		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00370	580AC	BW1+ 0.07	0.38		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00370	580AC	BW1+ 1.34	0.71		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00370	580AC	BW1+ 4.40	0.54		0	SAI	P 2
126	143		H	08H-VS1	08H-VS1	8	00371	580AC	09H+ 8.62	1.34		0	SAI	P 2
			H	08H-VS1	09H-VS1		00072	580BC	BW1+ 1.81	0.64		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00371	580AC	BW1+ 1.95	0.73		0	SAI	P 2
128	143		H	08H-VS1	08H-VS1	4	00328	580AC	BW1+ 3.98	0.50		0	SAI	P 2
105	144		H	08H-VS2	08H-VS2	8	00370	580AC	BW1+ 0.68	0.61		0	SAI	P 2
120	145		H	08H-VS2	08H-VS2	8	00374	580AC	09H+ 4.17	3.16		0	SAI	P 2
			H	08H-VS2	08H-VS2	8	00374	580AC	BW1+ 1.12	0.32		0	SAI	P 2
122	145		H	08H-VS1	08H-VS1	8	00374	580AC	08H+ 37.53	2.60		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00374	580AC	08H+ 37.72	2.60		0	MAI	P 2
			H	08H-VS1	08H-VS1	8	00374	580AC	BW1+ 0.22	2.66		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00374	580AC	BW1+ 3.21	0.50		0	SAI	P 2
			H	08H-VS1	08H-VS1	8	00374	580AC	BW1+ 6.53	0.19		0	SAI	P 2
128	145		H	08H-VS1	08H-VS1	8	00374	580AC	BW1+ 16.84	1.79		0	SAI	P 2
129	146		H	08H-VS1	08H-VS1	8	00379	580AC	BW1+ 16.68	1.59		0	SAI	P 2
118	147		H	08H-VS2	08H-VS2		00061	580BC	08H+ 38.52	1.25		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 38.90	2.14		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:14:35

ROW	COL	DATE	LEG	EXAM EXTENT PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	CURRENT VOLTS	MIL	DEG	%	CH
109	148		H	BW1-VS2	BW1-VS2		00334	580BC	BW1+ 0.60	0.25		0	SAI	P 2
111	148		H	08H-VS2	08H-VS2	8	00522	580AC	BW1+ 7.38	0.46		0	SAI	P 2
115	148		H	08H-VS2	08H-VS2	4	00318	580AC	BW1- 0.42	0.55		0	SAI	P 2
			H	08H-VS2	08H-VS2		00204	580BC	BW1- 0.18	0.48		0	SAI	P 2
117	148		H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 38.72	1.06		0	MAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 38.74	0.85		0	MAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	09H- 0.95	1.57		0	SAI	P 2
			H	08H-VS2	08H-VS2		00060	580BC	09H- 0.15	0.50		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	09H+ 0.40	0.79		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1- 0.80	1.30		0	SAI	P 2
			H	08H-VS2	08H-VS2		00060	580BC	BW1- 0.66	1.05		0	SAI	P 2
119	148		H	08H-VS2	08H-VS2	8	00380	580AC	08H+ 38.01	1.59		0	SAI	P 2
			H	08H-VS2	08H-VS2	8	00380	580AC	BW1+ 1.00	0.30		0	SAI	P 2
114	149		H	08H-VS2	08H-VS2	8	00382	580AC	BW1- 0.33	0.44		0	SAI	P 2
116	149		H	08H-VS2	08H-VS2	8	00382	580AC	BW1- 0.63	0.38		0	MAI	P 2
			H	08H-VS2	08H-VS2	8	00382	580AC	BW1- 0.63	0.46		0	MAI	P 2
118	149		H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 38.19	2.61		0	MAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 38.37	0.55		0	MAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 38.56	0.72		0	MAI	P 2
			H	08H-VS2	08H-VS2		00204	580BC	08H+ 38.94	2.35		0	SAI	1
			H	08H-VS2	08H-VS2		00204	580BC	08H+ 43.16	0.24		0	SAI	P 1
			H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 43.25	0.26		0	SAI	P 2
120	149		H	08H-VS2	08H-VS2	8	00522	580AC	08H+ 27.59	0.65		0	SAI	1
			H	08H-VS2	08H-VS2	8	00522	580AC	08H+ 32.30	1.06		0	SAI	1
109	150		H	08H-VS2	08H-VS2	8	00382	580AC	BW1- 0.71	1.55		0	SAI	P 2
			H	08H-VS2	08H-VS2	8	00382	580AC	BW1+ 0.79	0.28		0	SAI	P 2
115	150		H	08H-VS2	08H-VS2	8	00387	580AC	08H+ 36.25	0.94		0	SAI	P 2
117	150		H	08H-VS2	08H-VS2	8	00384	580AC	09H- 1.10	0.33		0	SAI	P 2
104	151		H	08H-VS2	08H-VS2	8	00388	580AC	BW1- 1.57	0.59		0	SAI	P 2
108	151		H	08H-VS2	08H-VS2	8	00392	580AC	BW1- 0.83	0.21		0	SAI	P 2
110	151		H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 35.64	2.08		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1- 2.15	0.35		0	MAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1- 2.15	3.54		0	MAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1+ 0.12	0.53		0	MAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1+ 3.23	1.21		0	SAI	P 2
			H	08H-VS2	08H-VS2		00038	580BC	BW1+ 3.25	0.42		0	SAI	P 2
105	152		H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 29.43	3.03		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1- 1.42	0.33		0	SAI	P 2
			H	08H-VS2	08H-VS2		00035	580BC	BW1+ 2.22	0.23		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1+ 2.23	0.98		0	SAI	P 2
108	153		H	08H-VS2	08H-VS2	4	00318	580AC	08H+ 34.55	1.35		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00318	580AC	BW1+ 0.56	0.22		0	SAI	P 2
			H	08H-VS2	08H-VS2		00035	580BC	BW1+ 0.59	0.23		0	SAI	P 2
103	154		H	08H-VS2	08H-VS2		00203	580BC	08H+ 0.29	0.29		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00328	580AC	08H+ 0.31	0.25		0	SAI	P 2
109	154		H	08H-VS2	08H-VS2	8	00522	580AC	BW1+ 2.64	0.29		0	SAI	P 2

TABLE A-2
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

PAGE: 14 OF 14
DATE: 03/03/94
TIME: 12:14:35

				EXAM EXTENT						CURRENT				
ROW	COL	DATE	LEG	PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	VOLTS	MIL	DEG	%	CH
103	158		H	08H-VS2	08H-VS2	8	00409	580AC	BW1+ 0.73	1.16		0	SAI	P 2
			H	08H-VS2	08H-VS2	8	00409	580AC	BW1+ 4.14	0.58		0	SAI	P 2
102	159		H	08H-VS2	08H-VS2		00203	580BC	BW1- 1.99	0.51		0	SAI	P 2
			H	08H-VS2	08H-VS2	4	00328	580AC	BW1- 1.69	0.48		0	SAI	P 2
99	160		H	08H-VS2	08H-VS2	8	00409	580AC	BW1+ 6.26	0.55		0	SAI	P 2

NUMBER OF TUBES SELECTED FROM CURRENT OUTAGE: 310
NUMBER OF DATA RECORDS SELECTED FROM CURRENT OUTAGE: 603

NO TREND ANALYSIS REQUESTED

DATA SELECTION CRITERIA:
Percent: MAI,SAI

REPORT OPTIONS:
Only examination results matching criteria are included

TABLE A-3:
CUMULATIVE REPORT
01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR : 22
OUTAGE DATA SET : CURRENT
SELECTION VARIABLES: Percent

DATE: 03/03/94
TIME: 12:25:03

				EXAM EXTENT						CURRENT				
ROW	COL	DATE	LEG	PROGRAM	ACTUAL	EXP	CAL	PROBE	LOCATION	VOLTS	MIL	DEG	%	CH
59	116		H	TSH-TSH	TSH-TSH		00003	610BC	TSH- 0.04	0.31		ID	SCI	P 2
			H	TSH-TSH	TSH-TSH	9	00400	600AC	TSH- 0.03	0.28		ID	SCI	1
56	117		H	TSH-TSH	TSH-TSH		00004	610BC	TSH- 0.03	0.22		ID	SCI	1
			H	TSH-TSH	TSH-TSH	9	00400	600AC	TSH- 0.02	0.28		ID	SCI	1
57	118		H	TSH-TSH	TSH-TSH		00003	610BC	TSH- 0.08	0.26		ID	SCI	P 1
			H	TSH-TSH	TSH-TSH	9	00401	600AC	TSH- 0.06	0.23		ID	SCI	1
54	119		H	TSH-TSH	TSH-TSH		00003	610BC	TSH- 0.04	0.35		ID	SCI	P 2
			H	TSH-TSH	TSH-TSH	9	00400	600AC	TSH- 0.04	0.26		ID	SCI	1

NUMBER OF TUBES SELECTED FROM CURRENT OUTAGE: 4
NUMBER OF DATA RECORDS SELECTED FROM CURRENT OUTAGE: 8

NO TREND ANALYSIS REQUESTED

DATA SELECTION CRITERIA:
Percent: MCI,SCI

REPORT OPTIONS:
Only examination results matching criteria are included

MAP OPTIONS:
Plot Variable = Indication Codes (Selected
Plot data from current examination only

FIGURE IV-1

PVNGS-2 CHEMICAL CLEANING

SG2-1 Magnetite Dissolution vs Time

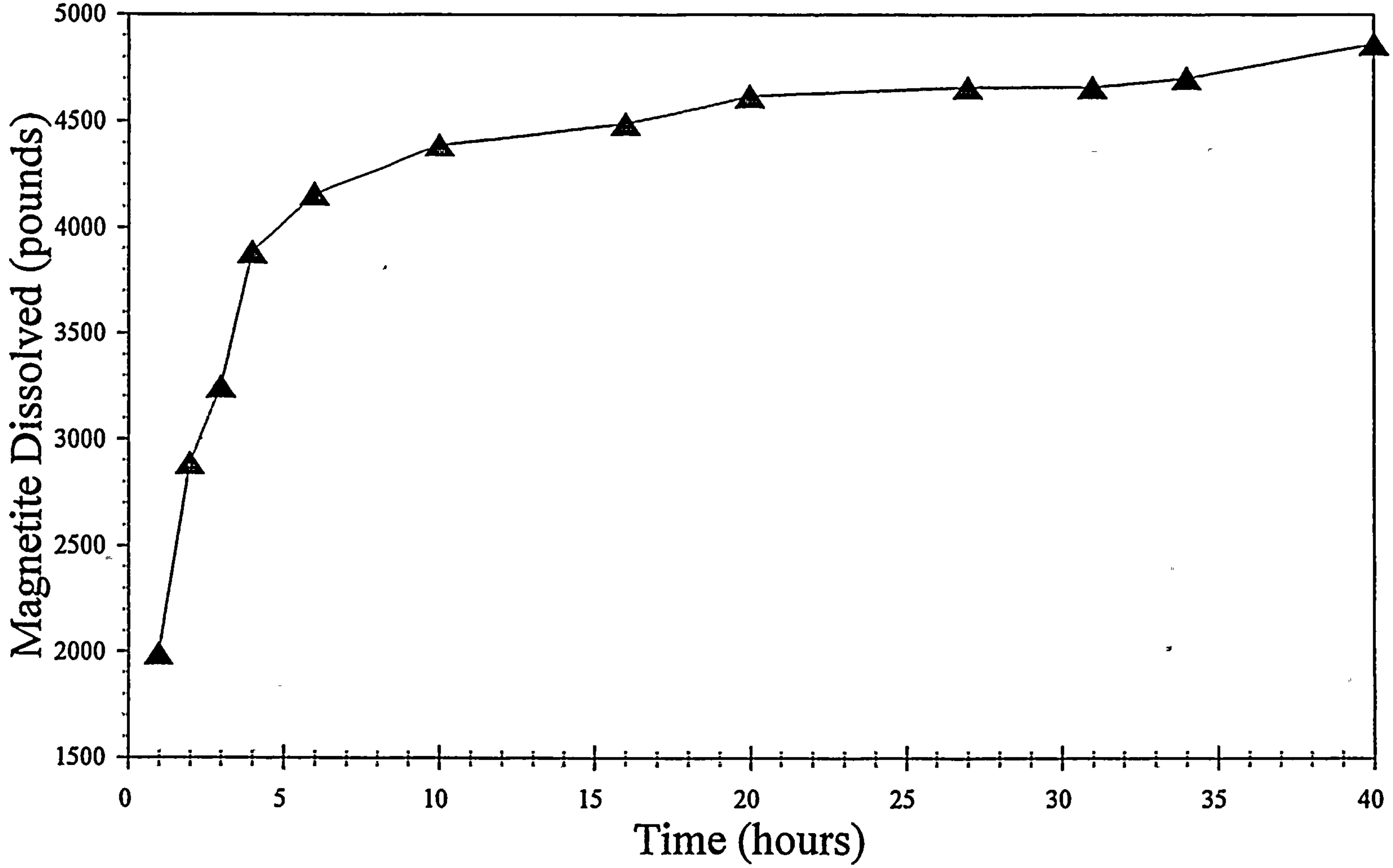


FIGURE IV-2

PVNGS-2 CHEMICAL CLEANING

SG2-2 Magnetite Dissolution vs Time

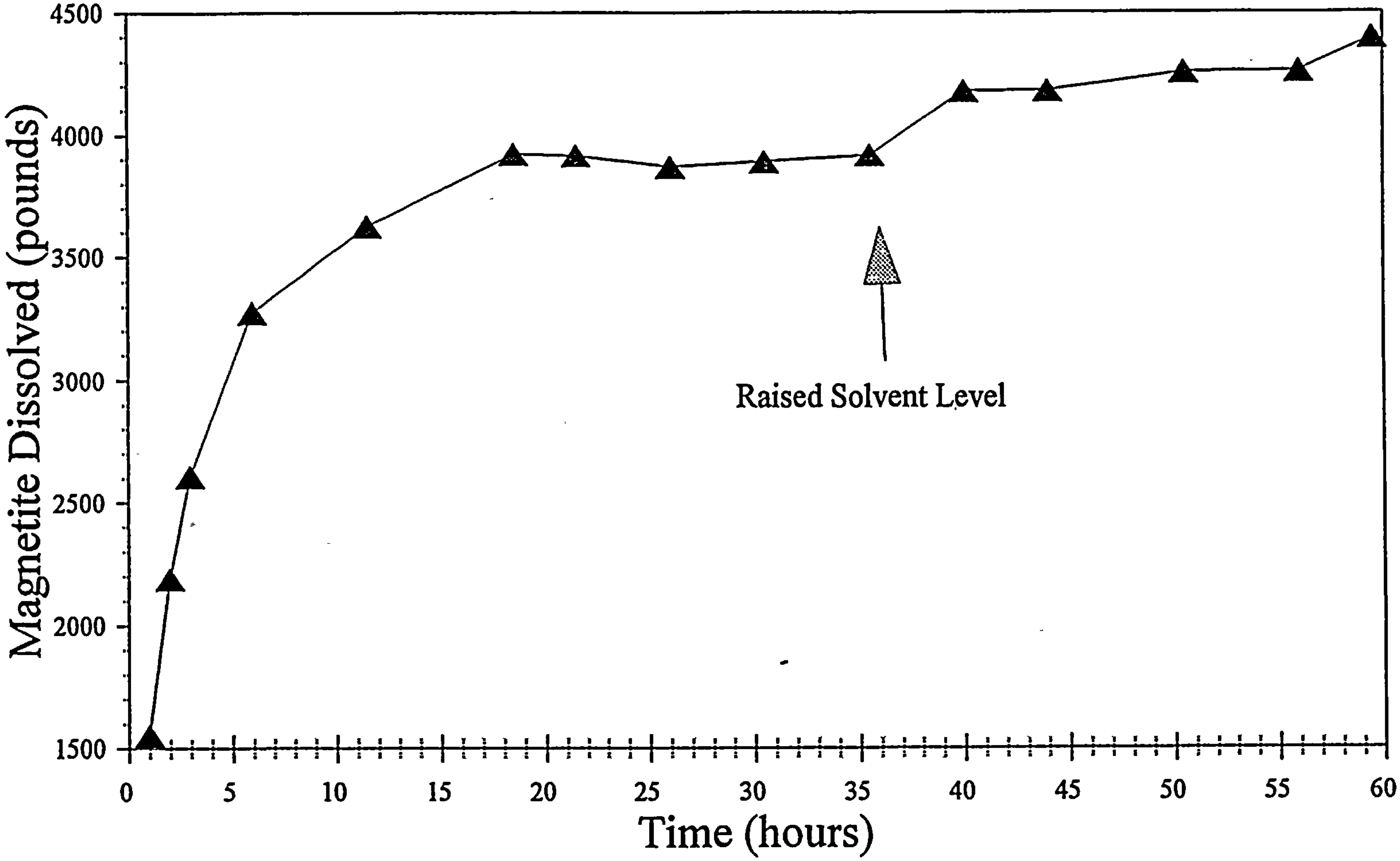


Figure [illegible]1

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

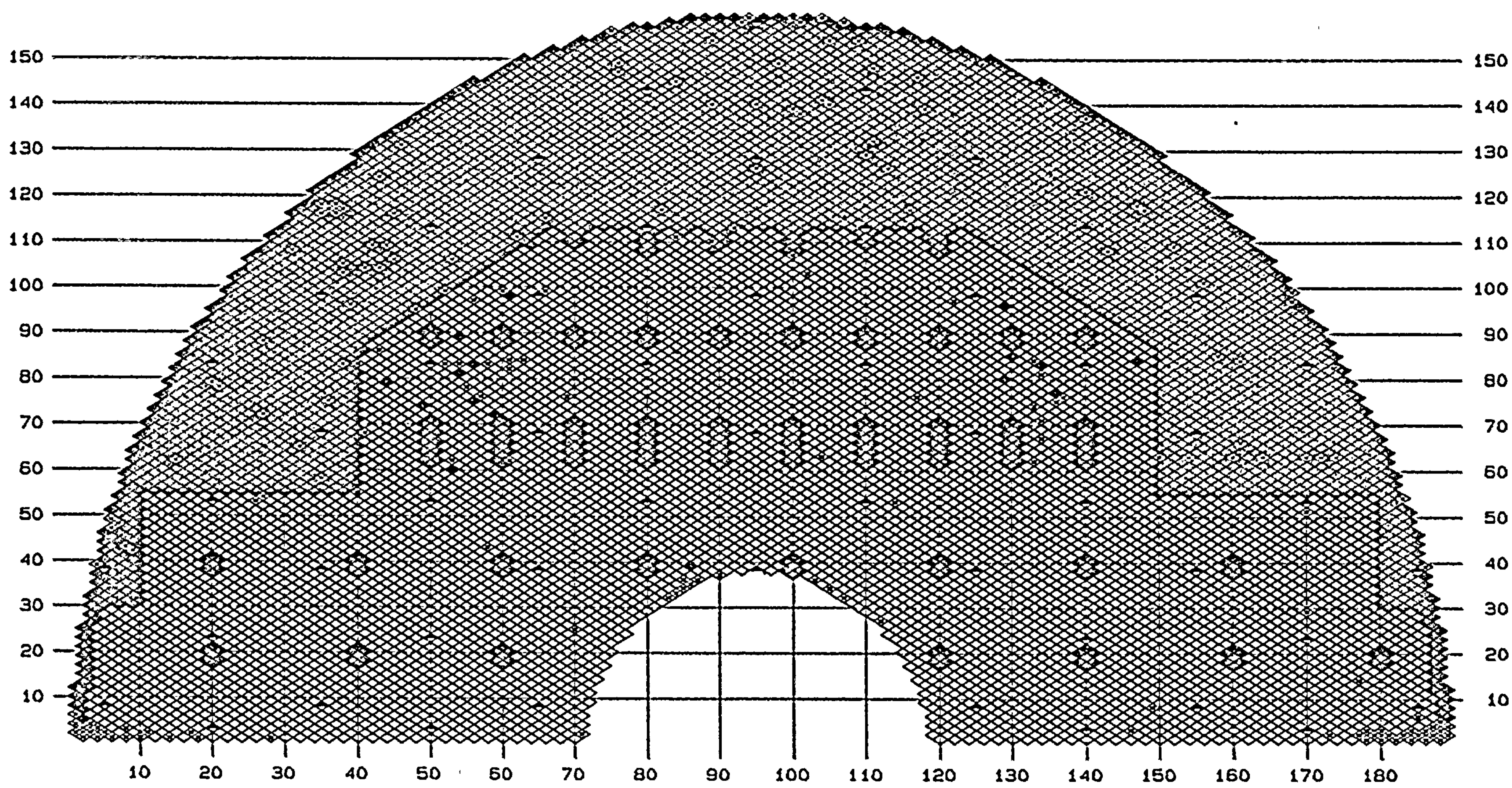
STEAM GENERATOR: 21

DATE: 03/03/94
TIME: 14:30:35

CRITERIA: ORIGINAL FULL LENGTH BOBBIN EXAM PLAN

STAYS ▲

PLUGGED 188 ✕ TEC-TEH 4418 ◆



CONAM NUCLEAR, INC. BW

Figure [illegible]2

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

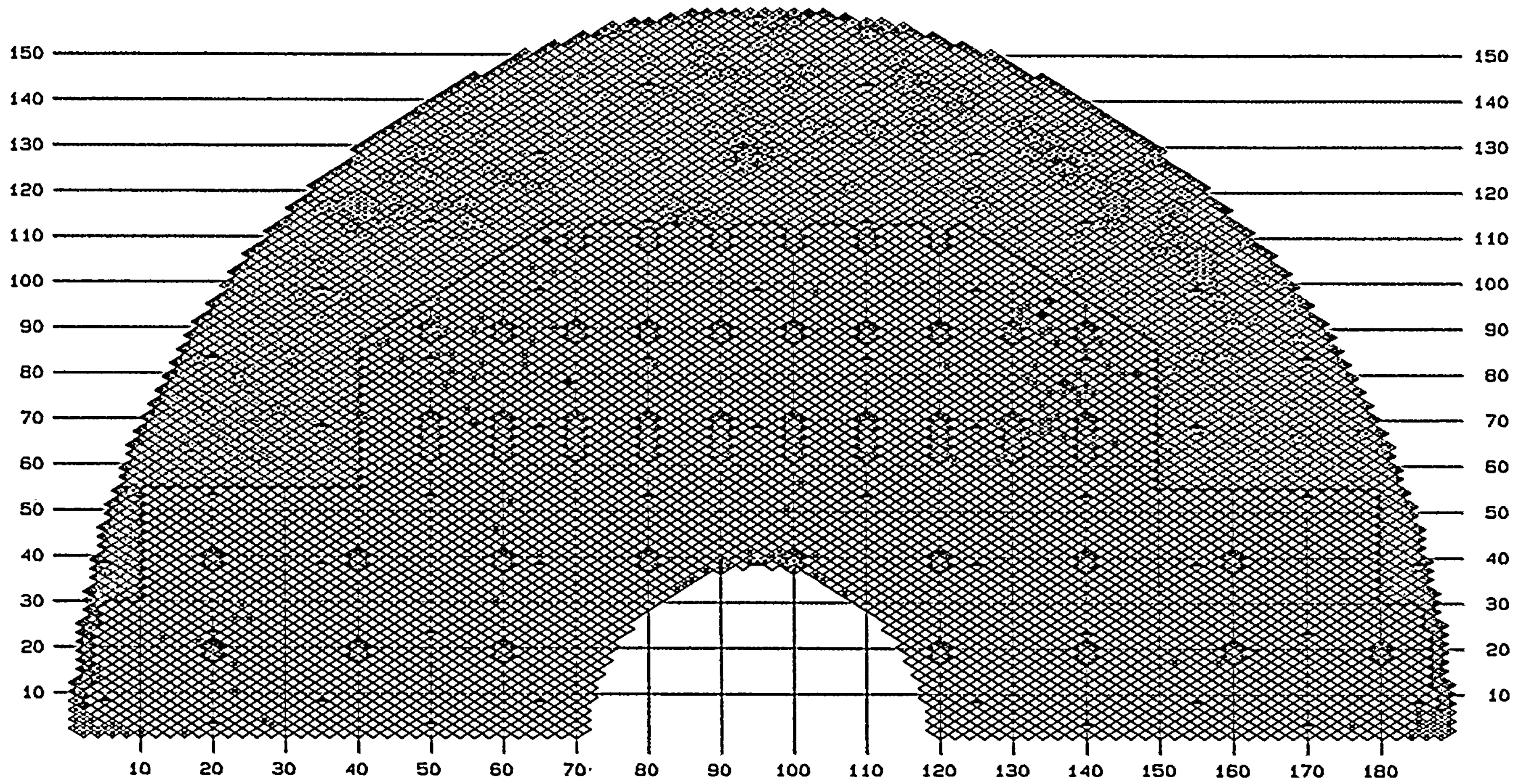
STEAM GENERATOR: 22

DATE: 03/03/94
TIME: 08:00:49

CRITERIA: ORIGINAL FULL LENGTH BOBBIN EXAM PLAN

STAYS ▲

PLUGGED 368 X TEC-TEH 4269 ◆



CONAM NUCLEAR, INC. BW

Figur[illegible]3

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

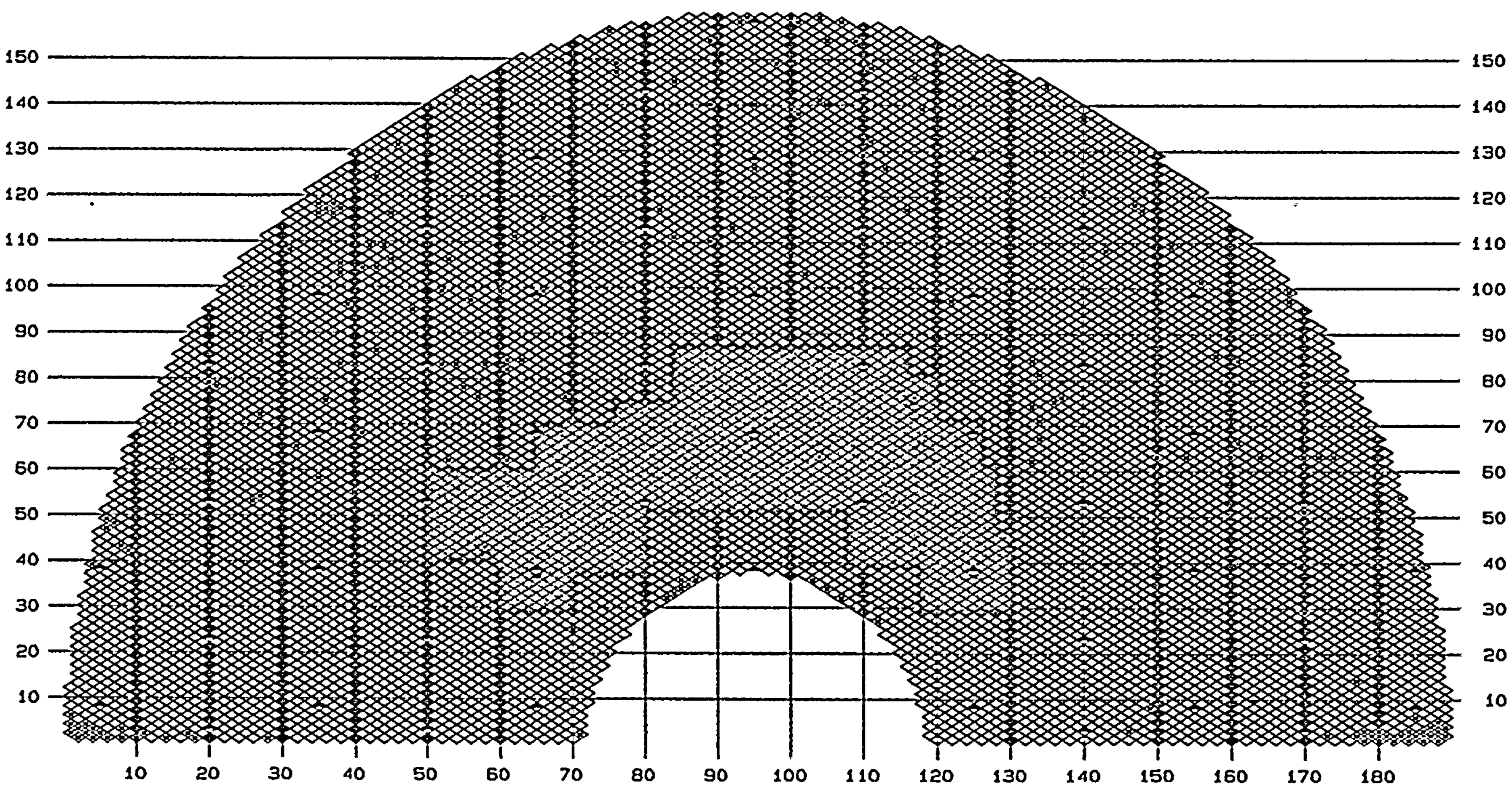
STEAM GENERATOR: 21

DATE: 03/03/94
TIME: 14: 44: 19

CRITERIA: ORIGINAL TSH-TSH MRPC EXAM PLAN

STAYS ▲

PLUGGED 188 X TSH-TSH 2270 ◆



CONAM NUCLEAR, INC. BW

Figure 4

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

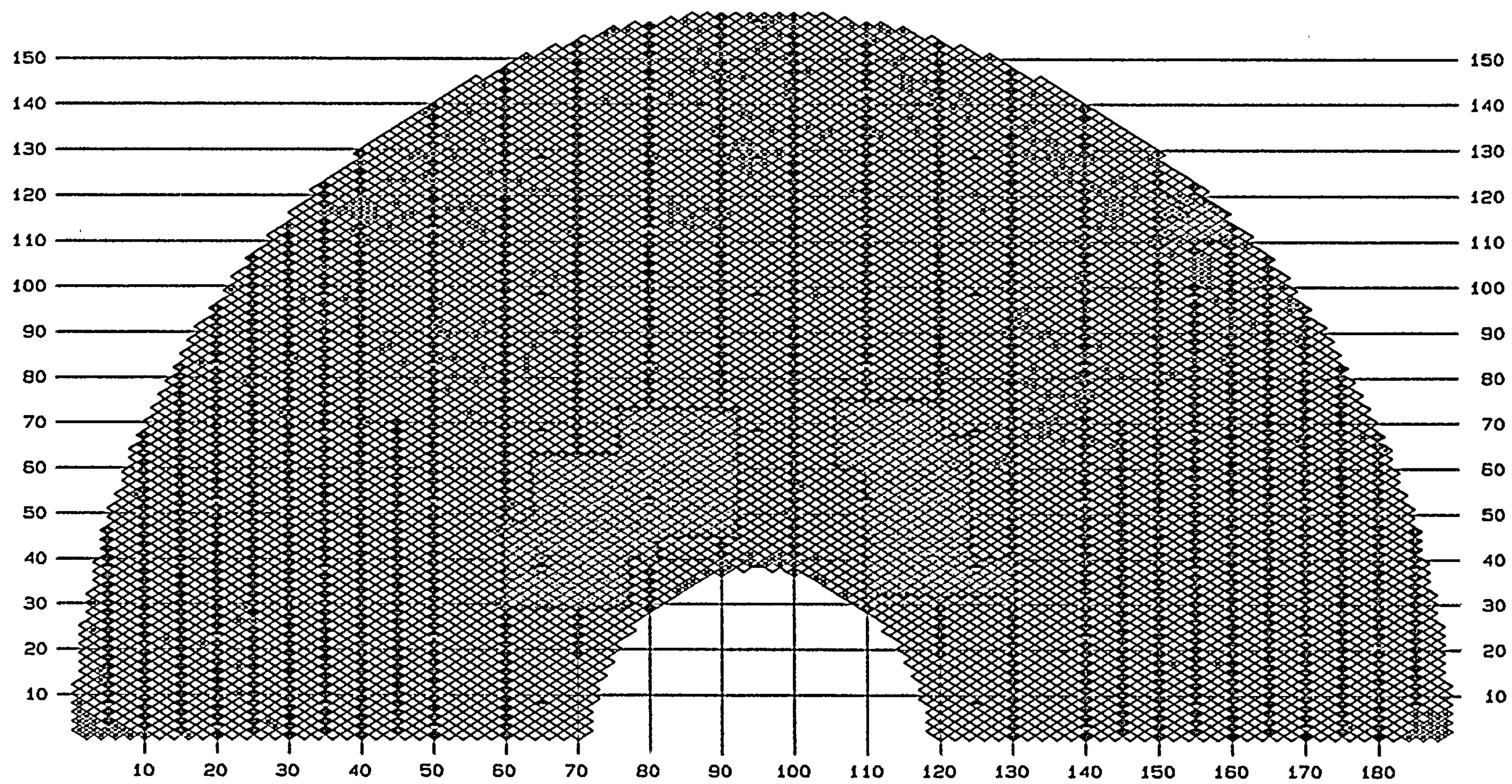
STEAM GENERATOR: 22

DATE: 03/03/94
TIME: 08: 07: 32

CRITERIA: ORIGINAL TSH-TSH MRPC EXAM PLAN

STAYS ▲

PLUGGED 368 X TSH-TSH 2245 ◆



CONAM NUCLEAR, INC. BW

Figure V

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

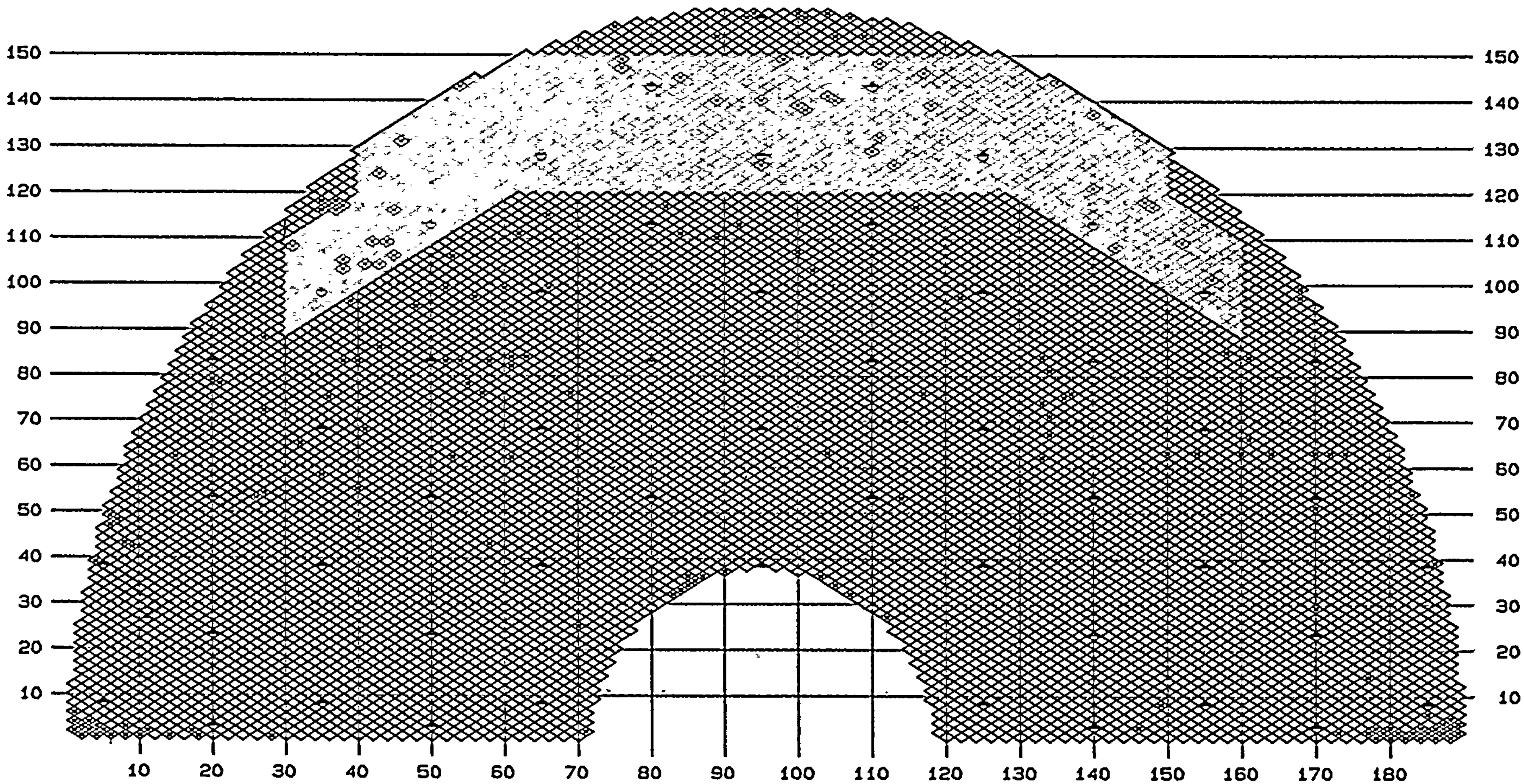
STEAM GENERATOR: 21

DATE: 03/03/94
TIME: 14:53:58

CRITERIA: ORIGINAL U-BEND (08H-1st VS) EXAM PLAN

STAYS ▲

PLUGGED 188 X   08H-VS2 551 ◇   BW1-VS2 1 ◇   08H-VS1 1351 ◇   08H-09H 1 ◇



CONAM NUCLEAR, INC. BW

Figur -6

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

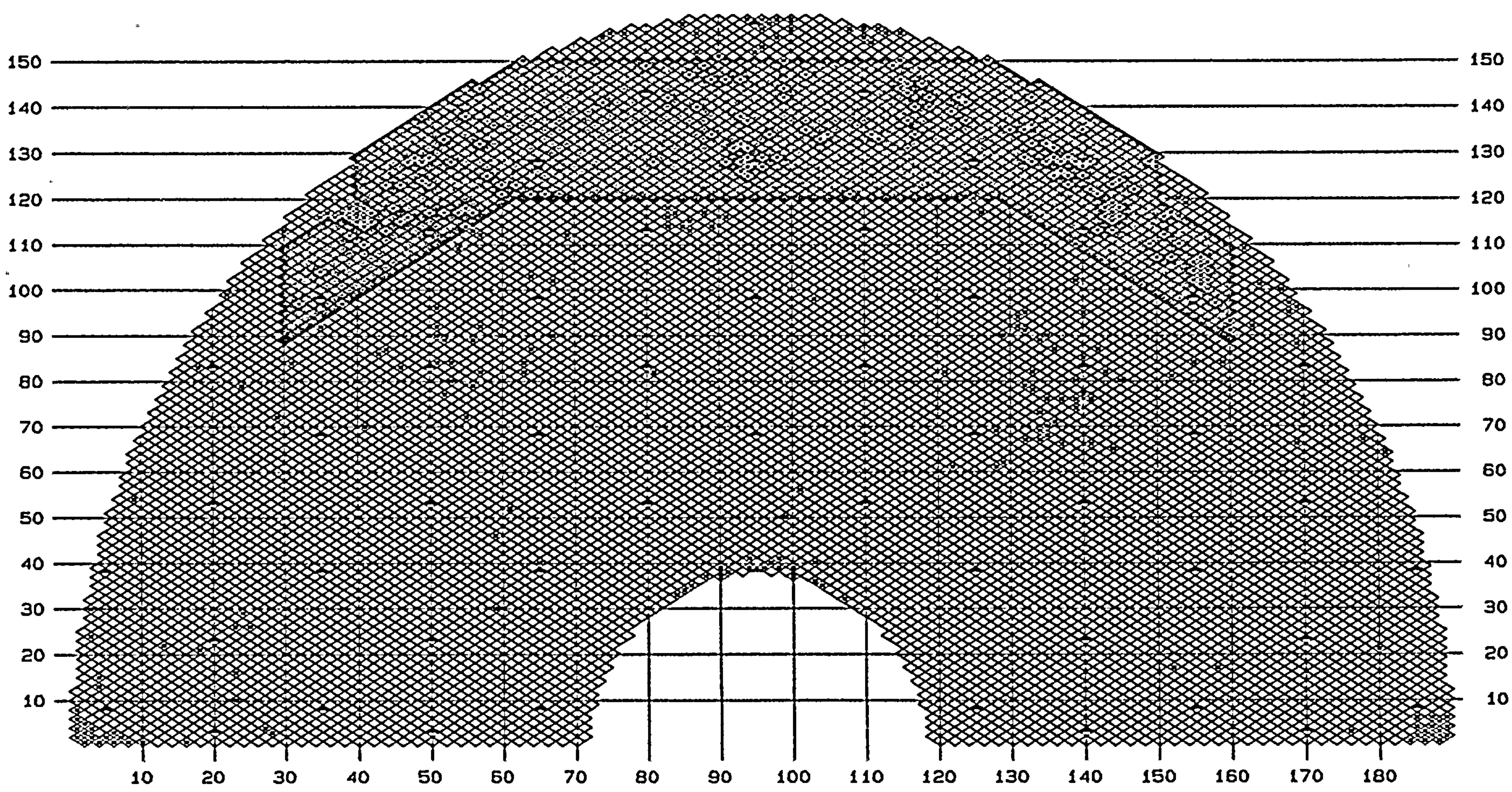
STEAM GENERATOR: 22

DATE: 03/03/94
TIME: 07: 09: 38

CRITERIA: ORIGINAL U-BEND MRPC EXAM PLAN

STAYS ▲

PLUGGED 368 X   08H-VS2 504 ◆   08H-VS1 1272 ◆   BW1-VS1 2 ◆



CONAM NUCLEAR, INC. BW

Figure [illegible]7

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

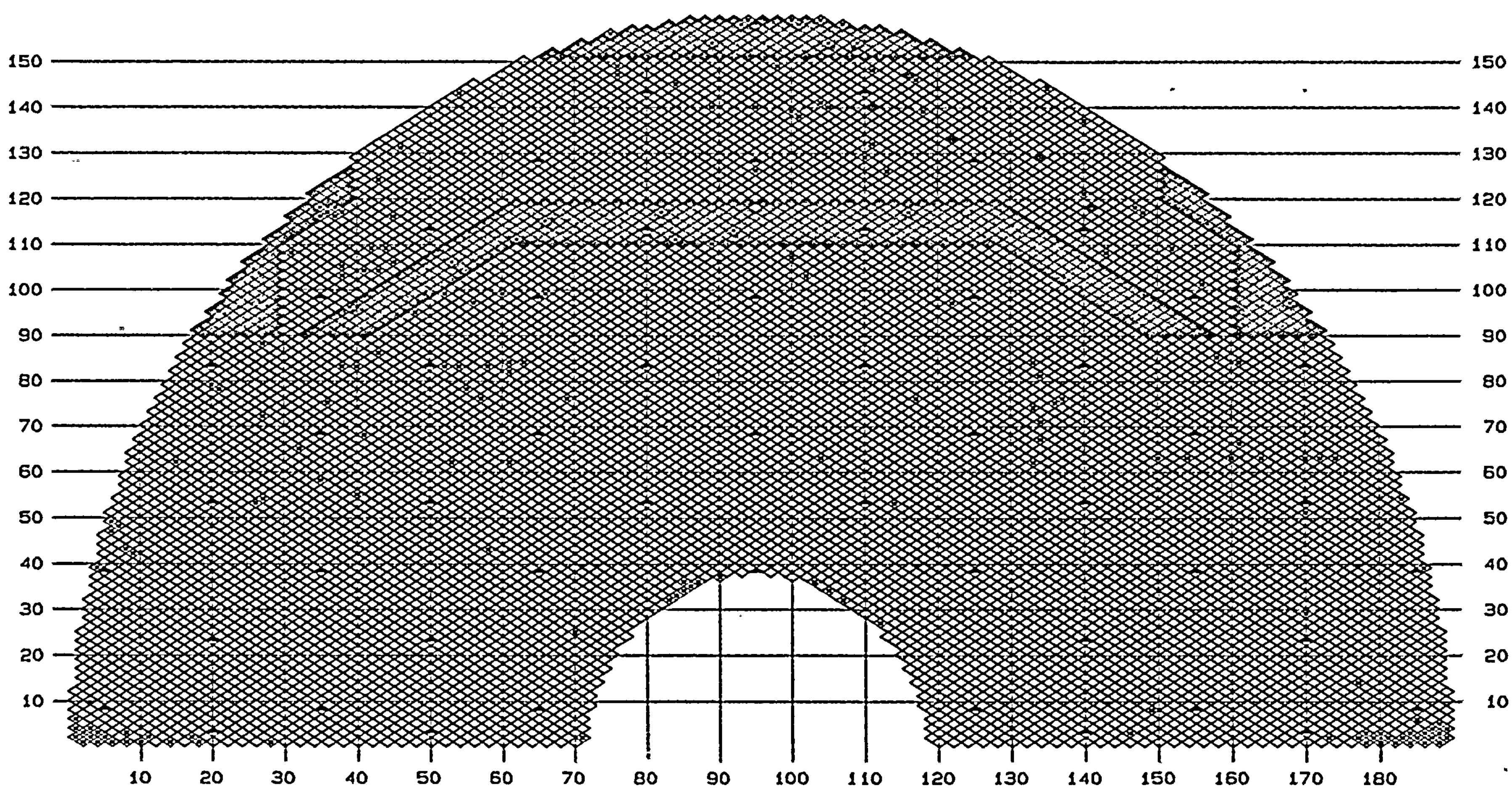
STEAM GENERATOR: 21

DATE: 03/03/94
TIME: 14:58:51

CRITERIA: EXPANSION 5 (HOT LEG)

STAYS . ▲

PLUGGED 188 X TEH-TEC 5 ◆ BH1-VS2 779 ◆ BH1-VS1 200 ◆ VS1-VS1 1 ◆



CONAM NUCLEAR, INC. BW

Figure [illegible]

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

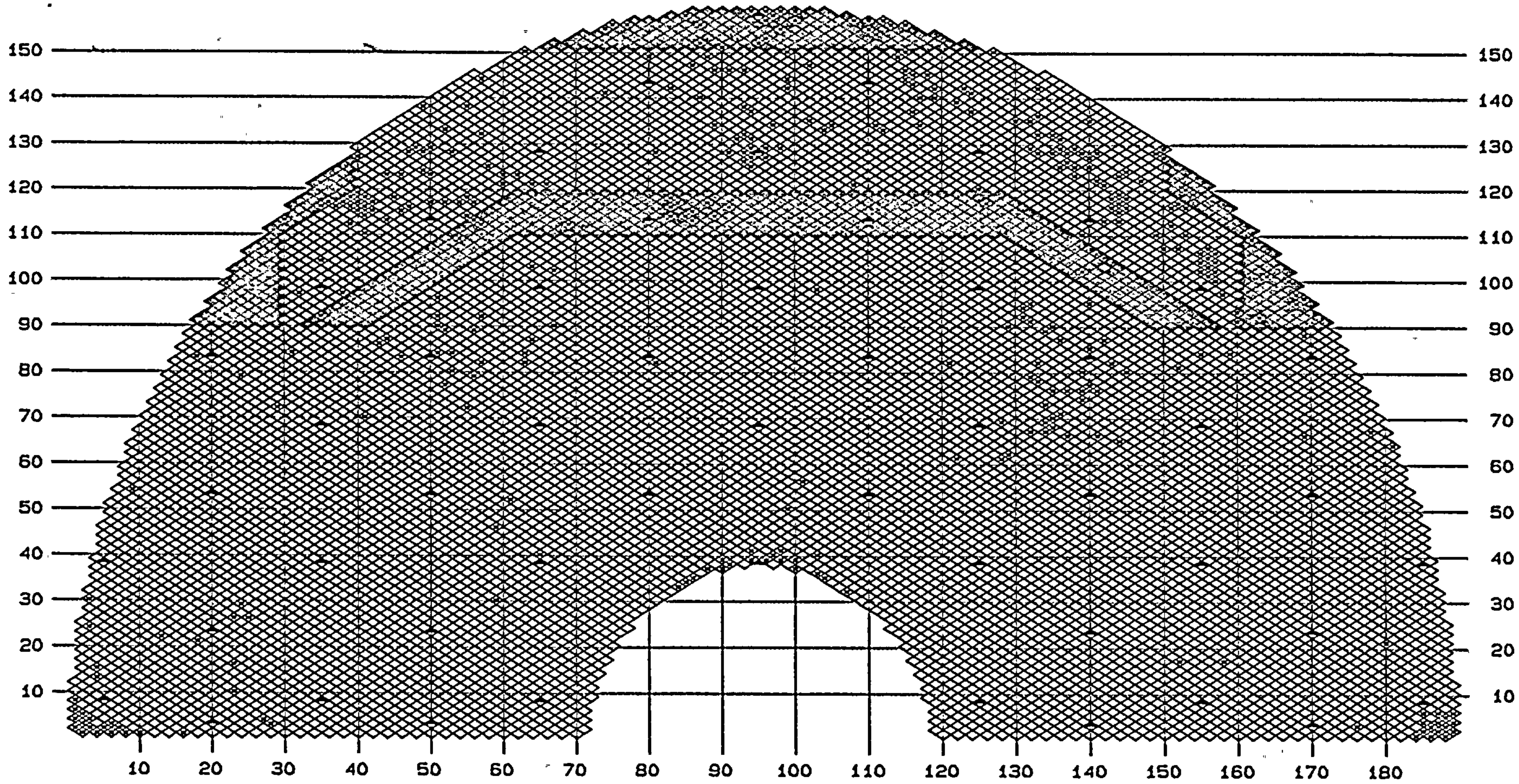
STEAM GENERATOR: 22

DATE: 03/03/94
TIME: 08:53:24

CRITERIA: EXPANSION 6 U-BEND 08H-1st VS MRPC (HOT LEG)

STAYS ▲

PLUGGED 368 ✕ 08H-VS2 764 ◆ 08H-VS1 187 ◆



CONAM NUCLEAR, INC. BW

Figure

01/94, ARIZONA PUBLIC SERVICE, PALO VERDE, UNIT 2

STEAM GENERATOR: 22

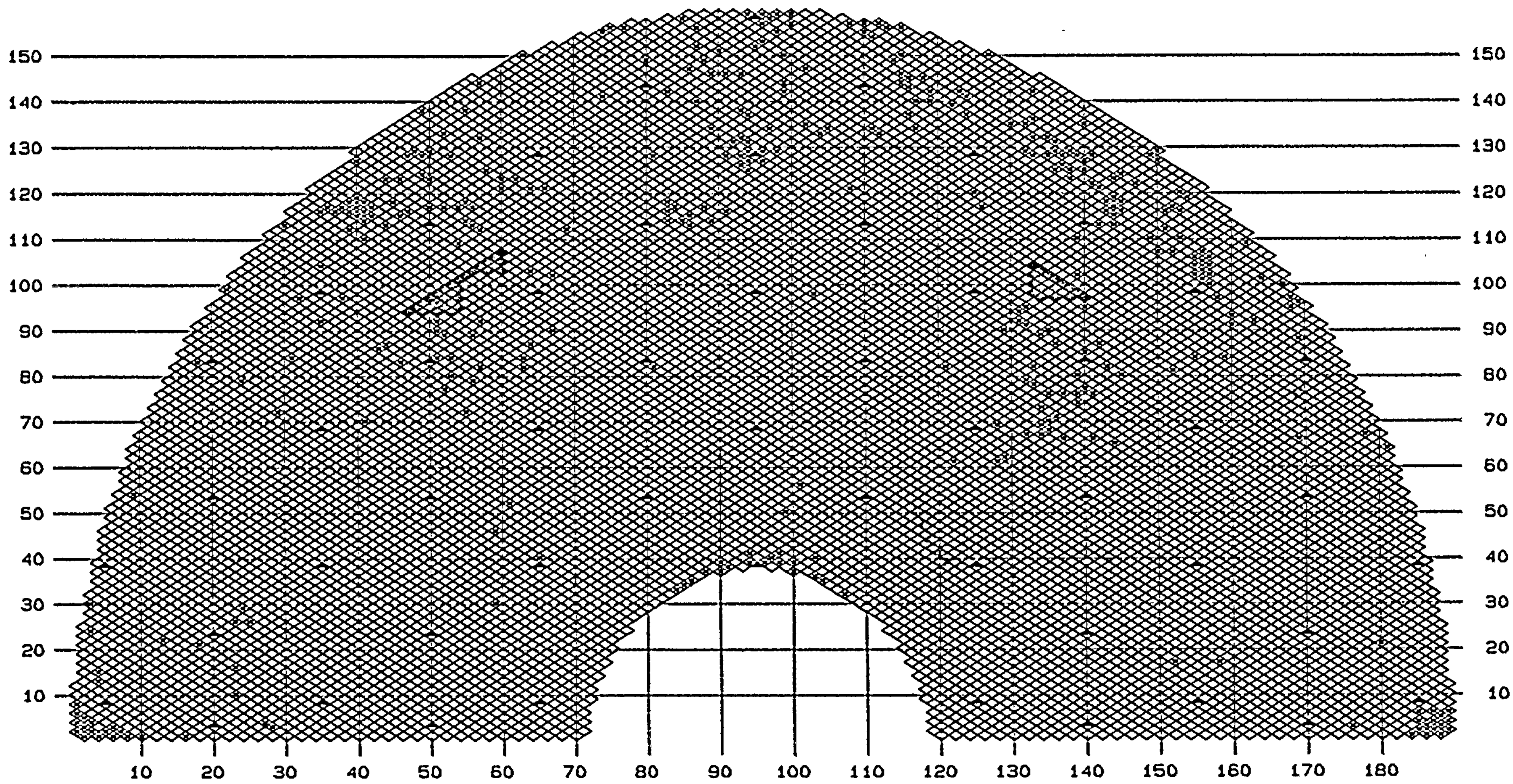
DATE: 03/03/94
TIME: 10: 27: 58

CRITERIA: EXPANSION 12 SAI BOUNDING (HOT LEG)

STAYS ▲

PLUGGED 368 ✕ Group97 29 ◆ Group98 20 ◆

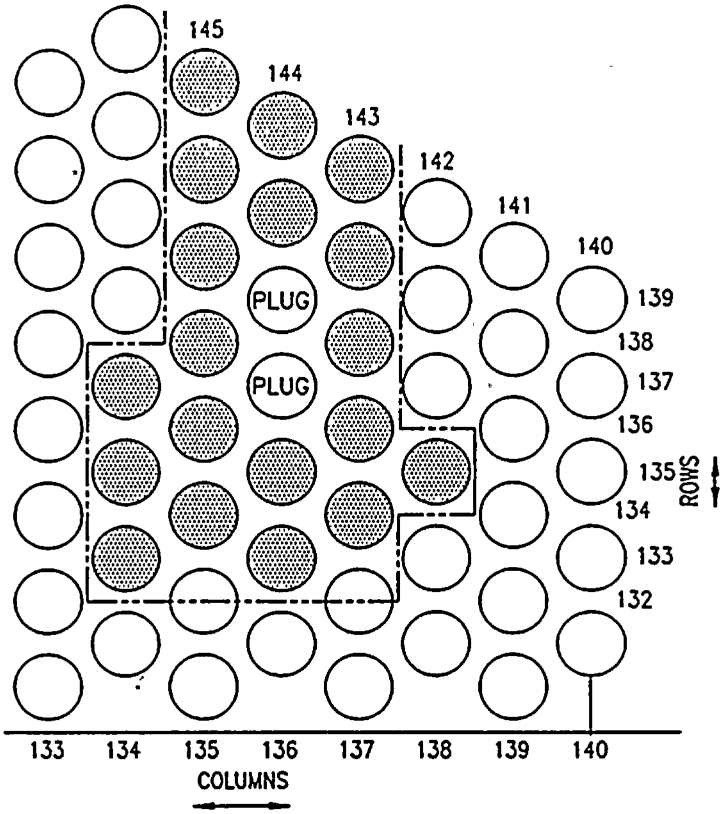
MULTIPLE 0 ◆



CONAM NUCLEAR, INC. BW

Figure V-10

SECONDARY SIDE TUBE PULL
TARGET TUBE LOCATIONS



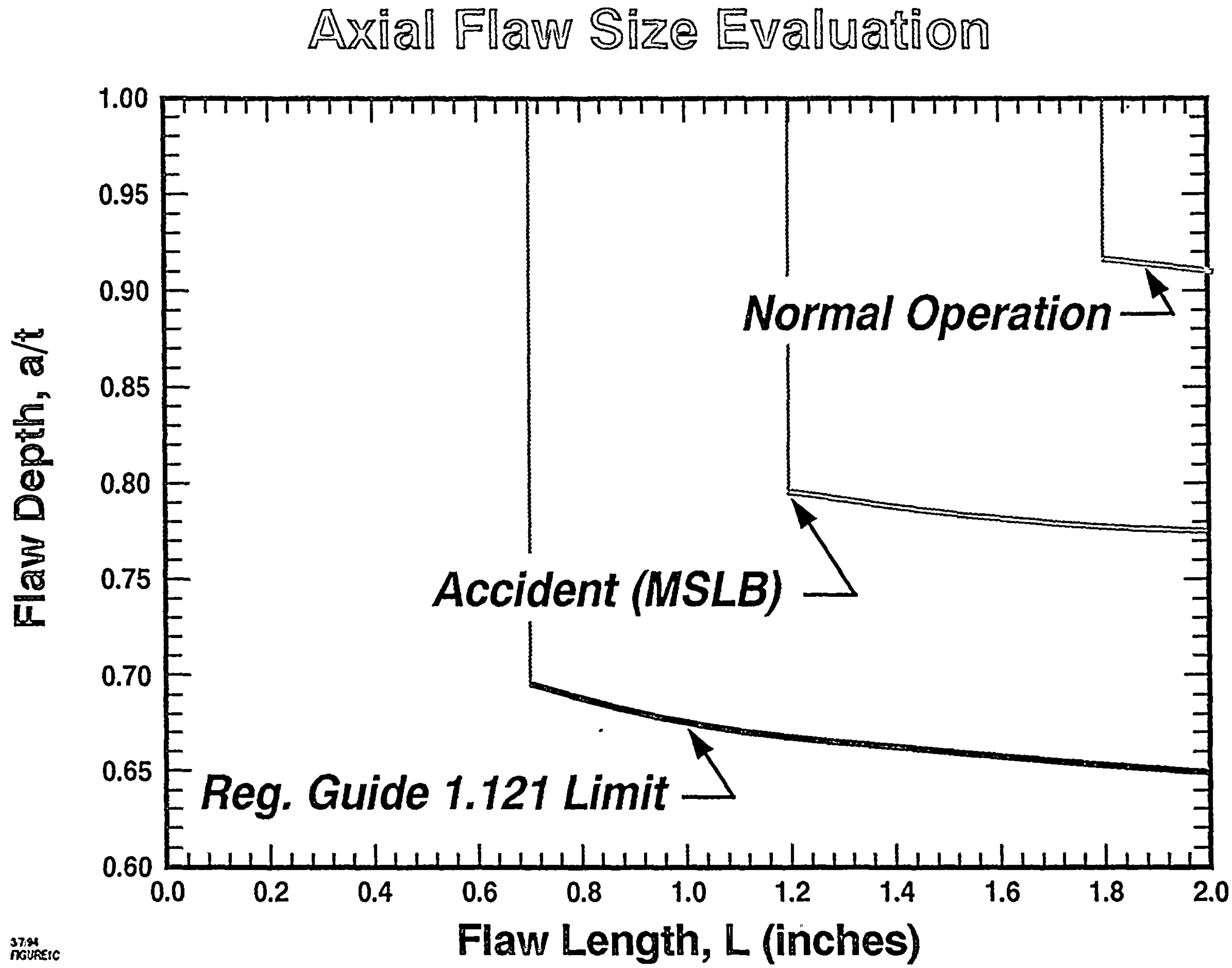

Axial Flaw Size Evaluation
Flaw Depth, a/t
Flaw Length, L (inches)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Normal Operation
Accident (MSLB)
Reg. Guide 1.121 Limit

FIGURE VI-1

FIGURE VI-2

Average Crack Depth vs. RPC Voltage

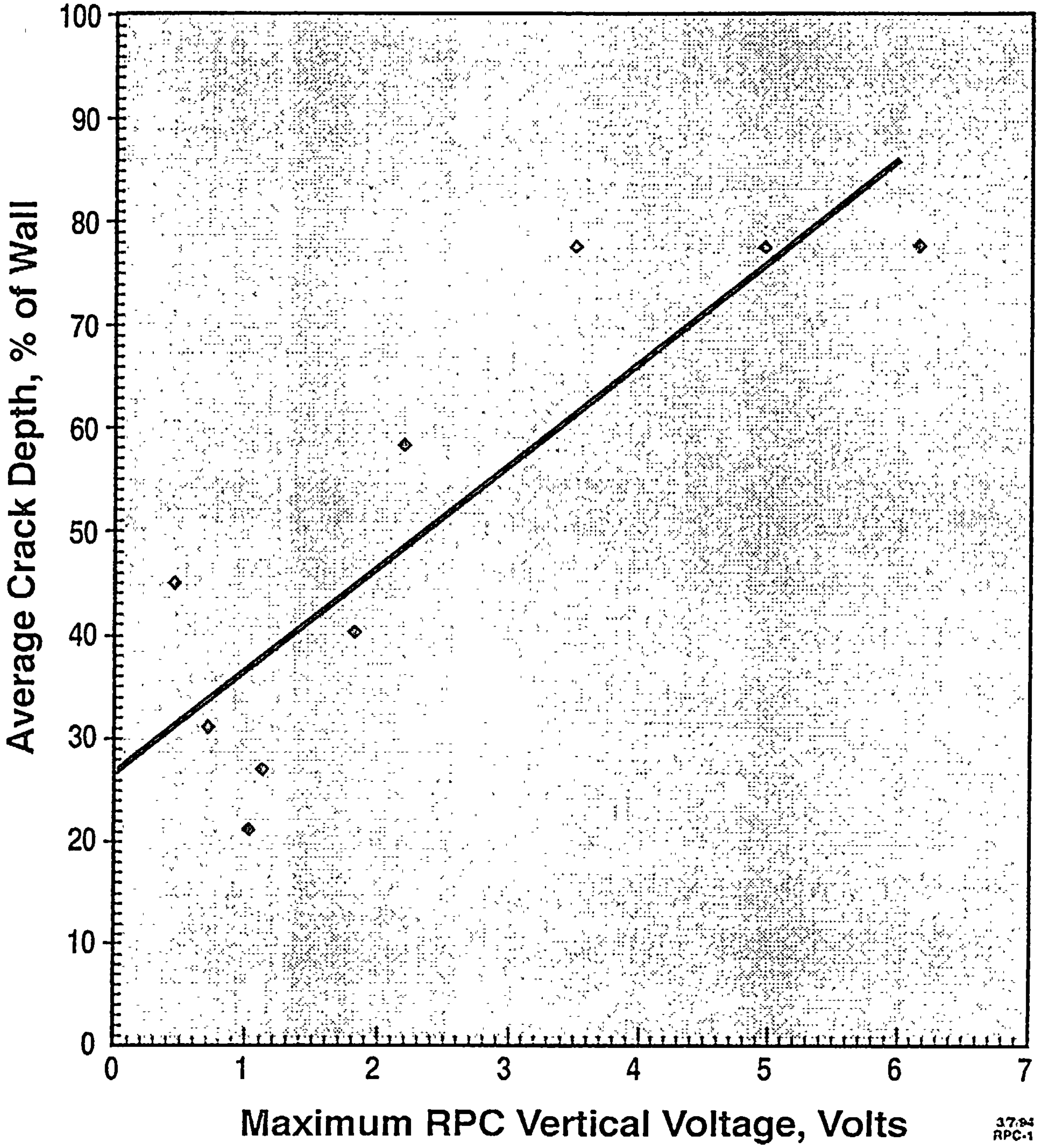


FIGURE VI-3

New vs. Old RPC Voltages

(Mid-Cycle vs. Beginning of Cycle)

0.080 Inch Diameter Coil

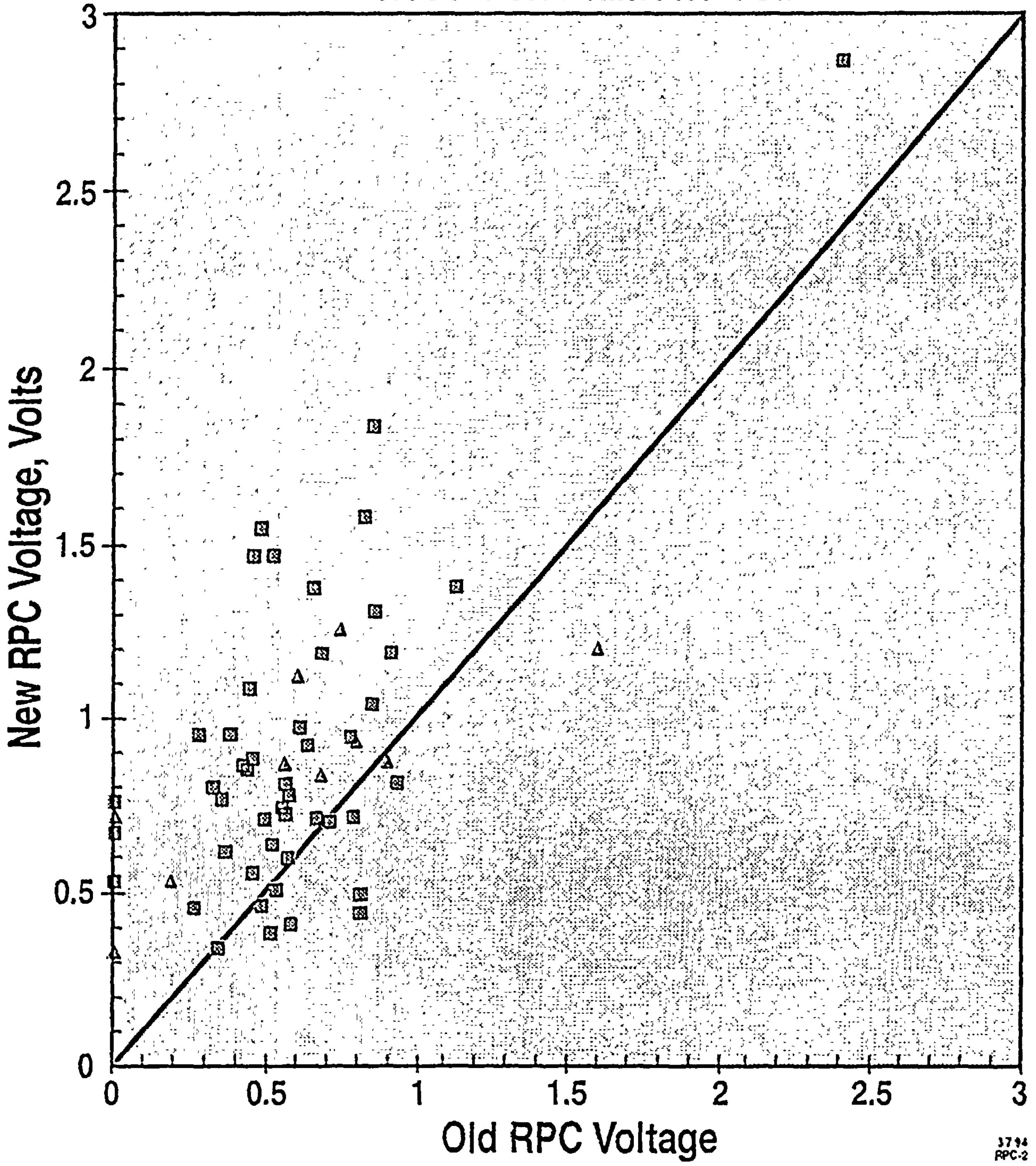
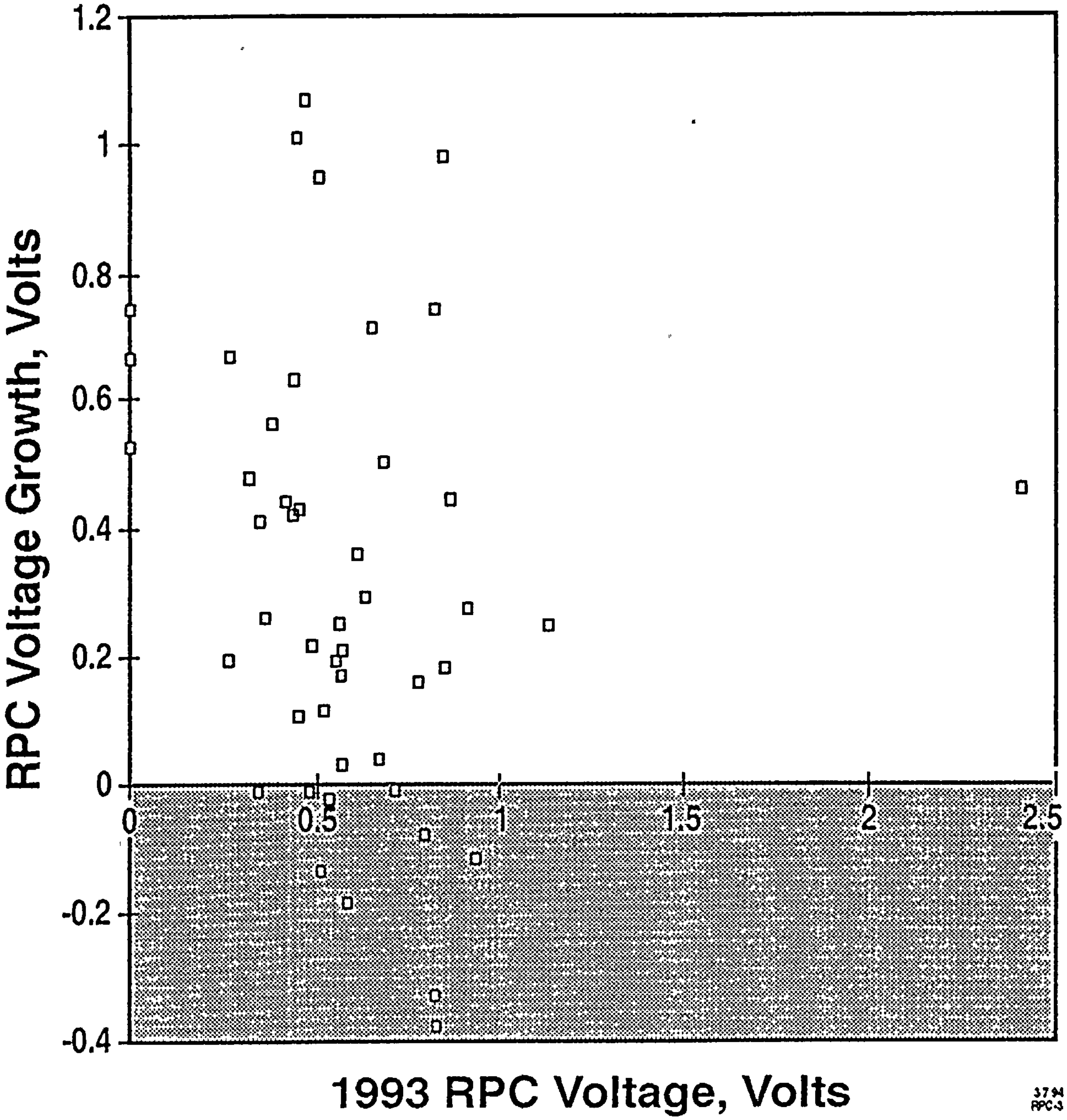


FIGURE VI-4

Voltage Growth vs. 1993 Voltage

(RPC Voltage Change vs. Beginning of Cycle Voltage)



3794
RPC-3

FIGURE VI-5

Schematic Illustrating Crack Growth Calculation

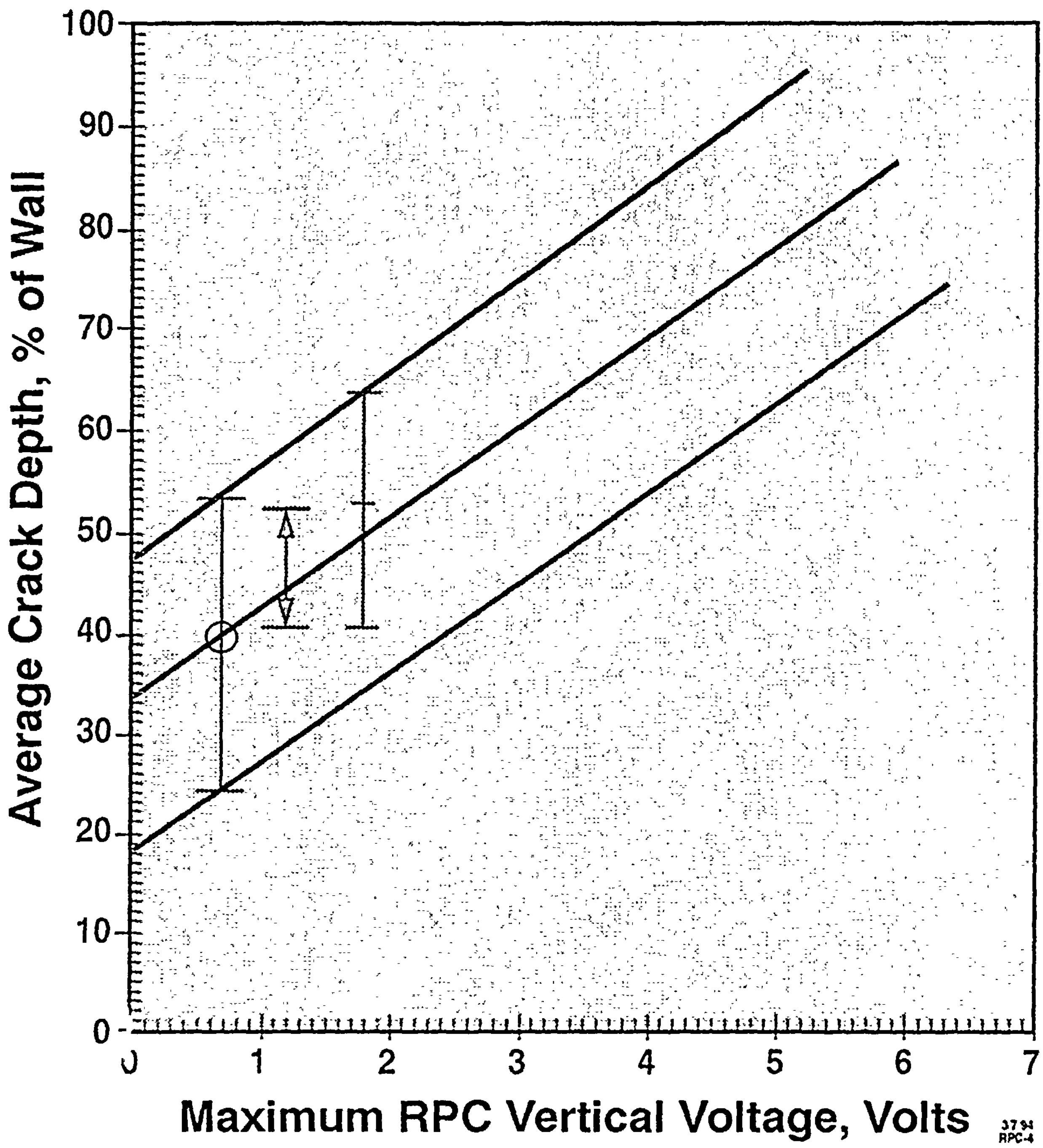
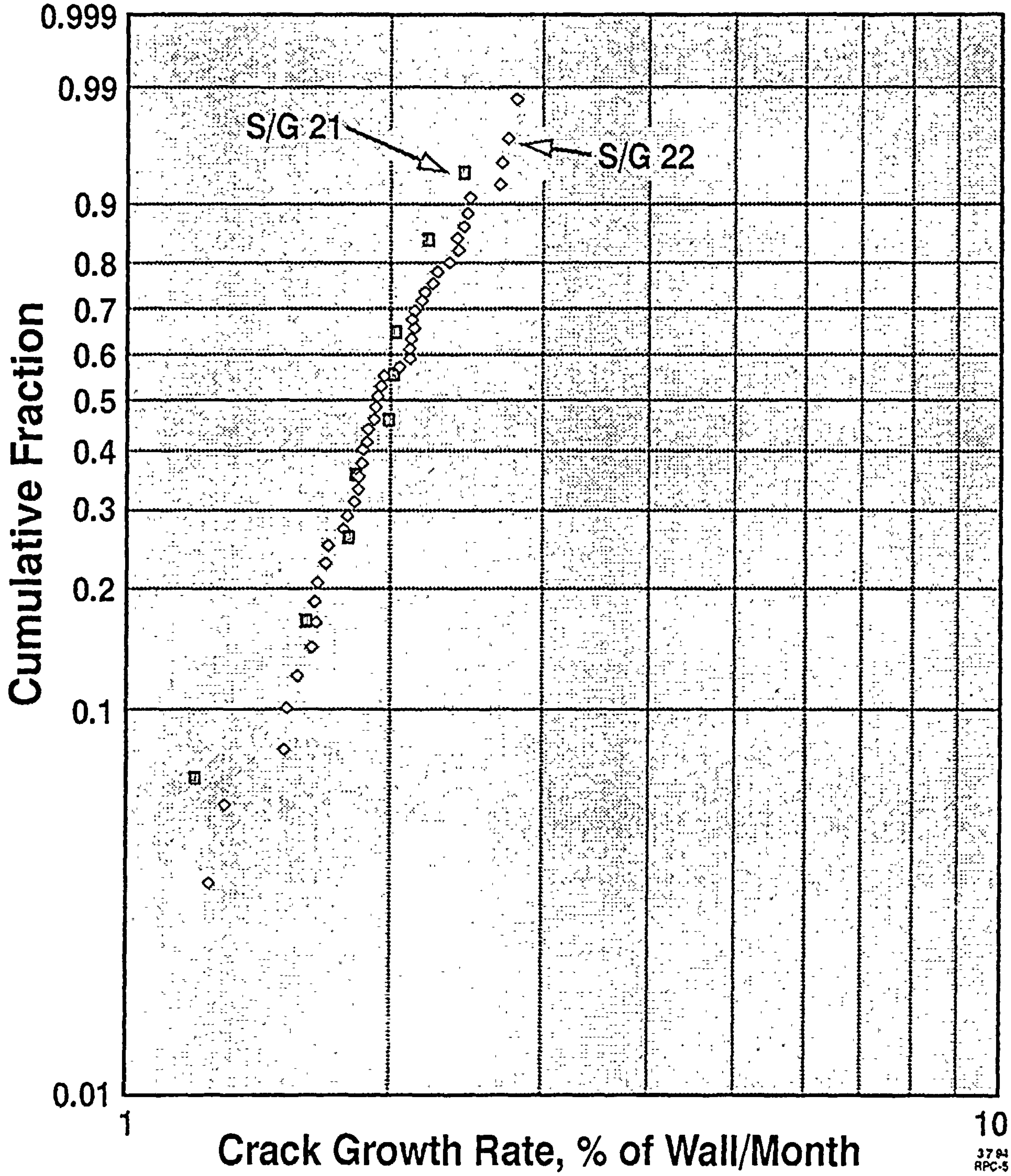


FIGURE VI-6

Weibull Probability Plot of Crack Growth Rates



Operational Time Limits For Reg. Guide 1.121

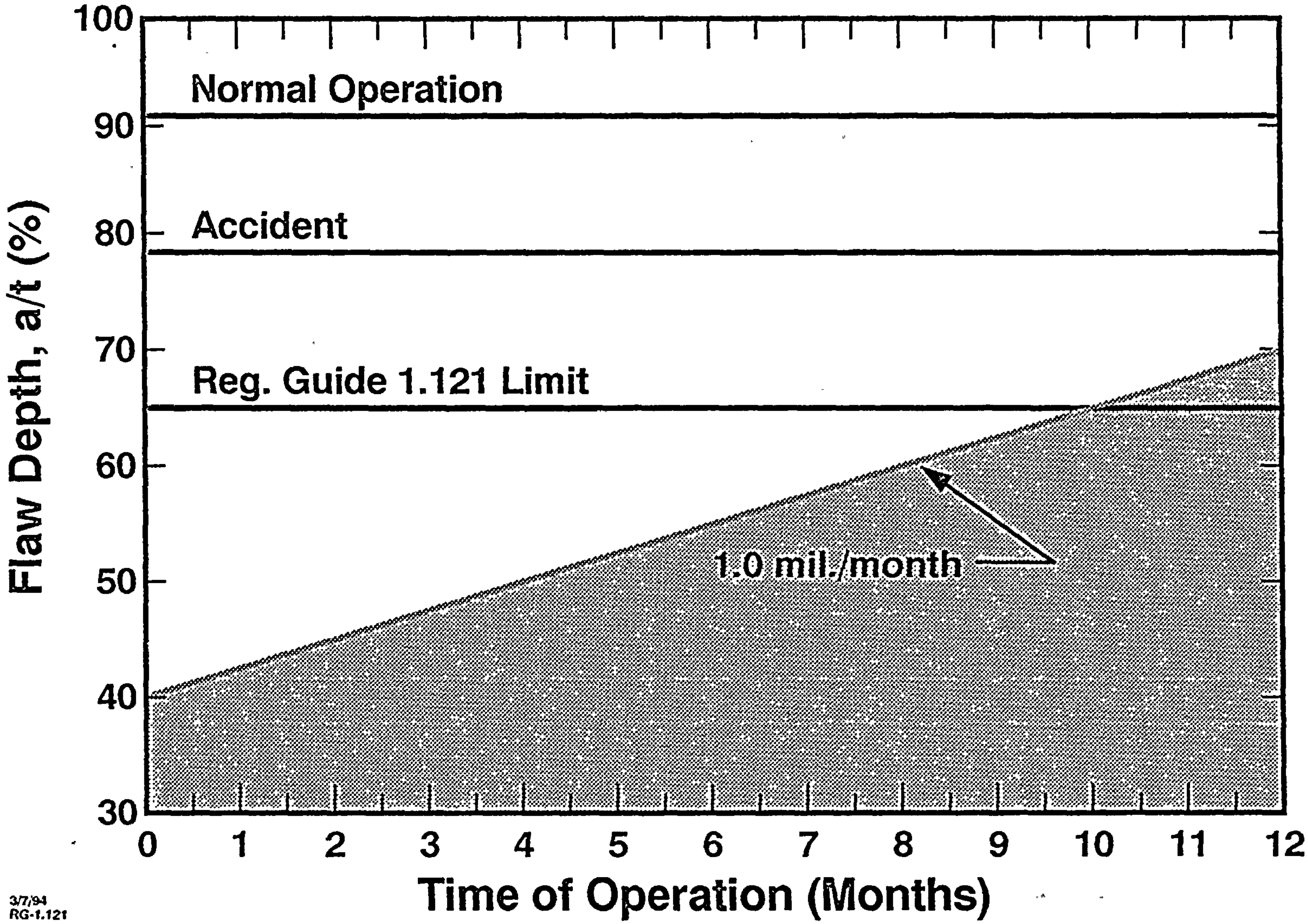


FIGURE VI-7

3/7/94
RG-1.121