December 29, 2000
RC-00-0377

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U. S. Nuclear Regulatory Commission
Washington, DC 20555

Gentlemen:

Subject: VIRGIL C. SUMMER NUCLEAR STATION
DOCKET NO. 50/395
OPERATING LICENSE NO. NPF-12
RESPONSE TO QUESTIONS DATED
DECEMBER 22, 2000
MSP 00-0244

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South Carolina Electric & Gas Company (SCE&G) submits the attached responses to the questions provided by the NRC by letter dated December 22, 2000. These questions pertain to the cracked weld in the "A" loop of the Reactor Coolant System, specifically about the integrity evaluation to support future operation.

Should you have any questions, please call Mr. Phil Rose at (803) 345-4052.

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Very truly yours,

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A001

Response to NRC questions received December 22, 2000

1. Discuss your plans for re-inspecting the nozzle welds, including the method(s) and scope of the inspections and the schedule for such inspections.

   RESPONSE
   As we stated in the presentation of December 20, 2000, we plan to perform our full 10-year, 3rd period of the 2nd interval, Inservice Inspection (ISI) in the fall of 2003. This is approximately 2 years, 9 months from this date. In this outage, we will perform the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code or Code) required non-destructive examinations (NDE). Any additional inspection methods developed by an industry initiative resulting from the "A" Hot Leg crack will be included.

   At present, we are making plans to re-inspect the hot leg nozzles in the spring of 2002 at Refuel 13 using the best available ultrasonic testing (UT) method, from the inside diameter. This inspection will be subject to the recommendations of the industry initiative, headed up by the EPRI managed Materials Reliability Project (MRP). We will also perform UT from the pipe outside diameter to correlate the data with that taken from the inside as necessary to establish the inside diameter inspection as the ISI baseline for the "A" hot leg. Plans for future eddy current (ET) examinations will be subject to recommendations developed by the industry initiative.

   The hot cell results have indicated that ET surface examination techniques will require further development before it can be qualified for this application. We proactively undertook the effort to perform ET examination in the present outage to ensure that we had comprehensive information regarding the condition of the pipes at V. C. Summer. However, it is our intent to continue with ET examinations in the future, subject to the industry initiative.

2. Discuss the basis for your statement that the frequency and extent of cracking at Ringhals is more severe than at V. C. Summer because of the double-V weld configuration.

   RESPONSE
   In the December 20, 2000 presentation to the NRC, two statements relative to Ringhals were included on the presentation materials.

The first statement was that PWSCC as an initiation mechanism is supported by (1) metallurgical examinations, (2) review of construction weld history (3) finite element analysis-2D, and (4) similarities with Ringhals. The arguments were presented in the order of significance, from direct correlation to general correlation. For example, the root cause is very specifically supported by the metallurgical investigations performed in the hot cell. Results from this investigation clearly showed an interdendritic corrosion mechanism strongly suggesting PWSCC. The weld history, presented in the October 25th meeting with the NRC in Atlanta, showed extensive repairs, including a complete removal by grinding of the inside diameter (360 degrees) portion of the weld and some very deep, through wall local repairs in the location of the crack. This is strong evidence but is somewhat indirect. A generic, 2-dimensional finite element analysis (FEA) was performed on the design joints of both Ringhals and V. C. Summer. The FEA supported the root cause, but this evidence is somewhat circumstantial in nature. Finally, the fact that the double-V weld joint used at Ringhals is somewhat similar to the as-repaired configuration of the "A" hot leg, generally supports the fact that the root cause of the A hot leg is similar to that found at Ringhals. The simple fact that Ringhals has seen cracking in Alloy 182 welds with repairs, generally supports the root cause.

The second slide mentioning Ringhals was presented in a similar order, which is from very direct correlation to more general correlation. The objective was to illustrate that the V. C. Summer "A" hot leg weld is unique in that the as-repaired configuration more closely resembles the Ringhals double-V weld design than it does the V. C. Summer J-bevel groove joint design. The wording of the bullet could be clearer in stating the general nature of the connection with the V. C. Summer weld.

We do not believe that we made the statement, and did not intend for it to be understood that Ringhals has a higher frequency or more extensive cracking than V. C. Summer.

3. Provide data and appropriate figures that characterize all indications found in all nozzle welds, including lengths (and depths, as available).

<u>RESPONSE</u>
There were no reportable indications by the Code UT in any of the welds except the loop "A" hot leg. The "A" hot leg indications have been removed through the spool piece replacement. The ET examinations revealed a number of indications in other nozzle welds. Those indications have been reported in the attached Wesdyne (December 5, 2000) final inspection report.

The reported indications were groupings of potentially relevant ET signals, and any grouping that showed a total length of 0.25 inch or longer was reported and

analyzed in Table 3-1 of WCAP-15615, Revision 1, which supports the return to power.

4. For all indications found in all nozzle welds, discuss how the ASME Section XI proximity rules combine these indications.

   RESPONSE
   The Section XI proximity rules cannot be directly applied to the ET indications, because both length and depth measurements from UT are required to do so. In this case (thick walled piping) there are no standard procedures for characterizing flaws found by ET inspection. The ET signals were grouped and combined by the inspecting personnel without the necessity of applying ASME Section XI proximity rules.

   Since the ET results can only provide the length dimension, other means were used to postulate the depth dimension and therefore the flaw shape, as described in Sections 4 and 5 of WCAP-15615, Revision 1.

   In the December 20th presentation in Atlanta, the presenter used ASME Section XI rules to illustrate the relative significance of the ET indications, using very conservative assumptions and postulating these to be flaws. The slide was intended to show that ASME Section XI would not reject these indications on the basis of length and depth if worse case uncertainties, as determined by the hot cell results, were applied to each indication. Using the Wesdyne report mentioned above, and based on orientation and location of the indications, there are no instances in which the grouping of indications would reduce the net section thickness of the pipe as determined by IWA-3390. However, we do not think it appropriate to conclude that these indications are treatable with ASME Section XI rules since, as discussed above, actual sizes and depths are not determinable solely from the ET examination. This is the basis for relying on the WCAP to disposition the ET indications and support safe operation of the plant.

5. Provide the bounding circumferential and axial cracks for each nozzle weld, and the technical justification supporting these determinations, including the ASME Code methodology used to evaluate these flaws.

   RESPONSE
   This information is discussed completely in WCAP-15615, Revision 1, supporting return to power. The methodology used is a direct application of Section XI, IWB 3640. The subcritical crack growth is covered in Section 4, and the flaw evaluations are discussed in detail in Section 5.

6. Provide your technical basis for the crack growth rate assumed in your determination that the nozzle welds are safe to operate for an additional cycle. Include your basis for the stress intensity factor (K) dependency and applications to various weld geometries. In particular, include a discussion of the finite element model utilized.

   a. If a limit load analysis was performed, provide the Z factors utilized.
   b. If a LEFM/EPFM analysis was performed, provide the material properties used.

   RESPONSE
   This information is discussed in Section 2 of WCAP-15615, Revision 1. The crack growth rate law was developed as part of an EPRI program carried out by Westinghouse over the last 2 years, and published as EPRI Technical report, TR-1000037, in June 2000. The report is reference 6 of WCAP-15615, Revision 1. The stress intensity factor expressions used are those for flaws in cylinders, as recommended in Section XI Appendix A. The original source is Raju and Newman.

   The stresses used in the analysis came from the loadings described in Section 2 of the report, which are specific to V. C. Summer. The loads were converted to stress distributions using standard formulae for cylindrical pipes. The other source of stresses was the welding residual stresses, which were taken from the recommended distributions for such stresses published with the technical basis for pipe flaw evaluation in Section XI. The residual stress distributions are shown directly in Figure 4-3 of the report, and in reference 3 of the WCAP.

   The fracture toughness of the Alloy 182 weld metal is equal to that of the base metal, unlike stainless steel flux welds. Therefore the fracture analysis used a limit load failure mechanism, and no Z factors were needed

7. Provide the technical justification for your statement that the residual stresses in the hoop direction are greater than those in the axial direction, and quantify these differences.

   a. Provide all operating stresses in both the circumferential and axial directions in all nozzle welds.

   b. Provide a comparison of the expected axial and circumferential residual stress distributions in the "A" loop nozzle weld which underwent extensive repairs to the axial and circumferential residual stress distributions in the other nozzle welds without extensive repairs. Make this comparison as quantitative as possible based on existing information and provide the bases for the expected stress distributions and a description of the models or testing used to develop them.

c. Provide a discussion of any available data regarding the threshold temperatures and stresses for PWSCC in Alloy 182/82. Using these threshold values discuss the susceptibilities of the "A" loop nozzle weld which cracked to the other nozzle welds.

d. Using your assumed stress distributions and crack growth assumptions, provide your calculated estimate of (1) the time it took for the axial through wall crack in the "A" hot leg to grow through wall and (2) the time it would take for an assumed axial flaw in one of the other hot legs to propagate through wall after initiation.

RESPONSE

The technical justification is provided in the original source documents for reference 3 of WCAP 15615, Revision 1. These residual stresses in piping flaw evaluations have been used since the publication of IWB 3640 in 1983. It is a fact that the residual stresses are different, but it is not clear which is actually higher, as may be seen in Figure 4-3 of WCAP-15615, Revision1. The operational stresses are higher in the hoop direction than in the axial direction, as are the total stresses when the residuals are added.

a. The loadings were provided completely in Section 2 of WCAP-15615, Revision 1, and simple piping stress formulae were used to obtain the stresses.

b. The fracture evaluation did not differentiate between the loop "A" hot leg nozzle, which underwent extensive repairs, and the other nozzles. This repair information was used only qualitatively as part of the root cause determination.

c. PWSCC is a thermally activated process, and the time to crack initiation is exponentially related to temperature. The crack growth rate has a similar dependence to temperature, so a flaw in a hot leg would grow at ten times the rate of a flaw in the cold leg. This has been demonstrated by testing, as discussed in the WCAP, in Section 4. The threshold temperature for cracking in this material has not been definitively determined, but no PWSCC has been experienced at temperatures below 500 degrees F.

d. The crack growth projections for various assumed flaws of both axial and circumferential orientations are shown in the figures of Section 4 of the WCAP. Using these figures, projected growth of a flaw of a given shape can be estimated. Each of the figures was developed for a fixed flaw shape and orientation, assuming the flaw was sufficiently deep to initiate cracking (e.g. K > 9 Mpa-rt-m).

To determine the service time to grow from one depth to another, draw a horizontal line across at the starting depth, and another horizontal line across at the ending depth. At the point where the starting depth line crosses the curve, project down to the time axis, and this is the starting time. At the point where the ending depth crosses the curve project down to the time axis, and this will be the ending time. The difference between the ending time and the starting time is the estimated time to get from the starting to the finishing depth.

The figures each have two curves, one marked 30 and the other marked 'zero'. These are the curves with and without residual stress. In each case the most limiting curve was used.

Using the curve which includes residual stress in Figure 4-4, the time for the initiated flaw in the loop A hot leg to propagate through wall can be estimated at 4.8 years. Using the curve without residual stresses would lead to an estimate of 13.4 years.

A number of estimates have been provided for various flaws assumed as a result of the ET indications in the WCAP, in Sections 4 and 5.

8. Discuss your plans for enhancing your leakage detection capabilities, including trending and revised action levels. Describe administrative procedures you have in place or plan to put in place to provide operators guidance on how to monitor for and respond to potential unidentified reactor coolant system leakage. Include the types and frequencies of monitoring methods as well as action levels and responses.

RESPONSE

The existing design of leak detection systems at V. C. Summer fully satisfies the performance requirements of Regulatory Guide 1.45 (May 1973). The leak detection hardware is supported by visual inspections, and engineering oversight of plant operation, including the data from leak detection systems and visual inspections.

Plant procedures and programs have been developed to provide testing requirements of the installed equipment and provide guidance on responding to abnormal indications of leakage. The Surveillance Test Procedures (STP) include procedures to check for leakage (STP 114.002 and STP 114.003) and are performed at a frequency to ensure that leakage approaching the Technical Specification limit of 1.0 gpm will be discovered. STP 114.002 uses the plant computer to calculate leak rates based on water inventory balances with an action level of 0.8 gpm. This surveillance is performed once a day with the TS requirement of once per 72 hours. Should the surveillance results indicate leakage of 0.8 gpm,

direction is provided to perform a more detailed calculation (PTP 175.001) to quantify the identified and unidentified leakage.

Annunciator Response Procedures (ARP) are used by the operations staff to provide guidance whenever a Main Control Board indication alarms. Direction is provided to verify the alarm condition and perform predetermined corrective actions.

Operators are trained on the use of the ARPs and required responses. When an annunciator alarm is received, the procedure is reviewed to determine probable causes and course of action. These procedures are kept within reach at the main control board and are used during simulator training.

The capability of the leakage detection system has been repeatedly demonstrated over the plant's operating history. The following examples are used as illustration:

a. On December 8, 1982, operators noted frequent automatic makeup to the RCS. An inventory balance was performed and unidentified leakage was found to be 1.56 gpm. Operators promptly investigated and discovered that a drain valve on a reactor coolant pump seal injection filter (outside containment, non-RCS) was leaking approximately 0.7 gpm.

b. On October 7, 1986, the reactor was shut down because the operators could not accurately verify the amount of unidentified leakage. Over a period of three weeks, identified leakage had increased slowly to 3.91 gpm. During performance of the required inventory balance, the reactor coolant drain tank (RCDT) relief valve opened and released an unknown volume of water to the Reactor Building Leak Detection Sump. Since the RCDT level is an input to the leak rate calculation, the actual leak rate could not be determined. Upon repair of the relief valve, unidentified leakage was 0.0 gpm

c. On December 5, 1994, RCS unidentified leakage was assessed to be 0.8 gpm. Operators initiated an investigation and concluded that 0.2 gpm was attributed to an unidentified source inside the reactor building. A visual inspection was conducted inside the reactor building and a leaking pressure boundary weld on a reactor coolant pump seal injection line was located. The plant was placed in cold shutdown to repair the weld.

d. On October 7, 2000, during visual inspections following shutdown for RF-12, plant personnel identified an accumulation of boric acid residue under the loop "A" hot leg. Further investigation resulted in the identification of pressure boundary leakage on October 12, 2000. Throughout the preceding cycle, unidentified leakage trended between 0.2 and 0.3 gpm.

Despite the success of the existing programs and systems, the following enhancements will be instituted:

a. The (particulate) radioactivity monitoring channel of RM-A2 continuously monitors the Reactor Building atmosphere. The Final Safety Analysis Report states that the sensitivity of this component is based in part on the activity in the RCS. Since the industry has been developing new fuel designs that are less prone to leaking, activity levels in the reactor coolant system (RCS) have decreased without a corresponding increase in sensitivity of this method of detecting leaks. This method will continue to be utilized in the leakage detection system but may not be effective in detecting small leaks given the present activity levels in the RCS. With the capability of the airborne radiation monitors diminished, other methods were investigated.

   SCE&G will perform noble gas sampling and analysis to provide additional verification of RCS integrity. A comparison will be made between the concentrations of Argon-41, Xenon-133, and Xenon-135 in the RCS and the concentrations of these isotopes in the reactor building atmosphere. This information cannot by itself identify or quantify a leak, however it will provide additional information to detect changes inside the Reactor Building which may require investigation. A procedure to perform this sampling and analysis will be developed by unit startup.

b. The plant Technical Specifications require that a RCS water inventory balance be performed at least once per 72 hours. This calculation will be performed daily. Currently the plant computer performs this requirement of our Technical Specifications. This calculation uses 1 minute averages to calculate a leak rate and is capable of detecting approximately 0.25 gpm change in unidentified leakage. This information is not currently trended; however, V. C. Summer will perform this calculation once per day and retain the information for trending. Investigation will begin at or before 0.8 gpm.

c. VCSNS has always depended on reactor building sump level and rate of change as part of the leakage detection system. A 15-minute average is computed which provides input into a leak rate calculation. Although the data from the level instruments are trended on the computer, there is no alarm function until the TS limit is reached. We will add a computer-generated alarm (OPCRIT) at 0.75 gpm or 0.5 gpm step change such that operators will be alerted prior to the leakage exceeding TS limits. The OPCRIT alarm is a plant computer generated alarm displayed on a monitor in the control room, accompanied by an audible chime to ensure operators are aware of the change in plant condition. Many computer points that can alarm in this manner are not alarmed on the main control board. When

alerted by this alarm, operators will investigate to verify the validity of the condition.

d. Additionally, the procedures for boric acid inspections, both to satisfy Generic Letter 88-05 and ASME Code, Section XI, will be enhanced to provide additional detail for the inspection and evaluation of RCS leakage. Specific components and locations to be inspected will be listed and guidance will be provided on methodologies for evaluation.

9. Identify all ASME Class 1 components at V. C. Summer with Alloy 82/182 Inconel welds. Include a discussion of the safety consequences if these welds develop cracks similar to that seen on the "A" hot leg nozzle weld. Address your plans for inspection of these welds.

RESPONSE

In 1990, the NRC issued Information Notice 90-10 to alert the industry that PWSCC was discovered in Alloy 600 materials used in applications other than steam generator tubing. It was suggested that utilities review their nickel based alloy applications. These components have been identified in the Westinghouse letter MSE-MNA-368 (94), Revision 1.

In addition to the nozzle to pipe welds for the reactor vessel, the nozzle to safe end welds on the pressurizer and steam generator channel-head nozzle to safe end welds contain Alloy 82/182. The steam generator nozzle to safe end joints have been isolated from primary water with a cladding of Alloy 52. This was included in the fabrication of the Delta-75 steam generators for V. C. Summer.

The pressurizer nozzle to safe end connections include the safety and relief valve nozzles, the spray nozzle and the surge line nozzle.

All the piping connections in the main loop as well as the connections to the pressurizer have been carefully fabricated and inspected to meet ASME Code and other regulatory requirements. Leak before break has been demonstrated for the entire main loop for VC Summer, and has been approved by the NRC. Although leak before break has not been specifically demonstrated for the surge line to the pressurizer, it has been demonstrated for a number of plants, and our judgement is that it could be demonstrated for VC Summer as well. The significance of this is that there is a significant margin between the flaw size at which leakage would be detected, and that which could lead to piping failure.

Since the cracks which have been observed to date in the hot cell are predominantly axial, the safety consequences are further reduced. The cracking is limited to the

susceptible material Alloy 82/182. This limits the propagation in the axial direction to the width of the weld.

Inspections on these identified Alloy welds for the future will include the following:

a. All subject welds are in the plant Inservice Inspection program, and will be inspected in the manner and at the frequency established by the program.

b. V. C. Summer will follow the industry guidance on dissimilar metal welds.

c. V. C. Summer will enhance the boric acid inspection program to ensure that all subject welds are included in the population of components that are visually inspected at refueling outages or when appropriate plant conditions permit access.

10. Since leak before break (LBB) is approved for your RCS main loop piping, and PWSCC has been identified as a cracking mechanism for the Alloy 82/182 welds, discuss your plans to mitigate this cracking mechanism such that your LBB analysis remains valid.

RESPONSE
This issue has been discussed in Section 6 of WCAP 15615, Revision 1.

V.C. SUMMER

REACTOR VESSEL OUTLET NOZZLE TO PIPE AND INLET NOZZLE TO ELBOW WELDS

EDDY CURRENT EXAMINATION SUMMARY REPORT
Revision 2

WesDyne International

December 5, 2000

SUMMARY

Pursuant to the resolution of utility nonconformance notice 00-1396 regarding indications found on the A Loop hot leg nozzle to pipe weld (outlet nozzle @ 25°), automated nondestructive examinations were performed on all six V.C. Summer reactor vessel hot leg and cold leg nozzle to pipe weld inside surfaces from November 4 through November 7, 2000. Scanning was performed with a single WesDyne SUPREEM robot, upper platform configuration, seated on the ledge of the reactor vessel flange.

Examinations included automated Ultrasonic Testing with data acquired and analyzed on the WesDyne Paragon system. Automated Eddy Current Testing was employed as a complimentary NDE technique with data acquired and analyzed on the Intraspect system. A high-resolution camera system was also attached to the nozzle end-effector for evaluation of the pipe weld inside surface. Examinations and qualification activities were performed by WesDyne and witnessed by V.C. Summer technical representatives and consulting utility NDE specialists, EPRI NDE specialists, USNRC resident, regional and consulting NDE specialists and the V.C. Summer plant ANII. This report summarizes the results of the Eddy Current Examination.

Technique qualification was performed at the site on an EPRI-supplied Safe-End Test Block (Specimen 19-36-2.5-PWR-316-BN). Two flaws with the shallowest depth were selected for eddy current technique qualification (the flaw "F" circumferentially oriented, and the flaw "K" axially oriented). The eddy current technique was able to detect and accurately map the surface contour (length) for both flaws. Characteristic graphics from these two flaws are shown in Figures 3 and 4. As seen in these figures, both of these flaws were detected with relatively high signal resolution (Signal-to-Noise Ratio: 10 or greater).

Following the ET qualification effort at the site, all six VC Summer reactor vessel nozzle safe-end regions were inspected using this technique. The results have shown the existence of several ET indications in nozzles N-25, N-95, N-145, N-265, and N-335. Only one indication was detected in nozzle N-215. Detailed location, signal amplitude, phase angle and characteristic orientation for each indication are enclosed in eddy

current result tables and graphics (see Examinations section). Characteristic orientation is based upon impedance plane quadrant orientation of the signal response as compared to known reflector orientations.

The following conclusions can be obtained from the ET NDE results:

1) The detected indications in the RPV nozzles have produced eddy current signal responses similar in character to ones obtained from flaws in the EPRI Test Block and notches in the WesDyne ET Calibration Block (Surry-1-B).

2) None of the ET signal magnitudes produced from the examinations were as large as the Axial Flaw "K" in the EPRI Test Specimen. The through-wall crack detected in "A" Hot Leg did produce a signal magnitude greater than the 0.050" deep axial calibration notch (Surry-1-B block).

3) The "A" Hot Leg Spool Piece cutout should be destructively tested to confirm the nature of ET indications recorded in areas where no recordable UT indications were reported. Specifically, indications located in the vicinity of 250 to 265 degree azimuth (0 top, clockwise positive looking out from vessel centerline) should be analyzed to provide a representative characterization of the material anomalies producing the ET indications to assist in dispositioning ET indications found in other nozzles. At the time of this writing, the destructive testing in this area has shown that ID surface-breaking cracks do exist in this region. The nature and character of the destructive analysis will be documented in a separate report.

4) The nature of ET indications in the clad regions is different from indications found in the weld regions. Due to the lack of correlation with the secondary ET probe and the unusually linear nature of the indications, these indications may be related to surface imperfections not associated with degradation.

5) Conservative grouping of ET indications was performed during the ET data analysis and is presented in the report conclusions. If stress corrosion is the underlying degradation mechanism, the aligned indications may reflect multiple initiation sites.

QUALIFICATION

On November 2, 2000 qualifications for the Ultrasonic and Eddy Current test systems were performed at the V.C. Summer plant site using an EPRI supplied 360° Supplement 10 flawed specimen having similar materials and weld joint geometry as the V.C. Summer plant reactor vessel hot leg to pipe weld joint (Specimen 19-36-2.5-PWR-316-BN, Ref. Appendix A). The qualifications were conducted "non-blind" with agreement by all parties on demonstration protocol and the selection of crack sizes and types.

A test was also performed at the site on a WesDyne-supplied test block, "Surry Safe-End Mock-up" (Westinghouse drawing 6439E23, Ref. Appendix B) to determine the effect of ID surface irregularities on the ET results. The Surry Safe-End Mock-up contains four sections depicting typical field weld root conditions for the nozzle-to-pipe weld area. The mockup materials and construction are very similar to the V. C. Summer outlet nozzles. No significant ET signal deviation was caused by scanning over the surface irregularities in this block as compared to the smooth surface conditions on the ID of the EPRI-supplied Safe-End Test Block used for qualification.

Eddy Current Qualification Protocol

One spring-loaded eddy current probe (primary probe sensitive to axial and circumferential indications) assembly was placed in the actual exam head and scanning was performed with an Amdata 5090 scanner at 4 inches per second using 0.125-inch increments. For the actual nozzle examination two probes were used in the scanning sled. These two probes are identical plus point coils, permanent magnet in X rotation orientation. The primary probe is sensitive to circumferential and axial flaws. The secondary probe is rotated 45 degrees for better sensitivity to off-axis (e.g., 45 degree) indications. Operating frequencies were 250 and 150KHz. Acquisition was performed

using the Intraspect EC Data Acquisition system at a rate of 40 samples per inch along the scan axis. Eddy Current calibration was performed in accordance with WesDyne procedure CGE-ISI-207-ET, Rev. 0 using the generic bi-metallic calibration block Surry-1-B containing EDM notches (Ref. CGE-ISI-207-ET, Rev. 0).

One circumferential and one axial-radial flaw from the Supplement 10 specimen was chosen for the qualification demonstration. Two flaws with the shallowest depth were selected for eddy current technique qualification (the notch "F" circumferentially oriented, and the notch "K" axially oriented).

Results of Eddy Current Qualification Demonstration

Calibration Response

The characteristic lissajous signal for notch "A" (0.050" deep circ. notch in inconel buttering) in the reference block (Surry-1-B) is shown in Figure 1.

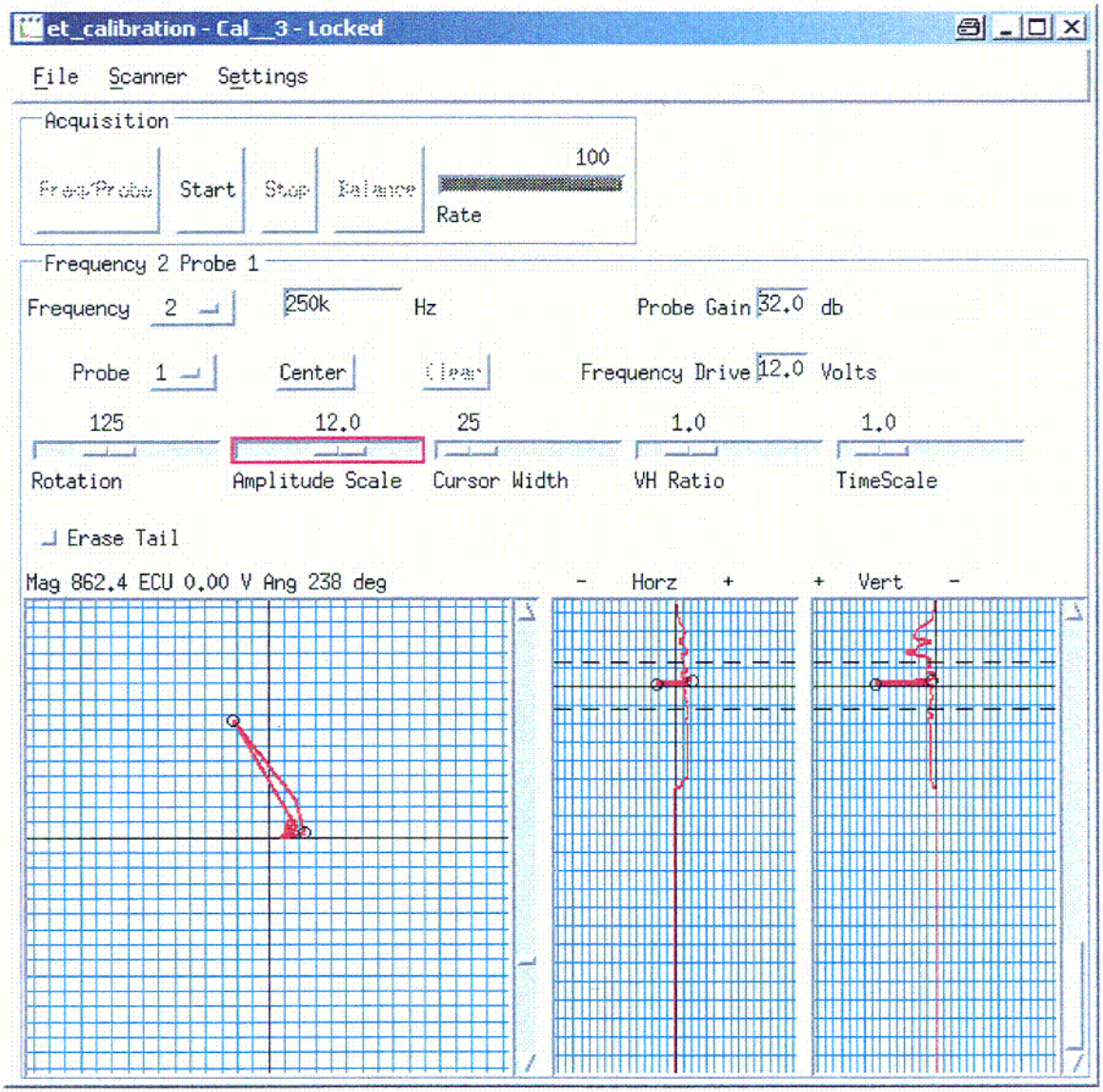


Figure 1
Lissajous from Circumferential Notch in Reference Block Surry-1-B
(Circumferential Notch - "A", in Inconel Buttering; Depth: 0.050")

The characteristic lissajous signal for notch "G" (0.050" deep axial. notch in as welded cladding) in the reference block (Surry-1-B) is shown in Figure 2.

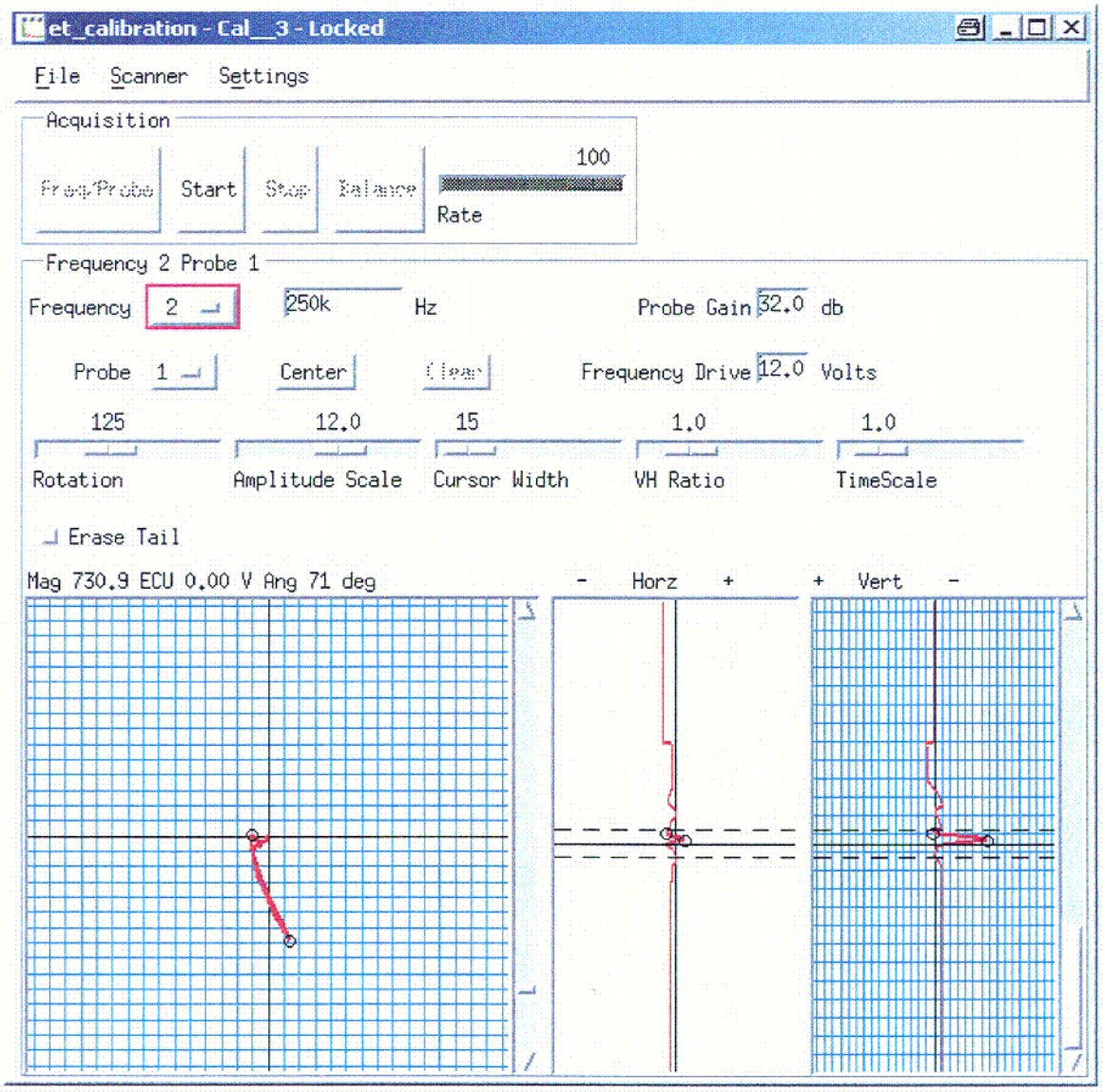


Figure 2
Lissajous from Axial Notch in Reference Block Surry-1-B
(Axial Notch – "G", in As Welded Cladding; Depth: 0.050")

Supplement 10 Specimen Response

Circumferential crack "F" is a 5.504 inch long, 0.380 inch deep crack located in the weld region of the Supplement 10 Specimen. As seen in Figure 3, detection of the circumferential crack "F"is seen in the 2nd quadrant of impedance (up, left) at approximately 10:1 signal to noise with an amplitude equal to the calibration notch.

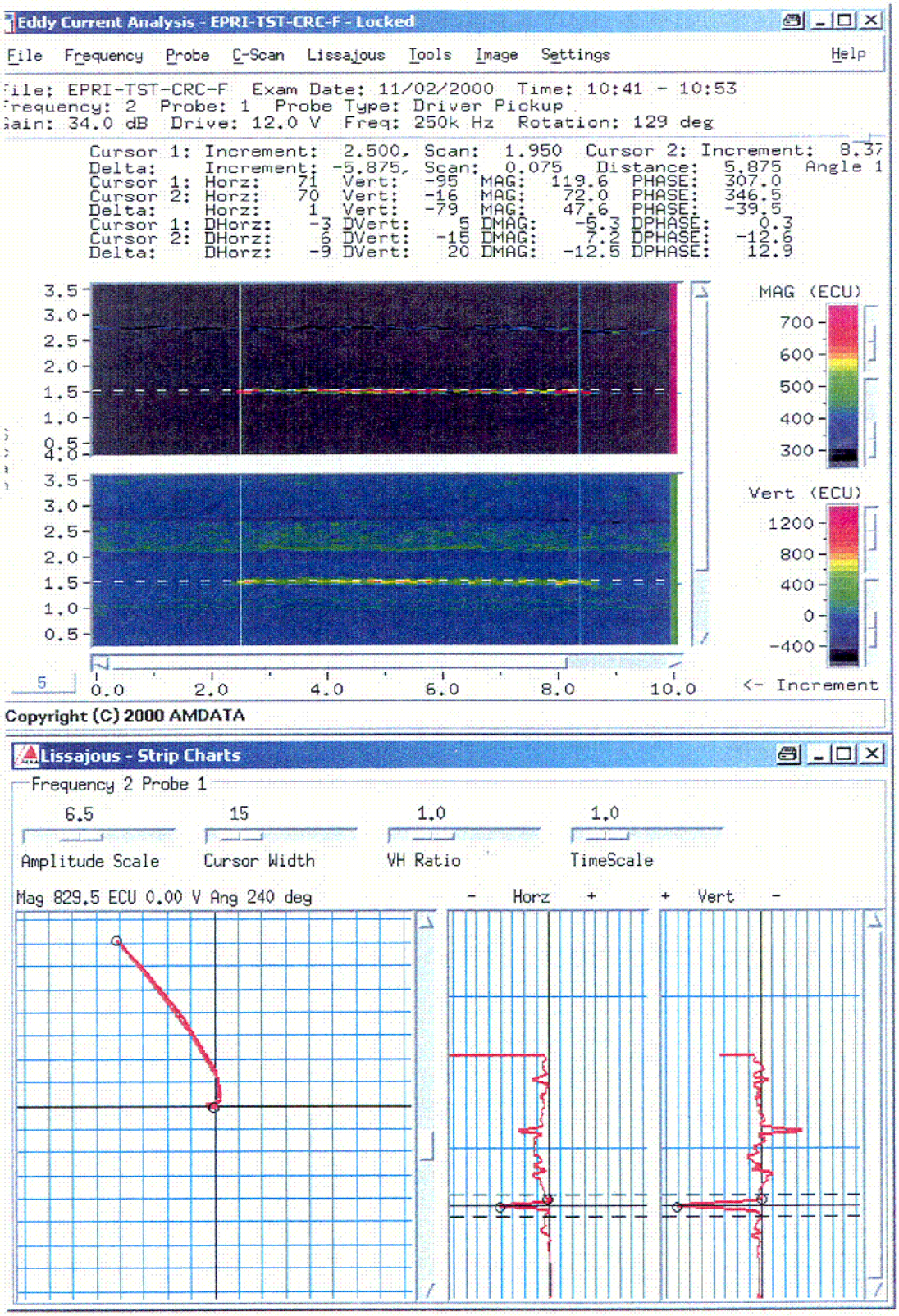


Figure 3
EPRI Safe-End Test Block, Eddy Current Response from Circumferential Flaw -"F"

C03

Axial crack "K" is a 0.468 inch long, 0.380 inch deep crack located in the weld region of the Supplement 10 Specimen adjacent to the buttering section. Detection of the axial crack (Figure 4) is seen in the 4th quadrant of impedance plane (down, right) at approximately 10:1 signal to noise with an amplitude approximately 20% greater than the calibration notch. Length measurements for both cracks were within .125" of actual.

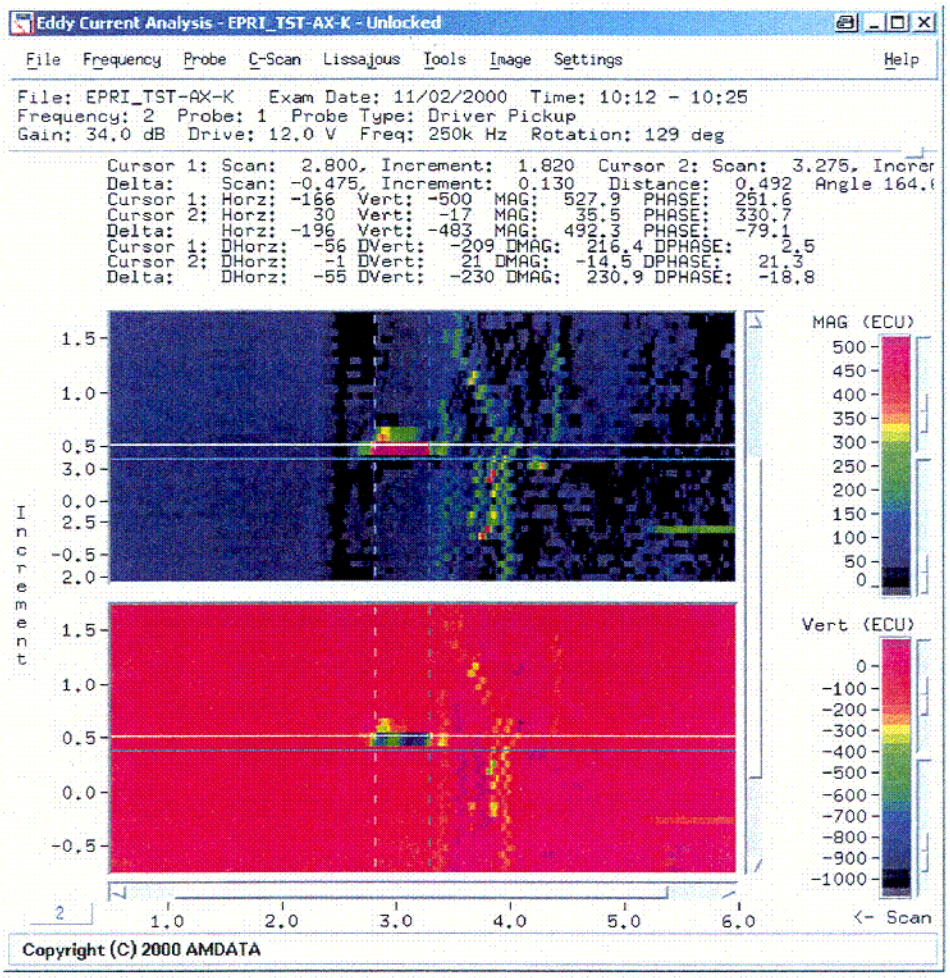


Figure 4
EPRI Safe-End Test Block, Eddy Current Response from Axial Flaw -"K"

C04

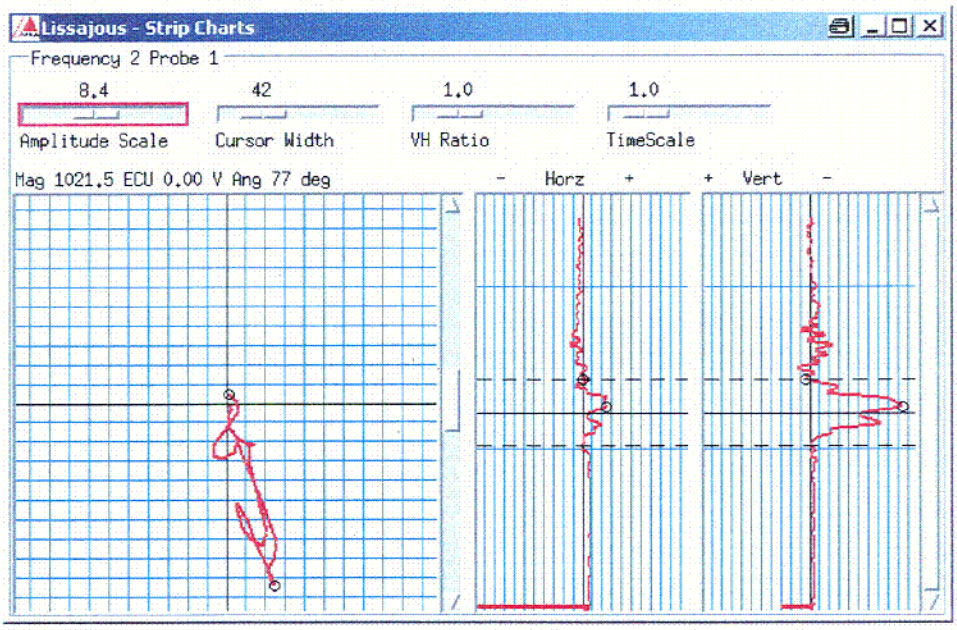


Figure 4
EPRI Safe-End Test Block, Eddy Current Response from Axial Flaw -"K" (Cont.)

EXAMINATIONS

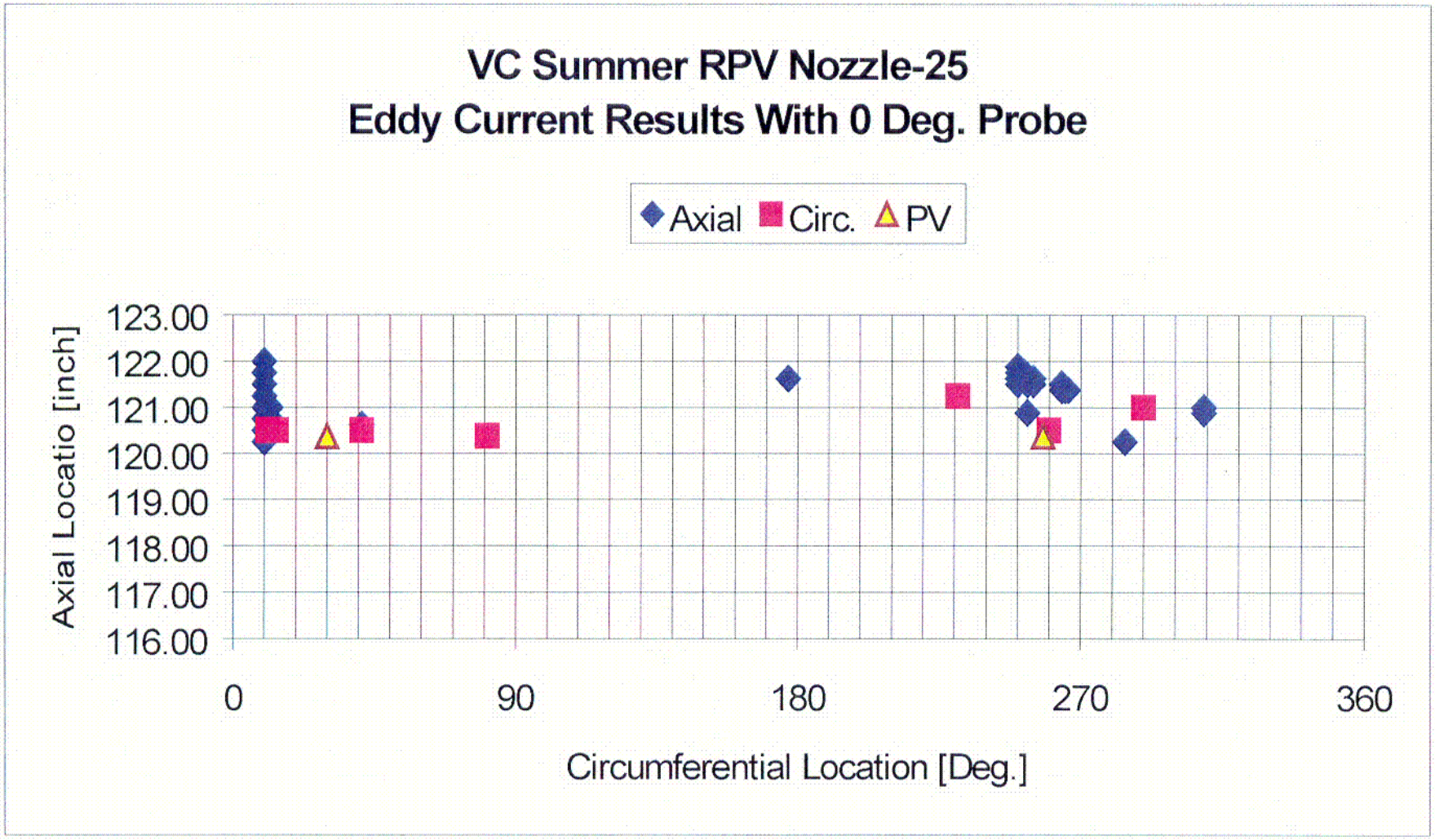
ET examinations of the V. C. Summer RPV nozzles were performed in accordance with WesDyne procedure CGE-ISI-207-ET, Rev. 0.

Circumferential scans were performed in each of the six RPV nozzle-to-pipe regions, using two ET probes in a single sled assembly (Ref. EPP). The primary probe is sensitive to axial and circumferential indications. A secondary probe, rotated 45 degrees from the primary probe, was also used for additional characterization of off-axis indications. The secondary probe data does not alter the primary probe ET examination results and is not included in this summary report for clarity. This secondary data will be included in the detailed final report containing all supporting documentation for the UT and ET exams.

The detailed examination results are tabulated for each of the six RPV nozzles, and are enclosed below. In addition to the tabular presentation, a plot for each nozzle is attached with characteristic indications and their axial and circumferential locations. Eddy current signal responses from one characteristic indication from each of the six nozzles are shown in Figures-5 to 11.

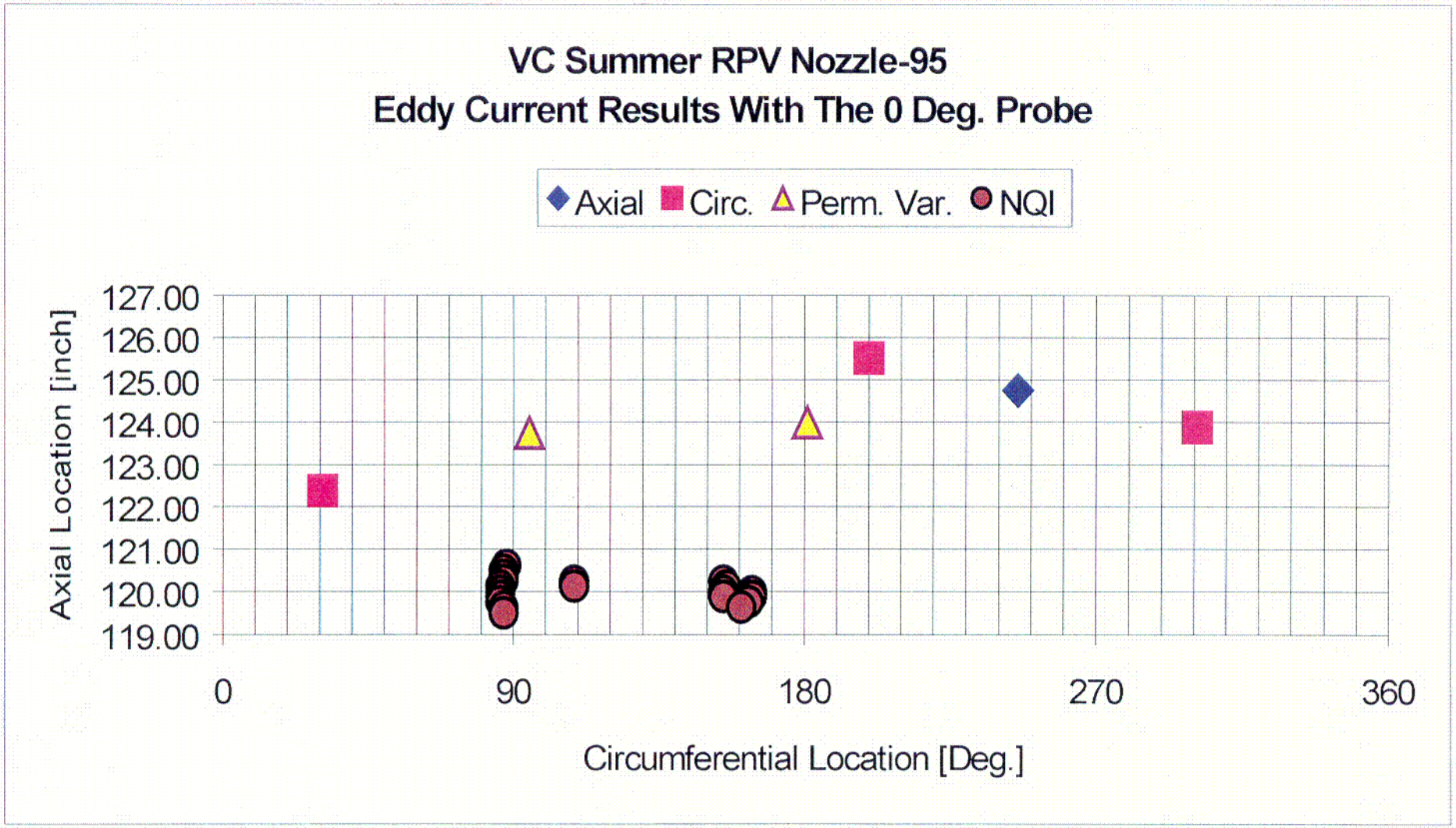
VC Summer RPV Nozzle N-25					
Axial Location [inch]	Circ. Loc.	[deg]	Signal Amplitude [ECU]	Signal Phase [deg]	Orientation
122.000	(1)	10	438.5	244	Axial
121.875	(2)	250	275.5	249	Axial.
121.750	(1)	10	560.4	243	Axial.
121.750	(2)	250	376	255	Axial.
121.750	(3)	252	308.8	250	Axial.
121.625		177	343.7	230	Axial.
121.625	(2)	250	265.7	250	Axial.
121.625	(3)	252	248	257	Axial.
121.625	(4)	255	181.4	237	Axial.
121.500	(1)	10	179.4	259	Axial.
121.500	(2)	250	95.5	264	Axial.
121.500	(3)	253	94.3	238	Axial.
121.500	(4)	255	351.9	247	Axial.
121.500	(5)	264	335.9	246	Axial.
121.375	(5)	264	259.2	246	Axial.
121.375		265	78.4	300	Axial.
121.375		266	82.6	291	Axial.
121.250	(1)	10	500.5	243	Axial.
121.250		231	113.8	77	Circ.
121.000	(1)	10	961.5	244	Axial.
121.000	(6)	12	160.8	261	Axial.
121.000		290	247	58	Circ.
121.000	(8)	309	95.3	283	Axial.
120.875		253	210.4	248	Axial.
120.875	(8)	309	101.7	277	Axial.
120.750	(1)	10	689.2	254	Axial.
120.750	(6)	12	260.4	246	Axial.
120.625		41	170.8	95	Circ.
120.500	(1)	10	791.3	247	Axial.
120.500	(7)	11	436.3	57	Circ.
120.500	(7)	12	436.3	57	Circ.
120.500	(7)	13	436.3	57	Circ.
120.500	(7)	14	436.3	57	Circ.
120.500		41	126.5	281	Axial.
120.500		260	161.6	66	Circ.
120.375		30	383.2	148	Perm. Var.
120.375		81	198	89	Circ.
120.375		258	295.6	127	Perm. Var.
120.250	(1)	10	199.4	255	Axial.
120.250		277	168.1	283	Axial.

Note: 1) **Perm. Var.** - Material local permeability variation
2) **(Ind. No.)*** - Same indication (Ind. No.) detected with multiple scans


VC Summer RPV Nozzle-25
Eddy Current Results With 0 Deg. Probe
Axial
Circ.
PV
Axial Locatio [inch]
123.00
122.00
121.00
120.00
119.00
118.00
117.00
116.00
0
90
180
270
360
Circumferential Location [Deg.]

VC Summer RPV Nozzle N-45				
Axial Location [inch]	Circ. Loc. [deg]	Signal Amplitude [ECU]	Signal Phase [deg]	Orientation
125.500	(5) 200	438.1	66	Circ.
124.750	246	208.8	247	Axial.
124.000	181	1078.7	136	Perm. Var.
123.875	301	172.2	80	Circ.
123.750	95	481.1	110	Perm. Var.
122.375	31	175.5	71	Circ.
120.625	(1) 88	287.2	52	NQI
120.500	(1) 87	287.3	65	NQI
120.375	(1) 87	195.9	69	NQI
120.250	(1) 87	250	48	NQI
120.250	(2) 109	254.2	54	NQI
120.250	(3) 155	259.1	67	NQI
120.125	(1) 86	237.4	57	NQI
120.125	(2) 109	367.9	68	NQI
120.125	(3) 156	419.5	63	NQI
120.000	(1) 86	438	71	NQI
120.000	(3) 155	656.8	78	NQI
120.000	(4) 164	239.2	69	NQI
119.875	(4) 164	338.6	69	NQI
119.875	(3) 155	562	69	NQI
119.875	(1) 86	526.7	67	NQI
119.750	(1) 86	649.6	74	NQI
119.750	(4) 163	276.8	64	NQI
119.625	160.6	285.7	76	NQI
119.625	(1) 87	450.4	67	NQI
119.500	(1) 87	620.4	71	NQI

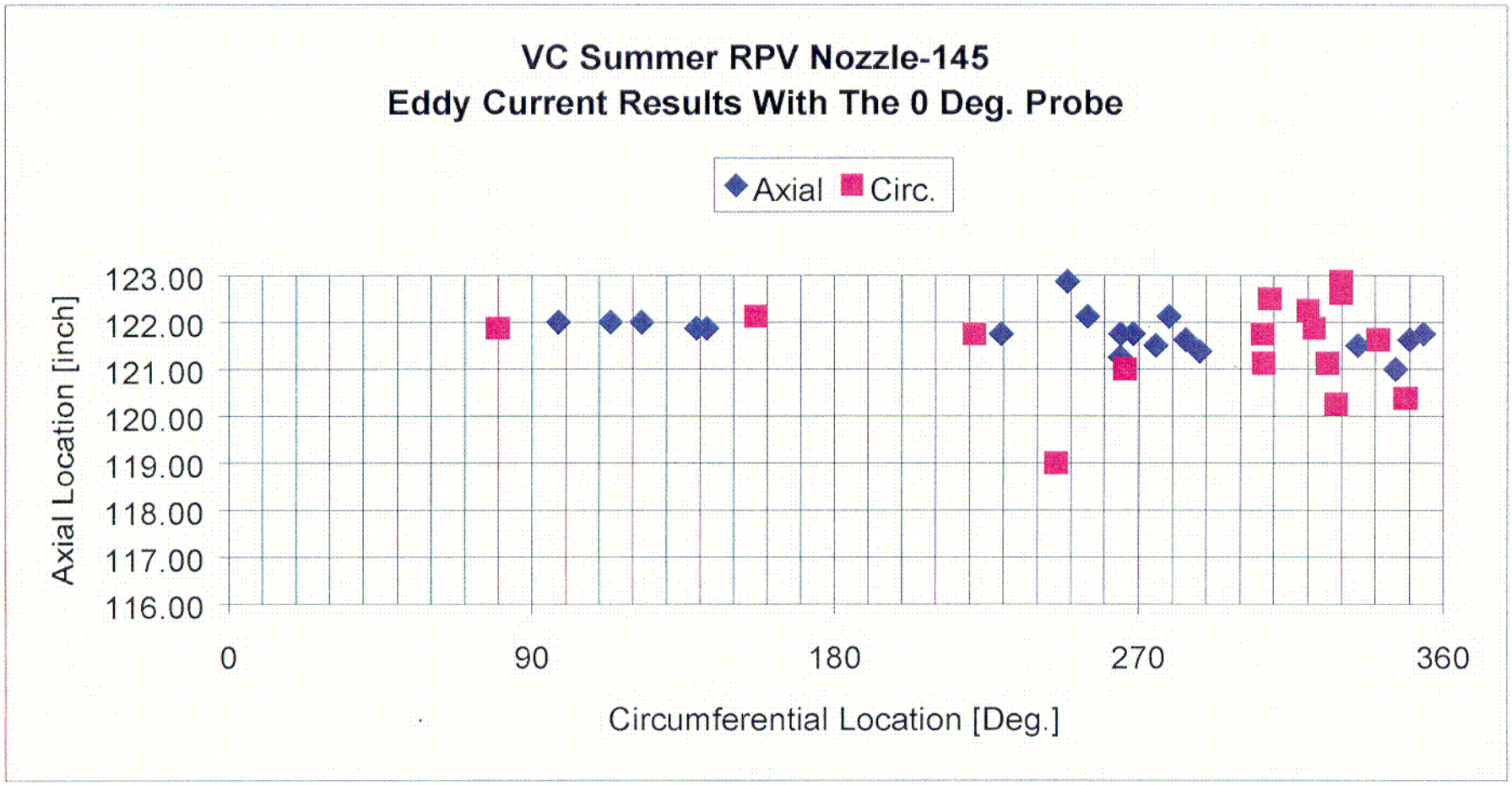
Note: 1) **Perm. Var.** – Material local permeability variation
2) **NQI** – Non Quantifiable Indication


VC Summer RPV Nozzle-95
Eddy Current Results With The 0 Deg. Probe
Axial
Circ.
Perm. Var.
NQI
Axial Location [inch]
127.00
126.00
125.00
124.00
123.00
122.00
121.00
120.00
119.00
0
90
180
270
360
Circumferential Location [Deg.]

C07

VC Summer RPV Nozzle N-145				
Axial Location [inch]	Circ. Loc. [deg]	Signal Amplitude [ECU]	Signal Phase [deg]	Orientation
122.875	249	114.2	300	Axial.
122.875	330	254.5	67	Circ.
122.625	330	128.7	69	Circ.
122.500	(1) 308.9	279.3	67	Circ/Multi.
122.250	320.2	216.1	70	Circ.
122.125	157	345.3	62	Circ./Multi
122.125	255	132.5	229	Axial.
122.125	279	129.2	230	**Axial/Multi.**
122.000	97.9	142.6	248	**Axial./Multi**
122.000	113.4	375.4	242	**Axial./Multi**
122.000	122.6	153.6	222	Axial.
121.875	80	114.3	57	Circ.
121.875	139	281.4	245	Axial.
121.875	142	179.9	280	Axial.
121.875	322	130	50	Circ.
121.750	221.6	158	68	Circ.
121.750	229.3	222.2	264	Axial.
121.750	264.7	242.5	245	**Axial./Multi**
121.750	268.5	259.6	234	Axial.
121.750	306.7	131	104	Circ.
121.750	354.1	261	241	Axial.
121.625	341	186.6	73	Circ.
121.625	284	365.1	255	**Axial./Multi**
121.625	350	332.2	250	**Axial./Multi.**
121.500	275.1	237	265	**Axial./Multi**
121.500	334.8	182.9	244	**Axial./Multi.**
121.375	288	449.9	255	Axial.
121.250	264.6	181.6	243	**Axial./Multi**
121.125	307	225.5	78	Circ.
121.125	326	185	68	Circ.
121.000	266.2	168.6	73	Circ.
121.000	345.9	191.1	235	**Axial./Multi.**
120.375	349	195.5	70	Circ.
120.250	328.6	319.6	35	Circ.
119.000	245.9	293.5	57	Circ.

Note: 1) **Circ./Multi.** - Multiple Circumferential indications
2 **Axial./Multi.** - Multiple axial indications

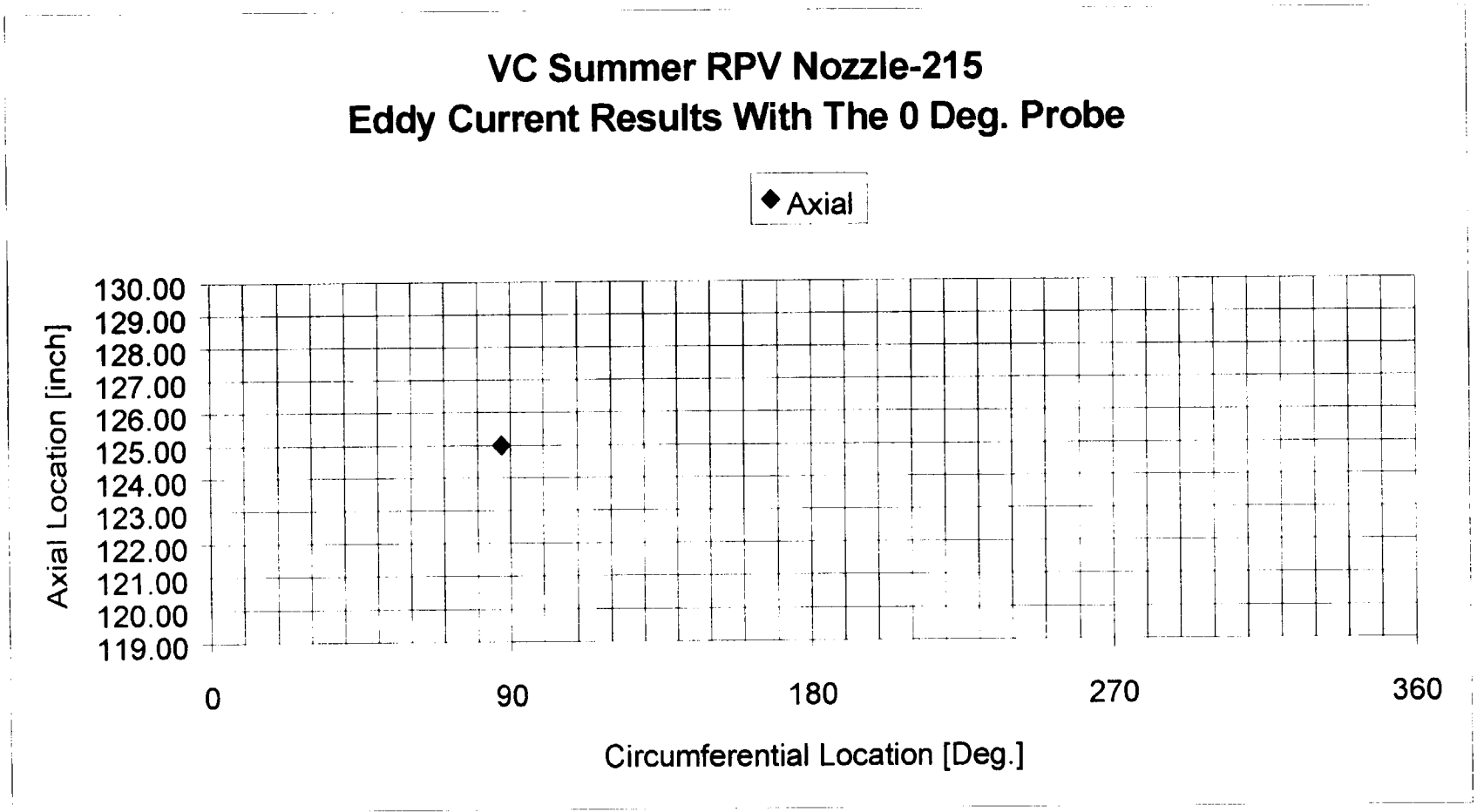

VC Summer RPV Nozzle-145
Eddy Current Results With The 0 Deg. Probe
Axial
Circ.
Axial Location [inch]
123.00
122.00
121.00
120.00
119.00
118.00
117.00
116.00
0
90
180
270
360
Circumferential Location [Deg.]

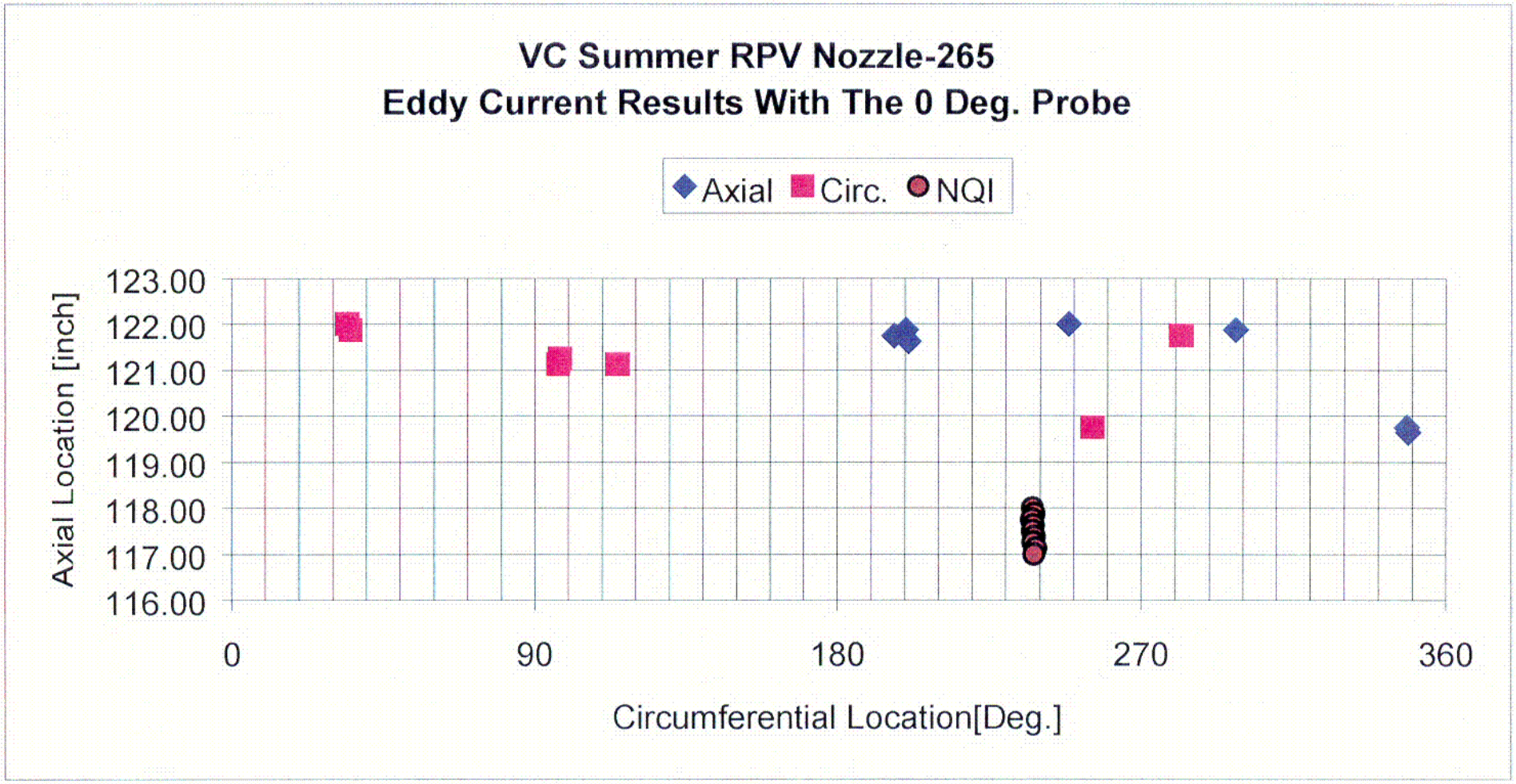
C08

VC Summer RPV Nozzle N-215				
Axial Location [inch]	Circ. Loc. [deg]	Signal Amplitude [ECU]	Signal Phase [deg]	Orientation
125.000	87.2	145.2	232	Axial.

VC Summer RPV Nozzle [illegible]				
Axial Location [inch]	Circ. Loc. [deg]	Signal Amplitude [ECU]	Signal Phase [deg]	Orientation
122.000	34.4	221.2	69	Circ.
122.000	248.6	107.7	239	Axial.
121.875	(3) 35.2	253.2	65	Circ.
121.875	(1) 200.3	335.2	256	Axial.
121.875	297.8	186.5	244	Axial.
121.750	(1) 196.9	302	251	Axial.
121.750	281.7	116.4	71	Circ.
121.625	(1) 201.2	128.8	242	Axial.
121.250	97.5	108.3	61	Circ.
121.125	96.9	122.6	55	Circ.
121.125	114.6	100	98	Circ.
119.750	255.5	123.9	55	Circ.
119.750	(4) 348.4	111	73	Axial.
119.625	(4) 348.8	105.5	68	Axial.
118.000	(2) 237.8	238.4	63	NQI
117.875	(2) 238.3	185.8	61	NQI
117.750	(2) 237.7	201.1	55	NQI
117.625	(2) 238.1	248.6	70	NQI
117.500	(2) 237.8	252.8	67	NQI
117.375	(2) 238.4	288.2	68	NQI
117.250	(2) 238.1	244.4	66	NQI
117.125	(2) 238.9	223.6	60	NQI
117.000	(2) 238.2	155.9	41	NQI

Note: **NQI** – Non Quantifiable Indication

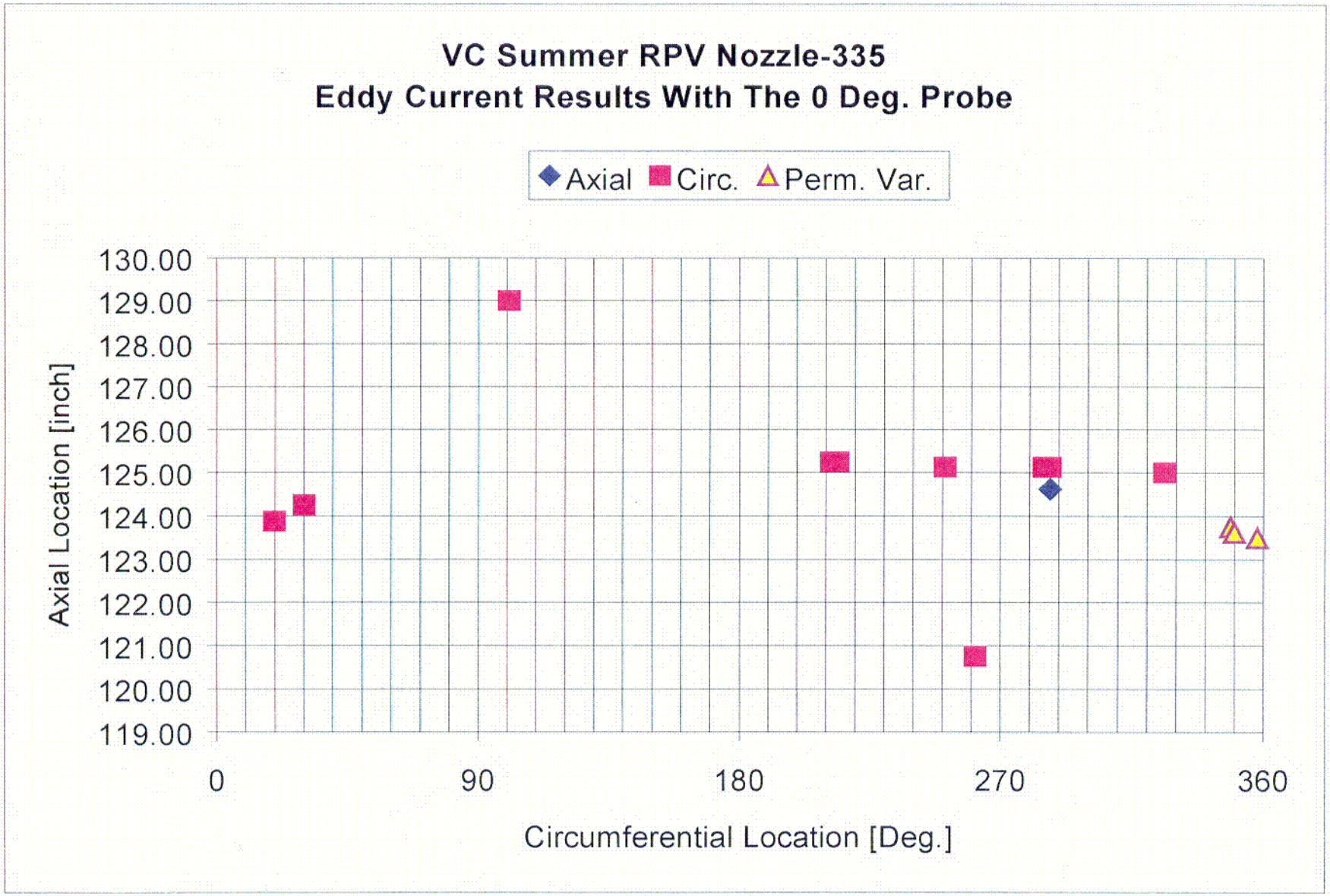

VC Summer RPV Nozzle-215
Eddy Current Results With The 0 Deg. Probe
Axial
130.00
129.00
128.00
127.00
126.00
125.00
124.00
123.00
122.00
121.00
120.00
119.00
Axial Location [inch]
0
90
180
270
360
Circumferential Location [Deg.]


VC Summer RPV Nozzle-265
Eddy Current Results With The 0 Deg. Probe
Axial
Circ.
NQI
Axial Location [inch]
123.00
122.00
121.00
120.00
119.00
118.00
117.00
116.00
0
90
180
270
360
Circumferential Location[Deg.]

C09

VC Summer RPV Nozzle N[illegible]				
Axial Location [inch]	Circ. Loc. [deg]	Signal Amplitude [ECU]	Signal Phase [deg]	Orientation
129.000	100.9	268.1	61	Circ
125.250	212	201.4	61	Circ
125.250	214	188.7	58	Circ
125.125	251	234.9	62	Circ
125.125	287	119.9	63	Circ
125.125	285	117.9	57	Circ
125.000	(1) 326	314.9	58	Circ
124.625	287	168	279	Axial
124.250	30.3	102.9	62	Circ
123.875	20	140.7	60	Circ
123.750	348.7	317.2	68	Perm var
123.625	350	660.1	93	Perm var
123.500	357.9	444.5	95	Perm var
120.750	261.5	306.8	75	Circ

Note: **Perm. Var.** – Material local permeability variation


VC Summer RPV Nozzle-335
Eddy Current Results With The 0 Deg. Probe
Axial
Circ.
Perm. Var.
130.00
129.00
128.00
127.00
126.00
125.00
124.00
123.00
122.00
121.00
120.00
119.00
Axial Location [inch]
0
90
180
270
360
Circumferential Location [Deg.]

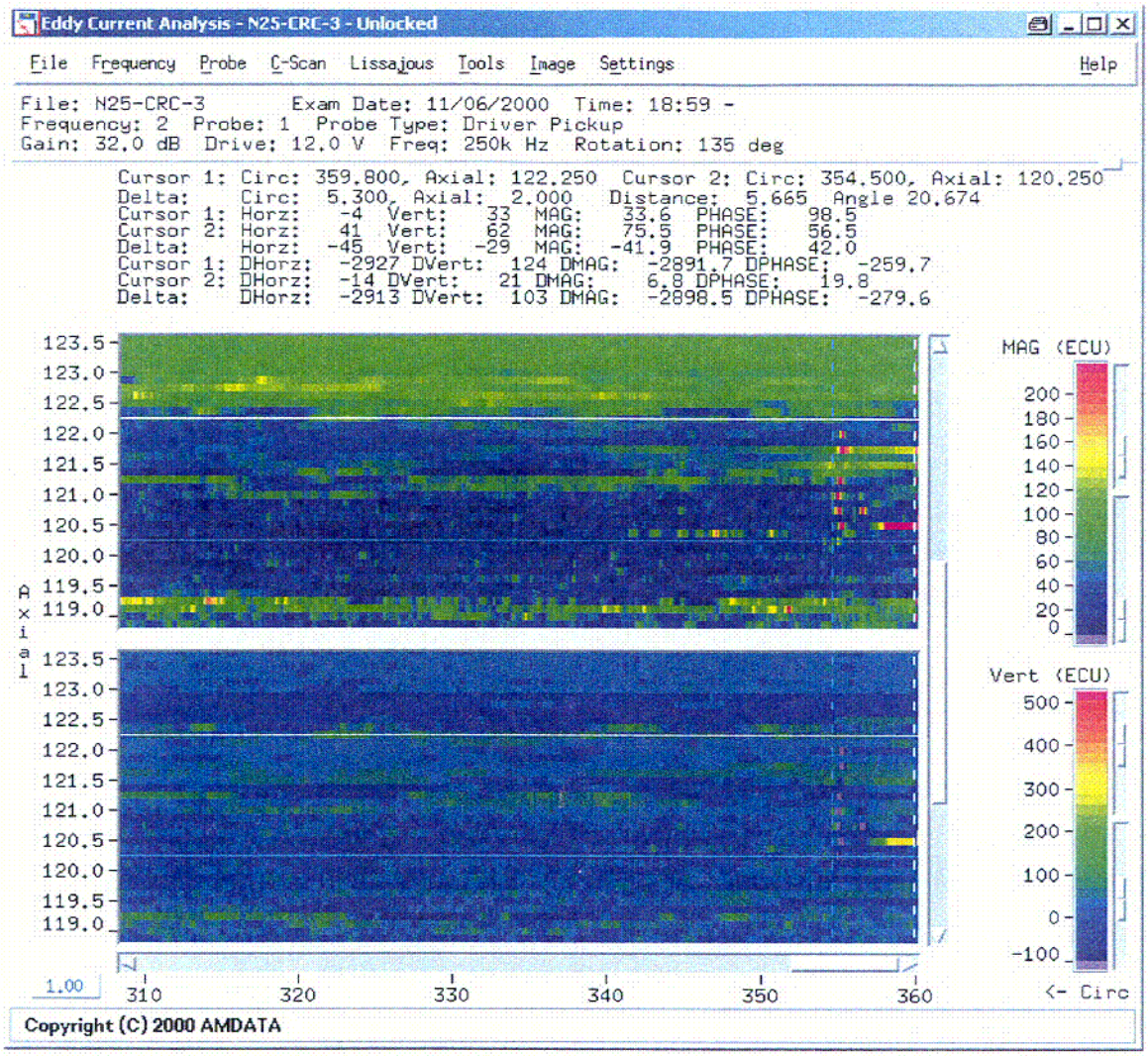
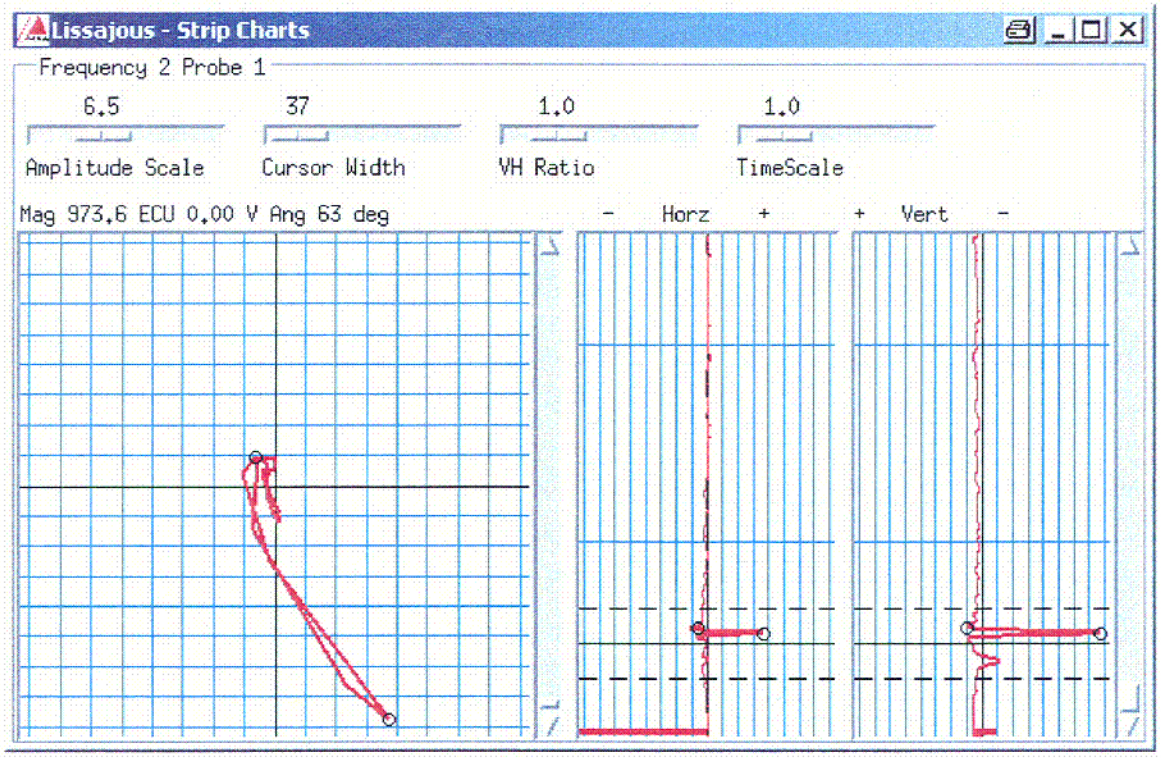


Figure 5
C-Scan Plot from Two Axial and One Circumferential indication in Nozzle N-25
(Axial: 120.50; Circ.: 0 to 10 deg. actual)



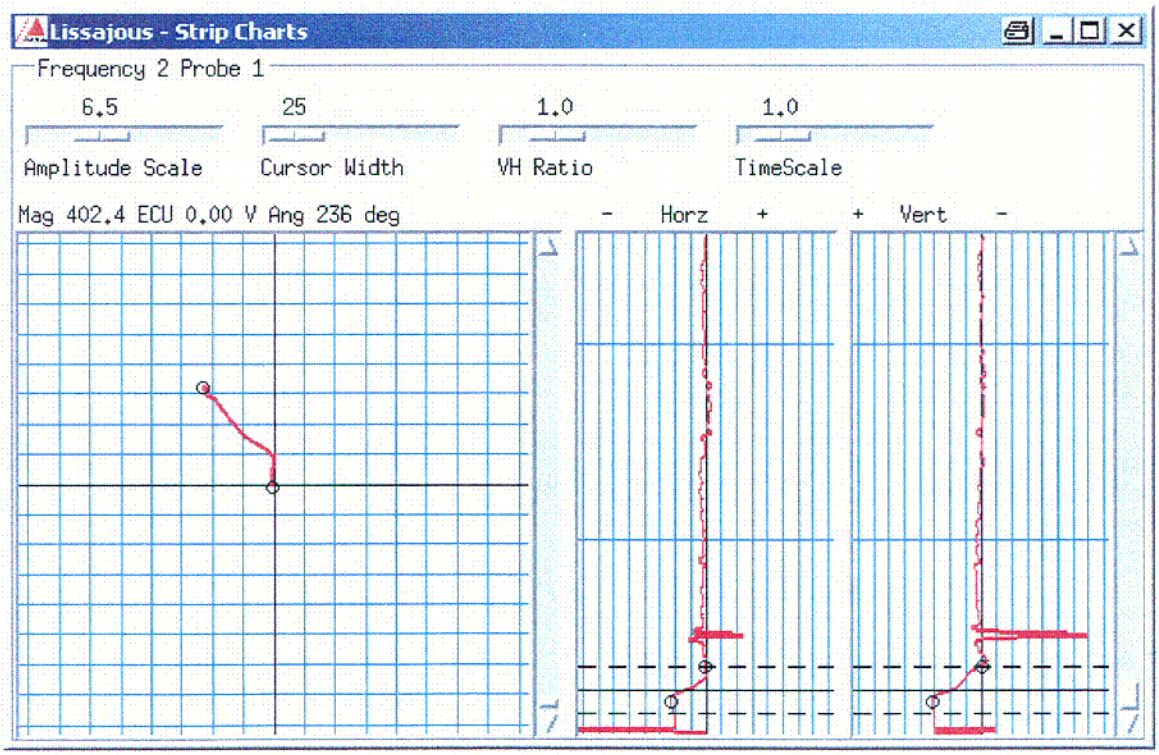


Figure 6
Lissajous from Two Axial (Top) and one Circumferential Indication (Bottom) in Nozzle N-25
(Axial: 120.50; Circ.: 0 to 10 deg. actual)

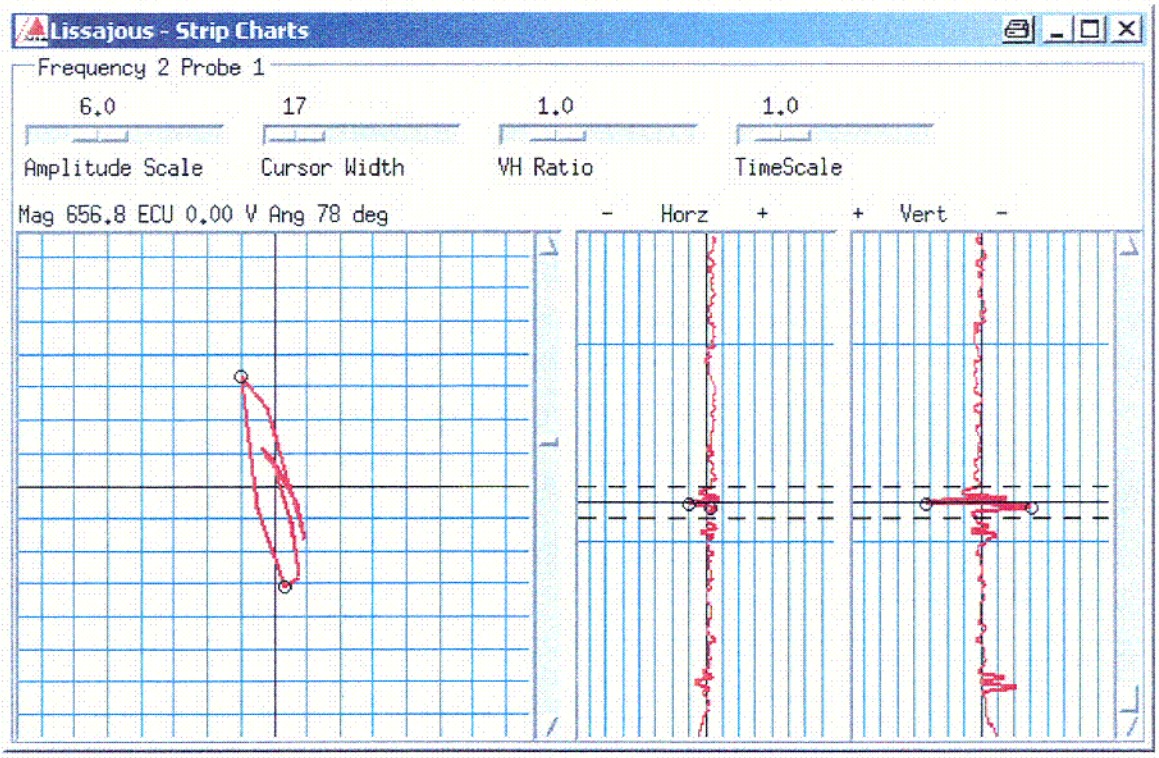


Figure 7
Lissajous from NQI 1 Indication in Nozzle N-95
(Axial: 120.00; Circ.: 155.2 deg. Actual)

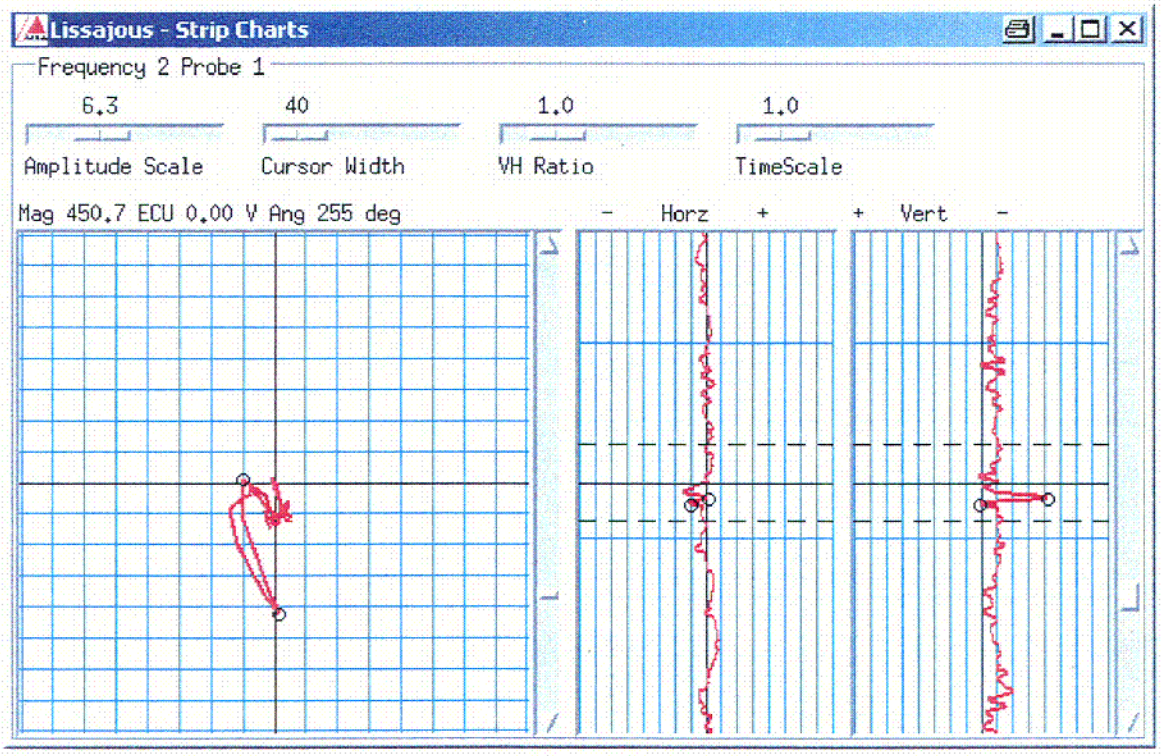


Figure 8
Lissajous from Axial Indication in Nozzle N-145
(Axial: 121.375; Circ.: 288 deg. Actual)

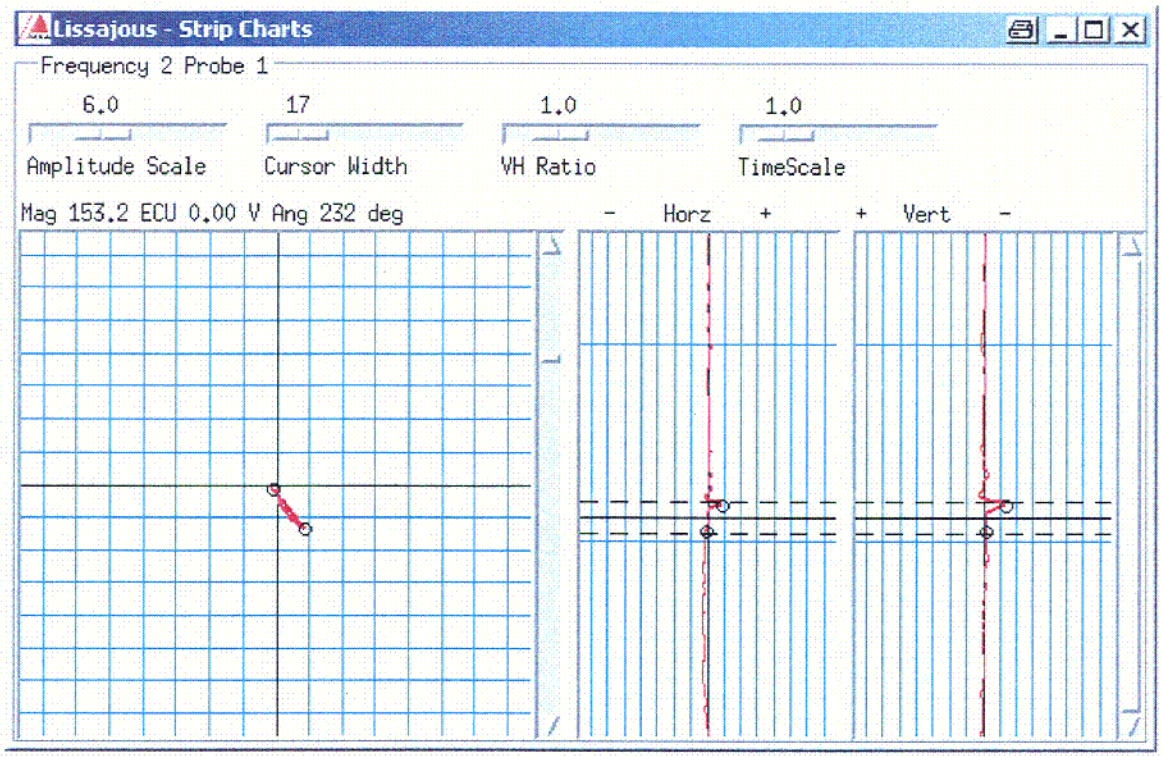


Figure 9
Lissajous from Axial Indication in Nozzle N-215
(Axial: 125.00; Circ.: 87.2 deg. Actual)

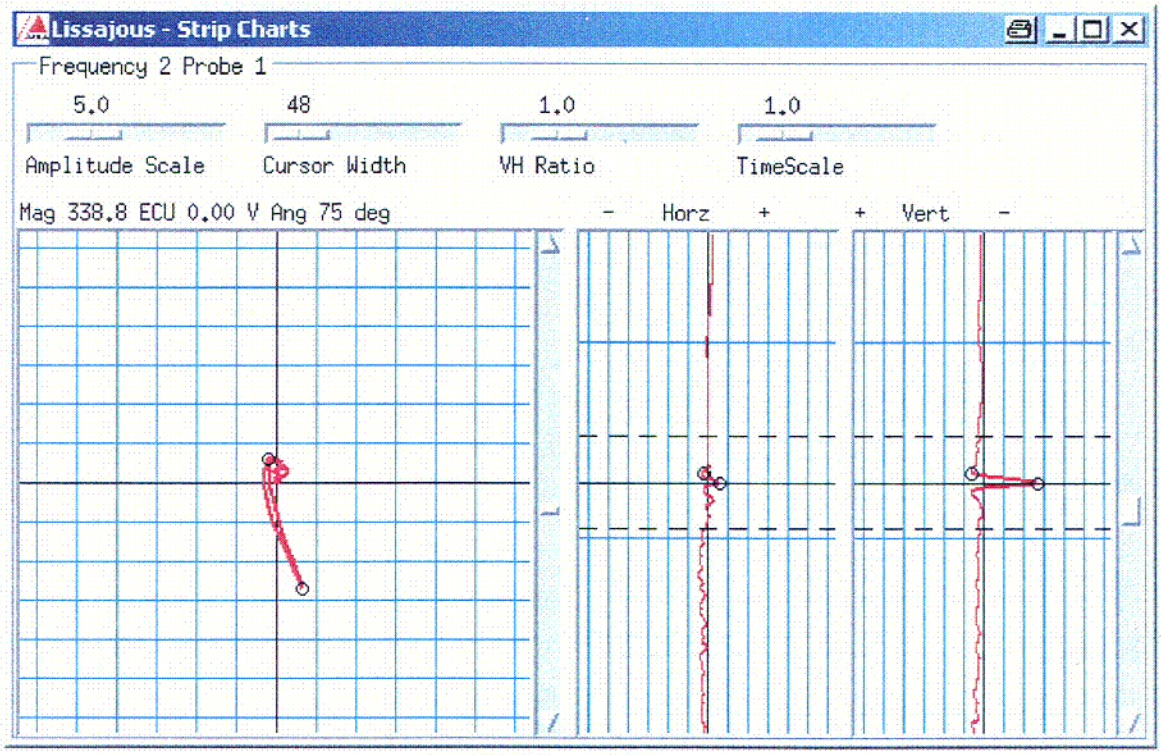


Figure 10
Lissajous from Axial Indication in Nozzle N-265
(Axial: 121.875; Circ.: 200.3 deg. Actual)

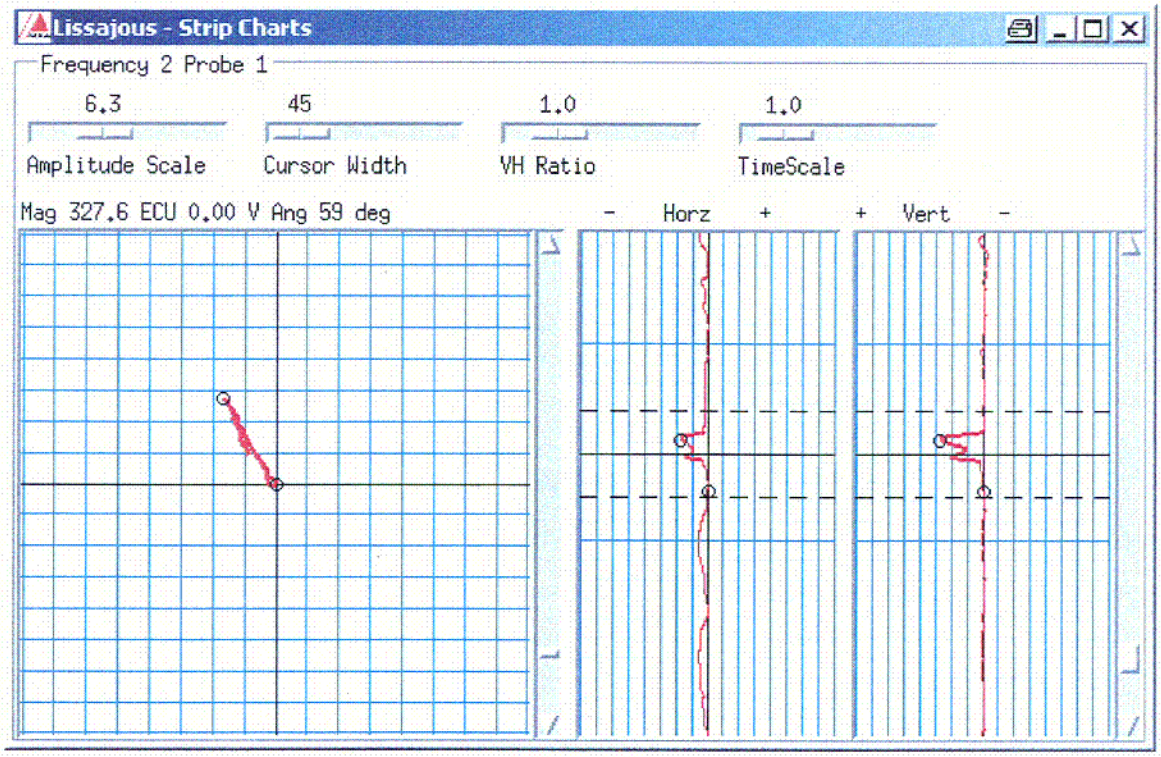


Figure 11
Lissajous from Circumferential Indication in Nozzle N-335
(Axial: 125.00; Circ.: 326 deg. Actual)

ADDITIONAL AXIAL CHARACTERIZATION SCANS

Additional axial characterization scans in A hot leg were also performed in two areas of interest around the 10-degree and 240-290 degree azimuth locations. C-scan presentations of these areas are shown in Figures 12 – 14.

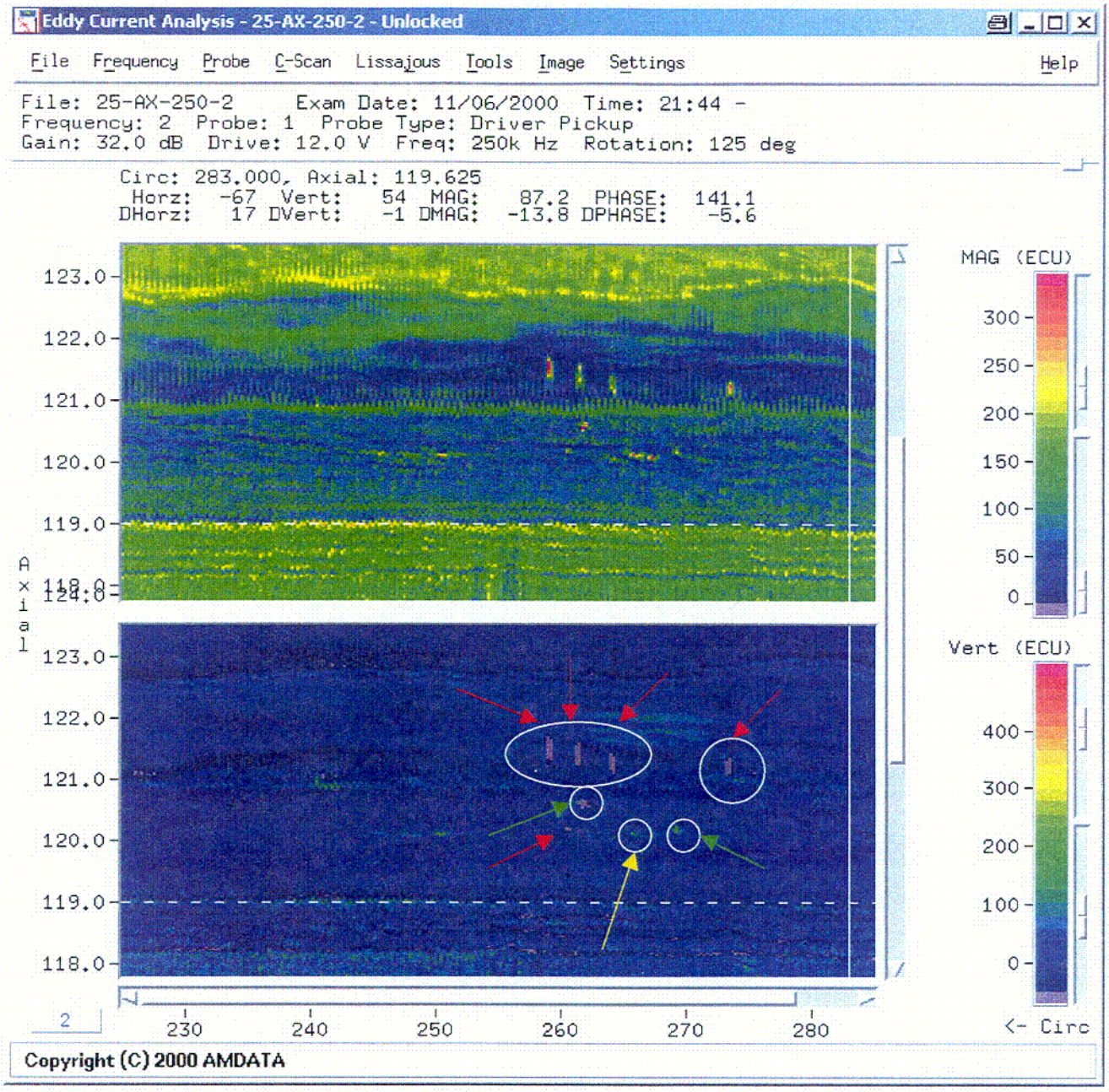


Figure 12

VC Summer RPV Nozzle N-25 Local High Resolution Raster (Axial) Scan for 240° to 290°

Axial Indication
Permeability Variation
Circumferential Indication

NOTE: The actual circumferential position is approximately -10° from the location shown in Figure 12.

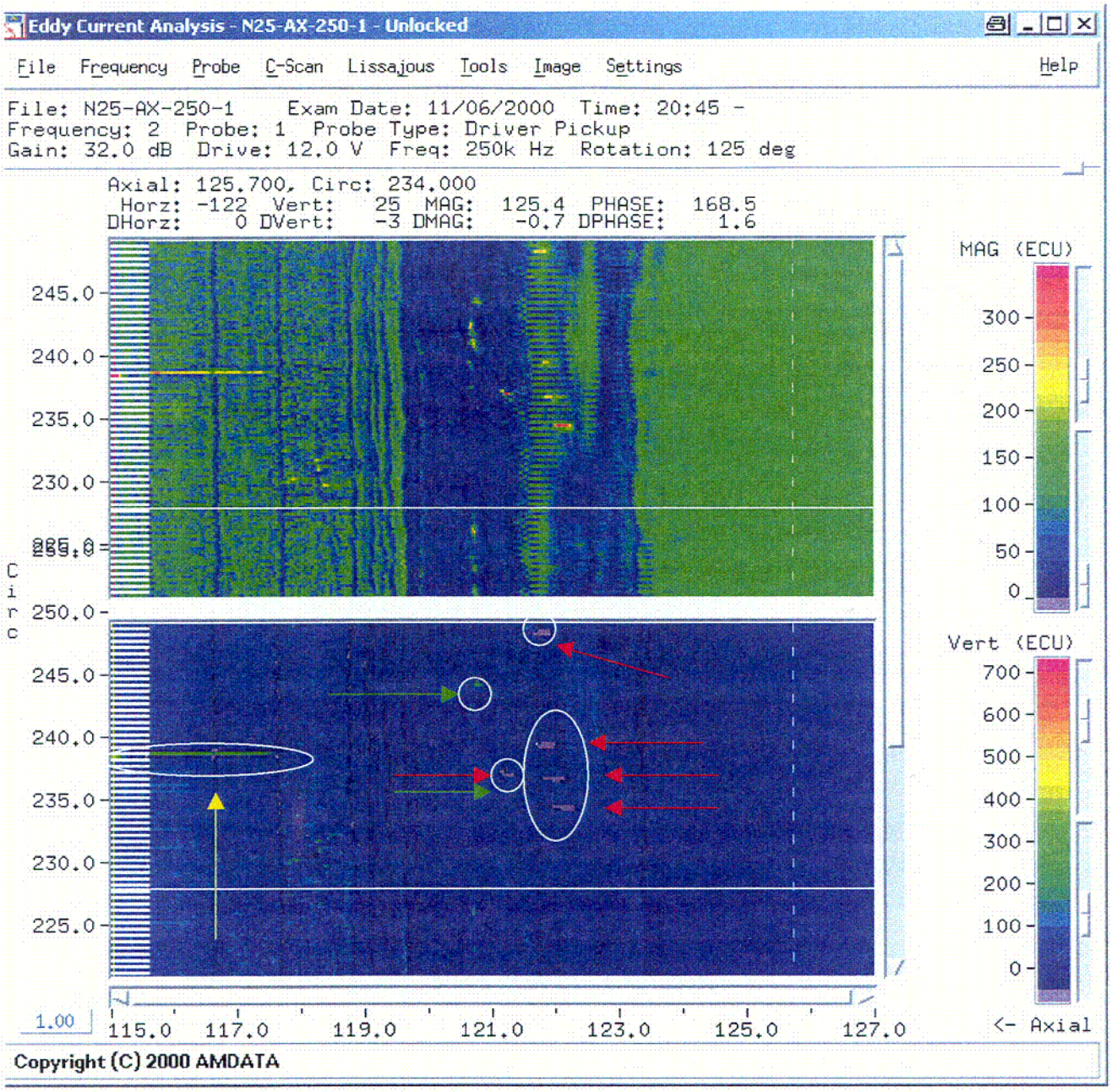


Figure 13

VC Summer RPV Nozzle N-25 Local Raster (Axial) Scan for 240° to 290°

Axial Indication
Permeability Variation
Circumferential Indication

NOTE: The actual circumferential position is at approximately +17° from the location shown on Figure 13.

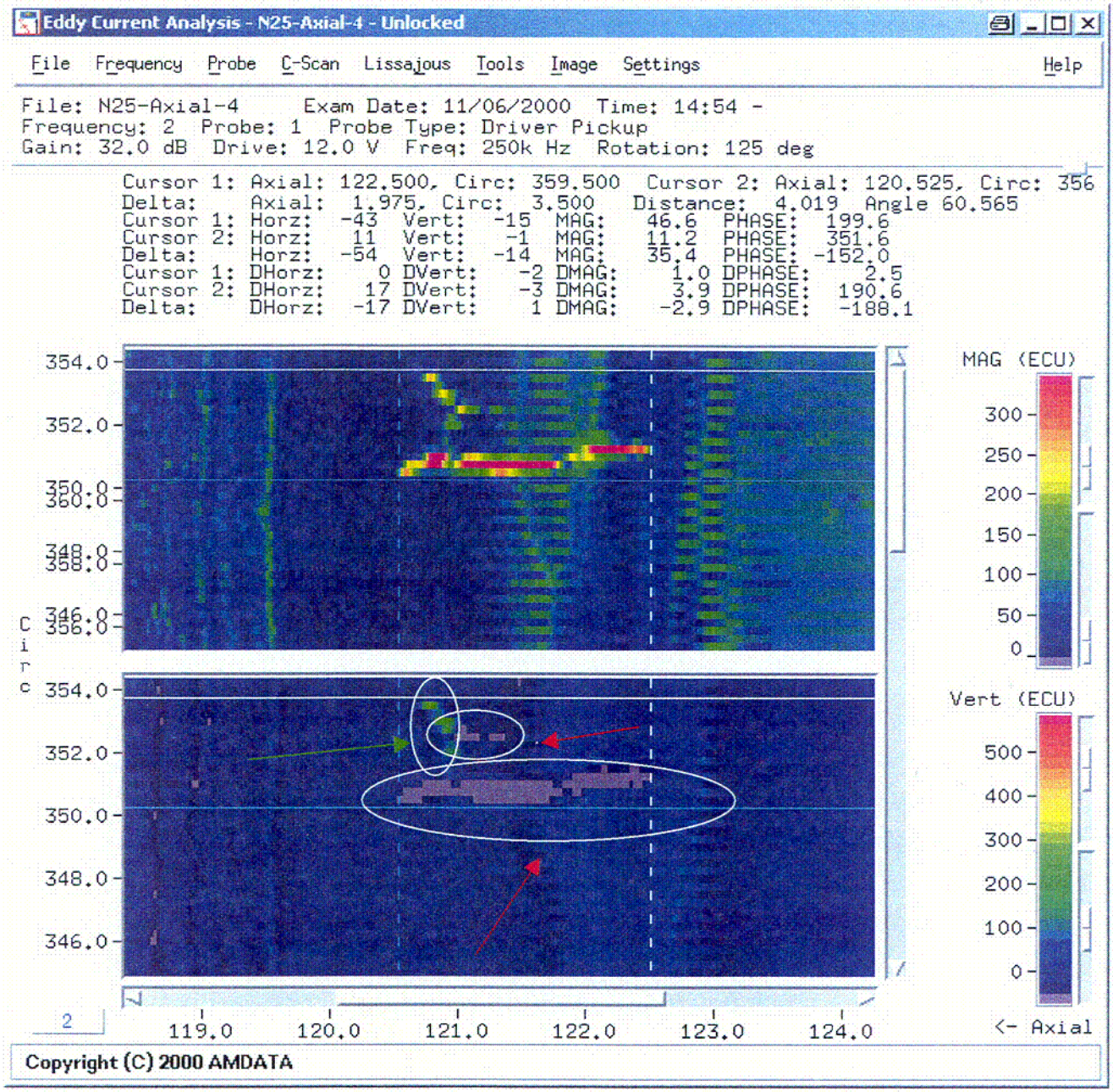


Figure 14

VC Summer RPV Nozzle N-25 Local Raster (Axial) Scan for 15° to 350°

Axial Indication
Permeability Variation
Circumferential Indication

NOTE: The actual circumferential position is at approximately +17° from the location shown on Figure 14.

CONCLUSIONS

Examinations were performed using two ET probes inside all six reactor vessel nozzles. Scanning was performed in directions parallel with the pipe weld. Additional axial scans were performed on the "A" Hot Leg Nozzle Indication. Examinations were performed using 0.125-inch increments for the primary circumferential scans, and at 0.0625-inch increments for the supplemental axial scans. The eddy current scanning boundaries were defined by the technique drawings in the examination program plan (EPP). The scan plan was constructed so that the bounding area for scanning included the ASME Code required volume plus a generous overlap to account for possible weld centerline mis-location.

In general, the indications identified in the examination are consistent with the responses observed from notches in the calibration block and the cracks in the EPRI sample. The exceptions were NQI (Non Quantifiable Indications) detected only in nozzles N-95 and N-265. The characteristic lissajous signal from NQI indication is shown on Figure 7. These indications were detected only with the primary probe (0° oriented probe). These indications have almost perfectly straight line shape, and differ from ones detected in the weld zone, where multiple indications were detected with both primary and secondary probes, which is typical for degradations with multiple initiation (characteristic for stress corrosion cracking). The most serious noise source anticipated for this inspection is that of permeability variations resulting from variations in the ferrite distribution. Responses of this type are expected to be confined to the stainless steel cladding of the nozzles and the cast elbows of the inlet nozzles. As a result, the indications found in the weld are believed to be due to some underlying discontinuity. The destructive evaluations of pipe segment locations containing indications in the "A" Hot Leg are critical to determining the nature of these discontinuities.

It is clear that there is a significant indication in the N25 "A" hot leg nozzle at approximately the 7 degree azimuth. This ET indication extends approximately 2 inches. In addition, there are a number of other indications, the majority of which are grouped around the 250 to 260-degree azimuth. Whether responses found at approximately the same azimuth in successive sweeps are due to the same origin is difficult to determine based on the current ET data set and lack of correlation with the

UT data set. A conservative grouping of indications yields the table of indications with apparent length of at least 0.25 inches is shown in Figure 15. This grouping of indications is produced from a conservative analysis; however, if stress corrosion is the underlying degradation mechanism, the indications could reflect multiple initiation sites. This will be an important evaluation during the destructive analysis process as well.

The length of axial groups presented in Figure 15 was determined by measuring axial extent with consecutive circumferential scans (index length for each scan is .125 inch), or by direct measurements from available axial scans (raster scans that were performed on N-25 for location at 10° and 250°). The length for circumferential indications was determined from circumferential scans and the actual indication's angular distribution.

ET indication groups with minimum length of 0.25"				
NOZZLE	INDICATION	TYPE	MIN LENGTH	LOCATION
N25	1	AXIAL	1.75	10 DEG
	2	AXIAL	0.5	250 DEG
	3	AXIAL	0.5	252 DEG
	4	AXIAL	0.4	255 DEG
	5	AXIAL	0.6	265 DEG
	6	AXIAL	0.5	12 DEG
	7	CIRC	1	11 to 14 DEG
	8	AXIAL	0.25	309 DEG
N95	1	NQI	1	87 DEG
	2	NQI	0.25	109DEG
	3	NQI	0.5	156 DEG
	4	NQI	0.375	164 DEG
	5	CIRC.	0.5	200 DEG
N145	1	CIRC	0.5	309 DEG
N215	N/A			
N265	1	AXIAL	0.25	200.8 DEG
	2	NQI	1	240 DEG
	3	CIRC	0.6	35 DEG
	4	AXIAL	0.25	348 DEG
N335	1	CIRC	0.5	326 DEG

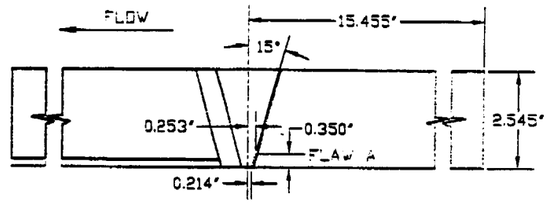
Figure 15

Conservative Linear Grouping of ET Indications From All Nozzles

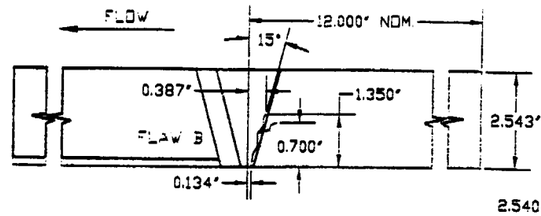
APPENDIX A

EPRI SPECIMEN 19-36-2. 5-PWR-316-BN

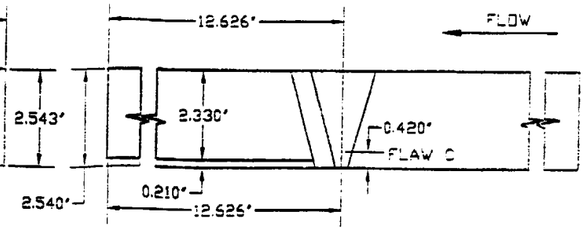
SECTIONS A-A



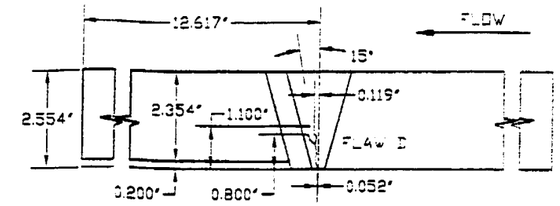
FLAW A



FLAW B



FLAW C



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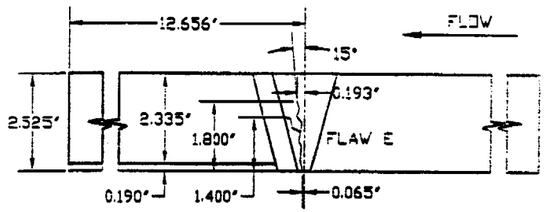

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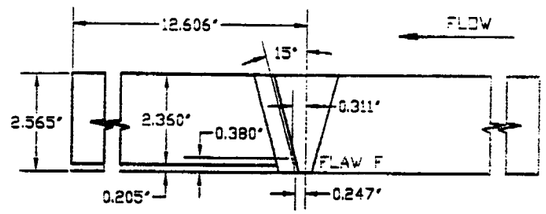

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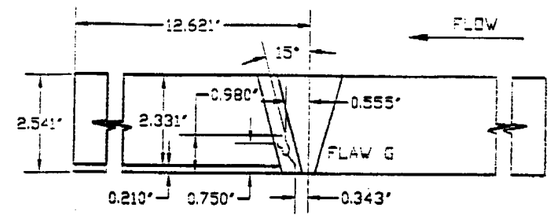

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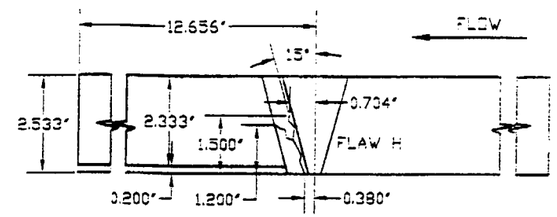

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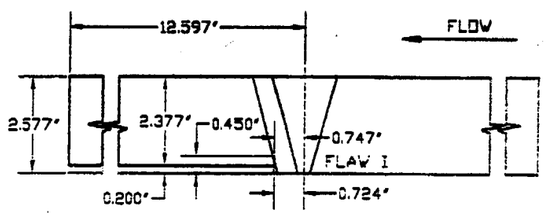

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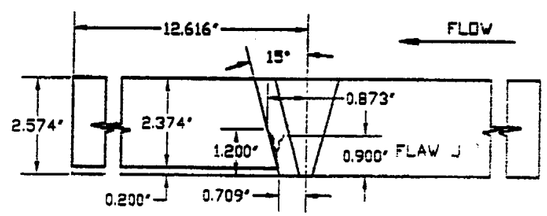

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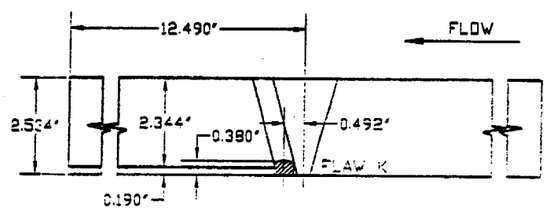

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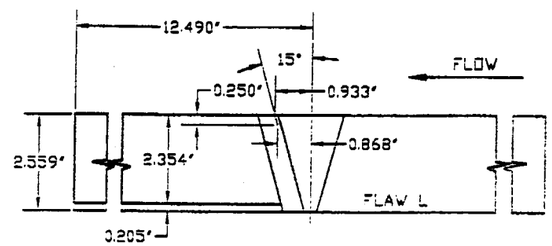

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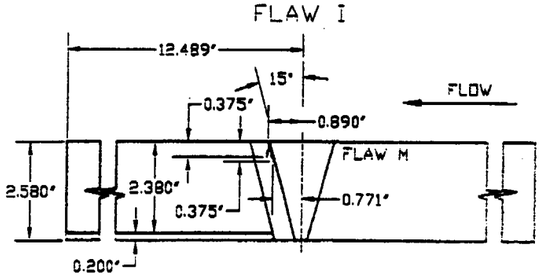

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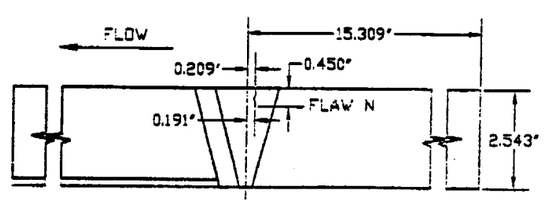

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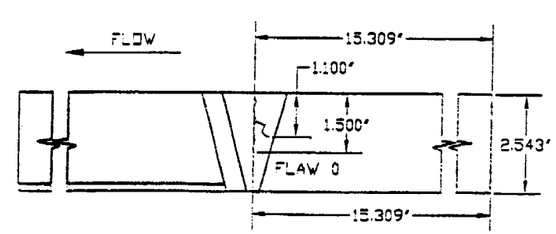

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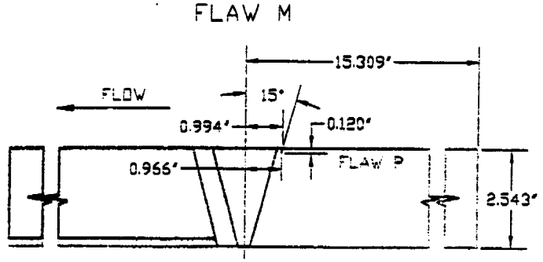

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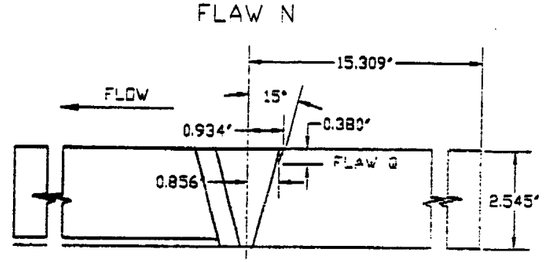


FLAW Q

NOTE: PEEN ALL O.D. FLAWS

REVISION HISTORY

REV	DESCRIPTION	DATE	APPR
1	CHANGE FLAW K TILT, ADDED OD AND ID RADIAL DIMS, REVERSED UP/DOWNSTREAM VERBAGE AND FLOW ARROWS, CORRECTED SS VERBAGE.	5/17/00	
2	REVERSED UP/DOWNSTREAM VERBAGE AND FLOW ARROWS.	5/5/00	
3	ADDED 'AS-BUILT' DIMENSIONS	8/31/00	

CLIENT: EPRI NDE CENTER

DRAWING NUMBER: 900473R3.DWG

REV: 0 1 2 3

FLAWTECH
FLAW MANUFACTURING TECHNOLOGY

SPECIMEN/PART NUMBER: 19-36-2.5-PVR-316-3N

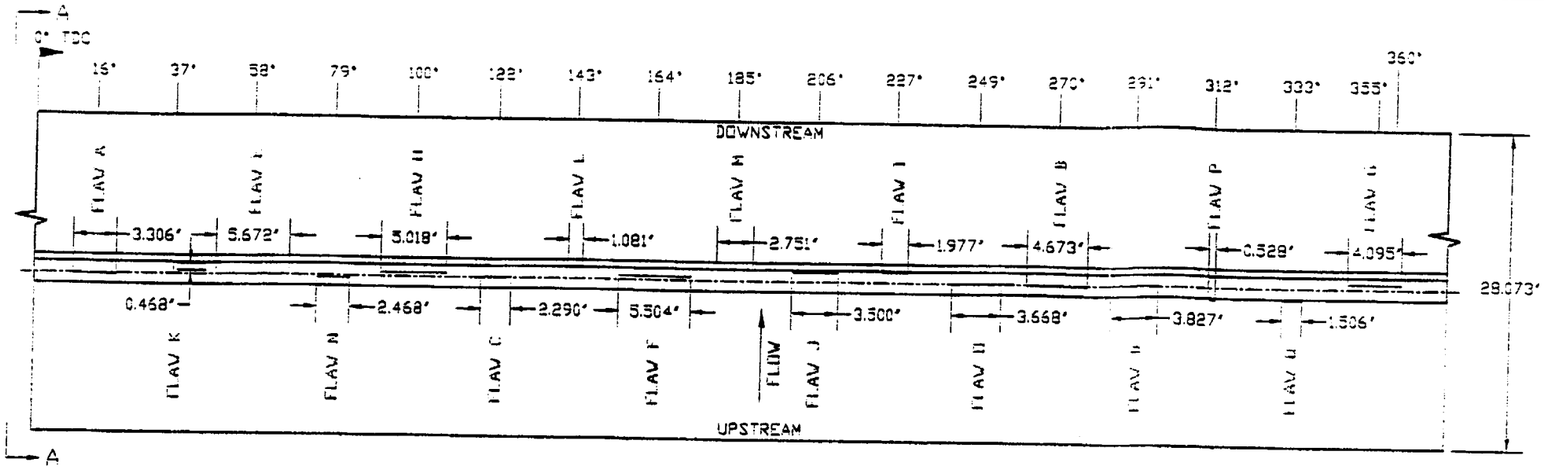
TITLE: APP. VIII, SUP. 10 FLAWED SAMPLE

DESCRIPTION: 33.25" X 2.5" WALL SS TO CS DM WELD

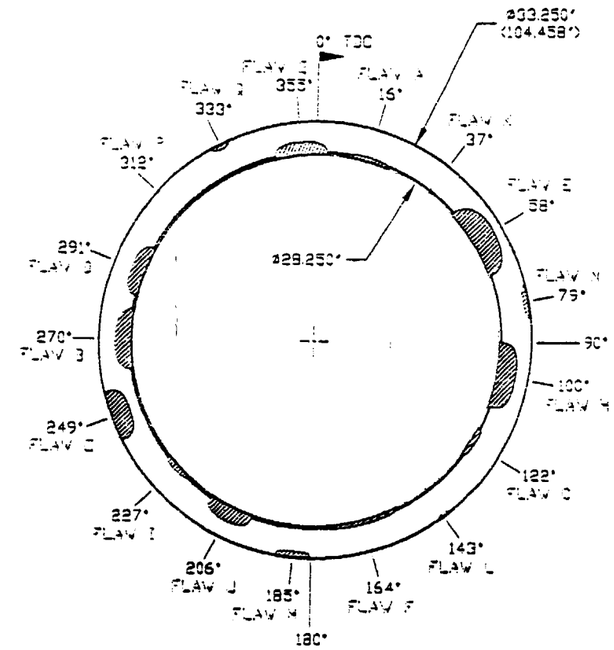
DRAWN BY:	DATE	APPROVED BY:	DATE
	3/30/00		3/30/00

SCALE: NTS

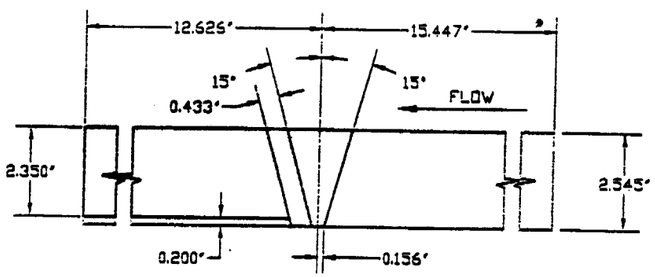
SHEET 2 OF 2



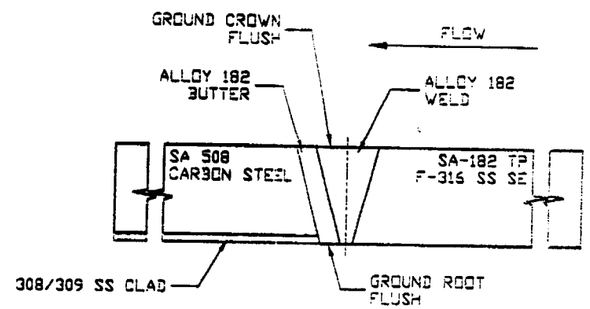
FLAT OUTSIDE DIAMETER VIEW



SECTION VIEW



WELD PREP
(NOMINAL DIMENSIONS)



WELD PROFILE

*"AS BUILT" DIMENSIONS ONLY

FLAW	FLAW TYPE	FLAW LOCATION	UPSTREAM/ DOWNSTREAM	FLAW ORIENTATION	FLAW SKEW	FLAW TILT	FLAW LENGTH	FLAW DEPTH (HEIGHT)	FLAW RATIO	DEPTH %	WELD C/L TO REF. END	WELD C/L TO FLAW BASE	WELD C/L TO FLAW TIP	I.D. TO O.D.	CIRC. DEGREE	CLADDING THICKNESS	GEOMETRY
A	FATIGUE FLAW	ID	UP	CIRC	0°	15°	3.306′	0.350′	9.4:1	13.8%	15.455′	0.214′	0.253′	2.545′	16°	0.190′ NOM.	
B	FATIGUE FLAW	ID	UP	CIRC	0°	15°	4.673′	1.350′	3.5:1	53.1%	15.445′	0.134′	0.387′	2.543′	270°	0.190′ NOM.	BRANCHED
C	FATIGUE FLAW	ID	DOWN	CIRC	0°	0°	2.290′	0.420′	5.5:1	16.5%	12.626′	N/A	0.008′	2.540′	122°	0.210′	
D	FATIGUE FLAW	ID	DOWN	CIRC	0°	5°	3.827′	1.100′	3.5:1	43.1%	12.617′	0.019′	0.090′	2.554′	291°	0.200′	BRANCHED
E	FATIGUE FLAW	ID	DOWN	CIRC	0°	5°	5.672′	1.800′	3.2:1	71.3%	12.656′	0.047′	0.295′	2.525′	58°	0.190′	BRANCHED
F	FATIGUE FLAW	ID	DOWN	CIRC	0°	15°	5.504′	0.380′	14.5:1	14.8%	12.606′	0.247′	0.311′	2.565′	164°	0.205′	
G	FATIGUE FLAW	ID	DOWN	CIRC	0°	15°	4.095′	0.980′	4.2:1	38.6%	12.621′	0.343′	0.555′	2.541′	355°	0.210′	BRANCHED
H	FATIGUE FLAW	ID	DOWN	CIRC	0°	15°	5.018′	1.500′	3.3:1	59.2%	12.656′	0.380′	0.704′	2.533′	100°	0.200′	BRANCHED
I	FATIGUE FLAW	ID	DOWN	CIRC	0°	0°	1.977′	0.450′	4.4:1	17.5%	12.597′	0.724′	0.747′	2.577′	227°	0.200′	
J	FATIGUE FLAW	ID	DOWN	CIRC	0°	15°	3.500′	1.200′	2.9:1	46.6%	12.616′	0.709′	0.873′	2.574′	206°	0.200′	BRANCHED
K	FATIGUE FLAW	ID	DOWN	AXIAL	90°	0°	0.468′	0.380′	1.2:1	15.0%	12.656′	0.492′	N/A	2.534′	37°	0.190′	
L	FATIGUE FLAW	OD	DOWN	CIRC	0°	15°	1.081′	0.250′	4.3:1	9.8%	12.606′	0.933′	0.868′	2.559′	143°	0.205′	OD CONNECTED
M	FATIGUE FLAW	OD	DOWN	CIRC	0°	15°	2.751′	0.500′	5.5:1	19.4%	12.586′	0.890′	0.771′	2.580′	185°	0.200′	OD CONN., BRANCHED
N	FATIGUE FLAW	OD	UP	CIRC	0°	0°	2.468′	0.450′	5.5:1	17.7%	15.485′	0.209′	0.191′	2.543′	79°	0.190′ NOM.	OD CONNECTED
O	FATIGUE FLAW	OD	UP	CIRC	0°	0°	3.668′	1.500′	2.4:1	59.0%	15.436′	N/A	N/A	2.543′	249°	0.190′ NOM.	OD CONN., BRANCHED
P	FATIGUE FLAW	OD	UP	CIRC	0°	15°	0.528′	0.120′	4.4:1	4.7%	15.436′	0.994′	0.966′	2.543′	312°	0.190′ NOM.	OD CONNECTED
Q	FATIGUE FLAW	OD	UP	CIRC	0°	15°	1.506′	0.380′	4.0:1	14.9%	15.445′	0.930′	0.856′	2.545′	333°	0.190′ NOM.	OD CONNECTED

REVISION HISTORY

REV	DESCRIPTION	DATE	APPR
1	CHANGE FLAW K TILT, ADDED OD AND ID RADIAL DIMS, REVERSED UP/DOWNSTREAM VERBAGE AND FLOW ARROWS ALL PLACES, CORRECTED SS VERBAGE,	5/17/00	
2	REVERSED UP/DOWNSTREAM VERBAGE AND FLOW ARROWS ALL PLACES, CORRECTED SYMBOL FOR DIAMETER TWO PLACES,	6/6/00	
3	CHANGED LENGTH OF FLAW "I"	6/21/00	
4	ADDED "AS-BUILT" DIMENSIONS	8/31/00	

CLIENT: EPRI NDE CENTER

DRAWING NUMBER: 90047AR4.DWG

REV: 0 | 1 | 2 | 3 | 4

FLAWTECH
FLAW MANUFACTURING TECHNOLOGY

SPECIMEN/PART NUMBER: 19-36-2.5-PVR-316-3N

TITLE: APP. VIII, SUP. 10 FLAWED SAMPLE

DESCRIPTION: 33.25′ X 2.5′ WALL SS TO CS DM WELD

DRAWN BY: GB | DATE: 3/30/00 | APPROVED BY: [signature] | DATE: 3/30/00

SCALE: NTS | SHEET 1 OF 2

APPENDIX B

SURRY SAFE-END MOCKUP

WESTINGHOUSE DRAWING 6439E23

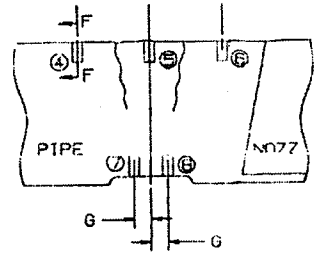
ENGTH AND ARC LENGTH WILL BE DETERMINED AFTER
OF NON-CRITICAL FABRICATING DIMENSIONS

±0.020"

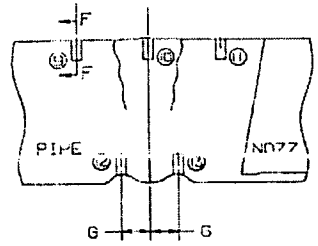
D ROOT AREA "CONDITIONING" SHALL BE PERFORMED
NATD ENGINEERING. FOUR DIFFERENT WELD ROOT AREA
IS WILL BE PREPARED BY GRINDING AND FEATHERING,
OCCUPYING A 30° SEGMENT (REF b,c,d AND e)
EPARED AT THE DIRECTION OF NATD ENGINEERING.

NOZZLE BORE CLADDING SHALL BE REQUIRED
NCE RESEMBLES THE SURRY PLANT NOZZLES.

ECTION DATA SHALL INCLUDE BLOCK
ECTOR DIMENSIONS ONLY. ALL OTHER
Y TO BE VERIFIED.



SEC B-B OF "B"



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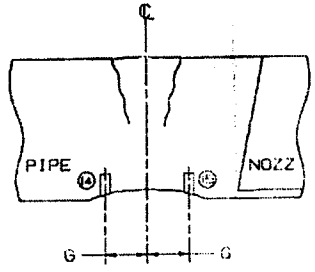

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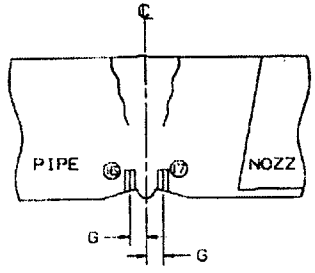


SEC E-E OF "E"

I.D. SURFACE CONDITION ILLUSTRATIVE ONLY-SEE NOTES
TYPICAL

DATABASE IDENTIFICATION NUMBER
A-FUSC-6439E23-01-001-111593

TOLERANCE & MACHINE NOTES
(UNLESS OTHERWISE SPECIFIED)
DRAWING PRACTICES, GEOMETRIC SYMBOLS, DIMENSIONING, TOLERANCING & INTERPRETATION BASED ON ANSI Y14 SERIES STANDARD & PS 8040MA
DIMENSIONS IN INCHES BASED ON 68°F (20°C)
RADIUS OR CHAMFER ALL EDGES-----.005-.030
FILLET RADII----------.03±.01
ANGULARITY CHAMFERS----------±2°
MAXIMUM SURFACE ROUGHNESS-250 μIN. (√)AA
DWG. REF.
NEXT ASSY.
THIRD ANGLE PROJECTION

WESTINGHOUSE PROPRIETARY DATA

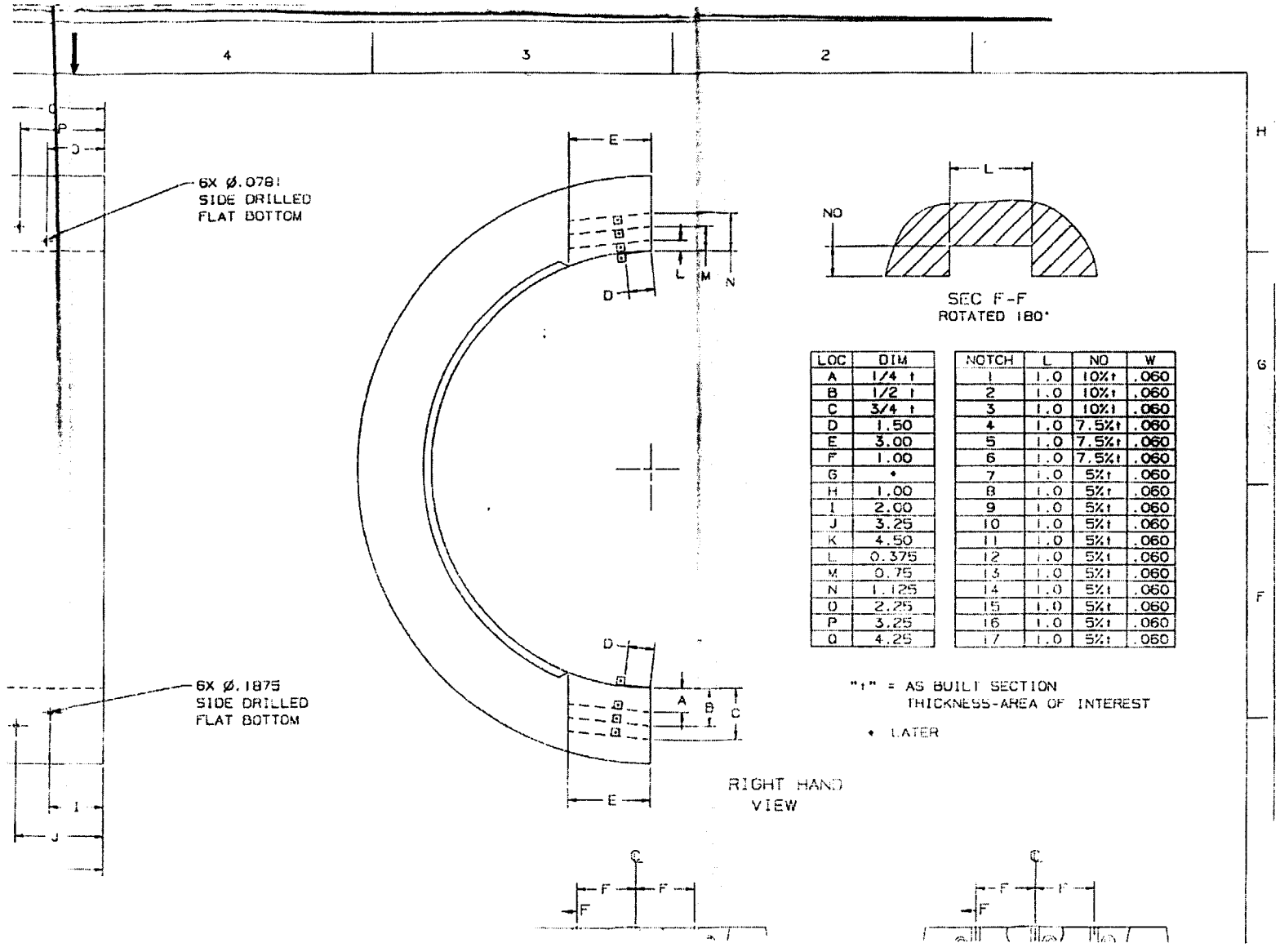
THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF THE WESTINGHOUSE ELECTRIC CORPORATION WATER REACTOR DIVISION. IT IS TRANSMITTED TO YOU IN CONFIDENCE AND TRUST, AND IS TO BE RETURNED UPON REQUEST. ITS CONTENTS MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO OTHERS OR USED FOR OTHER THAN THE PURPOSE FOR WHICH TRANSMITTED WITHOUT THE PRIOR WRITTEN PERMISSION OF THE WESTINGHOUSE WATER REACTOR DIVISIONS.

FUSCA 11-16-93
11-22-93
11-22-93
11-22-93
11/28/93

Westinghouse Electric Corporation
WATER REACTOR DIVISIONS - MONROEVILLE, PA. U.S.A.

SURRY
SAFE-END MOCK-UP

DIMENSIONS IN INCHES
SIZE E
DWG NO. 6439E23
REV. 1
SCALE N.T.S.

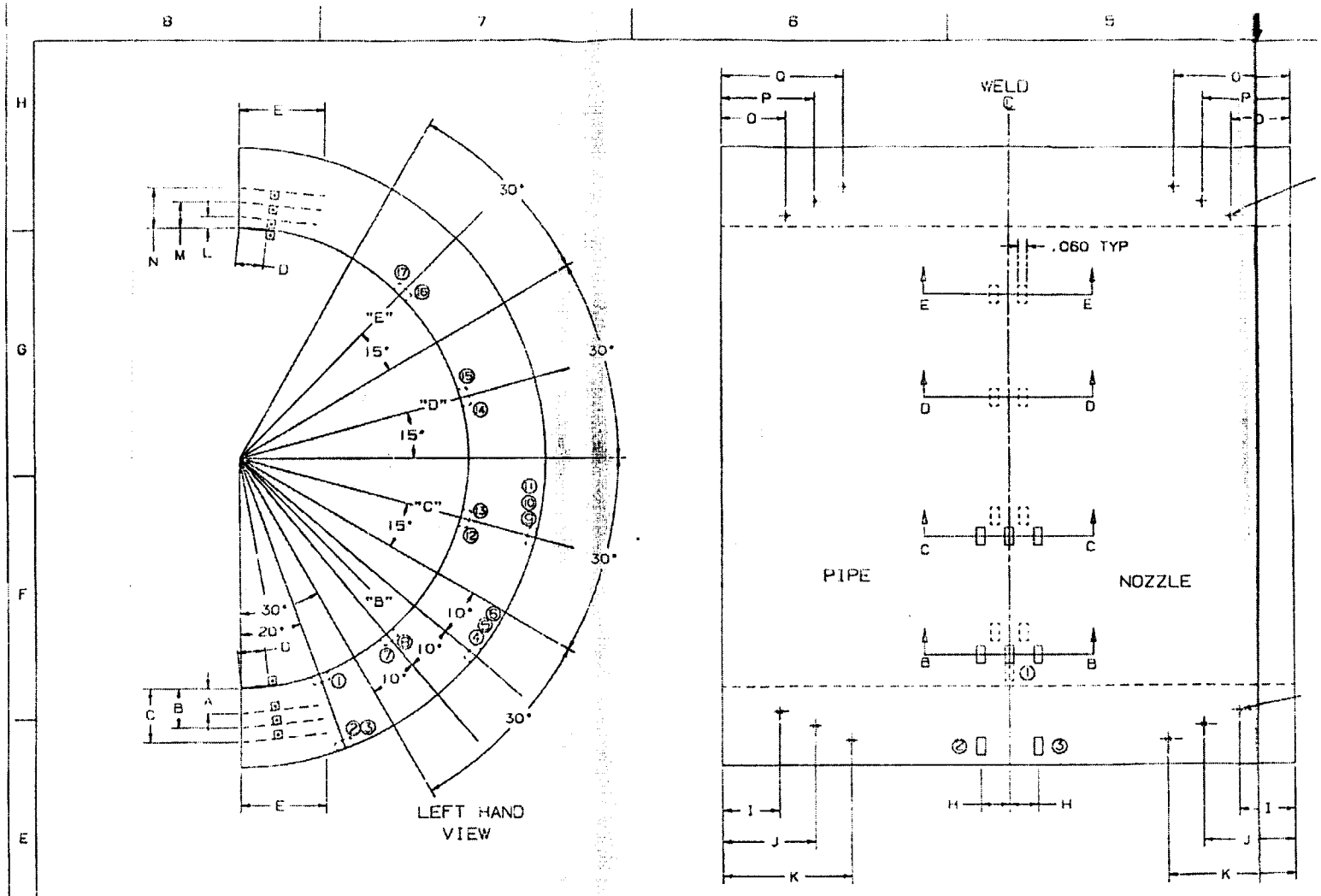


LOC	DIM
A	1/4 t
B	1/2 t
C	3/4 t
D	1.50
E	3.00
F	1.00
G	*
H	1.00
I	2.00
J	3.25
K	4.50
L	0.375
M	0.75
N	1.125
O	2.25
P	3.25
Q	4.25

NOTCH	L	NO	W
1	1.0	10%t	.060
2	1.0	10%t	.060
3	1.0	10%t	.060
4	1.0	7.5%t	.060
5	1.0	7.5%t	.060
6	1.0	7.5%t	.060
7	1.0	5%t	.060
8	1.0	5%t	.060
9	1.0	5%t	.060
10	1.0	5%t	.060
11	1.0	5%t	.060
12	1.0	5%t	.060
13	1.0	5%t	.060
14	1.0	5%t	.060
15	1.0	5%t	.060
16	1.0	5%t	.060
17	1.0	5%t	.060

"t" = AS BUILT SECTION THICKNESS-AREA OF INTEREST

* LATER



NOTES: "SURRY SAFE-END MOCK-UP" (REF: SKETCH # NATD/MNA 93-38)

1. MATERIALS:

4. OTHER DIMENSIONS

A- CLAD PRODUCTION NOZZLE SEGMENT IS SA 508 CL 2 FORGING, 309/308 SS CLADDING. SHEARON HARRIS UNIT 2 ,BY CBI MEMPHIS 1972 HT#02047W

B- WROUGHT STAINLESS STEEL SPOOL ATTACHMENT IS SA 182-F 316, HT#95249 (McINNES)

C- WELDING, BUTTERING AND CLADDING SHALL BE PER DIRECTION OF NATD/MNA (CHARLES KIM) PER APPROVED TSI PROCEDURE SMAW 308/309 REV.001

D- PRIOR TO BUTTERING OR WELDING, THE WELD PREP ENDS OF THE NOZZLE AND SPOOL PIECE SHALL BE ULTRASONICALLY EXAMINED FOR INTERFERING REFLECTIONS AT OR NEAR THE FUSION ZONES.

2. CONSTRUCTION:

A- WELD GROOVE PREPARATION, JOINT FIT-UP, JOINING PROCESS, AND WELD JOINT SECTION THICKNESS ARE SPECIFIED BY W PURCHASE REQUISITION #MB11184.

3. UT REFERENCE REFLECTORS

A- SKETCH NO.NATD/MNA 93-38 SHEET 1 OF 1 SHALL BE THE REFERENCE GUIDE FOR REFERENCE REFLECTORS AND I.D. SURFACE CONDITIONING.

B- A TOTAL OF 12 SIDE DRILLED HOLES AND 17 NOTCHES ARE REQUIRED WITH THE FOLLOWING GENERAL TOLERANCES:
SIDE DRILLED HOLES SHALL BE DRILLED 3.0" DEEP ±0.125", AND SHALL BE DRILLED SO THAT THE SPECIFIED THROUGH SECTION LOCATION IS NORMAL TO THE I.D. SURFACE AT A POINT 1.5" FROM THE BLOCK EDGE AS DEPICTED. HOLE DIAMETER ± 1/64", HOLE THROUGH SECTION LOCATION ±0.125".

C- A TOTAL OF 8 NOTCHES SHALL BE MACHINED BY THE EDM METHOD, LOCATED ON THE OUTSIDE DIAMETER, PARALLEL TO THE WELD GROOVE AS INDICATED. A TOTAL OF 9 NOTCHES SHALL BE MACHINED BY THE EDM METHOD, LOCATED ON THE INSIDE DIAMETER, PARALLEL TO THE WELD GROOVE, LOCATED ALONG THE I.D. SURFACE WHERE DIRECTED BY NATD ENGINEERING AFTER I.D. SURFACE CONDITIONING.
NOTCH GENERAL TOLERANCES ARE AS FOLLOWS: LENGTH: 1.0±0.125", "NO" DIM-.050"+.0.0[NOTE] THE "NO" DIMENSION SHALL BE MAINTAINED AT NOTCH PEAK ANGULAR LOCATION ONLY. NOTCH "W" (WIDTH) SHALL BE .060" +.0.0,-0.015" SCRIBE LINES AXIALLY ON THE BLOCK INSIDE DIAMETER AT THE PEAK ANGULAR LOCATIONS FOR ALL NOTCHES. THE NOTCH CENTERS (ALONG THE NOTCH LENGTH) SHALL BE LOCATED ±0.5 DEGREES OF THE SCRIBE LINES.

A- FINAL MOCK-UP LENGTH AND ARC WELDING. BOTH ARE NON-CRITIC

B- DIMENSIONS A-Q ±0.020"

5. INSIDE DIAMETER WELD ROOT AREA AT THE DIRECTION OF NATD ENGINE GEOMETRIC CONDITIONS WILL BE PR WITH EACH CONDITION OCCUPYING A TEMPLATES MAY BE PREPARED AT TH

6. CONDITIONING OF THE NOZZLE BORE SO THAT THE APPEARANCE RESEMBLE

7. TSI "AS-BUILT" INSPECTION DATA DIMENSIONS AND REFLECTOR DIMENS DIMENSIONS NEED ONLY TO BE VERI

SO. 305492-01
G. MEM/MNA-138
REVISION