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D. Naujock

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 2, 1997

MEMORANDUM TO: Edmund J. Sullivan, Jr., Chief
Section B
Materials and Chemical Engineering Branch
Division of Engineering

FROM: Donald G. Naujock, Metallurgist
Section B
Materials and Chemical Engineering Branch
Division of Engineering

SUBJECT: SUMMARY OF MEETING HELD ON APRIL 23 AND 24, 1997 WITH THE PERFORMANCE DEMONSTRATION INITIATION TO DISCUSS THEIR PROGRAM DESCRIPTION DOCUMENT, REVISION 1

Introduction

On April 23 and 24, 1997, the staff held a public meeting with representatives from the Performance Demonstration Initiative (PDI) at the Electric Power Research Institute (EPRI) Non-destructive Examination (NDE) Center in Charlotte, North Carolina. The purpose of the meeting was to discuss changes that occurred since the NRC assessment of PDI Program Description Document (PDD) Revision 0. PDI provided the NRC staff with 4 copies of their Program Description Document, Revision 1 before the meeting began, and the NRC staff returned the 4 copies at the close of the meeting. A list of attendees and their affiliations is provided as Attachment 1.

A PDI representative began the meeting with an overview of the agenda that was followed by a presentation on meeting objectives. A major objective of PDI was to develop an understanding of NRC's view regarding the acceptability of the PDI program. The handout used with the presentation is Attachment 2.

Regulatory Issues

PDI expressed concern with regulatory uncertainty surrounding the rulemaking of Appendix VIII, and the acceptance of the PDI program. PDI is searching for a way to receive generic acceptance of their program from the NRC. The NRC staff suggested that PDI submit their program as a topical report (topical). The topical will have to identify applicable Appendix VIII supplements, any exceptions to these supplements, and any other limitation that may affect utilization of the program by utilities. The topical will define the PDI program at the point in time of its submittal. After the NRC evaluates the topical, licensees may reference it in their request for relief as an alternative. Items not contained in the topical or that are plant-specific will have to be addressed separately by each licensee. The NRC staff suggested that the topical PDI submits uses a PDD that satisfies the 1995 Edition with 1996 Addenda of Section XI of the ASME Code.

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The NRC staff stated that rulemaking is referencing the 1995 Edition with 1996 Addenda of Section XI of the ASME Code. Rulemaking is progressing on schedule and is expected to be issued in July 1998. The NRC staff requested that PDI provide a list identifying the changes necessary to bring the PDI program into compliance with the 1995 Edition with 1996 Addenda along with the appropriate supplements, exceptions, and implementation times for each supplement. PDI will have to resolve any differences between the PDI program and ASME Code.

A PDI representative stated there was confusion with ANII and NRC inspections on the acceptability of the PDI program as an alternative to Regulation Guide 1.150 and/or the ASME Code. The inspectors were not accepting the PDI program as an alternative according to IWA-2240 without first witnessing a performance demonstration. PDI staff believed that the IWA-2240 approach appeared reasonable and hoped that the NRC staff would accept Appendix VIII as implemented by the PDI program as an acceptable alternative to Article 4 of Section V and Appendix III requirements. The NRC staff stated that as long as Appendix VIII is not part of the regulations, Appendix VIII or PDI qualified procedures that differ from those contained in the licensee's specified approved edition and addenda of the ASME Code will have to be handled as an alternative. The staff informed the attendees that requests for relief to use PDI qualified procedures as alternatives to ASME Code have been authorized according to the 10 CFR 50.55a(a)(3)(i). These requests for relief explained the differences between ASME Code and PDI qualified procedures. The ensuing discussion used Braidwood Nuclear Power Station, Units 1 and 2 request for relief NR-29 as an example on submitting an alternative to ASME Code and the staff's response to the submittal.

PDI staff requested that the NRC provide a person as a point of contact. At the meeting, Robert A. Hermann (301) 415-2768 was identified as this contact person.

Currently, PDI is planning on rewriting Appendix VIII and then submitting it as a code case to ASME. Because of funding limitations, PDI has made little progress with the rewrite.

The IGSCC Coordination Plan was terminated in January 1997. All IGSCC and weld overlay qualifications are being conducted by PDI. PDI has taken an exception to the staff's request for the continued maintenance of the IGSCC register. PDI believes that eliminating the IGSCC register is justified because the performance demonstration qualification summary (PDQS) sheet states when an examiner is IGSCC qualified. The qualifications can easily be verified by calling PDI. The NRC staff requested that PDI provide their explanation in writing.

RPV Specimens

PDI staff gave a presentation on reactor pressure vessel (RPV) specimen design and fabrication. The specimens being used for RPV performance demonstration testing are the same ones that were seen by the NRC staff during the assessment performed in early 1995. The handout used with this presentation is Attachment 3.

A second RPV presentation was given on the RPV demonstration process. PDI stated that most of the equipment and personnel performing UT with automated equipment have been qualified through PDI. PDI staff discussed the differences between their program and Supplements 4, 5, 6, 7, 11, and 12 to Appendix VIII. In the opinion of the NRC staff, most of these differences should be taken up with ASME Code and sent to the NRC as exceptions. The handout used with this presentation is Attachment 4.

The third RPV presentation was given on single side RPV shell weld examination performance demonstration. This presentation was in response to the NRC concerns that the specimens being used for the performance demonstration test did not adequately challenge the UT technique being used. The NRC staff believes that single-side RPV examinations were not part of the 1995 assessment and requested that PDI provide a written response to this NRC concern for review. The handout used with this presentation is Attachment 5.

The following NRC questions were submitted to PDI before the meeting. During the meeting, PDI provided their answers.

1. How will PDI resolve the open Issues 95-01-04 and 95-01-09 from the NRC Assessment Report on the PDI program?

Answer: The NRC issued a letter to Carl Osman (PDI) dated April 23, 1997, that provided recommendations for closing these two issues. At the end of the meeting, PDI provided a response to the NRC letter which contained wording similar to the NRC staff's recommendation. The NRC staff believes that PDI's response to the NRC letter should resolve the outstanding issues from the 1995 assessment of the PDI program.

2. ASME has asked PDI to make a side-by-side comparison of Appendix VIII to Section XI requirements with PDI's implementation of these requirements. What is the status of this request?

Answer: PDI state they have completed this task and submitted it to the ASME working group.

3. ASME has asked PDI to stop inundating the subcommittees with large numbers of code cases at each working meeting. Instead, PDI was asked by ASME to rewrite Appendix VIII and submit it to the subcommittee for review. What is the status of this task?

Answer: ASME has not formally asked PDI to stop inundating the subcommittee with large numbers of code cases.

4. PDI's implementation of Appendix VIII has resulted in many changes. Some of these changes involve moving from deterministic bounded criteria to statistical bounded criteria. Where have these changes occurred in the latest revision of PDI's Program Description Document (PDD), Revision 1, and where does PDI anticipate these type of changes to occur in the Appendix VIII rewrite?

Answer: These have occurred in PDD Revision 1. PDI has not looked ahead in the rewrite to determine if and where these kinds of changes will occur.

5. The NRC staff has received input from NDE personnel that flaw and blank implants installed in vessel specimens are recognizable with UT. There is concern that some candidates are developing techniques for finding the implants before finding the flaws. Explain what PDI is doing to deter this type of testmanship.

Answer: The discussions during the meeting and NRC staffs' observation of specimens and the test demonstration answered the question of testmanship. The NRC staff considered the specimen security provided by the PDI program as reasonable and effective.

6. There are inferences that candidates who have taken the PDI PD tests are collaborating with each other to develop flaw maps of the test specimens. This type of information sharing may not be preventable, and therefore, should be expected. Explain what PDI is doing to protect the integrity of the PD examinations.

Answer: PDI does not believe that their specimens are being compromised. The PDI program exhibited a high level of specimen integrity that would hinder any efforts to map flaws.

7. How does Appendix VIII, as implemented by PDI, embrace Appendix III and Section V, Article 4.

Answer: PDI does not embrace Appendix III or Section V, Article 4.

8. Appendix VIII, VIII-2100(d)(9) states that procedures shall specify methods and criteria for the discrimination of indications. However, procedures are being qualified that use amplitude gates (20% distance amplitude correction (DAC) curves, etc). Amplitude gates do not contribute to the discrimination of indications, i.e., geometric versus flaws. Explain how amplitude gates and other similar restrictions are supported by Appendix VIII.

Answer: The 20% DAC developed for calibration according to ASME Code is not the same 20% DAC in procedures being used for the performance demonstration tests. Any procedure that is able to pass the performance demonstration is acceptable. PDI considers the use of gates to be out of the scope of the PDI program.

9. Appendix VIII, VIII-2100(d)(9) states that procedures shall specify methods and criteria for the discrimination of indications. Indications determined to be flaws have ASME Code acceptance criteria based on flaw characterization (IWB-3600). Explain how the PD examination is ensuring that procedures and examiners are capable of finding and sizing flaws down to the minimum recordable flaw sizes set by ASME Code.

Answer: PDI has at least one flaw at this depth in the test set.

10. PDI's cladded vessel specimens have a cladded surface finish that represents approximately 90% of the reactor pressure vessels in the field. For the 10% of the vessels that are not being represented by PDI specimens, explain what method is being used to indicate their exclusion from the PDI program.

Answer: This is a plant specific problem and will have to be handled by those plants. The NRC staff suggested that the program descriptions clearly state what is covered and what is not covered.

11. PDI has been allowing candidates to qualify to Appendix VIII, Supplements 4 and 6 with only one performance demonstration test. Explain how PDI is satisfying the minimum number of flaws and flaw depth distribution for both supplements in the one PD test.

Answer: PDI staff observed that shallow flaws on the OD and ID are the hardest to find and medium to larger depth flaws are being found all (100%) of the time. So by keeping the shallow flaws from Supplement 4 and 6 and dropping some of the medium and larger depth flaws, PDI staff believes that the abbreviated performance demonstration test is as challenging as a performance demonstration of the two supplements separately. The NRC staff suggested that PDI bring this consolidation of supplements up with ASME Code. Since this consolidation is being used by PDI, NRC staff requested that PDI provide a detailed justification that included a statistical basis similar to the statistical analysis used to establish the acceptance criteria for these supplements.

Attachments: As stated

cc: J. R. Strosnider

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10. PDI's cladded vessel specimens have a cladded surface finish that represents approximately 90% of the reactor pressure vessels in the field. For the 10% of the vessels that are not being represented by PDI specimens, explain what method is being used to indicate their exclusion from the PDI program.

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Single Side RPV Shell Weld Examination Performance Demonstration

PDI, EPRI & NRC

Discussions

April 23-24, 1997

ASME Section XI Requirements

- Article I-2000 Examination Requirements
  - I-2100 Vessels Great Than 2 in, In Thickness
  - I-2110 Reactor Vessels
    - (a) Ultrasonic examination procedures, equipment and personnel used to detect and size flaws in reactor vessels greater than 2 in. in thickness shall be qualified by performance demonstration in accordance with Appendix VIII for the following specific examinations and no other I-2000 requirements apply.....

Requirements of Appendix VIII/PDI

- Article VIII-2000 General Examination System Requirements
  - VIII-2100 Procedure Requirements
    - (a) The examination procedure shall contain a statement of scope that specifically defines the limits of procedure applicability.
    - (d) (4) detection and sizing techniques, including (a) scan pattern and beam direction.....
      (e) extent of scanning and action to be taken for access restrictions;

Vendor Procedures

- Vendors UT procedures for performance demonstration included "single side" applications within the scope or application of the procedure

REMOTE INSERVICE EXAMINATION OF REACTOR VESSEL SHELL WELDS

1.0 PURPOSE

1.1 This document describes the equipment, examination techniques, sensitivity calibration, data recording and data interpretation requirements for mechanized inservice examination of the Reactor Vessel shell welds. The methodologies described herein are intended to satisfy the volumetric examination requirements of the ASME Code Section XI, 1992 Edition, 1994 Addenda including Appendix VIII, Supplements 4 and 6.

2.0 REFERENCES AND APPENDICES

2.1 ASME Boiler and Pressure Vessel Code, Section XI, 1989 Edition.

2.2 ASME B&PV Code, Section XI, Appendix VIII, 1992, 1993 Addenda.

2.3 Appendix 1 "Essential Hardware, Software and Operations Input Parameters"

2.4 WesDyne document "RV-ISI System Operations Manual, Rev. 0".

2.5 Examination Program Plan.

2.6 Dynapulser Qualification Procedure 96-QA-1113 Rev. 0.

3.0 SCOPE

3.1 This document provides general requirements for ultrasonic examinations of stainless steel clad carbon/low alloy steel shell full penetration welds of the Reactor Vessel and required volumes 4" through 12.3" in thickness. Complete access to one side of the weld for perpendicular and parallel beam directions shall be considered a minimum requirement. Where access to the examination volume is limited by component geometry, scanning will be performed to the extent practical from the available surfaces.

(2) Examinations performed where access from both sides of the weld exist shall be conducted as follows:

Examinations shall be performed using two 55-degree shear-wave search units and two SLIC-40 search units looking in opposite directions. A 0-degree search unit may also be used as described in Subsection 7.6 to detect laminar reflectors which may interfere with angle-beam examination and to determine component thickness.

(3) Examinations performed where access is limited to one side of the weld shall be conducted as follows:

Examinations shall be performed using two SLIC-40 search units, one 45-degree shear-wave search unit, and one 55-degree shear-wave search unit all looking in the same direction. A 0-degree search unit may be used as described in Paragraph 7.3(2).

7.4 Examination Limitations

When the specific SwRI Scan Plan requirements cannot be met, the "as performed" scanning parameters and the reason for the scanning limitations shall be documented.

7.5 Surface Condition

The contact surfaces shall be free from weld spatter, roughness, or other conditions which interfere with free movement of the search unit or impair the transmission of ultrasound.

7.6 Base Material Lamination Scan

(1) A straight-beam lamination examination may be performed during the initial angle-beam examination of welds and adjacent base material covering the entire area through which the angle beam is to be passed.

(2) In areas where no backwall reflection can be observed (such as tapered sections, etc.), obtain a backwall signal from the adjacent base material with parallel surfaces and adjust the signal to 80% ±5% of FSH.

8. RECORDING CRITERIA

Examinations performed in accordance with this procedure shall be recorded using EDAS. The EDAS parameters shall conform to this procedure with the EDAS storing all digitized A-scans from the active channels. Data will be stored on the system disk array and archived to 4-mm tape (see Figures 4 and 5).

8.1 Detection Criteria

(1) Indications must exhibit the following attributes to be considered a detected flaw:

(a) The indication must have a echo-dynamic presentation indicative of target movement through the sound beam.

1.0 SCOPE: This procedure shall govern the automated remote contact ultrasonic examination of full penetration clad-ferritic metal circumferential, longitudinal, and meridional welds in reactor vessels. Wall thicknesses ranging from 4 inches up to 12.3 inches with a minimum diameter of 142 inches (ID) may be examined with this procedure. The welds may join forgings or plates or combinations thereof. The clad type may consist of SMAW, multiple wire, or strip clad or combinations of these. The objective of this procedure is to detect and size flaws within the examination volumes described from the inside surface of the component.

This procedure is intended to be implemented by scanning the examination volumes from at least one perpendicular and one parallel direction for flaw detection. However, subsurface indications may be detected that cannot be confirmed by both transducers from the same side. When this condition exists, the suspect area shall be scanned from both sides in order to disposition the suspect indication. Half-node examination techniques will be used. Where geometric configurations preclude complete coverage from one direction, scanning from the opposite direction may be used to increase coverage. Flaw sizing techniques shall be applied from each side of the flaw where the configuration permits.

The examination of vessel welds described by this procedure meets the minimum requirements of ASME Boiler and Pressure Vessel Code, Section XI, 1992 Edition, Appendix VIII, Supplements 4 and 6.

2.0 SURFACE PREPARATION: The examination surface shall be free of dirt, loose scale, machining or grinding particles, weld spatter, or other loose foreign material or coatings which interfere with ultrasonic wave transmission. The surface shall be sufficiently smooth to maintain acoustic coupling and minimize surface noise. These requirements apply on all areas through which the sound beams pass. Generally, the condition of the vessel ID meets these requirements and no further surface conditioning is required.

3.0 PERSONNEL QUALIFICATIONS: There are three basic categories of personnel involved in performing this examination. They are data acquisition operator, calibration personnel, and data analysis personnel described as follows:

3.1 Data Acquisition Operator: Personnel operating the data acquisition system do not require training or certification in the ultrasonic method because their activity is limited to operation of equipment only and they do not make decisions concerning system configuration or the ultrasonic data itself. Their activity is limited to operation of the system controls which execute preestablished scan plans. All

Considerations for Performance Demonstration

- Appendix VIII does not describe access conditions but states ...*"Any procedure qualified in accordance with this Appendix is acceptable"*
  - Article VIII-1000 Scope
    - VIII-1100 General:
      - (e) Any procedure qualified in accordance with this Appendix is acceptable

PDI Program Requirements

- Test Administration PDP-Q-009.1
  - Paragraph D. The candidate organization and the PDA shall agree on any special limitations on the scope of the demonstration .....or a demonstration with examination access from only one side of the weld.

PDI Considerations

- PDI RPV Technical working group developed a description of Single Side to address the limitation for the purpose of performance demonstration
  - An ultrasonic procedure only allowing for ultrasonic data to be collected (and later analyzed) from only one perpendicular and transverse axis to the intended flaw volume. The surface must allow for the complete examination volume thickness to be examined by the ultrasonic beams.....

EPRI NDE CENTER

Subject

Originator P.J. Ahern

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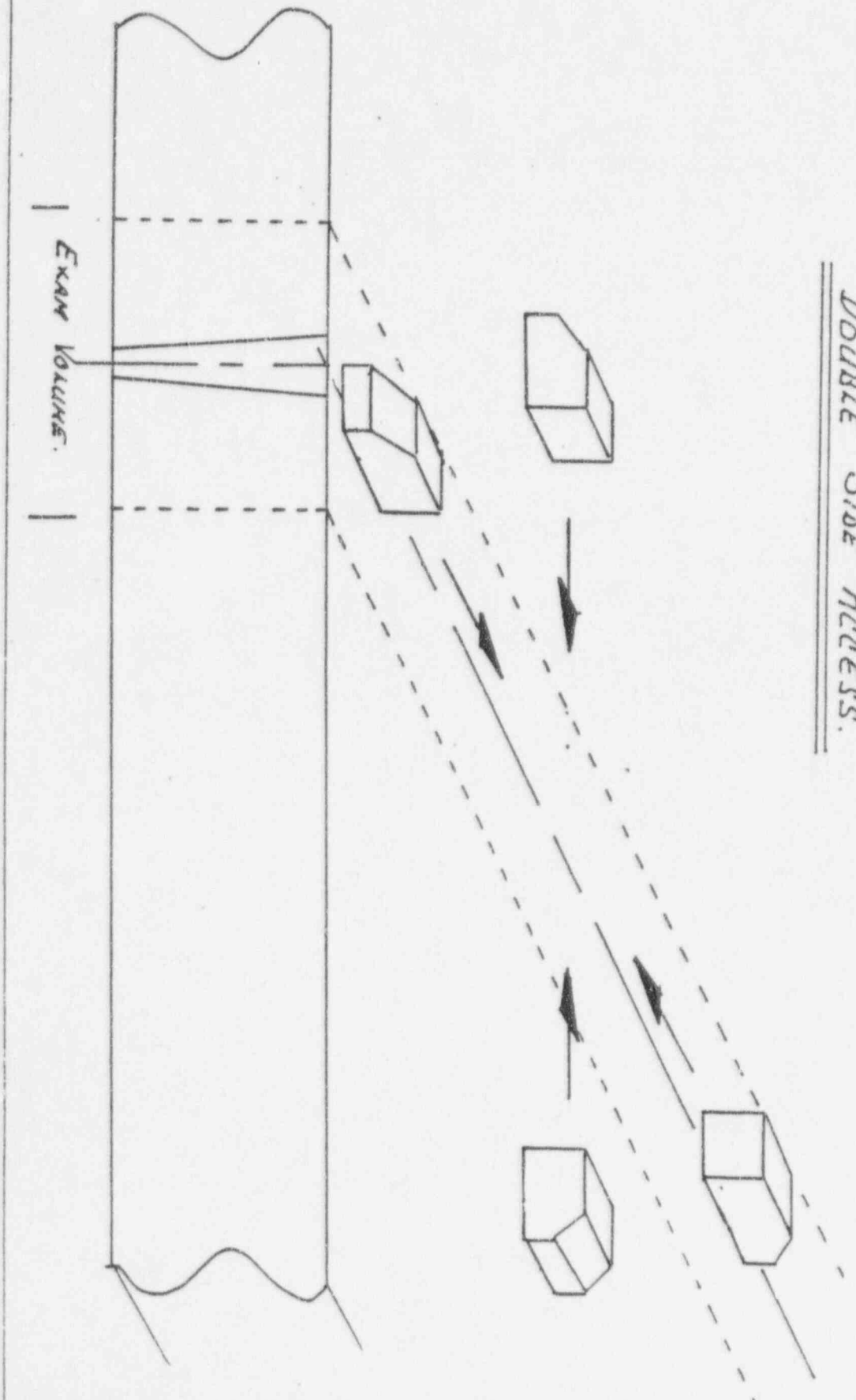
Date 4/21/97



DOUBLE SIDE ACCESS.

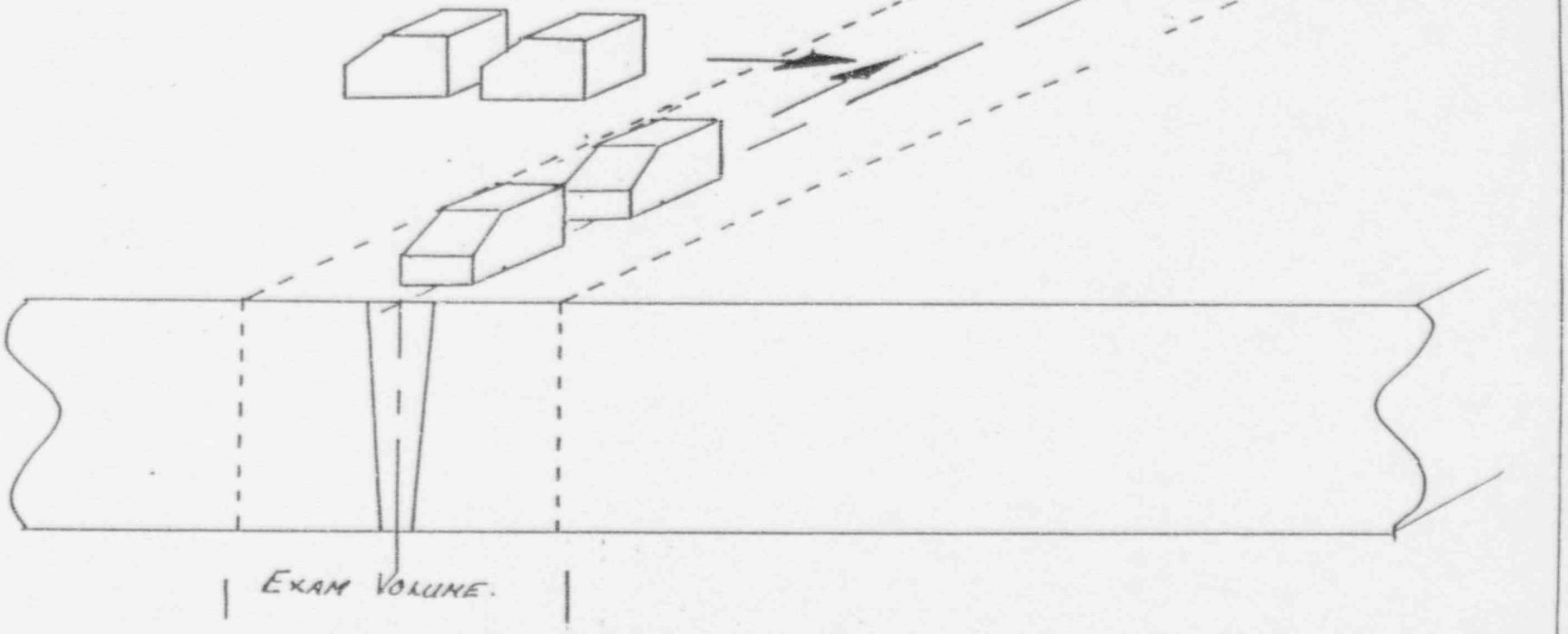
Page ____ of ____

Date 4/11/97

Originator R.P. Gilbert

Subject

SINGLE SIDE ACCESS.



Test Requirements of Appendix VIII/PDI

- Article VIII-3100 Qualification Test Requirements
  - VIII-3110 Detection
    - (b) The examination procedure, equipment, and personnel are qualified for detecting flaws upon successful completion of the performance demonstration specified in the appropriate Supplement listed in Table VIII-3110-1
  - VIII-3120 Sizing
    - (b) The examination procedure, equipment, and personnel are qualified for sizing flaws upon successful completion of the performance demonstration specified in the appropriate Supplement listed in Table VIII-3110-1

Other PDI Test Considerations

- Test Specimens and Flaws
  - Considered to be equally challenging from either side of the examination volume
    - Flaw manufacturing methodology does not favor any access
    - Flaw orientation is realistic
- Test Protocol
  - Shall be the same as that used for procedures without access limitations

Procedure Performance

- Procedures which have been demonstrated as "Single Side" have been shown to be equally effective as the procedures which require " double side" access.

Conclusions

- Single Side RPV Examination procedures are qualified in accordance with Code requirements
  - Test specimens contain realistic flaw types, location & orientation
- Procedures which have been demonstrated as "Single Side" have been shown to have code required flaw detection capability as have the procedures which require " double side" access.

RPV Demonstration Process

Automated RPV Procedure Demonstrations to PDI's Implementation of Appendix VIII, Supplement 4 and 6

PDI, EPRI & NRC

Discussions

April 23-24, 1997

Organization of Performance Demonstrations

- Responsibilities
- Demonstration Rules (Protocol)
- Procedure & Personnel Performance Demonstrations
  - Essential variables
  - Test Set Selection
  - Grading
  - Documentation
- Key to Successful RPV Demonstrations

Responsibilities - EPRI

- EPRI NDE Center is Performance Demonstration Administrator (PDA)
  - Develop Program
  - Develop Technical Basis
  - Administer and supervise demonstrations
  - Document results
  - Resource to assist utilities
- PDI provides guidance and oversight to PDA through the protocol
- Authorized Inspection Agencies (ANI)
  - Witness relevant portions of demonstrations
  - Review and UT procedures
  - Assure field implementation is to same standard as was demonstrated

Demonstration Rules - Protocol

- Prepared by PDI (Utilities) as instructions and interface document to all participants, *includes*
  - Perquisites for Performance Demonstration
  - PDA's Role in Procedure Review
  - Scheduling Criteria
  - Test Specimen Selection
  - Security
  - Administration of the Performance Demonstrations
  - Documentation for Performance Demonstrations
  - Grading Requirements
  - Retesting
  - Dispute Resolution

Performance Demonstrations

- The PDA - Performance Demonstration Administrator is responsible for all performance demonstration activities in accordance with PDI program procedures
  - Procedure review
  - Verification of personnel and procedure technique, equipment & essential variables
  - Develop and maintaining auditable records
  - Surveillance during the demonstration
  - Grading & Issue of demonstration results
- ANI may participate in PDA's administration of combined procedure/personnel demonstrations
  - -- Review UT procedures
  - Witness relevant portions of demonstration

Performance Demonstrations

- Candidate prerequisites
  - All candidates shall have completed the following
    - Signed a corporate and/or personnel use agreement
    - Registered for performance demonstration
      - Provided a performance demonstration plan and security plan
      - Procedure & essential variables
      - Provided statement of Level II certification
    - Prior to demonstration
      - Equipment certification (hardware and transducers)
      - Operating manuals
      - Copy of Software

Performance Demonstrations

- PDA prerequisites
  - The PDA shall have reviewed & accepted the candidates procedure
  - Selected the test specimens and developed test sets
  - Developed a detailed demonstration plan including security requirements
    - Demonstration facility
    - Specimen integrity
    - Personnel
    - Computer systems
  - Prepared all demonstration forms, checklists and grading sheets

PDA's Role in Procedure Review

- Procedure Review
  - Level III with nuclear plant ISI experience
  - Evaluates procedure to Appendix VIII requirements
  - Identify essential variables
  - Determines Range or Criteria based
  - Provide feedback to candidates on procedure revisions or improvements
  - Develops checklist for use during performance demonstrations
- Experience
  - Procedures typically need 2-3 revisions before acceptance for performance demonstration

PERFORMANCE DEMONSTRATION INITIATIVE

AUTO VESSEL DETECTION PROCEDURE ESSENTIAL VARIABLE REVIEW CHECKLIST

COMPANY	B&W Nuclear Technologies	PROCEDURE NO. REV. / DATE	ISI-800 0 - 10-2-95
TITLE	Remote Ultrasonic Examination of Reactor Vessel Welds in Accordance with ASME Section XI, Appendix VIII, Supplements 4 and 6		

ITEM	PROCEDURAL ITEM	RESULTS
1.0	SCOPE	
A	Verify that the procedure contains a statement of scope that specifically defines the limits of procedure applicability (e.g. essential variables and range of qualification). Material: Clad Ferritic Metal Product Form: RPV circumferential, longitudinal, and meridional welds Thickness Range: 4.0" to 12.3" Diameter: Min. 142 " Max. "	[*] 1 [Y]
B	Also, verify that the procedure list the weld types and configurations to be examined. (e.g., ASME Section XI, Supplements 4, 5, 6 & 7, etc.) Procedure Location: 1.0 Full Penetration Welds, Supplement 4 & 6	[Y]
C	LIMITATIONS ☐ Dual side access required for welds examination. ☑ Single side access required for welds examination. Clad Type: SMAW, Multiple Wire, and Strip Clad Clad roughness: ?	[N/A] [Y] [*] 5
	List any additional limitations: 1.0 The examination volumes will be scanned from at least one perpendicular and one parallel direction for flaw detection. Where geometric configurations preclude complete coverage, scanning from the opposite direction or the use of a full-node technique may be used to increase coverage. Flaw sizing techniques will be applied from each side of the flaw where the configuration permits.	[Y]
D	PERSONNEL REQUIREMENT Ensure that the procedure addresses provisions for personnel qualifications and duties for each classification. Procedure Location: 3.0	[Y]
2.0	SURFACE PREPARATION	
A	Verify the procedure adequately addresses surface preparation. Procedure Location: 2.0	[Y]
B	Ensure that the procedure specifies the examination scanning surface (e.g. ID, OD, Nozzle bore, etc.). Procedure Location: 1.0 (ID)	[Y]

INFORMATION

Notes: Candidate's procedure complies with ASME Section XI, Appendix VIII, Article VIII-2000: Y = Yes N = No N/A = Not Applicable, * = See Comment

PPS00-D2.DOC

ITEM	PROCEDURAL ITEM	RESULTS
3.0	EQUIPMENT	
	Instruments or Systems	
A	Ensure that the procedure identifies the instrument or system, includes the manufacturer and model or series of pulser, receiver, and amplifier, as well as display and processing Hardware Rev. Table A & B, Software Rev. Table A & B, and algorithms. Procedure Location: 4.1, and Table A & B	[Y]
	Search Unit Cables	
B	Ensure that the procedure identifies the Search Unit Cable(s), including, Type, Maximum Length, and maximum number of connectors. List Procedure Location: 4.3 and Table C	[Y]
	Search Units	
C	Ensure that the procedure identifies the number, size, shape, and configuration of active elements and wedges or shoes Procedure Location: 4.4 and Table D & E	[Y]
D	Verify that the procedure specifies a nominal value or a range of values for search units, Center Frequency, Bandwidth, or Wave-form Duration. Procedure Location: 4.4 and Table D & E	[Y]
E	Verify that the procedure describes any rotating, revolving, or scanning mechanisms, if used. Procedure Location: 4.2	[Y]
F	Verify that the procedure describes any special equipment, if used. Procedure Location: N/A	[N/A]
G	Verify that the procedure identifies the couplant to be used. Procedure Location: 4.5	[Y]
4.0	CALIBRATION	
A	Verify that the procedure provided a description of the calibration method for detection and sizing (e.g. action required to insure that the sensitivity and accuracy of the signal amplitude and time outputs of the examination system, whether displayed, recorded, or automatically processed, are repeated from examination to examination). List Procedure Location: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 9.1, 9.2, 9.3, 9.4 & 9.5	[Y]
B	Ensure that the calibration technique includes the establishment of reference sensitivity levels, instrument controls to be used, and acceptance standards for the calibrated condition. List Procedure Location: 7.2, 7.5, 7.6, 9.2, 9.3, 9.4 & 9.5	[Y]
C	List Procedure Location: Verify that the procedure addresses calibration block selection. List Procedure Location: 4.6.1, 4.6.2 & 4.6.3	[Y]
D	Verify that the procedure identifies the calibration data to be recorded. List Procedure Location: 14.0	[*] 2

INFORMATION

Notes: Candidate's procedure complies with ASME Section XI, Appendix VIII, Article VIII-2000: Y = Yes N = No N/A = Not Applicable, * = See Comment

ITEM	PROCEDURAL ITEM	RESULTS
5.0	**CALIBRATION DATA RECORD**	
A	Ensure that the procedure requires, as a minimum, the following data be recorded on a cal. data sheet:	
	(1) Calibration sheet identification and date of calibration.	[Y]
	(2) Names of examination personnel.	[Y]
	(3) Examination procedure number and revision.	[Y]
	(4) Basic calibration block identification.	[Y]
	(5) Ultrasonic instrument identification and serial number.	[Y]
	(6) Beam angle, couplant, and mode of wave propagation in the material.	[*] 2
	(7) Search unit identification - frequency, size, and manufacturer's serial number.	[Y]
	(8) Special search units, wedges, shoe type, or saddle's identification, if used.	[N/A]
	(9) Search unit cable type, length, and number of intermediate connectors.	[Y]
	(10) Times of initial calibration and subsequent calibration checks.	[Y]
	(11) Amplitudes and sweep readings obtained from the calibration reflectors.	[Y]
	(12) Software version, if applicable Procedure Location: 14.0	[Y]
B	If an electronic DAC curve is being used, a second record shall be made of the resultant amplitudes and sweep readings obtained from the calibration reflectors. List Procedure Location: N/A	[N/A]
6.0	**EXAMINATION TECHNIQUE**	
A	Verify that the procedure specifies a single value or a range of values for the following:	
	1. Mode of Propagation. Procedure Location: 10.1 and Table D & E	[Y]
	2. Nominal inspection angle. Procedure Location: 7.1, 7.2, 8.1, 10.1 and Table D & E	[Y]
	3. Detection and Sizing techniques, including: Scan pattern and beam direction. Procedure Location: 8.1 - 8.13 and 10.3 - 10.14	[Y]
	4. Maximum scan speed. Procedure Location: 8.2 & 10.2	[Y]
	5. Minimum and Maximum pulse rep rate. Procedure Location: ?	[N] 3
	6. Minimum sampling rate (automatic recording systems) Procedure Location: 8.5 & 10.5	[Y]
	7. Extent of scanning and action to be taken for access restrictions. Procedure Location: 5.1, 5.2, 6.0, 8.0, 10.0, 12.0 & 14.0	[Y]

INFORMATION

Notes: Candidate's procedure complies with ASME Section XI, Appendix VIII, Article VIII-2000: Y = Yes N = No N/A = Not Applicable, * = See Comment

ITEM	PROCEDURAL ITEM	RESULTS
7.0	**EXAMINATION DATA RECORDING**	
A	Verify that the procedure addresses the following examination data recording criteria:	
	1. Examination Data to be recorded.	
	a. Geometric Indications — Procedure Location: 11.3.1	[Y]
	b. Flaw Indications — Procedure Location: 11.3.2 & 11.3.3	[Y]
	2. Method of data recording. — Procedure Location: 4.1	[Y]
	3. Recording equipment (e.g., strip chart, analog tape, digitizing) when used. — Procedure Location: 4.1 & Table B	[Y]
B	Ensure that provisions are made for recording the following information on the examination data sheet:	
	(1) Data sheet identification and date and time period of examination;	[Y]
	(2) Names and certification levels of examination personnel;	[Y]
	(3) Examination procedure and revision;	[Y]
	(4) Calibration sheet identification;	[Y]
	(5) Identification and location of the weld and volume scanned;	[*] 4
	(6) Surface from which the examination is conducted and	[*] 4
	(7) Examination results. — Procedure Location: 14.0	[Y]
8.0	**INDICATION EVALUATION**	
A	Verify that the procedure provides a method and criteria for the discrimination of indications (e.g., geometric versus flaw indications and for length and depth sizing of flaws. Procedure Location: 11.1, 11.2, 11.3, 12.1 & 12.2	[Y]

INFORMATION

COMMENTS

PROCEDURE EVALUATION

This procedure as written is: ☐ Acceptable ☑ Unacceptable Reviewed By: D.E. Holthaus Dave Holthaus Date: 10/10/95

Additional Review: _____ (Organization)	Additional Review: _____ (Organization)
Reviewed By: _____	Reviewed By: _____

Notes: Candidate's procedure complies with ASME Section XI, Appendix VIII, Article VIII-2000: Y = Yes N = No N/A = Not Applicable, * = See Comment

A procedure change will be required to address comments 1 through 4 prior to participation in the Performance Demonstration Process.

Comment # 1 (Checklist No. 1.A)

Checklist item # 1.A required the procedure to contain a statement of scope that specifically defines the limits of procedure applicability (e.g. essential variables and range of qualification).

The scope, as it in presently written, is inadequate. The scope needs to be more specific with regards to limitations, applicability, coverage, etc.

Comment # 2 (Checklist No. 4.D & 5.A)

Checklist item # 4.D requires the procedure to identify the calibration data to be recorded and checklist item # 5.A provides a listing of the minimum information which needs to be recorded.

Paragraph 14.0 provides a listing of reporting information which includes most of the required calibration data with the exception of the examination couplant. This item need to be added to the procedure.

Comment # 3 (Checklist No. 6.A.5)

Checklist item # 6.A.5 requires the procedure specify the minimum and maximum pulse rep. rate.

The procedure needs to be revised to include this information.

INFORMATION

Comment # 4 (Checklist No. 7.B)

Checklist item # 7.B, requires the procedure to identify the examination data to be recorded

Paragraph 14.0 provides a listing of reporting information which includes most of the required examination data with the exception of , (1) time period of examination, (2) Weld identification, and (3) Surface from which the examination is conducted. The procedure needs to be revised to include this information.

The following comment(s) are provided as recommendations and don't necessarily require a procedure change.

Comment # 5 (Checklist No. 1.C)

Checklist item # 1.C addresses clad roughness.

Insofar as the procedure does not address this item, the PDQS will reflect cladding roughness as "ground".

Essential Variables

- Appendix VIII identifies essential variables
- PDA review procedure and equipment for additional essential variables
  - Custom hardware
  - Software
  - Techniques
- All essential variables are confirmed during performance demonstration

Test Specimen Selection

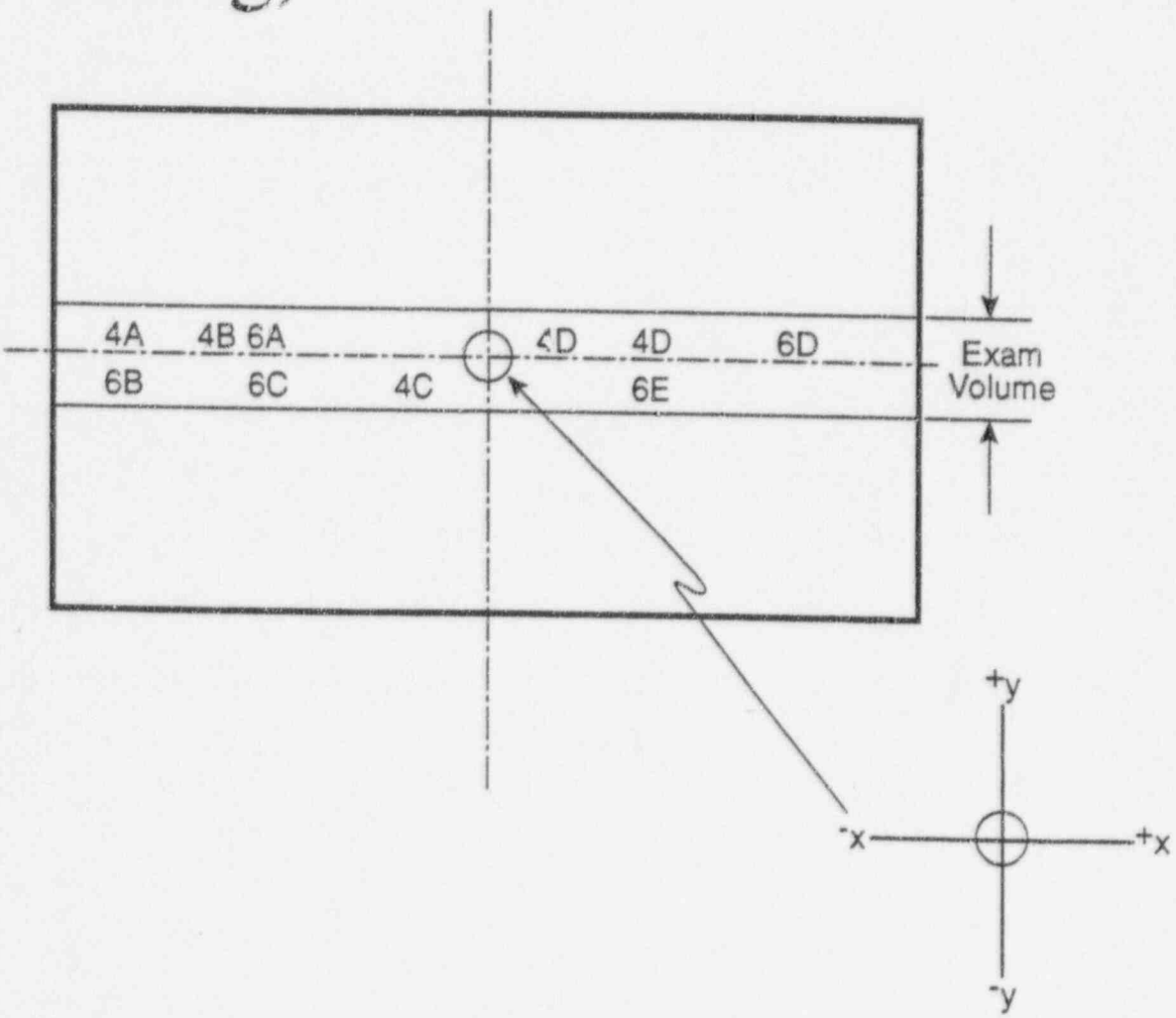
- Responsibility of PDA to develop specimen test set
  - Computer programs are used and test sets are reviewed for program compliance.
  - Min.. and Max. range of essential variables must be covered
  - Procedure limitations have to be considered
    - Limited access
    - Responsibilities of personnel for automated procedures
- Specimen Integrity is addressed

Test Set Requirements

- Combined Supplement 4 & 6 test set will include a minimum of 14 flaws for Detection and 20 for sizing
  - Detection min 7 flaws per supplement
  - Sizing min 10 flaws per supplement
  - Size & Orientation distribution per code requirements
- Test sets for personnel demonstrations may be smaller using a qualified procedure!

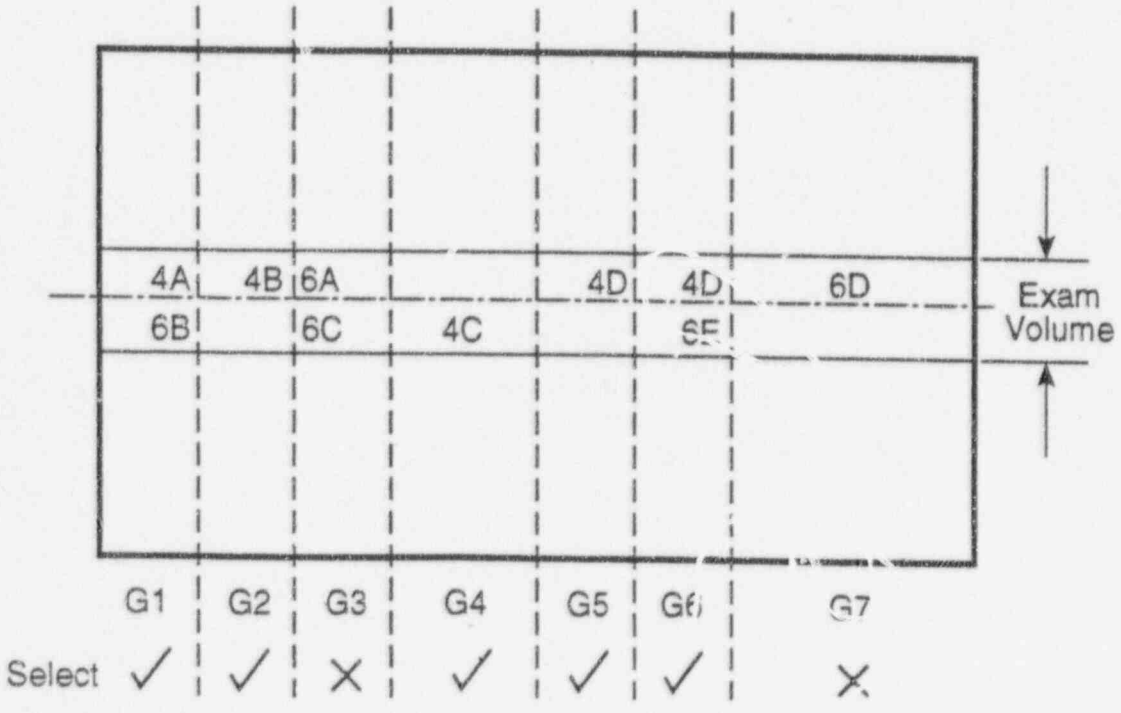
Development of RPV Test Set

- Specimens contain supplement. 4 & 6 flaws (detection and sizing)



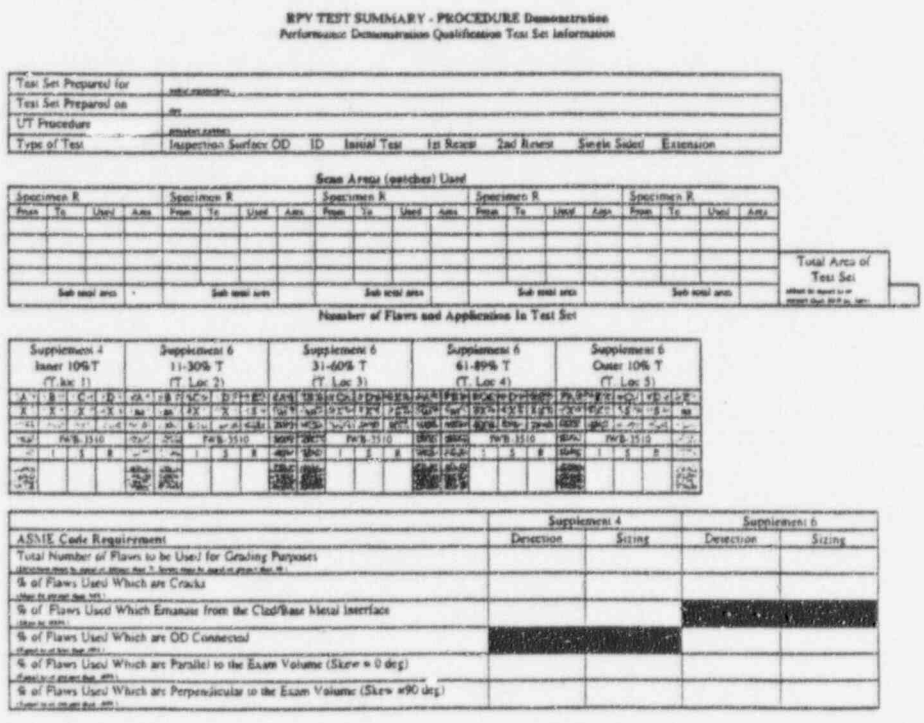
Development of RPV Test Set

- Specimen is divided into scan areas (patches)
- PDA selects different patches to make up test set



Development of RPV Test Set

- When combined with scan areas from other test specimens the number of flaws meet PDI program test set requirements



RPV TEST SUMMARY - PROCEDURE Demonstration
Performance Demonstration Qualification Test Set Information

Test Set Prepared for	[redacted]
Test Set Prepared on	[redacted]
UT Procedure	[redacted]
Type of Test	Inspection Surface: OD ID Initial Test 1st Review 2nd Review Single Sided Extension

Scan Areas (patches) Used

Specimen #				Specimen #				Specimen #				Specimen #				Specimen #			
From	To	Used	Area	From	To	Used	Area	From	To	Used	Area	From	To	Used	Area	From	To	Used	Area
Sub total area				Sub total area				Sub total area				Sub total area				Sub total area			

Total Area of Test Set

Number of Flaws and Application in Test Set

Supplement 4 Inner 10% T (T Loc 1)	Supplement 6 11-30% T (T Loc 2)	Supplement 6 31-60% T (T Loc 3)	Supplement 6 61-89% T (T Loc 4)	Supplement 6 Outer 10% T (T Loc 5)
A B C D	A B C D	A B C D	A B C D	A B C D
	Perp. to Weld	Perp. to Weld	Perp. to Weld	Perp. to Weld
1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

ASME Code Requirement	Supplement 4		Supplement 6	
	Detection	Sizing	Detection	Sizing
Total Number of Flaws to be Used for Grading Purposes				
% of Flaws Used Which are Cracks				
% of Flaws Used Which Emanate from the Clad/Base Metal Interface			[redacted]	
% of Flaws Used Which are OD Connected	[redacted]			
% of Flaws Used Which are Parallel to the Beam Volume (Skew = 0 deg.)				
% of Flaws Used Which are Perpendicular to the Beam Volume (Skew =90 deg.)				

Test set prepared by Date Form revision 0: 2/6/96

RPV TEST SUMMARY - PROCEDURE Demonstration

Performance Demonstration Qualification Test Set Information

Test Set Prepared for	name/ organization
Test Set Prepared on	date
UT Procedure	procedure numbers
Type of Test	Inspection Surface OD ID Initial Test 1st Retest 2nd Retest Single Sided Extension

Scan Areas (patches) Used

Specimen R				Specimen R				Specimen R				Specimen R				Specimen R			
From	To	Used	Area	From	To	Used	Area	From	To	Used	Area	From	To	Used	Area	From	To	Used	Area
Sub total area				Sub total area				Sub total area				Sub total area				Sub total area			

INFORMATION

Total Area of Test Set (Must be equal to or greater than 10.0 sq. feet)	

Number of Flaws and Application In Test Set

Supplement 4 Inner 10%T (T.loc 1)				Supplement 6 11-30% T (T. Loc 2)					Supplement 6 31-60% T (T. Loc 3)					Supplement 6 61-89% T (T. Loc 4)					Supplement 6 Outer 10% T (T. Loc 5)				
A	B	C	D	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
X	X	X	X	na	na	X	X	S	na	na	X	X	S	na	na	X	X	S	X	X	S	S	na
	IWB-3510					IWB-3510				IWB-3510					IWB-3510					IWB-3510			
	I	S	R			I	S	R		I	S	R			I	S	R			I	S	R	

ASME Code Requirement	Supplement 4		Supplement 6	
	Detection	Sizing	Detection	Sizing
Total Number of Flaws to be Used for Grading Purposes (Detection must be equal or greater than 7/ Sizing must be equal or greater than 10)				
% of Flaws Used Which are Cracks (Must be greater than 50%)				
% of Flaws Used Which Emanate from the Clad/Base Metal Interface (Must be 100%)				
% of Flaws Used Which are OD Connected (Equal to or less than 10%)				
% of Flaws Used Which are Parallel to the Exam Volume (Skew = 0 deg) (Equal to or greater than 40%)				
% of Flaws Used Which are Perpendicular to the Exam Volume (Skew =90 deg) (Equal to or greater than 40%)				

Test set prepared by Date Form revision 6: 2/6/96

Specimen Integrity

- Specimen Integrity is Maintained
  - Specimen are given an alias
  - Actual orientation is concealed
  - All data files are
    - given unique names
    - collected with a local datum point of 0/0
    - header information is identical
- The candidates **can not** develop knowledge of the specimen truth!

Planning for a Performance Demonstration

- All demonstrations are be carried out to a performance demonstration plan.
- Planning begins at least 3 months before
- The plan is important to achieve successful and efficient demonstrations & considers
  - Number of ultrasonic procedures / personnel
  - Location & facility requirements
  - Type of UT equipment to be used
  - Security plan
  - Demonstration specimens & calibration blocks
  - Schedules - Guided Practice - Demonstrations - Retesting

Administration of Performance Demonstrations

- Preparation
  - PDI provides candidates with practice specimens
  - PDA visit candidate facility to review, UT system, final UT procedure revisions and security requirements
  - Scan areas of the test specimens are provided to candidates for the preparation of scan plans

Demonstration Activities Set -Up

- Set-up
  - PDA facilities are secured, change locks, install video equipment, post signs etc....
  - Indoctrination of candidate personnel
  - Test specimens are shipped to arrive when PDA are on site
  - Demonstration area and equipment are secured
    - All equipment configurations are verified, (model/serial numbers are recorded)
    - Software is loaded (from back up copy)
    - Computer systems are logged.

Demonstration Activities Surveillance

- Surveillance
  - All performance demonstration activities are carried out under direct surveillance by PDA staff
    - Procedure demonstrations require 3 staff
    - Utility personnel may also participate
  - Checklists developed by PDA from procedure review are used to document procedure compliance
  - Additional surveillance by CCTV

Demonstration Activities Calibration

- Calibration
  - Any calibration method may be used but must be described in the procedure
  - The UT system and each transducer is calibrated in accordance with the procedure
    - ANI witness calibration
  - Calibration documents are retained on file

Demonstration Activities Data Collection

- Data Collection
  - PDA provides candidate with instructions where to collect data.
  - Checklists are used to verify data is collected in accordance with procedure essential variables.
  - Candidates may only access data in accordance with the procedure and equipment changes are not permitted without procedure criteria or technical justification

3rd STAGE SIZING DATA COLLECTION INSTRUCTIONS

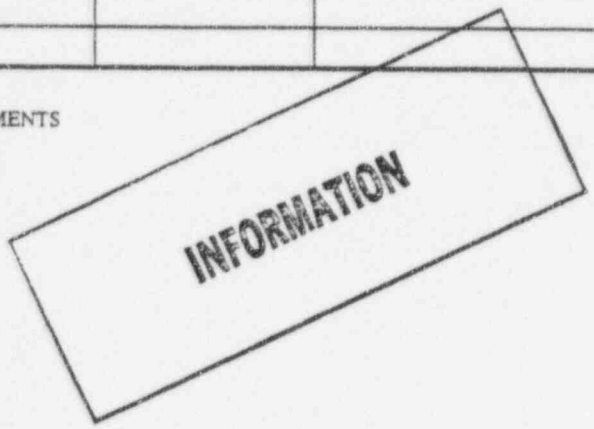
Patch Name _____

	TASK	INITIAL
1	Verify the specimen is and the orientation is correct	
2	Notify the Operator that the Patch data file name will be _____ and the start location is at _____ inches from the specimen zero.	

	CIRCUMFERENTIAL SCAN	
3	Verify the scanner is zeroed correctly on the test Specimen	
4	Provide the Operator with the scan sheet	
5	Verify the transducers are in the 0 degree orientation	
6	Verify the operator has selected the correct scan plan from the scanner control plan menu _____	
7	Verify the operator has selected the correct UT Set UP plan from the ACCUSONEX plan menu _____	
8	Verify the operator has selected set up #2	
8A	Channels - Toggle RF Switch	
8B	Apply Button	
8C	OK Button	
9	Verify the operator has turned on the UT system	
9A	Verify Scan Screen Display Peak & RF	
10	Verify the scanner moved to the patch zero and offset	
11	During Data Collection verify scan speed in log book.	
12	Record the status of the UT data in the following table	

LOCATION	FILE NAME	STATUS	OPERATOR	PDA

COMMENTS



Completed by: Date Time

Demonstration Activities Data Analysis

- Data Analysis Automated demonstrations
  - UT Data from 2-4 test sets is collected.
    - 2-4 analysts review data (4-5 files of data full test set)
  - Reporting requires
    - Completion of all procedure requirements & plotting on full size PDI top and side view sheets
  - PDA interview to verify compliance with the procedure
    - Every flaw reported must be demonstrated to the PDA in accordance with the criteria of the procedure.

OBJECTIVE EVIDENCE WORKSHEET for FLAW EVALUATION
B&WNT DEMONSTRATION

INFORMATION

CANDIDATE: _____
TEST SET: _____

The following techniques were used by the candidate for initial detection analysis of the indications in their test set as recorded by the PDA.

Indications are first separated into 2 categories 1) Geometry 2) Non-Geometry.
For recording a Non-Geometry indication, the following should apply:

_____ Indication Number

Does this indication exhibit target motion and peak amplitudes greater than the background noise.	YES ☐	NO ☐
What transducer was used for Initial recording	45°L ☐	45°S ☐
It's Maximum amplitude	>10% DAC ☐	>20% DAC ☐
What Transducer was used for verification	45°L ☐	45°S ☐
It's Maximum amplitude	>10% DAC ☐	>20% DAC ☐
For single side flaw detection, was this flaw verified with both the 45°L and the 45°S.	YES ☐	NO ☐

A "*Suspect*" Indication is a flaw that could NOT be verified from one direction with both the 45°L and 45°S wave detection transducers.

Is this flaw defined as a "Suspect" Indication.	YES ☐	NO ☐
Did the candidate ask for "Relook Data" from the *opposite* direction.	YES ☐	NO ☐
Was this indication confirmed from the opposite direction.	YES ☐	NO ☐
Does the indication exhibit target motion from the opposite direction.	YES ☐	NO ☐
Does the indication plot in the same approximate location from this opposite direction.	YES ☐	NO ☐
Is the amplitude of the indication of sufficient strength to be resolved from the background noise.	YES ☐	NO ☐
What Transducer was used for confirmation	45°L ☐	45°S ☐
It's Maximum amplitude	>10% DAC ☐	>20% DAC ☐

Any needed **COMMENTS**, for clarification, will be written on the back of this form.

OBJECTIVE EVIDENCE OF FLAW EVALUATION PER PROCEDURE

Remote Ultrasonic Examination of Reactor Vessel Welds in Accordance with ASME Section XI, Appendix VIII, SUPPLEMENT 4

PROCEDURE NO.: **REV. 1** **FIELD CHANGE:** 95-001, 95-002, 95-003 and 95-004

CANDIDATE:
TEST SET:

INFORMATION

The following techniques were used by the candidate to size the indications in their test set.

Flaw sizing is accomplished utilizing two (2) separate sizing techniques with three (3) tiers of analysis to the acceptance criteria of IWB-3500:

- #1 Sizing with the original coarse detection data.
- #2 Sizing with fine detection data.
- #3 Sizing with the Backward Scatter technique.

If tip signals are not apparent, sizing will be accomplished using satellite signals if present or the dB drop technique.

Step taken prior to establishing the length and TWE were as follows:

Identify those profiles which are related to the upper and lower extremities, tip signals, of the flaw at maximum amplitudes (if available).
Each scan line should be examined over the length of the flaw.
Use the same manner of depth measuring as was used during analysis of the calibration block data.
Increment through the data in both directions to the flaw edges where the amplitude fall to the appropriate technique for the length dimension.
All credible length and depth measurements, from the actual sizing techniques, shall be averaged for the final flaw dimensions.

The following sizing measurements were performed during **3rd STAGE ANALYSIS** (referenced above).

Flaw AA/BB
TWE was measured using the lower tip signal (-) the clad for both 45L and 55L.
Length sizing measured @ noise w/both 45L and 55L.
--All measurements were averaged for final flaw dimensions.

Flaw CC
TWE was measured using the lower tip signal (-) the clad for both 45L and 55L.
Length size measurement was taken from the 2nd stage sizing results which were measured @ noise w/both 45L and 50% DAC w/ both 70L.
The candidate considered the 2nd stage length a more credible value.
--All TWE measurements were averaged for final flaw dimensions.

Flaw DD/EE
TWE was measured using the lower tip signal (-) the clad w/both 45L and (1) 55L.
The other 55L TWE was not consistant with the other channels and believed not to be credible.
Length sizing measured @ noise w/both 45L and 55L.
--All but one TWE measurement was averaged for the final flaw dimensions.

Flaw C
TWE was measured using the lower tip signal (-) the clad for both 45L and 55L.
Length sizing measured @ noise w/both 45L and 55L.
--All measurements were averaged for final flaw dimensions.

Flaw F
TWE was measured using the lower tip signal (-) the clad for both 45L and 55L.
Length sizing measured @ noise w/both 45L and 55L and averaged with 2nd stage sizing result.
--All TWE measurements were averaged for final flaw dimensions.

Flaw G
TWE was measured using the lower tip signal (-) the clad for both 45L and 55L.
Length sizing measured @ noise w/both 45L and 55L and averaged with 2nd stage sizing result.
--All TWE measurements were averaged for final flaw dimensions.

Flaw S	TWE was measured using the lower tip signal (-) the clad for both 45L and 55L. Length sizing measured @ noise w/both 45L and 55L and averaged with 2nd stage sizing result. --All TWE measurements were averaged for final flaw dimensions.
Flaw Y	TWE was measured using the lower tip signal (-) the clad for both 45L and 55L. Length sizing measured @ noise w/both 45L and 55L and averaged with 2nd stage sizing result. --All TWE measurements were averaged for final flaw dimensions.
Flaw N	TWE was measured using the lower tip signal (-) the clad for both 45L and 55L. Length sizing measured @ noise w/both 45L and 55L. --All measurements were averaged for final flaw dimensions.
Flaw I	TWE was measured using the lower tip signal (-) the clad for both 45L and 55L. Length sizing measured @ noise w/both 45L and 55L. --All measurements were averaged for final flaw dimensions.
Flaw Z	TWE was measured using the lower tip signal (-) the clad for both 45L and 55L. Length sizing measured @ noise w/both 45L and 55L. --All measurements were averaged for final flaw dimensions.
Flaw B	TWE was measured using the lower tip signal (-) the clad for both 45L and 55L. Length sizing measured @ noise w/both 45L and 55L. --All measurements were averaged for final flaw dimensions.
Flaw A	TWE was measured using the lower tip signal (-) the clad for both 45L and 55L. Length sizing measured @ noise w/both 45L and 55L. --All measurements were averaged for final flaw dimensions.

DATA

All data was taken in a scan direction that was perpendicular to the flaw so an echo-dynamic pattern would be created for the use of flaw tip information..

All flaws were scanned from both sides (perpendicular) to flaw orientation.

INFORMATION

REVIEWED BY: _____ DATE: 12/14/95

INFORMATION

Techniques used by INFORMATION

2nd Stage Sizing:

LENGTH
All length sizing with the 70L transducers were done with the 50% DAC criteria
All length sizing with the 45L transducers were done with the @ noise level criteria.

NOTE: (If the flaw was below the recording criteria, a dimension was not obtained.)

DATA

TWE
For all (13) flaws, the tip signals were used for thruwall sizing.

NO 1/2 Max. Amplitude points were used for sizing
NO satellite signals were used for TWE

---All measurements obtained per flaw were averaged for final flaw dimensions---

3rd Stage Sizing:

LENGTH
All length sizing with the 45L and 55L transducers were done with the @ noise level criteria.
Five (5) out of the (13) flaws used the 2nd stage length result to help in the determination of the final 3rd stage result.

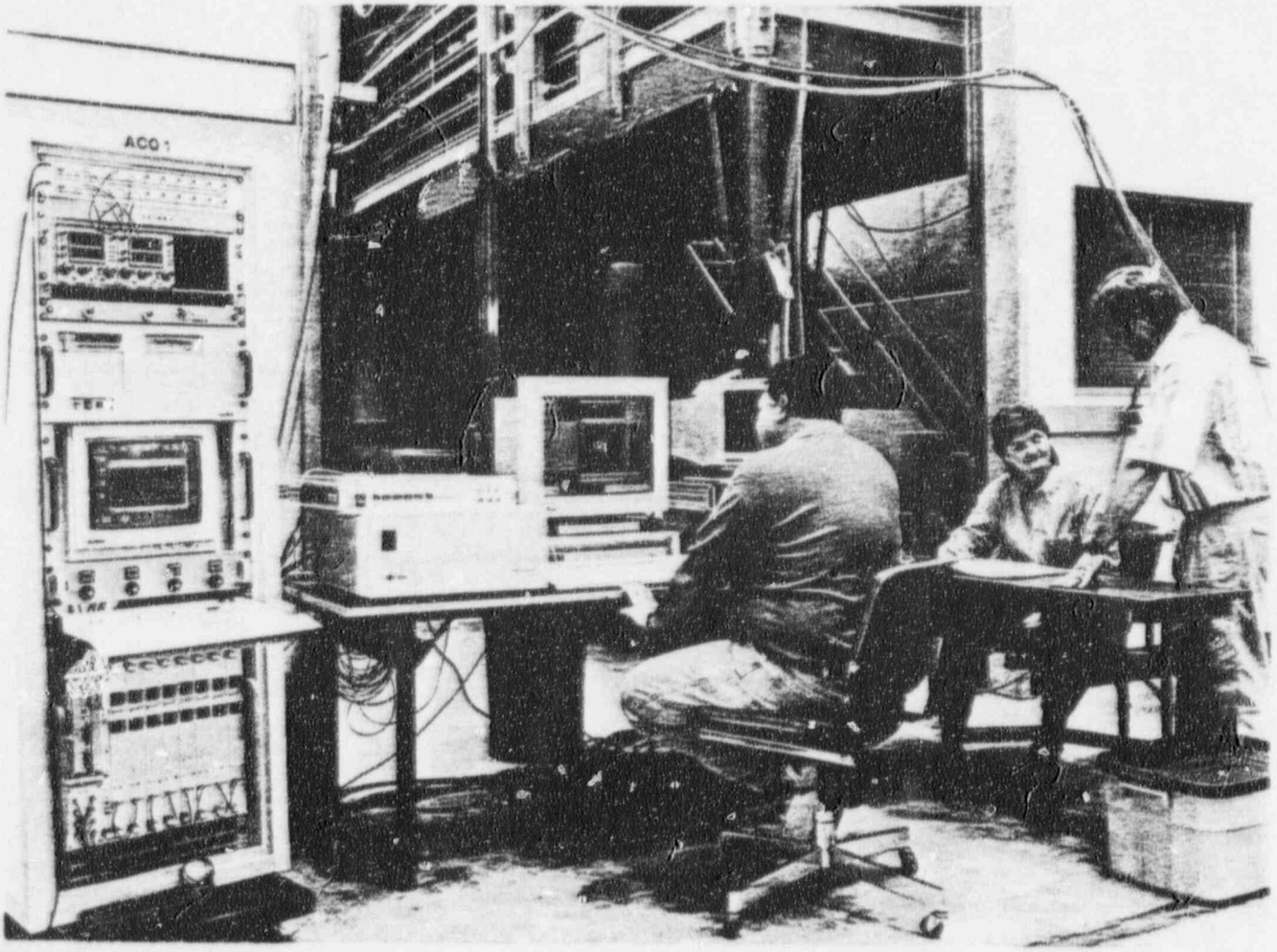
TWE
For all (10) of the flaws, tip signals were used for thruwall sizing.

NO 1/2 Max. Amplitude points were used for sizing
NO satellite signals were used for TWE

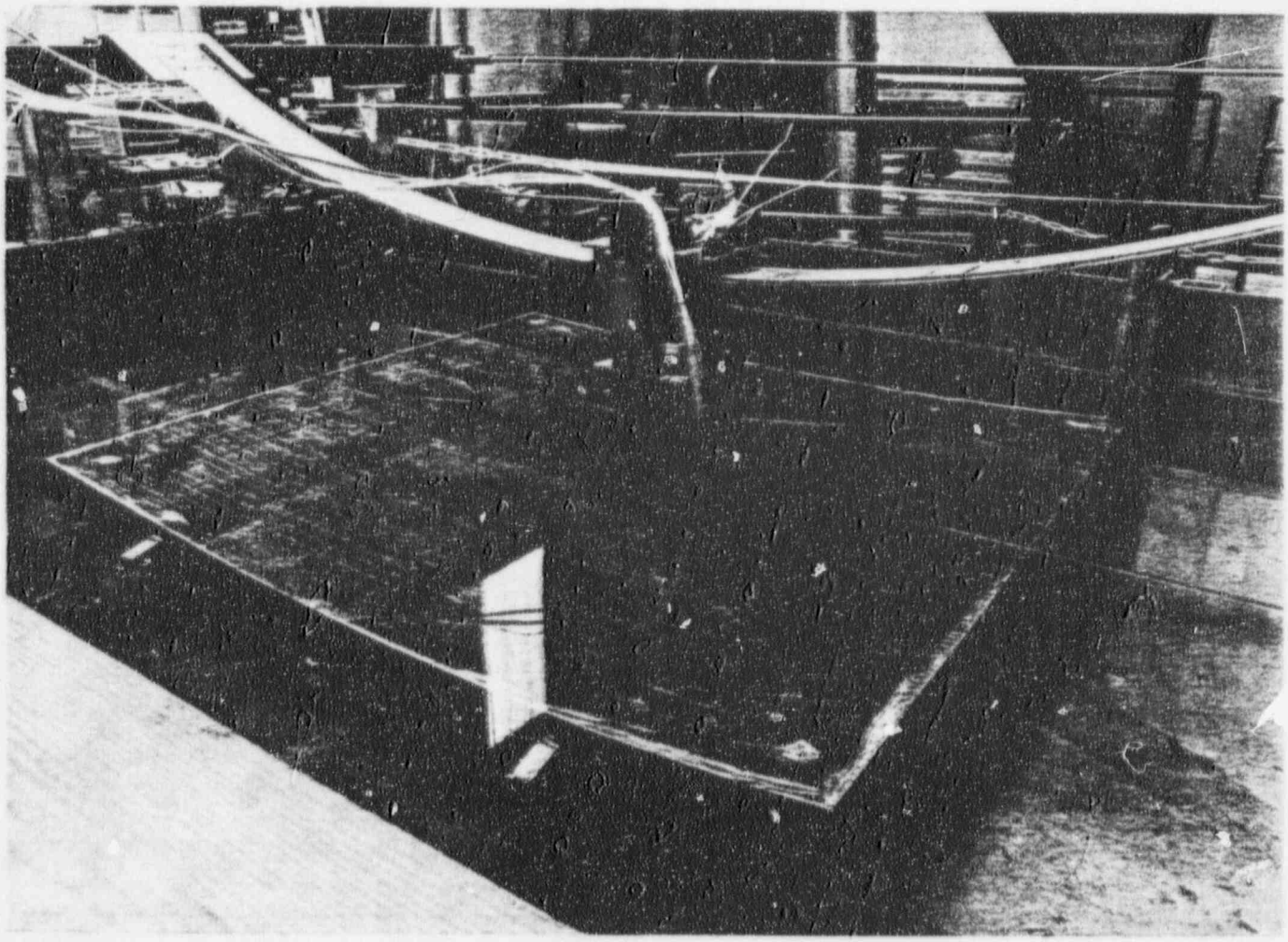
---All measurements obtained per flaw were averaged for final flaw dimensions---

INFORMATION

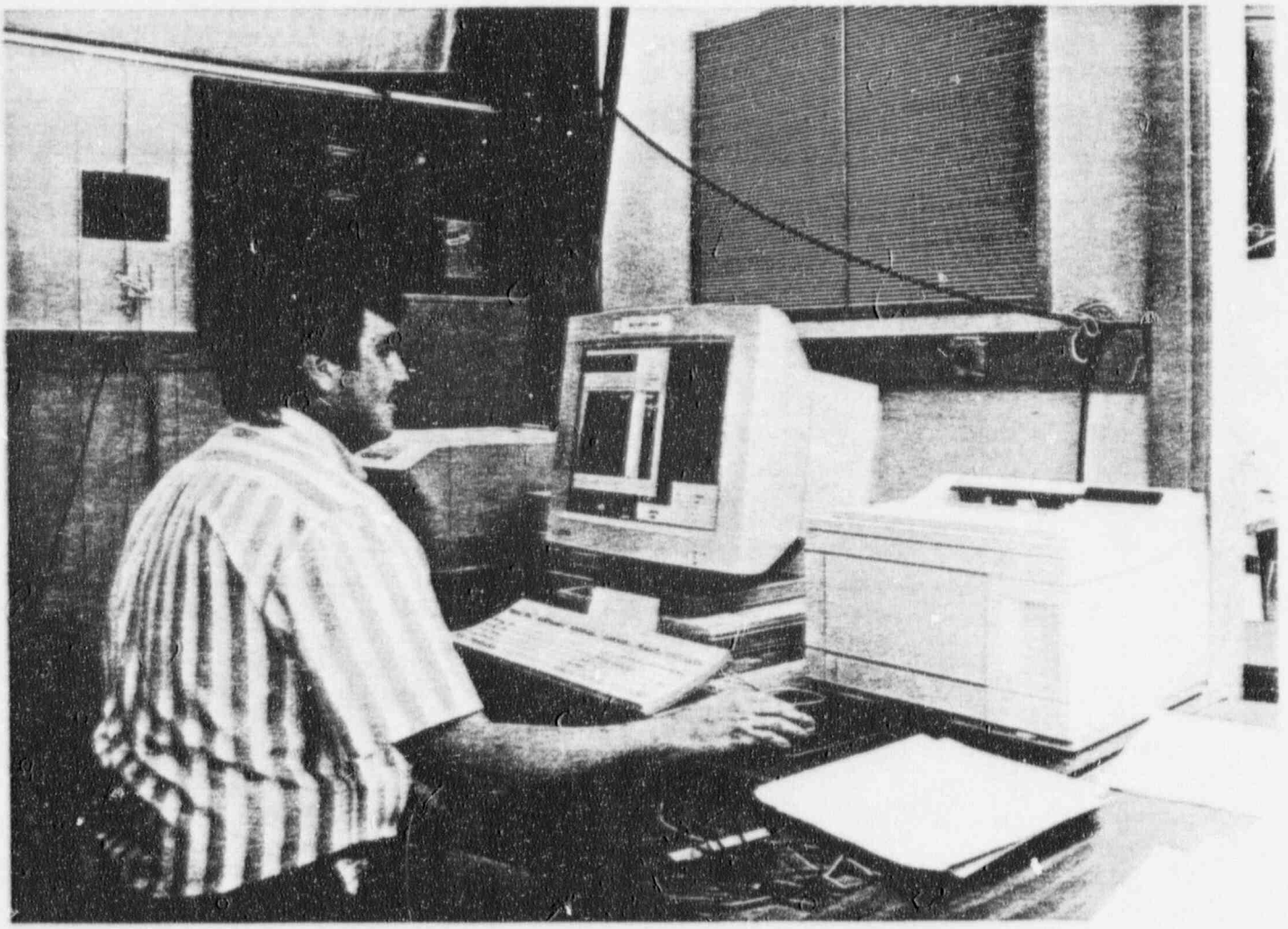
Verification of Equipment



Data Collection



Review of Results



Demonstration Activities Grading

- Program description includes the grading criteria for Procedure & Personnel demonstrations
    - Detection
        - Number of flaws / False calls
        - Location accuracy
    - Length & through wall sizing
        - RMS
  - Final grading is carried out using report overlays and computer programs.
  - Results are presented as Acceptable or Unacceptable

Demonstration Activities Retesting

- Results of grading
  - Procedure demonstrations results are withheld until all candidates have completed the demonstration
  - Personnel demonstrations results are available immediately following the demonstration
  - PDA provides candidates with objective feedback on performance
    - Trending
    - Procedure revisions
    - Additional training
  - Procedure retests require full demonstration test set
  - Personnel demonstrations may be limited to category type

Demonstration Activities Documentation

- Preparation, completion, processing, & retention of records is by EPRI NDE Center
- PDA staff keep log books of all demonstration activities
- PDA archives all documentation in an organized file system
    - UT Procedure
    - Hardware & software equipment certification
    - Essential variables
    - Ultrasonic data
    - Ali results & grading
- PDA compiles *Performance Demonstration Qualification Summary (PDQS)* document

Example of RPV Procedure

Performance Demonstration Initiative Program

In Accordance with the PDI Implementation of Section XI, Appendix VIII

Specific Detail of Qualifications

Printed: 22-Mar-96 (13)
PDQS No: 247 (14)
04091100 (15)

1 — **Owner:** _____

3 — **Procedure:** _____; **Revision: 1; Addenda: 0**

4 — **Automated Inside Surface Ultrasonic Examination of Ferritic Vessel Wall greater than 4.0 Inches in Thickness**

5 — PDQS Rev: 0
9 — Date of Issue: 01-Jan-96
8 — Category: RPV
12 — Scan Application: Fully-Automatic

a7 — Hardware: Enhanced Data Acquisition System (EDAS II)
a11 — Aquisition SW Type/Rev: AUT-CAL Software, 1.37
a10 — Analysis SW Type/Rev: EDAS Software, 1.0

Ranges Demonstrated:

Supplement:	Supplement 4 of ASME Appendix VIII	**TestDate:**	05-May-95		
Material:	Ferritic with SMAW as Ground, Cladding				
Surface:	Inner Diameter				
Access:	Dual Sided				
Examination:	Detection	**Thickness Range:**	0.000	to	0.000
Access:	Single Sided				
Examination:	Detection	**Thickness Range:**	0.000	to	0.000

(19)

Supplement:	Supplement 6 of ASME Appendix VIII	**TestDate:**	05-May-95		
Material:	Ferritic with SMAW as Ground, Cladding				
Surface:	Inner Diameter				
Access:	Dual Sided				
Examination:	Detection	**Thickness Range:**	4.000	to	12.290
Access:	Single Sided				
Examination:	Detection	**Thickness Range:**	4.000	to	12.290

Performance Demonstration Initiative Program

In Accordance with the PDI Implementation of Section XI, Appendix VIII

Specific Detail of Qualifications

Printed: 22-Mar-96
PDQS No: 247
04091189

Owner: _____

Procedure: _____; **Revision:** 1; **Addenda:** 0

Automated Inside Surface Ultrasonic Examination of Ferritic Vessel Wall greater than 4.0 Inches in Thickness

PDQS Rev:	0	**Hardware:**	Enhanced Data Acquisition System (EDAS II)
Date of Issue:	01-Jan-96	**Aquisition SW Type/Rev:**	AUT-CAL Software, 1.37
Category:	RPV	**Analysis SW Type/Rev:**	EDAS Software, 1.0
Scan Application:	Fully-Automatic		

Supplement 4 Acceptance Criteria:

When "Length Sizing" is indicated, the 0.750 RMS acceptance criteria per the PDI Program Description has been achieved.
When "Through Wall Extention" is indicated, the 0.150 RMS acceptance criteria per the PDI Program Description has been achieved.

Supplement 6 Acceptance Criteria:

When "Length Sizing" is indicated, the 0.750 RMS acceptance criteria per the PDI Program Description has been achieved.
When "Through Wall Extension" is indicated, the 0.250 RMS and 0.7 Slope acceptance criteria per the PDI Program Description has been achieved.

Comments:

1. The specimen set used to demonstrate the procedure included specimens with a maximum thickness of 6.88" and 11.06" (excluding clad).
2. Based on the specimen set thickness from comment #1, the "Thickness Range" specified above includes the "90% of Maximum Thickness" allowance per Appendix VIII.
3. The minimum range of the supplement 4 volume starts at the "clad to base metal interface" (0.000) and extends into the base metal (supplement 6 volume).

Limitations:

1. This procedure is qualified for detection only. See procedure SwRI-PDI-AUT2,r1,chg 0 for Length and TWE sizing.

Performance Demonstration Initiative Program

Printed: 22-Mar-96
PDQS No: 247
04091100

In Accordance with the PDI Implementation of Section XI, Appendix VIII

Specific Detail of Qualifications

Owner: _____

Procedure: _____ ; **Revision: 1; Addenda: 0**

Automated Inside Surface Ultrasonic Examination of Ferritic Vessel Wall greater than 4.0 Inches in Thickness

PDQS Rev:	0	Hardware:	Enhanced Data Acquisition System (EDAS II)
Date of Issue:	01-Jan-96	Aquisition SW Type/Rev:	AUT-CAL Software, i.37
Category:	RPV	Analysis SW Type/Rev:	EDAS Software, 1.0
Scan Application:	Fully-Automatic		

The above procedure has met the requirements of The Performance Demonstration Initiative's Implementation of The American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Appendix VIII as stated in this document.

_____ Date _____

P. J. Ashwin
Performance Demonstration Initiative
Reactor Pressure Vessel Supervisor/Level III

_____ Date _____

F. L. Becker
Performance Demonstration Initiative
Administrator

This document is not authentic without a raised seal.

Candidate and Procedure PDQS Use Guide for Piping and RPV (Manual & Automatic) & Bolting

The following items are designed to describe the information found on the PDQS Certificate for Manual or Automated Piping, RPV, and Bolting. Much of the information is common to all five types of qualification. The Manual Piping qualification is the base document and contains many common fields that will be found on all other qualifications. The common fields will not be preceded by a letter. If the number below is preceded by a "p, " it is unique to **Piping** qualifications. If the number is preceded by an "r," it is unique to **RPV** qualifications. If the number is preceded by an "a," it is unique to **Automated Piping** or **RPV** qualifications. If the number is preceded by a "b," it is unique to **Bolting** qualifications. Many of the items below describe both the Candidate and Procedure qualifications and will be designated, "candidate/procedure," where they both apply or where only one applies it will be designated as either "candidate" or "procedure."

1) Candidate/procedure qualified; Procedure PDQS will specify Owner's name. Personnel PDQS will specify Candidates' name.

2) Candidates' ID or Social Security Number. This will be blank for a Procedure PDQS.

3) Procedure number, revision number, and addenda number.

4) Title of demonstrated Procedure.

5) Candidate/procedure PDQS Revision number.

6) For a candidate PDQS this will specify the owner of the procedure that was used by the candidate during the demonstration.

a7) The type of automated system utilized for the collection and analysis of UT data (Tomoscan, P-Scan, I-98, GERIS-2000, EDAS, etc.).

8) Type of component candidate/procedure was demonstrated on (Bolting, Piping, RPV).

9) Candidate/Procedure PDQS "Date of Issue" (associated with number 5). This date will not precede 1-Jan-96 and will be updated with any revisions to the PDQS (i.e. Changes in "Ranges Demonstrated," Technical Justification information, or Typographical errors).

a10) This is the Automated systems analysis software type or name and its revision number.

a11) This is the Automated systems data acquisition software type or name and its revision number.

12) Type of scan application (Manual, Fully-Automatic, Semi-Automatic).

NOTE: <u>For an RPV procedure PDQS the above holds true. For an RPV automated candidate PDQS refer to item a30.</u>

13) The date the PDQS document was printed.

14) For a procedure, this is a unique identifying number for each procedure PDQS. For a candidate, this is a unique identifying number for that candidate. If a candidate has multiple qualifications, this unique number will appear on his/her PDQS documents.

15) This is an internal PDI tracking number.

16) This is the date the candidate/procedure was demonstrated with the ranges specified in numbers p17, and p18 for piping, r36 for RPV, and b31 for bolting.

p17) This is the minimum and maximum diameters qualified during the demonstration. For Tolerances to the stated values see item p25.

p18) This is the minimum and maximum thickness qualified during the demonstration. For Tolerances to the stated values see item p25.

19) This is an internal PDI tracking number.

20) The type of material qualified (Austenitic with or without IGSCC, Ferritic or Ferritic w/SMAW as ground cladding).

21) This describes the examination application that the candidate/procedure has successfully demonstrated (Detection, Length Sizing, Through Wall Sizing). If an examination type was not qualified it will not be listed.

22) Type of access restrictions the candidate/procedure is qualified to perform. For Piping this specifies weld access (Double Sided, Single Sided, Limited Single Sided).
For RPV this specifies volume access:
<u>Dual Sided</u> - Full examination coverage by opposing beam directions in both a perpendicular and parallel scan path.
<u>Single Sided</u> - Full examination coverage by only one (1) beam direction in both a perpendicular and parallel scan path.

Candidate and Procedure PDQS Use Guide for Piping and RPV (Manual & Automatic) & Bolting

The following items are designed to describe the information found on the PDQS Certificate for Manual or Automated Piping, RPV, and Bolting. Much of the information is common to all five types of qualification. The Manual Piping qualification is the base document and contains many common fields that will be found on all other qualifications. The common fields will not be preceded by a letter. If the number below is preceded by a "p, " it is unique to **Piping** qualifications. If the number is preceded by an "r," it is unique to **RPV** qualifications. If the number is preceded by an "a," it is unique to **Automated Piping** or **RPV** qualifications. If the number is preceded by a "b," it is unique to **Bolting** qualifications. Many of the items below describe both the Candidate and Procedure qualifications and will be designated, "candidate/procedure," where they both apply where only one applies it will be designated as either "candidate" or "procedure."

p23) Types of weld crown conditions the candidate/procedure is qualified to perform (Ground Flush, Flat Topped, As-Welded).

24) This is the acceptance criteria as specified by Appendix VIII.

p25) This is the "Tolerances" that are to be applied to the minimum and maximum diameter and thickness ranges (p17 & p18).

26) This statement refers to the requirements of Appendix VII. A candidate who successfully demonstrated an Appendix VIII **Detection** qualification with no more than 3 attempts in a one year period, meets the requirements of Appendix VII. The expiration date of Appendix VII is three years from the date (number 16) the candidate received their qualification. Only Appendix VIII, Supplements 2 & 3 examinations for Piping and Supplements 4 & 6 examinations for RPV meet the "Practical" requirements of Appendix VII.

NOTE: **For Piping, a Supplement 12, Ferritic add-on examination does not meet the requirements of Appendix VII.**

27) This is where any comments about the candidate/procedure will be located.

28) This section will have any candidate/procedure limitations which apply to the qualification. **This "Limitation" section should be reviewed very carefully.**

29) Authenticity of the "Original" document has been established with the application of a raised seal to the "Signature" page. All pages preceding the "Signature" page must be present for the qualifications to be valid.

a30) This field will state whether a candidate has Automated Data Acquisition, Automated Data Analysis, or both.

b31) This is the minimum and maximum metal path demonstrated during a Bolting qualification.

b32) If a candidate was successful with the Appendix A of Procedure PDI-UT-5 (Straight Beam for Bolts/Studs) they received the "Bore Hole Endorsement." **Candidates' with a "Bore Hole Endorsement" may only evaluate bolting indications that were recorded previously with the Straight Beam technique.** If a candidate was successful with Procedure PDI-UT-4 (Bore Hole Examination on Bolts/Studs) they do not require the "Bore Hole Endorsement" to evaluate indications detected with the Straight Beam technique.

b33) Type of Bolting access restrictions the candidate/procedure is qualified to perform (Top, Bottom, or Both). If a candidate has access to the "Top" or "Bottom" they are qualified to perform the examination on either end of the bolt or stud or with the bolt or stud in-place. If "Both" is listed then the candidate must have access to both ends of the bolt or stud.

r34) This specifies a supplement that is defined by Appendix VIII as a unique examination volume.

r35) This specifies which surface the examination was qualified from (Inside or Outside).

r36) This defines the thickness range that was qualified, which includes the "90% of Maximum Thickness" adjustment per Appendix VIII. From the ID for Supplement 4 a maximum thickness is not applicable. From the OD for Supplement 4 a minimum thickness is not applicable. For Supplement 6 the minimum thickness is specific per the procedure scope.

Summary of Personnel Qualifications – This is a one-page summary of a candidate's qualifications to be used as a convenient qualification determination. This summary document is not official without supporting documentation.

Keys to Successful RPV Demonstrations

- Written Instructions
  - Protocol
  - Technical basis document
  - Written implementing procedures
  - Experienced staff
- Preparation & planning
  - Schedule
  - Training & practice by candidates
  - Participation by utility, & ANI in demonstrations

Keys to Successful RPV Demonstrations

- Realistic Specimens
  - Full size specimens & realistic flaws
  - High quality & No ambiguous conditions
- Experienced & expert staff
  - Dedicated PDA staff
    - ISI experience
    - Participated in specimen fabrication program
    - Familiar with state of the art equipment and techniques
    - Knowledgeable in the Program requirements
- Cooperation
  - Utility -Administrator - Candidates

RPV Specimen Design & Fabrication Process

PDI Program
Appendix VIII -
Supplements 4, 5, 6 & 7

PDI - Specimen **Design**

- EPRI NDE Center
  - Responsible for Technical Basis **Design** & Procurement of Specimens.
  - NDE Center Experience
    - >15 Years Experience
    - Recruited 2 Specimen Design Engineers (ex IVC program)
    - Facilities
      - Material
      - Welding & Fabrication
      - Metalography
      - NDE

Design Objectives

- Guidelines To Test Specimen Design.
  - Comply with Appendix VIII.
  - Apply to as Many Utility Applications as Possible
  - Full Size
  - Realistic Flaws
  - Portable
  - Provide Diversity in Test Sets
  - Quality

US Plant Survey

- Survey of All Plants
  - Based on Appendix VIII Criteria
- Response
  - Approx.. 90% by July 91
    - 62 PWR Units
      - 8 BW / 11CE / 43 WE
    - 32 BWR Units
- Additional Information
  - Drawings/Weld Configurations
- Established a Comprehensive Data Base for Specimen Design

Appendix VIII Industry Survey 1991 - Reactor Vessel Configurations

Plant Name: SUSQUEHANNA Unit: 2 Type: BWR Sequence No.: 4

Date: 04/05/91 Revision No.: 0 Code Update Year: 1994

BWR Reactor Nozzle Configurations

Number	Function	Diam. ID Nom	Thick. Tn2	Plate Ts	Ratio Tn2/Ts
N1	Recirc. outlet	26.20	9.77	6.44	1.52
N2	Recirc. inlet	12.00	7.13	6.44	1.11
N3	Steam outlet	23.64	8.13	7.25	1.12
N4	Feedwater	12.00	7.13	6.44	1.11
N5	Core spray	12.00	7.13	6.44	1.11
N6	Head spray and spare	5.75	3.50	3.63	0.97
N7	Vent	3.83	2.65	3.63	0.73
N8	JPI	5.13	4.31	6.44	0.67
N9	CRD Hyd.	5.13	4.31	6.44	0.67
N10	Core diff press. - penet.	2.65	0.00	0.00	0.00
N11	Instrument - penet	1.94	0.00	0.00	0.00
N12	Instr. - penet.	1.94	0.00	0.00	0.00
N13	N/A	0.00	0.00	0.00	0.00
N14	N/A	0.00	0.00	0.00	0.00
N15	Drain - penet.	1.79	0.00	0.00	0.00
N16	Instr. - penet.	1.94	0.00	0.00	0.00
N17	N/A	0.00	0.00	0.00	0.00
N18	N/A	0.00	0.00	0.00	0.00
N19	N/A	0.00	0.00	0.00	0.00
N20	N/A	0.00	0.00	0.00	0.00
N21	N/A	0.00	0.00	0.00	0.00

Remarks: Drawings are provided.

Plate Thicknesses (PWR or BWR)

Nozzle belt line or maximum vessel thickness:	7.25
Core belt line shell course or minimum thickness:	6.19
Closure head:	5.13
Lower head:	8.25

Appendix VIII Industry Survey 1991 - Piping Configurations

****

Plant Name: SUSQUEHANNA Unit: 2 Type: BWR Seq. No.: 45

Date: 04/05/91 Revision No.: 0

Wrought Austenitic Piping
(NOT including main coolant loop)

Minimum Diameter pipe:	4.00	Thickness:	0.38	Material:	SA312 304L
Maximum Diameter pipe:	28.00	Thickness:	2.54	Material:	SA240 304
Minumum Thickness pipe:	0.38	Diameter:	4.00	Material:	SA312 304L
Maximum Thickness pipe:	2.54	Diameter:	28.00	Material:	SA240 304

Special conditions: Taken from calibration block list.

PWR Wrought Austenitic Main Coolant Loop Piping
(Does NOT include surge line or safety injection)

Minimum Diameter pipe:	0.00	Thickness:	0.00	Material:	
Maximum Diameter pipe:	0.00	Thickness:	0.00	Material:	
Minumum Thickness pipe:	0.00	Diameter:	0.00	Material:	
Maximum Thickness pipe:	0.00	Diameter:	0.00	Material:	

Are the elbows cast (Y/N)? N Are the elbows seam-welded (Y/N)? N

Safe end material: Wrought or cast (Y/N)?

Special conditions: Taken from calibration block list.

****

Appendix VIII Industry Survey 1991 - Piping Configurations

****

Plant Name: SUSQUEHANNA Unit: 2 Type: BWR Seq. No.: 45

Date: 04/05/91 Revision No.: 0

Ferritic Piping
(NOT including PWR main coolant piping)

Minumum Diameter pipe:	6.00	Thickness:	0.27	Material:	SA106 Gr B
Maximum Diameter pipe:	24.00	Thickness:	2.58	Material:	SA106 Gr B
Minumum Thickness pipe:	0.27	Diameter:	6.00	Material:	SA106 Gr B
Maximum Thickness pipe:	2.58	Diameter:	24.00	Material:	SA106 Gr B

Special conditions: Taken from calibration block list.

PWR Clad Ferritic Main Coolant Piping

Minimum Diameter pipe:	0.00	Thickness:	0.00	Material:	
Maximum Diameter pipe:	0.00	Thickness:	0.00	Material:	
Minumum Thickness pipe:	0.00	Diameter:	0.00	Material:	
Maximum Thickness pipe:	0.00	Diameter:	0.00	Material:	

Are the elbows Cast (Y/N)? N Are the elbows seam-welded (Y/N)? N

Safe end material: Wrought or cast?

Type of clad?

Special conditions? Taken from calibration block list.

****

Appendix VIII Industry Survey 1991 - Bolting Configurations

****

Plant Name: SUSQUEHANNA Unit: 2 Type: BWR Sequence No.:

Date: 04/04/91 Revision No.: 0

* *

RPV Closure Head Studs

Diameter: 5.63 Length: 58.16 Heater hole diameter: 0.63

Material: [redacted] Head Design: Slotted

Calibration standard available (Y/N)? N

If so, does it meet the requirements of Appendix VIII (Y/N)? N

Remarks:

* *

RCP Bolts

Diameter: 2.99 Length: 23.50 Heater hole diameter: 0.00

Material: 540 Gr B24 Head Design:

Calibration standard available (Y/N)? N

If so, does it meet the requirements of Appendix VIII (Y/N)? N

Remarks:

Appendix VIII Industry Survey 1991 - Bolting Configurations

Plant Name: R.E. GINNA Unit: 1 Type: PWR Sequence No.: 26

Date: 04/01/91 Revision No.: 0

* *

RPV Closure Head Studs

Diameter: 6.00 Length: 57.00 Heater hole diameter: 1.00

Material: SA320 L43 Head Design: Hex

Calibration standard available (Y/N)? Y

If so, does it meet the requirements of Appendix VIII (Y/N)? N

Remarks: Cal standard meets Appendix VI.

* *

RCP Bolts

Diameter: 3.50 Length: 30.56 Heater hole diameter: 0.75

Material: SA320 L43 Head Design: Threaded cylinder

Calibration standard available (Y/N)? Y

If so, does it meet the requirements of Appendix VIII (Y/N)? N

Remarks: Cal standard meets Appendix VI.

Appendix VIII Industry Survey 1991 - Piping Configurations

****

Plant Name: R.E. GINNA Unit: 1 Type: PWR Seq. No.: 26

Date: 04/01/91 Revision No.: 0

Ferritic Piping
(NOT including PWR main coolant piping)

Minumum Diameter pipe:	0.00	Thickness:	0.00	Material:
Maximum Diameter pipe:	0.00	Thickness:	0.00	Material:
Minumum Thickness pipe:	0.00	Diameter:	0.00	Material:
Maximum Thickness pipe:	0.00	Diameter:	0.00	Material:

Special conditions:

PWR Clad Ferritic Main Coolant Piping

Minimum Diameter pipe:	0.00	Thickness:	0.00	Material:
Maximum Diameter pipe:	0.00	Thickness:	0.00	Material:
Minumum Thickness pipe:	0.00	Diameter:	0.00	Material:
Maximum Thickness pipe:	0.00	Diameter:	0.00	Material:

Are the elbows Cast (Y/N)? N Are the elbows seam-welded (Y/N)? N

Safe end material: Wrought or cast?

Type of clad?

Special conditions?

****

Appendix VIII Industry Survey 1991 - Piping Configurations

****

Plant Name: R.E. GINNA Unit: 1 Type: PWR Seq. No.: 26

Date: 04/01/91 Revision No.: 0

Wrought Austenitic Piping
(NOT including main coolant loop)

Minimum Diameter pipe:	3.00	Thickness:	0.44	Material:	304 SS
Maximum Diameter pipe:	10.00	Thickness:	1.00	Material:	304 SS
Minumum Thickness pipe:	0.13	Diameter:	6.00	Material:	304 SS
Maximum Thickness pipe:	1.00	Diameter:	10.00	Material:	304 SS

Special conditions:

PWR Wrought Austenitic Main Coolant Loop Piping
(Does NOT include surge line or safety injection)

Minimum Diameter pipe:	27.46	Thickness:	2.40	Material:	304 SS
Maximum Diameter pipe:	28.92	Thickness:	2.50	Material:	304 SS
Minumum Thickness pipe:	2.40	Diameter:	27.46	Material:	304 SS
Maximum Thickness pipe:	2.50	Diameter:	28.92	Material:	304 SS

Are the elbows cast (Y/N)? Y Are the elbows seam-welded (Y/N)? Y

Safe end material: None Wrought or cast (Y/N)? N/A

Special conditions: Inconnel buttering on safe end to piping welds.

****

Appendix VIII Industry Survey 1991 - Reactor Vessel Configurations

Plant Name: R.E. GINNA Unit: 1 Type: PWR Sequence No.: 26

Date: 04/05/91 Revision No.: 0

Code Update Year: 2000

PWR Reactor Pressure Vessel Configurations

Nozzles

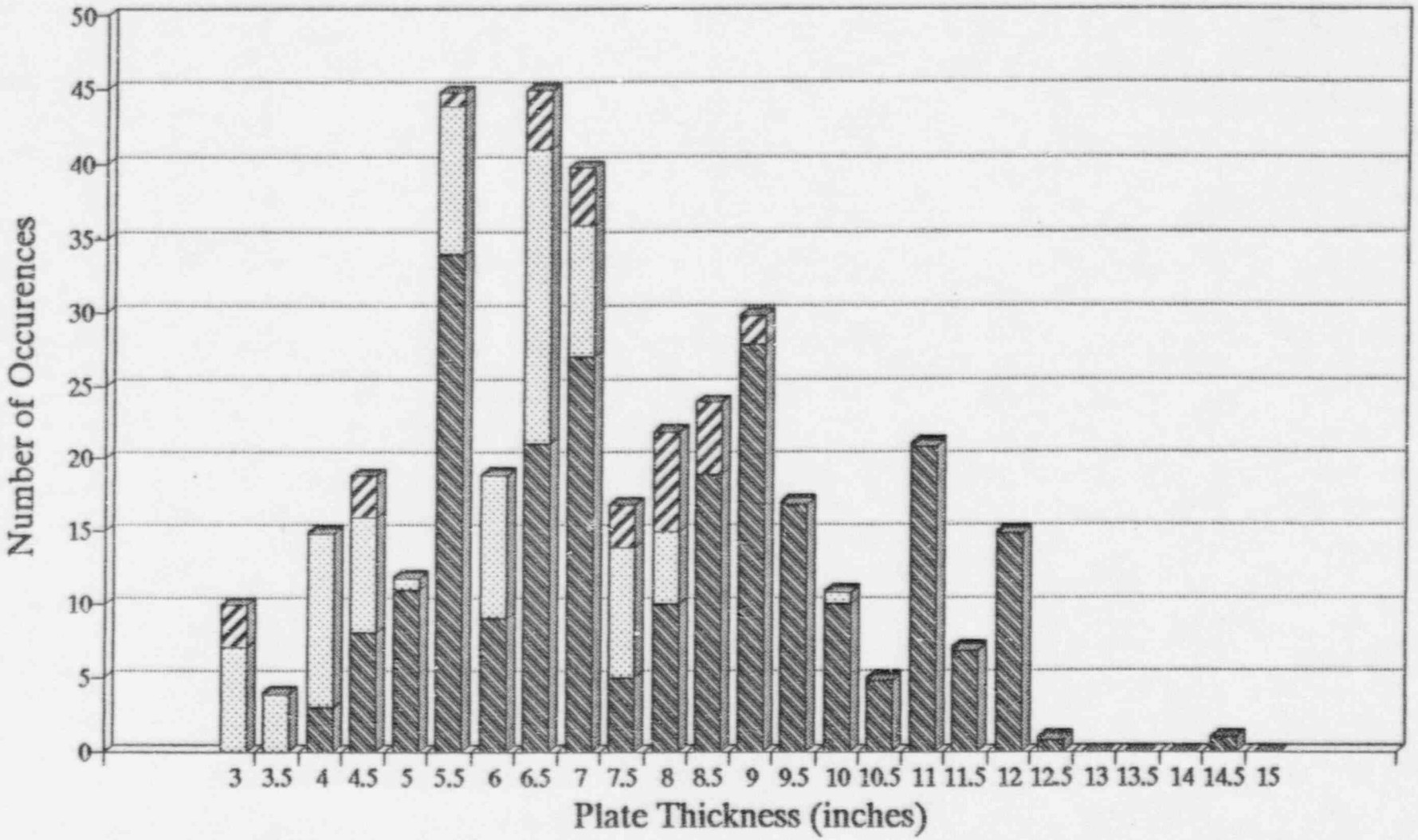
		Inlet	Outlet	Safety Injection
Nozzle ID Maximum		36.18	33.96	3.44
Nozzle ID Minimum		34.25	33.00	3.44
(At the Section XI Boundary for inner radius examination)				
Nozzle Extension	ID	27.46	28.92	3.44
(Pipe end side)	OD	34.00	35.00	5.40
Metal path to weld	Maximum	11.00	10.93	6.19
centerline:	Minimum	8.57	7.71	6.19
Nozzle bore taper	(degrees)	6.00	10.00	0.00

Plate Thicknesses (PWR or BWR)

Nozzle belt line or maximum vessel thickness:	9.16
Core belt line shell course or minimum thickness:	6.50
Closure head:	5.38
Lower head:	4.13

Vessel Plate Thicknesses

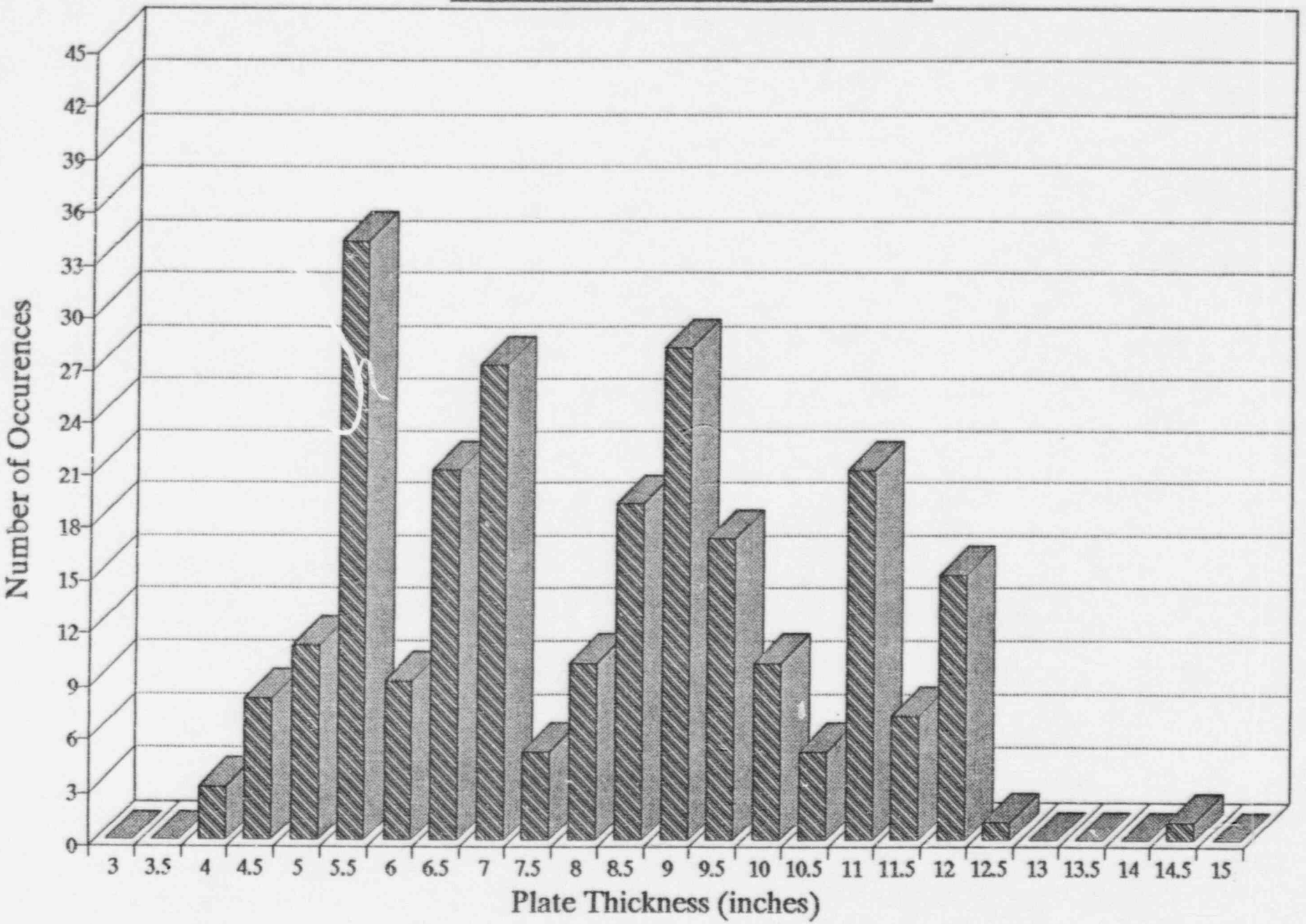
(94 Plants - July 29, 1991)



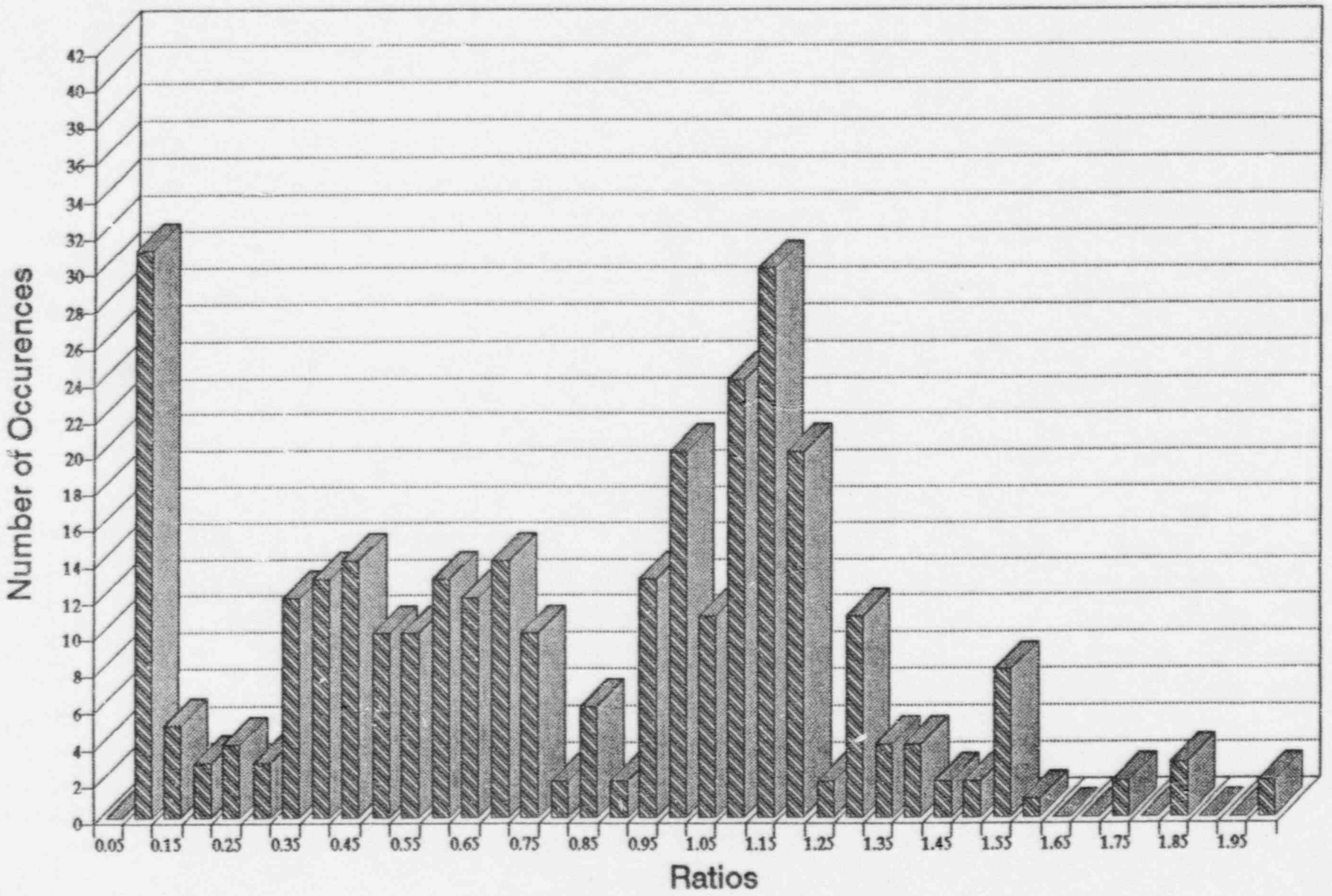
PWR's (62) BWR's less Lwr Hd BWR Lwr Hd Only

Vessel Plate Thicknesses

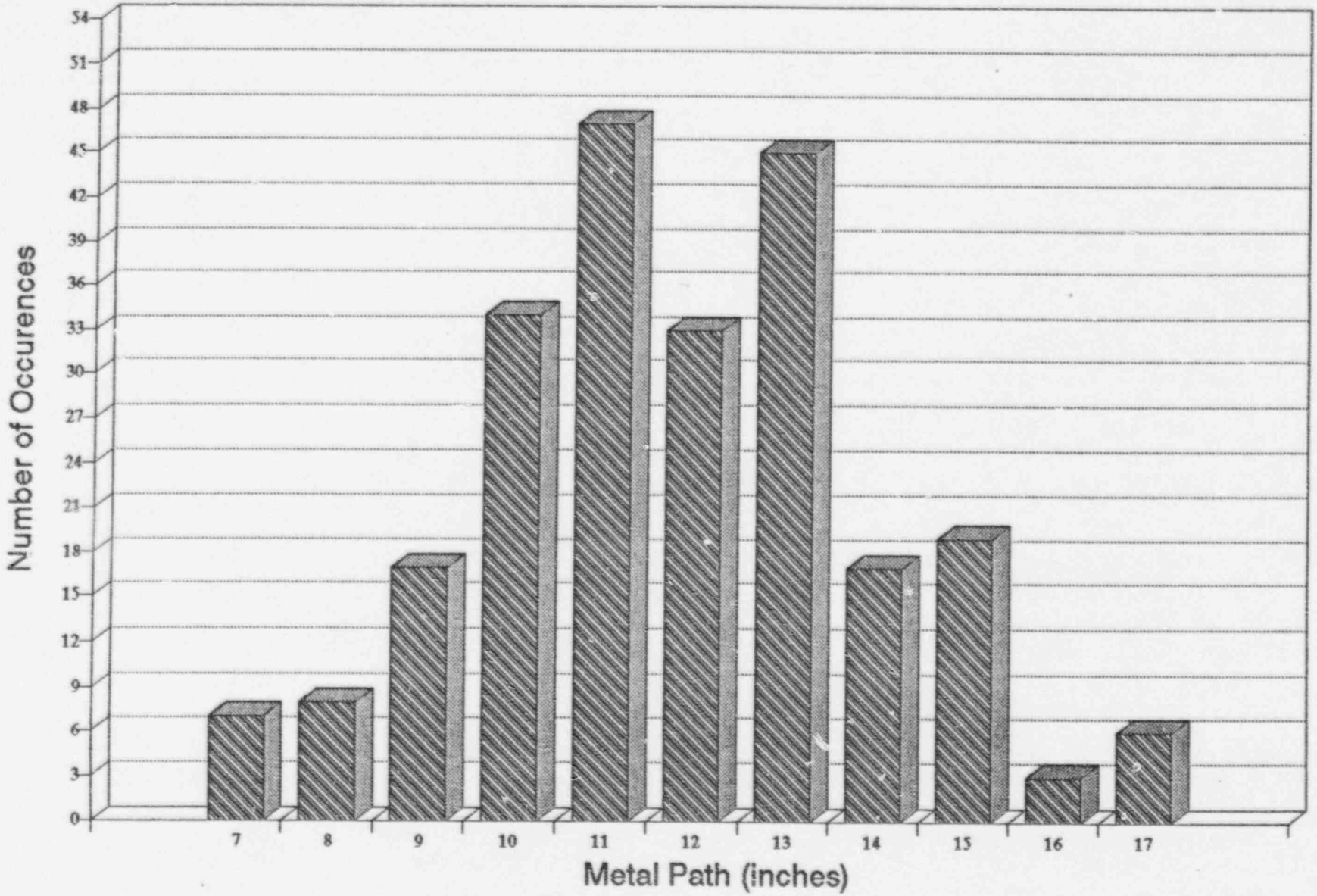
(62 PWR Plants - July 29, 1991)



BWR RPV Nozzle Ratios
(32 Plants - July 29, 1991)



PWR RPV Nozzle Metal Paths
(62 Plants - July 29, 1991)



App. VIII Design Requirements

- Supplement 4&6
  - May be Full Scale
  - Length & Width Shall be at 12 inches
  - Maximum Thickness of Vessel (within 90%)
    - *Test Specimens are Full Scale Sections of RPV Plate and cover up to 12.3 inches T*
  - Clad With Same Type Cladding
    - *SMAW Clad is Applied in the Examination Volume*

App. VIII Design Requirements

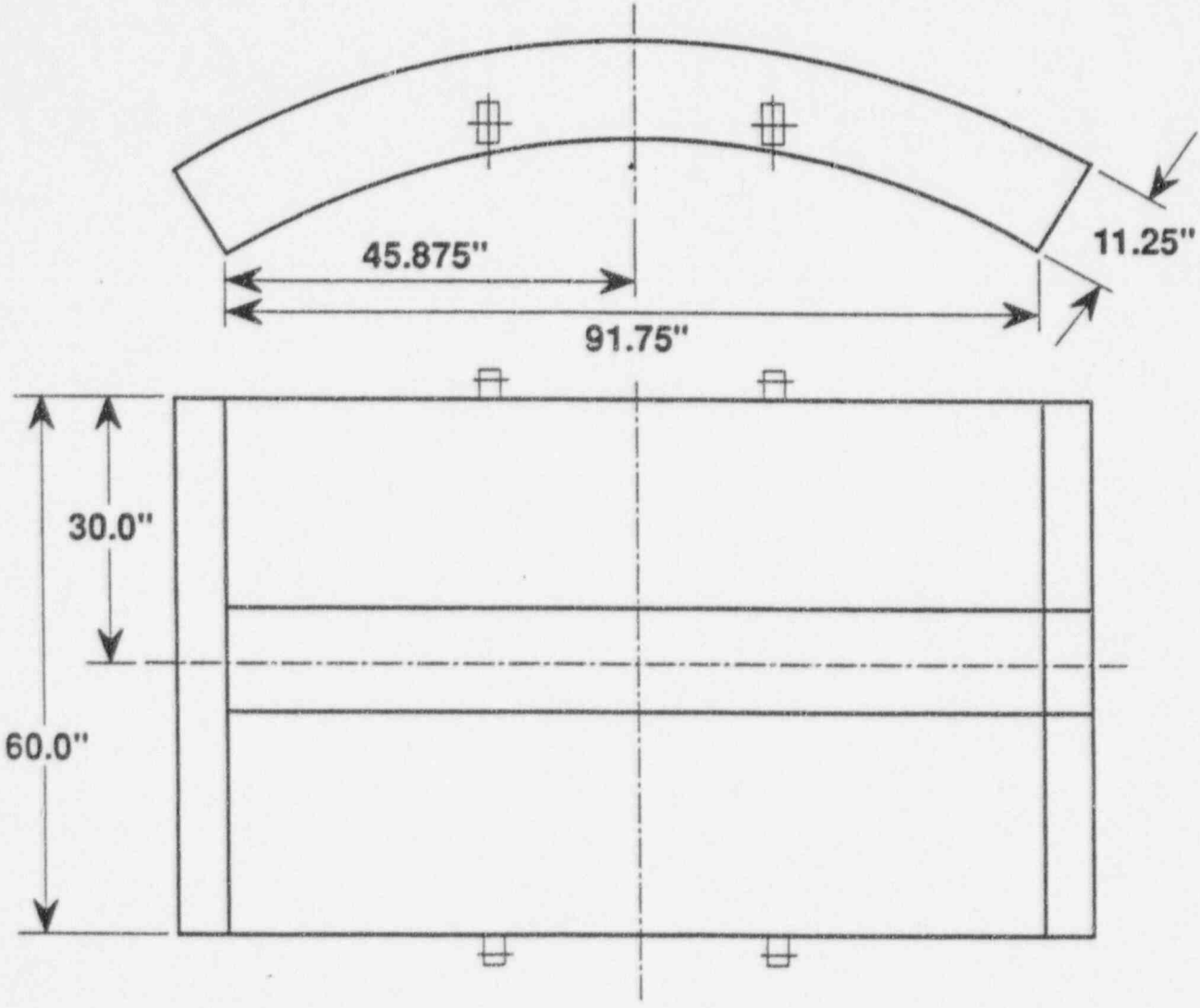
- 50% of the flaws Shall be Cracks
- Balance may be Cracks, Fabrication Defects (e.g.. Slag Inclusions) or Machined Notches
  - *Approx. 200 Flaws*
  - *80% are Cracks*
  - *14% are Fabrication Defects (Slag/LoF)*
  - *<6% are EDM Notches*
- Notches Shall Be
  - Perpendicular to Surface $\pm$2 deg.
  - Maximum Width of 0.0010 inch

App. VIII Design Requirements

- At Least 40% of the Flaws Shall be Parallel & 40% Perpendicular to the Clad Direction (Supp. 4) or Weld Direction in (Supp 6.)
  - *Flaws are Evenly Distributed*

- Supplement 4 & 6 Specific
  - Flaws Shall Emanate from the Clad Base Metal Interface
    - *Flaws Emanate From the Clad*
  - No More Than 10%Emanate from the Outer Surface
    - *Approx. 5% Are OD Connected*

Test Specimen R203 1 to 3
RPV Welds Less Than 12.5" Thick (Base Material)



- Automated Inspection from the Internal (Clad) Surface
- Manual & Automated Inspection from the External (Unclad) Surface (Thick Section BWR)
- Seam Welds
- Clad Base Metal Interface
- Detection & Sizing Demonstration

App. VIII Design Requirements

- Supplement 5 Nozzle Inner Radius
  - Flaws May Be Either Notches or Cracks
    - *Approx. 90 Flaws*
    - *>90% are Cracks*
    - *<10% are Notches*
  - For OD Techniques Nozzle to Shell Ratio Shall Be Within 30%
    - *4 Specimens Cover the Range of Ratios for BWR Plants*

App. VIII Design Requirements

- Supplement 7 Nozzle to Shell
  - Flaws May Be Notches or Cracks
    - *Approx. 40 Flaws*
    - *85% are Cracks*
    - *15% are Fabrication Defects (Slag/LoF)*
    - *Notches are not Used*

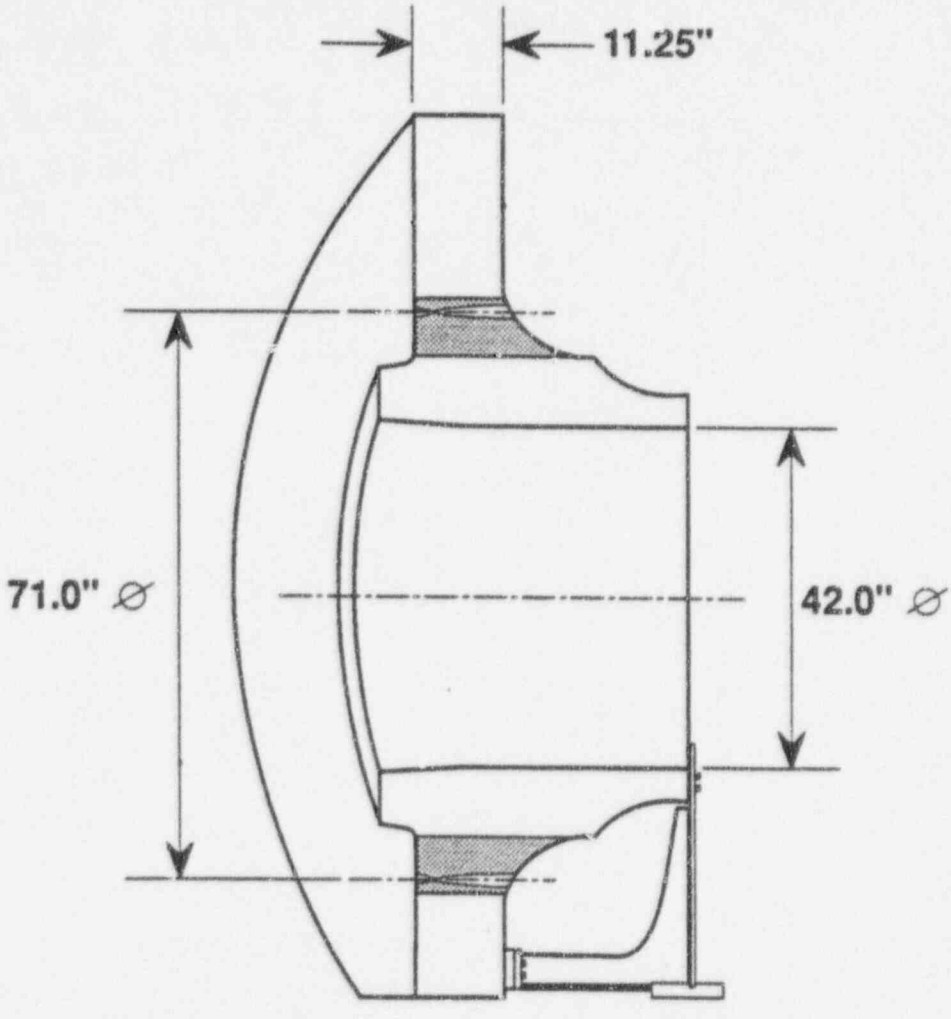
continued.....

App. VIII Design Requirements

- Supplement 7 Nozzle to Shell
  - For OD Examinations the Thickness of the Specimen Shall be 90% of the Maximum Thickness to be Examined
    - *PWR Covers 12.3 inches*
    - *BWR Covers 7.5 inches*
  - For Bore Examinations the Specimen Shall Provide at Least 1 Flaw Parallel to the Weld Within 10% of the Maximum Metal Path
    - *Metal Paths up to 19" are Included.*

Test Specimen R201

PWR Nozzle-to-Shell Welds
Up to 12.5" Thick



- Automated Inspection from Inside Surface
- Bore
- Shell
- Inner Radius Inspection (Corner Only)
- Metal Path 6-19"
- Detection & Sizing

PDI

App. VIII Design Requirements

- Flaw Size & Location
  - Through Wall Extent in 5 Ranges
    - Described as "a,b,c,d, e"
  - Length Requirements
    - No Flaw Shall Have An Aspect Ratio (depth/length) Less than 0.1
  - Depth Location (Z) and Application
    - Described for Each Supplement.....

Size and Location
of PDI Specimen Appendix VIII Flaws

TWE - Size	a 0.075 - 0.200	b 0.201- 0.350	c 0.351 -0.550	d 0.551-0.750	e 0.751-2.00
Application					
Supp. 4 & 5	X	X	X	X	-----
Supp. 6 & 7					
Inner 10%	Does not apply to clad vessels/specimens (see supplement 4)				
Outer 10%	X	X	S	S	-----
11-30% T	-----	-----	X	X	S
31-60% T	-----	-----	X	X	S
61-89% T	-----	-----	X	X	S

Legend

X Applies to Detection and Sizing Flaws

S Applies to Sizing Flaws

T Thickness of the Thickest Specimen in the Specimen Set

Full Size, Realistic and Portable

- Full Size
  - *All Specimen Designs Used Material Removed From Canceled US RPV's*
- Realistic
  - *Material Selected based on Size, Availability, & Quality.*
  - *Flaw Designs Based on PDI Technical Basis &Appendix VIII*
- Portability
  - *Size of Specimens Had to Consider ISI Vendor Facilities*

Provide Diversity in Test Sets

- Conceptual Drawings and Applications Were Developed for PDI Approval
  - Modular Design of Test Sets
  - Specimen Security
- Design Reviews of Final Manufacturing & Flaw Specifications Includes
    - PDI & Code Requirements
    - Application of Specimens
    - Beam Plots of Flaw Locations
    - Example Test Sets

Quality

- PDI Developed Specimen Fabrication QA Program Requirements
- QA Requirements Were Applied to Specimen Design and Fabrication
- All QA Requirements Were Passed on to Specimen Sub-contractors.....

Specimen Fabrication QA Requirements

- Design Control
- PDI Test Specimen Procurement
- PDI Document Control
- Material Control and Identification for PDI Specimen Fabrication
- Qualification of Inspection, Examination and Test Personnel for PDI Specimen Fabrication
- Qualification and Certification of NDE Personnel
- Calibration and Control of PDA Measurement and Test Equipment
- PDI Test Specimen and Information Security
- PDI Control of Nonconforming Items
- PDI Specimen Manufacturing and Examination Records Indexing
- PDI Test Specimen Quality Records Review Instruction
- Quality Assurance Monitoring
- Preparation, Use and Control of Process Control Sheets

Procurement of Specimens

- Vendor Information Meeting January 1992
  - Provided All Prospective Vendors With PDI Program Requirements
    - Security of Information
    - Timetable
    - Quality Assurance
  - Prerequisites for Bidding
    - All Vendors Required to Sign Non-Disclosure Statements & Submit Procedures to Guarantee Confidentiality of Test Specimen Flaw Truth

Procurement of Specimens

- Initial RPV Practice Specimen Bids Invited From
  - Ansaldo/NPP (Italy/USA)
  - Ensa (Spain)
  - Inqual/Sonospection (USA/UK)
  - SwRI (USA)
  - Westinghouse (USA)
  - The Welding Institute (UK)
  - Uddcomb Engineering (Sweden)
- Provided Overview of Flaw Technology & Capability

Bid Evaluation Process

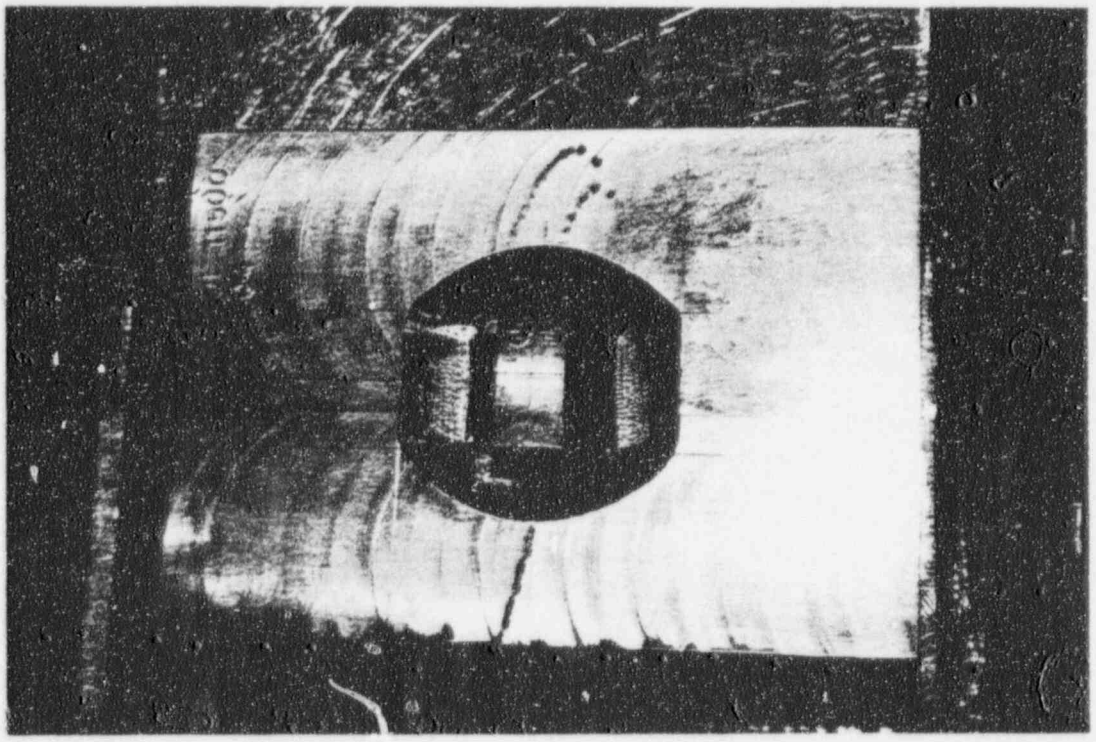
- Procedure was Established to Evaluate Proposals
  - Evaluation Process Weighted
    - QA, Security, Technical, Facilities, Experience, and Schedule 60%
    - Cost 40%
  - Contracts Were Placed With A Contingency that the Vendor Demonstrated Repeatability & Quality of the Proposed Flaw Manufacturing Method to PDI Program Requirements.

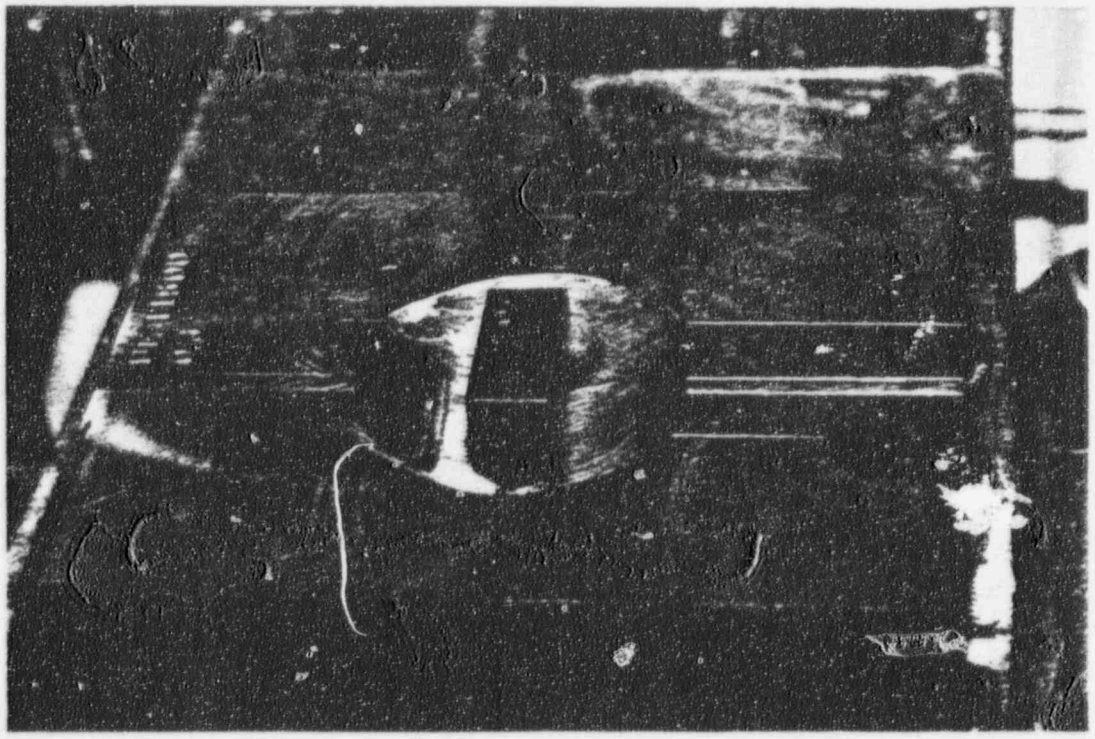
Vendor Qualification Requirements

- Used to Qualify Flaw Method, Welding Procedures and Welders for the Application
  - Manufacture 4 Flaws of Each Type
    - Working to Controlled Procedures.
    - Meet or Exceed PDI Specifications & Tolerances
  - Reporting
    - Full Manufacturing Documentation, NDE and Destructive Evaluation of 3 Flaws.

Vendor Flaws

- Vendors Proposed 3 Flaw Manufacturing Methods
  - Crack Implants
    - Flaws are Generated in Small Piece of Material and Then Implanted into the Test Specimen
  - Directly Induced Cracks
    - Flaws are Generated Directly in a the Test Specimen (Weld Solidification)
  - Slag/Lack of Fusion
    - Flaws are Fabricated Directly in the Test Specimen

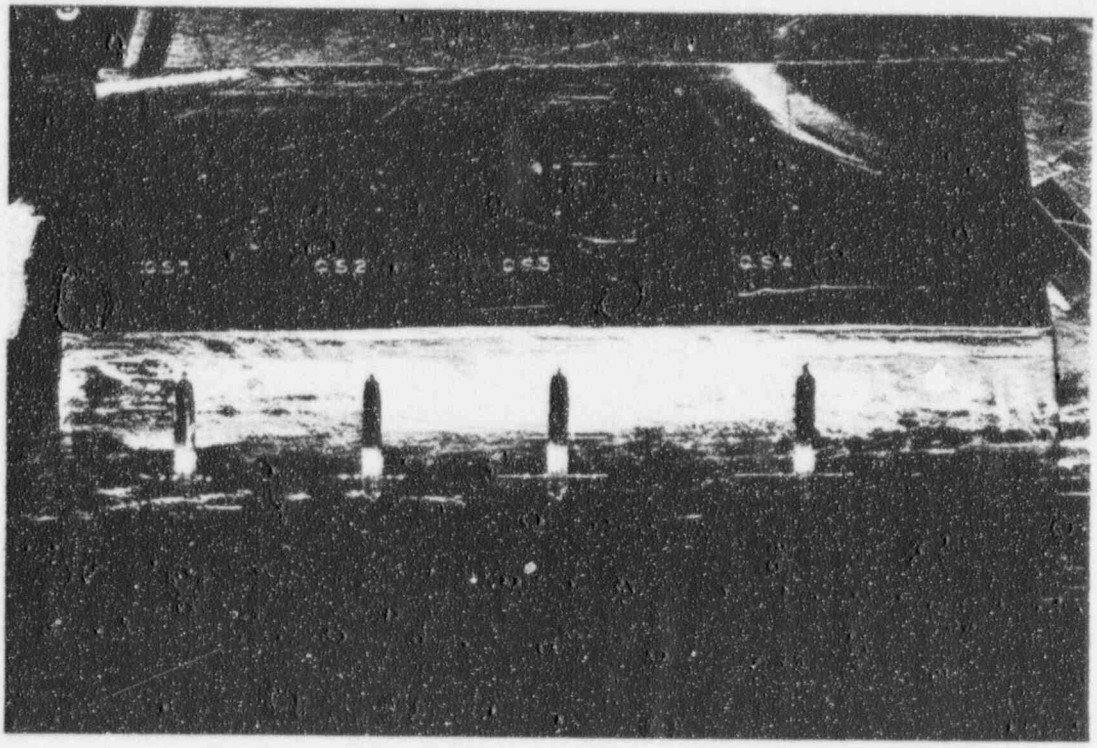




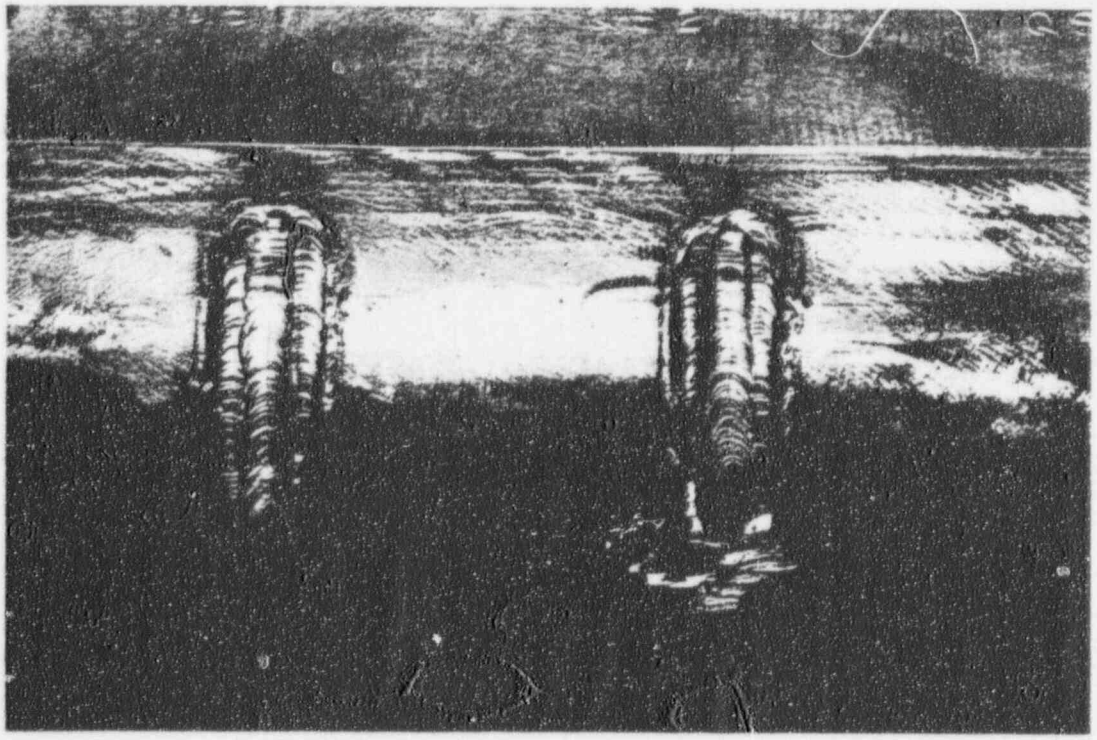
93-07-09
RL

Photos

11500 Qualification
QS1 → QS4



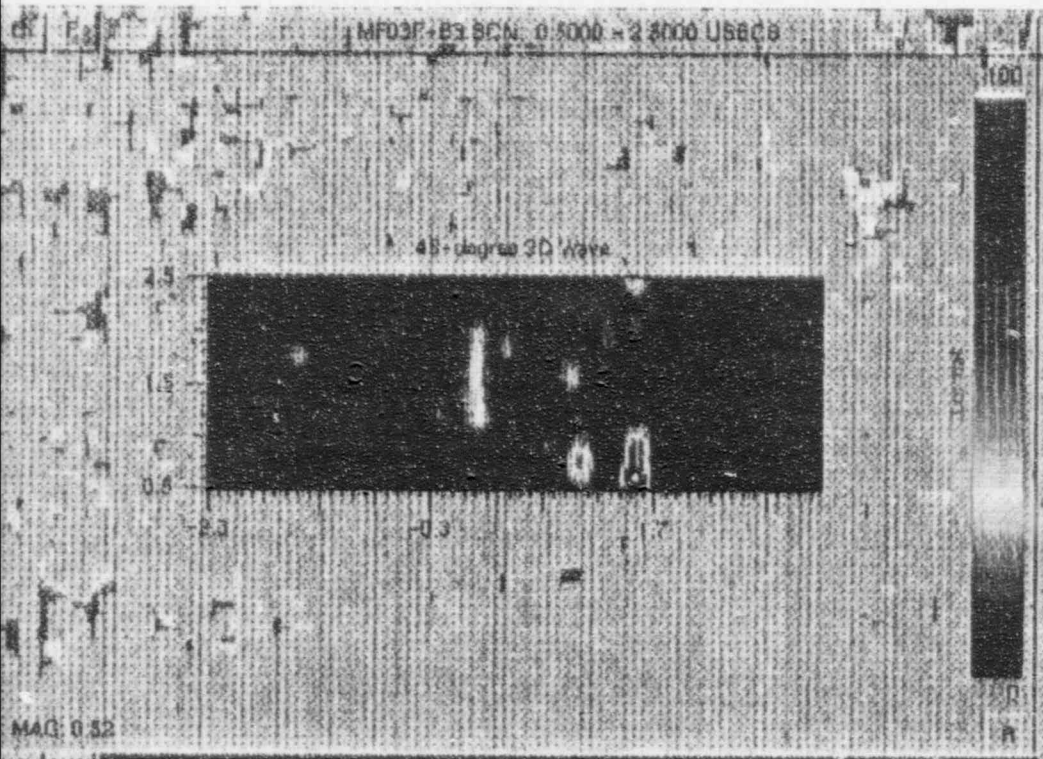
Weld preparation

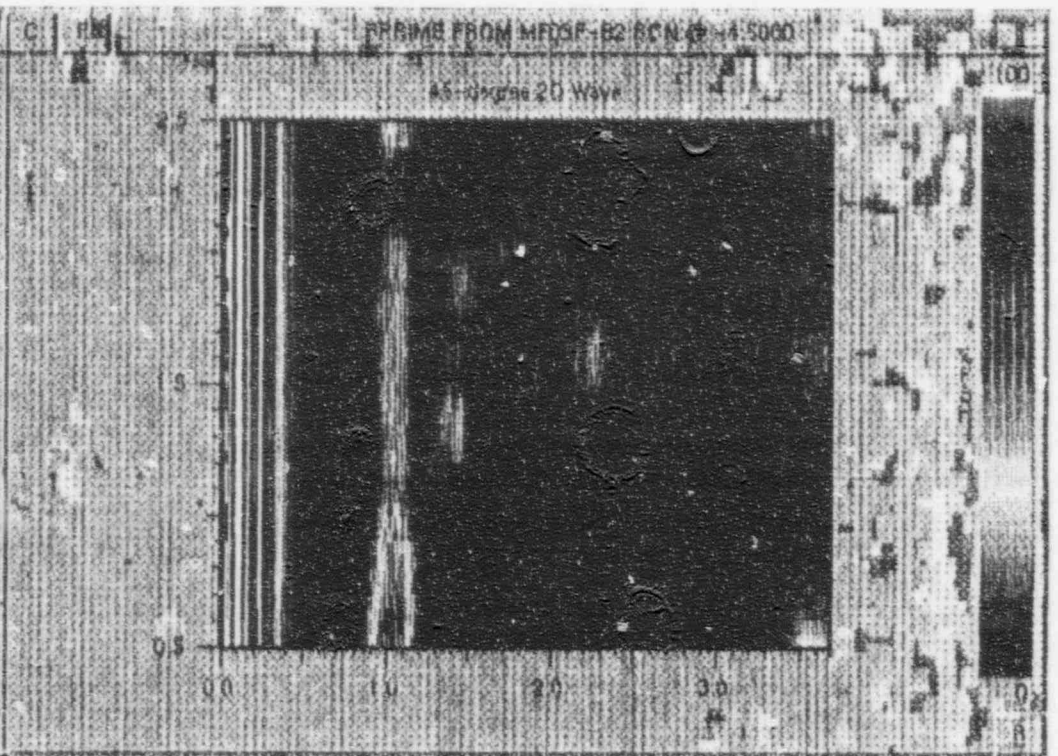


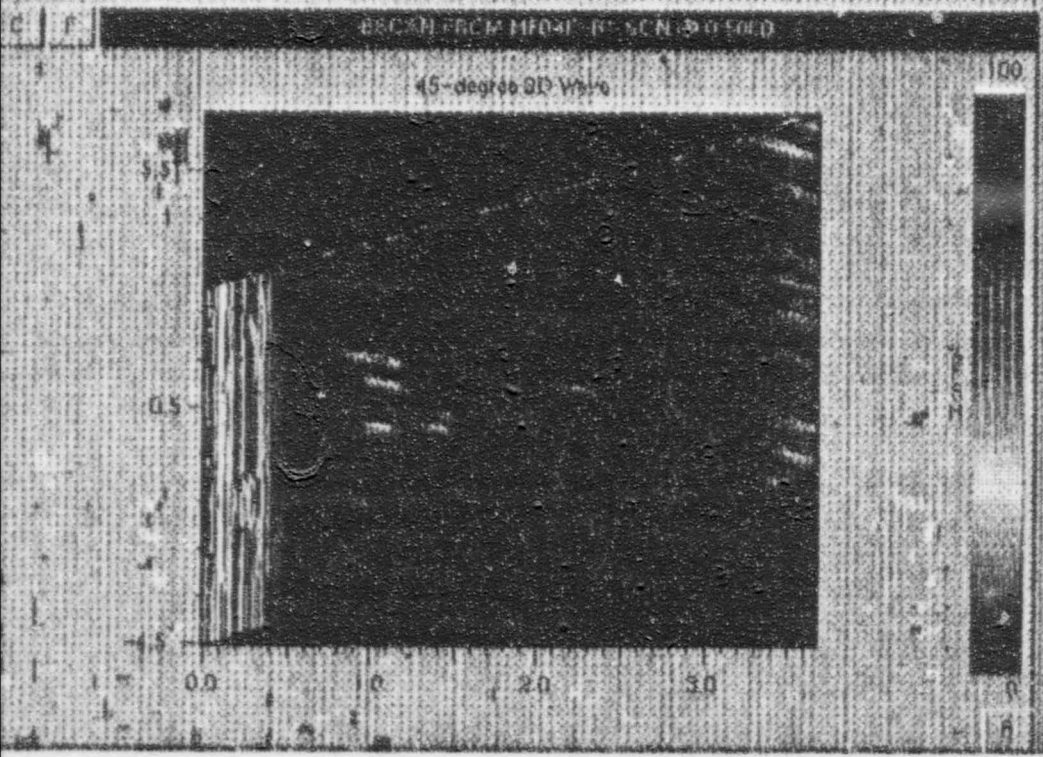
Welding

NDE of Vendor Qualification Flaws

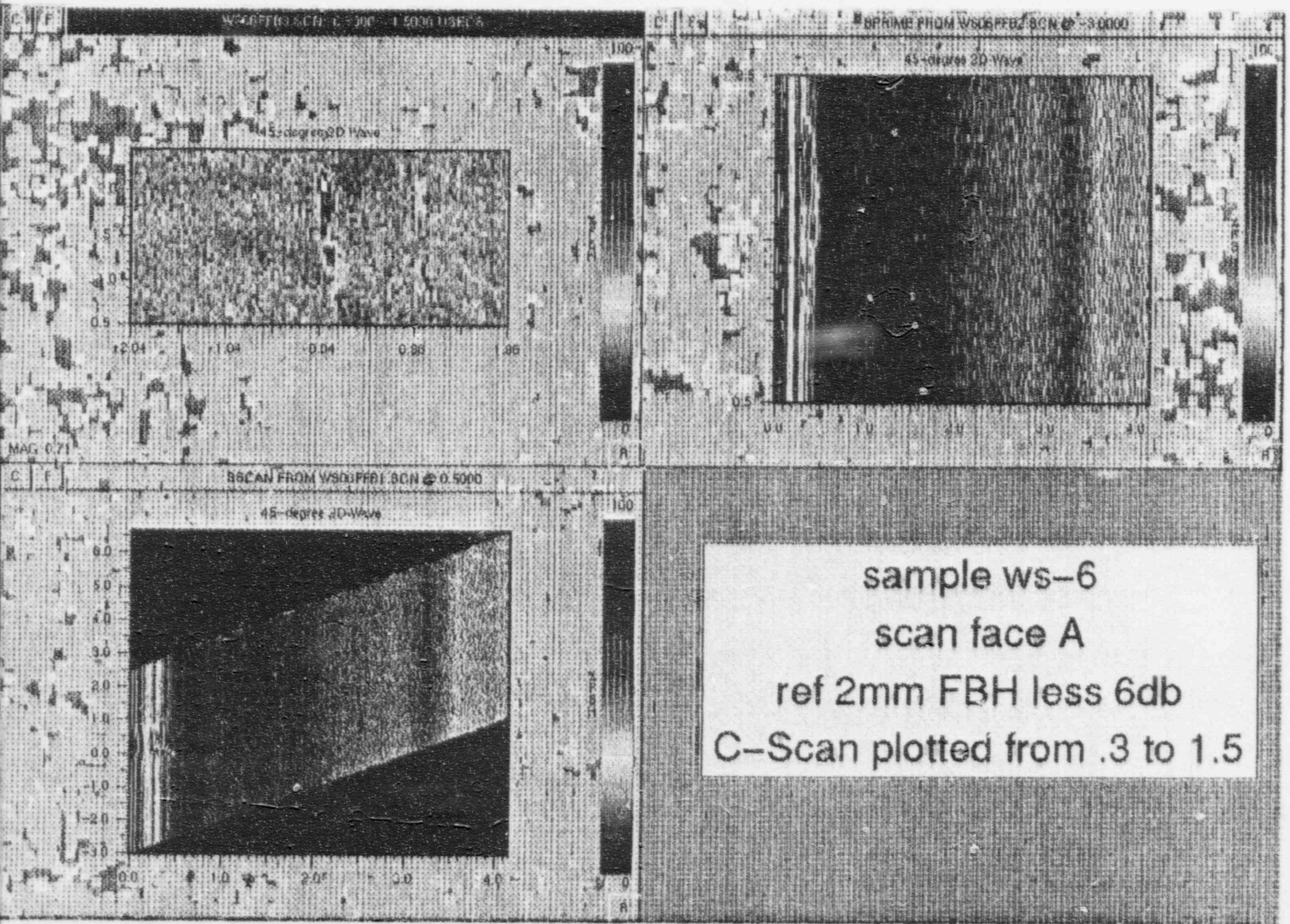
- Nondestructive Evaluation of 4 Flaws Verified
  - NDE Response & Characteristics of the Flaw
  - Weld Implant Quality to Identify Satellite UT Indications from Welding Process.
- One Flaw Was Kept as an Archive Example for Future NDE Evaluation







sample mf-3
scan face A
ref 2mm FBH


45-degree 2D Wave
MAG 0.71
45-degree 2D Wave
45-degree 2D-Wave
sample ws–6
scan face A
ref 2mm FBH less 6db
C–Scan plotted from .3 to 1.5

Destructive Evaluation of Qualification Flaws

- Destructive Analysis Included
  - Sectioning the Flaw and Surrounding Material or Breaking the Flaw Along its Length, providing.....
    - Position, X/Y & Z (Ligament)
    - Dimensions, Length & TWE
    - Realism
      - Shape
      - Flaw Tip Radius
      - Flaw Tightness
      - Flaw Surface Texture
    - Repeatability & Weld Quality

E.N.	EQUIPOS NUCLEARES, S.A. DEPARTAMENTO METALURGICO LABORATORIO METALOGRAFICO	EXAMEN METALOGRAFICO METALLOGRAPHIC EXAM.	EM. Nº 3430 HOJA Sheet 1 DE of 7

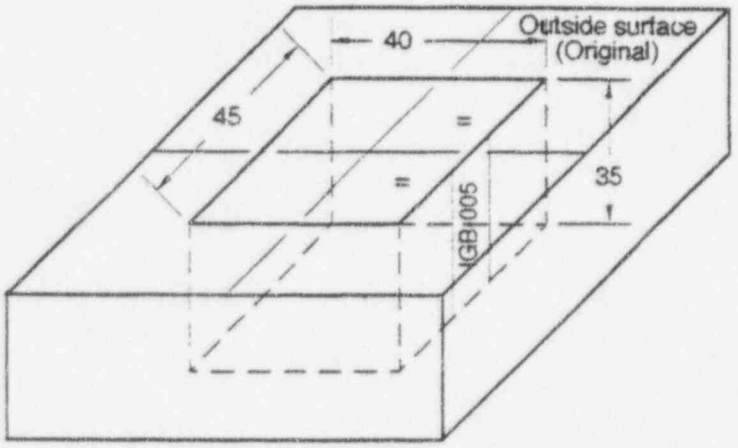
CLIENTE Customer	EPRI	CONTRATO Nº Job. nº	1CD9	CUPON Coupon	W-6333	FECHA Date	13-05-93

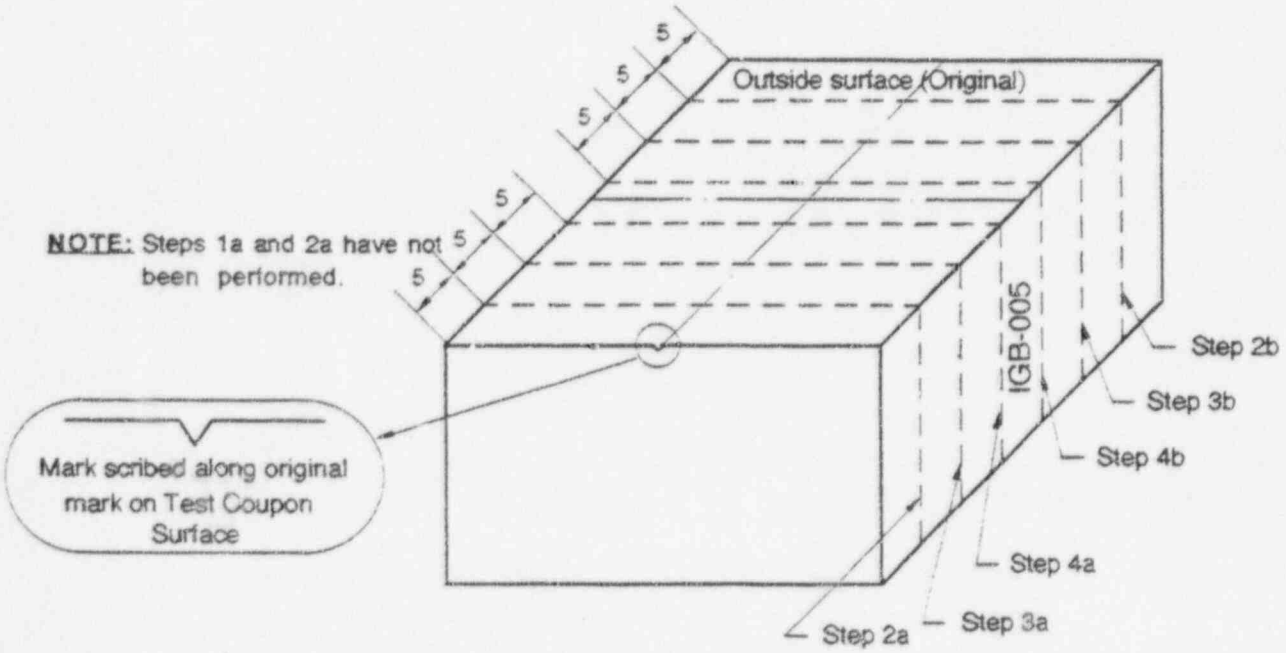
DEMONSTRATION OF MANUFACTURING PROCEDURES. ROUGH CRACK. PDI/EPRI PROJECTS. SAMPLE IGB 005.

Destructive examinations as required in FP E-02, sequence 15.

SEQ. 15: MACROGRAPHIES AFTER CROSS SECTIONING.

CROSS SECTIONING





MACROGRAPHIES

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13-05-93	13-05-93		

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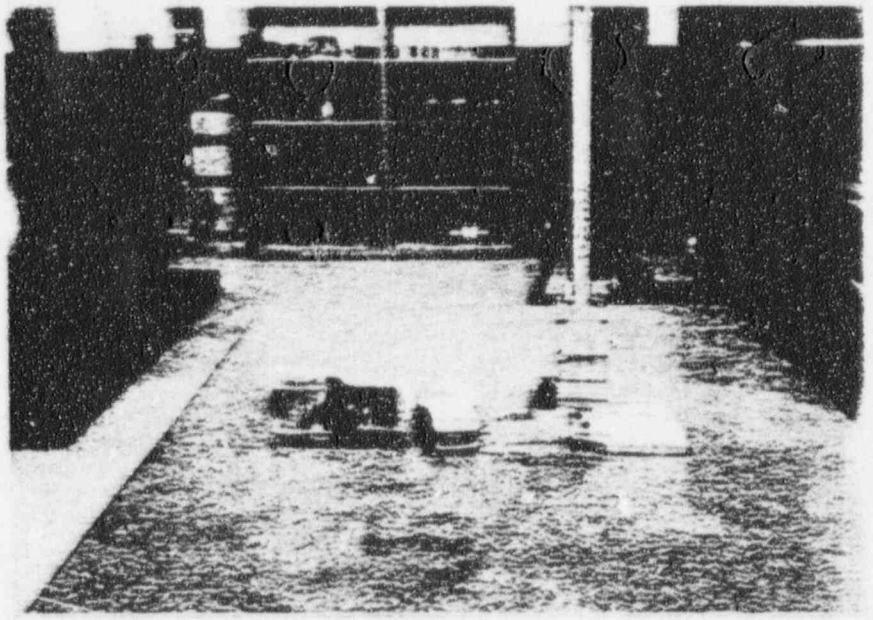
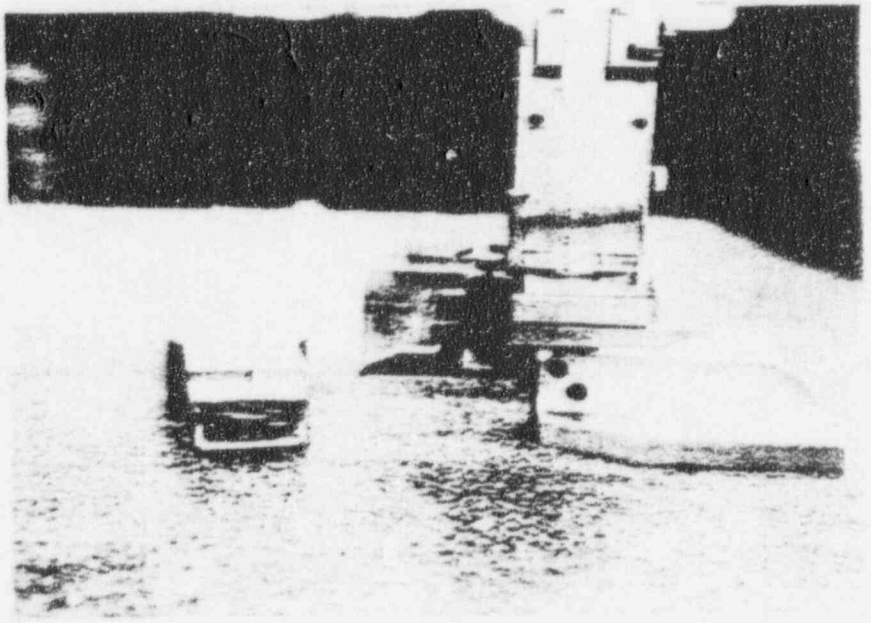
E.N.	EQUIPOS NUCLEARES, S.A. DEPARTAMENTO METALURGICO LABORATORIO METALOGRAFICO	EXAMEN METALOGRAFICO METALLOGRAPHIC EXAM.	EM. Nº 3396 HOJA Sheet 2 DE of 10

CLIENTE Customer	EPRI	CONTRATO Nº Job. nº	1CD9	CUPON Coupon	W 6294	FECHA Date	25-03-93





LIGAMENT MEASUREMENT BY DIFFERENCE BETWEEN TOP FACE HEIGHT AND UPPER PART DEFECT

Results: Ligament IGB 001 = 11.6 mm IGB 002 Ligament = 11.1 mm

PREPARADO POR Prepared by	COMPROBADO POR Checked by	INSPECCION OTROS EXTERNOS External Inspections	FIRMA Signed

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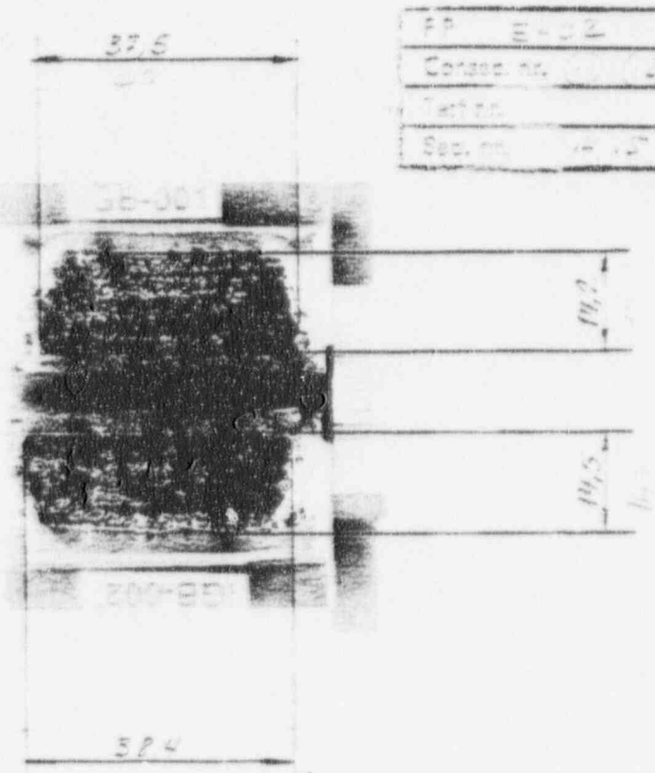
CLIENTE Customer	EPRI	CONTRATO Nº Job. nº	1CD9	CUPON Coupon	W-6294	FECHA Date	25-03-93

DEMONSTRATION OF MANUFACTURING PROCEDURES. ROUGH CRACK. PDI/EPRI PROJECTS.

SAMPLES IGB 001 - IGB 002 - IGB 003.

Destructive examinations as required in FP E-02. sequences 14 and 15.

SEQ. 14: TESTING BY PULLING APART (SAMPLES IGB 001-IGB 002).



PHOTOGRAPHY OF BROKEN SAMPLES

Results:

IGB 001 TWE = 14.2 mm. Length = 37.5 mm.
IGV 002 TWE = 14.5 mm. Length = 38.4 mm.

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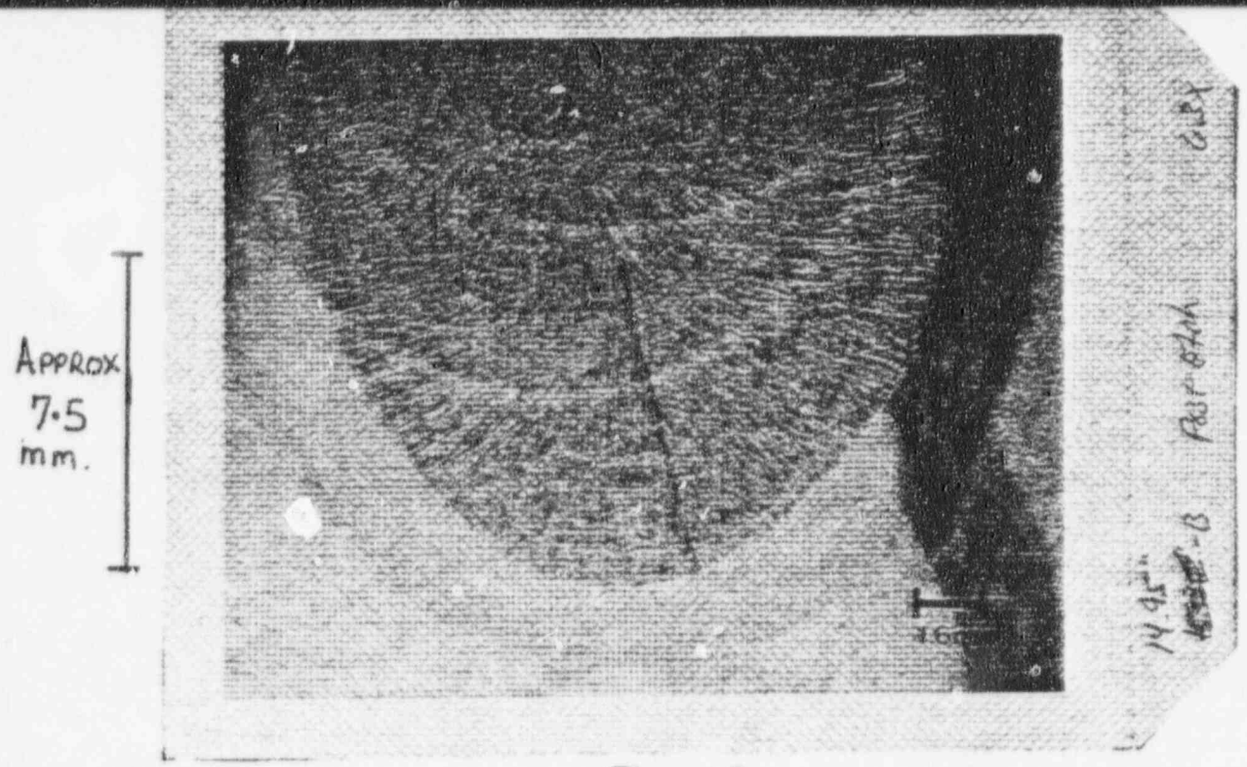
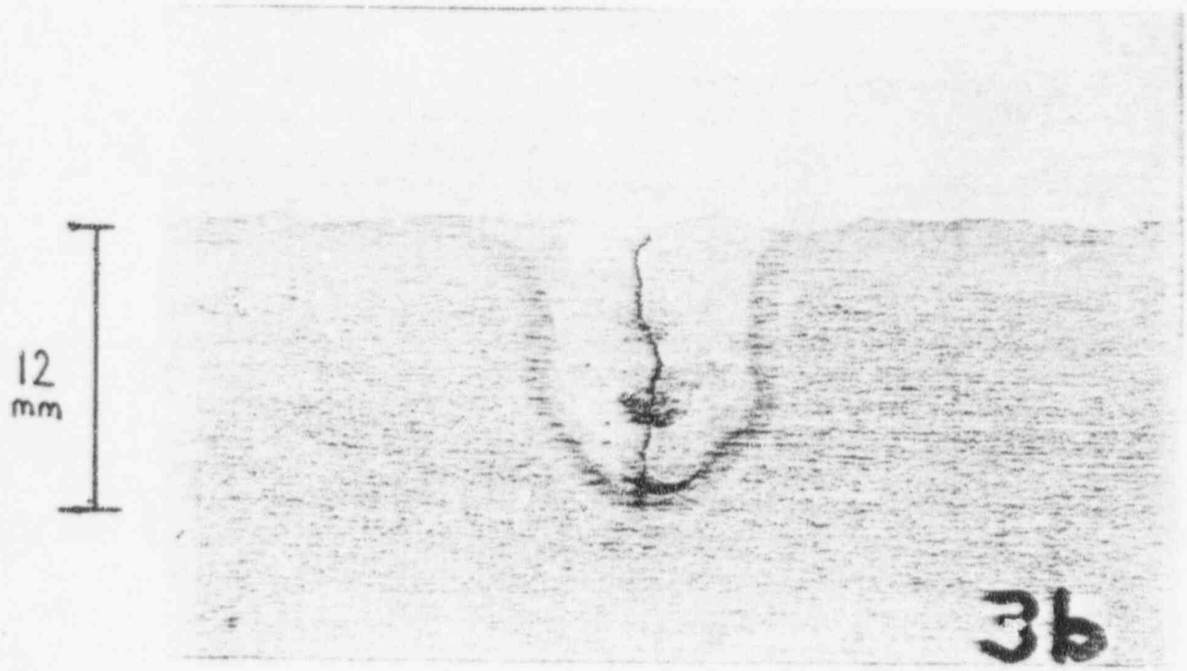
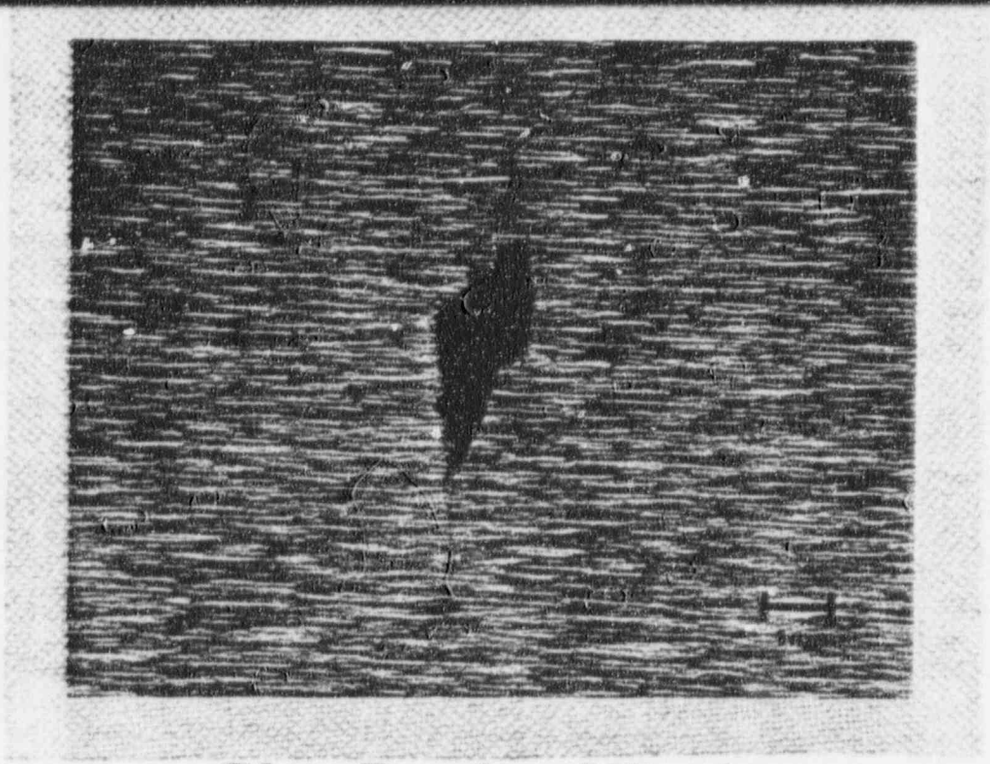
25-03-93	25-03-93		



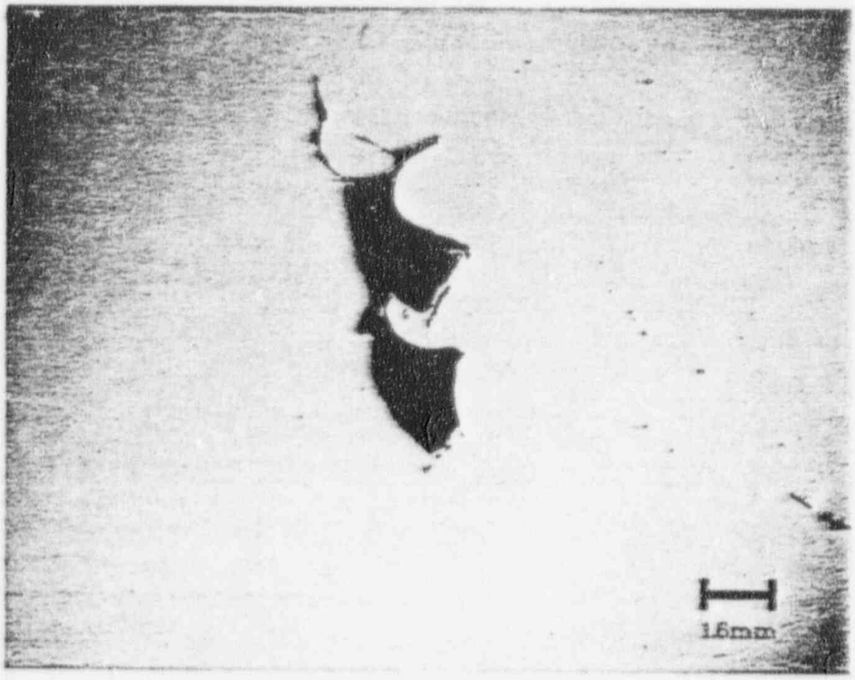
Crack
(ex Midland Vessel)



Crack
(PDI RPV- Specimen)

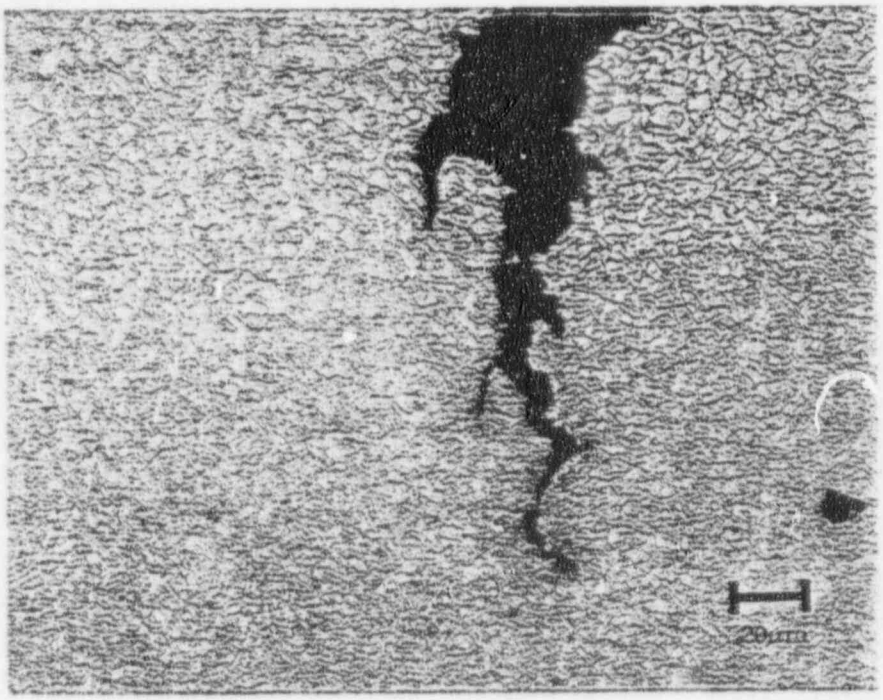


Slag/Lack of Fusion
(ex Midland Vessel)



Slag/Lack of Fusion
(PDI RPV- Specimen)

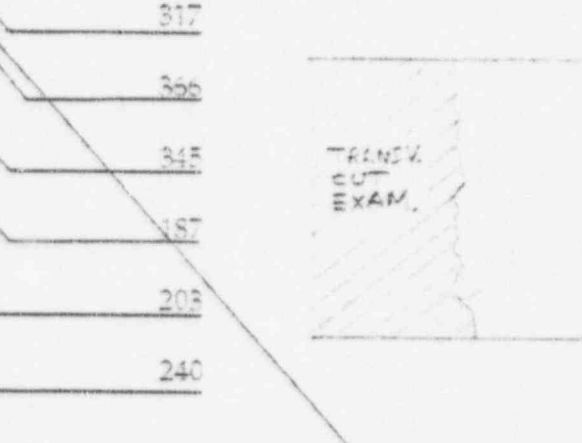
Typical Crack Tip



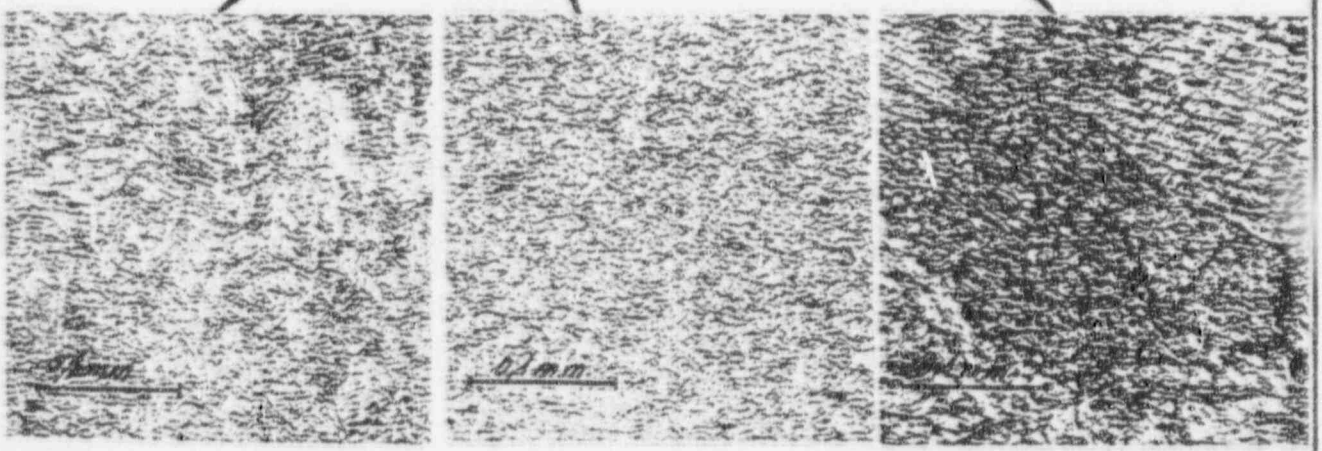
HARDNESS DETERMINATION (HV 10)

1. TYPICAL
   - Base Material: 180-220
   - Base Material HAZ: 220-280

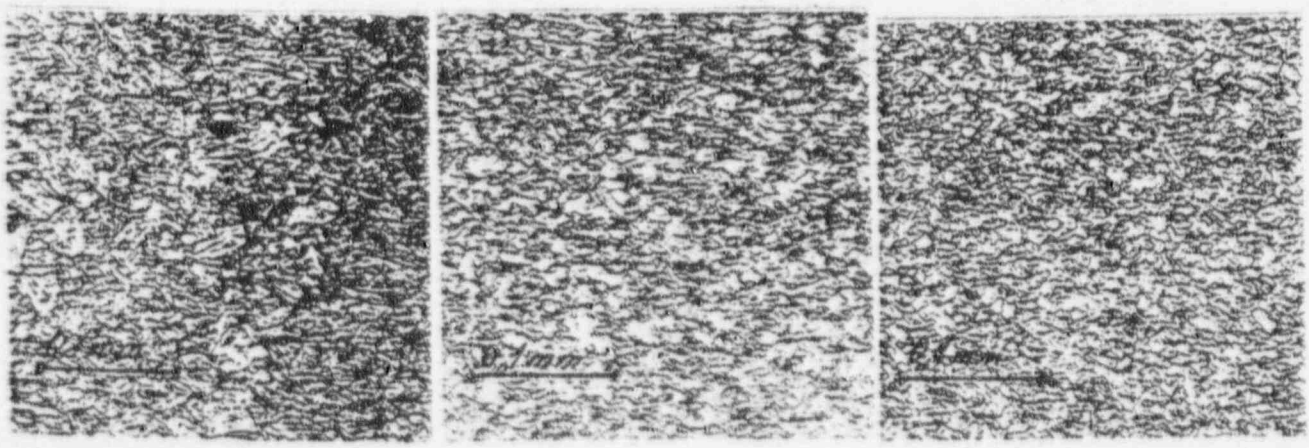
2. OBTAINED



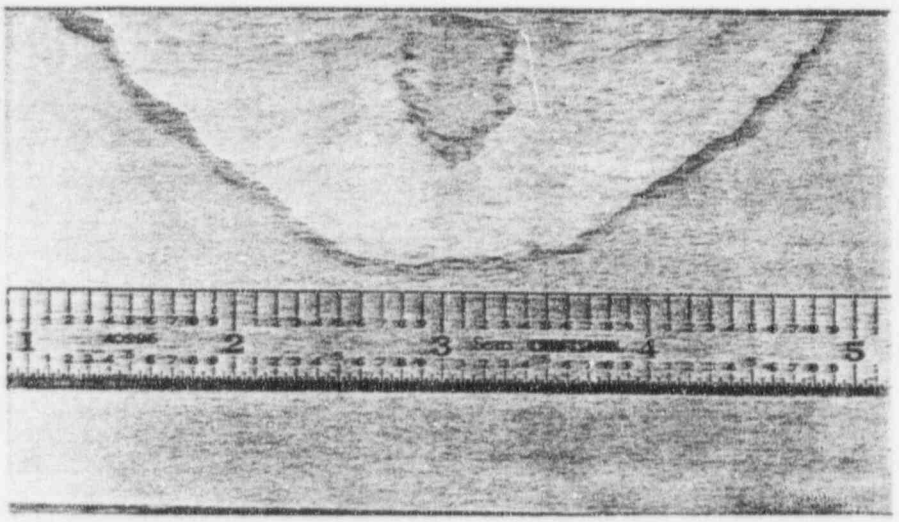
OBTAINED MICROSTRUCTURES



CONVENTIONAL NUCLEAR WELDS

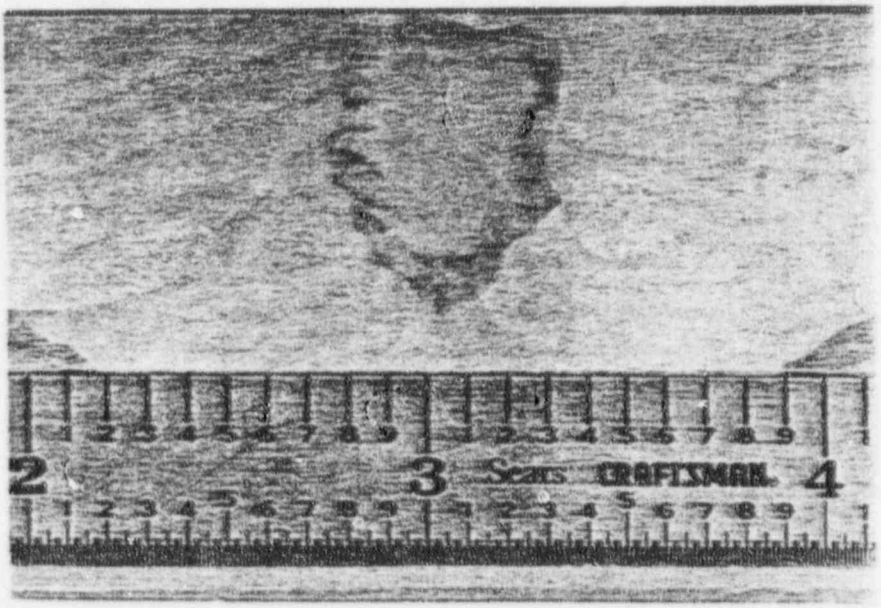


BASE MATERIAL P3 | HAZ GTAW P3 | WELD MATERIAL GTAW



1.06x No. 57798

Figure 1. Mechanical fatigue crack implant (dummy)



2.0x No. 57799

Figure 2. Mechanical fatigue crack implant (dummy)

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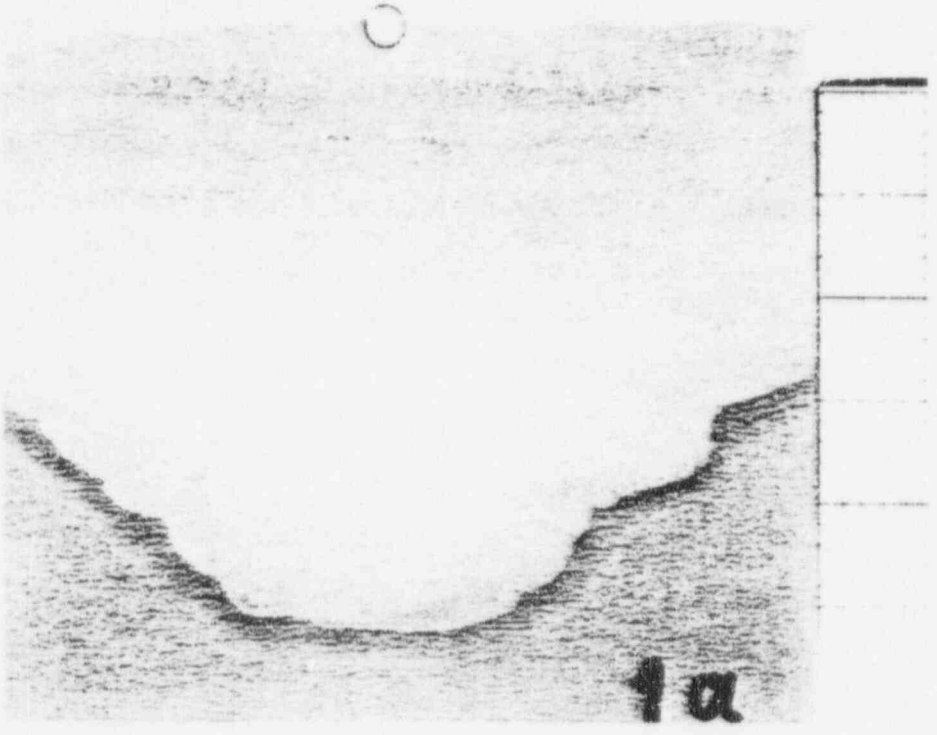
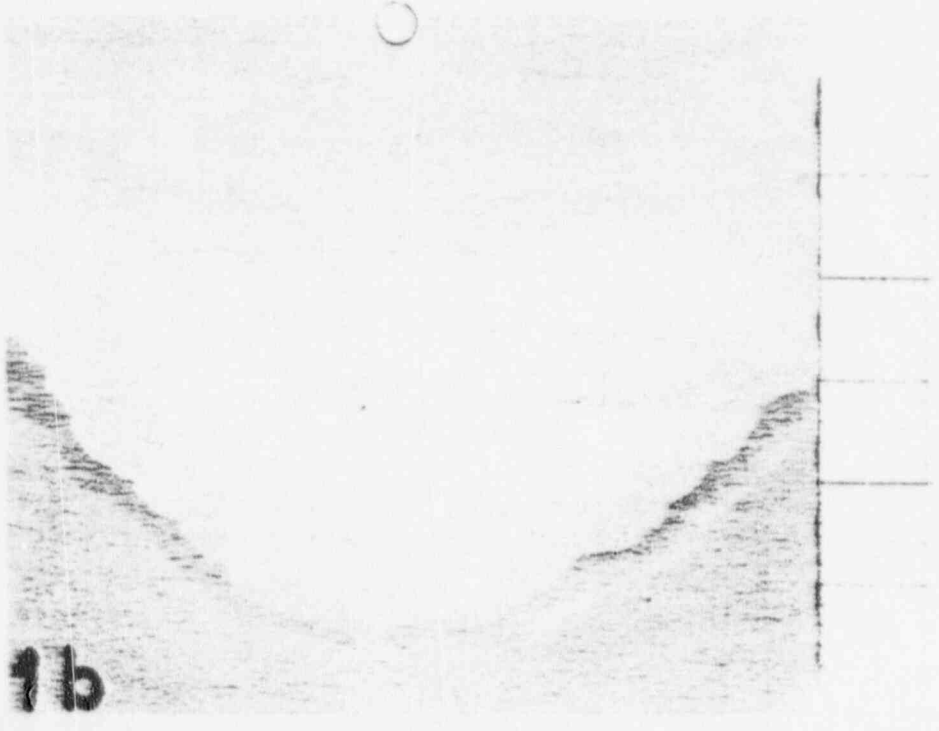
CLIENTE Customer	EPRI	CONTRATO Nº Job. nº	1CD9	CUPON Coupon	W 6294	FECHA Date	25-03-93





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25-03-93	25-3-93		

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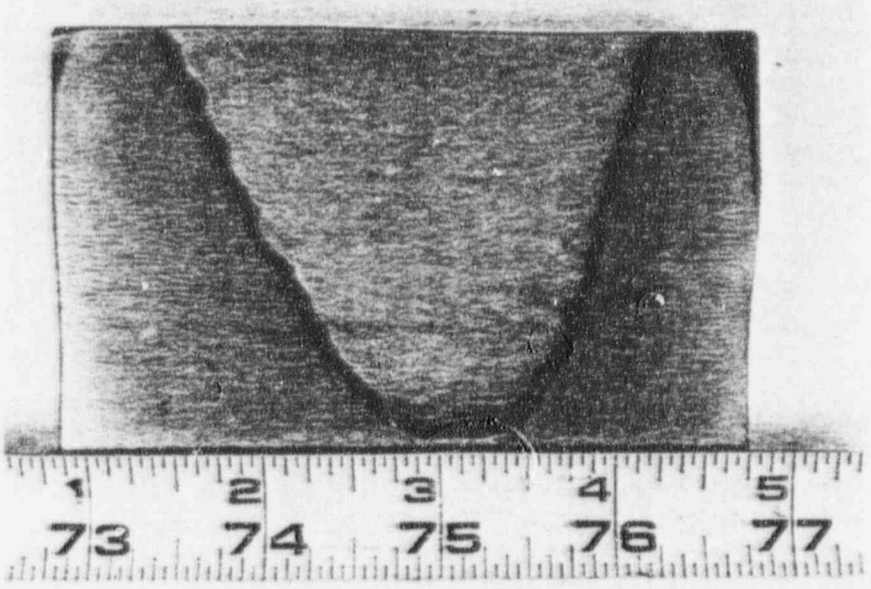
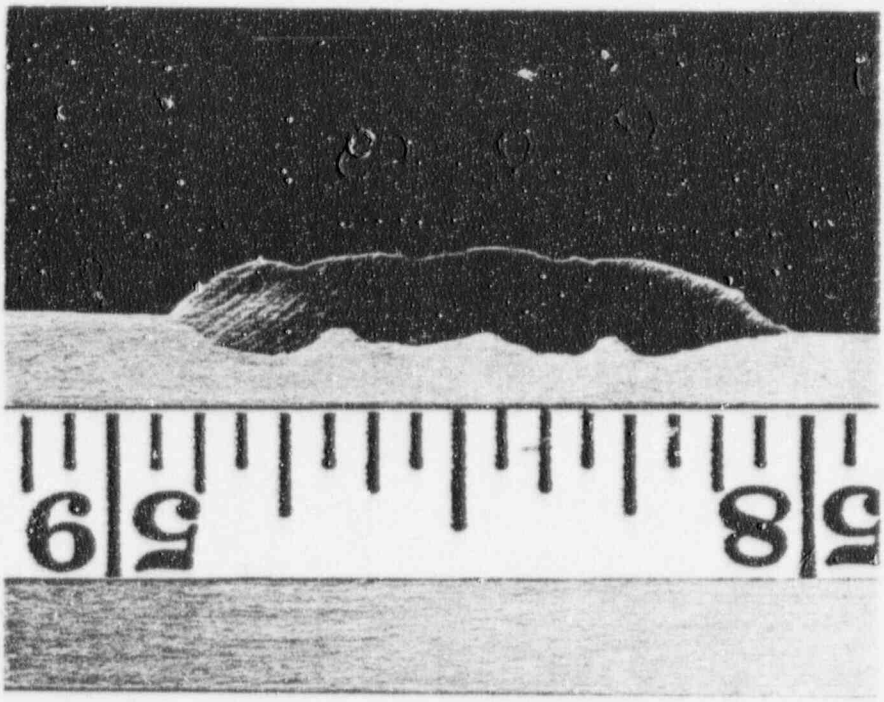
METALLOGRAPHY OF WELDER QUALIFICATION

The welder qualification block was welded in accordance with Drawing No. C-4988-610. This involves using the GTAW process {Procedure PDI-SQOP-17-4988(42)} for the bottom 1/2 inch of deposit, the SMAW process {Procedure PDI-SQOP-17-4988(41)} for the intermediate 3/4 inch, and the FLAW process {Procedure PDI-SQOP-17-4988(43)} for the final 3/4 inch. After ultrasonic and MT examinations, the block was sectioned at the transverse centerline and polished and etched. Figure 1 shows the cross section for welder Frank Garcia.



0.9X No. 57884

Figure 1. Cross Section of Welder Qualification Block for Frank Garcia.



3.6X 59726

Figure 1. A Photomacrograph of a Typical Cross Section

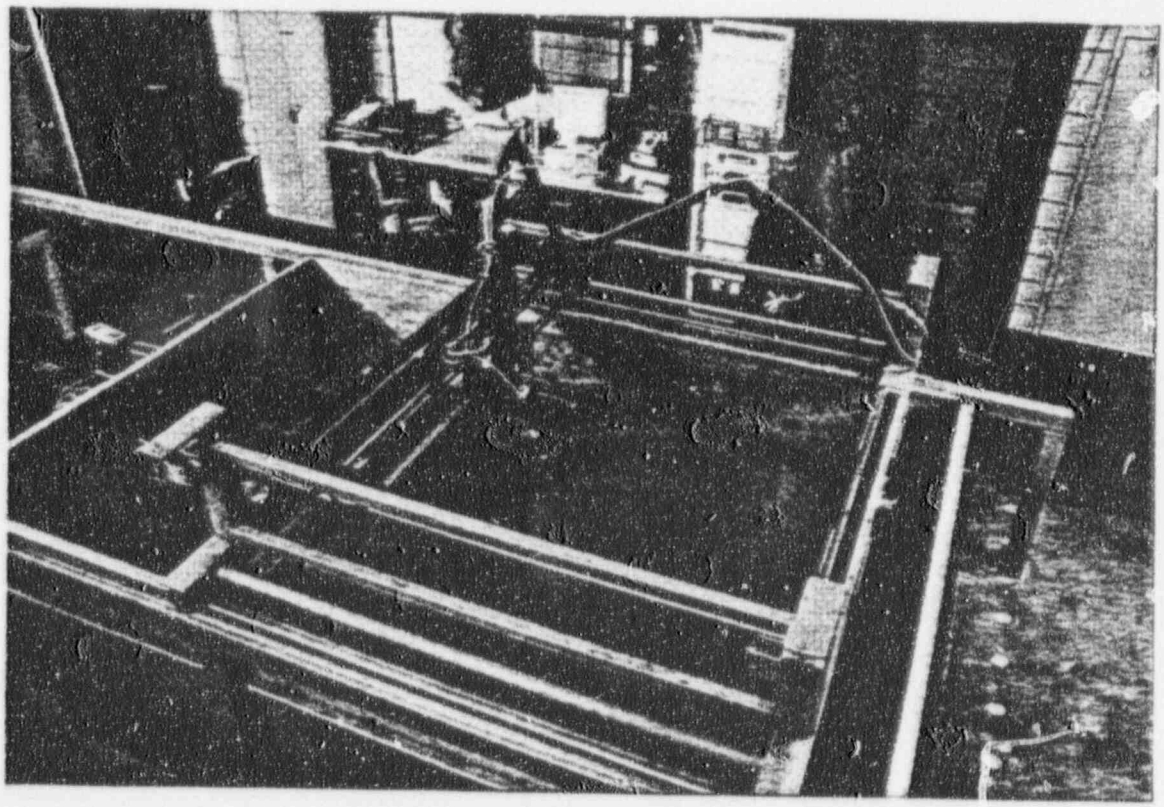
Summary of Flaw Manufacturing

- Crack Implants.
  - Flaw Dimension Accuracy
    - Acceptable
  - Weld Implant Quality
    - Unacceptable
- Directly Induced Cracks & Slag/LoF
  - Flaw Dimension Accuracy
    - Acceptable
  - Weld Quality
    - Acceptable

Specimen Fabrication

- Material Supplied by EPRI & PDI
  - From Canceled RPV Vessels
  - Subject to High Sensitivity Baseline NDE Examinations
    - Higher than Normal Code Exams
  - Material Identification was Established
    - QA Records
    - Sampling
  - >200 Tons!

Automated Baseline Exam



Specimen Fabrication

- PDI Technical Specifications and Drawings
  - Manufacturing Drawings
    - General Arrangement
    - Manufacturing Scheme
    - Flaw layout
  - Technical Specifications
    - Manufacturing and Quality Requirements
    - Flaw Requirements

Specimen Fabrication

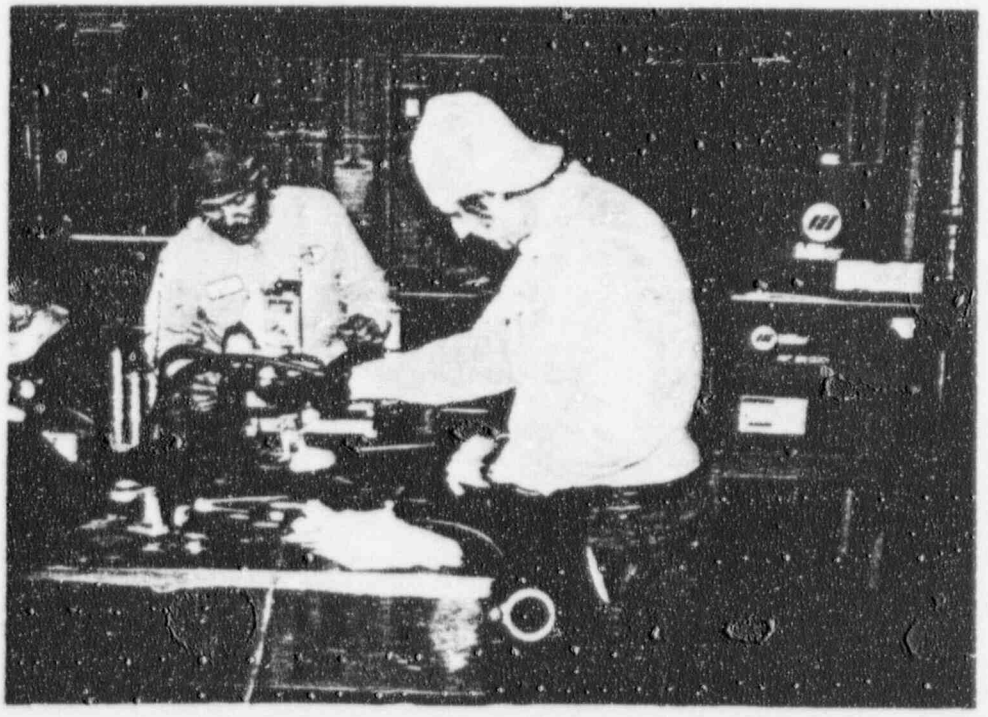
- Vendor Drawings, Procedures, and QA
  - All Drawings & Procedures Were Reviewed Before Fabrication
  - Hold Points Were Established for Vendor QA and EPRI Staff QA
  - Vendor Personnel Were Required to Sign Non-disclosure Forms for Security of Flaw Truth
  - QA Audits and Surveillance's Were Required

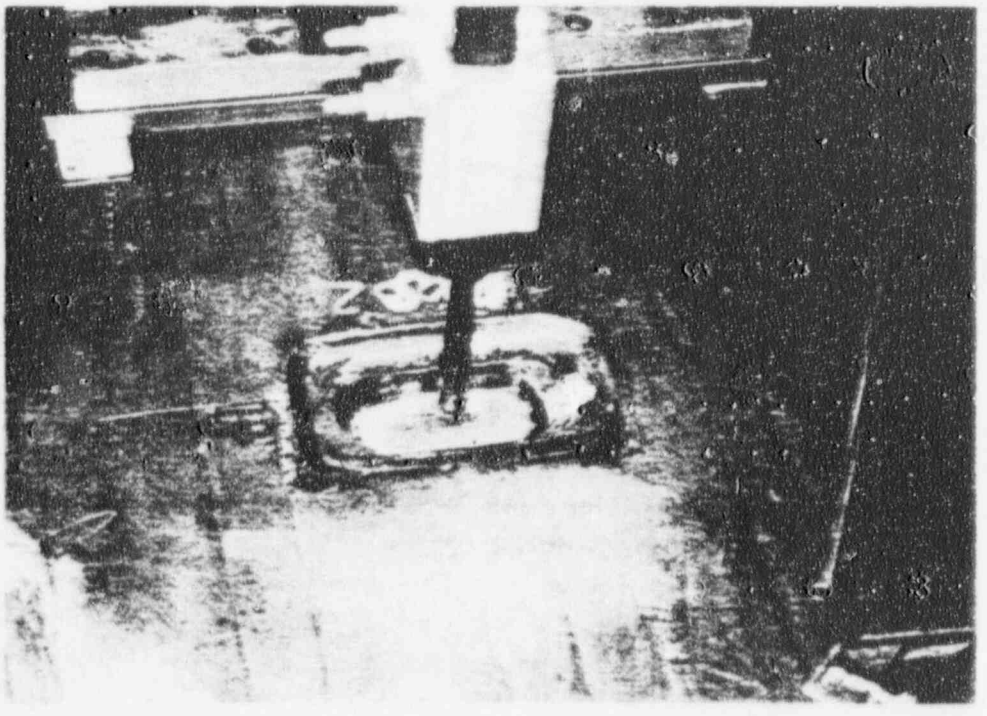
Specimen Fabrication

- Manufacturing
  - Each Fabrication Step was Identified on Work Instruction Sheets
  - Vendor Personnel Signed Off at Each Stage
  - QA and EPRI Staff Verified Flaw Locations
  - Full Documentation Was Kept

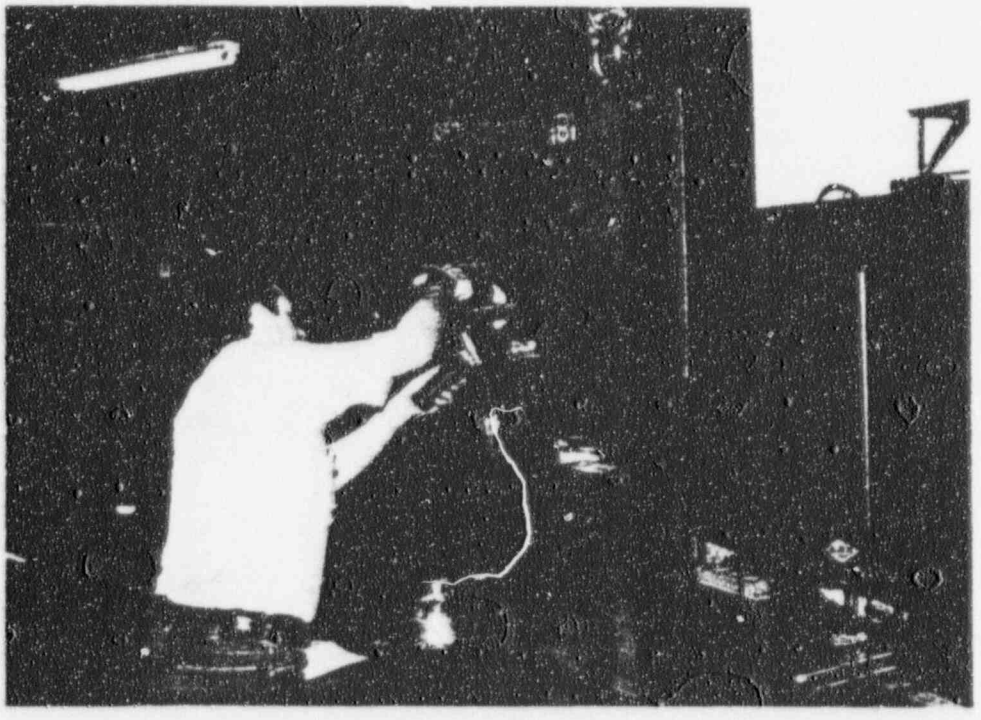
Specimen Fabrication

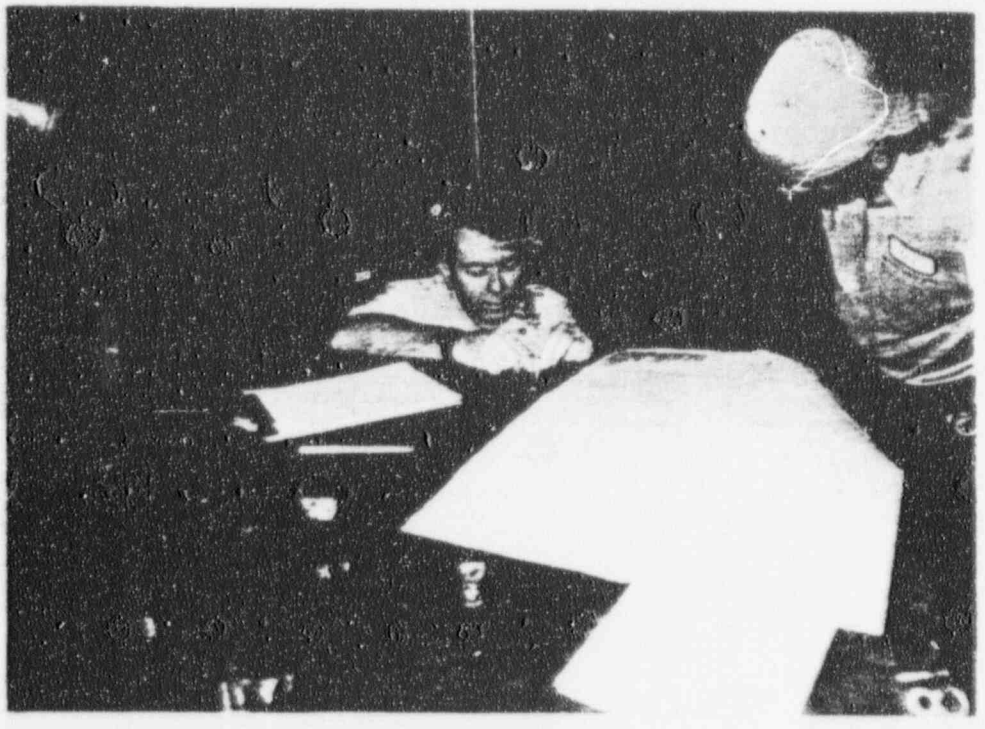
- Vendor Inspection
  - Specimen was Subject to Final Inspection Before Delivery
    - Visual
    - NDE- Surface and Volumetric
  - All Specimen Manufacturing Records Recovered & Delivered.
    - As Built Drawings





TRANSPARENCY. FOR Overhead Projection.





TRANSPARENCY. For Overhead Projection.

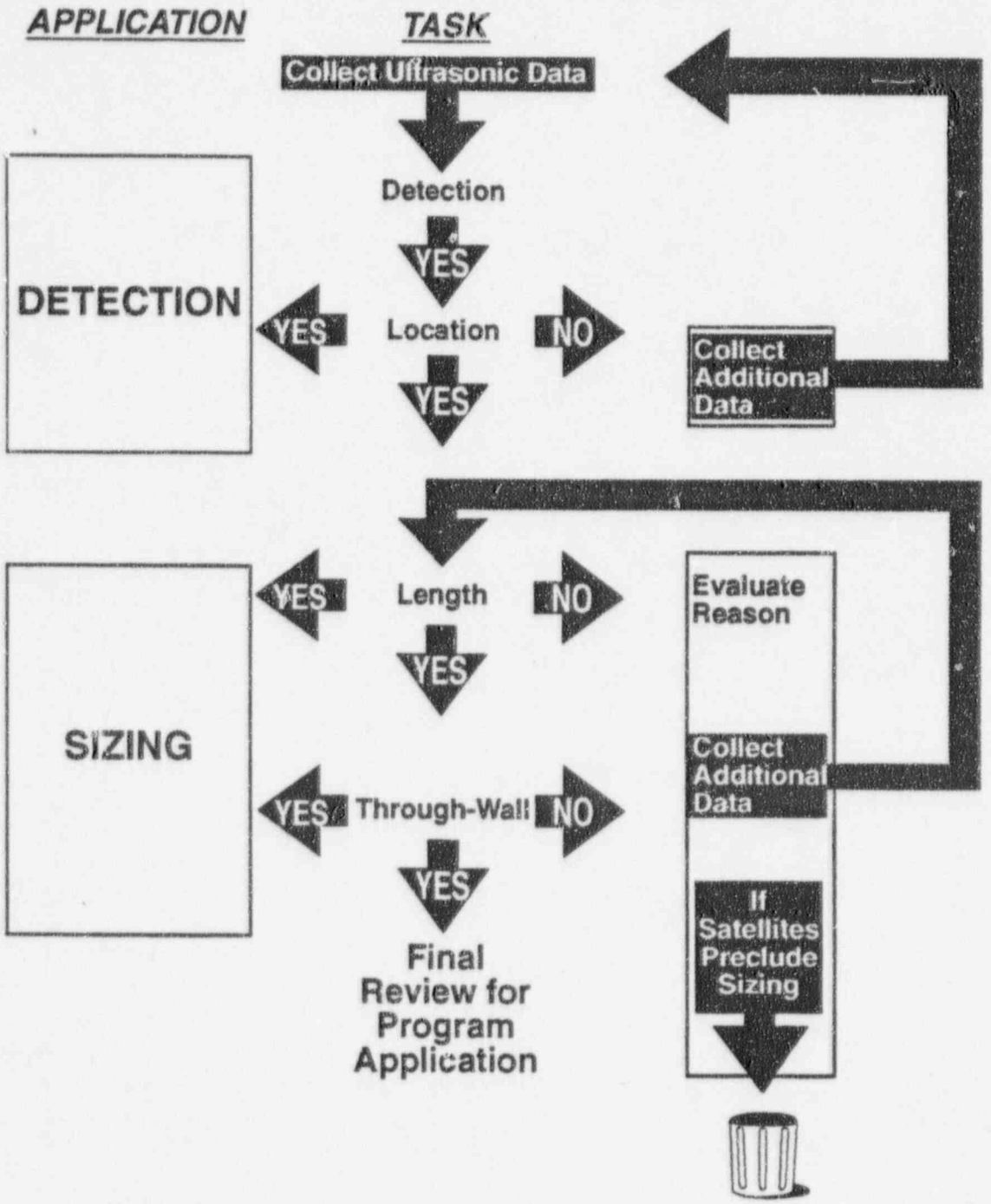
Receipt Inspection by EPRI

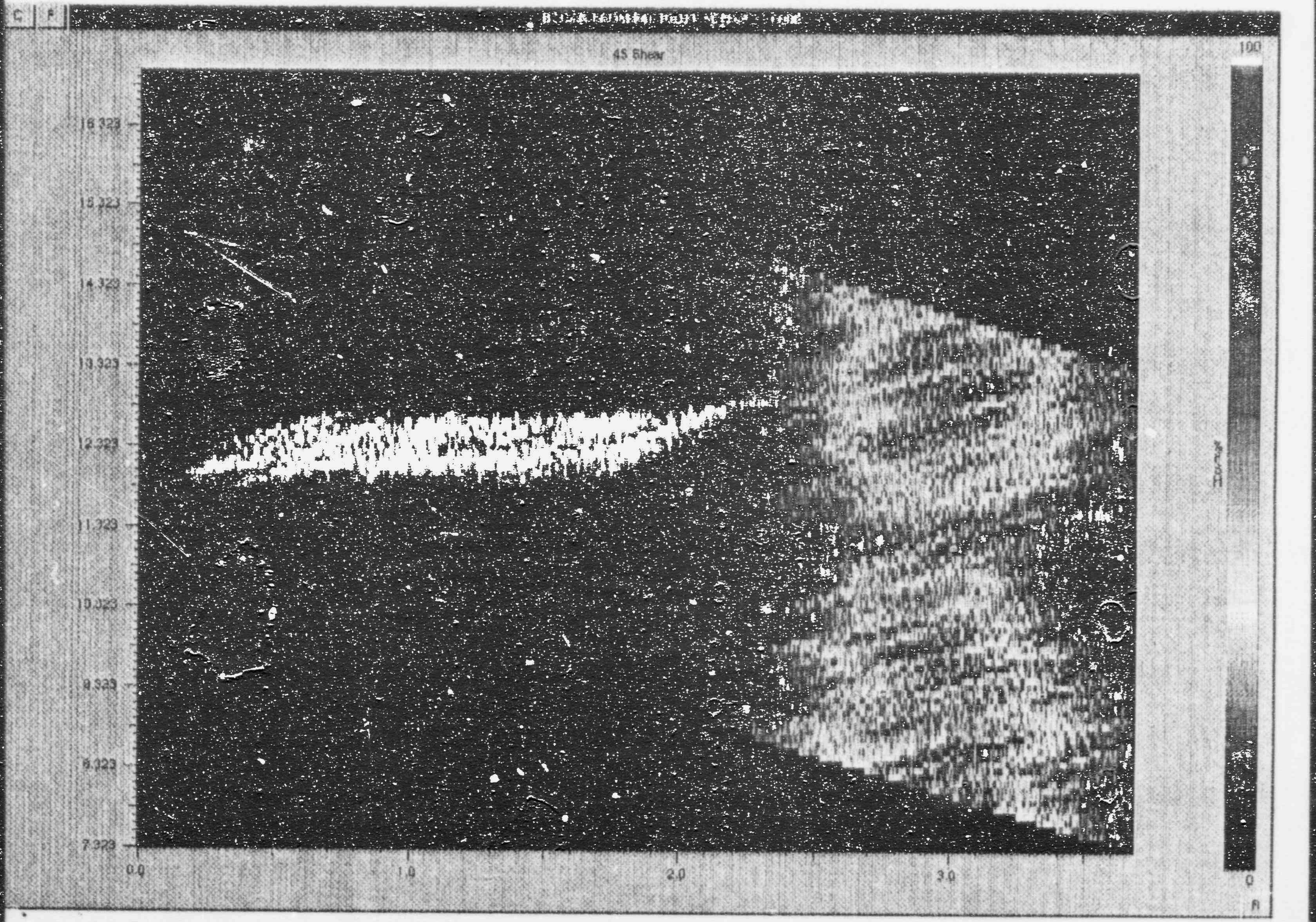
- Visual Inspection
- Review Manufacturing Records
  - Line by Line Review of All Fabrication Records
  - Fabrication Records Are Used to Establish Flaw Truth Tables
- Develop Dimensional Certificate of Conformance
- Prepare Application Drawings
- Ultrasonic Fingerprint

Ultrasonic Fingerprint

- Very High Sensitivity and Scan Resolution
- Objective's
  - Specimen Quality Meets PDI Specifications
  - Unintentional Indications Do Not Preclude Satisfactory Performance Demonstration
    - Signals Do Not Draw Attention to A Flaw and/or Signals Should Not Be Interpreted as Flaw Tips
  - Flaw is Suitable for Test Sets

PDI Specimen Ultrasonic Fingerprint




45 Shear
16.323
15.323
14.323
13.323
12.323
11.323
10.323
9.323
8.323
7.323
0.0
1.0
2.0
3.0
100
0

MAG 1M
8003
12003
15003
45 Shear
100
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PDI RPV Specimen Summary

- Meet All ASME Section XI, Appendix VIII Requirements
- Apply to Most Utility Applications
- Full Size and Contain Realistic Flaws
- Manufactured to Highest Quality Requirements
- Provide Diverse and Challenging Test Sets

PERFORMANCE
DEMONSTRATION PROGRAM

PDI, EPRI AND NRC
DISCUSSIONS
APRIL 23-24 1997

PROGRAM OBJECTIVES

- Uniform implementation of a high quality program
- Reduced cost through pooling of resources
- Maintain competitive environment for ISI vendors
- Provide focal point for communications with NRC and others

PDI PROGRAM TIMELINE

- Ad Hoc Committee established in 1989
- PDI established Jan. 1991
- 5 year funding Funding utilities 91-96,
- Presentation of PDI plans and schedules to NRC, Feb. 1991
- NRC requests accelerated implementation (complete by 1995), 1991
- Piping demonstrations start April 1994

PDI PROGRAM TIMELINE

- First RPV demo Nov. 1994
- NRC Assessment Jan. 1995
- Assessment Report Aug. 1995
- NRC/PDI Coordination meeting March 96
- NRC Accepts PDI for IGSCC Qualification March 1996
- Four Assessment Items remain open
- Three Party Agreement terminated Jan 1997

PDI PROGRAM STATUS

- Piping Supplements 2 & 3 fully implemented, 330 Candidates 292 Qualified
- Overlay Supplement 11 implemented with exceptions
- Bolting Supplement 8 fully implemented
- RPV Supplements 4&6 fully implemented 5 Vendors and 50 Analysts qualified
- Manual RPV qualifications initiated

PDI PROGRAM STATUS

- Program and Samples ready for Nozzle Supplements 5&7: activity on hold as a result of regulatory uncertainty
- IGSCC Piping demos transitioned to PDI
- PDI qualified RPV are being attempted, meeting with acceptance difficulty

PROGRAM DESCRIPTION DOCUMENT (PDD)

- Objective
  - Provide Utilities a line-by-line comparison between Appendix VIII and the PDI implementation of Appendix VIII
  - The document would be referenced by utilities in their Inspection programs
- Experience
  - The 89 version of Appendix VIII required many revisions

PDD continued

- Code Cases and Code Revisions presented to ASME
- Most have been accepted and incorporated
- Program Description Document (PDD) developed to assure all parties are aware of the program program actually being implemented.
- First efforts identified sample fabrication, and administration problems with appendix VIII

PDD continued

- Rev 0 September 1994 addressed:
  - Sample fabrication requirements and tolerances
  - Piping flaw length acceptance criteria
  - RPV length and depth acceptance criteria
  - Administrative details
- Rev 0 Basis for 1995 NRC Assessment

PDD continued

- Code Revisions
  - 15 Code revisions or Code Cases processed and accepted
  - Addresses most but not all of the Rev 0 differences
- Rev 1: based on RPV experience
- Rev 1 Change 1, incorporated BWROG Overlay program

PDD REV. 1 CHANGE 1-SUMMARY

- **SUPPLEMENT 2**
  - Revisions incorporated to maintain security of IGSCC samples
- **SUPPLEMENT 4**
  - Personnel demonstration will include a distribution of flaws size, orientations, and locations

PDD REV. 1 CHANGE 1-SUMMARY

- Supplement 4 continued
  - Flaws less than 50% of IWB-3500 not scored for detection
  - Combined Supplement 4 & 6 personnel examinations allowed
  - Flaw location tolerance of Code Case

PDD REV. 1 CHANGE 1- SUMMARY

- **SUPPLEMENT 5**
  - Adopted Code Case N-552 for examination from outside surface
  - For examination from inside surface:
    - Personnel qualification not required where techniques are the same as Supplement 4
    - Allowed false calls as in Code Case N-552

PDD REV. 1 CHANGE 1- SUMMARY

- **SUPPLEMENT 6**
  - Same revisions as Supplement 4
  - Plus allowed that all flaws between 50 and 100% of IWB are counted as detection flaws without regard to position in Table VIII-S6-1

PDD REV. 1 CHANGE 1- SUMMARY

- **SUPPLEMENT 7**
  - PDI will implement clad to base metal portion only, of Supplement 7
  - Personnel qualifications not required where techniques are same as Supplement 4
  - Procedure qualification will exceed the Code minimum requirements.

PDD REV. 1 CHANGE 1- SUMMARY

- **SUPPLEMENT 8**
  - Meets or exceeds Code requirement for personnel qualifications
  - Incorporated Code Case N-457, (notch location)
- **SUPPLEMENT 11**
  - Overlay added, Sample requirements and acceptance criteria are from the BWROG IGSCC Program.

PDD REV. 1 CHANGE 1- SUMMARY

- **SUPPLEMENT 12**
  - Added clarifications
  - Added combined length and depth sizing as revised by 95 & 96 Code Addenda

CODE ACTIVITIES

- Rewrite of Appendix VIII in progress
  - Separation of personnel and procedure Qualifications
  - Incorporation of Code Cases
  - Incorporation of differences between PDD and Code
  - Clarifying procedure requirements and essential variables

CLOSURE OF OPEN ITEMS

- 95-01-4 Demonstration of each technique described in procedure
- 95-01-09: Number of IGSCC and far side flaws in personnel demonstrations

TECHNICAL BASIS FOR RPV DESIGN

- Key design criteria for samples:
  - Sound material representative of PWR and BWR fabrication
  - Sample matrix to meet needs of all utilities
  - Representative conditions e.g. curvature, geometry, roughness, material type
  - Sufficient for sample diversity and security
  - Code Compliant

TECHNICAL BASIS FOR RPV

- Key sources of information:
  - Sample and weld geometry determined by survey of installed configurations,
  - Realistic flaw types and responses
    - PISC II and III
    - Under-Clad cracking experience TR NP2841
    - Destructive evaluation of Midland RPV samples TR102074

TECHNICAL BASIS FOR RPV FLAWS

- Crack tip radius less than 20 micron
- Notches will be held to absolute minimum
- Ultra-clean welds are required around flaws
- Imbedded flaws are fabrication type flaws
- Flaw tilt up to typical weld prep angles
- Typical flaw roughness required
- Conservative aspect ratios used, i.e. short