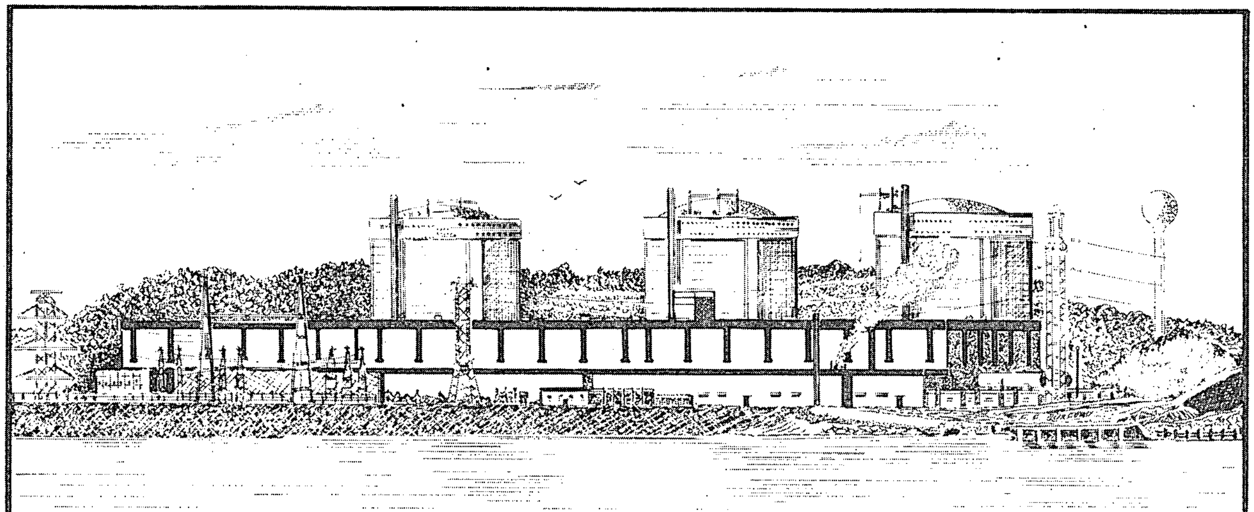

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DUKE POWER COMPANY
OCONEE NUCLEAR STATION
UNIT 2

Summary Report of the
10-Year Inservice Inspection
of
Reactor Vessel Welds

Report No.: 4
Assigned To: R.L. Gill

OCONEE NUCLEAR STATION
UNIT 2
MARCH 1982 REACTOR VESSEL REPORT

599-0442-14-08

Located At: Seneca, South Carolina

OWNER: Duke Power Company
P. O. Box 33189
Charlotte, NC 28242

Prepared By: P. L. Pitz — May 25, 1982
P. L. Pitz, Inspection Engineering, SPIS — Date
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Reviewed By: M. G. Hacker — May 25, 1982
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Duke Power Company
Oconee Nuclear Station
Unit 2

Summary Report of the 10-Year Inservice Inspection
Of Reactor Vessel Welds

Introduction

This report summarizes the 10-year inservice inspection (ISI) of the reactor vessel welds at Duke Power Company's Oconee Unit #2 Nuclear Station. The inspection was performed during January and February 1982. The reactor vessel weld inspection is only a portion of the total 10-year ISI that is being conducted. A report addressing all ISI inspections will be issued upon completion of the inservice inspection activities.

Background

The 10-year ISI of Oconee 2 was in the planning stage for many months prior to the start of the outage. In early 1981, significant efforts were started to support the upcoming Oconee reactor vessel inspections. Regulatory concerns relative to reactor vessel pressurized thermal shock and the draft Regulatory Guide addressing the ultrasonic testing of reactor vessel welds were primary items to be incorporated into the inspection program.

With regard to reactor vessel pressurized thermal shock, Duke decided to conduct a vessel examination that would reliably indicate the structural integrity of the beltline region welds. Further, being aware of the draft regulatory guide and its schedule for issuance, Duke determined that the requirements of the guide should be addressed and implemented where practical and technically justifiable. To this end, after several meetings with B&W, the Oconee NSSS vendor, and reactor vessel examiner, Duke met with the NRC on March 24, 1981, to discuss the proposed Oconee reactor vessel inservice inspection program. The results of the meeting were used in the preparation of the final examination plan which is described in the next section.

Examination Plan

The Oconee Unit 2 reactor vessel examination was performed in accordance with the requirements of the 1977 Edition of the ASME Boiler and Pressure Vessel Code, Section V, Article 4 with Addenda through the Summer of 1978. The recommendations of Regulatory Guide 1.150, "Ultrasonic Testing of Reactor Vessel Welds during Preservice and Inservice Examinations", were also satisfied to the extent possible, considering hardware, schedule, and engineering concerns.

The volume examined meets or exceeds the minimum requirements of the 1974 Edition of Section XI of the ASME Boiler and Pressure Vessel Code with Addenda through the Summer of 1975. The reactor vessel welds were prioritized in order to ensure that the minimum Code required examination would be performed and that the maximum lead time would be available in the event a flaw was detected which required a fracture mechanics analysis. A total of two outlet, four inlet, and two core flood nozzle to vessel welds and nozzle inside radius sections were examined 100% of the weld length. Four of the six circumferential vessel welds were examined 100% of the weld length. The two exceptions were the lower head to dutchman weld, which is located in the lower head, and the upper nozzle belt to lower nozzle belt, which is located in the center of the nozzle belt. Only 5% of these weld lengths were examined.

These examinations were performed using the Automated Reactor Inspection System (ARIS) tool (See Figure 1). Different inspection angles (0° long wave; 45°,60°,70° shear wave) were used to perform these examinations. An additional circumferential weld located in the reactor vessel closure head was also examined; however, conventional manual contact examination techniques were used on this weld.

Special emphasis was directed to flaw detection at the I.D. surface. The ARIS inspection tool utilizes immersion ultrasonic examination techniques, whereby many of the variables which usually limit or preclude an effective examination of the near surface (I.D.) can be eliminated. The techniques used for this examination provide qualified sensitivity to reliably detect flaw sizes consistent with those identified in the acceptance standards of IWB-3500 of ASME Section XI. The area examined with the near surface technique (seventy degree transducer) on each side of the weld was approximately equal to 1.8T when scanning perpendicular to the weld and .75T when scanning parallel to the weld (see Figure 2). This is substantially more than required by Code in the beltline region.

Figure 3 identifies the reactor vessel and closure head welds examined in accordance with Regulatory Guide 1.150. Each weld location number identified in this figure corresponds to a figure number as identified in Table 1, Weld Examination Summary. Evaluation reports which are referenced in Table 1 for specific figure numbers are included in Appendix A as supporting documentation.

Examination Results

A total of four (4) indications were recorded, all of which were acceptable to the Section XI evaluation criteria when measured with Section XI sizing requirements. There was one indication detected with the sixty degree transducer which did not meet the acceptance standards of Section XI IWB-3500 when measured with Reg Guide 1.150 sizing requirements. This indication is acceptable by analysis, however, in accordance with IWB-3600.

The indication detected with the seventy degree transducer is a small localized indication which could be either slag or a spot of porosity produced in the manufacturing process.[1]

The two indications detected with the sixty degree transducer are subsurface reflectors and could not be correlated to baseline reflectors.

The indication detected with the forty-five degree transducer is a subsurface reflector and could not be correlated to any baseline reflector.

Flaw sizing and location data are documented in Figures 4, 5, and 6.

The 70° flaw sizing techniques used were applied to a calibration notch in a nine inch calibration standard which is 0.20 inches in the through wall direction, starting at the clad base metal interface and penetrating into the base material. The notch is perpendicular to the clad surface of the calibration block. The results are that at 50% DAC, the recorded size of the simulated flaw is 0.25 inches. This represents a recorded dimension 25% greater than actual flaw size. At 20% DAC, the recorded size of the simulated flaw is 0.60 inches, which represents a recorded size 300% greater than actual flaw size. The data suggests that indications sized to the examination technique are conservative measurements and actual flaw size would be less than the recorded flaw size.

Direct correlation can not be made between the observed indications and the baseline data due to the many differences in test variables between the type of examination performed for the baseline and that performed during this examination. The major variables include the manual contact examination technique versus automatic immersion technique; baseline examination requirements versus current examination requirements; and calibration blocks used for baseline versus calibration blocks used for this examination.

(1) See Table 1 - Weld Examination Summary

Summary

The indications recorded during the examination were evaluated to be manufacturing-induced. Based on the examination performed, there is no evidence of any service-induced flaw in the Oconee Unit 2 vessel. Specifically, the examination has provided a high degree of confidence in the beltline region in that there are no surface flaws in the pressure retaining material that exceed 0.15 inches.

M. G. Hacker

M. G. Hacker
Level III

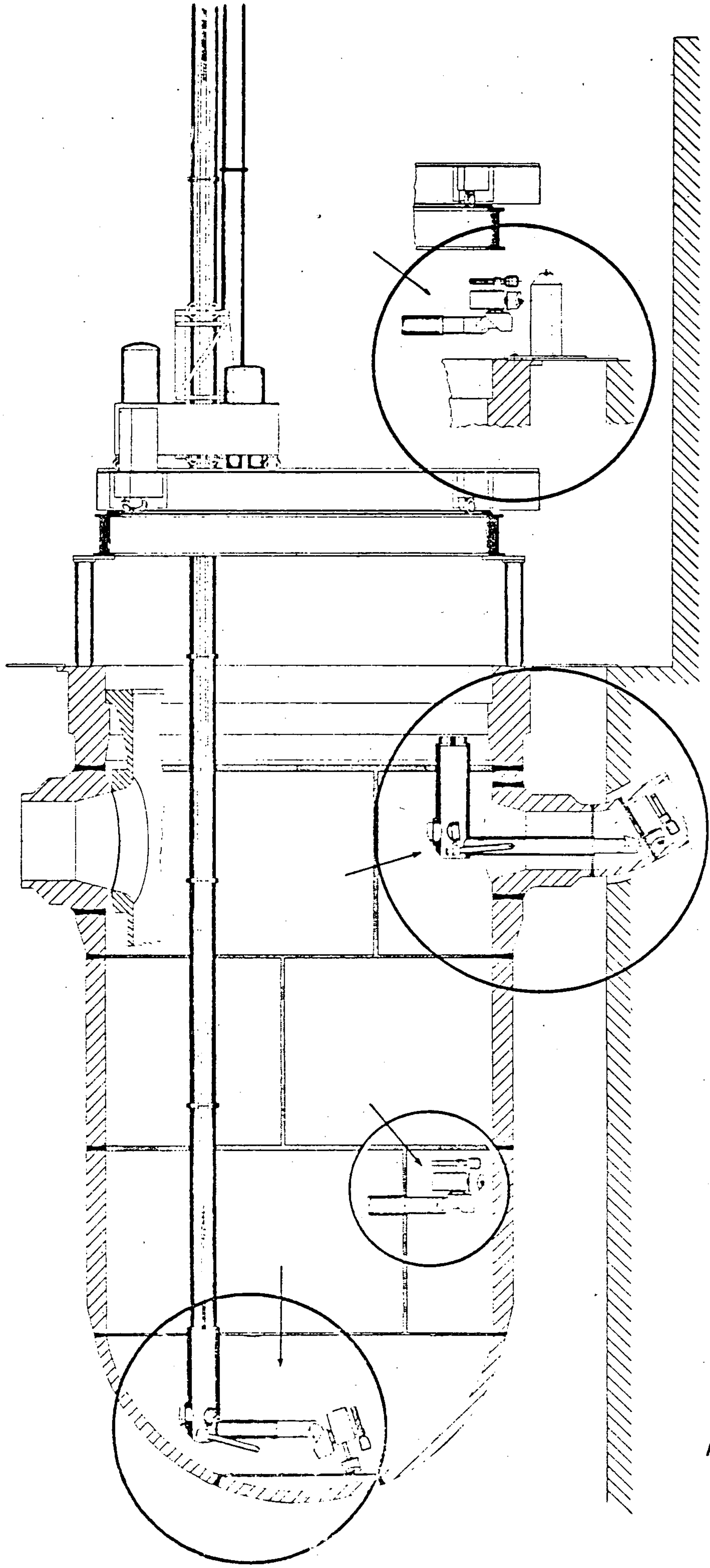
TABLE 1

Weld Examination Summary

Weld Location Number	Description	Weld ID #	Number of Flaw Indications Laminar/Planar**	Figure Number
1	Inter Shell to Lower Shell	WR1	None	B1.01.001
2	Upper Shell to Inter Shell	WR1A	None	B1.01.002
3	Transition to Lower Shell	WR34	0/3	*B1.02.001
4	Lower Head to Transition	WR35	None	B1.02.002
5	Lower Nozzle Belt to Upper Nozzle Belt	WR18	None	B1.02.003
6	Upper Nozzle Belt to RV Flange	WR19	0/1	*B1.03.001
7	Core Flood Nozzle to RV (W Axis)	WR54	None	B1.04.001
8	Core Flood Nozzle to RV (Y Axis)	WR54A	None	B1.04.002
9	Inlet Nozzle to RV (W-X Axis)	WR12	None	B1.04.003
10	Inlet Nozzle to RV (X-Y Axis)	WR12A	None	B1.04.004
11	Inlet Nozzle to RV (Y-Z Axis)	WR12B	None	B1.04.005
12	Inlet Nozzle to RV (Z-W Axis)	WR12C	None	B1.04.006
13	Outlet Nozzle to RV (X-Axis)	WR13	None	B1.04.007
14	Outlet Nozzle to RV (Z-Axis)	WR13A	None	B1.04.008
15	RV Head/Flange to Head	WH7	None	B1.03.002
16	Core Flood Nozzle to Safe End (W-Axis)	WR53	None	B4.01.051/051A
17	Core Flood Nozzle to Safe End (Y-Axis)	WR53A	None	B4.01.053/053A

* Refer to Volumetric Examination Evaluation Reports included in Appendix A as supporting documentation.

** An indication is considered to be laminar if it is oriented on a plane within 10 degrees of being parallel to the component surface.
An indication is considered planar if it is oriented in a single plane, other than parallel to the surface of the component.



ARIS II manipulator
Figure #1

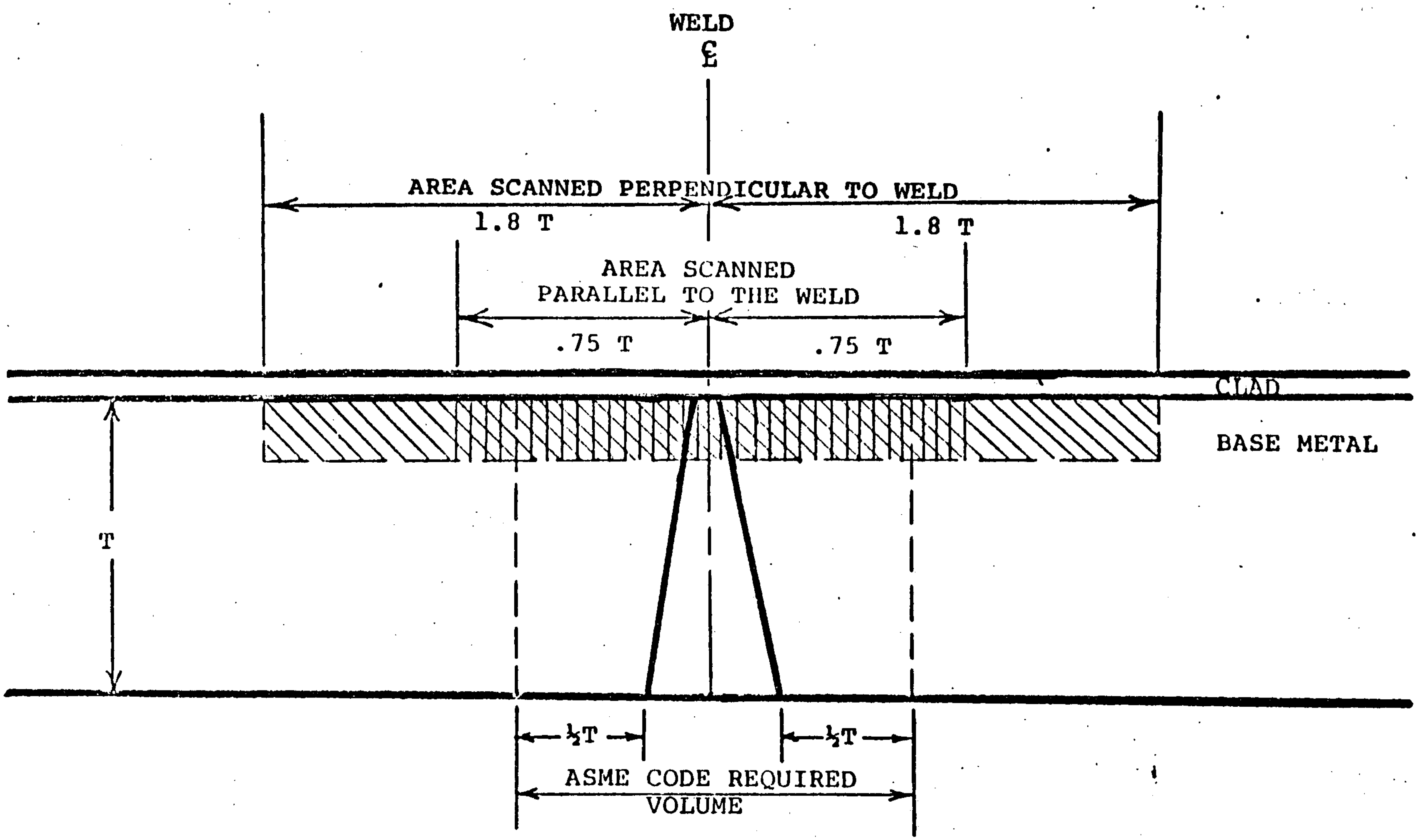


FIGURE #2

TYPICAL AREA SCANNED WITH NEAR SURFACE TECHNIQUE

OCONEE-2 REACTOR VESSEL

Figure #3

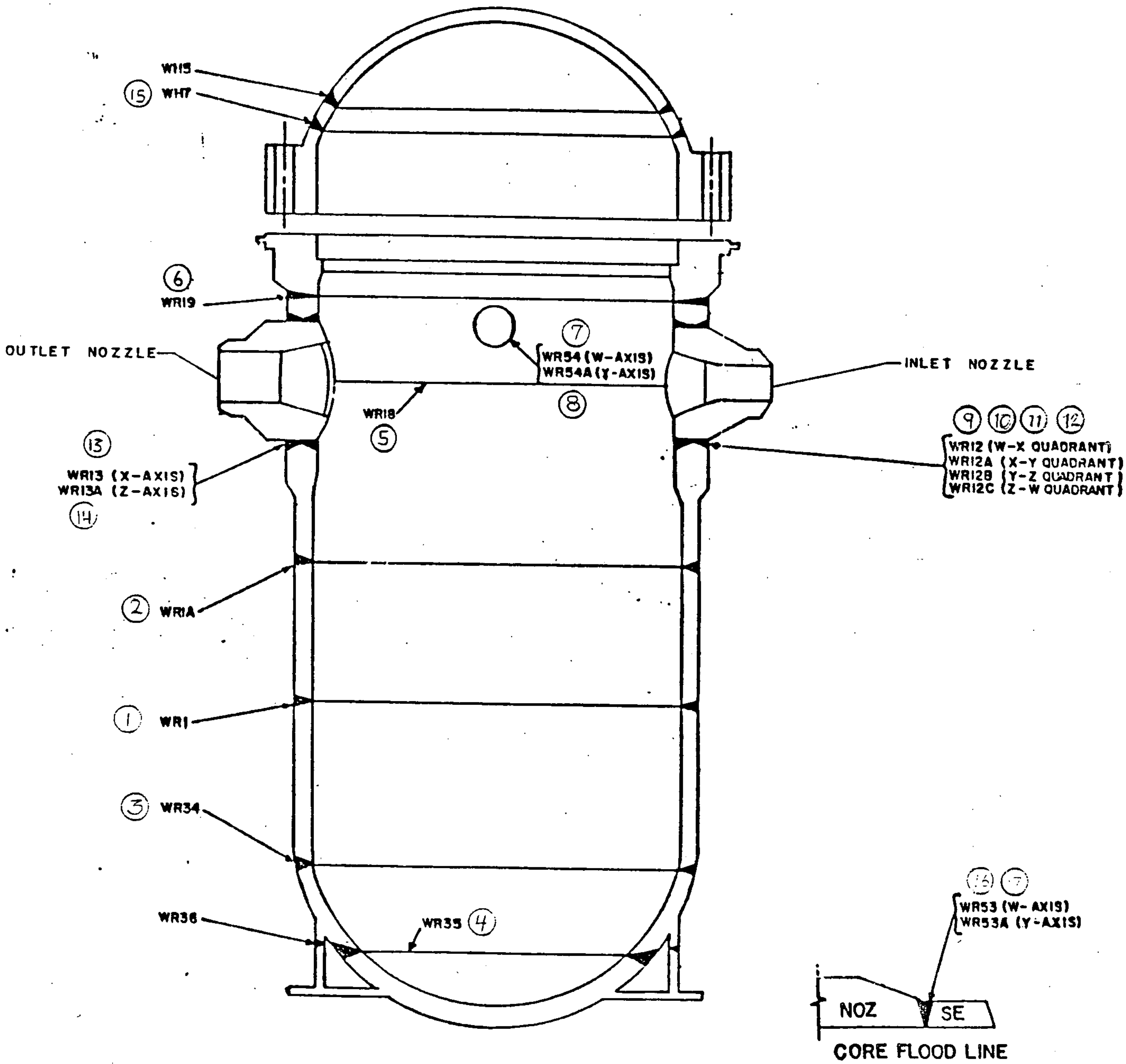


Figure Number	Indication	S	L	a	2a	a/L	t	a/t
B1.02.001	200	>a	0.45	0.10	0.20	0.22	4.6	2.2%
	400	>a	3.75	0.25	0.50	0.067	4.6	5.4%
	401	>a	1.95	0.05	0.10	0.026	4.6	1.1%
B1.03.001	600	>a	0.90	0.30	0.60	0.33	12.0	2.5%

$S \leq a$ --- Surface flaw

$S > a$ --- Subsurface flaw

The values for S, L, a, 2a, and t are in inches.
The values for L and a are at 20% DAC level.

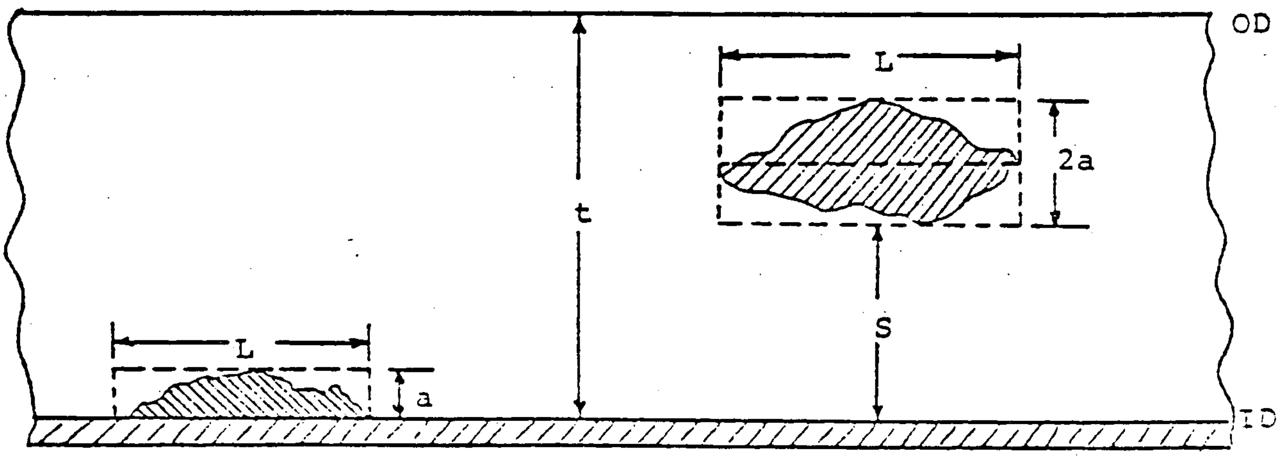
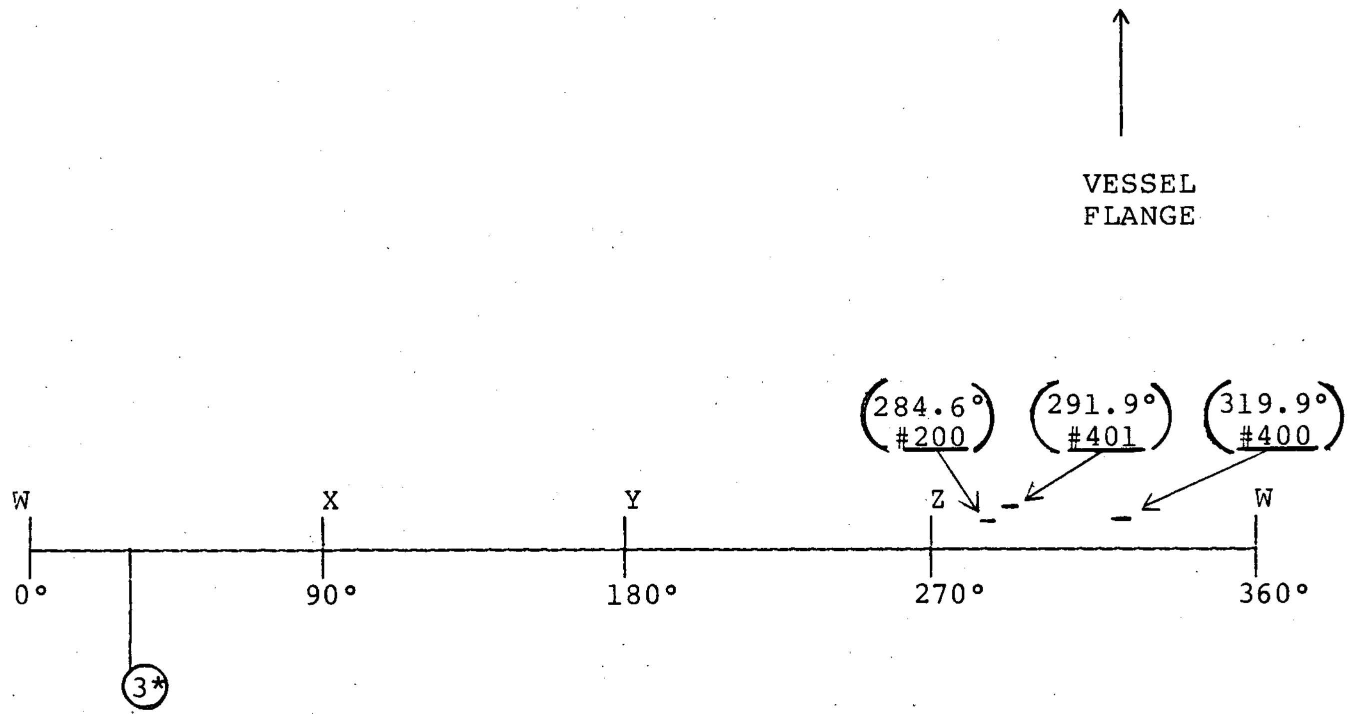


Figure 4. Flaw Sizing & Through Wall Location.

WELD ID: WR34
Figure Number: B1.02.001



* Solid line represents the weld centerline. 3 corresponds to the weld identification which is noted on Figure 3 and in Table 1.

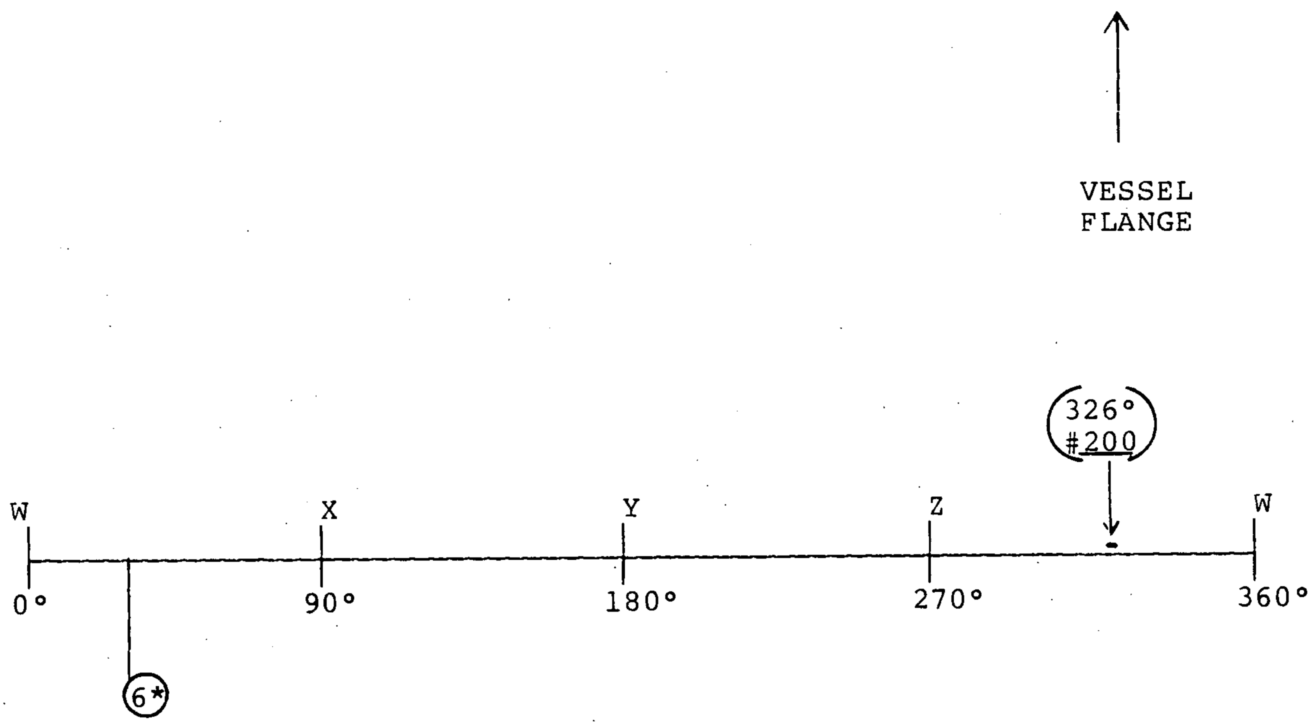
Indication #200 is located at 284.6 degrees and is approximately 6.9 inches from the weld centerline.

Indication #400 is located at 319.9 degrees and is approximately 7.4 inches from the weld centerline.

Indication #401 is located at 291.9 degrees and is approximately 10.4 inches from the weld centerline.

Figure 5. Weld WR34 Flaw Location.

WELD ID: WR19
Figure Number: B1.03.001



* Solid line represents the weld centerline. 6 corresponds to the weld identification which is noted on Figure 3 and in Table 1.

Indication #600 is located at 326 degrees and is approximately 1.5 inches from the weld centerline.

Figure 6. Weld WR19 Flaw Location.

APPENDIX A

EXAMINATION SUMMARY AND EVALUATION REPORTS

EXAMINATION SUMMARY

Figure or Item No.	Examination Status					Limited Exam		Remarks
	Recordable Yes	Recordable No	Indication Number(s)	Evaluation Report No.	Results	Yes	No	
B1.01.001		X					X	
B1.01.002		X					X	
B1.02.001	X		200,400,401	82-033	Acceptable*	X		Limited exam due to 12 guide lugs and 12 flow stabilizers
B1.02.002		X				X		Limited due to 12 flow stabilizers and instrumentation nozzles
B1.02.003		X					X	
B1.03.001	X		600	82-034	Acceptable	X		Limited due to flange configuration and flange taper
B1.04.001		X					X	
B1.04.002		X					X	
B1.04.003		X					X	
B1.04.004		X					X	
B1.04.005		X					X	
B1.04.006		X					X	
B1.04.007		X					X	
B1.04.008		X					X	

*All acceptable when sized in accordance with Section XI requirements; one is unacceptable when sized to Reg Guide 1.150 requirements, but acceptable to analysis.

EXAMINATION SUMMARY

Figure or Item No.	Examination Status					Limited Exam		Remarks
	Recordable		Indication Number(s)	Evaluation Report No.	Results			
	Yes	No				Yes	No	
B4.01.051		X					X	
B4.01.051A		X					X	
B4.01.053		X					X	
B4.01.053A		X					X	
B4.05.024		X					X	
B4.05.079		X					X	
B1.03.002		X				X		Limited due to lifting lugs, service structure mounts, axis indicator plaque, and configuration

BABCOCK & WILCOX
NUCLEAR POWER GENERATION DIVISION
VOLUMETRIC EXAMINATION EVALUATION REPORT

BWNP-20525-1(11-81)

EVALUATION NUMBER 82- 033

METHOD: UT ✓ RT ____

FILE NO. OR REFERENCE 0442-A.065

WELD NO. OR IDENTIFICATION: 2RPV-WR34

APPLICABLE CODE YEAR AND ADDENDA: 1977 Edition of Section XI thru the Summer of 1978 Addenda

DATE OF INITIAL EXAMINATION: Feb RE-EXAMINATION:

REPORTABLE INDICATION NUMBER(S): 200, 400, 401

COMMENTS:

ORIGINATOR: D. V. Ferre LEVEL: III DATE: Feb. 3, 1982

PRELIMINARY DISPOSITION

ACCEPTANCE STANDARD: IWB-3510-1

COMMENTS: Dimensions of flaws and calculated values are shown below.

Flaw No	TWD 20/20	TWD 50/50	TWD HMA	ℓ 20/20	ℓ 50/50	ℓ HMA	t	depth	a/ℓ at 20/20	a/t at 20/20	Disposition
200	0.20"	0	—	0.45"	0.15"	—	4.6"	3.0"	.22	2.2%	OK
400	0.50"	0.30"	0.20"	3.75"	3.0"	0	4.6"	3.8"	.067	5.4%	NOT OK
401	0.10"	0	—	1.95"	0.90"	—	4.6"	1.8"	.026	1.1%	OK

ALL FLAWS ARE SUBSURFACE, THEREFORE a = TWD/2.

☑ ACCEPTABLE INDICATION NUMBER(S) 200, 401

☑ REJECTABLE INDICATION NUMBER(S) 400 at 50/50 a/ℓ = .05, a/t = 3.3%, also NOT OK. At HMA it is OK.

LEVEL III: D. V. Ferre DATE: Feb. 23, 1982

FRACTURE MECHANICS ANALYSIS ☑ YES ☐ NO DOCUMENT NUMBER 32-1131835-00

FINAL DISPOSITION

COMMENTS: Indication #400 was evaluated by the stress intensity factor method described by Appendix A of Section XI. This evaluation shows that flaw indication #400 is acceptable.

☑ ACCEPTABLE INDICATION NUMBER(S) 200, 400, 401

☐ REJECTABLE INDICATION NUMBER(S)

LEVEL III: M. G. Hochen DATE: March 23, 1982

FIGURE NO. B1.02.001

Babcock & Wilcox   Nuclear Power Generation Division

BWNP-20553 (7-8

To: FILE	
From: D. V. FERREE, LEVEL III, UT	Customer or File
Subject: EVALUATION OF FLAW 400, FIGURE B1.02.001	Date: 3/22/82

To make sure that all interested parties understand the UT evaluation, these additional comments are offered.

The ASME Code, 1977 Edition through 1978 Summer Addenda requires that flaws exceeding 100% DAC must be sized at one-half maximum amplitude. The comparison to Code acceptance standards is then done with these dimensions. For Flaw 400, evaluation to the Code acceptance standards with the Code sizing requirements results in a Code acceptable flaw.

Regulatory Guide 1.150 requires, however, that flaws be sized at 50% DAC and 20% DAC. It then permits reduction of the 20% DAC measurements by a beam spread correction at 20%. Evaluation is made by comparing the smaller of these two sizing methods to the acceptance standards in Section XI. Flaw 400 fails this criterion.

To reiterate, Flaw 400 is acceptable to the Code; it is not acceptable to the Code acceptance standards when measured in in accordance with Regulatory Guide 1.150.

D. V. Ferree

D. V. FERREE

PULSE

BABCOCK & WILCOX
NUCLEAR POWER GENERATION DIVISION

B&W NP-20525-1 (11-81)

VOLUMETRIC EXAMINATION EVALUATION REPORT

EVALUATION NUMBER: 82- 034

METHOD: UT ✓ RT ____

FILE NO. OR REFERENCE: 0442-A.065

WELD NO. OR IDENTIFICATION: 2RPV - WR19

APPLICABLE CODE YEAR AND ADDENDA: 1977 Edition of Section XI thru the Summer of 1978 Addenda

DATE OF INITIAL EXAMINATION: Feb. 3, 1982 RE-EXAMINATION: ____

REPORTABLE INDICATION NUMBER(S): ~~PP~~ ~~200~~ 600

COMMENTS: ____

ORIGINATOR: D. V. Ferree LEVEL: III DATE: Feb. 4, 1982

PRELIMINARY DISPOSITION

ACCEPTANCE STANDARD: IWB- 3510-1

COMMENTS: Figure 1 shows the flaw location. The relevant dimensions of flaw 600 ~~200~~ follow:

TWD (20/20 DAC)	TWD (50/50 DAC)	l (20/20 DAC)	l (50/50 DAC)	t (in)	depth (in)	a/l (20/20 DAC)	a/t % (20/20 DAC)
0.6"	0.2"	0.9"	0.2"	12"	2.2"	0.33	2.5%

Since flaw is clearly acceptable at 20/20 DAC dimensions, it will be acceptable at 50/50 DAC. Flaw is acceptable.

☑ ACCEPTABLE INDICATION NUMBER(S) ~~200~~ 600

☐ REJECTABLE INDICATION NUMBER(S) ____

LEVEL III: D. V. Ferree DATE: Feb. 4, 1982

FRACTURE MECHANICS ANALYSIS ☐ YES ☑ NO DOCUMENT NUMBER ____

FINAL DISPOSITION

COMMENTS: ____

☑ ACCEPTABLE INDICATION NUMBER(S) 600

☐ REJECTABLE INDICATION NUMBER(S) ____

LEVEL III: M. G. Hacker DATE: Feb 11, 1982

FIGURE NO. B1.03.001