FORD 1

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RECIP. NAME RECIPIENT AFFILIATION
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SUBJECT: Forwards description of bases which util believe provides info to indicate condition stipulated by NRC 910514 SER of relief request from Code re RV core flood, inlet & outlet nozzel to pipe welds submitted 8410913 satisfied.

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RIDS/FORD 1 DOCUMENT

Attached is a description of the bases which we believe provides the necessary information to indicate the condition stipulated by the Safety Evaluation Report is fully satisfied. In terms of overall safety, we believe the capability to detect and size defects by the volumetric, ID examination technique, is adequate for the welds addressed in our relief request. It is requested NRC reconsider the position presented in Mr. Naujock's trip report, taking into consideration the attached information.

If discussion is needed to clarify this information, then Duke, with input from the B&W Owners Group, will be more than willing to participate in a phone conference to resolve this item.

The Oconee Unit 3 EOC 14 refueling outage is scheduled to begin December 28, 1993. This outage is the last scheduled outage for this Unit during the current Inservice Inspection interval. In order to support this outage, a resolution is needed to allow adequate time, if necessary, to explore other options or to plan the necessary work activities to perform the surface examination during the outage.

If you have questions or need further information you may contact D. W. Dalton at (803) 885-3372.

Very truly yours,

for J. W. Hampton
Site Vice President

Attachment

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ATTACHMENT 1

13 PAGES

BACKGROUND:

In May, 1985, the Babcock & Wilcox Company performed the ten-year reactor vessel examination at the Florida Power Corporation, Crystal River Unit-3, Nuclear Power Station. These examinations were conducted using the B&W Automated Reactor Inspection System (ARIS-II) utilizing immersion ultrasonic examination methods. Included in this examination were the core flood nozzle to safe-end welds. The examinations performed on the safe-end welds were in accordance with the ASME Code, Section XI, 1974 Edition with Addenda through the Summer 1975. Section XI, Table IWB-2500, Category B-F requires that the safe-end welds receive both a volumetric examination and a surface examination. The volumetric requirement was satisfied with the ultrasonic examination performed during the ten-year reactor vessel examination from the pipe ID. This examination encompassed the full thickness of the pipe wall, including the weld and base metal adjacent to the weld material for a distance of one pipe wall thickness. No recordable indications were detected. Although the volume examined included the area required to be examined by a surface examination method, the UT examination does not directly satisfy the Code requirement to perform the surface examination. However, the Code allows unacceptable indications which have been detected by surface examination methods to be dispositioned by the use of ultrasonic examination. This forms the basis for the B&WOG demonstration to satisfy the B&W Owners relief request.

Florida Power Corporation estimated that over 2,000 manhours and 5 man-rem were used for inspection and support for the performance of the surface examination for each of these welds from previous inspections. Because of the associated cost to perform examinations and the high radiation levels at these weld locations, Florida Power submitted a Request for Relief to the NRC requesting that the required surface examination be waived in lieu of the 1985 ultrasonic examination of the OD surface performed from the ID surface during the ten-year reactor vessel examination.

1989 DEMONSTRATION:

Subsequently, Florida Power Corporation decided to benchmark and demonstrate the detection capabilities for opposite surface (OD)

initiating reflector's to justify their Request for Relief for the examination performed in 1985. The benchmark and demonstration included the various materials involved in the core flood nozzle to safe-end weld joint configuration and the examination method used during the 1985 examination of these welds. Florida Power Corporation asked B&W to include the benchmark of current state-of-the-art UT technology and automated equipment in order to justify the Request for Relief for future examinations.

In order to benchmark the detection capabilities of the ultrasonic examination of the core flood safe-end weld, a mockup, Figure 1 of the weld joint was designed and fabricated. Included in this mockup were EDM notches which were used to establish the detection capabilities of the UT process. There were four sets of four circumferential notches each on the OD surface of the mockup. Each set contained one notch located in the austenitic clad ferritic nozzle base metal, one in the inconel buttering, one in the inconel weld and one in the austenitic safe-end steel base metal. Each set of notches were machined to a different depth. The sets of notches are 0.034, 0.084, 0.169 and 0.235 inches deep. Figure 2 depicts the mockup weld joint configuration with the notch locations distributed throughout the different materials.

Table 1 compares the reflector evaluations to the IWB-3514 acceptance standards for these demonstrations.

TABLE 1
CORE FLOOD SAFE-END WELD MOCKUP
IWB-3514 REFLECTOR EVALUATIONS

NOTCH	LENGTH (l) Inches	DEPTH (a) Inches	a/l	a/t%	ALLOWABLE a/t%
Nozzle	1.00	0.034	0.034	2.6	10.0
Buttering	1.00	0.034	0.034	2.3	10.4
Weld	1.00	0.034	0.034	2.3	10.4
Safe-end	1.00	0.034	0.034	2.3	10.4
Nozzle	1.00	0.084	0.084	6.4	10.4
Buttering	1.00	0.084	0.084	5.6	10.6
Weld	1.00	0.084	0.084	5.6	10.6
Safe-end	1.00	0.084	0.084	5.6	10.6
Nozzle	1.00	0.169	0.169	12.9	13.2
Buttering	1.00	0.169	0.169	11.3	10.9
Weld	1.00	0.169	0.169	11.3	10.9
Safe-end	1.00	0.169	0.169	11.3	10.9
Nozzle	1.00	0.253	0.253	19.3	14.6
Buttering	1.00	0.253	0.253	16.9	11.2
Weld	1.00	0.253	0.253	16.9	11.2
Safe-end	1.00	0.253	0.253	16.9	11.2

The thickness = 1.31 inches for the austenitic clad ferritic material and 1.50 inches for the buttering, weld and austenitic safe-end material.

From this table it can be seen that success in detection was demonstrated for simulated flaws that were less than that allowed in IWB-3514.

The UT examination technique utilized in 1985 consisted of a 45° shear wave, immersion scan which was used for the examination of the core flood nozzle to safe-end welds, demonstrated the detection capability of detecting opposite surface planar reflectors equal to or greater than 0.034 inches through-wall in the austenitic clad ferritic material, the inconel buttering material and the austenitic safe-end material.

In addition to the 45° shear wave, a 45° longitudinal wave technique was demonstrated to support future Relief Requests. This technique demonstrated detection capability of opposite surface initiating planar reflectors that were equal to or

greater than 0.034 inches in through-wall in all materials of the mockup.

In addition to the core flood nozzle to safe-end weld examinations, the capabilities of opposite surface (OD) planar reflectors was demonstrated for the reactor coolant nozzle to pipe, Category B-J welds. This demonstration was performed using an ID austenitic clad ferritic test block containing EDM notches ranging from 0.024 to 0.353 inches in through-wall dimension, see Figure 3.

Table 2 compares the reflector evaluations to the IWB-3514 acceptance standards for the reactor coolant nozzle to piping welds.

TABLE 2
REACTOR COOLANT NOZZLE TO PIPING WELDS
IWB-3514 REFLECTOR EVALUATIONS

NOTCH	LENGTH (l) Inches	DEPTH (a) Inches	a/l	a/t%	ALLOWABLE a/t%
A	0.380	0.125	0.33	5.2	13.8
B	0.375	0.062	0.17	2.6	10.9
C	0.376	0.024	0.06	1.0	8.6
D	0.623	0.251	0.40	10.5	13.8
E	0.623	0.124	0.20	5.2	11.7
F	0.623	0.050	0.08	2.1	9.1
G	0.826	0.175	0.43	14.7	13.8
H	0.826	0.175	0.21	7.4	12.0
I	0.826	0.043	0.05	1.9	8.6
J	0.375	0.130	0.35	5.4	13.8
K	0.376	0.065	0.17	2.7	10.9
L	0.374	0.031	0.08	1.3	9.1
M	0.624	0.255	0.41	10.6	13.8
N	0.625	0.129	0.21	5.4	12.0
O	0.627	0.054	0.09	2.3	9.2
P	0.826	0.352	0.43	14.7	13.8
Q	0.823	0.177	0.22	7.4	12.3
R	0.825	0.072	0.09	3.0	9.2

Thickness = 2.40 inches.

Again success in detection was demonstrated for simulated flaws less than the allowable in IWB-3514.

Opposite surface (OD) planar reflector detection equal to or greater than 0.024 inches in through-wall dimension were demonstrated.

Mr. Jim Coley representing Region 2 of the NRC attended the demonstration of these technique capabilities at the BWNT Lynchburg facilities in August 1989.

Florida Power Corporation was granted relief from performing the surface examinations for their current interval, provided that they demonstrate the planar flaw detection and sizing capability prior to the end of the next interval. This established the basis for the B&WOG 1993 demonstration for examining the component OD surface from the ID using automated techniques.

1993 B&WOG Demonstration Objective:

Present versions of ASME Boiler and Pressure Vessel Code Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components require outside diameter (OD) surface examination of Examination Category B-F and B-J welds ≥ four inch nominal pipe size. The Babcock and Wilcox (B&W) designed plants have approximately 10 welds of these types located inside the reactor vessel primary shield wall. Access to these welds for an OD surface examination requires removal of shielding and insulation along with surface preparation and examination resulting in significant personnel exposure, cost and possible increase in outage duration.

The B&W plant owners have separately requested relief from the surface examination requirements. However, all operating plants have the same materials and weld joint configurations. Full volumetric examination of these welds from the ID using ultrasonics was the proposed alternative examination. Using this technique, access to the welds is easily gained using the same inspection device used during the reactor vessel weld examinations. This approach results in almost negligible personnel exposure, associated costs and minimizes outage critical path duration.

The alternative examination approach has generally been acceptable to the NRC provided the licensee meets the following conditions that the NRC included in each plant's relief request:

(1) The remote volumetric examination includes the entire weld volume and heat affected zone instead of only the inner one-third of the weld.

(2) The ultrasonic testing instrumentation and procedures are demonstrated to be capable of detecting and sizing OD surface connected defects, in the circumferential orientation, in a laboratory test block. The defects should be cracks and not machined notches.

To address the requirement of demonstrating the detection capability of OD surface connected circumferential cracks the B&WOG NDE Committee fabricated two mockups containing OD surface connected thermal fatigue circumferential cracks.

The first mockup consisted of a 120° segment representing a reactor vessel outlet nozzle to pipe weld configuration similar to a B&W designed the 177 FA design. The outlet nozzle to pipe weld configuration was selected to demonstrate the technique based on the maximum thickness. This design consisted of a simulated ID austenitic clad ferritic nozzle welded to an ID clad ferritic piping section.

The second mockup consisted of a 360° core flood nozzle to safe-end weld and a safe-end to pipe weld configuration, similar to a B&W designed 177 FA unit. This design configuration consisted of an ID clad ferritic nozzle with the weld joint buttered with inconel weld metal and joined to a forged stainless steel safe-end by an inconel weld. The safe-end is then joined to the austenitic piping by an austenitic weld.

Although, ASME Section XI, Appendix VIII does not specifically address the examinations of the OD surface from the ID for these welds, Appendix VIII was used for guidance in the design of the mockups for the flaw type, size, location and acceptance criteria for detection and sizing. Appendix VIII, Supplement 3 - Qualification Requirements for Ferritic Piping Welds was used for the design of the reactor vessel outlet nozzle to pipe weld

mockup. The proposed Supplement 10 - Examination of Dissimilar Metal Welds was used for the design of the core flood nozzle to safe-end dissimilar metal weld configuration of the Core Flood Mockup. Supplement 2 - Qualification Requirements for Wrought Austenitic Piping Welds was used to design the core flood safe-end to pipe weld configuration of the Core Flood Mockup. Table 3 lists the IWB-3500 comparisons of each of the flaws contained within these mockups.

TABLE 3
B&WOG MOCKUP FLAW MATRIX OF ASME SECTION XI ALLOWABLE FLAW STANDARDS

Flaw No.	a/l	a/t%*	IWB-3514 Max. a/t%	t (inches)
Core Flood Nozzle to Safe-End				
1	.22	12.6	10.9	1.80
2	.25	25.2	11.0	1.80
3	.28	39.5	11.1	1.80
4	.45	62.9	11.8	1.80
Core Flood Safe-End to Pipe				
7	.17	22.0	11.1	1.10
8	.25	38.6	11.5	1.10
9	.29	71.8	11.6	1.10
10	.16	11.0	11.1	1.10
Reactor Coolant Outlet Nozzle to Pipe				
1	.25	7.6	11.7	3.0
2	.50	78.7	13.2	3.0
3	.27	16.3	12.3	3.0
4	.45	37.1	13.2	3.0
5	.28	10.9	12.6	3.0

This matrix consists of planar flaws which are within and exceed the allowable standards of the IWB-3514 tables. Flaws which are within the allowable standards of the IWB-3514 require no further analytical evaluation in accordance with IWB-3600.

*These values are in accordance with Appendix VIII flaw design requirements.

This project supports the B&W Owners Group request for a program to demonstrate the detection and sizing capabilities of OD surface circumferential flaws in the reactor coolant nozzle to pipe welds, core flood nozzle to safe-end welds and safe-end to pipe welds using the UT' techniques normally applied to these components from the ID surface.

In addition to qualifying the previously used detection techniques, flaw depth sizing was also investigated to define planar flaw sizing capabilities. These techniques included the use of tip diffraction, high angle longitudinal wave and mode conversion methods.

DISCUSSION:

In 1989 a benchmark and demonstration was performed using the examination method used during the 1985 examination of the core flood welds. The UT examination technique utilized in 1985 consisted of a 45° shear wave, immersion scan which was used for the examination of the core flood nozzle to safe-end welds. Detection capability of opposite surface planar reflectors equal to or greater than 0.034 inches through-wall in the austenitic clad ferritic material, the inconel buttering material and the austenitic safe-end material was demonstrated.

A 45° longitudinal wave technique was also demonstrated in 1989 to support future Relief Request. This technique demonstrated detection capability of opposite surface initiating planar reflectors that were equal to or greater than 0.034 inches in through-wall in all materials of the mockup.

The qualification program performed in 1993 addressed the requirements of the NRC by fabricating mockups of the applicable Examination Category B-F and B-J weld configurations. These mockups contain thermal fatigue cracks in accordance with ASME Section XI, Appendix VIII specifications to allow for the demonstration of qualification of examination techniques, procedures and instrumentation which were used to perform these flaw detection examinations during recent reactor vessel examinations. This qualification and benchmark program addresses the relief request for the Duke Power Company Oconee Plant in particular as well as the B&WOG operating plants.

The 1993 qualification test was performed evaluating the flaw detection capabilities as demonstrated to the NRC in

August, 1993 resulted in 100% detection of OD surface, circumferentially oriented, cracks in all three weld joint configurations. These configurations consisted of reactor coolant nozzle to pipe welds, core flood nozzle to safe-end welds and core flood safe-end to pipe welds.

The evaluation of planar flaw sizing capabilities indicates that the application of the tip diffraction, high angle longitudinal wave and mode conversion techniques produce results which satisfy ASME Section XI, Appendix VIII sizing criteria for both flaw length and depth.

Appendix VIII sizing criteria states that length sizing is considered acceptable if the flaw lengths estimated by ultrasonics are within one inch of the true length of the flaw. Depth sizing of flaws is considered acceptable if the RMS error of the flaw depths estimated by ultrasonics, as compared with the true depths is less than 0.125 inch.

OD surface examinations are normally performed to cover the near surface examination region just beneath the UT transducer, because UT techniques typically applied to piping weld examination lack the resolution to effectively examine this near surface region. However, the UT examinations for which the B&WOG are requesting relief are being performed from the opposite surface (ID) which allows the sensitivity and resolution to effectively examine the complete OD surface for surface flaws.

The detection of minimum through-wall reflectors were demonstrated during the 1989 demonstration to the NRC. The detection capability of these same notch reflectors was also demonstrated using the contact UT method in 1993. The NRC was given a graphic data sheet displaying these results during the August 1993 demonstration. This graphic data sheet depicts the detection images for the 0.034 and 0.084 inch through-wall series of notches. Also, included in this data is the image of Notch "A". This notch is 0.455 inches long and 0.070 inches through-wall. The image of this notch shows the data for a minimum of three scan lines at the scan index of 0.219 inches.

The most recent 1993 demonstrations were performed successfully in accordance with ASME Section XI, Appendix VIII for flaw type, size, location and acceptance criteria for flaw detection and sizing. Appendix VIII was utilized for guidance because no other requirements or criteria address the demonstration of examination reliability. The flaws were distributed throughout the base material and weld material.

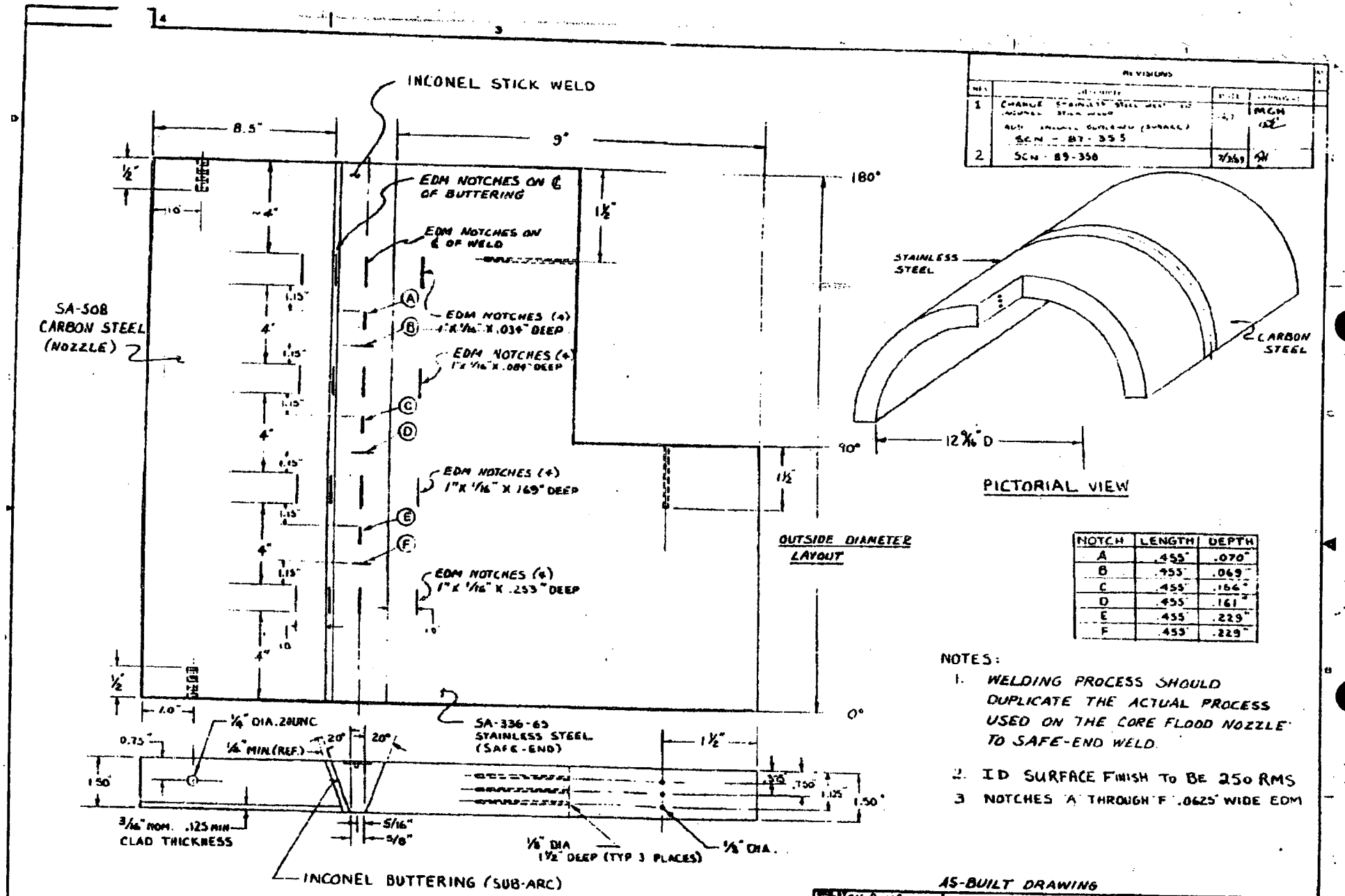
IWB-3514 addresses the acceptance standards for surface examinations. However, IWB-3514 also allows the disposition of any unacceptable surface indications by the use of volumetric techniques.

The B&WOG has comments from the Authorized Insurance Agents that witness the demonstration which states that they believe the demonstration was acceptable per Appendix VIII reguirments.

The B&WOG recognizes that ultrasonic examination is not as sensitive as surface examination techniques (liquid penetrant and magnetic particle) to short and shallow indications and are not attempting to prove equivalency. The B&WOG have demonstrated an effective and reliable examination of the opposite surface by the ultrasonic method and are requesting relief base on this demonstration and the significant personnel exposure, associated preparation costs and possible increase in outage duration associated with the removal of shielding and insulation along with surface preparation and examination.

CONCLUSION:

The B&WOG believes that the above described demonstrations provide an acceptable method of ensuring the integrity of the reactor vessel nozzle to safe-end piping weld joints.



NOTCH	LENGTH	DEPTH
A	.455"	.070"
B	.455"	.069"
C	.455"	.166"
D	.455"	.161"
E	.455"	.229"
F	.453"	.229"

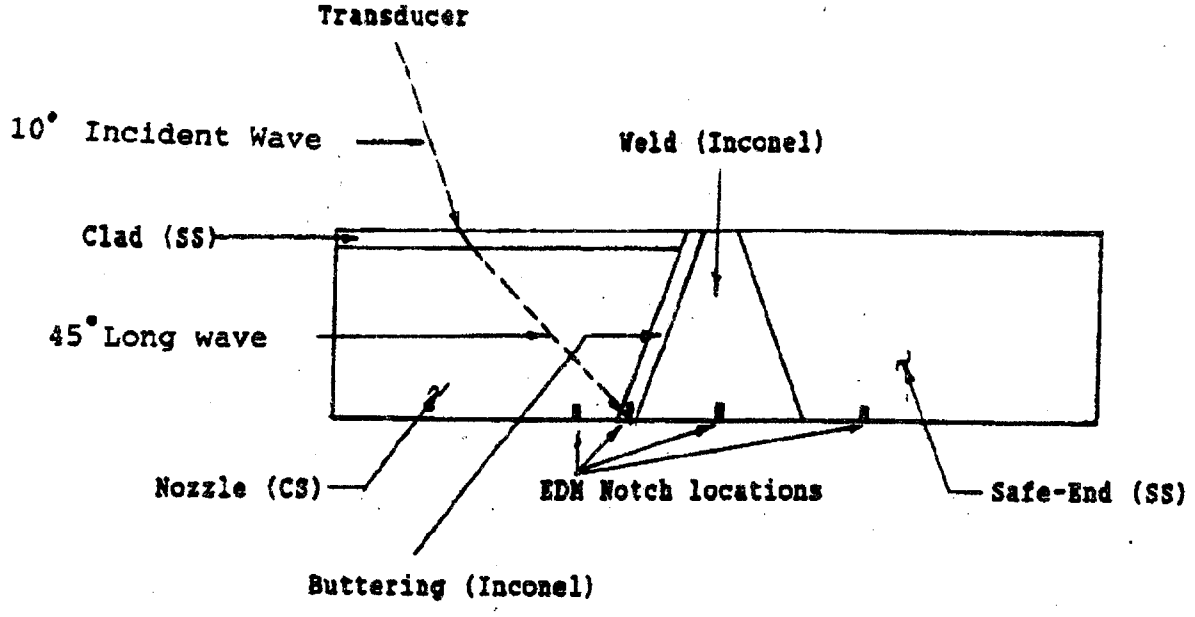
NOTES:

1. WELDING PROCESS SHOULD DUPLICATE THE ACTUAL PROCESS USED ON THE CORE FLOOD NOZZLE TO SAFE-END WELD.
2. ID SURFACE FINISH TO BE 250 RMS
3. NOTCHES A THROUGH F .0625" WIDE EDM

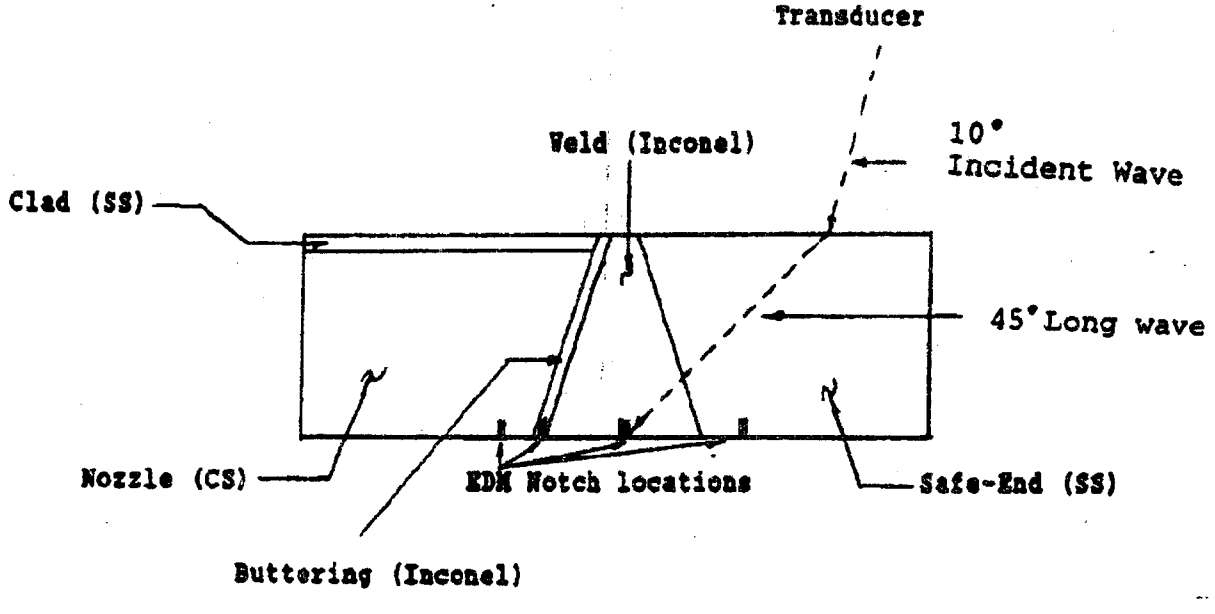
AS-BUILT DRAWING

	FLORIDA POWER CORPORATION	
	CORE FLOOD NOZZLE TO SAFE-END WELD MOCKUP	SCALE NONE
12-1-87		1183676 C 2

FIGURE 1



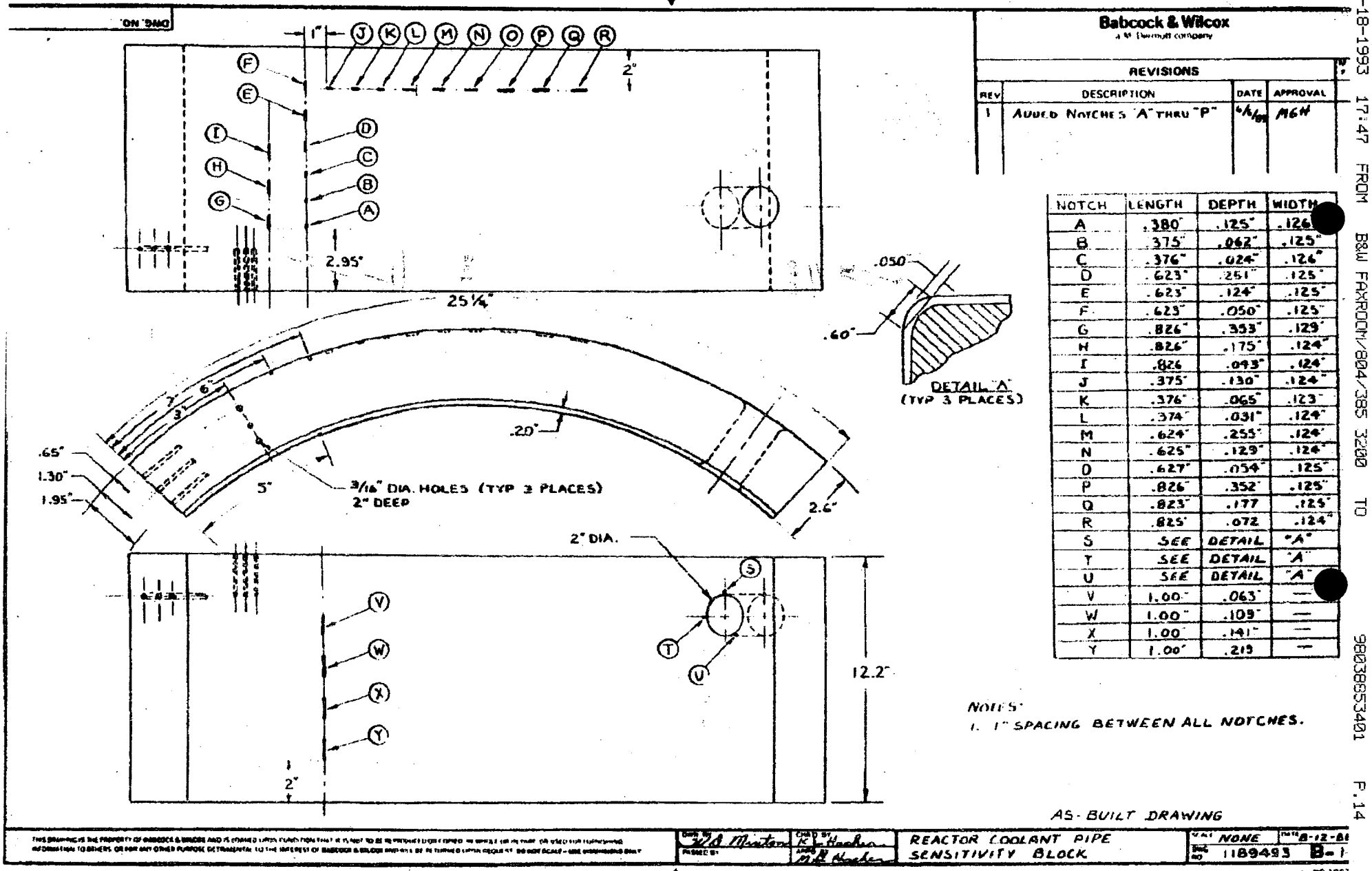
Beam Direction oriented towards the Safe-End



Beam direction oriented towards the Nozzle

FIGURE 2

FIGURE 3



Babcock & Wilcox
a McDermott company

REVISIONS			
REV	DESCRIPTION	DATE	APPROVAL
1	ADDED NOTCHES "A" THRU "P"	6/8/93	MGH

NOTCH	LENGTH	DEPTH	WIDTH
A	.380"	.125"	.126"
B	.375"	.062"	.125"
C	.376"	.024"	.126"
D	.623"	.251"	.125"
E	.623"	.124"	.125"
F	.623"	.050"	.125"
G	.826"	.353"	.129"
H	.826"	.175"	.124"
I	.826	.093"	.124"
J	.375"	.130"	.124"
K	.376"	.065"	.123"
L	.374"	.031"	.124"
M	.624"	.255"	.124"
N	.625"	.129"	.124"
O	.627"	.054"	.125"
P	.826"	.352"	.125"
Q	.823"	.177	.125"
R	.825"	.072	.124"
S	SEE	DETAIL	"A"
T	SEE	DETAIL	"A"
U	SEE	DETAIL	"A"
V	1.00"	.063"	—
W	1.00"	.109"	—
X	1.00"	.141"	—
Y	1.00"	.219	—

NOTES:
1. 1" SPACING BETWEEN ALL NOTCHES.

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REACTOR COOLANT PIPE SENSITIVITY BLOCK

SCALE NONE
DWG NO 1189493
SIZE B
REV 1
DATE 8-12-93
SHT B-1

PG 1087