# *ATTACHMENT 2*

Commonwealth Edison Co's NDE Procedure

NDT-C-38, for UT Examination of Cast

Stainless Steel Components.

# COMMONWEALTH EDISON COMPANY
# NONDESTRUCTIVE TESTING PROCEDURE FOR ULTRASONIC EXAMINATION OF FULL PENETRATION BUTT WELDS IN CAST STAINLESS STEEL COMPONENTS BYRON AND BRAIDWOOD STATIONS

## A. Scope

A.1 The ultrasonic methods described in this procedure are for the examination of full penetration butt welds in statically cast stainless steel material, SA-351 Grades CF8A and CF8M in PWR Reactor Coolant systems. The cast stainless steel (CSS) welds are of different types such as: forged pipe-to-cast elbows, pumps or valves and cast elbows-to-cast pumps or valves.

A.2 This procedure reflects the latest state of the art and "best effort" to meet ASME code requirements as provided by IWA-2240, and is specifically designed for detection of planar indications in the lower 25% to 50% of the component wall thickness for materials from approximately 2.0" to 4.0" thick.

A.3 This procedure utilizes straight beam ($0^{\circ}$) and angle beam (approx. $40^{\circ}$) refracted longitudinal wave techniques.

## B. Applicable Documents and Codes

B.1 The following codes and standards form a part of this examination procedure to the extent specified herein.

B.2 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, and section V, Nondestructive Examination, 1977 Edition, Summer of 1978 addenda.

B.3 American Society for Nondestructive Testing (ASNT) Recommended Practice for Nondestructive Testing Personnel Qualification and Certification SNT-TC-1A, Supplement C, 1975 or 1980 Edition.

B.4 Electric Power Research Institute (EPRI) Report, Ultrasonic Examination of Cast Stainless Steel Components In Main Coolant Piping Systems At Byron Nuclear Power Plant, December 18, 1985.

C. Application

C.1 The objectives of the methods given herein is the detection and recording of indications within the weld, the heat affected zone, and the base material adjacent to the weld. The indications that are located from 25% to 50% through wall depth are to be evaluated and identified by the inspector.

C.2 The examination shall be performed from the outside of the component by means of contact ultrasonic testing.

C.3 Examination areas shall include the entire circumference of the weld, the heat-affected zone and the cast stainless steel base material, to the extent possible, adjacent to the weld. When the afore mentioned volume cannot be examined due to surface contours and other restrictions (valves and pumps etc.) the maximum possible area shall be examined. The area examined and type of restrictions shall be documented on the report form.

C.4 Reflectors parallel to the weld shall be detected by angle beam scanning from the cast side/sides with the beam directed toward and perpendicular to the weld, to extent possible.

C.5 Reflectors transverse to the weld shall be detected by angle beam scanning on the weld surface and the cast base material side/sides with the beam directed parallel to the weld, in two directions, $180^{\circ}$ to each other, where possible.

C.6 A straight beam examination shall be performed on each weld for angle beam interference, for attenuation measurements, to obtain exact component wall thickness measurements at the counterbore area. Further more, straight beam examination is required to profile and plot I.D. geometry and to assist in determining examination coverage and signal evaluation.

D. Requirements

D.1 Personnel

D.1.1 All personnel performing and evaluating this ultrasonic examination(s) shall be certified to at least Level II in accordance with SNT-TC-1A, Supplement C, 1975 or 1980 Edition.

D.1.2 All personnel shall familiarize themselves with the objectives of this procedures by practicing on a mock-up or cracked specimens before performing an actual examination.

D.2 Equipment

D.2.1 Ultrasonic instruments shall be used with contact search units. The ultrasonic instrument shall be equipped with a dB calibrated gain control, accurate over its range to ± 20 percent or ± 2dB.

D.2.2 The ultrasonic instrument and specified angle beam search unit combination shall be capable of resolving the 10% deep I.D. notch on the calibration block with a minimum 2:1 signal noise ratio. It may be necessary to adjust the instrument to a lower or different frequency setting, than the transducer in

order to obtain satisfactory resolution. Documentation of certification for the ultrasonic instruments and transducers used shall be supplied when requested.

D.2.3 The modern digital microprocessor controlled ultrasonic instrument, such as the EPOCH 2002 is recommended to be used when doing this cast stainless steel component examination for the following reasons; good low frequency resolution, multiple calibration memory, material velocity readout and direct printer hookup.

D.2.4 The straight beam transducers shall be nominally 1.0 MHZ and .750" to 1.0" in diameter. The following specific set of angle beam search units, designed for optimum results on the 10% and 25% deep I.D. notches in the calibration blocks, were used in developing this procedure: KBA, Alpha type, .5 and 1.0 MHZ x 1.0" diameter transducers, mounted on axial and circumferential contoured wedges that produce an approximate $40^{\circ}$ dual focused refracted longitudinal wave mode. Other search unit frequencies, sizes and angles may be used, for performing and assisting evaluations or accomodating geometry problems, if

equal or better results are obtained on the calibration standard.

D.2.5 The search unit cable shall be of the coaxial type and shall not exceed 12 feet in length.

D.2.6 Glycerine or ultragel II are normally used as a couplant but other couplants may also be used if comparable results are obtained. All couplants used must have a certified analysis of halogen content of less than 300 ppm.

D.3 Calibration blocks

D.3.1 There are two calibration blocks (one thinner for 29" I.D. pipe and one thicker for 31" I.D. pipe) for each station that meet the recommended design and requirements of ASME Section V Article 5. The blocks have additional notches machined in them.

D.3.2 The calibration blocks have the same material specification, cast structure type, similar diameter and wall thickness and a representative surface finish as the components being examined.

D.3.3 There shall be documentation certifying the calibration block material.

D.3.4 Additional calibration blocks shall meet the same above requirements of this procedure.

D.3.5 Other reference blocks (IIW-2 DSC, Rompas, Etc) may be used for calibration verification checks.

D.3.6 Calibration Block Holes and Notches

The calibration blocks contain both axial and circumferential side drilled holes (S.D.H.) and I.D. notches. The S.D.H.'s are 3/16" dia. x 3" long, located at depths of 1/4, 1/2 and 3/4 wall thickness and are primarily used for sweep range (F.3.2) calibration. The I.D. notches are 2" long and machined to 10%, 25% and 50% depths and are primarily used for sensitivity (F.3.3) calibration. Other holes and notches may be present and used for aiding calibration if they don't interfere.

E. Surface Preparation

E.1 The examination surface shall be free of irregularities, loose material or coatings which interfere with ultrasonic wave transmission.

E.2 The component surface temperature shall be within $\pm$ 25$^{o}$F of the calibration block temperature.

E.3 Surface preparation shall include the weld and component surface either side of the weld, where possible, for a sufficient distance to allow examining the required volume.

F. Calibration of Equipment

F.1 Instrument Linearity Verification

F.1.1 Screen Height Linearity

The ultrasonic instrument shall provide screen height linearity within 5% of full range for at least 80% of the full screen height (FSH) (base line to maximum calibrated screen points). The screen height linearity check shall be made in accordance with Attachment #1 of this procedure and the results recorded on Form NDT-CF-2.

F.1.2 Amplitude Control Linearity

The ultrasonic instrument shall utilize an amplitude control, accurate over its useful range to ± 20%

of the nominal amplitude ratio, to allow measurement of indications beyond the linear range of the vertical display on the screen. The amplitude control linearity check shall be made in accordance with Attachment #1 of this procedure and the results recorded on Form NDT-CF-2.

F.1.3 Instrument calibrations for screen height and amplitude control linearity shall be performed at the beginning of each period of extended use or every 3 months, whichever is less.

F.2 Calibration General

F.2.1 Calibration shall include the complete ultrasonic examination system. Any change in search units, wedges, couplants, cables, ultrasonic instruments, recording devices, or any parts of the examination system shall be cause for recalibration, except when using a digital microprocessor controlled instrument (EPOCH 2002) several calibrations may be made at one time and recorded. These digital calibrations may be recalled or reprogrammed at any time within four hours of the original calibration or recalibration, that day. The initial calibration shall be made on the proper designated calibration block. The calibration verification shall be made on either the proper designated calibration block or the reference blocks listed in D.3.5. The calibration block and data shall be recorded on the calibration form.

F.2.2 Calibration shall be performed at the beginning of each day of examinations. A calibration verification shall be made at least every four hours during examinations, at the finish of each shift and whenever a change in examination personnel occurs.

F.2.2.1 Recalibration, Amplitude Only

If the amplitude on the CRT screen has changed by more than 20% of its original amplitude when a check is made on the calibration standard, all data forms since the last positive calibration check shall be marked void and destroyed. A new calibration shall be made and recorded and the voided examination areas shall be re-examined.

F.2.2.2 Recalibration, Sweep Only

If there is any indication that the sweep position has moved on the sweep line more than ten percent of the calibration sweep, correct the sweep range calibration and note the correction in the examination record. If recordable reflectors are noted on the data sheets, those data sheets shall be voided and destroyed. A new calibration shall be completed and recorded, and the voided examination shall be repeated.

F.3 Calibration, Specific

F.3.1 Calibration Block Selection: The 29" I.D. calibration block shall be used when calibrating for examination of the 27 1/2" and 29" I.D. components and the 31" I.D. calibration block for examining the 31" I.D. components.

F.3.2 Sweep Range Calibration: A 5.0" depth full screen range, using the 1/4, 1/2 and 3/4 T S.D.H.'s shall be established for both the straight beam and angle beam calibrations. Measure the depth of each S.D.H. from the calibration block O.D. surface, and with the search unit positioned for maximum hole signal response, from each hole, adjust the signal to it's corresponding 5.0" screen position. Repeat this process on each hole until the screen range is linear. The back reflection and the signals from the bottom of the notches may also be used for the straight beam calibration. If an accurate corner reflection signal is obtained from the 10% deep I.D. notch, it should also be used when calibrating the angle beam screen range. Use the staggered holes for the straight beam calibration and the in line holes for the angle beam calibration. A separate (Axial and Circumferential) calibration shall be performed

for each angle beam scan. If the hole signals do not line up exactly as stated, adjust them as best as possible with the greatest accuracy at the lower 50% block wall thickness.

F.3.3 Reference Sensitivity: The straight beam reference sensitivity shall be established by adjusting the minimum and maximum amplitude, 1st back reflections of the calibration block to 80% F.S.H. and recording both gain settings on the calibration form. During actual examination and scanning, the 1st back reflection shall be maintained at approximately 80% F.S.H. by readjusting the gain setting. The angle beam reference sensitivity, shall be established by maximizing the tip signal response of the 50%, 25% and 10% deep I.D. notches Adjust the maximum peak signal to 80% F.S.H. and mark on UT screen. At this gain setting mark the maximum amplitudes of the other two notches. Draw a DAC curve by connecting the three marked peaks and on the calibration form record their amplitudes and sweep positions. It should be noted that the notch depths do not always compare

exactly with their corresponding hole depth. Also, at reference sensitivity record the screen height noise level. During actual angle beam examination and scanning, a desired noise level (10 to 30% FSH) shall be maintained by raising or lowering the calibration gain setting.

F.4 Calibration Data Record

F.4.1 The following data shall be recorded on the calibration data Form.

a. Calibration sheet identification and date of calibration;

b. Names of examination personnel;

c. Examination procedure number and revision;

d. Basic calibration block identification and temperature;

e. Ultrasonic instrument identification and serial number;

f. Beam angle, couplant, and mode of wave propagation in the material;

g. Orientation of search unit with respect to the pipe (longitudinal or circumferential)

h. Search unit identification - frequency, size and Manufacturer's serial number;

i. Special search units, wedges, shoe type, or saddle's identification, if used;

j. Search unit cable type and length;

k. Times of initial calibration, subsequent calibration checks and final calibration.

l. Amplitudes and sweep readings obtained form the calibration reflectors.

## G. Examination Procedure

### G.1 Scanning

G.1.1 Scanning Coverage: Scan the examination volume with the sound beam path overlapping each scan by at least 10% of the transducer dimension measured perpendicular to the scan path.

G.1.2 Scanning Speed: The rate of search unit movement shall not exceed six inches per second.

G.1.3 Scanning Sensitivity: When performing straight beam examinations per paragraph C.6 it is recommended to maintain a 80% F.S.H. first back reflection. Angle beam scanning shall be performed at the relative reference amplitude (Para. F.3.3.) to the extent possible. Different cast material properties may require raising or lowering the gain to maintain a 10% to 30% F.S.H. noise level which is necessary to ensure a good examination. The scanning sensitivity (gain) used on each weld shall be recorded on the examination data form.

G.1.4 Scanning Motion: When straight beam examining per paragraph C.6, the search unit shall be moved progressively along and around the weld. For angle

beam axial and circumferential scanning for coverage per paragraphs C.3, C.4 and C.5 the search unit shall be moved towards and away from the weld and progressively around the diameter, where possible. The angle beam search unit should be oscillated slightly (as much as the curved wedge allows) during scanning.

H. Recording

H.1 Straight beam thickness measurements, and I.D./O.D. profiling shall be made every $90^{\circ}$ ($0^{\circ}$, $90^{\circ}$, $180^{\circ}$ and $270^{\circ}$) around the component diameter and the results recorded on the data sheets with profile plots attached.

H.2 When using the straight beam examination for the detection of indications which might effect the angle beam examination, the noted indication, other than noise, that have an amplitude equal to or greater than 50% of the initial back reflection and accompanied by a 50% reduction of the initial back reflection shall be recorded. Also, record the minimum and maximum gain settings needed to maintain an 80% FSH initial back reflection. If there are areas, due to high noise and attenuation, that preclude resolution of the initial back reflection these areas shall be noted in the data report.

H.3 For angle beam examination, all indications other than material noise, that equal or exceed 50% reference (DAC) level shall be recorded. Also, any indication of any amplitude that the operator believes to be a planar flaw shall be recorded.

H.4 For the purpose of establishing sound beam penetration and coverage, I.D. geometry indications that are detected below recording level shall be noted on the data report as a general comment.

I. Examination Data Record

I.1 The following data shall be recorded on the examination data sheet:

a. Data sheet identification and date of examination;

b. Names and level of examination personnel;

c. Examination procedure and revision;

d. Applicable calibration sheet identification;

e. Identification and location of weld or volume scanned (for example, marked up drawings or sketches);

f. Surface from which examination is conducted;

g. Record of indications or of volume free of indications;

h. Type of examination performed and orientation of search unit with respect to the pipe;

i. Couplant identification;

j. Pipe size, schedule and material type;

k. Unit and/or pipe system identification;

l. Pipe temperature.

I.1.1 For each recordable indication, the following information shall be recorded on the examination data sheet:

a. Give the indication a number and identify the scan in which detected.

b. For each recordable indication, the recording points for the minimum and maximum sweep distances, linear extent and surface distances will be 50% of the maximum signal amplitude at reference sensitivity

c. The reflectors maximum amplitude, as percent of the DAC curve at reference sensitivity. With the search unit still positioned at this maximum amplitude point, record the sweep distance to the reflector and surface distance (in inches) from the designated reference point (possibly, weld center line) to the search unit exit point. Again, at this location, record the sweep distance to the reflector and the surface distance from the designated reference point to the search unit exit point, when the signal drops 50% of its maximum amplitude as the search unit is moved toward and away from the reflector.

d. The search unit locations (possibly, distance around the pipe from top dead center) parallel to the reflector at its maximum and start and end points, when the signal amplitude drops to 50% of its maximum amplitude. This will establish the location and linear extent of the reflector.

I.2 The examiner shall evaluate, to the best of his ability, what's causing the recordable reflectors and try to determine their linear extent. Reflectors, such as possible I.D. geometry, root bead and weld grain boundaries, that are continuous or intermittent (proven by raising or lowering the gain) for a given length, shall be recorded as a single indication, with comments. The examiner shall supply any additional data obtained on indications that are evaluated as planar flaws.

I.3 The reference points (usually two) used for locating and plotting indications shall be designated by the station and the examiner shall identify these points on the data sheet.

I.4 The examiner or agency performing ultrasonic examinations in accordance with this procedure, shall be responsible for filling out the calibration and data sheets correctly and submitting them to the station ISI/PSI coordinator, within his designated time period.

ATTACHMENT #1

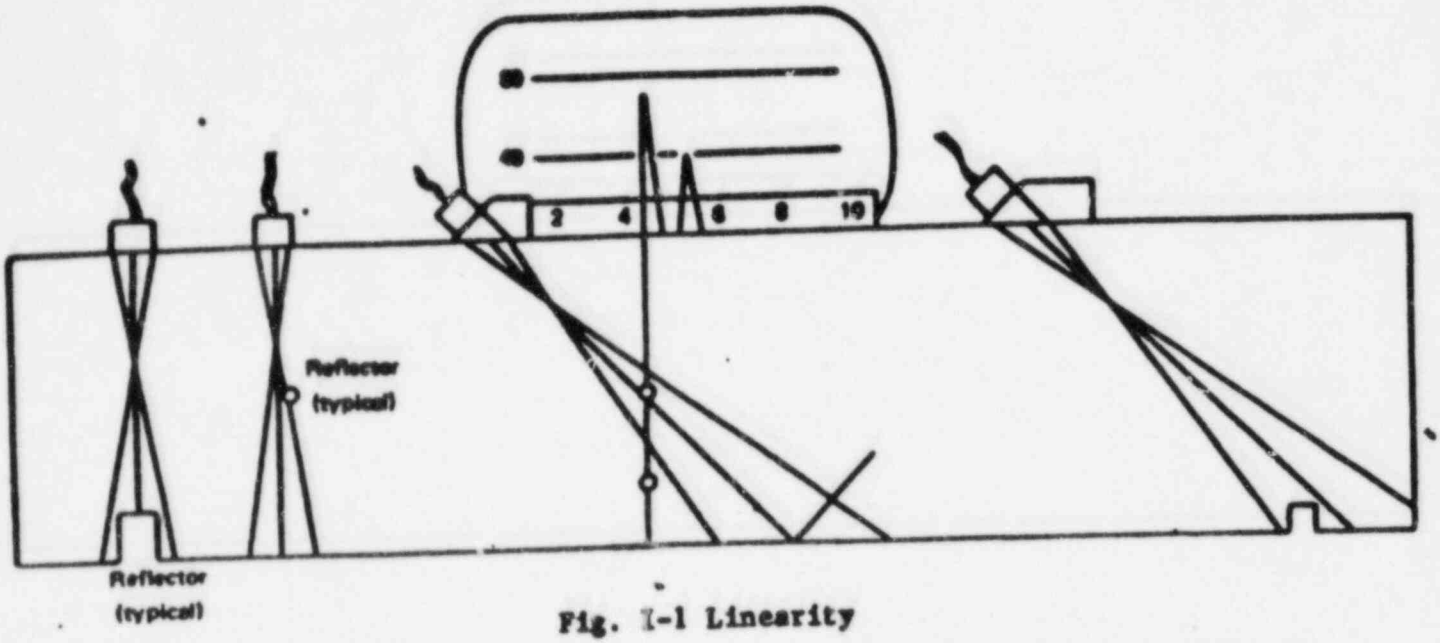



Fig. I-1 Linearity

## SCREEN HEIGHT LINEARITY

To verify the ability of the ultrasonic instrument to meet the linearity requirement of F.1.1, position an angle beam search unit as shown in Fig. I-1 so that indications can be observed from both the 1/2 and 3/4 T holes in a basic calibration block. Adjust the search unit position to give a 2 to 1 ratio of amplitudes between the two indications, with the larger set at 80% of full screen height. Without moving the search unit, adjust sensitivity (gain) to successively set the larger indication from 100% to 20% of full screen height, in 10% increments (or 2 dB steps if a fine control is not available), and read the smaller indication at each setting. The reading must be 50% of the larger amplitude, within 5% of full screen height. The settings and readings must be estimated to the nearest 1% of full screen. Alternatively, a straight beam search unit may be used on any calibration block which will provide amplitude differences.

## AMPLITUDE CONTROL LINEARITY

To verify the accuracy of the amplitude control of the ultrasonic instrument, as required in F.1.2, position an angle beam search unit as shown in Fig. I-1 so that the indication from the 1/2 T hole in a basic calibration block is peaked on the screen. With the increases and decreases in attenuation shown in the following table, the indication must fall within the specified limits. Other convenient reflectors from any calibration block may be used with angle or straight beam search units.

| Indication Set at % of Full Screen | dB Control Change | Indicatio Limits % Full Scre |
|---|---|---|
| 80% | - 6dB | 32 to 48% |
| 80% | -12 dB | 16 to 24% |
| 40% | + 6 dB | 64 to 96% |
| 20% | +12 dB | 64 to 96% |

The settings and readings must be estimated to the nearest 1% of full scree

## ULTRASONIC CALIBRATION FORM NDT-CF-2

This calibration form was used with procedure NDT-_____ Rev. _____

Date_____ Unit_____ Inspection_____ Calibration Sheet No._____

Examiner_____ Level_____ Calibration Standard No._____

Couplant_____ Transducer S/N_____ UT Instrument S/N_____
(Lot #):

BEAM SPREAD CALCULATION (Made once per search unit/calibration standard combination)

45° Transducer

| Hole Depth | 100% DAC | | 50% DAC-T | | 50% DAC-A | |
|---|---|---|---|---|---|---|
| | W | Sweep | W | Sweep | W | Sweep |
| 1/4 T | | N/A | | | | |
| 1/2 T | | | | | | |
| 3/4 T | | | | | | |

60° Transducer

| Hole Depth | 100% DAC | | 50% DAC-T | | 50% DAC-A | |
|---|---|---|---|---|---|---|
| | W | Sweep | W | Sweep | W | Sweep |
| 1/4 T | | N/A | | | | |
| 1/2 T | | | | | | |
| 3/4 T | | | | | | |

T = Moving toward reflector

A = Moving away from reflector

W = Distance, on the surface, between the transducer index point and the center line of the holes

AMPLITUDE LINEARITY CHECK

| | | | |
|---|---|---|---|
| 100% FSH | _____%FSH | 50% FSH | _____%FSH |
| 90% FSH | _____%FSH | 40% FSH | _____%FSH |
| 80% FSH | _____%FSH | 30% FSH | _____%FSH |
| 70% FSH | _____%FSH | 20% FSH | _____%FSH |
| 60% FSH | _____%FSH | | |

CONTROL LINEARITY CHECK

| | | |
|---|---|---|
| 80% FSH | -6dB_____ | (32-48) |
| 80% FSH | -12dB_____ | (16-24) |
| 40% FSH | +6dB_____ | (64-96) |
| 20% FSH | +12dB_____ | (64-96) |

Reviewed by: _____ AI_____

# ULTRASONIC CALIBRATION FORM

This calibration form was used with Procedure NDT-_____ Rev._____

☐ Straight Beam ☐ Angle Beam: Axial_____ Circ_____

Date_____ Unit No. & Inspection_____ Calibration Sheet No._____

Examiner_____ Level_____ Calibration Standard No._____

Couplant (Lot #): _____ Calibration Standard Thickness_____

Temperature _____

## FLAW DETECTION UNIT

Manufacturer_____

Model_____

Serial No._____

Cable: Type _____

Length _____

## TRANSDUCER

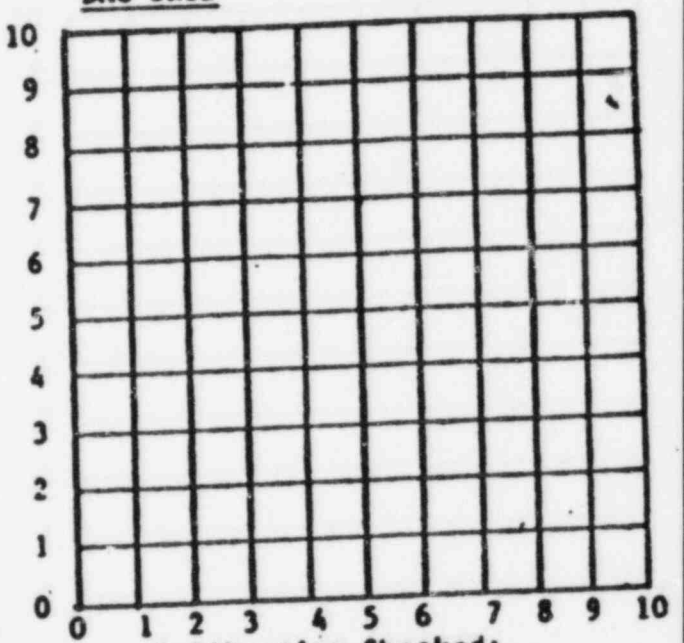
Size_____

Freq._____

Serial No._____

Angle_____

## DAC GRID

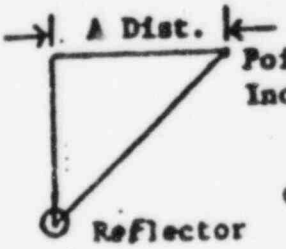



## CALIBRATION DATA

| | | | | | | |
|---|---|---|---|---|---|---|
| Reflector | | | | | | |
| Mode/Back Rf | | | | | | |
| Sweep/Depth | | | | | | |
| Amplitude | | | | | | |
| "A" Distance | | | | | | |

Calibration Checked:

| | Time | % Amp. | %Sweep | Oper. |
|---|---|---|---|---|
| INT. | | | | |
| PIN. | | | | |




Block Used _____

## INSTRUMENT CONTROLS

| | start | finish |
|---|---|---|
| DAC CURVE GAIN | | |
| Sweep | | |
| Delay | | |
| SENSITIVITY GAIN | | |
| Damping | | |
| Reject | | |
| Filter | | |

Attenuation

High_____

Low_____

Noise Level

%FSH_____

## CALIB. CHECKS

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

| Data Sheet No. | Weld No. |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

Reviewed by: _____ AI_____

# ULTRASONIC TESTING DATA SHEET

This data sheet was used with Procedure NDT-_____ Rev. _____

Date _____ Unit No. & Inspection _____ Data Sheet No. _____

System _____ Weld Type _____ Weld No. _____

Pipe Size _____ Schedule _____ Material _____

Examiner _____ Level _____ Couplant (Lot #) _____

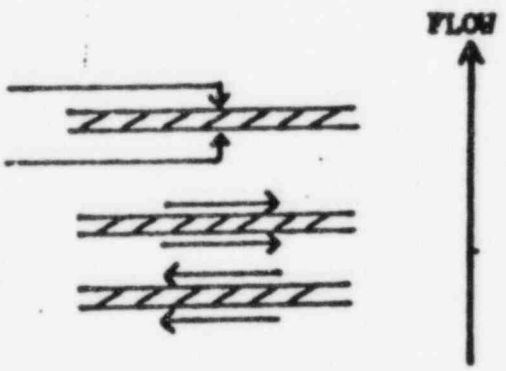
Calibration Sheet Nos: L-Wave _____ Angle Beam: Axial _____

Circ _____

Pipe Temperature _____

EXAMINATION SCANS

1) Base Metal L-Wave
2) Angle Beam-Normal
3) Angle Beam-Normal
4) Angle Beam-Along Weld
5) Angle Beam-Along Weld
6) L-Wave of Weld
7) Thickness Across Weld & Base Metal




| performed | | indication | |
|---|---|---|---|
| yes | no | yes | no |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | sweep | |

up str w dn str

Comments: _____

_____

_____

_____

_____

_____

_____

_____

Reviewed by: _____ AI _____

# ULTRASONIC DATA SHEET

DATA SHEET NO. _____ PROCEDURE USED _____ REV. _____

REFERENCE POINT LOCATIONS: _____

| | | | SWEEP DISTANCE | | | LINEAR EXTENT FROM REFERENCE | | | FORE AND AFT SURFACE DISTANCE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EXAM NO. | IND NO. | MAX AMP | TOWARD | AT MAX | AWAY | START | AT MAX | END | TOWARD | AT MAX | AWAY | EVALUATION |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

EXAMINER: _____ ASNT LEVEL: _____ DATE _____

REVIEWED BY: _____ AI _____

# PROCEDURE CERTIFICATION

Procedure Number: NDT-C-38 Revision: 0 Date: June, 1986

Procedure Title: Ultrasonic Examination of Full Penetration Butt Welds in Cast Stainless Components Byron and Braidwood Stations

This is to certify that the above titled procedure is in compliance with the requirements of the ASME Boiler and Pressure Vessel Code, 1977 Edition, Summer 1978 Addenda, Section (s) V & XI

This procedure has been reviewed, witnessed and approved by:

Signature of SNT-TC-1A Level III — Date: 6-17-86

Authorized QA Department Signature — Date: 6-19-86

I, the undersigned, of the _____ holding a valid certificate issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State of Illinois, have reviewed the above procedure and find it acceptable.

Signature of Authorized Inspector & No. — Date

# *ATTACHMENT 3*

Byron Unit-2 and Braidwood Unit-1 UT

Inspection Results Summery Report.

BYRON UNIT #2 U.T. EXAMINATION RESULTS
OF R.C. CAST FITTINGS
LOOP A

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclusion | Other | | |
| 2RC01AA 29" | J3 | pipe to valve | Base Metal (valve) 52-61 Weld 42-47 | 1* | X | | X | | | | 2* | Circ scan limited due to weld configuration |
| 2RC01AA 29" | J4 | valve to elbow | valve side 55-62 elbow side 52-61 | 1* valve side | X | | X | | | ID | 2* | Weld configuration limited circ scan |
| 2RC01AA 29" | F2 | elbow to st. gen | 53-64 | | X | | X | | | | 2* | Circ. scan sometimes restricted due to weld configuration |
| 2RC02AA 31" | F1 | st. gen to elbow | weld 59-70 elbow side 57-63 | 1* elbow side | X | | X | | X | | 2*, 4* C. Bore | No circ scan on weld crown due to configuration |
| 2RC02AA 31" | J1 | elbow to pipe | elbow side 51-56 weld side 48-58 | 1* elbow side | X | | X | | | | 2* | No circ scan on crown of weld due to configuration |
| 2RC02AA 31" | J2 | pipe to elbow | 56-72 | | X | | X | | | | 2* | 3* |

1* High Noise Level  2* 360° Intermittent or continuous  3* No restrictions  4* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 2RC02AA 31" | J3 | elbow to pipe | 58-70 | | X | | X | | | | 2* | 3* |
| 2RC02AA 31" | J7 | pipe to elbow | 56-73 | | X | | X | | | | 2* | 3* |
| 2RC02AA 31" | J8 | elbow to pump | weld 52-61 | 1* elbow & pump side | X | | X | X | | | 2*, C.Bore | No circ scan on weld crown due to configuration |
| 2RC03AA 27 1/2 | J1 | pump to pipe | 49-65 | 1* | X | | | | | I.D. | 2* I.D. | Limited circ scan due to configur-ation |
| 2RC03AA 27 1/2 | J5 | pipe to valve | 45-62 | 1* | X | | | X | | | 2* Root or I.D. | Circ scan limited due to weld config-uration |
| 2RC03AA 27 1/2 | J6 | valve to pipe | 45-60 | 1* | X | | X | | | | 2* | Configuration limited circ. scan |
| 2RC03AA 27 1/2 | J11 | pipe to elbow | weld 38-46 base metal 55-61 | 1* | X | | X | | | | 2* | 3* |

1* High Noise Level  2* 360° Intermittent or continuous  3* No restrictions  4* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 2RC03AA 27 1/2 | J12 | elbow to RPV S.End | elbow side 62-68 weld 48-60 | 1* elbow side | | | | | | | | Limited circ. scan due to configur-ation No axial scan performed due to AS-CAST transition located near weld |

1* High Noise Level  2* 360° Intermittent or continuous  3* No restrictions  4* Radiograph Reviewed

# BYRON UNIT #2 U.T. EXAMINATION RESULTS OF R.C. CAST FITTINGS LOOP B

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 2RC01AB 29" | J3 | pipe to elbow | weld 49-69 valve side 51-60 | 1* | X | | X | | | | 2* | No circ scan on weld due to config-uration |
| 2RC01AB 29" | J4 | valve to elbow | valve side 57-64 elbow side 58-67 | 1* elbow side | X | | X | | | | 2* | No circ scan on weld due to O.D. geometry |
| 2RC01AB 29" | F2 | elbow to st. gen | elbow side 62-70 weld 52-59 | 1* elbow side | X | | X | | | | 2* | No circ scan on weld due to config-uration |
| 2RC02AB 31" | F1 | st. gen. to elbow | weld 59-68 elbow side 60-64 | 1* elbow side | X | | X | | | | 2* | No circ on weld due to weld config-uration |
| 2RC02AB 31" | J1 | elbow to pipe | elbow side 52-59 weld 47-57 | 1* elbow side | X | | X | | | I.D. | 2* | Circ scan limited 55"-63" and axial scan limited 3" to 6" due to concavity in base metal |
| 2RC02AB 31" | J2 | pipe to elbow | 48-67 | | X | | X | X | | | 2* | 3* |

1* High Noise Level 2* 360° Intermittent or continuous 3* No restrictions 4* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 2RC02AB 31" | J3 | elbow to pipe | 48-71 | | X | | X | X | | | 2* | 3* |
| 2RC02AB 31" | J7 | pipe to elbow | 48-67 | | X | | X | X | | | 2* | 3* |
| 2RC02AB 31" | J8 | elbow to pump | elbow side 45-60 pump side-see comments | 1* pump side | X | | X | | | | 2* | No circ scan on weld crown due to configuration |
| 2RC03AB 27 1/2 | J1 | pump to pipe | 44-65 | 1* pump side | X | | X | X | X | I.D. | 2* | Circ scan limited due to config-uration |
| 2RC03AB 27 1/2 | J5 | pipe to valve | 46-60 | 1* valve side | X | | | X | | | 2* | Limited circ scan due to configu-ration. Axial scan limited 3% due to permanent support |
| 2RC03AB 27 1/2 | J6 | valve to pipe | 47-62 | 1* valve side | X | | X | X | | | 2* | Circ scan limited due to config-uration |
| 2RC03AB 27 1/2 | J11 | pipe to elbow | 53-76 | | X | | X | | | | 2* | 3* |

1* High Noise Level  2* 360° Intermittent or continuous  3* No restrictions  4* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 2RC03AB 27 1/2 | J12 | elbow to RVP | 50-72 | | | | | | | | | Limited circ scan due to config-uration. No axial exam was performed due to as-cast transition located near weld. |

1* High Noise Level  2* 360° Intermittent or continuous  3* No restrictions  4* Radiograph Reviewed

BYRON UNTI #2 U.T. EXAMINATION RESULTS
OF R.C. CAST FITTINGS
LOOP C

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclusion | Other | | |
| 2RC01AC 29" | J3 | pipe to valve | 48-68 | | X | X | | X | | ID | 2*, 4* | Circ. scan limited due to configuration |
| 2RC01AC 29" | J4 | valve to elbow | 49-71 | | X | | X | | | ID | 2* | Limited circ. scan due to configuration |
| 2RC01AC 29" | F2 | elbow to st. gen | 59-71 | | X | | X | | X | | 2*, 4* C. Bore | Weld configuration limited circ. scan |
| 2RC02AC 31" | F1 | st. gen to elbow | 48-71 | | X | | X | | | | 2* | Limited scan due to weld configuration |
| 2RC02AC 31" | J1 | elbow to pipe | 48-74 | | X | | X | | | | 2* | 3* |
| 2RC02AC 31" | J2 | pipe to elbow | 42-58 | 1* | X | | X | | | | 2* | 3* |
| 2RC02AC 31" | J3 | elbow to pipe | 48-64 | 1* | X | | X | | | | 2* | No circ. scan on weld due to configuration |
| 2RC02AC 31" | J7 | pipe to elbow | 45-69 | | X | | X | X | | | 2* | 3* |

1* High Noise Level  2* 360° Intermittent or Continuous  3* No Restrictions  4* Radiograph Reviewed

| Line No | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 2RC02AC 31" | J8 | elbow to pump | 48-70 | 1* pumpside | X | | | | | ID | 2* | Limited circ scan due to configuration of weld |
| 2RC03AC 27 1/2 | J1 | pump to pipe | 43-64 | 1* | X | | | | | ID | 4* | Circ. scan limited due to weld configuration |
| 2RC03AC 27 1/2 | J5 | pipe to valve | 45-63 | 1* | X | | X | | | | 2* | Limited circ. scan due to weld configuration |
| 2RC03AC 27 1/2 | J6 | valve to pipe | 49-63 | 1* | X | | | | | ID | 2* | Weld configuration limits circ. scan |
| 2RC03AC 27 1/2 | J12 | pipe to elbow | 57-70 | | X | | X | | | | 2* | 3* |
| 2RC03AC 27 1/2 | J13 | elbow to RPV | 58-73 | Scan restricted due to as-cast transition | | | | | | | | Limited circ. scan due to weld configuration. No axial exam performed due to as-cast transition near weld |

1* High Noise Level  2* 360° Intermittent or Continuous  3* No Restrictions  4* Radiograph Reveiwed

BYRON UNTI #2 U.T. EXAMINATION RESULTS
OF R.C. CAST FITTINGS
LOOP D

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 2RC01AD 29" | J4 | pipe to valve | 51-71 | | X | | | X | | ID | 2* | Limited circ. scan due to OD contour |
| 2RC01AD 29" | J5 | valve to elbow | valve side 49-74 elbow side 51-72 | | X | | | X | | ID | 2* | 3* |
| 2RC01AD 29" | F2 | elbow to st. gen | 58-78 | | X | | | | X | ID | 2*, 4* ID | Limited scan due to weld OD contour |
| 2RC02AD 31" | F1 | st. gen to elbow | weld 58-69 elbow 62-67 | 1* | X | | X | | | | 2* | No circ. scan on weld due to config-uration |
| 2RC02AD 31" | J1 | elbow to pipe | elbow 54-60 weld 46-55 | 1* | X | | X | | | | 2* | 3* |
| 2RC02AD 31" | J2 | pipe to elbow | 50-68 | 1* | X | | X | | X | | 2*, 4* C.Bore | 3* |
| 2RC02AD 31" | J3 | elbow to pipe | 50-68 | 1* | X | | | X | | | 2* | 3* |

1* High Noise Level  2* 360° Intermittent or Continuous  3* No Restrictions  4* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 2RC02AD 31" | J7 | pipe to elbow | 47-69 | | X | | X | | | | 2* | 3* |
| 2RC02AD 31" | J8 | elbow to pump | 47-69 | Backwall not resolved on pump side due to OD geometry | X | | | X | | ID | 2* | Scan limited on weld due to OD contour |
| 2RC03AD 27 1/2 | J1 | pump to pipe | not ob-tainable | Attenuation was not measured due to OD geometry | X | | | | X | ID | 4* | Circ. scan limited due to OD contour |
| 2RC03AD 27 1/2 | J5 | pipe to valve | 48-70 | | X | | | X | | ID | 2* | Limited circ. scan due to OD contour |
| 2RC03AD 27 1/2 | J6 | valve to pipe | 47-70 | | X | | | | | ID | 2* | Scan limited due to OD contour |
| 2RC03AD 27 1/2 | J11 | pipe to elbow | 57-70 | | X | | X | | | ID | 2* | 3* |
| 2RC03AD 27 1/2 | J12 | elbow to RPV | 53-70 | Scan restricted due to as-cast transition | | | | | | | | Circ. scan limited to weld crown due to as-cast condition. No axial exam performed due to as-cast transition near weld |

1* High Noise Level  2* 360° Intermittent or Continuous  3* No Restrictions  4* Radiograph Reviewed

# BRAIDWOOD UNIT #1 U.T. EXAMINATION RESULTS

## OF R.C. CAST FITTINGS

## LOOP #1

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | Additional Comments |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 1RC-01-29" | 3 | pipe to valve | 49-65 | Obtained a good back wall reflection | X | | | X | | | 1* | 2* |
| 1RC-01-29" | 4 | valve to elbow | valve side 36-58 elbow side 42-50 | A loss of backwall was noted when approching either side of toe weld | X | X | X | X | | | 1* | 2* Axial is in parent material of valve |
| 1RC-01-31" | 8 | elbow to nozzle | 64.9 | Backwall not always resolved due to OD geometry, or non-parallel sides | X | | X | X | | | 1* | 2* |
| 1RC-01-31" | 9 | nozzle to elbow | 65 | | X | | X | | | | 1* | 2* |
| 1RC-01-31" | 10 | elbow to pipe | 50-58 | A loss of backwall was noted on either side of weld toe due to OD geometry | X | | X | | | ID | 1* | 2* |
| 1RC-01-31" | 11 | pipe to elbow | 55-70 | Unable to obtain a backwall (appr. 50% of the time) due to cast structure | X | | X | | | | 1* | 2* |

1* 360° Intermittent  2* No Restrictions  3* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclusion | Other | | |
| 1RC-01-31" | 12 | elbow to pipe | 45-65 | Unable to obtain a backwall (appr. 50% of the time) due to cast structure | X | | X | | | | 1* | 2* |
| 1RC-01-31" | 16 | pipe to elbow | elbow side 56 weld 57 | | X | | | X | | ID | 1* | 2* Loss of back reflection on elbow side from weld center line due to possible ramp on CB |
| 1RC-01-31" | 17 | elbow to circ pipe | 46-65 | Backwall not always resolved on pipe side due to high noise level | X | X | X | X | | | 3* | No axial or circ scans were performed when approaching either side of weld toe due to OD geometry |
| 1RC-01-27 1/2 | 18 | pump to pipe | 60-63 | | X | | | | | ID | 1* | 2* |
| 1RC-01-27 1/2 | 22 | pipe to valve | 60.8-64 | | X | | | X | | | 1* | 2* |
| 1RC-01-27 1/2 | 23 | valve to pipe | 40-50 | Backwall not always resolved due to OD geometry | X | | | X | | ID | 1* | Scans #4 & 5 had a slight restriction over the weld. The transducer edge could only be moved to the weld center line |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 1RC-01-27 1/2 | 30 | pipe to elbow | 51-64 | Loss of backwall was noted due to material grain structure noise | X | | | X | X | ID | 1* | when approaching weld toe, scans 1, 2,4,&5 have a tendency to lose coupling due to base metal-to-weld transition |
| 1RC-01-27 1/2 | 31 | elbow to safe-end | 46-66 | Backwall difficult to resolve due to excessive noise | | X | | X | | ID | | No axial scans performed due to OD configurations. Scan #1 limited due to elbow prep transition. |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

BRAIDWOOD UNIT #1 U.T. EXAMINATION RESULTS

OF R.C. CAST FITTINGS

LOOP #2

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclusion | Other | | |
| 1RC-02-27 1/2 | 1 | pump to pipe | 55-70 | Backwall difficult to resolve due to non-parallel sides | X | | | X | | | 1* | Slight Restriction on axial and circ. scans due to (hump/dip) at toe of weld on pump side. |
| 1RC-02-27 1/2 | 5 | pipe to valve | 45-55 | Backwall resolved most of the time | X | | | X | | ID | 1* | Approx. 1 ft. at TDC, both axial & circ. scans could not be performed due to a beam in the way. Also (dip) at toe weld. |
| 1RC-02-27 1/2 | 6 | valve to pipe | 51-64 | | X | | X | | | ID | | Scans 3,4,& 5 were sometimes restricted due to surface contact at the toe of the weld on valve side. |
| 1RC-02-27 1/2 | 12 | pipe to elbow | 62-65 | Loss of backwall occurred at the elbow-to-weld transition due to poor transducer-to-surface contact | X | X | X | X | | ID | 1* | While performing scans 2,4,& 5 the transducer did not make good contact with the surface at the elbow-to-weld transition |

1* 360° Intermittent  2* No Restrictions  3* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclusion | Other | | |
| 1RC-02-27 1/2 | 13 | elbow to safe-end | 63-65 | | | | | | | | | The following restrictions were due to transducer-to-surface contact. Scan #3 restricted due to taper of elbow. Scans 4 & 5 restricted to weld only. Scans 1 & 7 "best effort" exam elbow side |
| 1RC-02-29" | 17 | pipe to valve | 67 | | X | X | X | | | ID | | Scans 4 & 5 restricted 45 to 90 degrees and from 180 to 225 degrees due to weld crown narrows. Scans 1, 2,4,5,& 7 restricted due to no transducer contact. |
| 1RC-02-29" | 18 | valve to elbow | valve side 51.9-61 elbow side 54-68 | Loss of backwall noted on elbow side due to high noise level | X | | X | X | | ID | 1* | Scans 1,2,3,4 &5 are limited when approaching either side of weld toe due to OD geometry |
| 1RC-02-31" | 19 | elbow to nozzle | 63 | | X | | X | | | ID | 1* | 2* |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 1RC-02-31" | 23 | nozzle to elbow | 42-56 | Loss of backwall was noted on either side of weld toe due to OD geometry | X | | X | X | | ID | 1* | Scans 4 & 5 restricted on weld and weld toe due to OD geometry |
| 1RC-02-31" | 24 | elbow to pipe | 52.9 | | X | | X | X | | ID | 1* | 2* |
| 1RC-02-31" | 25 | pipe to elbow | 66-72 | | X | X | X | X | | ID | 1* | 2* Scan 4-probable mid wall noise indications |
| 1RC-02-31" | 26 | elbow to pipe | 43-65 | Backwall resolved most of the time | X | X | X | | | | 1* | 2* Scan 4 appears as ID roll or noise signal |
| 1RC-02-31" | 30 | pipe to elbow | 58.5 | | X | | X | X | | ID | 1* | 2* |
| 1RC-02-31" | 31 | elbow to pump | 57.8 | | X | | X | X | | ID | 1* | Scans 4 & 5 restricted 1 inch on either side of weld center line due to OD geometry |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

BRAIDWOOD UNIT #1 U.T. EXAMINATION RESULTS

OF R.C. CAST FITTINGS

LOOP #3

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 1RC-03-29" | 3 | pipe to valve | 50-58 | | X | X | X | X | X | | 3* possible base metal inclusion verified on radiograph | Scans 4 & 5 had loss of coupling due to OD geometry Scans 1 & 2 limited at weld toe due to OD geometry |
| 1RC-03-29" | 4 | valve to elbow | valve side 40-54 elbow side 38-56 | A loss of backwall was noted when approaching either side of weld toe due of OD geometry | X | X | X | X | | ID | Scans 4 & 5 possible ID geometry | scans 4 & 5 limited when approaching either side of weld toe due to OD geometry |
| 1RC-03-31" | 8 | elbow to nozzle | 90 | | X | | X | X | | | 1* | 2* |
| 1RC-03-31" | 9 | nozzle to elbow | 91 | | X | | X | X | | | 1* | 2* |
| 1RC-03-31" | 10 | elbow to pipe | 91 | | X | | X | X | | | 1* | 2* |
| 1RC-03-31" | 11 | pipe to elbow | 53-64 | | X | | X | X | | ID | 1* | Scans 4 & 5 loose coupling for approx 50% of the scan due to OD geometry |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclusion | Other | | |
| 1RC-03-31" | 12 | elbow to pipe | 48.4 - 54 | | X | | X | X | | ID | 1* | 2* |
| 1RC-03-31" | 16 | pipe to elbow | 48-65 | Straight beam exam scanned at .5 MHz to 1.0 MHz to resolve backwall | X | | X | X | | | 1* | 2* |
| 1RC-03-31" | 17 | elbow to pump | 50-65 | Backwall could not be resolved on pump side most of the time | X | | X | | | | 1* | Circ and axial scans limited due to surface contour at toe of weld. Also a partial scan was obtained over the weld center line |
| 1RC-03-27 1/2 | 18 | pump to pipe | 50-75 | Backwall difficult to resolve on pump side due to noise | X | | X | X | | ID | 1* | Poor contact was noted on circ and axial scans at junction between weld toe and pump |
| 1RC-03-27 1/2 | 22 | pipe to valve | 64 | Loss of backwall occurred at the toe of the weld on the pipe side & valve side from 0 to 90 degrees | X | X | | X | X | | 3* Scans 4 & 5 revealed a small base metal inclusion. | 2* |
| 1RC-03-27 1/2 | 23 | valve to pipe | 55-58 | | X | | X | X | | ID | 1* | 2* |

1* 360° Intermittent  2* No Restrictions  3* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 1RC-03-27 1/2 | 31 | pipe to elbow | 62 | A loss of back reflextion occurred at the weld-to-base metal transition on elbow side due to transducer lift off | X | | X | X | | | 1* | Transducer lift off occurred on scans 2,4, &5 primarily from 180 to 0 degrees |
| 1RC-03-27 1/2 | 32 | elbow to safe-end | 71 | Scan #1 was performed where best transducer-to-surface could be obtained | | | | | | | | Scans 4 & 5 were performed on the weld only. No scan 3 could be performed due to lack of transducer-to-surface contact. |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

BRAIDWOOD UNIT #1 U.T. EXAMINATION RESULTS

OF R.C. CAST FITTINGS

LOOP #4

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 1RC-04-29" | 4 | pipe to valve | 62 | Backwall difficult to resolve 50% of the time due to unparallel surfaces or waviness of the OD | X | X | X | X | X | | 1*, 3* Possible base metal inclusion verified on radiograph | Loss of surface contact was noted on scans 4 & 5 approx. 1 foot on either side of 180 degrees |
| 1RC-04-29" | 5 | valve to elbow | 51.3 - 61.4 | Excessive noise is present on scan #1 due to grain structure | X | X | X | | | ID | 3* | Scans 1,4, & 5 restricted either side of weld toe due to base metal and weld transition Scans 2 & 3 lose coupling due to OD |
| 1RC-04-31" | 9 | elbow to nozzle | 58-60 | | X | X | X | | X | I.D. | 1* Scan 4 & 5 possible base metal inclusion | 2* |
| 1RC-04-31" | 10 | nozzle to elbow | 61.7 | | X | | X | X | | ID | 1* | 2* |
| 1RC-04-31" | 11 | elbow to pipe | 89 | | X | | X | X | | ID | 1* | 2* |
| 1RC-04-31" | 12 | pipe to elbow | 53.9 | | X | | X | X | | ID | 1* | 2* |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclusion | Other | | |
| 1RC-04-31" | 13 | elbow to pipe | 53.7-66.8 | | X | | X | | | | 1* | Scans 3,4,&5 restricted when approaching weld toe due to OD geometry |
| 1RC-04-31" | 17 | pipe to elbow | 55-60 | | X | | X | X | | | 1* | 2* |
| 1RC-04-31" | 18 | elbow to pump | 66.5 | No back reflection could be detected on pump side due to noise | X | | X | X | | | 1* | Scans 4 & 5 were restricted .5" on either side of weld center line due to OD geometry |
| 1RC-04-27 1/2 | 19 | pump to pipe | 60-64 | A reduction of back reflection was noted on pump side due to ID geometry | X | | X | X | | | 1* | Scans 1,3,4,&5 limited on either side of weld toe due to OD geometry |
| 1RC-04-27 1/2 | 23 | pipe to valve | 40-65 | | X | | X | X | | | | 2* |
| 1RC-04-27 1/2 | 24 | valve to pipe | 60 | | X | | X | X | | ID | 1* | 2* |
| 1RC-04-27 1/2 | 31 | pipe to elbow | 55-66 | Backwall difficult to resolve on elbow side due to high noise level | X | | X | X | | | | Scan #2 had a tendency to lose coupling when the crystal approached weld toe. |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

| Line No. | Weld No. | Weld Configuration | Straight Beam Examination | | Angle Beam Examination | | | | | | | Additional Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Atten. Measur. dB | Comments | Indication | | Reflectors Recorded | | | | Comments | |
| | | | | | Circ | Axial | Count Bore | Root | Inclu-sion | Other | | |
| 1RC-04-27 1/2 | 32 | elbow to safe-end | 47-59 | | | | | | | | | No axial scans performed from elbow side due to OD configuration. Scan #1 limited due to transition on elbow side. Straight beam limited to weld material and approx. 1-1/2" from center line on elbow side. Scans #4 & 5 performed on weld material only |
| | | | | | | | | | | | | |

1* 360° Intermittent 2* No Restrictions 3* Radiograph Reviewed

ATTACHMENT B

BYRON UNIT 2 RELIEF REQUESTS:

| | |
|---|---|
| NR-1 | Limited ultrasonic examinations were performed on cast stainless steel elbow-to-cast pump or valve welds. |
| NR-2 | Limited ultrasonic examinations were performed on cast staionless steel elbow-to-reactor vessel nozzle safe-end welds. |
| NR-3 | Limited ultrasonic examinations were performed on cast stainless steel elbow-to steam generator nozzle welds. |
| NR-12 | Limited ultrasonic examinations were performed on cast stainless steel; elbow, pump or valve-to-pipe welds. |

# RELIEF REQUEST NR-1

1. SYSTEM: Reactor Coolant

2. NUMBER OF ITEMS: 8

Cast Stainless Steel SA-351-CF8A (Elbow)
to
Cast Stainless Steel SA-351-CF8 (Pump)

| Line Number | Weld Number | Attachment Numbers |
|---|---|---|
| 2RC02AA-31" | J-8 | 1 & 2 |
| 2RC02AB-31" | J-8 | 1 & 2 |
| 2RC02AC-31 | J-8 | 1 & 2 |
| 2RC02AD-31 | J-8 | 1 & 2 |

Cast Stainless Steel SA-351-CF8A (Elbow)
to
Cast Stainless Steel SA-351-CF8M (Valve)

| Line Number | Weld Number | Attachment Numbers |
|---|---|---|
| 2RC01AA-29" | J-4 | 1 & 3 |
| 2RC01AB-29" | J-4 | 1 & 3 |
| 2RC01AC-29" | J-4 | 1 & 3 |
| 2RC01AD-29" | J-5 | 1 & 3 |

3. ASME CODE CLASS: 1

4. ASME CODE SECTION XI REQUIREMENTS: Table IWB-2500-1, Examination Category B-J, Item B9.11 requires a surface and volumetric examination of the regions described in Figure IWB-2500-8 for piping 4 in. nominal pipe size and greater. In addition, Examination Category B-P, Item B15.50 requires a system leakage test in accordance with IWB-5221 each refueling outage for all pressure retaining components. Article IWB-2200, "Preservice Examination" states that:

   a. Examinations required by this Article shall be completed prior to initial plant startup. In addition, the preservice examinations shall be extended to include essentially 100% of the pressure retaining welds in all Class 1 components except in those components exempted from examination by IWB-1220 (a), (b), or (c).

   b. Shop and field examinations may serve in lieu of the on-site preservice examination provided:

      1) In the case of vessels only, the examination is performed after the hydrostatic test required by Section III has been completed;
      2) such examinations are conducted under conditions and with equipment and techniques equivalent to those that are expected to be employed for subsequent inservice inspections;

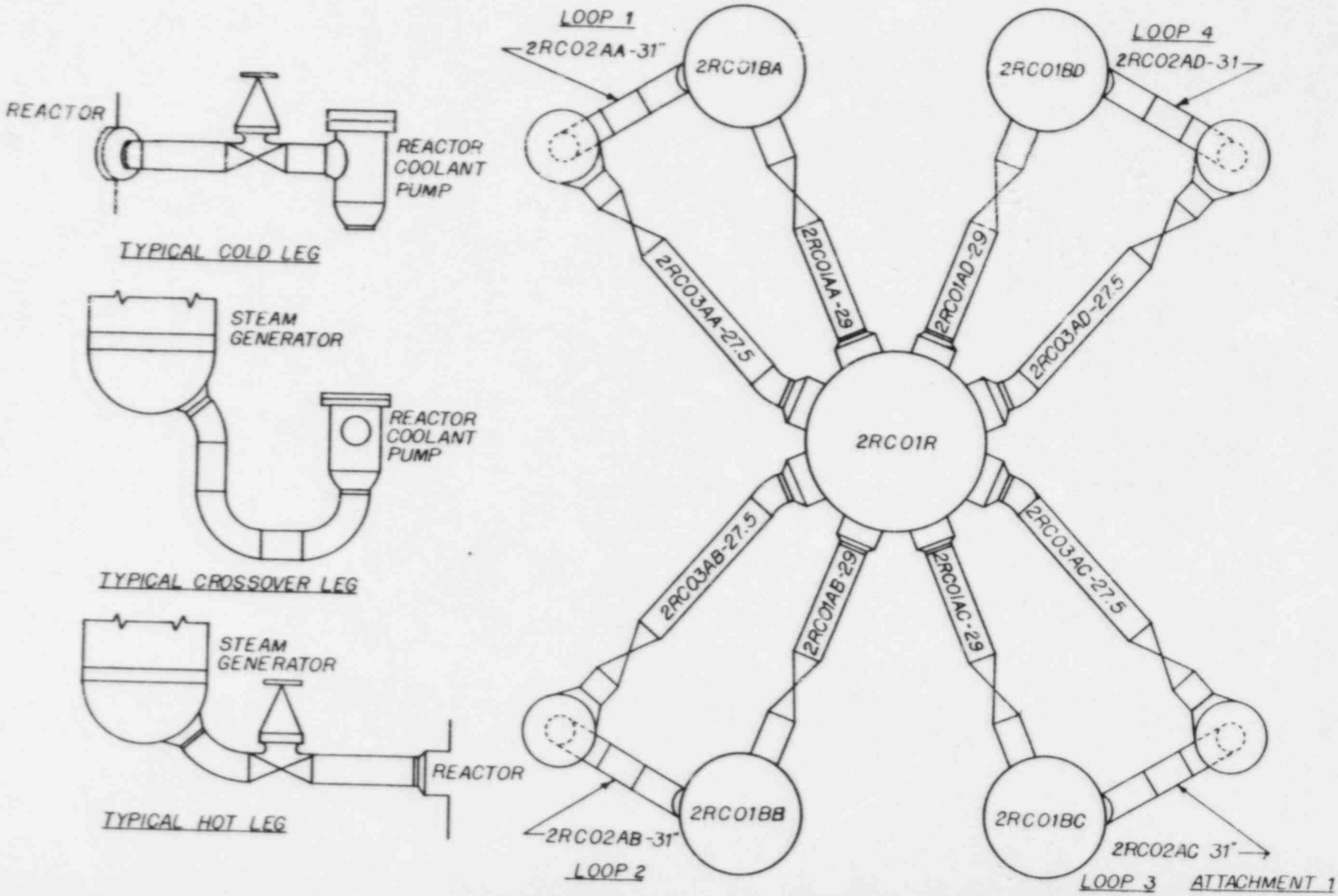
3) the shop and field examinations records are, or can be, documented and identified in a form consistent with those required in IWA-6000.

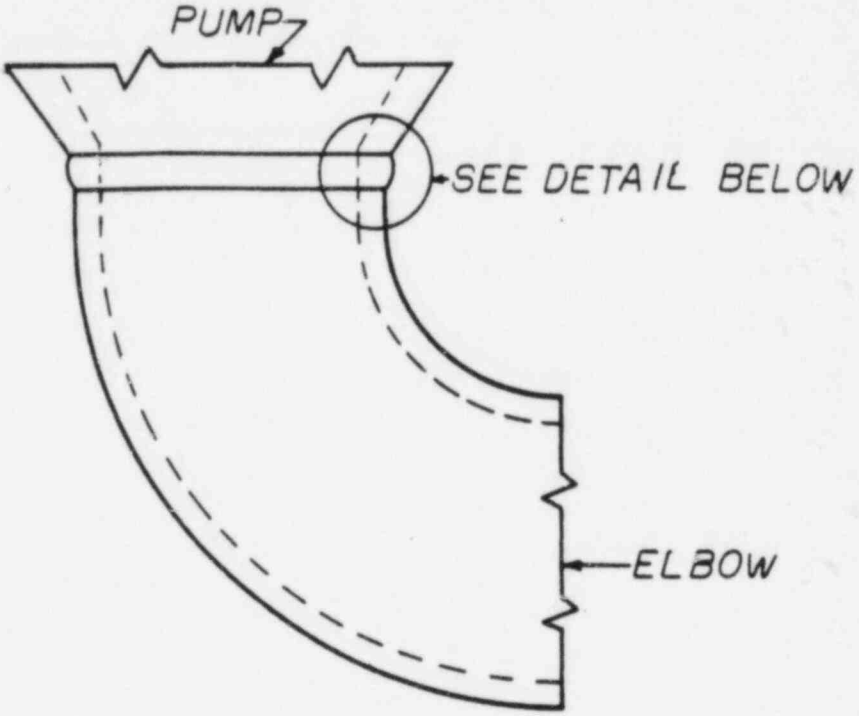
5. BASIS FOR RELIEF: All of the welds listed above are cast austenitic stainless steel to cast austenitic stainless steel. Acceptable radiographic examinations of these welds have been completed to meet the preservice volumetric inspection requirement. However, we do not intend to use radiography as the inservice volumetric examination method.

   A "best effort" ultrasonic examination, consisting of the code required axial 1/2 V-path scan from both sides of the weld and circumferential 1/2 V-path scan along the weld, was completed for each of the above listed welds. However, the code required sensitivity was not attainable due to the attenuation characteristics of cast austenitic stainless steel. In addition, the unwieldy characteristics of the contoured wedge search unit and the valve body contour on the O.D. surface presented some limitations during the axial scans (except weld J5 on line 2RC01AD-29" which had no examination restrictions). Circumferential scans were limited a short distance from the edge of the weld crown for both the valve and pump welds because of the search unit dimensions and the physical shape of these castings. These restrictions precluded the 100% examination coverage as required by the procedure.

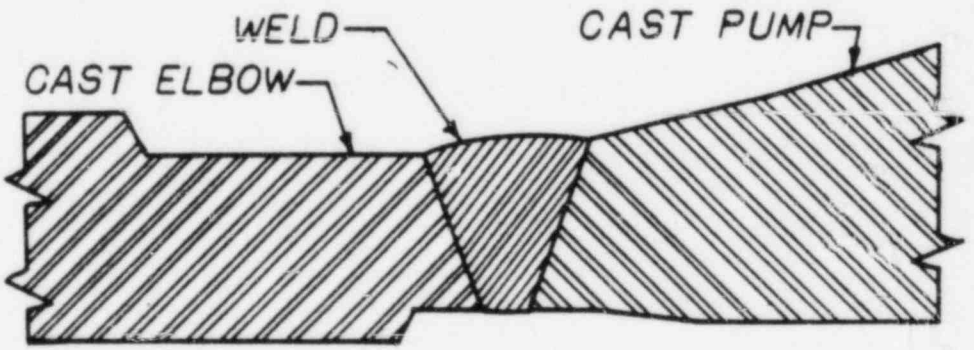
6. ALTERNATE TEST METHOD: None.

7. JUSTIFICATION: The examinations performed on the above listed welds represent the state-of-the-art, best effort, technique available for the inspection of cast austenitic stainless steel. The ultrasonic inspection technique utilizes two 1.0 inch diameter x 1.0 MHz transducers, mounted on a contoured wedge search unit, that produce an approximate 41 degree, dual, refracted longitudinal wave focused near the calibration block I.D. surface. The calibration standards were machined from a representative cast stainless steel elbow. The ultrasonic examination technique was proven capable of penetrating ultrasound to the weld I.D. and detecting large flaws (25% or greater through wall dimension) in the cast material. Despite the reported limitations, both axial and circumferential scans were capable of locating flaws within the counterbore region as verified by the identification of root and counterbore signals. This counterbore region (See Attachments) closely resembles the ASME Code required examination volume and thus is the primary area of interest for volumetric flaw detection. The combination of acceptable radiographic examinations and these state-of-the-art ultrasonic examinations assures an acceptably high level of structural integrity for these welds.


REACTOR
REACTOR COOLANT PUMP
TYPICAL COLD LEG
STEAM GENERATOR
REACTOR COOLANT PUMP
TYPICAL CROSSOVER LEG
STEAM GENERATOR
REACTOR
TYPICAL HOT LEG
LOOP 1
2RC02AA-31"
2RC01BA
2RC01BD
LOOP 4
2RC02AD-31
2RC03AA-27.5
2RC01AA-29
2RC01AD-29
2RC03AD-27.5
2RC01R
2RC03AB-27.5
2RC01AB-29
2RC01AC-29
2RC03AC-27.5
2RC01BB
2RC01BC
2RC02AB-31"
LOOP 2
2RC02AC 31"
LOOP 3
ATTACHMENT 1



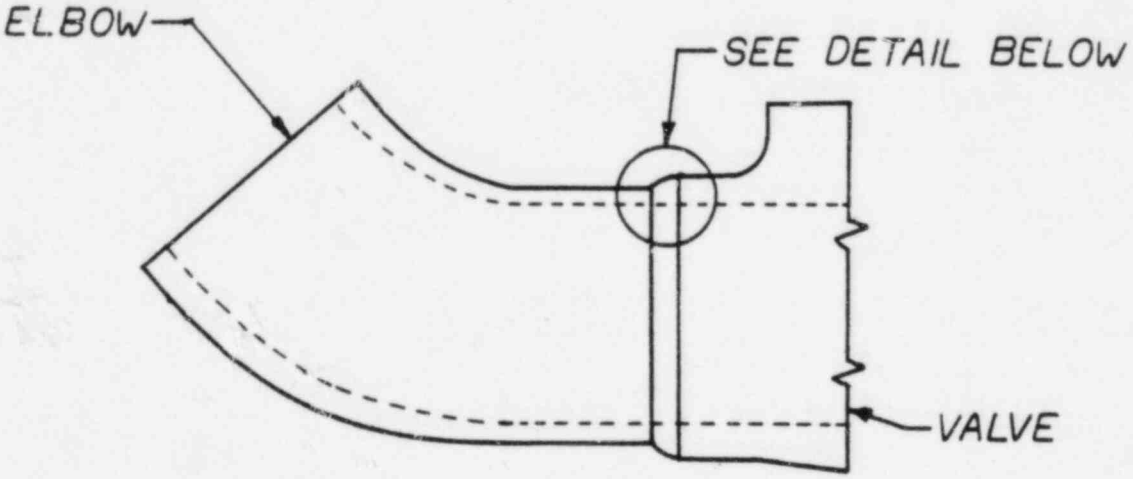

ELBOW TO PUMP



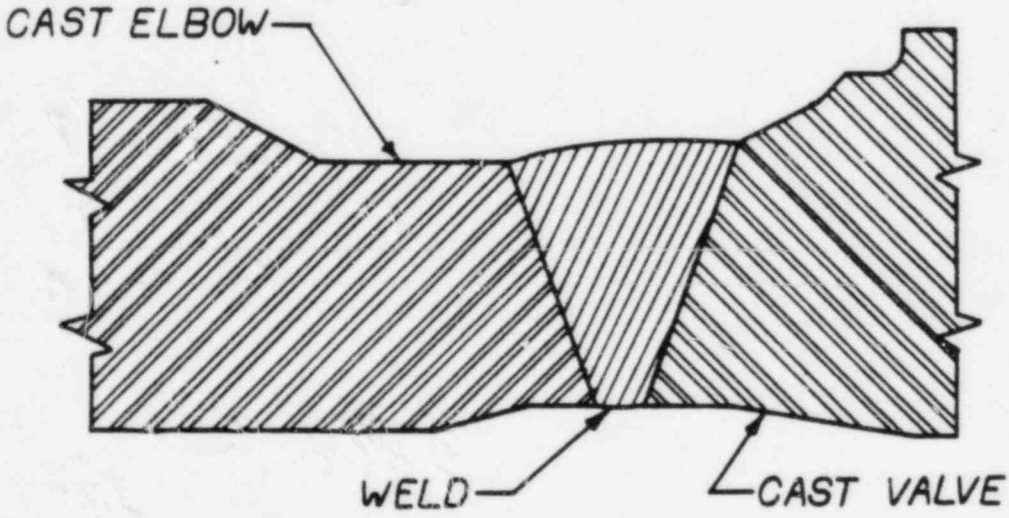

WELD DETAIL

ATTACHMENT 2

NR-1




ELBOW TO VALVE




WELD DETAIL

ATTACHMENT 3
NR-1

# RELIEF REQUEST NR-2

1. SYSTEM: Reactor Coolant

2. NUMBER OF ITEMS: 4

Cast Stainless Steel SA-351-CF8A (Elbow)
to
Stainless Steel SA-182 GR-F316 (Safe-end)

| Line Number | Weld Number | Attachment Number |
|---|---|---|
| 2RC03AA-27.5" | J-12 | 1 & 2 |
| 2RC03AB-27.5" | J-12 | 1 & 2 |
| 2RC03AC-27.5" | J-13 | 1 & 2 |
| 2RC03AD-27.5" | J-12 | 1 & 2 |

3. ASME CODE CLASS: 1

4. ASME CODE SECTION XI REQUIREMENTS: Table IWB-2500-1, Examination Category B-J, Item B9.11 requires surface and volumetric examination of the regions described in Figure IWB-2500-8 for piping 4 in. nominal pipe size and greater. In addition, Examination Category B-P, Item B15.50 requires a leakage test in accordance with IWB-5221 each refueling outage for all pressure retaining components.

Article IWB-2200 "Preservice Examination" states that:

a. Examinations required by this Article shall be completed prior to initial plant startup. In addition, the preservice examinations shall be extended to include essentially 100% of the pressure retaining welds in all Class 1 components except in those components exempted from examination by IWB-1220 (a), (b) or (c).

b. Shop and field examinations may serve in lieu of on-site preservice examination provided:

   1) In the case of vessels only, the examination is performed after the hydrostatic test required by Section III has been completed;
   2) such examinations are conducted under conditions and with equipment and techniques equivalent to those that are expected to be employed for subsequent inservice inspections;
   3) the shop and field examination records are, or can be, documented and identified in a form consistent with those required in IWA-6000.

Ultrasonic examination requirements from Mandatory Appendix III, Article III-4000, require examination for:

a. reflectors parallel to the weld seam. The angle beam examination for reflectors parallel to the weld seam shall be performed by a full V path from one side or a one-half V path from two sides of the weld, where practicable.

b. reflectors transverse to the weld seam.

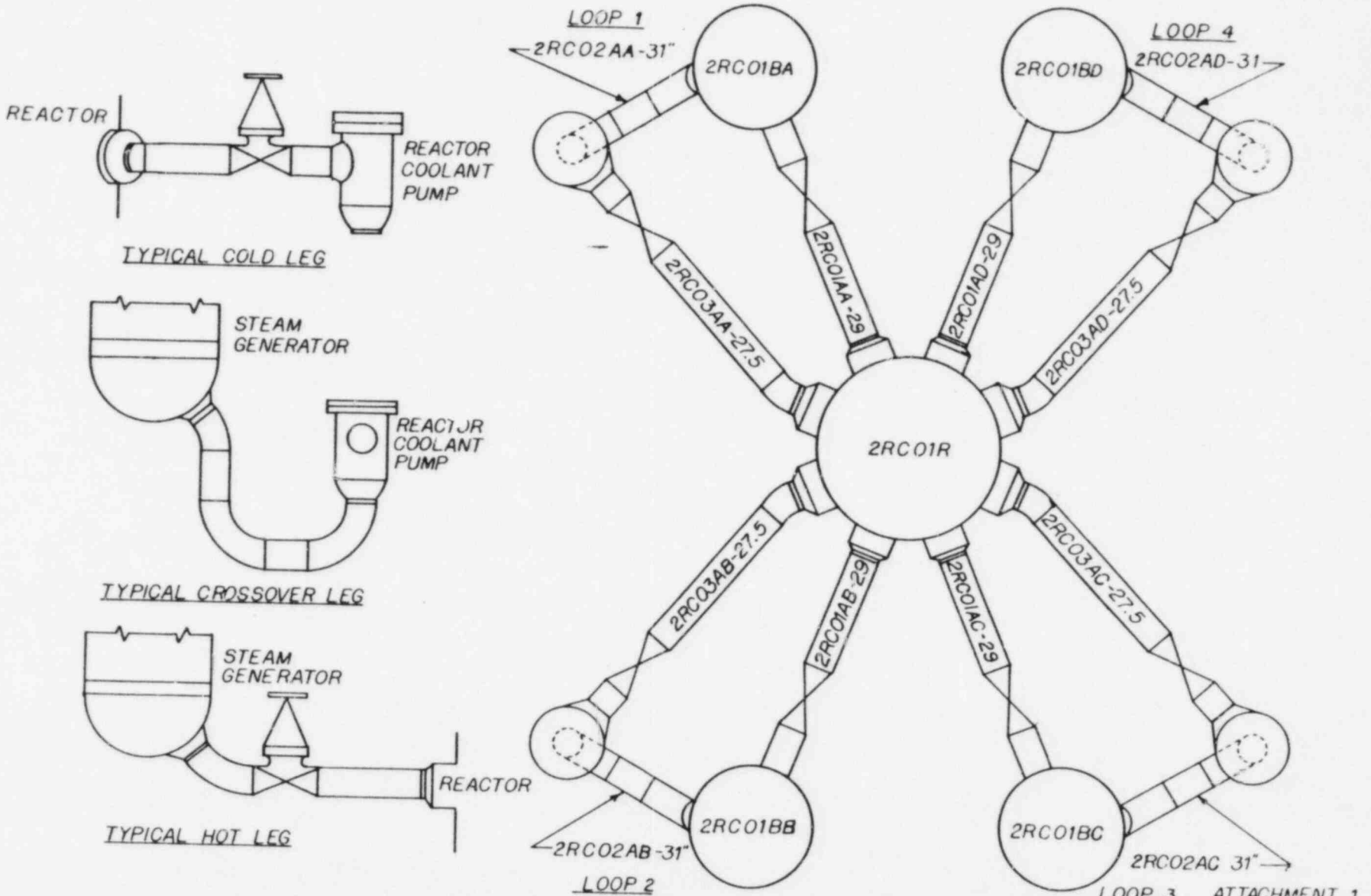
1) The angle beam examination for reflectors transverse to the weld seam shall be performed on the weld crown on a single scan path to examine the weld root by one-half V path in two directions along the weld.
2) For inservice examination, only those welds showing reportable preservice indications need be examined for transverse reflectors.

5. BASIS FOR RELIEF: The welds listed above are all cast austenitic stainless steel to Reactor Vessel nozzle safe-ends. These welds have received radiographic and surface examinations to meet the preservice volumetric and surface examination requirements. However, we do not intend to use radiography as the inservice volumetric examination method.

Ultrasonic examinations were performed circumferentially in both directions for transverse reflectors, and axially for parallel reflectors, from the safe-end side only, on each of the above listed welds. In addition, a "best effort" ultrasonic examination, consisting of circumferential 1/2 V-path scans of the elbow side base metal, was performed. The unwieldy characteristics of the contoured wedge search unit and the as-cast transition on the elbow O.D. surface prevented performance of an axial scan from the elbow side. The elbow side circumferential scans were limited a short distance from the edge of the weld crown due to the inability of the search unit to maintain sufficient coupling while scanning over the weld to base metal transition. The code required sensitivity was, also, not attainable on the elbow side due to the attenuation characteristics of cast austenitic stainless steel. These restrictions precluded the 100% examination coverage as required by the procedure.

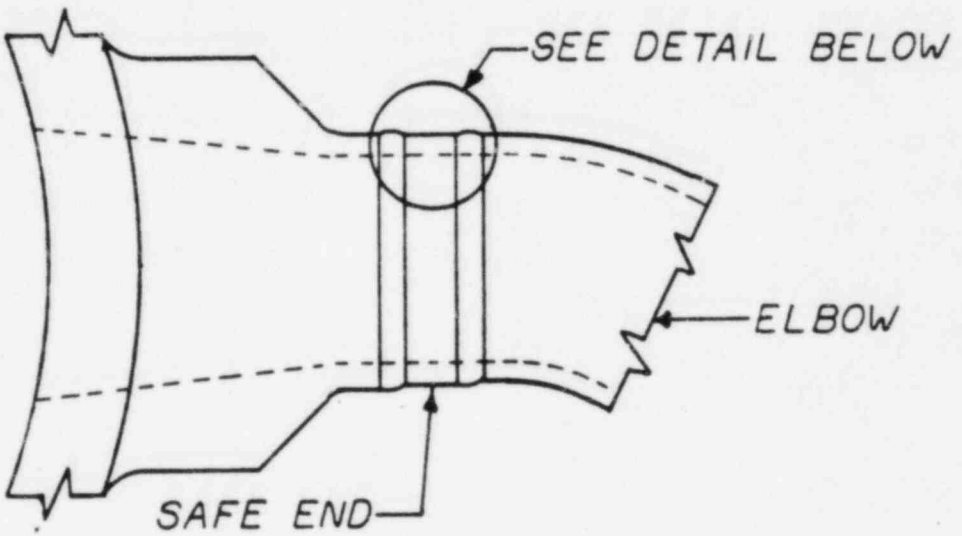
6. ALTERNATE TEST METHOD: None.

7. JUSTIFICATION: The examinations performed from the cast (elbow) side of the above listed welds represent the state-of-the-art, best effort, technique available for the inspection of cast austenitic stainless steel. The ultrasonic inspection technique utilizes two 1.0 inch diameter x 1.0 MHz transducers, mounted on a contoured wedge search unit, that produce an approximate 41 degree, dual, refracted longitudinal wave focused near the calibration block I.D. surface. The calibration standards were machined from a representative cast stainless steel elbow. The ultrasonic examination technique was proven capable of penetrating ultrasound to the weld I.D. and detecting large flaws (25% or greater through wall dimension) in the cast material. The circumferential scans were capable of locating flaws in the volume of metal adjacent to the weld, near the I.D. surface. Having performed acceptable radiographic and one-sided ultrasonic (from the safe-end side) examinations as well as the state-of-the-art ultrasonic examination (from the elbow side), an acceptably high level of structural integrity for these welds is assured.

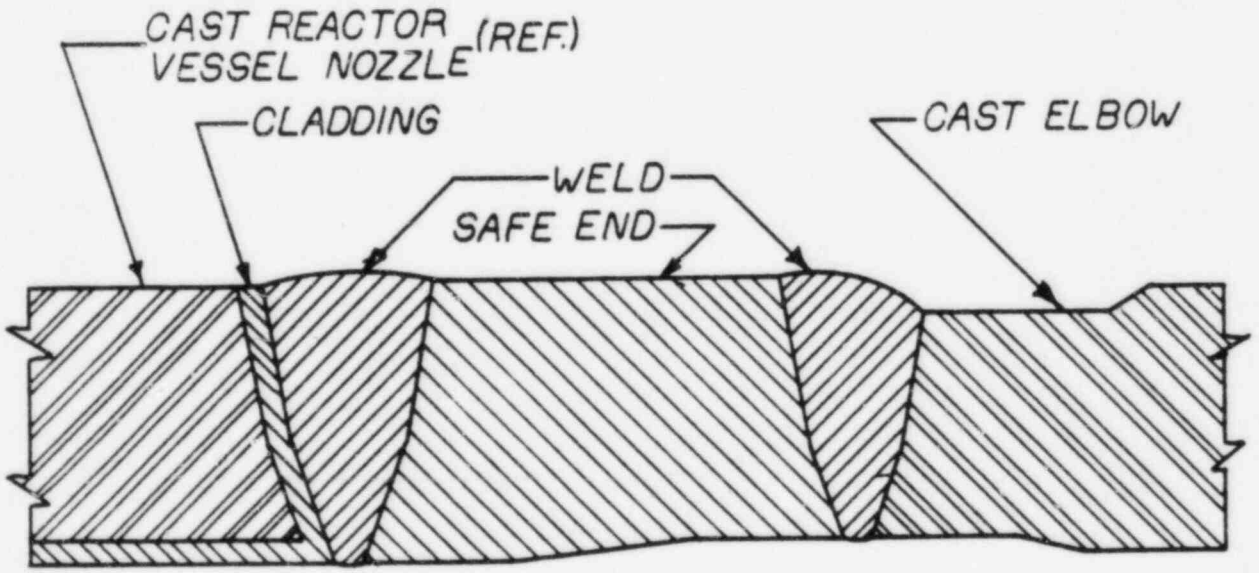



ATTACHMENT 1

NR-2




ELBOW TO SAFE END




WELD DETAIL

ATTACHMENT 2

NR-2

RELIEF REQUEST NR-3

1. SYSTEM: Reactor Coolant

2. NUMBER OF ITEMS: 8

Cast Stainless Steel SA-351-CF8A (Elbow)
to
Cast Carbon Steel SA-216 GR-WCC (Nozzle)

| Line Number | Weld Number | Attachment Numbers |
|---|---|---|
| 2RC01AA-29" | F-2 | 1 & 2 |
| 2RC02AA-31" | F-1 | 1 & 2 |
| 2RC01AB-29" | F-2 | 1 & 2 |
| 2RC02AB-31" | F-1 | 1 & 2 |
| 2RC01AC-29" | F-2 | 1 & 2 |
| 2RC02AC-31" | F-1 | 1 & 2 |
| 2RC01AD-29" | F-2 | 1 & 2 |
| 2RC02AD-31" | F-1 | 1 & 2 |

3. ASME CODE CLASS: 1

4. ASME CODE SECTION XI REQUIREMENTS: Table IWB-2500-1, Examination Category B-F, Item B5.30 requires surface and volumetric examination of the regions described in Figure IWB-2500-8 for all Steam Generator nozzle-to-safe end welds. In addition, Examination Category B-P, Item B15.30 requires a system leakage test in accordance with IWB-5221 each refueling outage for the steam generator pressure retaining boundary.

Article IWB-2200, "Preservice Examination", states that:

a. Examinations required by this Article shall be completed prior to initial plant startup. In addition, the preservice examinations shall be extended to include essentially 100% of the pressure retaining welds in all Class 1 components except in those components exempted from examination by IWB-1220 (a), (b) or (c).

b. Shop and field examinations may serve in lieu of on-site preservice examinations provided:

   1) In the case of vessels only, the examination is performed after the hydrostatic test required by Section III has been completed;
   2) such examinations are conducted under conditions and with equipment and techniques equivalent to those that are to be employed for subsequent inservice inspections;
   3) the shop and field examination records are, or can be, documented and identified in a form consistent with those required in IWA-6000.

Ultrasonic examination requirements from Mandatory Appendix III, Article III-4000, require examination for:

a. Reflectors parallel to the weld seam. The angle beam examination for reflectors parallel to the weld seam shall be performed by a full V path from one side or a one-half V path from two sides of the weld, where practicable.

b. Reflectors transverse to the weld seam.

1) The angle beam examination for reflectors transverse to the weld seam shall be performed on the weld crown on a single scan path to examine the weld root by one-half V path in two directions along the weld.
2) For inservice examination, only those welds showing reportable preservice indications need be examined for transverse reflectors.

5. BASIS FOR RELIEF: The welds listed above are cast austenitic stainless steel SA-351-CF8A to cast carbon steel SA-216 GR-WCC with austenitic stainless steel cladding. Acceptable radiographic examinations of these welds have been completed to meet the preservice volumetric inspection requirement. However, we do not intend to use radiography as the inservice volumetric examination method.

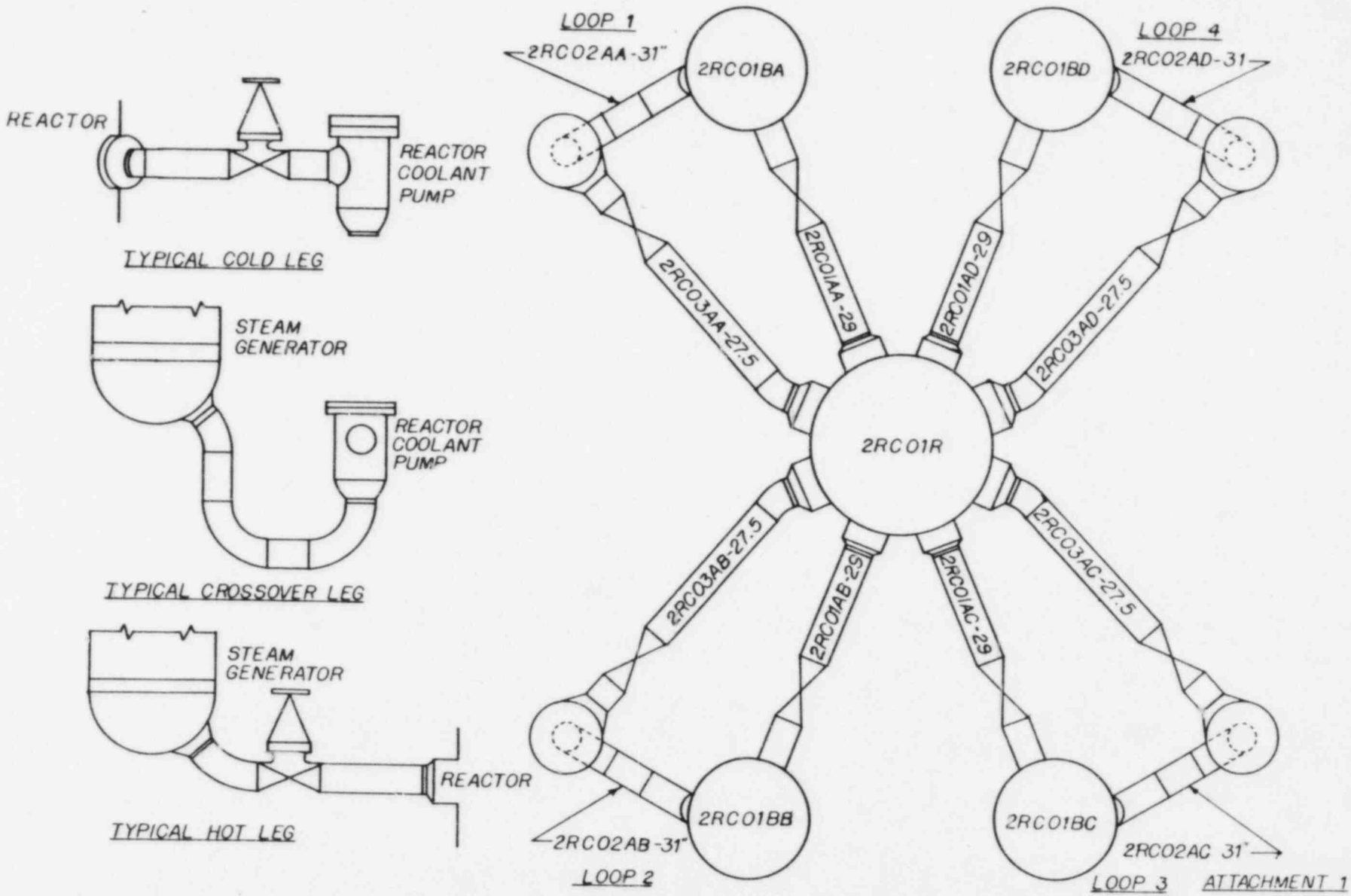
Ultrasonic examinations were performed circumferentially in both directions for transverse reflectors, and axially for parallel reflectors, from the steam generator nozzle side with a 1/2 V-path scan. In addition, a "best effort" ultrasonic examination, consisting of the code required axial 1/2 V-path scan from the elbow side and circumferential 1/2 V-path scans along the weld, was completed for each of the above listed welds. However, the code required sensitivity was not attainable on the elbow side due to the attenuation characteristics of cast austenitic stainless steel. The elbow side circumferential scans were limited a short distance from the edge of the weld crown due to the inability of the search unit to maintain sufficient coupling while scanning over the weld to base metal transition. These restrictions precluded the 100% examination coverage as required by the procedure.

6. ALTERNATE TEST METHOD: None.



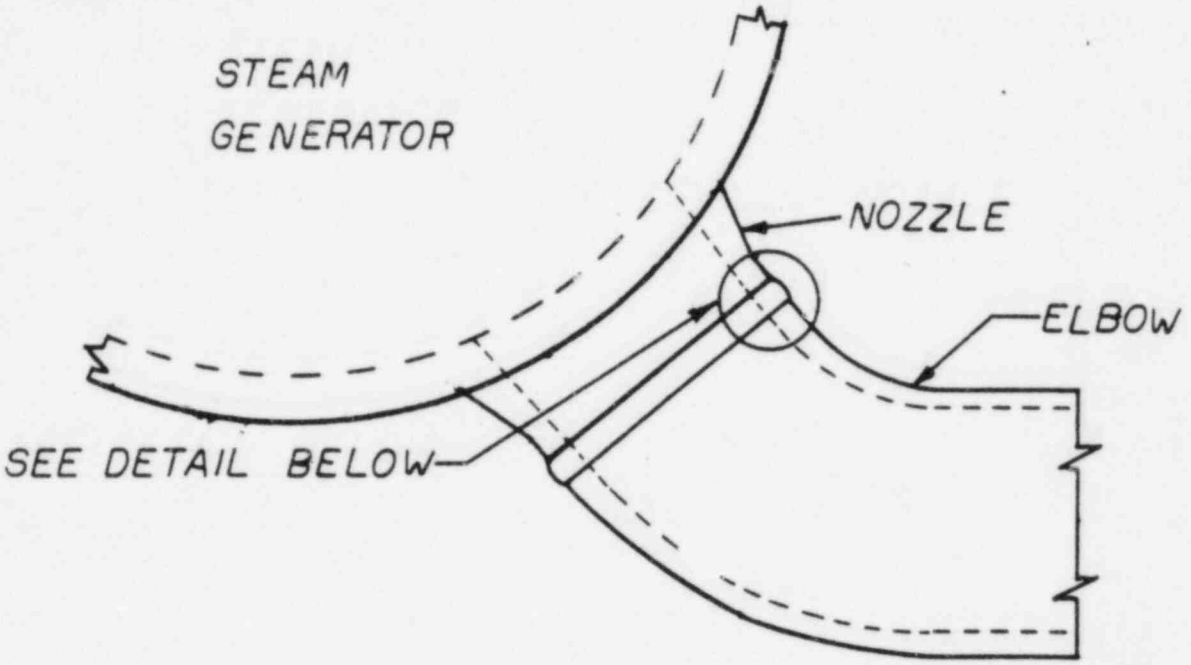
(0946M/0095M)

7. JUSTIFICATION: The examinations performed from the elbow side of the above listed welds represent the state-of-the-art, best effort, technique available for the inspection of cast austenitic stainless steel. The ultrasonic inspection technique utilizes two 1.0 inch diameter x 1.0 MHz transducers, mounted on a contoured wedge search unit, that produce an approximate 41 degree, dual, refracted longitudinal wave focused near the calibration block I.D. surface. The calibration standards were machined from a representative cast stainless steel elbow. The ultrasonic examination technique was proven capable of penetrating ultrasound to the weld I.D. and detecting large flaws (25% or greater through wall dimension) in the cast material. Despite the reported limitations, both axial and circumferential scans were capable of locating any flaws within the counterbore region as verified by the identification of root and counterbore signals. This counterbore region (See Attachments) closely resembles the ASME Code required examination volume and thus is the primary area of interest for volumetric flaw detection. The combination of acceptable radiographic examinations, acceptable ultrasonic examinations from the steam generator side, and these state-of-the-art ultrasonic examinations from the elbow side assures an acceptably high level of structural integrity for these welds.

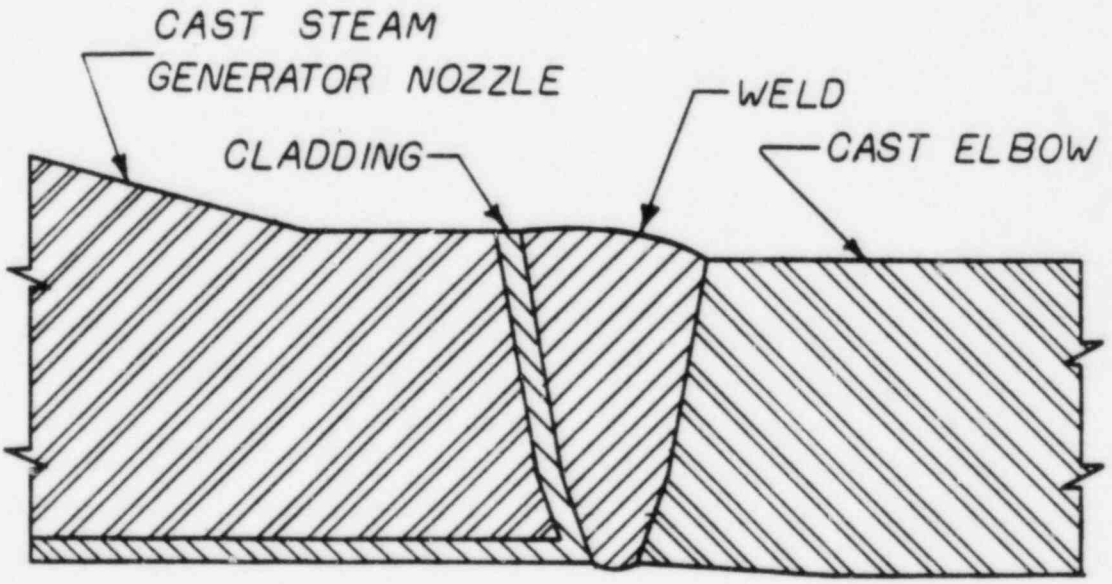



ATTACHMENT 1

NR-3




ELBOW TO NOZZLE




WELD DETAIL

ATTACHMENT 2

NR-3

# RELIEF REQUEST NR-12

1. SYSTEM: Reactor Coolant

2. NUMBER OF ITEMS: 36

Cast Stainless Steel SA-351-CF8A (Elbow)
to
Stainless Steel SA-376 Type 304N (Pipe)

| Line Number | Weld Numbers | Attachments Numbers |
|---|---|---|
| 2RC02AA-31" | J-1, J-2, J-3, J-7 | 1 & 2 |
| 2RC02AB-31" | J-1, J-2, J-3, J-7 | 1 & 2 |
| 2RC02AC-31" | J-1, J-2, J-3, J-7 | 1 & 2 |
| 2RC02AD-31" | J-1, J-2, J-3, J-7 | 1 & 2 |
| 2RC03AA-27.5" | J-11 | 1 & 2 |
| 2RC03AB-27.5" | J-11 | 1 & 2 |
| 2RC03AC-27.5" | J-12 | 1 & 2 |
| 2RC03AD-27.5" | J-11 | 1 & 2 |

Cast Stainless Steel SA-351-CF8 (Pump)
to
Stainless Steel SA-376 Type 304N (Pipe)

| Line Number | Weld Numbers | Attachment Numbers |
|---|---|---|
| 2RC03AA-27.5 | J-1 | 1 & 3 |
| 2RC03AB-27.5 | J-1 | 1 & 3 |
| 2RC03AC-27.5 | J-1 | 1 & 3 |
| 2RC03AD-27.5 | J-1 | 1 & 3 |

Cast Stainless Steel SA-351-CF8M (Valve)
to
Stainless Steel SA-376 Type 304N (Pipe)

| Line Number | Weld Number | Attachment Number |
|---|---|---|
| 2RC01AA-29" | J-3 | 1 & 4 |
| 2RC01AB-29" | J-3 | 1 & 4 |
| 2RC01AC-29" | J-3 | 1 & 4 |
| 2RC01AD-29" | J-4 | 1 & 4 |
| 2RC03AA-27.5" | J-5, J-6 | 1 & 4 |
| 2RC03AB-27.5" | J-5, J-6 | 1 & 4 |
| 2RC03AC-27.5" | J-5, J-6 | 1 & 4 |
| 2RC03AD-27.5 | J-4, J-5 | 1 & 4 |

3 ASME CODE CLASS: 1

4. ASME CODE SECTION XI REQUIREMENTS: Table IWB-2500-1, Examination Category B-J, Items B9.11 and B9.12 require surface and volumetric examination of the regions described in Figure IWB-2500-8 for piping 4 in. nominal pipe size and greater. In addition, Examination Category B-P, Item B15.50 requires a system leakage test, IWB-5221, each refueling outage for all pressure retaining components.

Article IWB-2200, "Preservice Examination" states that:

a. Examinations required by this Article shall be completed prior to initial plant startup. In addition, the preservice examination shall be extended to include essentially 100% of the pressure retaining welds in all Class 1 components except in those components exempted from examination by IWB-1220 (a), (b), or (c).

b. Shop and field examinations may serve in lieu of on-site preservice examinations provided:

   1) In the case of vessels only, the examination is performed after the hydrostatic test required by Section III has been completed;

   2) such examinations are conducted under conditions and with equipment and techniques equivalent to those that are expected to be employed for subsequent inservice inspections;

   3) the shop and field examination records are, or can be, documented and identified in a form consistent with those required in IWA-6000.

Ultrasonic examination requirements from Mandatory Appendix III, Article III-4000 require examination for:

a. Reflectors parallel to the weld seam.

   The angle beam examination for reflectors parallel to the weld seam shall be performed by a full V-path from one side or a one-half V-path from two sides of the weld, where practicable.

b. Reflectors transverse to the weld seam

   1) The angle beam examination for reflectors transverse to the weld seam shall be performed on the weld crown on a single scan path to examine the weld root by one-half V-path in two direction along the weld.

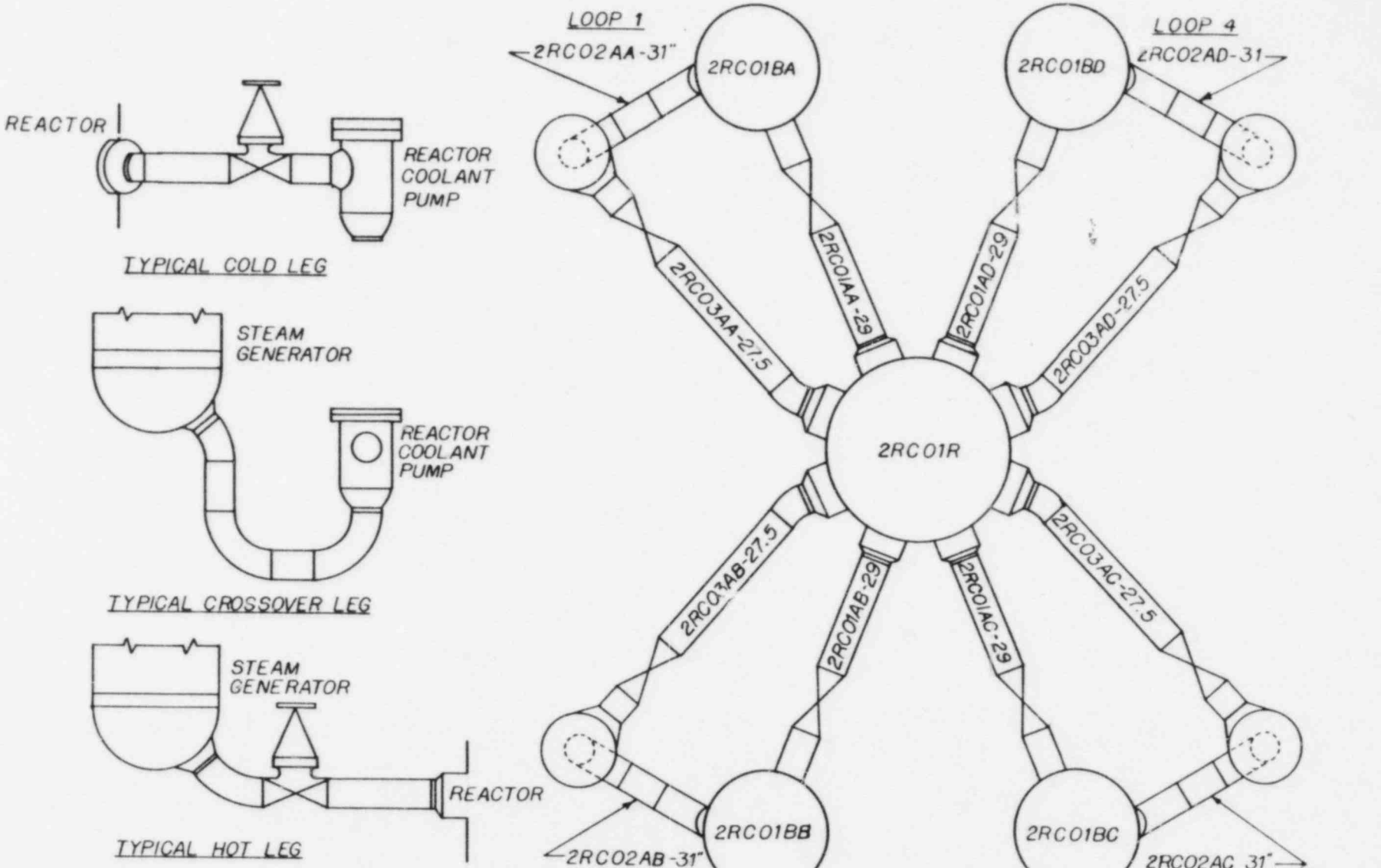
   2) For inservice examination, only those welds showing reportable preservice indications need be examined for transverse reflectors.

5. BASIS FOR RELIEF: The welds listed above are all cast austenitic stainless steel to stainless steel pipe. We have completed acceptable radiographic and surface examinations to meet the preservice volumetric and surface requirements. However, we do not intend to use radiography as the inservice volumetric examination method.

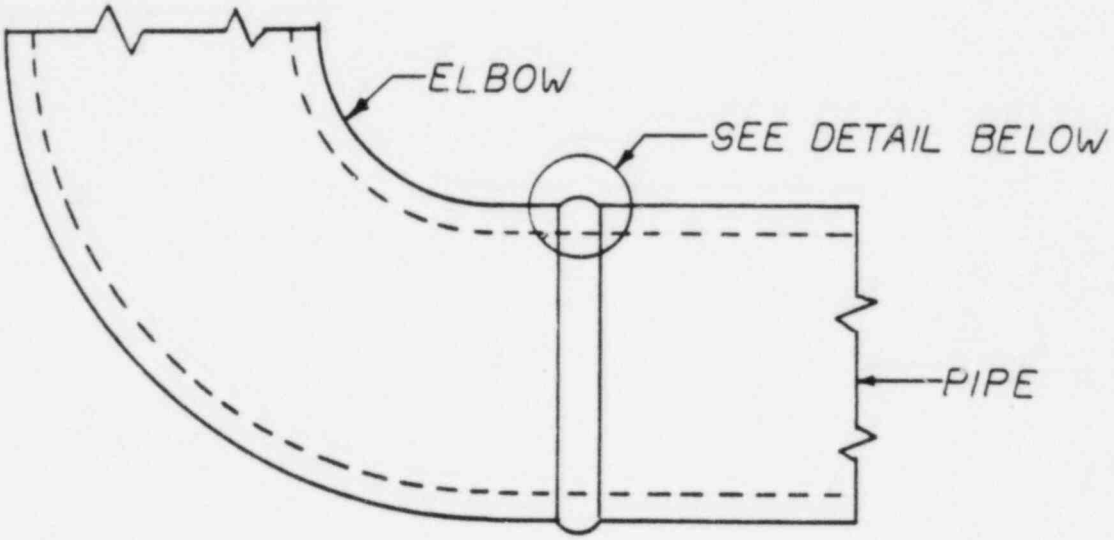
   Ultrasonic examinations were performed circumferentially in both directions for transverse reflectors, and axially for parallel reflectors, from the pipe side with a 1/2 V-path scan. In addition, a "best effort" ultrasonic examination, consisting of the code required axial 1/2 V-path scan from the component (elbow, pump, or valve) side and circumferential 1/2 V-path scans along the weld, was completed for each of the above listed welds. However, the code required sensitivity was not attainable on the component side due to the attenuation characteristics of cast austenitic stainless steel. The axial scans of welds J1 and J5, on lines 2RC02AB-31" and 2RC03AB-27.5" respectively, were limited by 3% due to base metal concavity (J1) and a permanent support (J5). The unwieldy characteristics of the contoured wedge search unit and the valve body contour on the O.D. surface presented some limitations during the axial scans of the pipe-to-valve welds. Circumferential scans were limited a short distance from the edge of the weld crown for all the pipe-to-valve welds, all the pipe-to-pump welds, and three of the pipe-to-elbow welds (2RC02AA-31"/J1, 2RC02AB-31"/J1, and 2RC02AC-31"/J3) because of the inability of the search unit to maintain sufficient coupling while scanning over the weld to base metal transition. These restrictions precluded the 100% examination coverage as required by the procedure.

6. ALTERNATE TEST METHOD: None

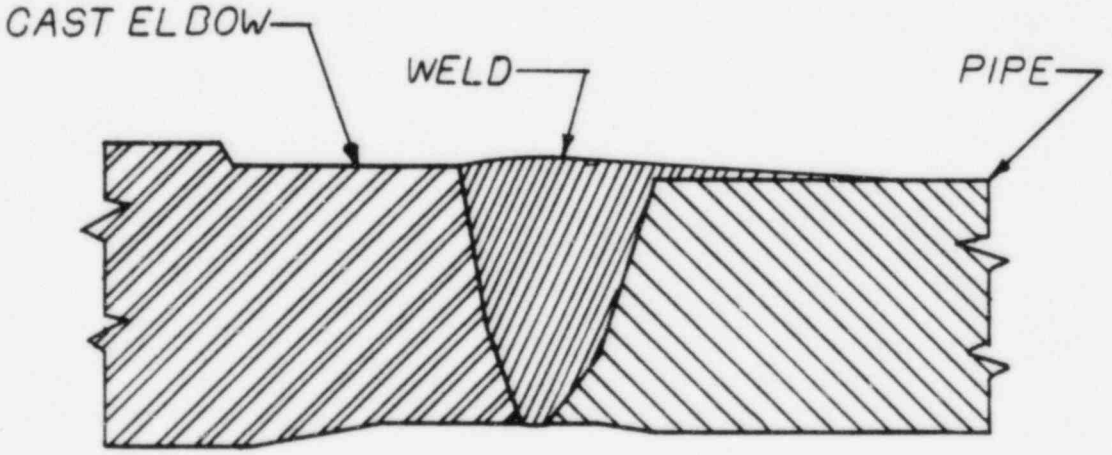
7. JUSTIFICATION: The examinations performed from the component side of the above listed welds represent the state-of-the-art, best effort, technique available for the inspection of cast austenitic stainless steel. The ultrasonic inspection technique utilizes two 1.0 inch diameter x 1.0 MHz transducers, mounted on a contoured wedge search unit, that produce an approximate 41 degree, dual, refracted longitudinal wave focused near the calibration block I.D. surface. The calibration standards were machined from a representative cast stainless steel elbow. The ultrasonic examination technique was proven capable of penetrating ultasound to the weld I.D. and detecting large flaws (25% or greater through wall dimension) in the cast material. Despite the reported limitations, both axial and circumferential scans were capable of locating flaws within the counterbore region as verified by the identification of root and counterbore signals. This counterbore region (Sec Attachments) closely resembles the ASME Code required examination volume and thus is the primary area of interest for volumetric flaw detection. The combination of acceptable radiographic examinations, acceptable ultrasonic examinations from the pipe side, and these state-of-the-art ultrasonic examinations from the component side assures an acceptably high level of structural integrity for these welds.




ATTACHMENT 1
NR-12



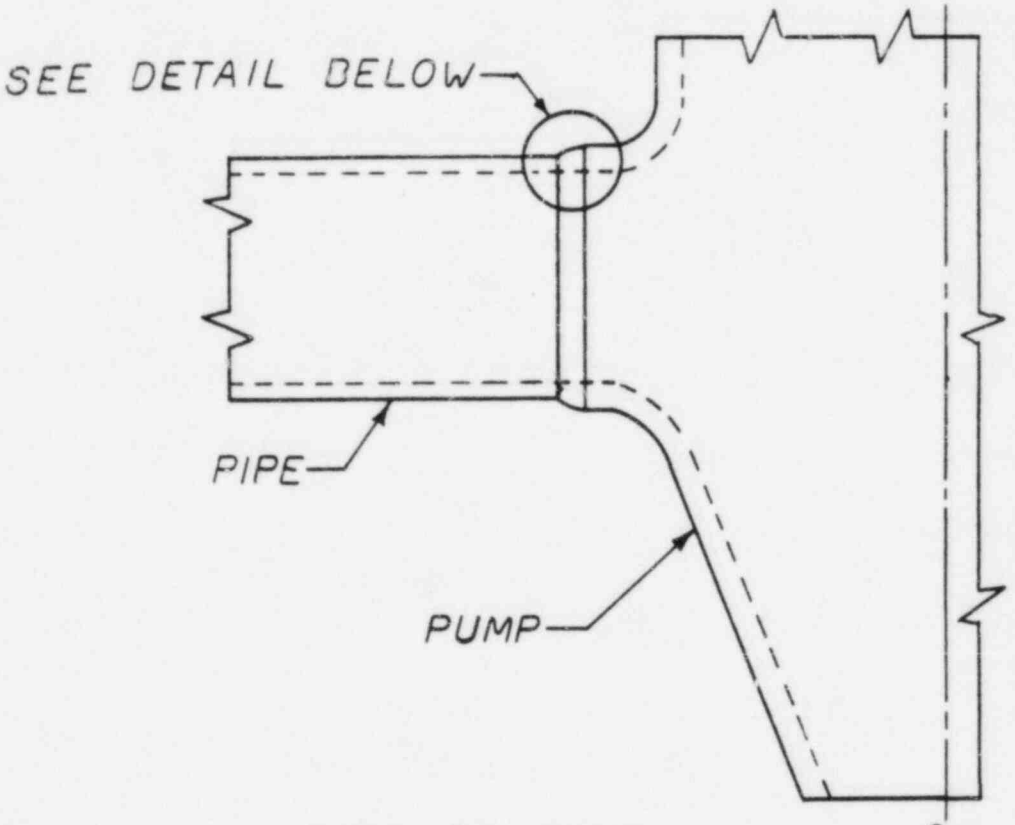

PIPE TO ELBOW



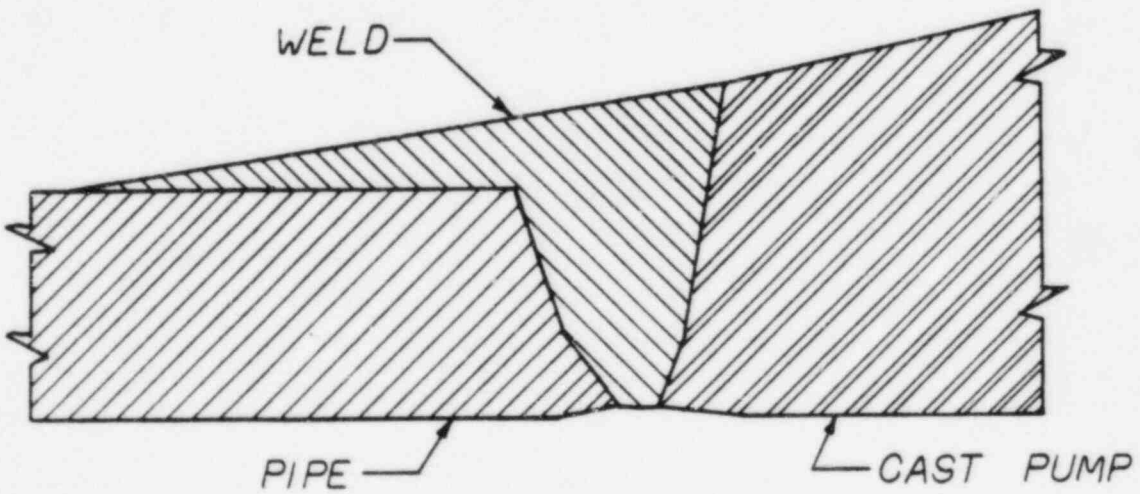

WELD DETAIL

ATTACHMENT 2

NR-12

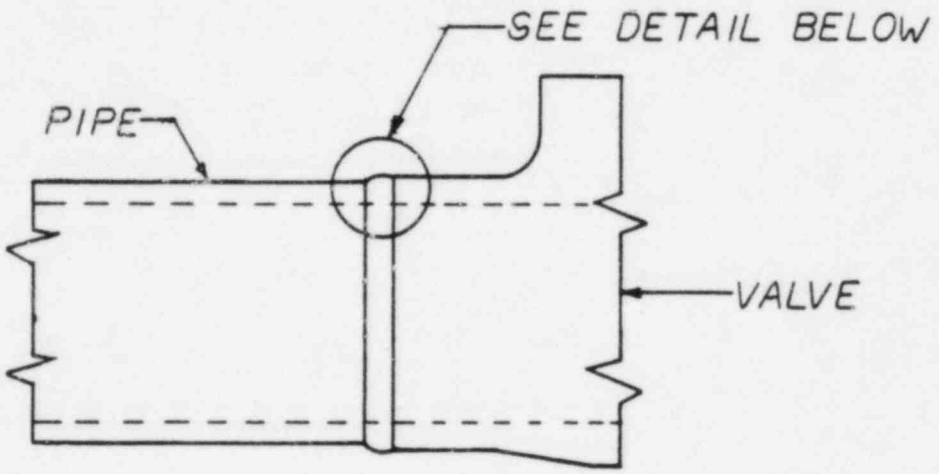



PIPE TO PUMP

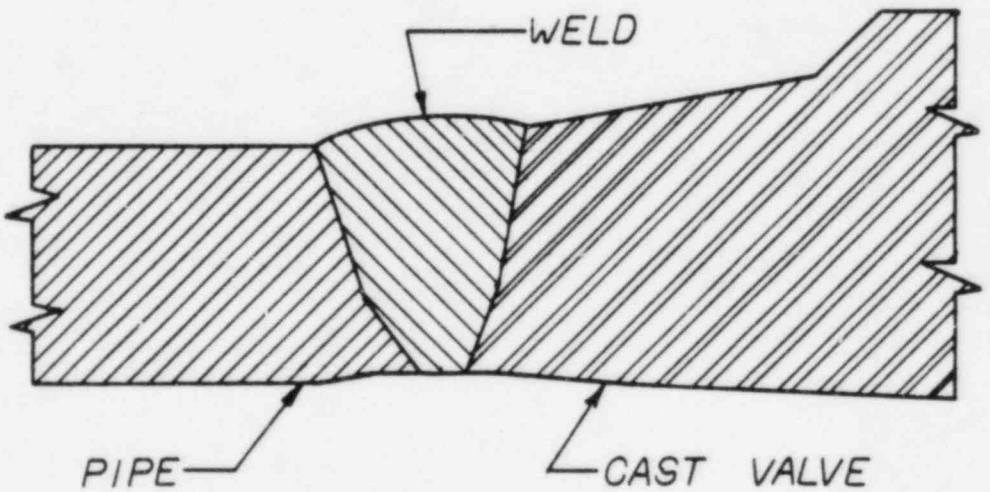



WELD DETAIL

ATTACHMENT 3
NR-12




PIPE TO VALVE




WELD DETAIL

ATTACHMENT 4

NR-12

ATTACHMENT C

BRAIDWOOD UNIT 1 RELIEF REQUESTS:

| | |
|---|---|
| 1NR-2 | Limited ultrasonic examinations were performed on cast stainless steel elbow-to-cast pump or valve welds. |
| 1NR-5 | Limited ultrasonic examinations were performed on cast stainless steel elbow-to-steam generator nozzle welds. |
| 1NR-6 | Limited ultrasonic examinations were performed on cast stainless steel elbow, pump or valve-to-pipe welds. |
| 1NR-7 | Limited ultrasonic examinations were performed on cast stainless steel elbow-to-reactor vessel nozzle safe-end welds. |

RELIEF REQUEST 1NR2 Rev. 2

1. SYSTEM: Reactor Coolant

2. NUMBER OF ITEMS: 8

| Line Number | Weld Number |
|---|---|
| 1RC02AA-31 | 1RC-01-17 |
| 1RC02AB-31 | 1RC-02-31 |
| 1RC02AC-31 | 1RC-03-17 |
| 1RC02AD-31 | 1RC-04-18 |
| 1RC01AA-29 | 1RC-01-4 |
| 1RC01AB-29 | 1RC-02-18 |
| 1RC01AC-29 | 1RC-03-4 |
| 1RC01AD-29 | 1RC-04-5 |

3. A.S.M.E. CODE CLASS: 1

4. A.S.M.E. CODE SECTION XI REQUIREMENTS: Table IWB-2500-1, Examination Category B-J, Item B.9.11 requires surface and volumetric examination of the regions described in Figure IWB-2500-8 for piping 4 in. nominal pipe size and greater, this examination includes essentially 100% of the weld length. In addition, Appendix III, Supplement 7, requires that ultrasonic examination sensitivity be established using I.D. notches with a depth of 10% wall thickness.

5. BASIS FOR RELIEF: The above listed welds are cast stainless elbows to either cast pumps or cast valves.
The optimized ultrasonic technique used for the statically cast stainless steel welds will detect large flaws (25% or greater through the wall) therefore this sensitivity is less than that required by code.
In addition, due to the unwieldly characteristics of the contoured wedge search units and variations in the machined surfaces, the welds listed above experienced axial and circumferential scanning limitations.

6. ALTERNATE TEST METHOD: None.

7. JUSTIFICATION: The structural integrity of these welds has been assured by:

   a. Having performed a best effort ultrasonic exam, based on state of the art techniques, of the cast stainless welds.

   b. Having performed acceptable radiographic and surface examinations.

RELIEF REQUEST 1NR-5 Rev. 2

1. SYSTEM: Reactor Coolant

2. NUMBER OF ITEMS: 8

Cast Stainless Steel SA 351-CF8A (Elbow)
to
Cast Carbon Steel SA-216 GR-WCC (Nozzle)

| Line Number | Weld Number |
|---|---|
| 1RC01AA-29" | 1RC-01-8 |
| 1RC02AA-31" | 1RC-01-9 |
| 1RC01AB-29" | 1RC-02-19 |
| 1RC02AB-31" | 1RC-02-23 |
| 1RC01AC-29" | 1RC-03-8 |
| 1RC02AC-31" | 1RC-03-9 |
| 1RC01AD-29" | 1RC-04-9 |
| 1RC02AD-31" | 1RC-04-10 |

3. ASME CODE CLASS: 1

4. ASME CODE SECTION XI REQUIREMENTS: Table IWB-2500-1, Examination Category B-F, Item B5.30 requires surface and volumetric examination of the regions described in Figure IWB-2500-8 for all Steam Generator nozzle-to-safe end welds. This examination includes essentially 100% of the weld length. In addition, Appendix III Supplement 7, requires that ultrasonic examination sensitivity be established using I.D. notches with a depth of 10% wall thickness.

5. BASIS FOR RELIEF: The welds listed above are cast austenitic stainless steel SA-351-CF8A to cast carbon steel SA-216 GR-WCC with austenitic stainless steel cladding. The techniques used to examine the cast stainless side of these welds will detect large flaws (25% or greater through the wall) therefore this sensitivity is less than that required by code. In addition, Weld 1RC-02-23 had limited circumferential scans near the weld toe area. This limitation is due to the transducer system's inability to maintain coupling while scanning over the weld-base metal transition.

6. ALTERNATE TEST METHOD: None.

7. JUSTIFICATION: The structural integrity of these welds has been assured by:

   a. Having performed a best effort ultrasonic exam, based on state of the art techniques, from the cast stainless side.

   b. Having performed an acceptable ultrasonic exam from the carbon steel side.

   c. Having performed acceptable radiographic and surface examinations.

1. SYSTEM: Reactor Coolant

2. NUMBER OF ITEMS: 36

Cast Stainless Steel SA-351-CF8A (Elbow)
to
Stainless Steel SA-376 Type 304N (Pipe)

| Line Number | Weld Number |
|---|---|
| 1RC02AA-31" | 1RC-01-10, 11, 12, 16 |
| 1RC02AB-31" | 1RC-02-24, 25, 26, 30 |
| 1RC02AC-31" | 1RC-03-10, 11*, 12, 16 |
| 1RC02AD-31" | 1RC-04-11, 12, 13*, 17 |
| 1RC03AA-27.5" | 1RC-01-30 |
| 1RC03AB-27.5" | 1RC-02-12 |
| 1RC03AC-27.5" | 1RC-03-31 |
| 1RC03AD-27.5" | 1RC-04-31 |

Cast Stainless Steel SA-351-CF8 (Pump)
to
Stainless Steel SA-376 Type 304N (Pipe)

| Line Number | Weld Number |
|---|---|
| 1RC03AA-27.5 | 1RC-01-18* |
| 1RC03AB-27.5 | 1RC-02-1* |
| 1RC03AC-27.5 | 1RC-03-18* |
| 1RC03AD-27.5 | 1RC-04-19* |

Cast Stainless Steel SA-351-CF8M (Valve)
to
Stainless Steel SA-376 Type 304N (Pipe)

| Line Number | Weld Number |
|---|---|
| 1RC01AA-29" | 1RC-01-3 |
| 1RC01AB-29" | 1RC-02-17* |
| 1RC01AC-29" | 1RC-03-3* |
| 1RC01AD-29" | 1RC-04-4* |
| 1RC03AA-27.5" | 1RC-01-22, 23* |
| 1RC03AB-27.5" | 1RC-02-5*, 6* |
| 1RC03AC-27.5" | 1RC-03-22, 23 |
| 1RC03AD-27.5" | 1RC-04-23, 24 |

3. ASME CODE CLASS: 1

4. ASME CODE SECTION XI REQUIREMENTS: Table IWB-2500-1, Examination Category B-J, Item B9.11 requires surface and volumetric examination of the regions described in Figure IWB-2500-8 for piping 4 in. nominal pipe size and greater, this examination includes essentially 100% of the weld length. In addition, Appendix III, Supplement 7, requires that ultrasonic examination sensitivity be established using I.D. notches with a depth of 10% wall thickness.

5. BASIS FOR RELIEF: The above listed welds are cast stainless steel to wrought stainless pipe. The optimized ultrasonic technique used for the statically cast stainless steel welds will detect large flaws (25% or greater through the wall) therefore this sensitivity is less than that required by code. In addition, due to the unwieldly characteristics of the contoured wedge search units and variations in the machined surfaces those welds listed with a asterik, experienced axial and circumferential scanning limitations.

6. ALTERNATE TEST METHOD: None.

7. JUSTIFICATION: The structural integrity of these welds has been assured by:

   a. Having performed a best effort ultrasonic exam, based on state of the art techniques, from the cast stainless side.

   b. Having performed an acceptable ultrasonic exam from the non cast side.

   c. Having performed acceptable radiographic and surface examinations.

RELIEF REQUEST 1NR-7 Rev. 2

1. SYSTEM: Reactor Coolant

2. NUMBER OF ITEMS: 4

Cast Stainless Steel SA-351-CF8A (Elbow)
to
Stainless Steel SA-182 GR-F316 (Safe-end)

| Line Number | Weld Number |
|---|---|
| 1RC03AA-27.5" | 1RC-01-31 |
| 1RC03AB-27.5" | 1RC-02-13 |
| 1RC03AC-27.5" | 1RC-03-32 |
| 1RC03AD-27.5" | 1RC-04-32 |

3. ASME CODE CLASS: 1

4. ASME CODE SECTION XI REQUIREMENTS: Table IWB-2500-1, Examination Category B-J, Item B9.11 requires surface and volumetric examination of the regions described in Figure IWB-2500-8 for piping 4 in. nominal pipe size and greater, this examination includes essentially 100% of the weld length. In addition, Appendix III, Supplemental 7, requires that ultrasonic examination sensitivity be established using I.D. notches with a depth of 10% wall thickness..

5. BASIS FOR RELIEF: The above listed welds are all cast austenitic stainless steel to Reactor Vessel nozzle safe-ends. The optimized ultasonic technique used for the statically cast side of these welds will detect large flaws (25% or greater through the wall) therefore this sensitivity is less than that required by code. In addition, due to the unwieldly characteristics of the contoured wedge search units and variations in the machined surfaces, the welds listed above experienced axial and circumferential scanning limitations..

6. ALTERNATE TEST METHOD: None.

7. JUSTIFICATION: The structual integrity of these welds has been assured by:

   a. Having performed a best effort ultrasonic exam, based on state of the art techniques, from the cast stainless side.

   b. Having performed an acceptable ultrasonic exam from the non-cast steel side.

   c. Having performed acceptable radiographic and surface examinations.