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EDF

February 25, 2011

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTENTION: Document Control Desk

SUBJECT: **R.E. Ginna Nuclear Power Plant**
Docket No. 50-244

Response to Request for Additional Information Regarding Relief Request ISI-04, Alternate Depth Sizing Qualification

References:

(1) Letter from P. Swift, Ginna LLC, to NRC Document Control Desk, dated November 24, 2010, Subject: 10 CFR 50.55a Request ISI-04: Request for Use of an Alternate Depth Sizing Qualification. (Agencywide Documents Access and Management System (ADAMS) Accession No. ML 103350217)

(2) Letter from D. V. Pickett, NRC, to J. T. Carlin, Ginna LLC, dated February 7, 2011, Subject: Request for Additional Information Regarding Relief Request ISI-04, Alternate Depth Sizing Qualification – R.E. Ginna Nuclear Power Plant (TAC No. ME5120). (Agencywide Documents Access and Management System (ADAMS) Accession No. ML 110320155)

In Reference 1, R.E. Ginna Nuclear Power Plant, LLC (Ginna LLC) requested the use of alternate depth sizing qualification pertaining to examinations for the Fourth Interval Inservice Inspection (ISI) Program to be performed during the 2011 RFO. The request for relief is from certain examination coverage requirements imposed by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, 1995 Edition/1996 Addenda. Ginna LLC proposes to apply the difference between the examination vendor's achieved Root Mean Square (RMS) error and the NRC approved Code Case N-695 required 0.125 inch RMS error to actual flaw depths when depth-sizing of indications is required. Applying the difference between the required RMS error and the achieved RMS error to the actual flaw being sized will ensure a bounding flaw depth for dissimilar metal welds examined.

In Reference 2, the Nuclear Regulatory Commission (NRC) sent a request for additional information (RAI). The questions in the RAI and the corresponding responses are in the attached enclosure.

A047
NRR

WPLNRC-1002387

Ginna LLC requests review and approval of this relief request by April 15, 2011, in support of the spring 2011 RFO.

There are no regulatory commitments contained in this letter. Should you have questions regarding this matter, please contact Thomas Harding (585) 771-5219, or Thomas.hardingjr@cengllc.com.

Very truly yours,

Paul Swift

Enclosure: Response to Request for Additional Information Regarding Relief Request ISI-04, Alternate Depth Sizing Qualification

cc: W. M. Dean, NRC
D. V. Pickett, NRC
Resident Inspector, NRC (Ginna LLC)

ENCLOSURE

Response to Request for Additional Information Regarding Relief Request ISI-04, Alternate Depth Sizing Qualification

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Question No. 1

If cladding is on the inside diameter (ID) scanning surface, provide a representative sketch showing the cross section of the weld, butter, cladding, and base metal.

Response

Figures 1-1 through 1-3 provide representative sketches of the inlet nozzle to elbow welds, the outlet nozzle to pipe welds, and the safety injection nozzle to safe-end weld that were developed from design drawings and which will be used by the R. E. Ginna Nuclear Power Plant, LLC (Ginna) ISI vendor.

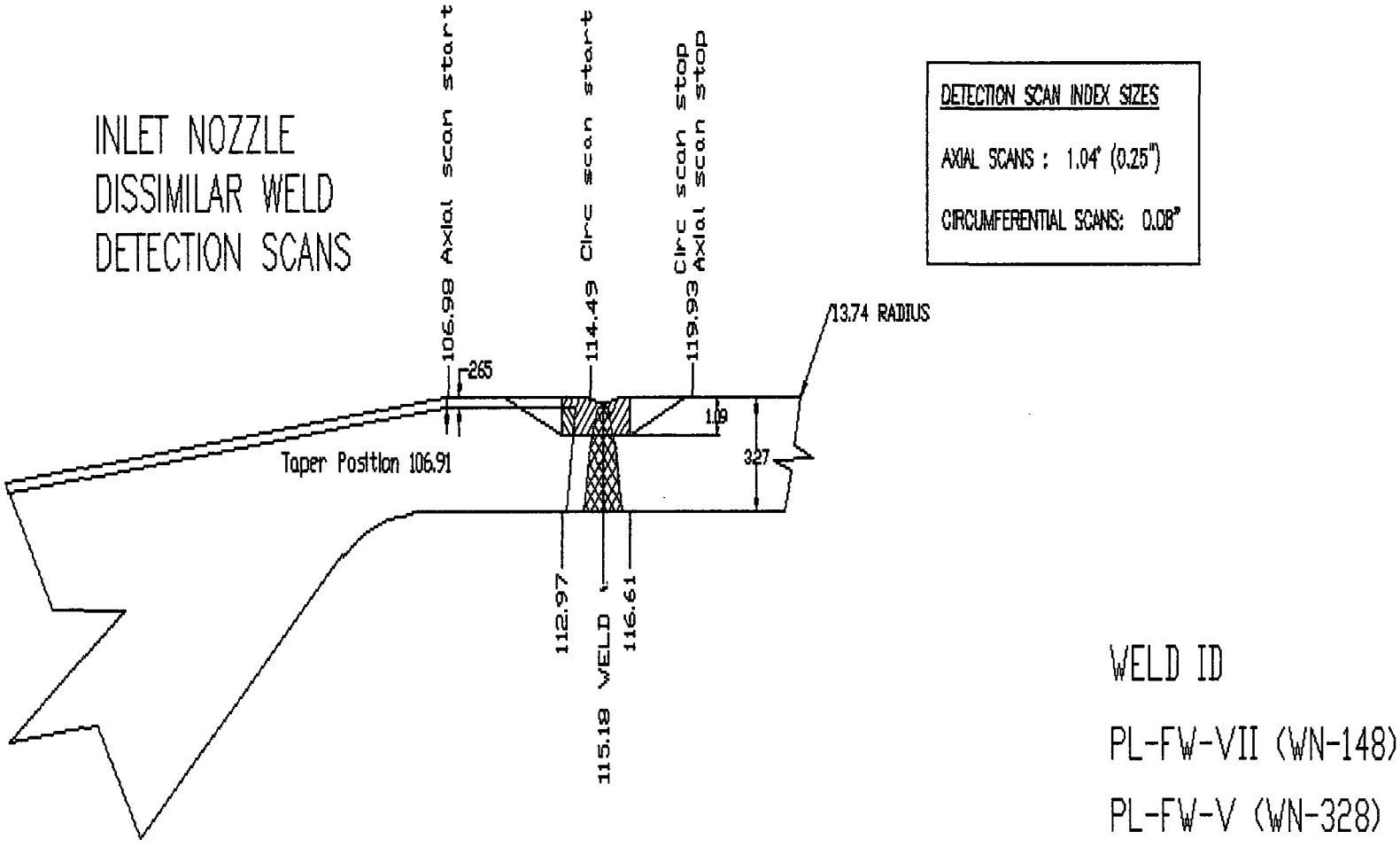

FIGURE 1-1: INLET NOZZLE TO ELBOW WELDS

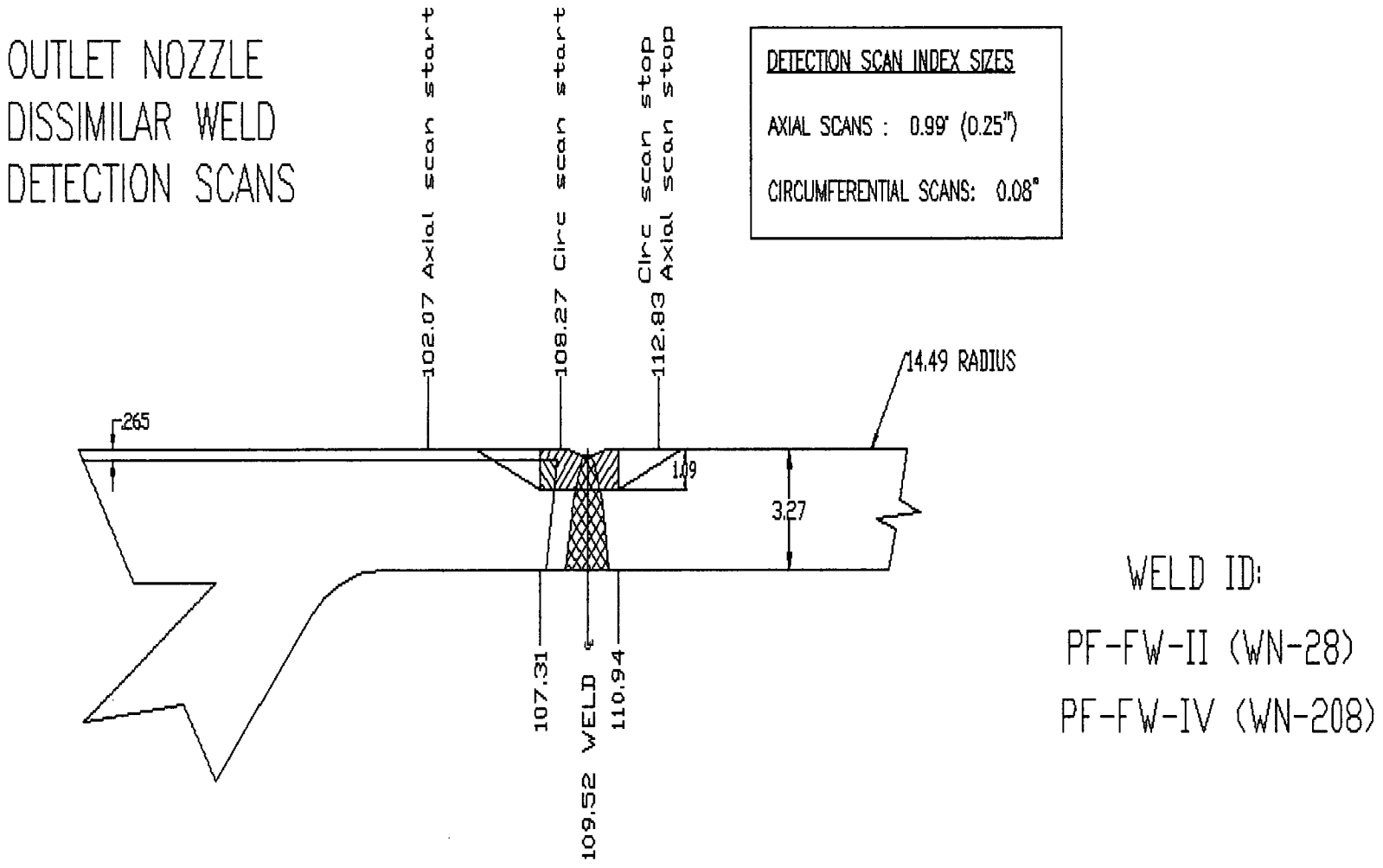

FIGURE 1-2: OUTLET NOZZLE TO PIPE WELDS

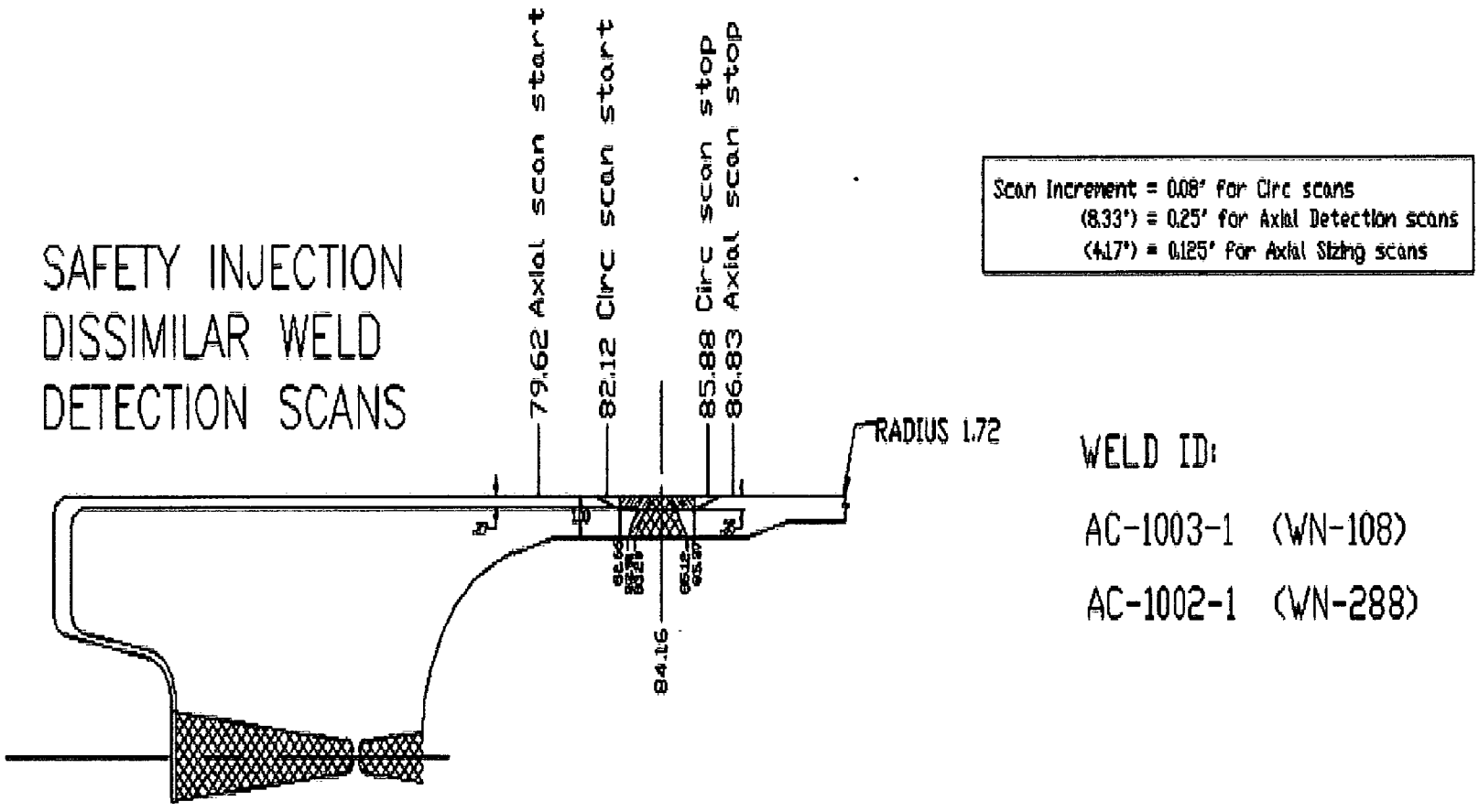

FIGURE 1-3: SAFETY INJECTION NOZZLE TO SAFE-END WELDS

Question No. 2

The Electric Power Research Institute (EPRI) – Performance Demonstration Initiative (PDI) program tests candidates on large diameter, thick wall representative mockups containing rough and wavy, inside diameter (ID) surfaces (Reference 3). Smaller diameter, thinner wall mockups are available for add-on performance demonstrations. Provide the nominal inside diameter and nominal wall thickness (the thickness used to determine inspection volume) for the components in Reference 1, Table A. For the three different weld configurations, discuss the ID surface roughness/waviness and scanning restrictions, if any (counter bore, field weld bead, etc).

Response

Table 2-1 provides the nominal inside diameter and nominal wall thickness that was used to define the inspection volume. It is expected that the outlet nozzle to pipe and inlet nozzle to elbow welds will have counter-bores as shown on design drawings. The Safety Injection nozzle to safe-end welds have no counter-bores.

Localized manual grinding and weld shrinkage may also have created localized roughness/waviness regions within the counter-bore regions. A review of previous internal visual examination videos from 1999 of the internal surfaces of the large bore welds show smooth surfaces leading to the counter-bore regions. It is expected that the same smooth surfaces will be found within the Safety Injection Nozzle to safe-end internal surface.

Table 2-1: Nominal ID and Nominal Wall Thickness Dimensions

Weld Description	Nominal ID	Nominal Wall Thickness	Known Surface Scanning Restrictions
RV Outlet Nozzle to Pipe	28.97"	3.27"	Counter-bore
RV Inlet Nozzle to Elbow	27.48"	3.27"	Counter-bore
RV Safety Injection Nozzle to Safe-End	3.44"	1.0"	None

Question No. 3

Starting in 2004 (Reference 4), EPRI has requested licensees to make surface profilometry measurements of dissimilar metal (DM) welds and adjacent similar metal welds to identify scanning gaps greater than 1/32-inch between the transducer and ID surface. The last ID examination of the subject welds occurred prior to DM weld performance-based qualification requirements. Discuss the transducer footprint on the inspection subject weld areas (i.e., curvature gaps, contoured transducers, etc.). Discuss Ginna's effort to identify and record surface roughness/waviness of the selected welds and to locate scanning gaps greater than 1/32-inch between the transducer and ID surface.

Response

During the nozzle weld examination process, ID surface profile data will be recorded using an immersion UT process that was used in the required ASME performance demonstrations for the Ginna ISI vendor's UT procedures. The UT data is processed and displayed in a format as shown in Figure 3-1.

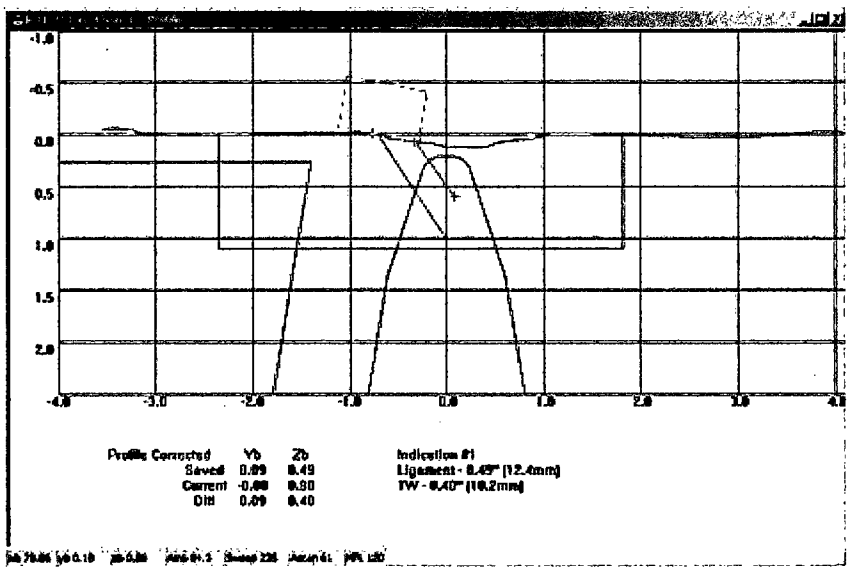

Figure 3-1: Example Surface Profile Display Used by the Ginna ISI Vendor

The display shows the actual footprint of the transducers (side view for axial beams and front view for circumferential beams) on the same scan increment as the flaw detection scans. The vendor will utilize contour wedges that match the ID contour when the examination is performed during the 2011 Refueling Outage. This display is interactive with the actual UT data such that key flaw characterization information such as flaw depth sizing and flaw location can be compensated for by using the surface profile directly underneath the transducer. The software also calculates the areas where the water path

under the transducer is greater than 1/32-inch; this information is used to calculate inspection volume coverage where detection scans are limited.

Ginna's effort to identify and record surface roughness/waviness is discussed in the response to Question no. 4.

Question No. 4

Discuss the nondestructive examination (NDE) methods and techniques used for examining the subject welds during the 2011 refueling outage (RFO). Discuss the NDE improvements (over prior examinations) that will be used for the 2011 RFO examinations, such as, performance-based qualifications, video camera records, surface waviness records, supplemental eddy current examinations, visual examinations, etc.

Response

The Ultrasonic examination that was performed in 1999 met or exceeded ASME Section XI Code, 1986 Edition and USNRC Regulatory Guide 1.150, Revision 1. PDI-qualified Appendix VIII, Supplement 4 & 6 examination techniques were utilized.

The Ginna 2011 RFO reactor vessel nozzle dissimilar metal weld examinations will be completed using the inner diameter (ID) applied PDI-qualified ultrasonic examination equipment, personnel, procedures and techniques (including the safety injection nozzle to safe-end weld add-on) qualified by WesDyne International. Surface profilometry data will be recorded and used to compensate for localized waviness and to calculate where a gap greater than 1/32-inch between the transducer and surface is observed. The 1/32-inch value is generally considered for OD examinations, but offers a conservative reference for the ID inspection. Eddy current examinations will cover the ID surface and counter-bore geometry regions and are used to assist in the characterization of surface-breaking flaws. Supplemental visual examinations using other delivery devices such as a remotely-operated submersible will be used as necessary to help resolve ultrasonic and eddy current test indications.

Question No. 5

Some vendors have performed supplemental, configuration specific, non-blind depth sizing demonstrations on smooth ID surfaces of reactor coolant mockups containing statistically significant number of flaws (Example, Reference 5). Excluding the ASME Code required blind performance demonstrations (administered by the EPRI-PDI), discuss demonstrations that Ginna's vendor performed that supported depth sizing effectiveness on configurations similar to the subject weld configurations. Include in the discussion mockup dimension (ID diameter and wall-thickness), materials, through-wall flaw distributions, flaw types and quantities, blind/non-blind demonstrations, and RMSE's.

Response

Ginna's inspection vendor has participated in three non-ASME Code required performance demonstrations associated with depth sizing of planar flaws in dissimilar metal welds. The demonstrated techniques were conducted from the inner diameter (ID) surface. Each of these demonstrations used ultrasonic test procedures and equipment nearly identical to those to be applied for the upcoming Ginna RPV nozzle weld examinations. Summary information on these demonstrations is provided below.

The first demonstration (non-blind) was conducted in 2002/2003 as part of an open procedure qualification for a Swedish nuclear power plant and was performed under the auspices of the Swedish Qualification Centre (SQC). The test sample, supplied by the power plant owner, consisted of six partial ring segments that when put together formed a 360° test piece. The inner diameter was 597mm (23.5") and the weld thickness was 84mm (3.3"). The materials of construction included a stainless steel clad SA508 Class 1A ferritic steel forging buttered with Inconel™ and welded to a SA312 Type 316 stainless steel forging. The weld material was Inconel™. The ID surface was smooth. Of the twenty-five defects within the segments, ten were ID surface-connected branched cracks confined to the weld and buttering. Details of these ID surface flaws are provided in Table 5-1; this defect matrix included both circumferential and axial cracks. Table 5-1 also provides the UT measured through-wall dimension for each of the defects and the RMSE value. It is noted that if the RMSE adjustment of 0.064" (1.63mm), consistent with the Ginna Relief Request, were added to each of the UT measurements, the adjusted RMSE value is 0.133" (3.39mm).

The second demonstration (non-blind) was conducted in 2007 as part of a weld inlay equivalency site specific demonstration and was performed under the auspices of EPRI. This block was a full-scale, 360° mock-up and is approximately 41-inches long, 27.5" ID and 2.9" thick. It contains a dissimilar metal weld (Inconel™ buttering and Inconel™ weld metal) between a SA-508 ferritic steel forging (nozzle) and a 316 stainless steel forging (safe-end). An Alloy 52 weld inlay was added to three of the four quadrants across the dissimilar metal weld. The inlay thickness for each of the three quadrants was 0.2-inch, 0.07-inch, and 1.0-inch for the 2nd, 3th and 4th quadrants, respectively. Four alternative planar flaws were added to each of the three inlaid quadrants. These four flaws are essentially identical to flaws in the PDI 601 Series Practice Mock-up. The ID surface included a 10° - 15° taper on the safe-end. Details of the flaws are provided in Table 5-2 ; this defect matrix included both circumferential and axial cracks. Table 5-2 also provides the UT measured through-wall dimension for each of the sixteen defects and the RMSE value. If the RMSE adjustment of 0.064" (1.63mm) was added to each of the UT measurements, the adjusted RMSE value is 0.083" (2.11mm).

The third demonstration (blind) was conducted in 2010 as the initial test in a series of round robin examinations on RPV nozzle to safe-end welds. Examinations are being conducted blind on six individual test coupons. Each test coupon consisted of a dissimilar metal Alloy 82/182 buttering/weld between a ferritic steel forging and a stainless steel safe-end, and contained a single axial stress corrosion crack. Each test coupon was approximately 736mm (29") in diameter and was approximately 73mm (2.9")

thick. The ID surface was smooth. Each test coupon was destructively analyzed to determine the actual crack depth. Information on the flaws is noted in Table 5-3; this defect matrix included only axial cracks. Table 5-3 also provides the UT measured through-wall dimension for each of the six defects and the RMSE value. If the RMSE adjustment of 0.064" (1.63mm) was added to each of the UT measurements, the adjusted RMSE value is 0.125" (3.17mm).

Each of these test samples included variables common to dissimilar metal welds - multiple materials with different acoustic properties, and dendritic and coarse-grained microstructures. These two variables lead to inaccuracies in locating the ultrasonic response from a planar flaw extremity within the weld and buttering. Demonstrations 1 and 3 did not involve additional ultrasonic examinations to determine the ID surface profile which is used to compensate for beam propagation in the weld. Also different in each of these test samples is the type of planar flaw, the flaw morphology, and the actual dendritic structure of the weld and buttering. These differences between the demonstrations are factors in the variation in RMSE values. When the three data sets from Tables 5-1, 5-2 and 5-3 are combined, the RMSE is 0.092" (2.3mm). Note that these data sets do not include the RMSE adjustment of 0.064" (1.63mm).

Table 5-1: Defect Matrix for Open Procedure Qualification – ID Surface Connected Planar Flaws Only					
Flaw Description	**Orientation**	**Ligament (mm)**	**Truth Length Dimension (mm/in)**	**Truth Through-Wall Dimension (mm/in)**	**UT-Measured Through-Wall Dimension (mm/in)**
Flaw 1.1 – Branch Crack (in weld)	Circ / 9° skew / 10° tilt	0	17.83 / 0.70	6.11 / 0.24	8.58 / 0.34
Flaw 1.2 – Branch Crack (in buttering)	Circ / 0° skew / 9° tilt	0	22.08 / 0.87	9.1 / 0.36	11.30 / 0.44
Flaw 1.3 – Branch Crack (in buttering)	Circ / 1° skew / 0° tilt	0	30.17 / 1.19	12.19 / 0.48	9.60 / 0.38
Flaw 1.4 – Branch Crack (in buttering)	Circ / 0° skew / 2° tilt	0	70.05 / 2.76	26.03 / 1.02	27.79 / 1.09
Flaw 1.5 – Branch Crack (in weld)	Circ / 10° skew / 10° tilt	0	70.5 / 2.78	33.7 / 1.33	36.0 / 1.42
Flaw 2.1 – Branch Crack (in buttering/weld)	Ax / 10° skew / 8° tilt	0	17.4 / 0.68	6.4 / 0.25	7.0 / 0.28
Flaw 2.2 – Branch Crack (in buttering)	Ax / 8° skew / 0° tilt	0	12.38 / 0.49	6.28 / 0.25	5.49 / 0.22
Flaw 2.3 – Branch Crack (in weld)	Ax / 11° skew / 10° tilt	0	17.1 / 0.67	8.35 / 0.33	9.7 / 0.38
Flaw 2.4 – Branch Crack (in buttering/weld)	Ax / 8° skew / 0° tilt	0	21.05 / 0.83	8.88 / 0.35	11.99 / 0.47
Flaw 2.5 – Branch Crack (in buttering/weld)	Ax / 0° skew / 9.5° tilt	0	43.7 / 1.72	17.95 / 0.71	20.7 / 0.82

RMSE	2.13 / 0.084
RMSE with Vendor Tolerance Adjustment	3.39 / 0.133

Table 5-2: Defect Matrix for Open Weld Inlay Equivalency Test Demonstration – ID Surface Connected Planar Flaws Only					
Flaw Description	**Orientation**	**Ligament (mm)**	**Truth Length Dimension (mm/in)**	**Truth Through-Wall Dimension (mm/in)**	**UT-Measured Through-Wall Dimension (mm/in)**
Flaw 1-Q2 (Thermal Fatigue Crack)	Circ / 8° skew / 0° tilt	0	45.72 / 1.80	8.61 / 0.339	9.4 / 0.37
Flaw 1-Q3 (Thermal Fatigue Crack)	Circ / 8° skew / 0° tilt	0	45.72 / 1.80	8.61 / 0.339	10.67 / 0.42
Flaw 1-Q4 (Thermal Fatigue Crack)	Circ / 8° skew / 0° tilt	0	45.72 / 1.80	8.61 / 0.339	9.14 / 0.36
Flaw 2-Q2 (Thermal Fatigue Crack)	Circ / 0° skew / 0° tilt	0	66.80 / 2.63	8.89 / 0.35	8.64 / 0.34
Flaw 2-Q3 (Thermal Fatigue Crack)	Circ / 0° skew / 0° tilt	0	66.80 / 2.63	8.89 / 0.35	8.38 / 0.33
Flaw 2-Q4 (Thermal Fatigue Crack)	Circ / 0° skew / 0° tilt	0	66.80 / 2.63	8.89 / 0.35	9.4 / 0.37
Flaw 3-Q2 (Alternative Planar Flaw)	Axial / 11° skew / 0° tilt	0	12.7 / 0.50	9.5 / 0.374	10.16 / 0.40
Flaw 3-Q3 (Alternative Planar Flaw)	Axial / 11° skew / 0° tilt	0	12.7 / 0.50	9.5 / 0.374	9.4 / 0.37
Flaw 3-Q4 (Alternative Planar Flaw)	Axial / 11° skew / 0° tilt	0	12.7 / 0.50	9.5 / 0.374	6.86 / 0.27
Flaw 12-Q2 (Thermal Fatigue Crack)	Circ / 5° skew / 0° tilt	0	77.47 / 3.50	20.7 / 0.815	20.57 / 0.81
Flaw 12-Q3 (Thermal Fatigue Crack)	Circ / 5° skew / 0° tilt	0	77.47 / 3.50	20.7 / 0.815	20.57 / 0.81
Flaw 12-Q4 (Thermal Fatigue Crack)	Circ / 5° skew / 0° tilt	0	77.47 / 3.50	20.7 / 0.815	19.56 / 0.77
Flaw 1 (Thermal Fatigue Crack)	Circ / 8° skew / 0° tilt	0	45.72 / 1.80	8.61 / 0.339	9.4 / 0.37
Flaw 2 (Thermal Fatigue Crack)	Circ / 0° skew / 0° tilt	0	66.80 / 2.63	8.89 / 0.35	9.91 / 0.39

Table 5-2: Defect Matrix for Open Weld Inlay Equivalency Test Demonstration – ID Surface Connected Planar Flaws Only					
Flaw Description	**Orientation**	**Ligament (mm)**	**Truth Length Dimension (mm/in)**	**Truth Through-Wall Dimension (mm/in)**	**UT-Measured Through-Wall Dimension (mm/in)**
Flaw 3 (Alternative Planar Flaw)	Axial / 11° skew / 0° tilt	0	15.24 / 0.60	9.5 / 0.374	11.18 / 0.44
Flaw 12 (Thermal Fatigue Crack)	Circ / 5° skew / 0° tilt	0	77.47 / 3.50	20.7 / 0.815	20.07 / 0.79

RMSE	0.88 / 0.035
RMSE with Vendor Tolerance Adjustment	2.11 / 0.083

Table 5-3: Defect Matrix for Blind Round Robin Program – Axial Flaws Only					
Flaw Description	**Orientation**	**Ligament (mm)**	**Truth Length Dimension (mm/in)**	**Truth Through-Wall Dimension (mm/in)**	**UT-Measured Through-Wall Dimension (mm/in)**
M1 (SCC)	Axial	0	Not provided	30.0 / 1.18	29.85 / 1.18
M2 (SCC)	Axial	0	Not provided	9.3 / 0.37	4.68 / 0.18
M3 (SCC)	Axial	0	Not provided	16.7 / 0.66	14.19 / 0.56
M4 (SCC)	Axial	0	Not provided	15.4 / 0.61	9.41 / 0.37
M5 (SCC)	Axial	0	Not provided	4.0 / 0.16	2.33 / 0.09
M6 (SCC)	Axial	0	Not provided	22.9 / 0.90	15.92 / 0.63

RMSE	4.38 / 0.17
RMSE with Vendor Tolerance Adjustment	3.17 / 0.125

Question No. 6

The submittal was based on 10 CFR 50.55a(a)(3)(i). However, the industry has been unable to achieve the ASME Code required depth sizing RMSE requirement which was imposed on DM welds on November 22, 2002. The RMSE performance demonstration acceptance requirement occurred after Ginna was constructed and after the last examinations of the subject welds. However, the blind DM weld performance demonstrations administered by the EPRI-PDI program have not qualified any ultrasonic testing personnel, equipment, or procedures for ID depth sizing. The NRC staff has determined that the appropriated Title 10 of the Code of Federal Regulations Part 50 paragraph for this request (Reference 1) is 10 CFR 50.55a(g)(5)(iii). Provide a discussion on the difficulties Ginna would experience trying to meet the RMSE requirement.

Response

Ginna agrees that 10 CFR 50.55a(g)(5)(iii) is appropriate for this request.

To date, although examination vendors have qualified for detection and length sizing of flaws in accordance with the ASME Code requirements for examinations from the inner diameter surface, these same vendors have not met the established RMSE of 0.125-inch for flaw indication depth sizing. The vendor contracted to perform the examinations that are identified within request ISI-04, Table A, has demonstrated the ability to depth size flaw indications in dissimilar metal welds with a RMSE of 0.189-inch instead of the 0.125-inch RMSE required by Appendix VIII Supplement 10 and Code Case N-695.

Numerous attempts by these inspection vendors to meet the Supplement 10 and Code Case N-695 required RMSE value for flaw depth sizing when examining from the inside diameter have been unsuccessful. Several process enhancements including new delivery systems, new transducers, and software modifications have been implemented but did not achieve the desired improvements in performance. This result indicates that the ASME Code acceptance standard for flaw depth sizing is impractical for use with the ID ultrasonic examination technology employed in the qualification efforts. At this time, additional attempts to improve the depth sizing RMSE value are not warranted since the technology has not evolved significantly since the most recent efforts.

Ginna welds identified within request ISI-04, Table A, were fabricated in the late 1960s timeframe, prior to implementation of Appendix VIII qualification requirements. Current vendors are incapable of meeting the stringent 0.125 inch RMSE flaw depth sizing tolerance requirement when examining from the inside diameter surface. Compliance with the EPRI PDI qualification program without alternative implementation would necessitate significant modification to the reactor coolant system welds. Alterations such as this may result in reduced structural integrity of the reactor coolant pressure boundary. Even with such modifications, the vendor depth sizing accuracy issue would not be addressed.

Question No. 7

The licensee's proposed alternative (Reference 1) is to use Code Case N-695 qualifications for Appendix VIII, Supplement 10 qualifications. The proposal also contains words in the "Reason for the Request" that reference Supplement 2. If Supplement 2 is part of this relief request, provide the information to support the proposed alternative RMSE; if not, provide clarification.

Response

This request is specifically for Supplement 10 and not for Supplement 2. The EPRI PDI report ("Summary of Wesdyne International, LLC Supplements 2 and 10 Depth Sizing Results Obtained from the Inside Surface") that was provided to Ginna for the selected vendor that will be performing the examination on welds identified within request ISI-004, Table A, describes this. The EPRI PDI report documents the vendor RMSE capabilities for both Supplement 10 and Supplements 2 and 10 combined. Supplement 2 was only referenced within "Reason for the Request" to be consistent with the terminology that was used within the EPRI PDI report.

Question No. 8

From prior Relief Request 19 (Reference 2), Ginna identified the likely failure mechanism for the subject welds as fatigue cracking. In a response (Reference 6) to an NRC request for additional information, Ginna provided a crack depth divided by crack length (aspect ratio) of 6 to support a discussion on crack growth. The ASME Code, Section XI, Table IWB-3514-2, "Allowable Planar Flaw," in austenitic material gives a range of aspect ratios for acceptable flaw depths. The most conservative aspect ratio in this range is 0.05. The fatigue crack length is measured by ultrasonic testing and/or eddy current testing which can be used to estimate fatigue crack depth.

The proposal is for a crack depth sizing criterion that is based on the vendor's RMSE from a non-qualified performance demonstration. The criterion is being applied as a tolerance for determining crack depth. Since fatigue is the likely failure mechanism, the crack depth sizing proposal should include a comparison between values based on a conservative aspect ratio (assuming measured crack length by one or more methods) with values derived by adding the vendor's RMSE tolerance adjustment to the fatigue crack depth. Provide a discussion on using an aspect ratio for fatigue crack depth determinations. Provide application criteria for aspect ratio and RMSE performance demonstration tolerance adjustment that result in selecting the more conservative fatigue crack depth for disposition.

Response

From the discussion and information provided in the response to Question no. 5, the through-wall depth sizing of planar flaws using ultrasonic test (UT) techniques does provide a measured estimate of the through-wall depth with a reasonable accuracy regardless whether the flaws are circumferential or axial. While the required ASME performance demonstration process has indicated that such UT techniques cannot meet the ASME defined tolerance of 0.125" (3.2mm) RMSE for through-wall depth sizing, it does result in a consistently achieved tolerance of 0.189" (4.8mm) RMSE for the Ginna ISI vendor as documented by the EPRI PDI. As such, the achieved tolerance demonstrates that the measurement of the through-wall depth of a flaw can be realistically measured by UT means. Reliance on an assumed

conservative aspect ratio of depth/length given a fatigue cracking mechanism is not realistic or consistent with the ASME Code intent for flaw characterization.

The correlation between the actual and measured through-wall depth for the non-ASME performance demonstration data discussed in the response to Question no. 5 is shown in Figure 8-1 below. The average through-wall measurement error for the 32 data points is -0.12mm (-0.005").

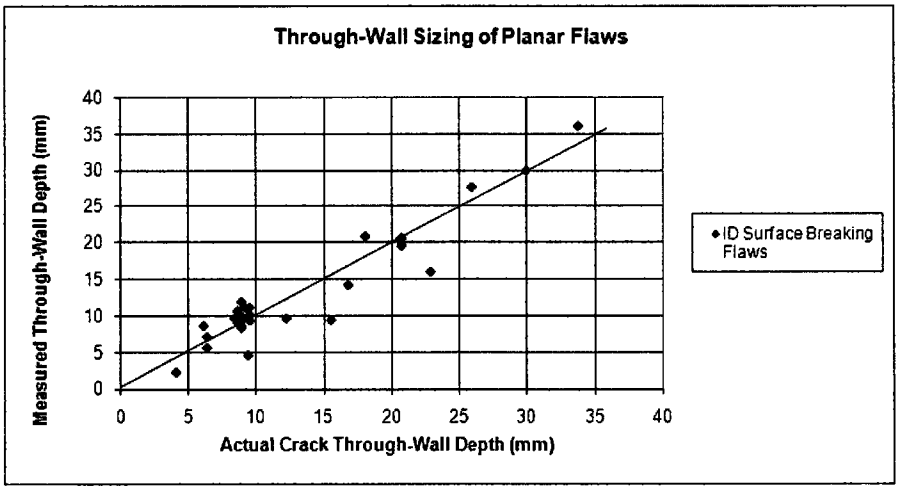

Figure 8-1: Correlation Between Actual Planar Flaw Through-Wall Depth and the UT Measured Planar Flaw Through-Wall Depth

Figure 8-2 provides a similar correlation with the exception that the Ginna ISI vendor's RMSE adjustment of 0.064" (1.6mm) has been added to the measured through-wall depth for each flaw. The average through-wall measurement error for the 32 data points is 1.5mm (0.059").

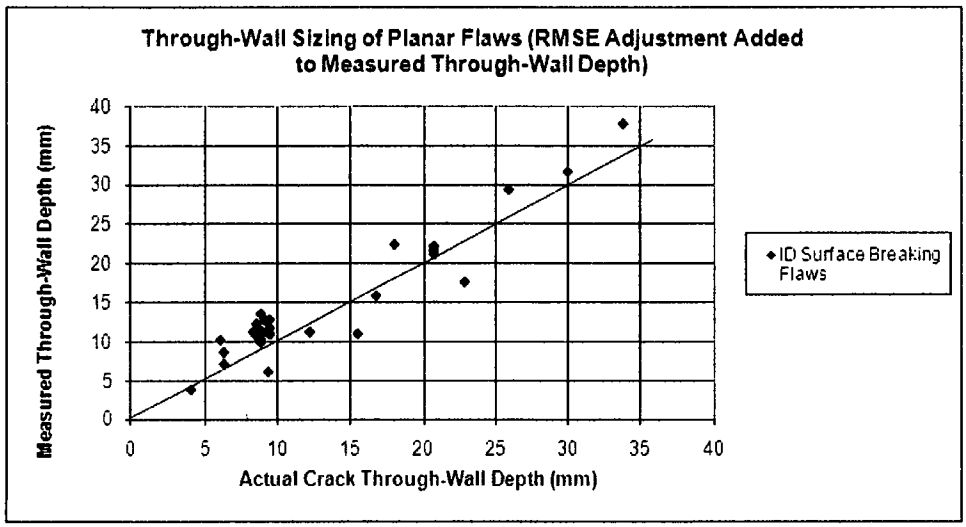

Figure 8-2: Correlation Between Actual Planar Flaw Through-Wall Depth and the UT Measured Planar Flaw Through-Wall Depth with the RMSE Adjustment of 0.064" (1.6 mm)

The derivation of the through-wall depth of a fatigue-type planar flaw using an assumed aspect ratio (a/l, where 'a' is the through-wall depth and 'l' is the measured UT length) is not realistic for defining a key parameter used in the flaw indication evaluation of IWB-3514 particularly when the ultrasonic test measurement process is consistent and shown to be a realistic means of through-wall depth measurement (see Figure 8-1). An example of the two approaches is provided below using the thermal fatigue crack data (twelve cracks) in the response to Question no. 5.

Figure 8-3 provides the correlation between the actual thermal fatigue crack depth compared to that measured by UT with the RMSE adjustment, and to that estimated using aspect ratios of 0.05 and 0.5 and the measured UT length. The aspect ratio of 0.5 provides a very conservative estimate of the flaw depth. The aspect ratio of 0.05 provides an underestimate of the through-wall depth but is conservative with respect to the allowable planar flaw standards in Table IWB-3514-2. The UT measurement is more consistent with the actual flaw depth and is conservative given the RMSE adjustment.

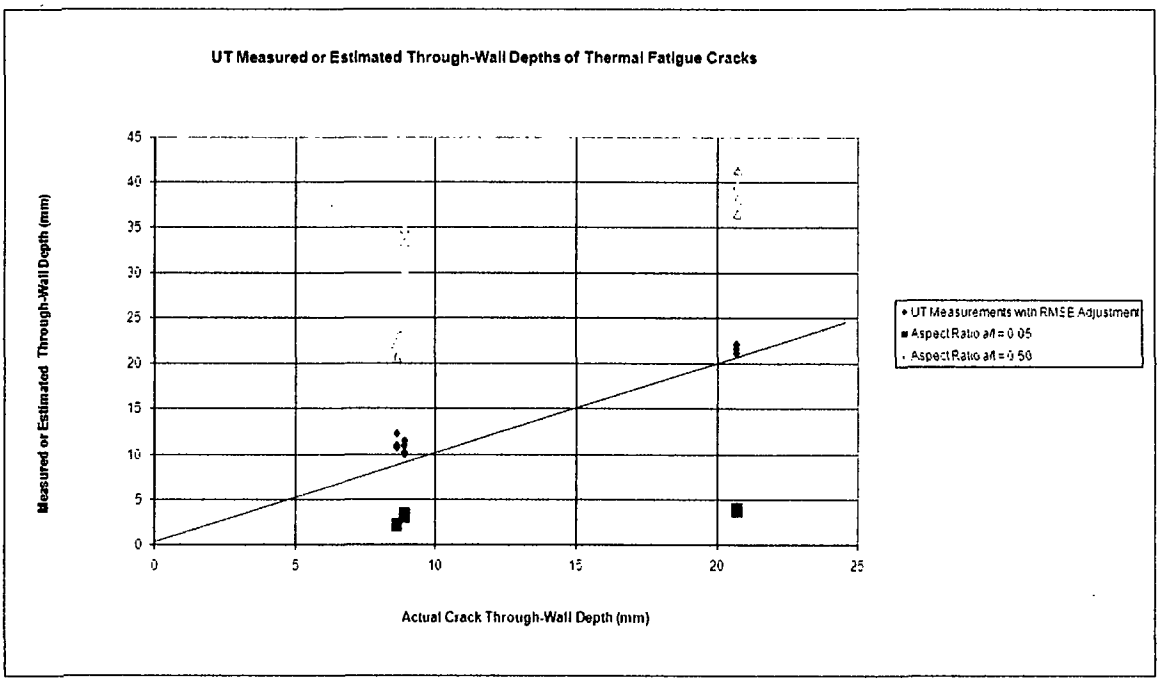

Figure 8-3: Correlation Between Actual Thermal Fatigue Crack Through-Wall Depth, the UT Measured Thermal Fatigue Crack Through-Wall Depth with RMSE Adjustment, and the Estimated Thermal Fatigue Crack Through-Wall Depth Using Aspect Ratios of 0.05 and 0.5

When such flaw sizes are used to determine their relevance to the allowable planar flaw standards of Table IWB-3514-2, the results of Table 8-1 are obtained. Flaws with an assumed aspect ratio of 0.05 are acceptable whereas flaws characterized solely by UT and using an assumed aspect ratio of 0.5 are unacceptable. A flaw characterized by UT with the RMSE adjustment on flaw depth would yield a larger 'a/t' (where "a" is the through-wall depth and "t" is the component thickness) actual than that derived using actual UT measurements (Table 8-1) and would also be unacceptable.

Whereas the use of the aspect ratio of 0.5 and the measured UT length provides the most conservative fatigue crack depth for disposition it may yield an unrealistic flaw depth and thus cause additional hardship for Ginna in terms of an unnecessary repair. Flaw depth sizing by UT has proven to be a consistent methodology for both circumferential and axial flaws that provides a reasonable

measurement for use in flaw indication dispositions. Whereas the currently defined ASME performance demonstration tolerance for UT measurement of flaw depth (0.125" RMSE) cannot be met, it has demonstrated to be consistent as a function of the UT procedure and UT analysis personnel. For the Ginna ISI vendor, this tolerance has been demonstrated to be 0.189" RMSE associated with the test blocks and flaws within the required ASME performance demonstration test program. The same procedure and personnel used on a different series of test blocks with a different flaw matrix will yield a different set of RMSE values for flaw depth that again are consistent. This has been demonstrated by the Ginna ISI vendor in Sweden and Japan.

As such, any flaws in the RPV nozzle to safe-end welds detected by UT during the Ginna Spring 2011 outage will be sized in depth and in length using the required ASME performance demonstrated procedure and personnel. Flaw disposition to Section IWB-3514 standards will be performed using the measured UT flaw length and the measured UT flaw depth with an added factor of 0.064" (1.6mm). This added factor is to satisfy the intent of the ASME Code for flaw depth sizing accuracy. This applied methodology will result in a flaw disposition that is realistic in terms of quality and safety.

Table 8-1: Comparison of Example Thermal Fatigue Crack Sizes to Table IWB-3514-2 Allowable Planar Flaws

Flaw	UT Measured Through-Wall Depth [a] (in)	UT Measured Length [l] (in)	'a/t' Allowable per Table IWB-3514-2 (%)	'a/t' Actual (%)	Disposition
UT Measured Through-Wall Depth & UT Measured Length					
1	0.37	1.875	10.0	12.8	Unacceptable
2	0.39	2.75	9.8	13.4	Unacceptable
12	0.79	3.25	10.2	27.2	Unacceptable
1-Q2	0.37	1.75	10.2	12.8	Unacceptable
1-Q3	0.42	1.75	10.2	14.5	Unacceptable
1-Q4	0.36	1.625	10.2	12.4	Unacceptable
2-Q2	0.34	2.75	9.8	11.7	Unacceptable
2-Q3	0.33	2.375	9.8	11.4	Unacceptable
2-Q4	0.37	2.625	9.8	12.8	Unacceptable
12-Q2	0.81	3.00	10.3	27.9	Unacceptable
12-Q3	0.81	2.875	10.3	27.9	Unacceptable
12-Q4	0.77	3.125	10.3	26.6	Unacceptable
Estimated Through-Wall Depth Assuming Aspect Ratio of 0.05 & UT Measured Length					
1	0.09	1.875	9.6	3.1	Acceptable
2	0.14	2.75	9.6	4.8	Acceptable
12	0.16	3.25	9.6	5.5	Acceptable
1-Q2	0.09	1.75	9.6	3.1	Acceptable
1-Q3	0.09	1.75	9.6	3.1	Acceptable
1-Q4	0.08	1.625	9.6	2.8	Acceptable
2-Q2	0.14	2.75	9.6	4.8	Acceptable
2-Q3	0.12	2.375	9.6	4.1	Acceptable

2-Q4	0.13	2.625	9.6	4.5	Acceptable
12-Q2	0.15	3.00	9.6	5.2	Acceptable
12-Q3	0.14	2.875	9.6	4.8	Acceptable
12-Q4	0.16	3.125	9.6	5.5	Acceptable
Estimated Through-Wall Depth Assuming Aspect Ratio of 0.50 & UT Measured Length					
1	0.94	1.875	11.0	32.4	Unacceptable
2	1.38	2.75	11.0	47.6	Unacceptable
12	1.63	3.25	11.0	56.2	Unacceptable
1-Q2	0.88	1.75	11.0	30.3	Unacceptable
1-Q3	0.88	1.75	11.0	30.3	Unacceptable
1-Q4	0.81	1.625	11.0	27.9	Unacceptable
2-Q2	1.38	2.75	11.0	47.6	Unacceptable
2-Q3	1.19	2.375	11.0	41.0	Unacceptable
2-Q4	1.31	2.625	11.0	0.45	Unacceptable
12-Q2	1.50	3.00	11.0	51.7	Unacceptable
12-Q3	1.44	2.875	11.0	49.7	Unacceptable
12-Q4	1.56	3.125	11.0	53.8	Unacceptable