Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-18-120

October 11, 2018

10 CFR 50.55a

ATTN**:** Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Browns Ferry Nuclear Plant, Unit 1
Renewed Facility Operating License No. DPR-33
NRC Docket No. 50-259

Subject: **Response to Request for Additional Information Regarding Browns Ferry Nuclear Plant Unit 1, American Society of Mechanical Engineers Boiler and Pressure Vessel Code Section XI, Inservice Inspection (ISI) Program, Unit 1 Second Ten-year Interval Request for Relief for 1-ISI-28 (EPID L-2018-LLR-0079)**

References: 1. TVA letter to NRC, CNL-18-080, "Browns Ferry Nuclear Plant Unit 1, American Society of Mechanical Engineers Boiler and Pressure Vessel Code Section XI, Inservice Inspection (ISI) Program, Unit 1 Second Ten-year Interval Request for Relief for 1-ISI-28 and 1-ISI-29," dated May 31, 2018 (ML18177A379)

2. NRC Electronic Mail to TVA, "Browns Ferry Unit 1: RAI Associated with Relief Request 1-ISI-28," dated September 11, 2018 (ML18255A334)

In Reference 1, Tennessee Valley Authority (TVA) submitted a relief request, 1-ISI-28, for Nuclear Regulatory Commission (NRC) approval for the Browns Ferry Nuclear Plant (BFN) Unit 1 second ten-year inspection (ISI) interval. Reference 1 requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," ASME Code Class 1, Table IWB-2500-1, which requires a volumetric examination of essentially 100 percent (%) of the weld and adjacent base material.

In Reference 2, the NRC transmitted a request for additional information (RAI) and requested a response by October 15, 2018. The enclosure to this letter provides the TVA response to the RAI.

There are no new regulatory commitments associated with this submittal. Please address any questions regarding this request to Anthony Brown at 423-751-3275.

Respectfully,

E. K. Henderson
Director, Nuclear Regulatory Affairs

Enclosure: Response to Browns Ferry Unit 1 RAIs Related to Request for Relief for 1-ISI-28 (EPID L-2018-LLR-0079)

cc (w/Enclosures):

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant
NRC Project Manager - Browns Ferry Nuclear Plant

Response to Browns Ferry Unit 1 RAIs Related to Request for Relief for 1-ISI-28 (EPID L-2018-LLR-0079)

NRC Introduction

By letter dated May 31, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML18177A379), Tennessee Valley Authority (TVA, the licensee) submitted relief requests 1-ISI-28 and -29, requesting relief from the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, for Browns Ferry Nuclear Plant (Browns Ferry) Unit 1. Specifically, pursuant to Title 10 of the Code of Federal Regulations (10 CFR) 50.55a(g)(5)(iii), the licensee requested relief from the "essentially 100 percent" volumetric examination coverage requirements of ASME Code Section XI for the welds on the basis that the code requirement is impractical. The NRC has determined that the following additional information is necessary to complete its review and make a regulatory decision.

RAI 1

How do the coverages obtained during this interval compare to those of the last interval. If there has been any drop in coverage from the last interval, please discuss what caused the decrease in obtainable coverage and justify how this examination provides an equivalent or greater standard of quality and safety.

TVA Response to RAI-1

Request for Relief 1-ISI-28 is associated with the Browns Ferry Nuclear Plant (BFN) Unit 1 second inservice inspection (ISI) interval (i.e., June 2, 2008 - June 1, 2017). Previous examinations of the components in Relief Request 1-ISI-28 were performed during the BFN Unit 1 first ISI Interval (August 1, 1974 to June 1, 2008) including BFN Unit 1 Recovery (U1C6R in 2007). Examinations performed during the first ISI interval were performed in BFN Unit 1 Cycles 1 (U1C1 in 1975), 2 (U1C2 in 1979), 4 (U2C4 in 1981), and U1C6R. The examinations performed prior to Cycle 6R were performed with the technology and techniques that differ significantly to those utilized during later inspections; therefore, the previous examinations do not provide a meaningful comparison to current NDE coverages. First Interval ISI examinations performed during U1C6R utilized newer techniques and equipment and are considered to provide a more relevant comparison. Differences in coverage percentages between those for which relief is requested and those performed in U1C6R exist primarily due to newer qualified techniques, equipment, and modeling differences. Table 1 provides previous examination coverage percentages for comparison.

Where previous BFN U1C6R data was available and coverage decreases occurred, the decreases in coverage percentages were between two and seven percent. These minor differences in coverage percentages are attributable to differences in equipment, modelling, and calculated coverage methodology. The examinations were conducted in accordance with the technology and demonstrated methods available when the examinations were conducted. In all but two cases, essentially 100 percent (%) of the inner 15% of the reactor pressure vessel (RPV) nozzle to vessel weld was examined. This inner 15% is the primary area of interest for ID initiated cracking mechanisms. Due to nozzle proximity to a permanent insulation ring, only 86.1% of the inner 15% of the N5A and N5B RPV nozzle to vessel welds (N5A-NV and N5B-NV) could be obtained. The examination of the welds and inner radii to the maximum extent practical provides an acceptable level of quality and safety because the information and data

obtained from the volume examined provides sufficient information to judge the overall integrity of the components. Therefore, the standard of quality and safety is not affected by these limited examinations.

Table 1					
Weld Number (Description)	**Second ISI Interval Examination Coverage Percent (Nearest %)**	**Unit/Cycle Inspection Performed**	**Previous Examination Coverage Percent (Nearest %)**	**Previous Inspection Performed**	**Previous Examination Comments**
N1A-NV (Recirc Outlet)	27	U1R8	31	U1C6R R1322	95% coverage of the lower 15%
N1B-NV (Recirc Outlet)	25	U1R9	31	U1C6R R638	95% coverage of the lower 15%
N2D-NV (Recirc Inlet)	38	U1R8	Indeterminate	U1C4 R103	limited examination nozzle configuration
N2E-NV (Recirc Inlet)	38	U1R8	41	U1C6R R1397	100% coverage of the lower 15%
N2G-NV (Recirc Inlet)	38	U1R8	41	U1C6R R1321	100% coverage of the lower 15%
N3D-NV (Main Steam)	33	U1R8	Indeterminate	U1C2 R028	limited examination
N4A-NV (Feedwater)	70.4	U1R11	39	U1C6R R1067	100% coverage of the lower 15%
N4B-NV (Feedwater)	32	U1R9	39	U1C6R R1149	100% coverage of the lower 15%
N4C-NV (Feedwater)	32	U1R9	39	U1C6R R1290	99% coverage of the lower 15%
N4D-NV (Feedwater)	32	U1R9	39	U1C6R R1068	100% coverage of the lower 15%
N4E-NV (Feedwater)	32	U1R9	39	U1C6R R1148	100% coverage of the lower 15%
N4F-NV (Feedwater)	32	U1R9	38	U1C6R R1289	97% coverage of the lower 15%

Table 1					
Weld Number (Description)	**Second ISI Interval Examination Coverage Percent (Nearest %)**	**Unit/Cycle Inspection Performed**	**Previous Examination Coverage Percent (Nearest %)**	**Previous Inspection Performed**	**Previous Examination Comments**
N5A-NV (Core Spray)	32 (86.1 inner 15%)	U1R8	Indeterminate	U1C2 R027	limited examination permanent insulation angle iron
N5B-NV (Core Spray)	32 (86.1 inner 15%)	U1R8	29	U1C6R R1406	100% coverage of the lower 15%
N6A-NV (Instrumentation)	37	U1R8	Indeterminate	U1C2 R029	examined 12/8/1978
N8A-NV (Jet Pump Instrumentation)	81	U1R8 U1R11	83	U1C6R R1323	100% coverage of the lower 15%
N9-NV (CRD)	28	U1R9	Indeterminate	U1C4 R0193/204/232/235	limited examination nozzle configuration
N10-NV (SLC)	76 (97 Inner 15%)	U1R9	57	U1C6R R1405	100% coverage of the lower 15%
N2D-IR (Recirc Inlet)	60	U1R8	Indeterminate	U1C4 R109	examined 5/8/1981
N2E-IR (Recirc Inlet)	60	U1R8	Indeterminate	U1C1 TVA-1-068	examined 2/7/1975.
N2G-IR (Recirc Inlet)	60[1]	U1R8	Indeterminate	U1C2 R065	examined 1/8/1979
N5A-IR (Core Spray)	50	U1R8	Indeterminate	U1C4 R098	limited examination permanent insulation
N5B-IR (Core Spray)	60	U1R8	Indeterminate	U1C2 R067	limited examination permanent insulation angle iron
N8A-IR (Jet Pump Instrumentation)	75	U1R8	Indeterminate	U1C4 R229	examined 6/12/1981
N10-IR (SLC)	90	U1R9	50	U1C6R R2224	VT-1E Performed

[1] See response to RAI 2 regarding the examination coverage for N2D-IR, N2E-IR, and N2G-IR

RAI 2

Regarding weld numbers N2D-IR (Recirc Inlet), N2E-IR (Recirc Inlet), N2G-IR (Recirc Inlet), N5A-IR (Core Spray), N5B-IR (Core Spray), N8A-IR (Jet Pump Instrumentation), and N10-IR (SLC) please provide diagrams showing the coverage that was obtained, coverage calculations and obstructions inhibiting further examination.

TVA Response to RAI-2

Nozzles N2D-IR, N2E-IR, N2G-IR, N5A-IR, N5B-IR, and N8A-IR

The inner radius examination of the recirculation nozzles (N2D-IR, N2E-IR, and N2G-IR), core spray nozzles (N5A-IR and N5B-IR), and the jet pump instrumentation nozzle (N8A-IR) identified in RAI-2 were conducted in accordance with ASME Code Case N-648-1, utilizing modified VT-1 visual techniques as required by the NRC's condition in Regulatory Guide 1.147, Revision 16. Because these are visual examinations, there are no diagrams showing the coverage that was obtained. The examinations were conducted to the fullest extent practical although it was not possible to achieve 100% coverage of the examination area. When limitations were encountered, whether obstructed from view or unable to manipulate the camera within the resolution requirements determined during calibration of the camera system, the percentage of coverage was estimated based on observed results. Estimation of the percentage coverage was necessary as there were no readily available dimensional data to ascertain calculated coverage. The following information provides further detail on the actual limitations encountered during the visual examination of the N2D-IR, N2E-IR, N2G-IR, N5A-IR, N5B-IR, and N8A-IR nozzles.

- N2D-IR, N2E-IR, and N2G-IR

  A portion of the nozzle inner radius was obstructed by the welded thermal sleeve that attaches the reactor pressure vessel (RPV) interior jet pump riser piping to the recirculation nozzles. Additionally the jet pump riser piping and associated diffusers restricts camera manipulation and prevents obtaining the required distance and angle considerations associated with the resolution requirements. During the development of this RAI response, TVA identified an error in the reported examination coverage for weld number N2G-IR. Table 1 to Enclosure 1 in relief request 1-ISI-28 of TVA letter CNL-18-080, stated the examination coverage for weld number N2G-IR was 30%, the correct value is 60% (i.e., two segments of 30% each for a cumulative total of 60% coverage), which is more conservative. This error has been entered into the TVA corrective action program.

- N5A-IR and N5-IRB

  A portion of the nozzle inner radius is obstructed by the welded thermal sleeve that attaches the nozzle to the core spray RPV interior piping tee-box. Additionally the core spray piping tee-box and the feedwater sparger directly above the core spray nozzles, restricts camera manipulation and prevents obtaining the required distance and angle considerations associated with the visual resolution requirements.

- N8A-IR

  Access to nozzle inner radius is restricted due to several instrumentation lines protruding through the nozzle opening that are eventually attached to the RPV internal jet pump components. Additionally, adjacent jet pump diffuser assemblies restrict camera access and prevents obtaining the required distance and angle considerations associated with the visual resolution requirements.

Nozzle N10-IR

Regarding the standby liquid control (SLC) nozzle N10-IR, the inner radius examination of the nozzle was conducted using ultrasonic techniques. The ultrasonic examination was performed utilizing a vendor-provided procedure and personnel that were qualified in accordance with the provisions of the Performance Demonstration Initiative (PDI). The vendor ultrasonic inner radius procedure was qualified with identified ranges that required modeling to determine the optimal parameters required for effective examinations of individual nozzles. The modeling for the N10-IR nozzle was performed by the Electric Power Research Institute (EPRI) using dimensional data obtained from fabrication drawings [EPRI report IR-2004-43, "Browns Ferry Standby Liquid Control Nozzle (N10) Inner Radius Examinations"]. The modeling identified the required search unit angles, mode of sound propagation, required metal paths, skew angles, scan surfaces, probe radial positioning, and other detailed parameters to conduct the examination. The results of the modeling for flaw detection determined that two shear wave search units scanning from the outside RPV shell surface with angles of 65° and 70° within the identified parameters of the modeling report would achieve 90.5% coverage of the required examination volume. The ultrasonic inner radius examination was conducted in accordance with the EPRI modeling report in conjunction with the vendor PDI qualified procedure by qualified personnel.

The following table and illustrations are excerpts from EPRI Report IR-2004-43 and provide additional information.

Table 2-3 from EPRI Report IR-2004-43, as shown below, provides information regarding scan parameters with each search unit.

Table 2-3 from EPRI Report IR-2004-43
Spreadsheet Model Detection Techniques for Browns Ferry Standby Liquid Control Nozzle (N10)

Probe Angle	Probe Skew	Scan Surface	Min R	Max R	Min MP	Max MP	Maximum Misorientation
70	±(2 to 23)	Vessel	2.94	15.54	2.30	16.07	18
65	±(1 to 10)	Vessel	13.85	15.54	14.14	16.07	14

Figure 2-4 from EPRI Report IR-2004-43 is a depiction of the effective examination coverage realized with the 70° search unit. Beam angle is displayed in blue and the red in the diagram illustrates the examination area. The area depicted in red above the beam angle in the upper left portion of sketch is the area that is not examined by either the 65° or the 70° search units.

Figure 2-5 from EPRI Report IR-2004-43 is a depiction of the additional effective examination coverage realized with the 65° search unit. Beam angle is displayed in green and the red in the diagram illustrates the examination area.

Figure 2-4 from EPRI Report IR-2004-43
Browns Ferry Standby Liquid Control Nozzle (N10): Probe Scan Limits and Examination Coverage for Detection Technique 70/(2 to 23)vs at Theta = 0°

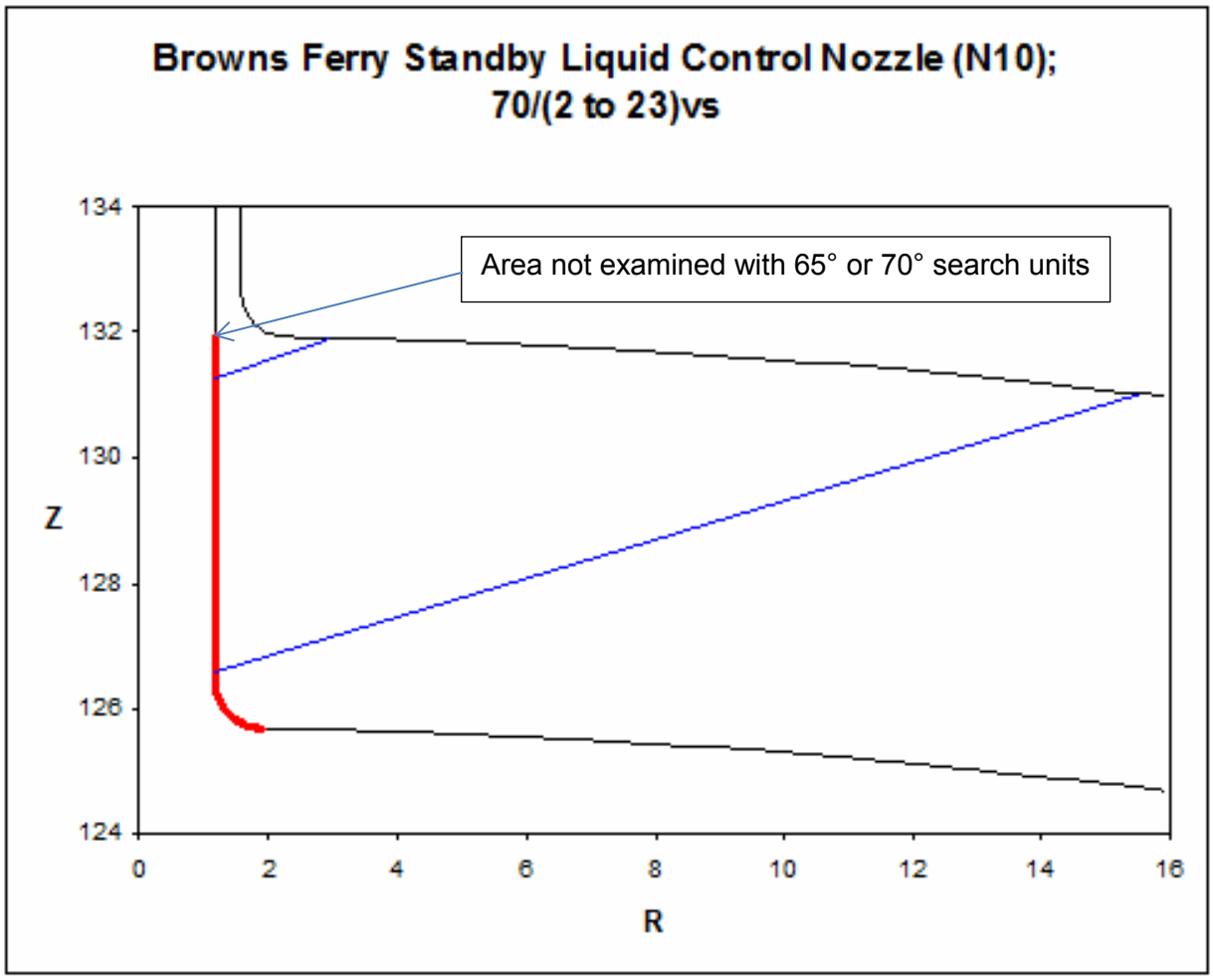
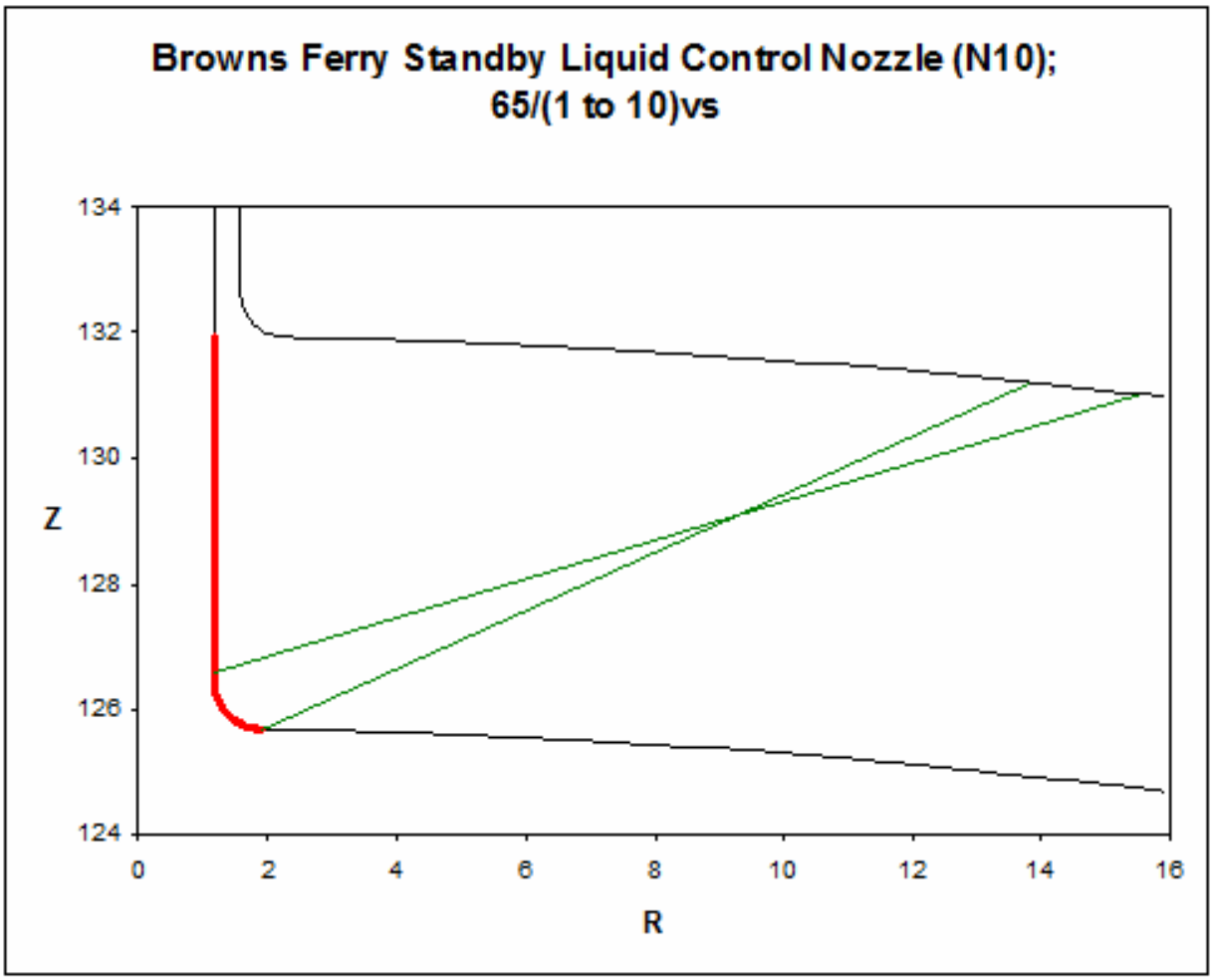


Figure 2-5 Browns Ferry Standby Liquid Control Nozzle (N10): Probe Scan Limits and Examination Coverage for Detection Technique 65/(1 to 10)vs at Theta = 0°



RAI 3

Regarding the 22 indications that were found in the vicinity of Feedwater nozzle N-4A, please confirm whether there were any changes in number, or growth, of indications compared to those found in U1-R6. Additionally, if any changes were present, please confirm that Browns Ferry will follow any ASME Code required adjustments to the examination schedule.

TVA Response to RAI-3

There were no changes in the number of indications found in the vicinity of the N4A feedwater nozzle. However, there were slight changes in the reported dimensions of the indications and grouping of indications when proximity rules are applied (see Table 2). These changes are the result of advances in technology that provide improved detection and more accurate sizing of the indications present.

Table 2

N4A Indication	2007		2016		Difference	
	Length (ℓ)	Height (H) (2a)	L(ℓ)	H(2a)	ΔL	ΔH
1	0.97	0.32	0.62	0.14	-0.35	-0.18
2	1.28	0.28	0.38	0.13	-0.9	-0.15
3	1.48	0.24	0.26	0.11	-1.22	-0.13
3/4[1]	1.94	1.16	1.02	0.48	-0.92	-0.68
4	1.48	0.72	0.76	0.32	-0.72	-0.40
5	0.83	0.36	0.26	0.26	-0.57	-0.10
5/6[1]	N/A	N/A	0.91	0.30	N/A	N/A
6	1.17	0.32	0.65	0.24	-0.52	-0.08
7	0.94	0.36	0.47	0.19	-0.47	-0.17
7/8[1]	1.52	0.6	0.71	0.19	-0.81	-0.41
8	0.91	0.24	0.24	0.15	-0.67	-0.09
9	0.81	0.24	0.63	0.11	-0.18	-0.13
9/11/12/13[1]	2.61	0.84	N/A	N/A	N/A	N/A
10	1.44	0.48	0.67	0.21	-0.77	-0.27
10/11/12/13[1]	N/A	N/A	2.53	0.5	N/A	N/A
11	0.99	0.52	0.53	0.44	-0.46	-0.08
12	0.8	0.4	0.53	0.26	-0.27	-0.14
13	0.86	0.36	0.80	0.24	-0.06	-0.12
14	0.89	0.32	0.81	0.25	-0.08	-0.07
14/16/22[1]	N/A	N/A	1.73	0.74	N/A	N/A
15	1.09	0.36	0.55	0.22	-0.54	-0.14
15/18[1]	1.51	0.88	N/A	N/A	N/A	N/A
16	1.12	0.36	0.66	0.31	-0.46	-0.05
17	0.47	0.0	0.41	0.08	-0.06	+0.08
18	0.94	0.44	0.27	0.26	-0.67	-0.18
19	1.07	0.44	0.82	0.30	-0.25	-0.14
20	0.54	0.0	0.32	0.09	-0.22	+0.09
21	0.53	0.0	0.41	0.08	-0.12	+0.08
22	0.60	0.36	0.26	0.20	-0.34	-0.16

[1] Combined Indication

ASME Section XI Code Case N-526 provides alternate requirements for re-examination of subsurface flaws found by volumetric examinations in lieu of the requirements in IWB-2420(b). Code Case N-526 is accepted without condition in Regulatory Guide 1.147 Revision 17.

Code Case N-526 states that re-examinations in accordance with IWB-2420(b) of vessel examination volumes containing subsurface flaws are not required, provided the following are met:

(a) The flaw is characterized as subsurface in accordance with Figure 1 provided in the Code Case.

(b) The NDE technique and evaluation that detected and characterized the flaw, with respect to both sizing and location, shall be documented in the flaw evaluation report.

(c) The vessel containing the flaw is acceptable for continued service in accordance with IWB-3600, and the flaw is demonstrated acceptable for the intended service life of the vessel.

Because the indications in Table 2 are all subsurface and satisfy the provisions of Code Case N-526, subsequent, re-examinations of the indications identified in weld N4A are not required.