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

Vogtle Electric Generating Plant – Unit 2
Inservice Inspection Program
Owner's Activity Report for Outage 2R19

Ladies and Gentlemen:

Enclosed is the ASME Section XI Code Case N-532-5 OAR-1 Owner's Activity Report for the 2R19 Refueling Outage. Table 1, "Items with Flaws or Relevant Conditions that Required Evaluation for Continued Service," lists evaluations performed for continued service, and is provided as Enclosure 2. Table 2, "Abstract of Repairs, Replacement or Corrective Measures Required for Continued Service," lists repair/replacement activities, and is provided as Enclosure 3. The structural evaluation of leaking abandoned instrument line off the Unit 2 steam generator 2 is provided as Enclosure 4.

This report is for the first period of the 4th Interval ISI activities (Interval 4, Period 1, Outage 1).

This letter contains no NRC commitments. If you have any questions, please contact Ken McElroy at (205) 992-7369.

Respectfully submitted,

J. J. Hutto
Regulatory Affairs Director

JJH/kgl/cg

Enclosures:

1. 2R19 Form OAR-1 Owner's Activity Report

2. 2R19 Form OAR-1 Owner's Activity Report, Table 1, Items with Flaws or Relevant Conditions that Required Evaluation for Continued Service

3. 2R19 Form OAR-1 Owner's Activity Report, Table 2, Abstract of Repairs, Replacement or Corrective Measures Required for Continued Service

4. Structural Evaluation of Leaking Abandoned Instrument Line off the U2 Steam Generator 2

Cc: Regional Administrator, Region II
NRR Project Manager – Vogtle 1 & 2
Senior Resident Inspector – Vogtle 1 & 2
RType: CVC7000

Alvin W. Vogtle Nuclear Plant – Unit 2
Inservice Inspection Program
Owner's Activity Report for Outage 2R19

Enclosure 1

2R19 Form OAR-1 Owner's Activity Report

FORM OAR-1 OWNER'S ACTIVITY REPORT

Report Number 2-4-1-1 (Unit 2, 4th Interval, 1st Period, 1st Report)

Plant Alvin W. Vogtle Electric Generating Plant

Unit No. 2 (if applicable) Commercial service date May 20, 1989 Refueling outage no. 2R19

Current inspection interval 4th (Also includes 3rd interval activities performed after refueling outage 2R18) (1st, 2nd, 3rd, 4th, other)

Current inspection period 1st (Also includes 3rd period activities performed after refueling outage 2R18) (1st, 2nd, 3rd)

Edition and Addenda of Section XI applicable to the inspection plans The 2001 Edition through 2003 Addenda is applicable to the 3rd Inspection Interval. The 2007 Edition through 2008 Addenda is applicable to the 4th Inspection Interval.

Date and revision of inspection plans 3rd Inspection Interval inspection plans – Volume 1- 03/07/2017 (Version 10.0) and Volume 4 – 02/17/2016 (Version 8.0). 4th Inspection Interval inspection plans – Volume 1- 09/14/2017 (Version 1.0), Volume 3 – 11/30/2017 (Version 1.0), and Volume 4 – 12/13/2017 (Version 1.0). 2R19 Outage Plan – 09/14/2017 (Version 1.0) with 2R19 Outage Plan Scope Change SC-001 -11/09/2017

Edition and Addenda of Section XI applicable to repair/replacement activities, if different than the inspection plans Same

Code Cases used for inspection and evaluation: N-716-1, N-722-1, N-729-4, and N-770-2 (if applicable, including cases modified by Case N-532 and later revisions)

CERTIFICATE OF CONFORMANCE

I certify that (a) the statements made in this report are correct; (b) the examinations and tests meet the Inspection Plan as required by the ASME Code, Section XI; and (c) the repair/replacement activities and evaluations supporting the completion of 2R19 (refueling outage number) conform to the requirements of Section XI.

Signed Brian A. Coker EFIN Manager / Acting Engineering Director Date 12-19-17
Owner or Owner's Designee, Title

CERTIFICATE OF INSERVICE INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Hartford, CT, have inspected the items described in this Owner's Activity Report, and state that, to the best of my knowledge and belief, the Owner has performed all activities represented by this report in accordance with the requirements of Section XI.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the repair/replacement activities and evaluation described in this report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Steve Fitzwater Commission GA-1249, NB15193 A, N, I
Inspector's Signature (National Board Number and Endorsement)

Date 12/19/17

Alvin W. Vogtle Nuclear Plant – Unit 2
Inservice Inspection Program
Owner's Activity Report for Outage 2R19

Enclosure 2

2R19 Form OAR-1 Owner's Activity Report, Table 1, Items with Flaws or Relevant Conditions that Required Evaluation for Continued Service

Table 1

Items with Flaws or Relevant Conditions That Required Evaluation for Continued Service

Examination Category and Item Number	Item Description	Evaluation Description
C-H and C7.10[1]	Through-wall flaw on ¾ inch pipe stub off of Steam Generator 2 (Location - 21201B6002)	This flaw was evaluated by Structural Integrity Associates, Inc. (File No.: 1700924.301) with the methodology described in ASME Section XI Nonmandatory Appendix C "Evaluation of Flaws in Piping". This evaluation demonstrated that the as-found flaw with the leakage monitoring plan was adequate to operate safely and within its safety basis for the period of time necessary to complete fabrication and installation of an Appendix IX mechanical clamping device. Specific details associated with the proposed alternative to utilize an Appendix IX mechanical clamping device are contained in NRC letter dated December 8, 2017 "Vogtle Electric Generating Plant, Unit 2 – Proposed Alternative VEGP-ISI-ALT-04-03 Regarding the Repair of a Pipe on the Steam Generator (CAC No. MF9922; EPID L-2017-LLR-0048)" (ADAMS Accession No. ML17338A480) and associated documents. The mechanical clamping device was removed and a permanent code repair was completed during the refueling outage.

Note

[1]Enclosure 4 contains Structural Integrity Associates, Inc – Structural Evaluation of Leaking Abandoned Instrument Line off the U2 Steam Generator 2 (File No: 1700924.301)

Alvin W. Vogtle Nuclear Plant – Unit 2
Inservice Inspection Program
Owner's Activity Report for Outage 2R19

Enclosure 3

2R19 Form OAR-1 Owner's Activity Report, Table 2, Abstract of Repairs, Replacement or Corrective Measures Required for Continued Service

Table 2
Abstract of Repair / replacement Activities Required for Continued Service

Code Class	Item Description	Description of Work	Date Completed	Repair / Replacement Plan Number
1	Seal Table (Location - 21201V6001)	Replaced Seal Table fittings to improve design to eliminate leakage associated with mechanical connections	10/02/2017	819373-T1
2	Main Feedwater Piping (Line Number-2-1305-155-6 inch)	Replaced degraded section of piping due to wear from Flow Accelerated Corrosion	10/04/2017	795543-T1
3	Nuclear Service Cooling Water Transfer Pump No. 8 (Location - 21202P4008)	Replaced degraded pump discharge flange bolting	01/15/2017	832118-T1

Alvin W. Vogtle Nuclear Plant – Unit 2
Inservice Inspection Program
Owner's Activity Report for Outage 2R19

Enclosure 4

Structural Evaluation of Leaking Abandoned Instrument Line off the U2 Steam Generator 2 (File No: 1700924.301)

Structural Integrity Associates, Inc.®

CALCULATION PACKAGE

File No.: 1700924.301

Project No.: 1700924

Quality Program Type: ☒ Nuclear ☐ Commercial

PROJECT NAME:
Vogtle U2 SG2 Leak Evaluation

CONTRACT NO.:
PO No. SNG10160912

CLIENT:
Southern Company

PLANT:
Vogtle Electric Generating Plant, Unit 2

CALCULATION TITLE:
Structural Evaluation of Leaking Abandoned Instrument Line off the U2 Steam Generator 2

Document Revision	Affected Pages	Revision Description	Project Manager Approval Signature & Date	Preparer(s) & Checker(s) Signatures & Date
0	1 - 12 A-1 - A-7	Initial Issue	Eric Houston EJH 7/13/17	Eric Houston EJH 7/13/17 Stephen Parker SMP 7/13/17

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1.0 INTRODUCTION

A leaking through-wall flaw was recently discovered on an abandoned 3/4 -inch instrument line of Steam Generator #2 at the Vogtle Electric Generating Plant (VEGP), Unit 2 [1]. The leak is in the weld metal of the socket welded pipe-to-cap weld. A photograph of the observed leakage is provided in Figure 1 [1].

Figure 1: Photograph of As-Found Piping Configuration

The objective of this evaluation is to assess the structural stability of the remaining ligament for continued operation. Detailed NDE examinations are not available. Therefore, the remaining ligament is evaluated parametrically in order to assess the flaw tolerance of the component.

The structural limits as defined by the ASME Boiler and Pressure Vessel Code, Section XI [2] are used in the development of the acceptance criteria. The results of the calculations herein will be used to support an NRC submittal.

2.0 METHODOLOGY

The methods of ASME Code, Section XI and Nonmandatory Appendix C are appropriate for demonstrating the structural stability of a piping component in the presence of a crack. For the present analysis, the methods of linear elastic fracture mechanics are used to evaluate margin to flaw instability of the component.

The flaw is structurally acceptable if the following condition is met [2, IWB-3612]:

$$K_I < \frac{K_{Ic}}{SF} \tag{1}$$

Where:

K_I = Maximum applied stress intensity factor for the service level under evaluation, $ksi\sqrt{in}$.

K_{Ic} = Static material fracture toughness for crack initiation under plane strain, $ksi\sqrt{in}$.

SF = Structural factor based on service level, unitless.
$SF = \sqrt{10}$ for normal, upset, and test conditions.
$SF = \sqrt{2}$ for emergency and faulted conditions.

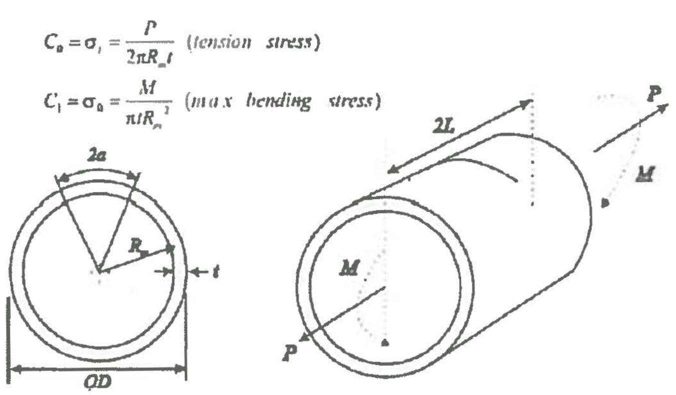
Note that the structural factor is specifically for ferritic vessel flaws. However, the structural factor of $\sqrt{10}$ is greater than the structural factor for Service Level A in Section XI, Appendix C [2, C-2621]. Therefore, $\sqrt{10}$ is conservatively used in this evaluation.

Section XI flaw evaluations typically assume a crack length to depth ratio, with an allowable flaw size based on the extent of the flaw depth. However, the evaluation herein is for a through-wall flaw. As such, the calculated K_I in Equation 1 is based on a through-wall flaw length.

The analysis uses published fracture mechanics models to approximate the as-found flaw. Using the model for a through-wall circumferential crack in a cylinder under tension and bending (See Figure 2), K_I is calculated for a range of wall thicknesses and flaw lengths.

It is necessary to transform the observed configuration to the fracture mechanics model shown in Figure 2. The leak location is assumed to be along the fillet weld-to-cap interface. The fillet weld throat is conservatively used as the nominal evaluated wall thickness and the nominal inside radius is taken as the cap inside radius. Lack of fusion is likely a contributing factor in the initial through-wall failure based on the leak location (approximately at the bottom dead center of the instrument line) and the difficulty in obtaining complete weld fusion at the root pass of socket welds. Therefore, it is possible that some portion of the root pass weld contains defects. In addition, the potential for corrosion at this location prior to the defect going through-wall could further decrease the remaining ligament. Figure 3 illustrates the transformation of the observed flaw to the geometry appropriate for evaluation in the fracture mechanics model.

The evaluation herein is concerned only with failure due to primary loading associated with postulated events. Secondary stresses, such as thermal and weld residual stresses, are self-limiting and do not contribute significantly to gross structural failure in ductile materials in the presence of a through-wall flaw. Secondary stresses may contribute to flaw growth and are considered in a separate evaluation.



Stress/Load Input	
Stress Coefficients	✓
Coeffs. from Stress Table	✗
Stress Table	✗
Stress Intensity Factors (1D)	✗
Stress Intensity Factors (2D)	✗
C_0 = Membrane Stress C_1 = Max. Bending Stress	
Crack Dimensions: a Component Dimensions: t R_m	
Range: $1.5 < R_m/t \leq 100$ $a/(\pi R_m) < 0.611$ Source: [3]	

Figure 2: Fracture Mechanics Model

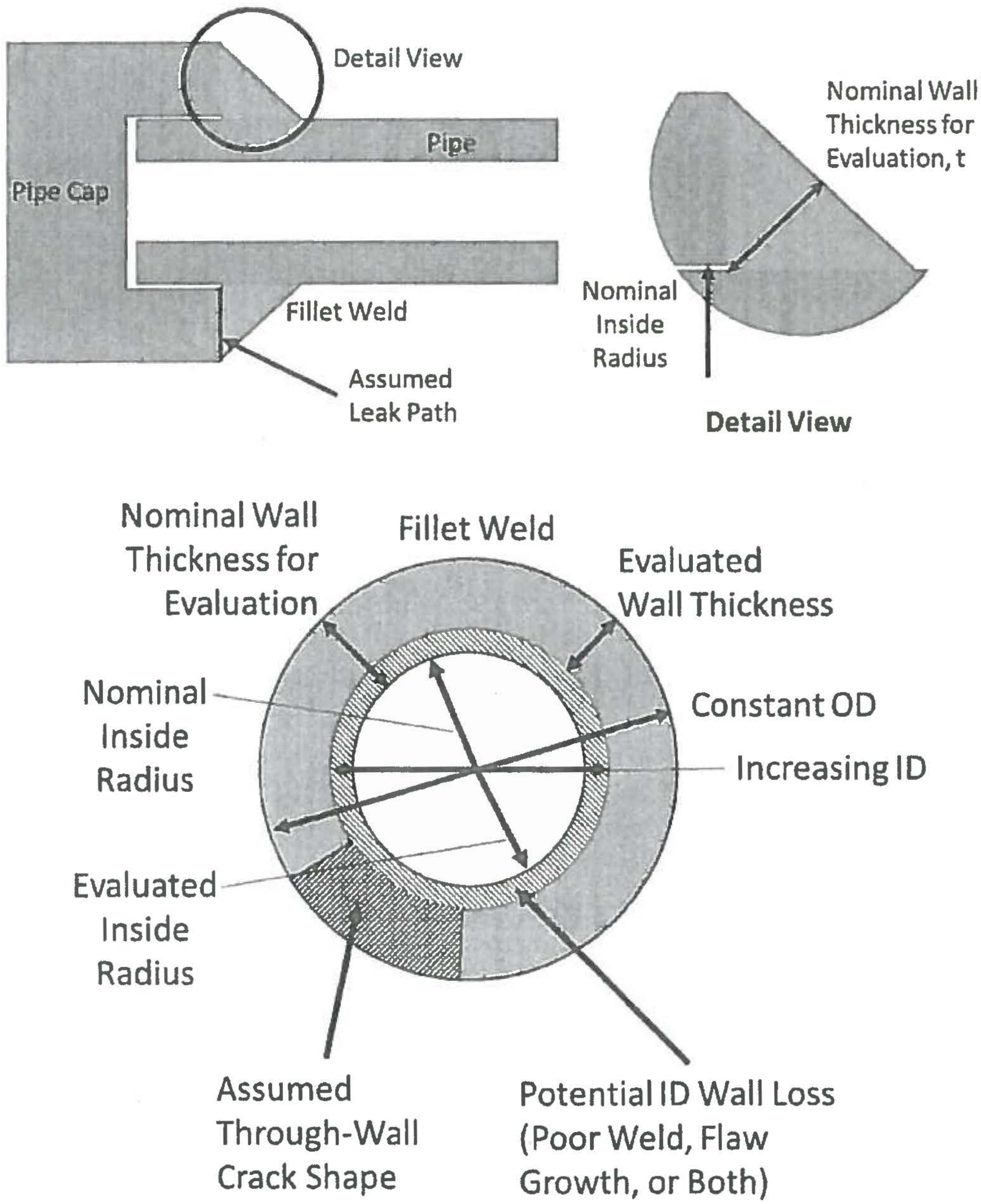


Figure 3: Crack Flaw Model

3.0 DESIGN INPUTS

The following design inputs are used in the analysis:

1. Nominal Pipe Size: ¾-inch schedule 160 [1]
2. Fillet Weld nominal size: 0.25 inch [1]
3. Pipe Cap: 6,000 lb, SA-105 Grade II [1]
4. Design pressure: 1185 psig [1]
5. Design temperature: 600°F [1]
6. Code of Record for repair: Section III 1971 Edition with Addenda through Summer 1972 [1]
7. Allowable stress at design temperature: 17.5 ksi [4, Table I-7.1]
8. Modulus of elasticity at design temperature: 25,700 ksi [4, Table I-6.0]
9. Lower bound fracture toughness at lower shelf, J_{Ic} = 45 in-lb/in^2 [2, Table C-8321-1]
10. Vertical acceleration during design basis seismic event: 5.4g [1]
11. Horizontal acceleration during design basis seismic event: 5.3g [1]
12. Seismic multimode factor: 1.7 [1]

The pipe cap weight is 5/8 lb [5]. The pipe cap dimensions are taken from Reference [5] and shown in Figure 4.

- A = 1.0625 in
- B = 1.75 in
- C = 1.065 in
- D = 0.5625 in

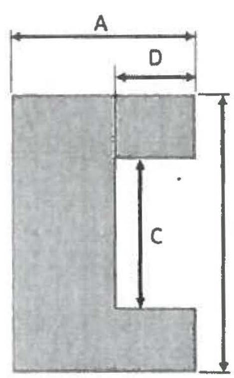


Figure 4: Pipe Cap Dimensions

4.0 ASSUMPTIONS

The following assumptions are used in this evaluation:

1. The leak location is assumed to be along the fillet weld-to-cap interface. This is consistent with the photograph in Figure 1. In addition, the ID of the weld root is assumed to have some level of degradation by corrosion, the presence of weld defects, or both. The exact degradation is not known but is conservatively assumed to affect the entire cross section (i.e., full circumferential). The impact of this assumption is evaluated parametrically and the results given in Table 2.
2. Residual stress due to the pipe-to-cap fillet weld is a steady state secondary stress. As described in Section 2.0, secondary stresses do not contribute to gross structural failure in ductile materials. Therefore, secondary stresses are not evaluated. The contribution to flaw growth by residual stresses, if any, will be determined in a separate evaluation.
3. Poisson's ratio is taken as 0.3 for all materials evaluated, which is a typical value for carbon steels.
4. Reference [5] is a manufacturer's catalog from 1954 and is not entirely consistent with the most recent standard for socket welded pipe caps [8]. Because the exact cap dimensions are not known, the 1954 catalog is assumed to be representative. The differences between the two references are small and do not impact the results of the evaluation. Therefore, use of this assumption is acceptable.

5.0 CALCULATIONS

Volumetric NDE has not been performed on the as-found through-wall flaw. The current flaw length is estimated from the photograph in Figure 1. A markup of that photograph is shown in Figure 5. Conservatively taking the through-wall portion of the flaw as 45° and the outside diameter of the cap as 1.75 inch, the flaw length is calculated to be less than 0.7 inch.

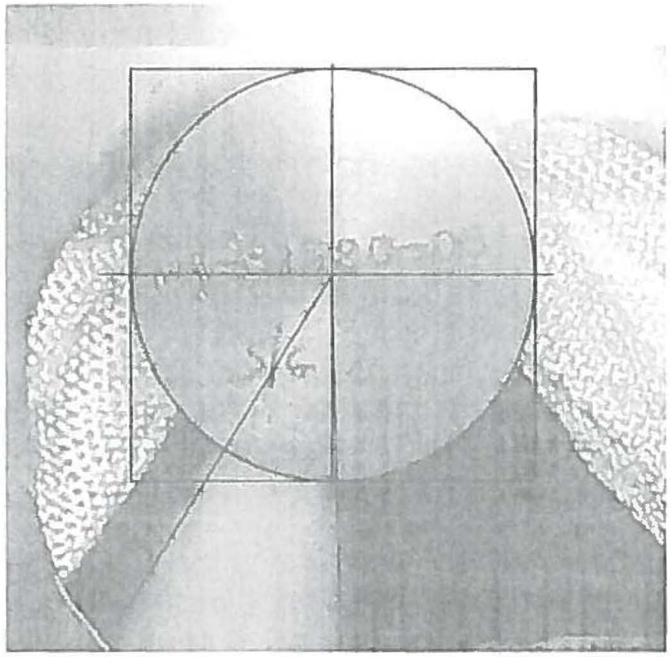


Figure 5: Estimated Through-Wall Flaw Length

Loading that acts to open a circumferentially oriented crack are pressure and moment loads. The axial membrane stress, σ_{mem}, is calculated from the design pressure of 1185 psig and the evaluated inside radius as shown in Figure 3:

$$\sigma_{mem} = \frac{F}{A_{metal}} = \frac{\frac{P}{A_{flow}}}{\pi\left(r_{o\_nom}^2 - r_i^2\right)} = \frac{\frac{P}{\pi r_i^2}}{\pi\left(\left(r_{i\_nom} + t_{nom}\right)^2 - r_i^2\right)} \quad (2)$$

Where:

F	=	Axial membrane force due to pressure, lb
A_{metal}	=	Cross-sectional area of un-cracked metal, in^2
A_{flow}	=	Cross-sectional area over which internal pressure acts, in^2
r_{o_nom}	=	Outside radius based on r_{i_nom} and t_{nom} (see Figure 3), in
r_i	=	Radius to inside surface over which internal pressure acts, in
r_{i_nom}	=	Inside radius of pipe cap, dimension C in Figure 4, in
t_{nom}	=	Nominal fillet weld throat thickness, in

The nominal fillet weld throat is calculated as 0.177 inch and the resulting outside diameter is 1.419 inches. As the remaining ligament (i.e., the weld throat) is decreased, the inside radius, axial force, and resulting membrane stress increases. Table 1 shows results for the uncracked membrane stress to be used in the fracture mechanics evaluation.

Table 1: Axial Force and Stress

Evaluated Wall Thickness (in)	Inside Radius (in)	Uncracked Metal Area (in^2)	Flow Area (in^2)	Axial Force (lb)	Membrane Stress (psi)
0.177	0.533	0.690	0.891	1,056	1,531
0.150	0.559	0.598	0.983	1,164	1,948
0.100	0.609	0.414	1.166	1,382	3,336

The design basis seismic loading is a 5.4g acceleration in the vertical direction and 5.3g acceleration in the horizontal direction. The vector sum of the accelerations acting perpendicular to the axis of the nozzle is 7.6g acceleration. This acceleration is increased by a multimode factor and produces inertial loading that is evaluated as static moment loading in a piping system. Multiplying the cap weight by the acceleration of 7.6g, the multimode factor, and the lever arm equivalent to the full length of the pipe cap (1-1/16 inch) results in a moment of less than 9 in-lbs. Acceleration of 5.3g coincident with the axis of the nozzle produces an axial force rather than a moment. Utilizing the same approach, the axial force is calculated to be less than 6 lbs. The axial force and moment loads, and the resulting stresses, are insignificant. Therefore, loading due to postulated seismic events is taken as zero in the evaluation.

The axial stress values in Table 1 are based on the design pressure and do not vary with service level. Therefore, only the normal condition is required to be evaluated because the structural factor in IWB-3612(a) (SF = $\sqrt{10}$) is higher than of the emergency and faulted condition in IWB-3612(b) (SF = $\sqrt{2}$) [2]. The static fracture toughness under plane strain conditions, K_{Ic}, is calculated in accordance with Section XI, Appendix C, C-7200:

$$K_{Ic} = \sqrt{\frac{J_{Ic}E'}{1,000}} \qquad E' = \frac{E}{1-\upsilon^2} \tag{3}$$

Where:

J_{Ic} = Material toughness, in-lb/in^2
E = Elastic modulus, ksi
υ = Poisson's ratio

Based on the input above, K_{Ic} is calculated as 35.6 ksi-in$^{1/2}$. Using a structural factor of $\sqrt{10}$, the allowable stress intensity factor is 11.2 ksi-in$^{1/2}$.

The through-wall circumferential cracked cylinder model under tension is evaluated using SI's proprietary software **pc-CRACK** 4.0 [6]. **pc-CRACK** was developed under SI's Nuclear Quality Assurance program, which is controlled by SI's Quality Assurance Manual [7]. The model iterates the half flaw length and calculates an applied stress intensity factor, K_I. The flaw is considered acceptable for all stress intensities that satisfy Equation 1. The maximum acceptable flaw is at the point where the

stress intensity factor is just less than the available fracture toughness, K_{Ic}, including the effect of the structural factor.

As an additional check, the stress in the remaining ligament is calculated and compared to the material allowable stress, S, which is 17,500 psi at the design temperature.

6.0 RESULTS OF ANALYSIS

The evaluation is conducted using **pc-CRACK** to model the through-wall circumferential cracked cylinder under tension. As can be seen from Table 2, the critical flaw length is significantly greater than the conservatively characterized flaw length of 0.7 inch. Note that the critical flaw length is defined as the flaw length for which the stress intensity factor, including the structural factor of $\sqrt{10}$, is equal to the allowable stress intensity factor. The **pc-CRACK** output files are included with this calculation in Appendix A.

Table 2: Critical Through-Wall Flaw Sizes

Evaluated Wall Thickness (in)	Critical Through-Wall Flaw (in)
0.177	2.0
0.15	1.9
0.10	1.4

The stress in the remaining ligament is calculated for each flaw configuration in Table 2. The maximum stress ratio (which is the applied stress divided by the allowable stress) is less than 0.5. Therefore, the remaining ligament meets the stress limits of the Construction Code.

7.0 CONCLUSIONS

A leaking through-wall flaw was recently discovered on an abandoned 3/4 -inch instrument line of Steam Generator #2 at VEGP, Unit 2. The leak is in the weld metal of the socket welded pipe-to-cap weld.

This evaluation demonstrates that the component with the as-found flaw maintains the structural limits, as defined by the ASME Boiler and Pressure Vessel Code, Section XI, based on the inputs and assumptions used herein. The evaluation conservatively reduced the remaining ligament thickness in order to demonstrate the flaw tolerance of the piping configuration.

Two failure modes of the remaining ligament are analyzed: structural stability using LEFM and stress overload. In all cases, LEFM is the limiting evaluation approach. The flawed component has been

shown to demonstrate structural adequacy, as defined by the ASME Boiler and Pressure Vessel Code, Section XI, under postulated design conditions.

8.0 REFERENCES

1. Southern Nuclear Operating Company RER Response Form No. SNC881195, Sequence 01, "Design Input to Structural Integrity for U2 SG#2 Steam Leak Evaluation," SI File No. 1700924.202.
2. ASME Boiler and Pressure Vessel Code, Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, 2007 Edition with Addenda through 2008.
3. Takahashi, Y., "Evaluation of leak-before-break assessment methodology for pipes with a circumferential through-wall crack. Part I: stress intensity factor and limit load solutions," International Journal of Pressure Vessels and Piping, Volume 79, pp. 385-392, 2002.
4. ASME Boiler and Pressure Vessel Code, Section III, *Rules for Construction of Nuclear Power Plant Components*, 1971 Edition with Addenda through Summer 1972.
5. Ladish General Catalog No. 55, "Forged and Seamless Welding Pipe Fittings," 1954.
6. pc-CRACK 4.1, Version 4.1.0.0 CS, December 31, 2013.
7. SI Quality Assurance Manual, Revision 8, March 28, 2013.
8. ASME B16.11-2016, "Forged Fittings, Socket-Welding and Threaded."

Appendix A

PC-CRACK OUTPUT FILES

pc-CRACK 4.1 CS

Version Control No. 4.1.0.0

Structural Integrity Associates, Inc.
www.structint.com
pccrack@structint.com

Date: 07/08/2017 14:43

Input Data read from C:\Users\ehouston\Documents\Data\Projects - Active\170XXXX (Vogtle SG2 Leak)\Vogtle U2 SG2 Leak t=0.050.pcf

Analysis Title: Vogtle U2 SG2 Eval t_0_177

Units Selected: US Customary

Analysis Type: Stress Intensity Factors

Crack Model: 311-Through-Wall Circumferential Crack in Cylinder Under Tension And Bending
Half Crack Length, a = 0.1000
Wall Thickness, t = 0.1770
Mean Radius, Rm = 0.6209
Maximum a/(PI*Rm) = 0.611
Crack Depth Print Increment for SIF Tabulation = 0.1

Total Load Cases: 1

Load Case 1:Pressure
Type: Stress Coefficients Input by User

Coefficient C0 = 1.5310
Coefficient C1 = 0.0000
Coefficient C2 = 0.0000
Coefficient C3 = 0.0000

messages/Warnings:

Number of Warnings in Inputs: 0

---------- ANALYSIS RESULTS ---------

STRESS INTENSITY FACTORS

Load Case # 1: Pressure

a	a/(PI*Rm)	K
0.1000	0.0513	0.8749
0.2000	0.1025	1.3323
0.3000	0.1538	1.8088
0.4000	0.2051	2.3486
0.5000	0.2563	2.9815
0.6000	0.3076	3.7501
0.7000	0.3589	4.7226
0.8000	0.4101	6.0006
0.9000	0.4614	7.7254
1.0000	0.5127	10.0831
1.1000	0.5639	13.3096

Critical A/B Half Flaw Length

Number of Runtime Warnings: 0

*** End of pc-CRACK output ***

pc-CRACK 4.1 CS

Version Control No. 4.1.0.0

Structural Integrity Associates, Inc.
www.structint.com
pccrack@structint.com

Date: 07/08/2017 14:44

Input Data read from C:\Users\ehouston\Documents\Data\Projects - Active\170XXXX (Vogtle SG2 Leak)\Vogtle U2 SG2 Leak t=0.050.pcf

Analysis Title: Vogtle U2 SG2 Eval t_0_15

Units Selected: US Customary

Analysis Type: Stress Intensity Factors

Crack Model: 311-Through-Wall Circumferential Crack in Cylinder Under Tension And Bending
Half Crack Length, a = 0.1000
Wall Thickness, t = 0.1500
Mean Radius, Rm = 0.6343
Maximum a/(PI*Rm) = 0.611
Crack Depth Print Increment for SIF Tabulation = 0.05

Total Load Cases: 1

Load Case 1:Pressure
Type: Stress Coefficients Input by User

Coefficient C0 = 1.9480
Coefficient C1 = 0.0000
Coefficient C2 = 0.0000
Coefficient C3 = 0.0000

messages/Warnings:

Number of Warnings in Inputs: 0

---------- ANALYSIS RESULTS ---------

STRESS INTENSITY FACTORS

Load Case # 1: Pressure

a	a/(PI*Rm)	K
0.1000	0.0502	1.1152
0.1500	0.0753	1.4126
0.2000	0.1004	1.7042
0.2500	0.1255	2.0047
0.3000	0.1505	2.3212
0.3500	0.1756	2.6582
0.4000	0.2007	3.0194
0.4500	0.2258	3.4089
0.5000	0.2509	3.8320
0.5500	0.2760	4.2954
0.6000	0.3011	4.8079
0.6500	0.3262	5.3808
0.7000	0.3513	6.0277
0.7500	0.3764	6.7655
0.8000	0.4015	7.6140
0.8500	0.4266	8.5964
0.9000	0.4516	9.7394
0.9500	0.4767	11.0735
1.0000	0.5018	12.6331
1.0500	0.5269	14.4568
1.1000	0.5520	16.5873
1.1500	0.5771	19.0719
1.2000	0.6022	21.9622

Critical A/B Half Flaw Length

Number of Runtime Warnings: 0

*** End of pc-CRACK output ***

pc-CRACK 4.1 CS

Version Control No. 4.1.0.0

Structural Integrity Associates, Inc.
www.structint.com
pccrack@structint.com

Date: 07/08/2017 14:46

Input Data read from C:\Users\ehouston\Documents\Data\Projects - Active\170XXXX (Vogtle SG2 Leak)\Vogtle U2 SG2 Leak t=0.050.pcf

Analysis Title: Vogtle U2 SG2 Eval t_0_10

Units Selected: US Customary

Analysis Type: Stress Intensity Factors

Crack Model: 311-Through-Wall Circumferential Crack in Cylinder Under Tension And Bending
Half Crack Length, a = 0.1000
Wall Thickness, t = 0.1000
Mean Radius, Rm = 0.6593
Maximum a/(PI*Rm) = 0.611
Crack Depth Print Increment for SIF Tabulation = 0.05

Total Load Cases: 1

Load Case 1:Pressure
Type: Stress Coefficients Input by User

Coefficient C0 = 3.3360
Coefficient C1 = 0.0000
Coefficient C2 = 0.0000
Coefficient C3 = 0.0000

messages/Warnings:

Number of Warnings in Inputs: 0

---------- ANALYSIS RESULTS ---------

STRESS INTENSITY FACTORS

Load Case # 1: Pressure

a	a/(PI*Rm)	K
0.1000	0.0483	1.9207
0.1500	0.0724	2.4471
0.2000	0.0966	2.9717
0.2500	0.1207	3.5188
0.3000	0.1448	4.0995
0.3500	0.1690	4.7196
0.4000	0.1931	5.3834
0.4500	0.2173	6.0955
0.5000	0.2414	6.8624
0.5500	0.2655	7.6929
0.6000	0.2897	8.5994
0.6500	0.3138	9.5980
0.7000	0.3380	10.7096
0.7500	0.3621	11.9597
0.8000	0.3862	13.3794
0.8500	0.4104	15.0053
0.9000	0.4345	16.8805
0.9500	0.4587	19.0542
1.0000	0.4828	21.5826
1.0500	0.5069	24.5289
1.1000	0.5311	27.9639
1.1500	0.5552	31.9658
1.2000	0.5794	36.6209
1.2500	0.6035	42.0237

Critical A/B Half Flaw Length

Number of Runtime Warnings: 0

*** End of pc-CRACK output ***