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919-362-2502

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10 CFR 50.55a

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400

Subject: Relief Request I3R-12, Accumulator Fill Valve Piping Weld, Inservice Inspection Program – Third Ten-Year Interval

Ladies and Gentlemen:

Pursuant to 10 CFR 50.55a(a)(3)(ii), Duke Energy Progress, Inc., hereby requests NRC approval of the attached relief request for the Shearon Harris Nuclear Power Plant, Unit 1 (HNP) inservice inspection program, third ten-year interval. This relief request is being submitted because a through-wall flaw was discovered in the weld attaching piping to the "C" accumulator fill isolation valve on October 20, 2013. HNP performed repair activities in accordance with ASME Section XI, Appendix IX, on October 30, 2013, with the intervening time used for evaluation, design, planning, and implementation of the repair.

Duke Energy requests approval by May 7, 2014, which provides six months for NRC staff review.

This document contains no regulatory commitments.

Please refer any questions regarding this request to Dave Corlett, Regulatory Affairs Manager, at (919) 362-3137.

Sincerely,

Ernest J. Kapopoulos, Jr.

Enclosure: Relief Request I3R-12

cc: Mr. J. D. Austin, NRC Sr. Resident Inspector, HNP
Mr. A. Hon, NRC Project Manager, HNP
Mr. V. M. McCree, NRC Regional Administrator, Region II

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400

Relief Request I3R-12
Accumulator Fill Valve Piping Weld
Inservice Inspection Program – Third Ten-Year Interval

Proposed Alternative
In Accordance with 10 CFR 50.55a(a)(3)(ii)
Hardship or Unusual Difficulty without
Compensating Increase in Level of Quality or Safety

1. ASME Code Component Affected

a. Description

A through-wall flaw was identified on October 20, 2013, in the weld metal of the socket joint joining the 1" accumulator 'C' fill line 2SI1-157SA-1 to the accumulator 1C-SA fill isolation valve, 1SI-188.

Component:	1SI-188, accumulator 1C-SA fill isolation valve
Code Class:	2
Examination Category:	C-H
Code item Number:	C7.10 (pressure retaining components)
System:	Safety injection
Design Pressure:	700 PSI
Design Temperature:	200 degrees F
Size:	1 inch, schedule 40 nominal pipe size
Pipe Material:	ASTM A-312, Grade TP304
Pipe Thickness:	0.133 inches

b. Function:

The safety injection system consists of multiple water reservoirs and flow paths to provide emergency cooling water to the reactor coolant system. 1SI-188 is operated from the main control board and opened to fill the 'C' accumulator.

c. Description of the Flaw:

The flaw is a through wall, circumferential, planar flaw in the weld metal of the socket joint between the pipe and valve body. The flaw is in the face of the weld and was measured to be approximately 22/32 inches in circumferential length on October 21. The flaw propagated to approximately 24/32 inches in length as measured on October 29. During the installation of a support associated with the repair on October 30, the valve was elevated. Subsequent to the support installation, the flaw length was approximately 1-1/32 inches. The weld effective throat is 0.198 inches. The circumference at the weld effective throat is approximately 5.375 inches. The outside diameter of weld at the effective throat is approximately 1.711 inches.

2. Applicable Code Edition and Addenda

ASME Boiler and Pressure Vessel Code, Section XI, 2001 Edition through the 2003 Addenda.

3. Applicable Code Requirement

ASME Section XI Code, subsection IWC, "Requirements for Class 2 Components of Light-Water Cooled Power Plants", subparagraph IWC-3122.2, "Acceptance by Repair/Replacement Activity, " states in part:

> *A component whose examination detects flaws that exceed the acceptance standards of Table IWC-3410-1 is unacceptable for continued service until… the component is corrected by a repair/replacement activity…*

4. Reason for Request

A decreasing trend in ‘C’ accumulator pressure and level was investigated during a containment entry on October 20, 2013. A walkdown determined that the weld of the socket joint on the downstream side of valve 1SI-188, accumulator 1C-SA fill isolation valve, in line 2SI1-157SA-1 was leaking. Valve 1SI-188 is the ASME Section III Class 2 pressure boundary. Line 2SI1-157SA-1 from 1SI-188 to the accumulator is ASME Class 2. This location is not isolable from the ‘C’ accumulator.

The leak rate trend appears to have started at approximately 21:00 on October 18. The leak rate increased from approximately 1 gallon per hour on October 20 to about 7.1 gallons per hour on October 30, prior to installation of the repair.

Technical Specification 3/4.5.1, “Accumulators,” specifies that the accumulators must be operable in Modes 1, 2, and 3. The action for one accumulator inoperable specifies, “With one accumulator inoperable, except as a result of a closed isolation valve or boron concentration not within limits, restore the inoperable accumulator to OPERABLE status within 1 hour or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to less than 1000 psig within the following 6 hours.”

The repair could not be completed within the one hour allowed outage time for the ‘C’ accumulator. The requirement to enter the shutdown action statement in the limiting condition for operation is a hardship or unusual difficulty without a compensating increase in level of quality or safety. A flaw evaluation was performed which demonstrated that structural integrity would be maintained up to a flaw length of 1.651 inches, providing assurance that adequate safety margins existed.

A repair was completed on October 30. This request addresses the period of time from discovery until completion of the repair, which was needed to evaluate, develop, plan and implement the repair. ASME Code Case N-513-3, “Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping,” does not apply because the flaw is in the weld metal of a socket welded joint.

5. Proposed Alternative and Basis for Use

The proposed alternative is to use-as-is, deferring repair for approximately 10 days to allow evaluation, design, planning, and implementation of the repair. Shutdown of the plant until completion of the repair does not have a compensating increase in the level of quality or safety, based upon a flaw evaluation and compensatory actions as described below.

a) The flaw geometry was characterized by physical measurement. The full pipe circumference at the flaw location was inspected to characterize the surface length of flaw in the pipe section. The depth of the identified flaw was known to be through-wall.

b) The through-wall flaw was classified as planar.

c) Only the single flaw was identified.

d) A flaw evaluation was performed to determine the conditions for flaw acceptance. The flaw evaluation demonstrated that structural integrity would be maintained up to a flaw length of 1.651 inches, providing assurance that adequate safety margins existed. The flaw evaluation is attached.

e) Frequent periodic surface inspections were performed to determine the flaw growth rate and to confirm the flaw length was well below the allowable length.

f) Leak rate, monitoring of the flaw by remote camera, and walkdowns confirmed the analysis conditions used in the evaluation remained valid.

Ultrasonic thickness examinations were performed on the piping adjacent to the flawed weld. The ultrasonic examinations confirmed that there were no general wall thinning concerns in the measurement locations.

Administrative limits were established on leak rates to ensure the accumulator remained operable. If the administrative limits had been reached prior to implementation of the repair, operability of the accumulator would have been reassessed.

The potential effects of boric acid on nearby components were evaluated in the boric acid control program. Continued active borated water leakage was evaluated as acceptable in this case until the scheduled start of the refueling outage on November 9.

The overall degradation mechanism is likely to be stress corrosion cracking, exacerbated by a combination of high deadweight plus pressure stress being close to the service level ‘A’ ASME Code allowable, and noticeable vibration levels on the weld joint.

6. <u>Duration of Proposed Alternative</u>

Relief for the proposed alternatives is requested from the time of discovery on October 20, 2013, until completion of repair activities completed in accordance with ASME Section XI, Appendix IX, on October 30, 2013.

Attachment:

1. Flaw Evaluation

HNP-13-108

Attachment to Enclosure

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400

Flaw Evaluation
(8 pages plus cover)

FLAW EVALUATION OF WELD TO 1SI-188 Based on As-Built Dimensions

Problem

CR 636488 documents a loss of level in the 'C' Cold Leg Accumulator at an approximate rate of 1 gallon per hour. A containment entry on Sunday, October 20, 2013 reveled a leak through the weld of valve 1SI-188 Accumulator 1C-SA Fill Isolation Valve. The weld is on the ASME Class 2 side of the valve. The valve is a boundary valve from Class 2 to non-safety related (Category 4 pipe), reference drawing 5-G-0809.

The flaw is a through wall, circumferential planar flaw in the weld of the socket joint between the pipe and valve body. The flaw is in the face of the weld and was measured to be approximately 0.69" in circumferential length on Monday, October 21, 2013. The circumference at the weld effective throat is approximately 5.375" (where the outside diameter of weld at the effective throat is approximately 1.711", see below). The 0.69" flaw length correlates to approximately 45.5 degrees around the circumference.

Discussion

Code Case N-513-3 is used to accept flaws including through-wall flaws in moderate energy Class 2 and 3 piping without performing a repair/replacement activity for a limited time.

NOTE: While provisions of the Code Case N-513-3 does not apply specifically to the weld metal of socket welded joints or operating pressure greater than 275 psig, structural integrity may be demonstrated by modeling the leaking socket weld as a cracked pipe at the operating pressure and applying the stress intensification factor (SIF) to the axial bending loads.

A Relief Request should be submitted to the NRC based on exception to (a) and (b) below.

The following criteria is from Code Case N-513-3:

(a) These requirements apply to the ASME Section III, ANSI B31.1, piping classified by the Owner as Class 2 or 3. The provisions of this Case do not apply to the following:

(1) pumps, valves, expansion joints and heat exchangers;
(2) weld metal of socket welded joints;
(3) leakage through a flange joint;
(4) threaded connections employing nonstructural seal welds for leakage protection.

In this case, the flaw is in a the weld metal of a socket welded joint. This evaluation will be used to demonstrate the structural integrity of the weld and provide a maximum crack length with the methodology in the Code Case.**As such, a relief request should be submitted to the NRC.**

(b) The provisions of this Case apply to Class 2 or 3 piping whose maximum operating temperature does not exceed 200 deg F and whose maximum operating pressure does not exceed 275 psig.

In this case, the operating pressure and temperature are 660 psig and 120 deg F, respectively. ***Code Case 513-3 is only applicable for piping whose maximum operating pressure is 275 psig. Technically the use of higher pressure is acceptable based on Fracture Mechanics. As such,*** **a relief request should be submitted to the NRC.**

(c) The flaw evaluation criteria are permitted for pipe and tube. The flaw evaluation criteria are permitted for adjoining fittings and flanges to a distance of $(R_o t)^{1/2}$ from the weld centerline.

NOTE: Since the flaw is in the weld metal of a socket weld joint, this provision is not applicable to the configuration.

(d) The provisions of the flaw evaluation, per the Code Case, demonstrates the integrity of the piping component and not the consequences of the leakage. The consequences of the leakage will be addressed in the Operability Condition Report in AR 636488.

The methodology in Code Case N-513-3, paragraph 3.1(b) will be used as guidance to demonstrate the structural integrity of the weld. For planar flaws in austenitic piping, the evaluation procedure in Appendix C (ASME Section XI) shall be used.

DESIGN INPUT

Line Number: 2SI1-157SA-1 (1-inch, schedule 40S pipe) analyzed in stress calculations 3133-3. The piping material is ASTM A-312, Grade TP 304 per EDB.

Valve body material is ASME SA182, Grade F316 per drawing 1364-002929. The weld material is ER 316 per the construction Weld Data Report.

The following evaluation uses the weld properties in the evaluation. The minimum leg size of a socket weld is equal to 1.09 times the nominal pipe wall thickness. The nominal pipe wall thickness for 1-inch, schedule 40 pipe is 0.133". Considering the socket weld to be an equal leg fillet, the effective throat for the socket weld is 0.103" (0.133" x 0.707). This is the minimum required weld thickness. The actual weld thickness is 9/32" (0.281"). The effective throat is 0.198" (0.281" x 0.707).

Pipe support SI-H-00685 was measured to be 8-1/2" from the outlet of valve 1SI-188. The following evaluation is based on a pipe stress study run with the support at 8-1/2" from valve, file name 31333AB1.adi, run date 10/30/13.

WELD EFFECTIVE THROAT $t := 0.198\,in$

OPERATING PRESSURE $p := 660psi$

DESIGN PRESSURE $P_D := 700psi$

OPERATING TEMPERATURE $T := 120\,°F$

DESIGN TEMPERATURE $200\,°F$

WELD OUTSIDE DIA $D_o = 1.711\,in$

WELD INSIDE DIA (PIPE OD) $D_i := D_o - 2\cdot t$ $D_i = 1.315\,in$

WELD MEAN RADIUS $R := \frac{D_o - t}{2} = 0.757\,in$

WELD SECTION MODULUS $S_{weld} := \frac{\pi\cdot\left(D_o{}^4 - D_i{}^4\right)}{32\cdot D_o}$ $S_{weld} = 0.32\,in^3$

PIPE SECTION MODULUS $S_{pipe} := 0.1328\cdot in^3$

MATERIAL STRENGTH

PIPE MATERIAL TYPE IS ASTM A-312, GRADE TP 304
all material properties are based on operating temperature

MATERIAL ALLOWABLE STRESS $S_h := 16600 \cdot psi$

MATERIAL YIELD STRENGTH $S_y := 30000psi$

MATERIAL ULT. TENSILE STRENGTH $S_u := 75000psi$

VALVE MATERIAL TYPE IS ASME SA182, GRADE F316

MATERIAL YIELD STRENGTH $S_{y\_valve} := 30000psi$

MATERIAL ULT. TENSILE STRENGTH $S_{u\_valve} := 75000psi$

WELD MATERIAL TYPE IS ER 316

MATERIAL YIELD STRENGTH $S_{y\_weld} := 58000psi$

MATERIAL ULT. TENSILE STRENGTH $S_{u\_weld} := 84100psi$

Circumferential Flaw Evaluation

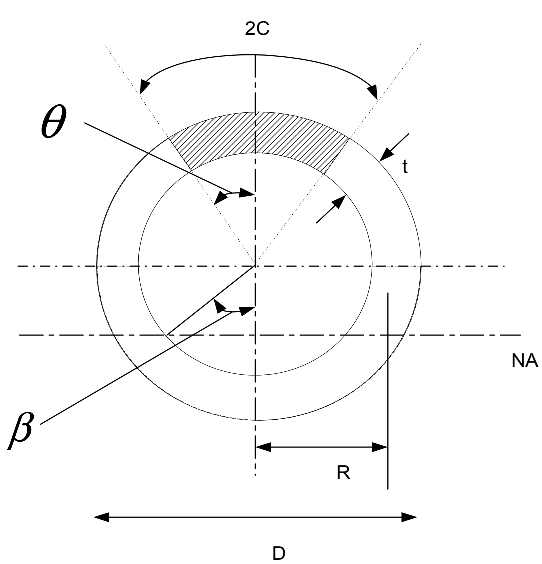

Figure 1
Circumferential Flaw

For planar flaws in austenitic piping, the evaluation procedure of Appendix C, subsection C-5300 is used. Flaw depths up to 100% of wall thickness is evaluated with the flaw depth to thickness ratio, a/t, is to unity.

CHECK COMBINE BEND STRESSES FOR CIRCUMFERENTIAL FLAW FOR ALL SERVICE LEVELS (REF. C-5320)

The following pipe stresses are from the study run on 10/30/13 for the piping associated with valve 1SI-188 with support SI-H-00685 modeled in the as-built location (8-1/2" from outlet of valve). The pipe stresses were obtained at the stress point 2246:

Eq. 8 = 1,730 + 15,520 psi = 17,250 psi
Eq. 9U = 17,250 + 18,007 = 35,257 psi
Eq. 9E = 17,250 + 25,635 = 42,885 psi

Revised membrane stress based on weld cross-section, due to operating pressure:

$$\sigma_m := \frac{p \cdot D_i^2}{D_o^2 - D_i^2} = 952.4 \text{ psi}$$

primary membrane stress due to operating presssure

$$a := t$$

crack thru wall (maximum flaw depth)

Revised bending stresses based on weld section modulus:

$$\sigma_{dw} := 15520 \cdot \text{psi} \cdot \frac{S_{pipe}}{S_{weld}} = 6437 \text{ psi}$$

$$\sigma_{obe} := 18007 \cdot \text{psi} \cdot \frac{S_{pipe}}{S_{weld}} = 7469 \text{ psi}$$

$$\sigma_{dbe} := 25635 \cdot \text{psi} \cdot \frac{S_{pipe}}{S_{weld}} = 10632 \text{ psi}$$

The following combined stresses are based on weld section properties:

Eq. 8 = 952 + 6,437 psi = 7,389 psi
Eq. 9U = 7,389 + 7,469 = 14,858 psi,
Eq. 9E = 7,389 + 10,632 = 18,021 psi

NOTE: Even though the flaw is in the weld, the pipe material properties will conservatively be used to evaluate the weld.

$$\sigma_f := \frac{(S_y + S_u)}{2} = 52500 \text{ psi}$$

C-5321 and C-8200
Material Flow Stress

For a flaw not penetrating the compressive side of the pipe such that $\Theta + \beta <= \pi$, between applied load and flaw depth at incipient collapse given below. See Fig 1 above.

$$\sigma_b := 2 \cdot \frac{\sigma_f}{\pi} \cdot \left(2 \cdot \sin(\beta) - \frac{a}{t} \cdot \sin(\Theta) \right)$$ C-5321

$$\beta := \frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f} \right)$$

Combining two equations

$$\sigma_b(\Theta) := 2 \cdot \frac{\sigma_f}{\pi} \cdot \left[2 \cdot \sin\left[\frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f} \right) \right] - \frac{a}{t} \cdot \sin(\Theta) \right]$$

SERVICE LEVEL A BENDING STRESS S_c

$SF_{mA} := 2.7$ $SF_{bA} := 2.3$ C-2621

$$S_c := \frac{\sigma_b(\Theta)}{SF_{bB}} - \sigma_m \cdot \left(1 - \frac{1}{SF_{mB}} \right)$$

For Level A bending stress is 7389 psi based on the weld section properties, the angle Θ can be calculated by solving two equations. This calculation shall be repeated for all applicable service levels.

$S_c := 7389 \cdot psi$ $\Theta := .1 \cdot rad$ Level A bending stress is 7389 psi based on the weld section properties

$$out := root\left[\frac{2 \cdot \frac{\sigma_f}{\pi} \cdot \left[2 \cdot \sin\left[\frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f} \right) \right] - \frac{a}{t} \cdot \sin(\Theta) \right]}{SF_{bA}} - \sigma_m \cdot \left(1 - \frac{1}{SF_{mA}} \right) - S_c, \Theta \right]$$ C-5321

$out = 1.35 \cdot rad$ $\Theta := out$

$L := \Theta \cdot D_o$ $L = 2.309\ in$

$$\beta := \frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f} \right)$$ $\beta = 0.867 \cdot rad$ $\Theta + \beta = 2.217 \cdot rad$ C-5321

$\Theta = 1.35$

$if(\Theta + \beta < \pi, "OK", "NG") = "OK"$

SERVICE LEVEL B BENDING STRESS S_c

$SF_{mB} := 2.4$ $SF_{bB} := 2.0$ C-2621

$$S_c := \frac{\sigma_b(\Theta)}{SF_{bB}} - \sigma_m \cdot \left(1 - \frac{1}{SF_{mB}}\right)$$

$S_c := 14858 \cdot psi$ Level B bending stress is 14858 psi based on the weld section properties

$$out := root\left[\frac{2 \cdot \frac{\sigma_f}{\pi} \cdot \left[2 \cdot \sin\left[\frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f}\right)\right] - \frac{a}{t} \cdot \sin(\Theta)\right]}{SF_{bB}} - \sigma_m \cdot \left(1 - \frac{1}{SF_{mB}}\right) - S_c, \Theta\right]$$

$out = 0.965 \cdot rad$ $\Theta := out$

$L := \Theta \cdot D_o$ $L = 1.651\ in$

$$\beta := \frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f}\right)$$

$\beta = 1.06 \cdot rad$ $\Theta + \beta = 2.025 \cdot rad$

$if(\Theta + \beta < \pi, "OK", "NG") = "OK"$

SERVICE LEVEL C BENDING STRESS S_c

$SF_{mC} := 1.8$ $SF_{bC} := 1.6$ C-2621

$$S_c := \frac{\sigma_b(\Theta)}{SF_{bC}} - \sigma_m \cdot \left(1 - \frac{1}{SF_{mC}}\right)$$

$S_c := 18021 \cdot psi$ Level C bending stress is 18021 psi based on the weld section properties

$$out := root\left[\frac{2 \cdot \frac{\sigma_f}{\pi} \cdot \left[2 \cdot \sin\left[\frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f}\right)\right] - \frac{a}{t} \cdot \sin(\Theta)\right]}{SF_{bC}} - \sigma_m \cdot \left(1 - \frac{1}{SF_{mC}}\right) - S_c, \Theta\right]$$

$out = 1.003 \cdot rad$ $\Theta := out$

$L := \Theta \cdot D_o$ $L = 1.715\ in$

$$\beta := \frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f} \right)$$

$\beta = 1.041 \cdot rad$ $\Theta + \beta = 2.044 \cdot rad$

$if(\Theta + \beta < \pi, "OK", "NG") = "OK"$

SERVICE LEVEL D BENDING STRESS S_c

$SF_{mD} := 1.3$ $SF_{bD} := 1.4$ C-2621

$$S_c := \frac{\sigma_b(\Theta)}{SF_{bD}} - \sigma_m \cdot \left(1 - \frac{1}{SF_{mD}} \right)$$

$S_c := 18021 \cdot psi$ Level D bending stress is 18021 psi based on the weld section properties

$$out := root\left[\frac{2 \cdot \frac{\sigma_f}{\pi} \cdot \left[2 \cdot \sin\left[\frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f} \right) \right] - \frac{a}{t} \cdot \sin(\Theta) \right]}{SF_{bD}} - \sigma_m \cdot \left(1 - \frac{1}{SF_{mD}} \right) - S_c, \Theta \right]$$

$out = 1.119 \cdot rad$ $\Theta := out$

$L := \Theta \cdot D_o$ $L = 1.915\ in$

$$\beta := \frac{1}{2} \cdot \left(\pi - \frac{a}{t} \cdot \Theta - \pi \cdot \frac{\sigma_m}{\sigma_f} \right)$$

$\beta = 0.983 \cdot rad$ $\Theta + \beta = 2.102 \cdot rad$

$if(\Theta + \beta < \pi, "OK", "NG") = "OK"$

CHECK MEMBRANE STRESSES FOR CIRCUMFERENTIAL FLAW FOR ALL SERVICE LEVEL A CONDITION (REF. C-5322)

$\sigma_m = 952\ \text{psi}$ membrane stress from pipe stress calc. or above calulated long stress.

$\Theta := 1.585$ from service Level C - shortest allowable crack length $\sin(\Theta) = 0.9999$

$$\gamma := \sin\left[\left[0.5\cdot\left(\frac{a}{t}\right)\cdot\sin(\Theta)\right]\right]^{-1}$$

$\gamma := 0.511$

$$\sigma_{mc} := \sigma_f\cdot\left[1 - \left(\frac{a}{t}\right)\cdot\left(\frac{\Theta}{\pi} - 2\cdot\frac{\gamma}{\pi}\right)\right]$$

$$S_t := \frac{\sigma_{mc}}{SF_{bA}}$$

$S_t = 18735\ \text{psi}$ > $(\sigma_m) = 952\ \text{psi}$

CONCLUSION:

Based on the above evaluation, the maximum flaw length allowed is 1.651" in the circumferential direction to maintain structural integrity of the piping. This length is conservative based on using the pipe material properties instead of weld material properties.