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SOUTHERN COMPANY
Energy to Serve Your World℠

December 3, 2004

Docket No.: 50-321

NL-04-2265

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

Edwin I. Hatch Nuclear Plant
Unit 1 Updated Analysis of Core Shroud Vertical Welds and Supplemental Information

Ladies and Gentlemen:

By letter dated November 14, 2003, Southern Nuclear Operating Company (SNC) provided to the NRC the calculation and a description of the methodology of the updated flaw analysis of the Edwin I. Hatch Nuclear Plant Unit 1 flawed Core Shroud Vertical welds. In a subsequent letter dated January 30, 2004, SNC provided to the NRC the related fluence calculation and methodology.

The two flawed shroud vertical welds were re-examined using ultrasonic examination techniques during the Spring 2004 refueling outage. SNC contracted Structural Integrity Associates, Inc. to perform an update to the flaw analysis using the most recent inspection results and the guidance provided by BWRVIP-76. Enclosure 1 provides responses to questions previously asked by the staff per the facsimile dated March 11, 2004 regarding the previous analysis, and Enclosure 2 provides the most recent analysis prepared by Structural Integrity Associates, Inc. The responses and analysis in the enclosures supercede the analysis submitted by the letter dated November 14, 2003.

This letter contains no NRC commitments. If you have any questions, please advise.

Sincerely,

Lewis Sumner

H. L. Sumner, Jr.

HLS/ifl/sdl

Enclosures:
1. Responses to NRC Questions Regarding Hatch Unit 1 Shroud EPFM Analysis
2. Elastic-Plastic Fracture Mechanics Evaluation of the Plant Hatch Unit 1 Core Shroud V5 andV6 Welds

A001

cc: Southern Nuclear Operating Company
Mr. J. T. Gasser, Executive Vice President
Mr. G. R. Frederick, General Manager – Plant Hatch
RTYPE: CHA02.004

U. S. Nuclear Regulatory Commission
Dr. W. D. Travers, Regional Administrator
Mr. C. Gratton, NRR Project Manager – Hatch
Mr. D. S. Simpkins, Senior Resident Inspector – Hatch

Edwin I. Hatch Nuclear Plant

Enclosure 1

Responses to NRC Questions Regarding
Hatch Unit 1 Shroud EPFM Analysis

Structural Integrity Associates, Inc.

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November 11, 2004
MLH-04-085

Mr. Denver Atwood
MC B052
Sr. Engineer
Southern Nuclear Operating Co.
40 Inverness Center Parkway
Birmingham, AL 35242

Subject: Transmittal of Structural Integrity Associates Responses to NRC Questions Regarding Hatch Unit 1 Shroud EPFN Analysis

Reference: SIR-04-120, Rev. 0, October 2004

Dear Denver:

Structural Integrity Associates (SI) is pleased to transmit the enclosed responses to NRC questions regarding the referenced report.

Please contact me or Stan Tang if you have any questions.

Very truly yours,

Marcos L. Herrera, P.E.
Senior Associate

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Enclosure
cc: HTCH-07Q Project File

Responses to
Request for Additional Information
The Updated Analysis of Core Shroud Vertical Welds
Edwin I. Hatch, Unit 1
Southern Nuclear Operating Company
TAC No. MC 1322

1.1 On Page 1 of Attachment 1 it is stated that a constant crack growth rate (CGR) of 5x10-5 in/hr was assumed. As a result of the Nuclear Regulatory Commission (NRC) staff's review of the Boiling Water Reactor (BWR) Vessel and Internal Project (BWRVIP) reports, the staff has approved the used of different constant CGRs for applications to BWR internals under different water conditions using hydrogen water chemistry (HWC) and noble metal chemistry application (NMCA). The continued use of these CGRs has to be justified when new data become available. Provide the worst applied stress intensity factor (K) for flaws in the core shroud vertical welds to demonstrate that your constant CGR is still valid in light of the new data in BWRVIP-99, "BWR Vessel and Internals Project – Crack Growth Rates in Irradiated Stainless Steels in BWR internal Components," for high fluence applications. When you calculate the applied K for flaws in the core shroud vertical welds, you need to consider weld residual stresses

Response:

The longest through-wall crack at the end of next 15 years re-inspection interval is about 37 inches, compared to the length of the vertical weld of about 98 inches, close to 40% of the total weld length. If included the remaining two cracks, Figure 4 of Attachment 1, the total crack length would be about 66 inches, at 67% of the total weld length. Since the weld residual is self equilibrium in nature, as the crack grows in length, the residual stress is relaxed and reduced to essentially non-existence when the through-wall crack extends to the entire length of the vertical weld. In the current evaluation, it is reasonable to assume the residual stress, if it exists, is very small and insignificant. Therefore, in the subsequent evaluation, the effect of residual stress on the applied stress intensity factor and crack growth rate is not significant and can be ignored.

A linear elastic fracture mechanics evaluation was performed for the longest axial through-wall crack in the V6 weld. Under only pressure loading, using a center crack panel, the stress intensity factor is calculated to be about 13 ksi$\sqrt{in}$ for the longest through-wall crack in the V6 weld. Using the normal water chemistry disposition curve, the crack growth rate is about $5x10^{-5}$ in/hr. If the hydrogen water chemistry disposition curve is used, the crack growth rate is about $2x10^{-5}$ in/hr. Therefore, the use of a constant $5x10^{-5}$ in/hr in the current evaluation is judged to be conservative.

Report SIR-03-115 by Structural Integrity Associates, Inc.

2-1 On Page 3-1 of Report SIR-03-115 it is stated that the J-Integral considers internal pressure only. Not considering weld residual stresses in your previous evaluation of the core shroud weld flaws was justified because limit load analysis was used there. This is not generally true when elastic-plastic fracture mechanic (EPFM) or linear elastic fracture mechanics is the dominant fracture mechanism. Justify that you could ignore weld residual stresses in the current EPFM application.

Response:

It is referred to the response to Question 1.1 for the justification of not including the residual stress in the evaluation.

2.2 On Page 3-1 of Report SIR-03-115, it is stated that $J_{applied}$-$T_{applied}$ curves are based on J-Integral by incrementing the crack size. It is further stated on Page 4-1 of this report that the J-integral is calculated from the crack tip opening displacement (CTOD), as reported in EPRI Report NP-1735, "Methodology for Plastic Fracture." To validate this CTOD approach, provide a comparison of the J-integral determined from a numerical integration over a path encircling the crack tip and those from the CTOD approach.

Response:

The original definition of J-integral is best suited for two dimensional models. This original form is not suited for three-dimensional problems in numerical analysis. It is necessary to convert the original equation into a volume integral before it could process the results from the three dimensional finite element crack models.

A verification of CTOD approach was performed using **pc-CRACK**, [1]. **pc-CRACK** has the capabilities of performing linear elastic and elastic-plastic fracture mechanics evaluation. The elastic-plastic fracture mechanics is based on the estimation scheme developed by C. F. Shih, under the sponsorship of the Electric Power Research Institute. This scheme is similar to the approach using integration over a path encircling the crack tip.

Two problems were used in the verification. The first problem is a part through circumferential crack in a cylinder under remote tension, Figure 1. The cylinder has a thickness of 9 inches with t/R = 0.1. Two different crack sizes and loading conditions were considered. The first case is with a crack depth ratio, a/t, of 0.25 and a remote tension stress at 40 ksi. Both plane strain and plane stress conditions were considered. The second case is a through wall circumferential crack in cylinder under remote tension, Figure 2. The cylinder has a wall thickness of 0.4 inches, with an outside diameter of 2.4 inches. The through crack length ratio, a/b (crack length to circumference), is 0.125, with a remote tension load of 200 kips.

The finite element models for the J-integral calculation using CTOD are shown in Figures 3 and 4. The part-through circumferential crack finite element model is shown in Figure 3. The through-wall circumferential crack finite element model is shown in Figure 4.

Table 1 presents the verification results between the J-integral calculated from CTOD approach and **pc-CRACK**. It shows a very reasonable comparison, indicating the validity of using the CTOD approach for estimating the J-T curve.

Reference:

1. **pc-CRACK** for Windows, Version 3.1-98348, Structural Integrity Associates, 1998.

Table 1 Comparison of J-Integral Results

Model	Stress, Load	a/t, a/b	Condition	J-Integral (in-kip/in^2)	
				CTOD	pc-CRACK
Part through Circumferential Crack, under remote tension	40 ksi	025	Plane strain	9.59	9.6
			Plane stress	7.18	9.97
Through wall Circumferential crack under remote tension	200 kips	0.125	Plane strain	3.93	3.40
			Plane stress	2.94	3.46

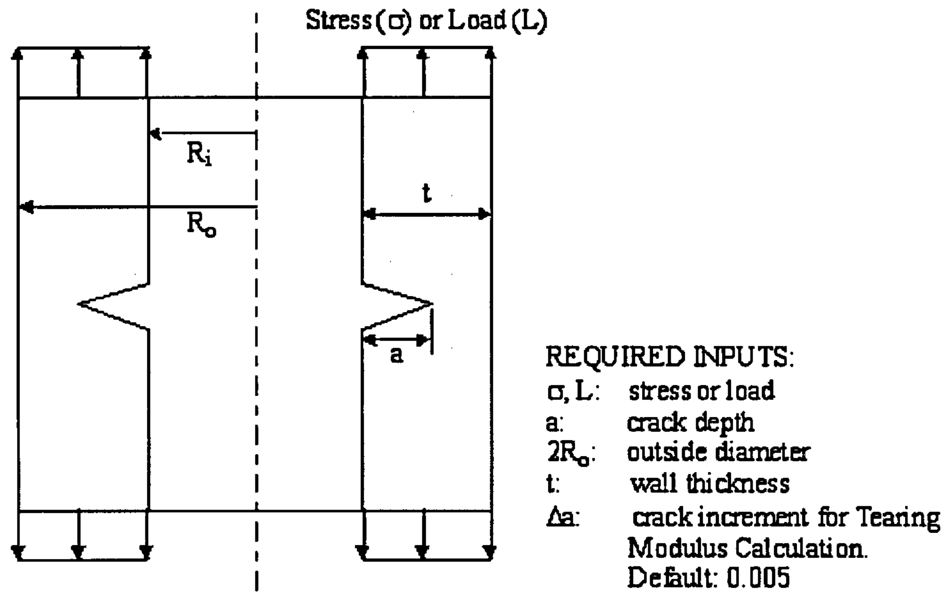

Figure 1 Part-Through Circumferential Crack in Cylinder Under Remote Tension

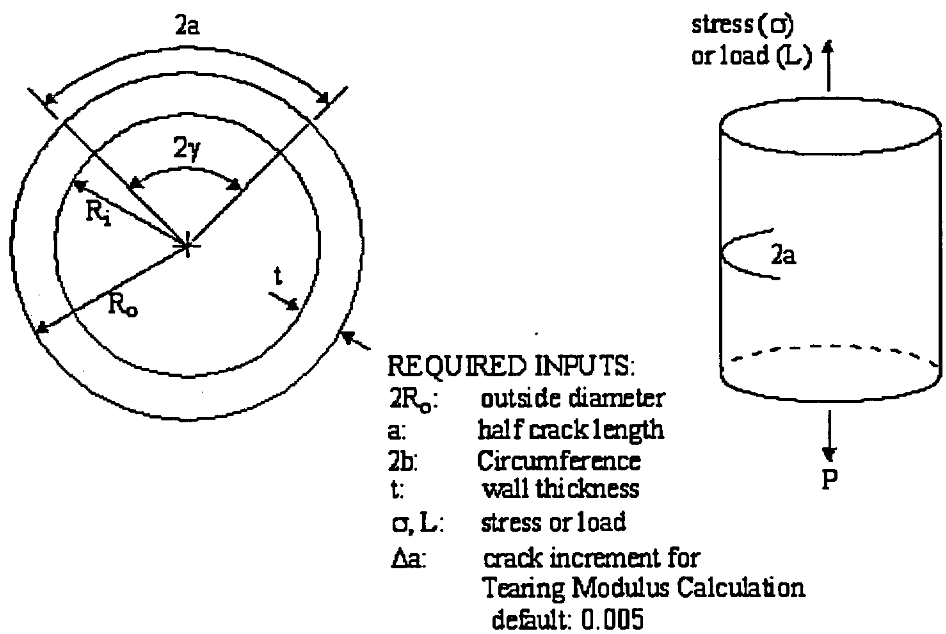

Figure 2 Through-Wall Circumferential Crack in Cylinder Under Remote Tension

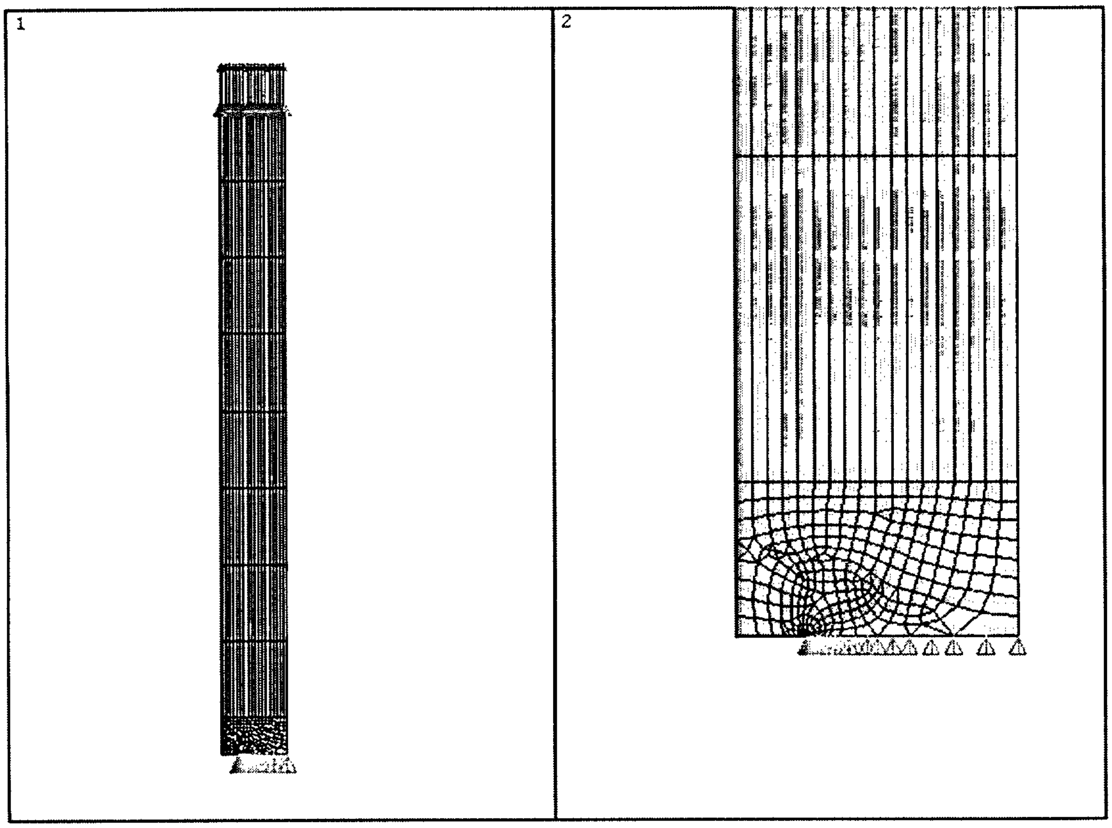

Figure 3: Finite Element Model of Part Through Circumferential Crack for J-Integral Calculation using CTOD

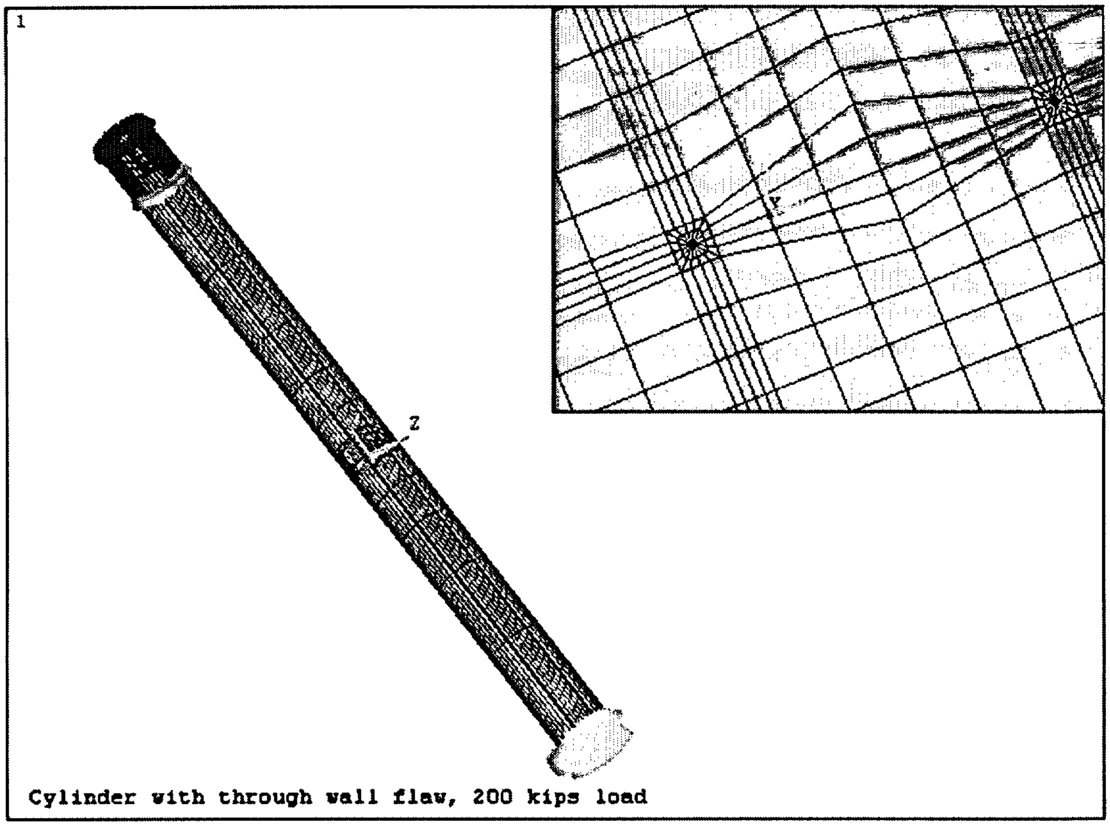

Figure 4: Finite Element Model of Circumferential Through Wall Crack for J-Integral Calculation using CTOD