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

Vogtle Electric Generating Plant – Units 1 and 2
Proposed Alternative VEGP-ISI-ALT-04-01 Implementation of Code Case N-729-4

Ladies and Gentlemen:

Pursuant to 10 CFR 50.55a(z)(2), Hardship without a Compensating Increase in Quality and Safety, Southern Nuclear Operating Company (SNC) hereby requests Nuclear Regulatory Commission (NRC) approval of Alternative VEGP-ISI-ALT-04-01 for the use of American Society of Mechanical Engineers (ASME) Code Case N-729-4, for Vogtle Electric Generating Plant (VEGP) Units 1 and 2.

Alternative VEGP-ISI-ALT-04-01 for Code Case N-729-4 supports reactor closure head examinations of pressure retaining partial-penetration welds called out in ASME Code Case N-729-4, Item B4.20. For certain CRDM head penetrations, SNC is not capable of achieving the required examination coverage specified in N-729-4.

To support work planning and preparation, SNC requests that the NRC approve the proposed alternative by August 30, 2018.

This letter contains no NRC commitments. If you have any questions, please contact Ken McElroy at 205.992.7369.

Respectfully submitted,

Justin T. Wheat
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JTW/kgl/cg

Enclosure:

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

**Vogtle Electric Generating Plant - Units 1 and 2**
**Proposed Alternative VEGP-ISI-ALT-04-01 Implementation**
**of Code Case N-729-4**

**Enclosure**

**Proposed Alternative VEGP-ISI-ALT-04-01 Implementation**
**of Code Case N-729-4, Version 1.0**

**10 CFR 50.55a Request No. VEGP-ISI-ALT-04-01**
**Implementation of Code Case N-729-4**
**Vogtle Electric Generating Plant - Units 1 and 2**
**Proposed Alternative in Accordance with 10 CFR 50.55a(z)(2)**
**Acceptable Level of Quality and Safety**

## 1. ASME Code Component(s) Affected

Code Class: 1
Reference: ASME Code Case N-729-4 / 10 CFR 50.55a(g)(6)(ii)(D)
Item Number: B4.20
Description: UNS N06600 Nozzles and UNS N06082 or UNS W86182 partial-penetration welds in head

## 2. Requested Approval Date

Approval is requested by August 30, 2018.

## 3. Applicable Code Edition and Addenda

The current code of record for the Vogtle Electric Generating Plant (VEGP), Units 1 and 2, fourth ten-year Inservice Inspection (ISI) interval is the ASME Section XI Code, 2007 Edition through the 2008 Addenda, as augmented by ASME Code Case N-729-4, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds Section XI, Division 1," (Reference 1) as amended and noticed in the Federal Register (82 FR 32934, July 18, 2017).

## 4. Applicable Code Requirements

10 CFR 50.55a(g)(6)(ii)(D)(1) requires that examinations of the reactor vessel head be performed in accordance with ASME Code Case N-729-4 subject to the conditions specified in paragraphs 10 CFR 50.55a(g)(6)(ii)(D)(2) through (4).

Paragraph 2500 of Code Case N-729-4 states, in part:

> If obstructions or limitations prevent examination of the volume or surface required by Fig. 2 for one or more nozzles, the analysis procedure of Mandatory Appendix I shall be used to demonstrate the adequacy of the examination volume or surface for each such nozzle. If Mandatory Appendix I is used, the evaluation shall be submitted to the regulatory authority having jurisdiction at the plant site.

10 CFR 50.55a(g)(6)(ii)(D)(2) states that Appendix I of ASME Code Case N-729-4 shall not be implemented without prior NRC approval.

Figure 2 in the ASME Code Case, as referenced by paragraph 2500, requires that the

volumetric or surface examination coverage distance below the toe of the J-groove weld (dimension "a") be 1.5 inches for incidence angle, $\theta$, less than or equal to 30 degrees; 1 inch for incidence angle, $\theta$, greater than 30 degrees; or to the end of the tube, whichever is less. These coverage requirements are applicable to VEGP, Units 1 and 2, reactor vessel head penetrations as follows:

| Penetration Nos | Incident Angle, $\theta$ (degrees) | Required Coverage, "a" (inches) |
|---|---|---|
| 1 to 29 | ≤30 | 1.5 |
| 30 to 78 | >30 | 1.0 |

## 5. Reason for Request

Due to the physical configuration and limitations of the examination equipment associated with certain reactor head penetration nozzles, the full examination volume required by ASME Code Case N-729-4 Table 1 cannot be achieved for Item No. B4.20. The bottom end of the VEGP, Units 1 and 2, reactor vessel head control rod drive mechanism (CRDM) penetrations are externally (i.e., outside diameter, or OD) threaded, internally (i.e., inside diameter, or ID) tapered, and have an ultrasonic testing corner shadow zone produced by the thread relief. The shadow zone precludes ultrasonic or eddy current data acquisition in the lower nozzle area. For several of the penetrations, this geometric limitation reduces the lower coverage inspection distance from the bottom of the J-groove weld fillet to the top of the thread relief to a value less than the required coverage dimension "a" shown in Figure 2 of Code Case N-729-4.

Sketches 1 through 4 in Attachment 1 provide additional details for the actual configuration of the nozzles. Sketch 1 shows the configuration of the Unit-1 CRDM nozzles 1 through 78 and the Unit-2 CRDM nozzles 74 through 78. Also enclosed is Sketch 2 which provides the details of the threaded/chamfered nozzle end (Type X). The toe of the weld is located above the reduced cross section. Sketch 3 shows the configuration of the Unit-2 CRDM nozzles 1 through 73. In addition, Sketch 4 shows a top view of the Units 1 and 2 reactor pressure vessel (RPV) head CRDM configuration in order to show the relative location of the CRDMs. Sketches 1 and 3 were generated from Figure 2 from ASME Code Case N-729-4 to help identify the required examination volume and the physical limitations. The coverage lengths listed in Tables 1 and 2 correspond to the "a" dimension (below the J-groove weld) identified in Figure 2 of ASME Code Case N-729-4.

As required by the NRC Order EA-03-009 (Reference 6), Southern Nuclear Operating Company, Inc. (SNC) performed volumetric examinations and obtained examination coverage data on all 78 CRDM penetrations in each of the reactor vessel heads at VEGP. This information was used to support SNC's NRC Order Relaxation Requests (References 3 and 4) regarding examination coverage below the J-groove weld; the Relaxation Requests were approved by the NRC in Reference 5. The second volumetric examinations at VEGP were performed following the issuance of 10 CFR 50.55a(g)(6)(ii)(D), "Reactor vessel head inspections," on September 10, 2008, which required implementation of Code

Case N-729-1 with NRC conditions by December 31, 2008. Once a licensee implemented the provisions of 10 CFR 50.55a(g)(6)(ii)(D). VEGP similarly could not meet coverage requirements under Code Case N-729-1 and requested VEGP-ISI-ALT-07 (ML12086A106) and received authorization (ML12199A233) for the coverage limitations for the third ISI interval. This submittal for the 4th ISI interval request is consistent with the 3rd ISI interval request as supplemented by SNC's response (ML12166A232) to the staff's request for additional information (RAI).

10 CFR 50.55a(g)(6)(ii)(D) was modified in the Final Rule issued on June 21, 2011. The latest change to 10 CFR 50.55a(g)(6)(ii)(D) to utilize Code Case N-729-4 was issued on July 18, 2017. This change to rulemaking does not result in a change to the technical basis for VEGP's 4th interval request to propose an alternate examination zone for the reactor pressure vessel upper head.

The distance from the top of the thread relief to the bottom of the fillet of the J-groove weld, identified as "a" in Figure 2 of Code Case N-729-4, varies based on location of the penetration in the reactor vessel head. This distance is generally longer for penetrations at inboard locations and becomes progressively shorter for penetrations located farther away from the center of the reactor vessel head.

The design configurations at the bottom of the VEGP penetration nozzles included threaded sections, chamfered regions, and regions having a radius. The dimensional configuration at some nozzles is such that the inspectable distance from the lowest point at the toe of the J-groove weld to the bottom of the scanned region is less than the 1.5-inch or 1-inch lower boundary.

Tables 1 and 2 list the extent of the inspection coverage for the reactor vessel head penetrations at VEGP, Units 1 and 2, respectively, under the NRC Order EA-03-009 examinations. The attainable examination coverage in inches below the toe of the J-groove weld fillet on the limiting (i.e., downhill) side of each penetration corresponds to the proposed alternative coverage being requested. The examination coverage required by ASME Code Case N-729-4 Figure 2 is also shown in Tables 1 and 2. Penetrations with coverage lower than the requirements of Code Case N-729-4 have been shaded. SNC documented the results of these examinations in reports to the NRC after the Unit 1 outage in Fall 2006 (Reference 7) and the Unit 2 outage in Spring 2007 (Reference 8).

The last volumetric inspection for the RPV occurred during the Fall 2012 for VEGP Unit 1 and Spring 2013 for VEGP Unit 2. Unlike the previous ultrasonic inspections, WesDyne personnel were qualified through the Electric Power Research Institute (EPRI) RPV head demonstration beginning in 2009. In addition to the personnel qualification, procedures were also demonstrated and qualified. These qualification demonstrations did require some changes from the previous inspection in 2006 which enhanced the inspection technique. One of the requirements was to utilize both the circumferential and axial shooting TOF (time of flight) techniques for the required volume (Coverage) utilizing Code Case N-729-1. This requirement led to development and deployment of WesDyne's Combo 2 blade probe

which has both TOF directions with a zero-degree probe for leak path assessment which was also demonstrated and qualified at PDI along with the open housing probes. No in-service degradation was reported with the RPV CRDM examinations.

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**Vogtle Electric Generating Plant - Units 1 and 2**
**Proposed Alternative in Accordance with 10 CFR 50.55a(z)(2)**
**Acceptable Level of Quality and Safety**

Table 1: VEGP, Unit 1, Inspection Coverage Obtained and Alternative Coverage Requested for CRDM Penetrations

| Pen No. | Angle of Incidence, $\theta$ (Degrees) | N-729-4 Required Exam Coverage (Inches) | Inspection Coverage Obtained/ Alternative Requested (Inches) |
|---|---|---|---|
| 1 | 0.0 | 1.5 | 1.80 |
| 2 | 11.4 | 1.5 | 1.52 |
| 3 | 11.4 | 1.5 | 1.64 |
| 4 | 11.4 | 1.5 | 1.72 |
| 5 | 11.4 | 1.5 | 1.52 |
| 6 | 16.2 | 1.5 | 1.60 |
| 7 | 16.2 | 1.5 | 1.56 |
| 8 | 16.2 | 1.5 | 1.68 |
| 9 | 16.2 | 1.5 | 1.40 |
| 10 | 18.2 | 1.5 | 1.92 |
| 11 | 18.2 | 1.5 | 2.04 |
| 12 | 18.2 | 1.5 | 2.00 |
| 13 | 18.2 | 1.5 | 1.88 |
| 14 | 23.3 | 1.5 | 1.40 |
| 15 | 23.3 | 1.5 | 1.48 |
| 16 | 23.3 | 1.5 | 1.76 |
| 17 | 23.3 | 1.5 | 1.60 |
| 18 | 24.8 | 1.5 | 1.44 |
| 19 | 24.8 | 1.5 | 1.44 |
| 20 | 24.8 | 1.5 | 1.60 |
| 21 | 24.8 | 1.5 | 1.36 |
| 22 | 26.2 | 1.5 | 1.56 |
| 23 | 26.2 | 1.5 | 1.80 |
| 24 | 26.2 | 1.5 | 1.92 |
| 25 | 26.2 | 1.5 | 1.76 |
| 26 | 26.2 | 1.5 | 1.92 |
| 27 | 26.2 | 1.5 | 1.76 |
| 28 | 26.2 | 1.5 | 1.68 |
| 29 | 26.2 | 1.5 | 1.88 |
| 30 | 30.2 | 1.0 | 1.32 |
| 31 | 30.2 | 1.0 | 1.28 |
| 32 | 30.2 | 1.0 | 1.44 |
| 33 | 30.2 | 1.0 | 1.36 |
| 34 | 30.2 | 1.0 | 1.40 |
| 35 | 30.2 | 1.0 | 1.44 |
| 36 | 30.2 | 1.0 | 1.40 |
| 37 | 30.2 | 1.0 | 1.20 |
| 38 | 33.9 | 1.0 | 1.20 |
| 39 | 33.9 | 1.0 | 1.40 |
| 40 | 33.9 | 1.0 | 1.36 |
| 41 | 33.9 | 1.0 | 1.48 |
| 42 | 35.1 | 1.0 | 1.12 |
| 43 | 35.1 | 1.0 | 1.36 |
| 44 | 35.1 | 1.0 | 1.28 |
| 45 | 35.1 | 1.0 | 1.28 |
| 46 | 35.1 | 1.0 | 1.28 |
| 47 | 35.1 | 1.0 | 1.40 |
| 48 | 35.1 | 1.0 | 1.36 |
| 49 | 35.1 | 1.0 | 1.40 |
| 50 | 36.3 | 1.0 | 1.24 |
| 51 | 36.3 | 1.0 | 1.44 |
| 52 | 36.3 | 1.0 | 1.52 |
| 53 | 36.3 | 1.0 | 1.40 |
| 54 | 38.6 | 1.0 | 1.24 |
| 55 | 38.6 | 1.0 | 1.12 |
| 56 | 38.6 | 1.0 | 1.16 |
| 57 | 38.6 | 1.0 | 1.12 |
| 58 | 38.6 | 1.0 | 1.28 |
| 59 | 38.6 | 1.0 | 1.08 |
| 60 | 38.6 | 1.0 | 1.24 |
| 61 | 38.6 | 1.0 | 1.16 |
| 62 | 44.3 | 1.0 | 1.20 |
| 63 | 44.3 | 1.0 | 0.92 |
| 64 | 44.3 | 1.0 | 1.00 |
| 65 | 44.3 | 1.0 | 0.92 |
| 66 | 45.4 | 1.0 | 0.96 |
| 67 | 45.4 | 1.0 | 0.80 |
| 68 | 45.4 | 1.0 | 0.96 |
| 69 | 45.4 | 1.0 | 1.00 |
| 70 | 45.4 | 1.0 | 1.12 |
| 71 | 45.4 | 1.0 | 1.28 |
| 72 | 45.4 | 1.0 | 1.04 |
| 73 | 45.4 | 1.0 | 1.00 |
| 74 | 48.7 | 1.0 | 1.04 |
| 75 | 48.7 | 1.0 | 1.27 |
| 76 | 48.7 | 1.0 | 1.28 |
| 77 | 48.7 | 1.0 | 1.04 |
| 78 | 48.7 | 1.0 | 0.72 |

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**Implementation of Code Case N-729-4**
**Vogtle Electric Generating Plant - Units 1 and 2**
**Proposed Alternative in Accordance with 10 CFR 50.55a(z)(2)**
**Acceptable Level of Quality and Safety**

Table 2: VEGP, Unit 2, Inspection Coverage Obtained and Alternative Coverage Requested for CRDM Penetrations

| Pen No. | Angle of Incidence, $\theta$ (Degrees) | N-729-4 Required Exam Coverage (Inches) | Inspection Coverage Obtained/ Alternative Requested (Inches) |
|---|---|---|---|
| 1 | 0.0 | 1.5 | 2.36 |
| 2 | 11.4 | 1.5 | 2.48 |
| 3 | 11.4 | 1.5 | 2.52 |
| 4 | 11.4 | 1.5 | 2.48 |
| 5 | 11.4 | 1.5 | 2.4 |
| 6 | 16.2 | 1.5 | 2.48 |
| 7 | 16.2 | 1.5 | 2.16 |
| 8 | 16.2 | 1.5 | 2.56 |
| 9 | 16.2 | 1.5 | 2.36 |
| 10 | 18.2 | 1.5 | 2.92 |
| 11 | 18.2 | 1.5 | 2.6 |
| 12 | 18.2 | 1.5 | 2.84 |
| 13 | 18.2 | 1.5 | 2.84 |
| 14 | 23.3 | 1.5 | 2.32 |
| 15 | 23.3 | 1.5 | 2.36 |
| 16 | 23.3 | 1.5 | 2.48 |
| 17 | 23.3 | 1.5 | 2.2 |
| 18 | 24.8 | 1.5 | 2.52 |
| 19 | 24.8 | 1.5 | 2.4 |
| 20 | 24.8 | 1.5 | 2.36 |
| 21 | 24.8 | 1.5 | 2.32 |
| 22 | 26.2 | 1.5 | 2.64 |
| 23 | 26.2 | 1.5 | 2.8 |
| 24 | 26.2 | 1.5 | 2.64 |
| 25 | 26.2 | 1.5 | 2.6 |
| 26 | 26.2 | 1.5 | 2.88 |
| 27 | 26.2 | 1.5 | 2.64 |
| 28 | 26.2 | 1.5 | 2.64 |
| 29 | 26.2 | 1.5 | 2.64 |
| 30 | 30.2 | 1.0 | 2.24 |
| 31 | 30.2 | 1.0 | 2.28 |
| 32 | 30.2 | 1.0 | 2.2 |
| 33 | 30.2 | 1.0 | 2.4 |
| 34 | 30.2 | 1.0 | 2.24 |
| 35 | 30.2 | 1.0 | 2.12 |
| 36 | 30.2 | 1.0 | 1.96 |
| 37 | 30.2 | 1.0 | 2.12 |
| 38 | 33.9 | 1.0 | 2.24 |
| 39 | 33.9 | 1.0 | 2.16 |
| 40 | 33.9 | 1.0 | 2.12 |
| 41 | 33.9 | 1.0 | 2 |
| 42 | 35.1 | 1.0 | 2.04 |
| 43 | 35.1 | 1.0 | 2.32 |
| 44 | 35.1 | 1.0 | 2.2 |
| 45 | 35.1 | 1.0 | 2 |
| 46 | 35.1 | 1.0 | 2.24 |
| 47 | 35.1 | 1.0 | 1.92 |
| 48 | 35.1 | 1.0 | 1.88 |
| 49 | 35.1 | 1.0 | 1.92 |
| 50 | 36.3 | 1.0 | 2.16 |
| 51 | 36.3 | 1.0 | 2.32 |
| 52 | 36.3 | 1.0 | 2.24 |
| 53 | 36.3 | 1.0 | 2.08 |
| 54 | 38.6 | 1.0 | 1.6 |
| 55 | 38.6 | 1.0 | 2.16 |
| 56 | 38.6 | 1.0 | 2.12 |
| 57 | 38.6 | 1.0 | 1.92 |
| 58 | 38.6 | 1.0 | 2.12 |
| 59 | 38.6 | 1.0 | 1.84 |
| 60 | 38.6 | 1.0 | 2.04 |
| 61 | 38.6 | 1.0 | 1.68 |
| 62 | 44.3 | 1.0 | 1.84 |
| 63 | 44.3 | 1.0 | 1.48 |
| 64 | 44.3 | 1.0 | 1.52 |
| 65 | 44.3 | 1.0 | 1.4 |
| 66 | 45.4 | 1.0 | 1.32 |
| 67 | 45.4 | 1.0 | 1.48 |
| 68 | 45.4 | 1.0 | 1.94 |
| 69 | 45.4 | 1.0 | 1.68 |
| 70 | 45.4 | 1.0 | 1.62 |
| 71 | 45.4 | 1.0 | 1.6 |
| 72 | 45.4 | 1.0 | 1.48 |
| 73 | 45.4 | 1.0 | 1.56 |
| 74 | 48.7 | 1.0 | 1.2 |
| 75 | 48.7 | 1.0 | 1.04 |
| 76 | 48.7 | 1.0 | 1.24 |
| 77 | 48.7 | 1.0 | 0.72 |
| 78 | 48.7 | 1.0 | 1.48 |

Based on the measured values listed in Tables 1 and 2, deviation from the volumetric and surface examination coverage requirements of ASME Code Case N-729-4 of Item B4.20 is anticipated. Specifically, deviation from the required inspection coverage is sought for the reactor vessel head penetrations summarized in Table 3 below. Since the ultrasonic (UT) length measurement is performed in increments of 0.04 inches, penetrations included are within the 0.04 inches of the Code specified coverage.

Table 3: VEGP Units 1 and 2 Reactor Vessel Head Penetrations Requiring Relief from Volumetric and Surface Examination Coverage Requirements

| | Incident Angle ($\theta$) ≤ 30 degrees Required coverage (a) = 1.5 Inches | Incident Angle ($\theta$) > 30 degrees Required coverage (a) = 1.0 Inches |
|---|---|---|
| VEGP Unit 1 | 2, 5, 9, 14, 15, 18, 19 and 21 | 63, 64, 65, 66, 67, 68, 69, 72, 73, 74, 77 and 78 |
| VEGP Unit 2 | None | 75 and 77 |

Using the Reinspection Year (RIY) equation in N-729-4, Paragraph 2410 (b) reproduced here (and a head temperature of 560° F), the VEGP Unit 1 and Unit 2 time period for achieving a 2.25 RIY is greater than every fourth refueling outage, and less than every fifth refueling outage. The examination frequency for VEGP Units 1 and 2 is therefore, every fourth refueling outage

$$RIY = \sum_{j=n1}^{n2} \left\{ \Delta EFPY_j \exp\left[ -\frac{Q_g}{R}\left( \frac{1}{T_{headj}} - \frac{1}{T_{ref}} \right) \right] \right\}$$

## 6. Proposed Alternative and Basis for Use

### Proposed Alternative

As an alternative to the volumetric and surface examination coverage requirements shown as dimension "a" in Figure 2 of ASME Code Case N-729-4, SNC proposes the use of attainable ultrasonic examination distances shown in Tables 1 and 2 of this request for those head penetrations listed in Table 3. The expected examination coverage for the other penetrations is expected to be met or exceeded. In addition, SNC will examine the wetted surfaces on the vent line and vent line J-groove weld using the eddy current method as was done in the previous examinations.

### Basis for Use

Appendix I of ASME Code Case N-729-4 provides the analysis procedure for the evaluation of an alternative examination area or volume to that specified in Figure 2 of the Code Case if impediments prevent the examination of the complete zone. Section I-1000 of ASME Code Case N-729-4 requires that for alternative examination zones that eliminate portions of the

Figure 2 examination zone below the J-groove weld, the analyses shall be performed using at least the stress analysis method (Section I-2000) or the deterministic fracture mechanics analysis method (Section I-3000) to demonstrate that the applicable criteria are satisfied. In support of this relief request, the techniques of both Sections I-2000 and Method 1 of Section I-3200 were validated against Reference 2.

### 6.1 Stress Analysis in Accordance with ASME Code Case N-729-4

Section I-2000 of ASME Code Case N-729-4 requires that plant-specific analyses demonstrate that the hoop and axial stresses remain below 20 ksi (tensile) over the entire region outside the alternative examination zone but within the examination zone defined in Figure 2 of the Code Case. Analyses were performed for five different CRDM geometries, including the outermost row at 0-degree angular position from the reactor vessel centerline, rows at 26.2 degrees, 44.3 degrees, 45.4 degrees and 48.7 degrees. The penetration nozzle numbers that are bounded by the analyzed penetration nozzle incidence angles are shown in Table 4.

Table 4: VEGP, Units 1 and 2, Bounding Analyses

| Analyzed Penetration Nozzle Incidence Angle ($\theta$) | Penetration Nozzle Numbers Bounded by the Analyzed Nozzle | Applicable Figure No. for Nozzles with Limited Access |
|---|---|---|
| 0° | 1-21 | Figure 1 |
| 26.2° | 22-61 | Not Applicable |
| 44.3° | 62-65 | Figure 2 |
| 45.4° | 66-73 | Figure 3 |
| 48.7° | 74-78 | Figure 4 |

The distance below the J-groove weld that needs to be examined, as determined by the point at which the CRDM penetration hoop stress distribution for the operating stress levels is less than 20,000 pounds per square inch (psi) tension, was obtained from the graphs contained in Appendix A of Reference 2, Topical Report WCAP-16493-P, Revision 0, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Vogtle Units 1 and 2," dated November 2005. Reference 2 was previously submitted to the NRC as part of Reference 4 to support the examinations under the NRC Order. The WCAP was reviewed and continued applicability was confirmed (Reference 9).

The stress analysis methodology and conclusions are in Section 5 of Reference 2. The hoop stress distribution plots for the analyzed geometries are provided in Figures 1 through 4 of this submittal. Note that in each case the hoop stresses during steady state operation dominate the axial stresses; Sections 5.3 through 5.5 of Reference 2 provide additional discussion.

The hoop stress distribution plots in Figures 1 through 4 indicate that the minimum

achievable inspection coverage below the bottom of the J-groove weld ensures the stresses remain below 20 ksi (tensile) over the entire region outside the alternative examination zone but within the examination zone defined in Figure 2 as required by I-2000 of ASME Code Case N-729-4. Figures 1 through 4 were used to prepare the crack growth predictions shown in Figures 5 through 8 of this submittal and demonstrate that obtaining the examination coverages below the J-groove weld as shown in Table 5 is sufficient to allow for a minimum of six effective full power years (EFPY) or four 18-month cycles between examinations.

### 6.2 Deterministic Fracture Mechanics Analysis in Accordance with ASME Code Case N-729-4 Section 1-3200, Method 1

A fracture mechanics analysis was performed and documented in Reference 2. The analysis does demonstrate that a potential axial crack in the unexamined zone will not grow to the toe of the J-groove weld prior to the examination frequency specified in Table 1 of ASME Code Case N-729-4.

The fracture mechanics analysis was performed using input from the previously discussed stress analysis. The results of the analysis are shown as flaw tolerance charts, which can be used to determine minimum required inspection coverage. This ensures that any flaws initiated below the weld, in the region of the penetration nozzle not being inspected, would not reach the bottom of the weld before the next inspection. The flaw tolerance chart for the applicable VEGP Units 1 and 2 penetrations are shown in Figures 5 through 8.

The flaw tolerance chart in Figures 5 through 8 demonstrates that a postulated through-wall flaw at the bottom edge of the proposed alternative examination zone will not grow to the toe of the J-groove weld within an inspection interval of four refueling cycles. The assumed initial upper extremity locations of axial through-wall flaws are conservative based on achievable inspection coverage because the assumed upper crack extremities are located within the achievable inspection zone. The alternative examination for the as-built configuration zone extends from the toe of the weld down the nozzle for the dimension identified in Table 5, as noted in column listing "a". This "a" dimension below the weld is shown on Sketches 1 and 3. The as-designed dimensions of the J-groove welds are given in Table 6.

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**Vogtle Electric Generating Plant - Units 1 and 2**
**Proposed Alternative in Accordance with 10 CFR 50.55a(z)(2)**
**Acceptable Level of Quality and Safety**

Table 5: Listing of Nozzles with Limitations

| Pen # | | Coverage below Weld in Inches "a" | L3 (Inches) | L4 (Inches) | Weld Thickness (Inches) |
|---|---|---|---|---|---|
| Unit 1 | 2 | 1.52 | 2.66 | 3.74 | 1.08 |
| Unit 1 | 5 | 1.52 | 2.66 | 3.70 | 1.04 |
| Unit 1 | 9 | 1.40 | 2.54 | 4.02 | 1.48 |
| Unit 1 | 14 | 1.40 | 2.62 | 3.82 | 1.20 |
| Unit 1 | 15 | 1.48 | 2.62 | 3.98 | 1.36 |
| Unit 1 | 18 | 1.44 | 2.78 | 4.10 | 1.32 |
| Unit 1 | 19 | 1.44 | 2.62 | 3.94 | 1.32 |
| Unit 1 | 21 | 1.36 | 2.50 | 3.86 | 1.36 |
| Unit 1 | 63 | 0.92 | 1.94 | 4.58 | 2.64 |
| Unit 1 | 64 | 1.00 | 2.18 | 4.34 | 2.16 |
| Unit 1 | 65 | 0.92 | 2.02 | 4.34 | 2.32 |
| Unit 1 | 66 | 0.96 | 2.18 | 4.66 | 2.48 |
| Unit 1 | 67 | 0.80 | 1.90 | 4.22 | 2.32 |
| Unit 1 | 68 | 0.96 | 2.14 | 4.26 | 2.12 |
| Unit 1 | 69 | 1.00 | 2.10 | 4.54 | 2.44 |
| Unit 1 | 72 | 1.04 | 2.34 | 4.70 | 2.36 |
| Unit 1 | 73 | 1.00 | 2.26 | 4.42 | 2.16 |
| Unit 1 | 74 | 1.04 | 1.82 | 4.10 | 2.28 |
| Unit 1 | 77 | 1.04 | 1.86 | 4.34 | 2.48 |
| Unit 1 | 78 | 0.72 | 1.78 | 3.90 | 2.12 |
| Unit 2 | 75 | 1.04 | 1.82 | 3.78 | 1.96 |
| Unit 2 | 77 | 0.72 | 1.46 | 4.14 | 2.68 |

Table 6: J-Groove Design Dimensions

| Analyzed Angle (degrees) | As-Designed J-Groove Dimension (inches) | Pen- #s |
|---|---|---|
| 0.0 | 0.94 | 1 - 21 |
| 44.3 | 1.31 | 22 - 65 |
| 45.4 | 1.30 | 66 - 73 |
| 48.7 | 1.37 | 74 - 78 |

The flaw evaluations performed in WCAP-16493-P was based upon the as-designed J-groove dimensions. Westinghouse has performed a separate analysis using arbitrarily larger weld heights for peripheral nozzles (48.7-degree downhill side angle, 1.46-inch design dimension). The analysis cases included 1.46, 2.35, and 2.97-inches to determine their stress profiles. The 20 ksi criterion is reached in a shorter distance for the larger

length welds; therefore, the 1.46 design value bounds the as-built dimensions of the CRDM nozzles for the current analysis.

Examination of portions of the nozzle significantly below the J-groove weld is not pertinent to the phenomena of concern, which include leakage through the J-groove weld and circumferential cracking in the nozzle above the J-groove weld. In each case, the measured coverage is adequate to allow VEGP Units 1 and 2 to continue to operate prior to the hypothetical flaws reaching the J-groove weld. In accordance with 10 CFR 50.55a(g)(6)(ii)(D) requirements, the next required examination would be completed prior to potential flaw propagation into the J-groove welds.

### 6.3 Surface Examination

Note (6) of Table 1 in Code Case N-729-4 states in part that "if a surface examination is being substituted for a volumetric examination on a portion of a penetration nozzle that is below the toe of the J-groove weld the surface examination shall be of the penetration nozzle inside and outside wetted surface. "

To reduce personnel radiation exposure, the nozzles are typically inspected using remotely operated volumetric examination equipment. Although dye penetrant testing of threaded surfaces is possible, it is not practical. The threaded outside diameter (OD) makes a dye penetrant examination on the lower section of the penetration impractical because of excessive bleed-out from the threads. Eddy current examination would similarly not be effective due to the threaded configuration. In addition, radiation levels under the reactor vessel head have historically been observed in the range of 1 REM/hour to 5 REM/hour contingent upon the VEGP unit involved for the general area. If examinations were required to be performed, this would result in a condition contrary to the principle of ALARA (As Low As Reasonably Achievable). Therefore, no surface examination alternative is proposed for those CRDM nozzles having only limited examination coverage below the J-groove weld.

### Summary for Proposed Alternative and Basis

To summarize, Table 7 compares the VEGP baseline examination coverage to the minimum examination coverage described in the WCAP evaluation; in each case, the examination coverage meets or exceeds the WCAP minimum values for those penetration nozzles where the examination requirements of Figure 2 for Code Case N-729-4 cannot be met. The required examination coverage can be obtained for penetration nozzles 22 through 61 and, as a result, are not referenced in Table 7.

Table 7: VEGP, Units 1 and 2, Minimum Examination coverage
(Distance below the lowest Point of the J-groove weld)
For Penetration Nozzles with Limitations

| Penetration Nozzle Numbers | Range of Examination Coverage from Previous Examinations | WCAP Minimum Coverage for Penetration Nozzles with Limitations |
|---|---|---|
| 1-21 | 1.36 to 1.48 inches | 0.55 inches |
| 62-65 | 0.92 inches | 0.35 inches |
| 66-73 | 0.80 to 0.96 inches | 0.35 inches |
| 74-78 | 0.72 inches | 0.25 inches |

## 7. Duration of Proposed Alternative

The duration of the proposed alternative is for the VEGP Units 1 and 2 fourth ten-year ISI interval. These examinations are scheduled to be next performed on VEGP Unit 1 and Unit 2 during the Fall 2018 and Spring 2019 refueling outages, respectively, and every fourth refueling outage thereafter. The current interval is scheduled to end on May 30, 2027.

## 8. Precedents

Precedents for relief from the requirements of examination coverage exist since Vogtle Units 1 & 2 (ML12199A233); Beaver Valley Unit 2 (ML092640111); Indian Point, Unit 2 (ML16147A519); have all been granted relief for the same issue.

The current request applies to the nozzles listed in Table 3 due to the same geometric limitations encountered in satisfying the Order requirements.

## 9. References

1) ASME Code Case N-729-4, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1,"dated June 22, 2012

2) WCAP-16493-P, Revision 0, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Vogtle Units 1 and 2," dated November 2005

3) Letter from L. M. Stinson (SNC) to U. S. NRC, "Vogtle Electric Generating Plant Request for Relaxation of the First Revised NRC Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated May 18, 2006 (NRC ADAMS Accession No. ML061390036)

4) Letter from D. E. Grissette (SNC) to U. S. NRC, "Southern Nuclear Operating Company

Response to NRC Question Regarding the Vogtle Electric Generating Plant Units 1 and 2 First Revised Order EA-03-009 Relaxation Request, Alternate Examination Coverage for Reactor Pressure Vessel Head Penetration Nozzles," dated June 2, 2006 (NRC ADAMS Accession No. ML061580121)

5) Letter from T. J. McGinty (U. S. NRC) to D. E. Grissette (SNC), "Vogtle Electric Generating Plant, Units 1 and 2 - Relaxation of Requirements Associated with First Revised Order Modifying Licenses EA-03-009, Dated February 20, 2004, Relaxation Request, Inspection Coverage Requirements (TAC Nos. MD1805 and MD1806)," dated August 30, 2006 (NRC ADAMS Accession No. ML062360585)

6) NRC Order EA-03-009, "Issuance of First Revised Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated February 20, 2004

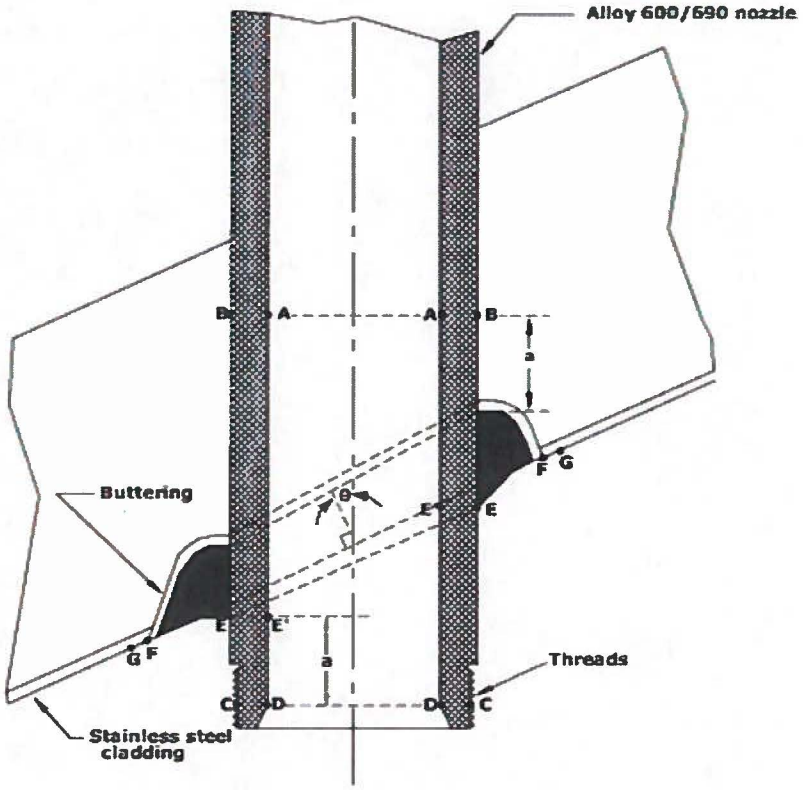
7) Letter from D. E. Grissette (SNC) to the U. S. NRC, "Vogtle Electric Generating Plant, Unit 1, Results of Reactor Vessel Head Inspections Required by First Revised Order EA-03-009," dated December 22, 2006 (NRC ADAMS Accession No. ML063600040)

8) Letter from B. J. George (SNC) to the U. S. NRC, "Vogtle Electric Generating Plant, Unit 2, Results of Reactor Vessel Head Inspections Required by First Revised Order EA-03-009," dated June 21, 2007 (NRC ADAMS Accession No. ML071730265)

9) Letter from L. E. Markle (Westinghouse) to T. E. Tynan (SNC), "Southern Nuclear Operating Company Vogtle Electric Generating Plant Unit 1 and 2 Transmittal of LTR-PAFM-12-18, "Applicability of WCAP-16493-P to Mandatory Appendix I of ASME Code Case N-729-1,"dated January 31, 2012

# Attachment 1
# 10 CFR 50.55a Request No. VEGP-ISI-ALT-04-01

Sketch 1 - Typical Configuration of Vogtle Unit 1 CRDM Nozzles 1 through 78 and Vogtle Unit 2 CRDM Nozzles 74 through 78 as depicted on Figure 2 of Code Case N-729-4




The below Notes are taken from Code Case N-729-1 and do not indicate actual dimensions of penetration.

a = 1.5 in. (38mm) for Incidence Angle, β≤30 deg and for all nozzles ≥4.5 in. (115 mm) OD or 1 in. (25 mm) for Incidence Angle, θ, >30 deg; or to the end of the tube, whichever is less

A-B-C-D = Extent of volumetric examination for the tube (base metal)

A-D = Extent of surface examination for the tube inside surface

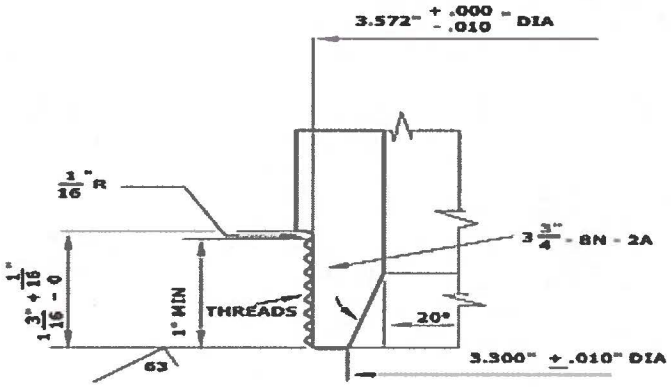
G-F = ½ in. (6 mm) from the theoretical point "F" in accordance with the design drawings, including tolerances, unless the point "F" can be physically determined.

G-F-E-C = Extent of surface examination for the J-groove weld (filler metal and buttering) and tube outside surface below the weld

G-F-E = Extent of surface examination zone for the J-groove weld (filler metal and buttering)

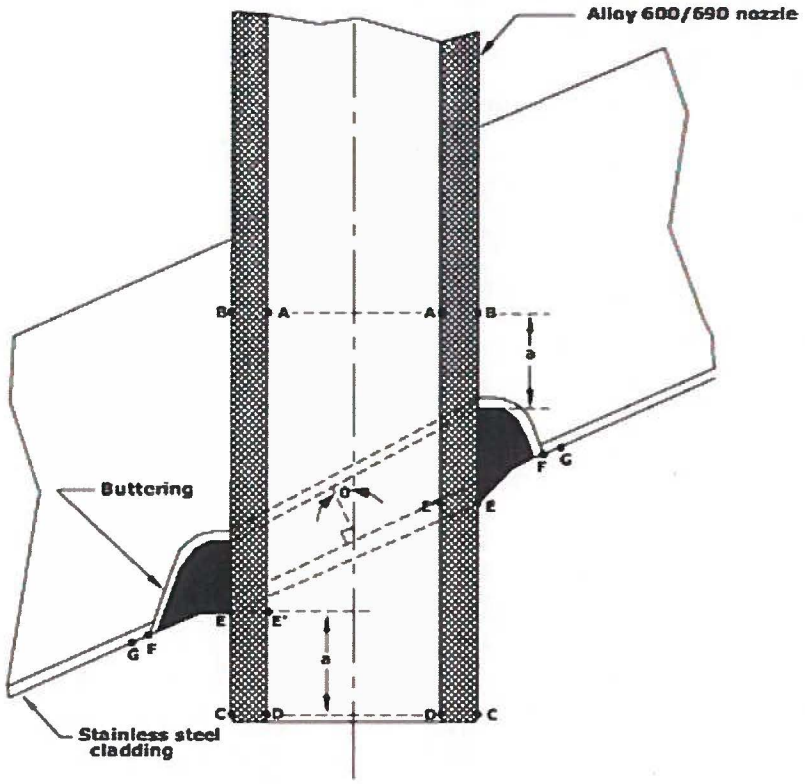
**Attachment 1**
**10 CFR 50.55a Request No. VEGP-ISI-ALT-04-01**

Sketch 2 - Typical Configuration of Threaded Portion of CRDM Nozzles on Vogtle Unit 1 CDRM Nozzles 1 thru 78 and Vogtle Unit 2 CRDM Nozzles 74 thru 78




**Note: The above figure was taken from Vogtle drawings 1/2X6AA00-00320. This configuration is designated as TYPE "X" on the drawings.**

Sketch 3 - Typical Configuration of Vogtle Unit 2 CRDM Nozzles 1 through 73 as depicted on Figure 2 of Code Case N-729-4




The below Notes are taken from Code Case N-729-1 and do not indicate actual dimensions of penetration.

a = 1.5 in. (38mm) for Incidence Angle, $\beta$ ≤30 deg and for all nozzles ≥4.5 in. (115 mm) OD or 1 in. (25 mm) for Incidence Angle, $\beta$, >30 deg; or to the end of the tube, whichever is less

A-B-C-D = Extent of volumetric examination for the tube (base metal)

A-D = Extent of surface examination for the tube inside surface

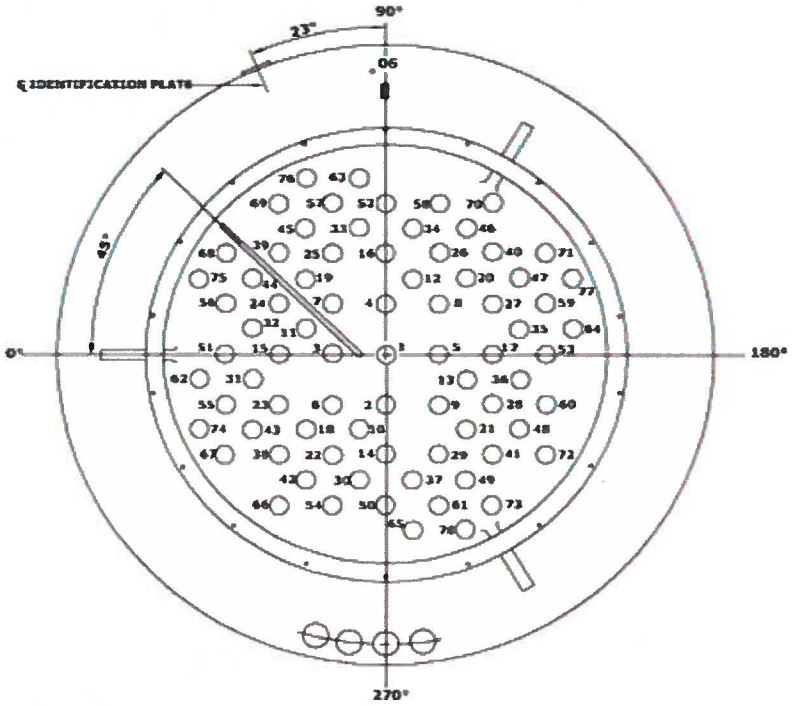
G-F = ¼ in. (6 mm) from the theoretical point "F" in accordance with the design drawings, including tolerances, unless the point "F" can be physically determined.

G-F-E-C = Extent of surface examination for the J-groove weld (filler metal and buttering) and tube outside surface below the weld

G-F-E = Extent of surface examination zone for the J-groove weld (filler metal and buttering)

## Attachment 1
## 10 CFR 50.55a Request No. VEGP-ISI-ALT-04-01

Sketch 4 - Layout of Vogtle Unit 1 and 2 Reactor Pressure Vessel Head CRDM Configuration



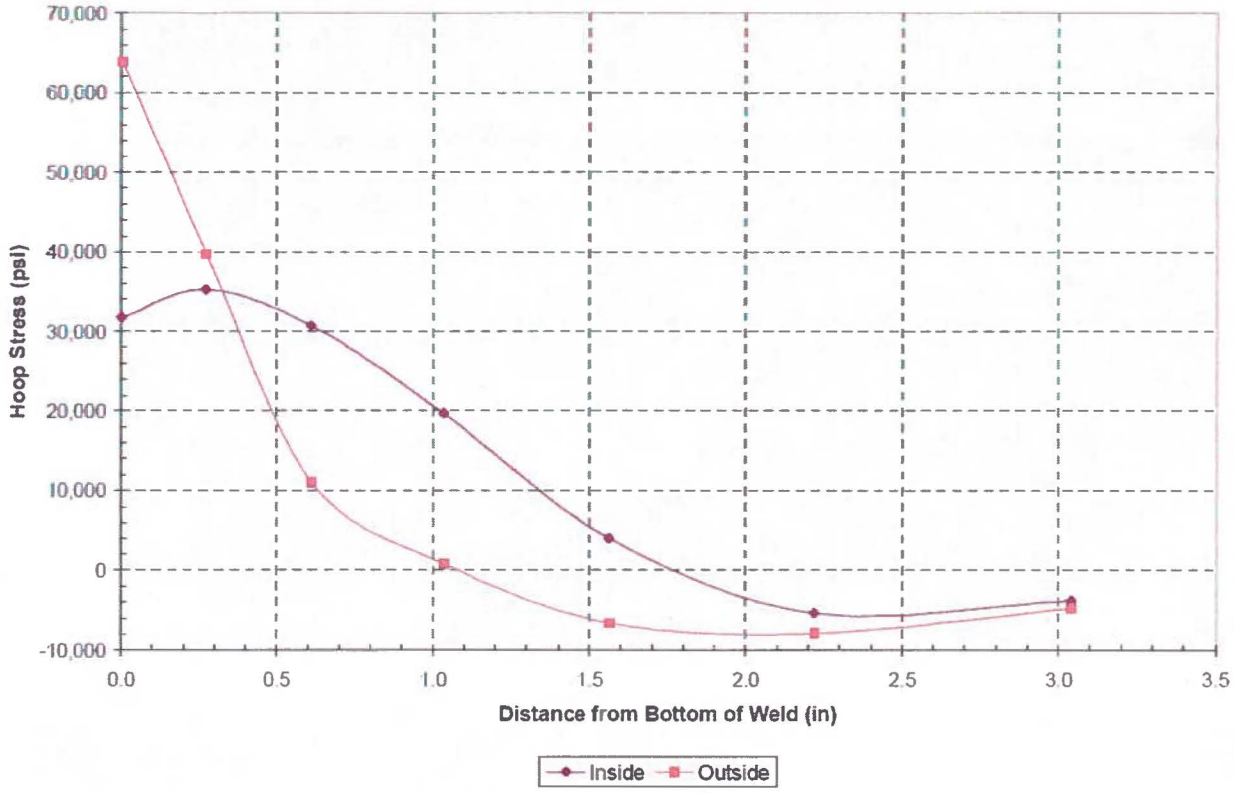



**Figure 1: Hoop Stress Distribution Downhill and Uphill Side for 0° CRDM Penetration Nozzle for VEGP Units 1 and 2**
(Figure A-1 from Reference 2)

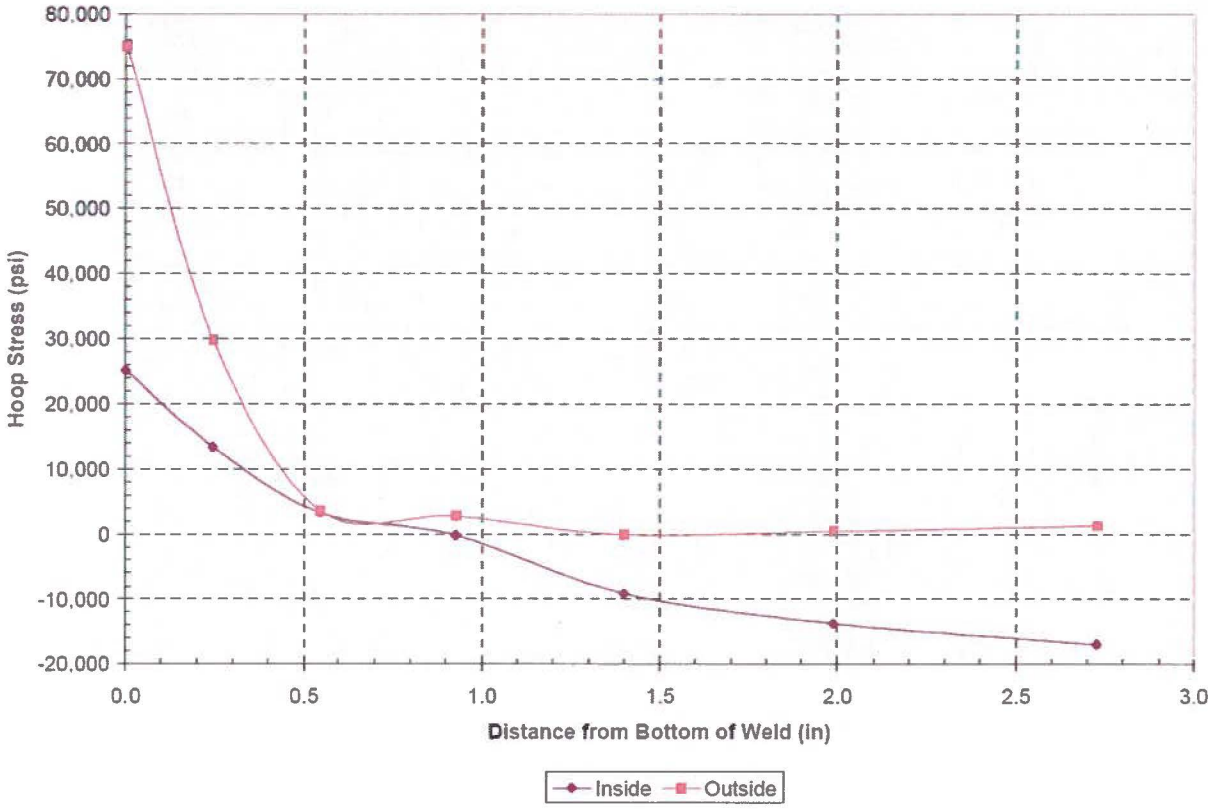



**Figure 2: Hoop Stress Distribution Downhill Side for 44.3° CRDM Penetration Nozzle for VEGP Units 1 and 2**
**(Figure A-5 from Reference 2)**

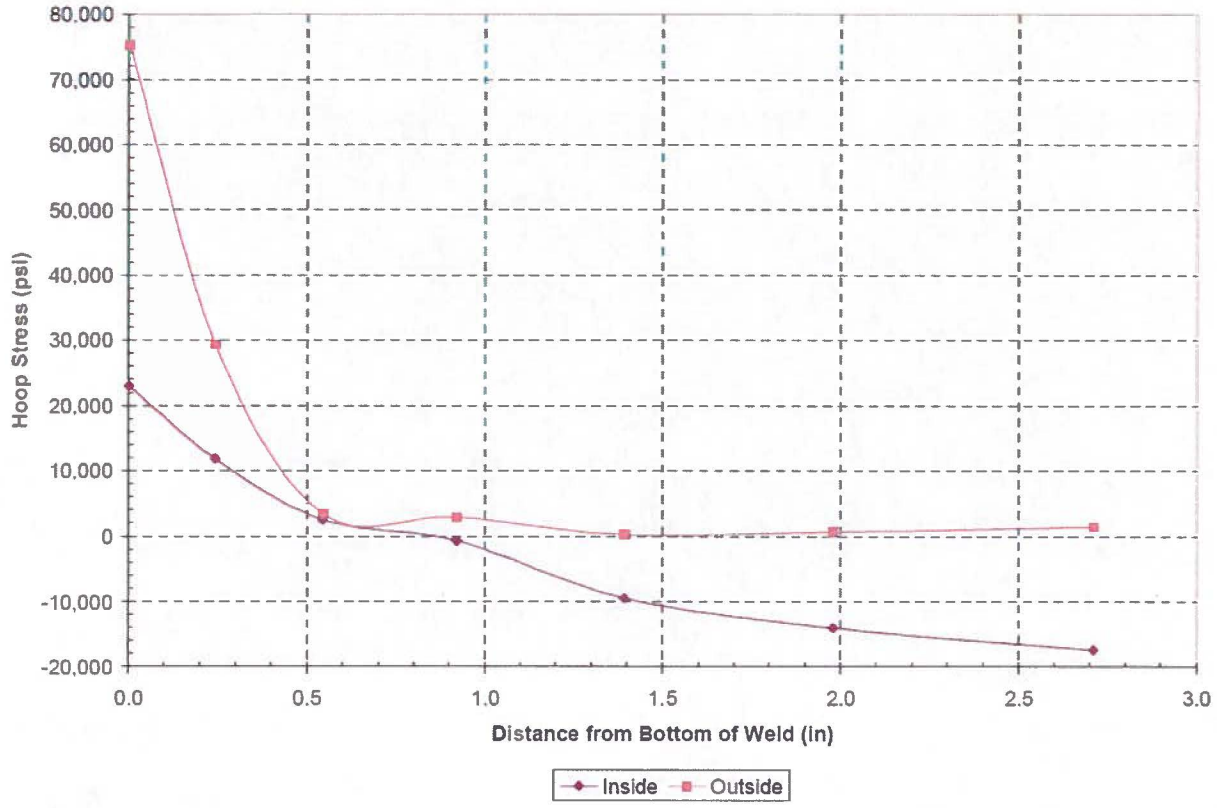



**Figure 3: Hoop Stress Distribution Downhill Side for 45.4° CRDM Penetration Nozzle for VEGP Units 1 and 2**
**(Figure A-7 from Reference 2)**

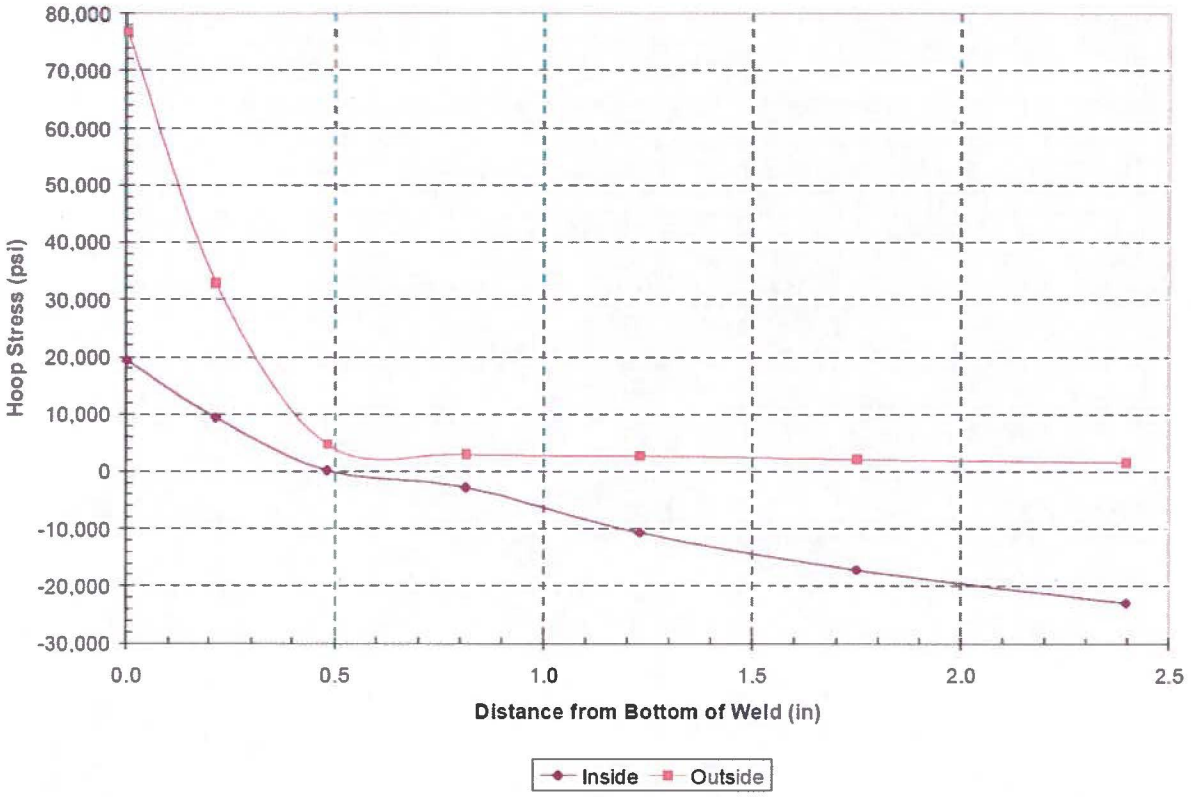



**Figure 4: Hoop Stress Distribution Downhill Side for 48.7° CRDM Penetration Nozzle for VEGP Units 1 and 2**
**(Figure A-9 from Reference 2)**

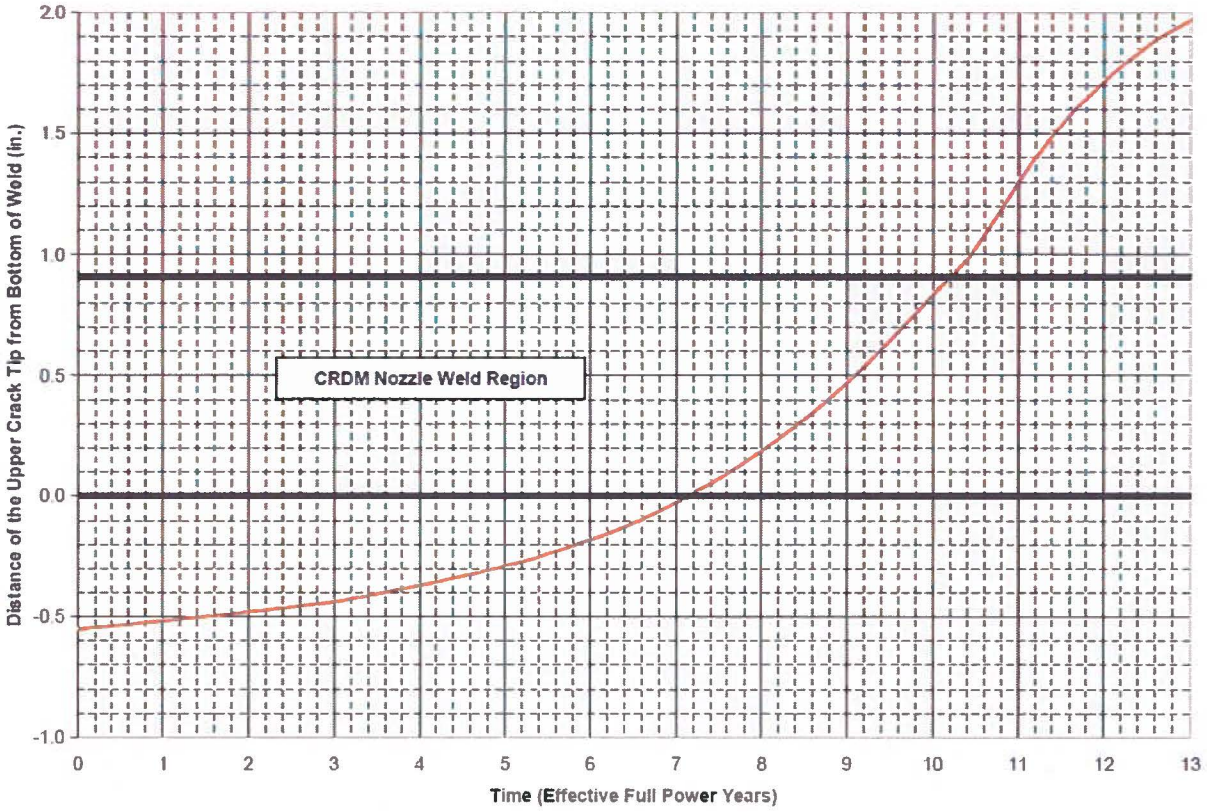



**Figure 5: Through-Wall Longitudinal Flaws Located in Center CRDM (0.0 Degrees) Penetration- Crack Growth Predictions for VEGP Units 1 and 2 (Figure 6-12 from Reference 2)**

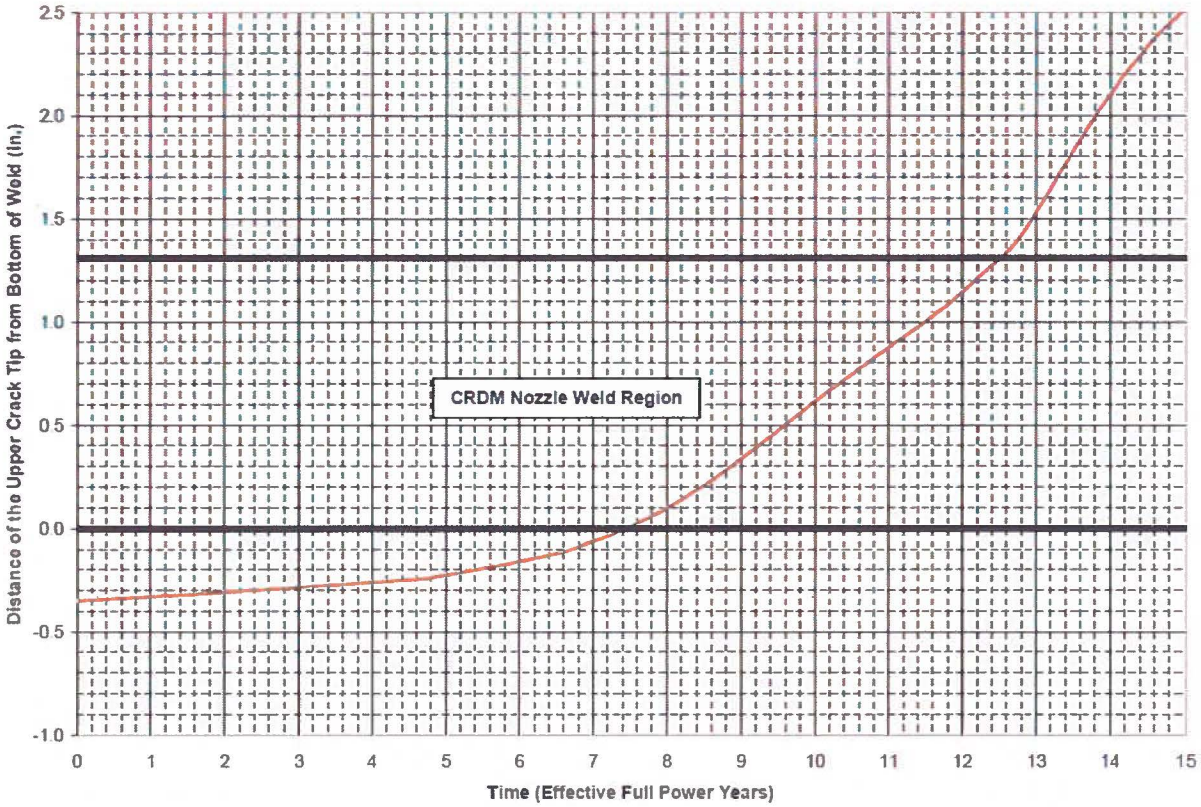



**Figure 6: Through-Wall Longitudinal Flaws Located in the 44.3 Degrees CRDM Row of Penetrations, Downhill Side- Crack Growth Predictions for VEGP Units 1 and 2 (Figure 6-14 from Reference 2)**

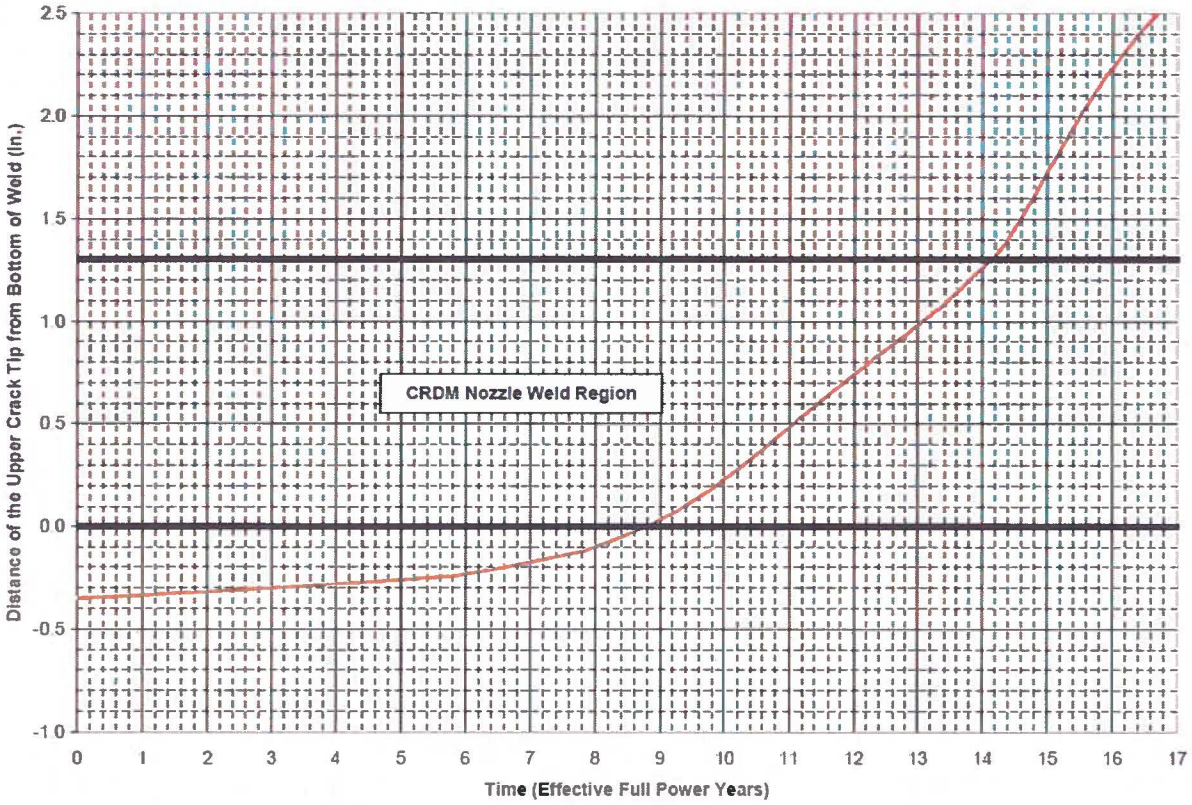



**Figure 7: Through-Wall Longitudinal Flaws Located in the 45.4 Degrees CRDM Row of Penetrations, Downhill Side- Crack Growth Predictions for VEGP Units 1 and 2 (Figure 6-15 from Reference 2)**

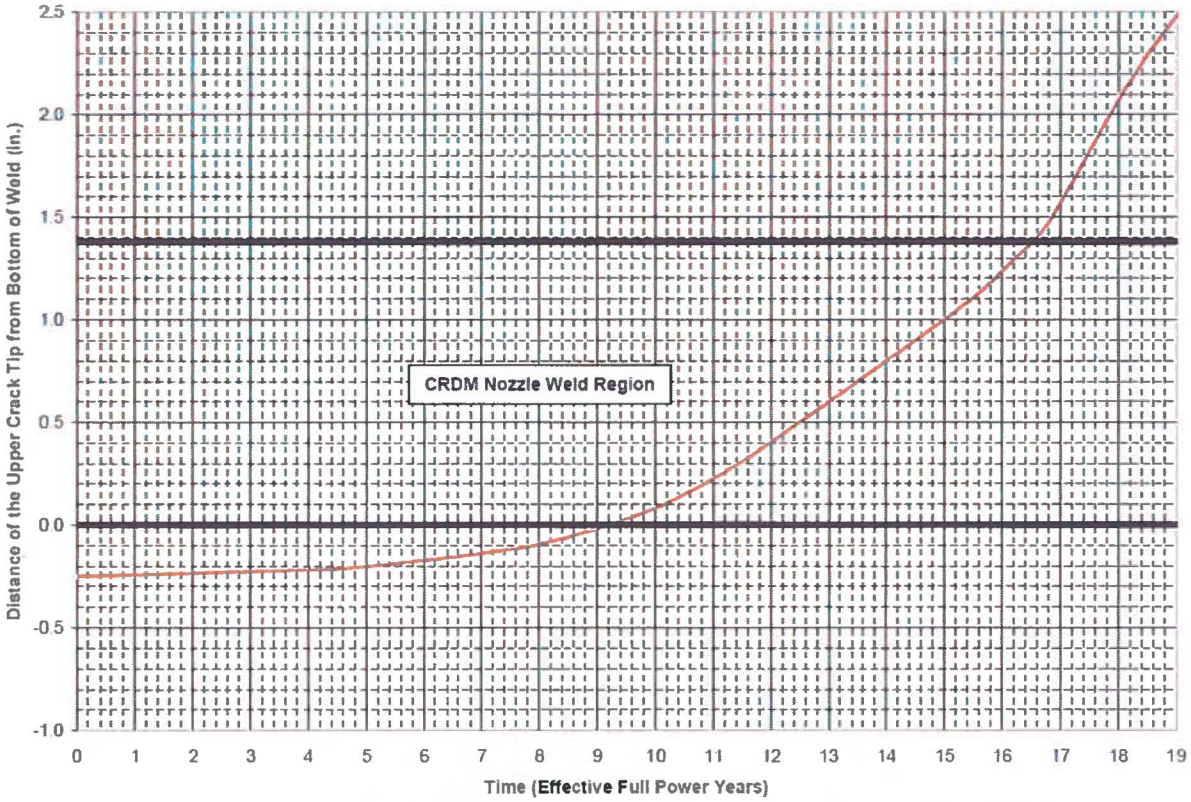



**Figure 8: Through-Wall Longitudinal Flaws Located in the 48.7 Degrees CRDM Row of Penetrations, Downhill Side- Crack Growth Predictions for VEGP Units 1 and 2 (Figure 6-16 from Reference 2)**