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Constellation Energy eDF

July 27, 2012

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

ATTENTION: Document Control Desk

SUBJECT: **R.E. Ginna Nuclear Power Plant**
Docket No. 50-244

Response to Request for Additional Information RE: Request for Relief from Requirements for Examination of the Reactor Vessel Head Penetration Nozzles

REFERENCES: (a) Letter from Mr. T. G. Mogren (Ginna LLC) to Document Control Desk (NRC) dated May 24, 2012, Subject: 10 CFR 50.55(a) Request ISI-07 and ISI-08: Proposed Alternative Reactor Vessel Closure Head Penetration Nozzle Examinations for the Fifth Interval Inservice Inspection (ISI) Program (ML12151A405)

By Reference (a), R.E. Ginna Nuclear Plant, LLC (Ginna LLC) submitted Relief Requests ISI-07 and ISI-08 to propose alternatives to complying with the code examination requirements specified in 10 CFR 50.55a(g)(6)(ii)(D). On June 25, 2012, the NRC requested additional information regarding this submittal. Attached please find the response to the staff's questions.

Should you have any questions regarding this matter, please contact Mr. Thomas Harding at (585) 771-5219 or Thomas.HardingJr@cengllc.com.

Very truly yours,

Thomas D Mogren

Thomas Mogren

Attachment 1: Response to Request for Additional Information

cc: W. M. Dean, NRC
M. C. Thadani, NRC
Resident Inspector, NRC

A047
NRR

WPLNRC-1002580

ATTACHMENT 1

Response to Request for Additional Information

R.E. Ginna Nuclear Power Plant, LLC
July 27, 2012

ATTACHMENT 1

Response to Request for Additional Information

RAI-1

The May 24, 2012, submittal did not provide information on axial stresses for the control rod drive mechanism (CRDM) penetration nozzles on the basis that the hoop stresses are limiting. As indicated in Pacific Northwest National Laboratory (PNNL) Report 17763, "Final Report – Inspection Limit Confirmation for Upper Head Penetration Nozzle Cracking," dated August of 2008, this basis is not always true. Case 12 of Figure 9, Case 61 of Figure 11, and Cases 87, 88, 89 of Figure 13 of the PNNL report all indicated that the axial stresses are more limiting than the hoop stresses. When you study the above quoted figures in the PNNL report, please note that, for axial stresses, the longer distance from the triple point to where the stress drops to 20 ksi means that a longer portion of the penetration nozzle is at stresses greater than 20 ksi.

Please provide additional plant-specific information on axial stresses to substantiate your claim that the hoop stresses are limiting.

Response:

The attached figures 1 - 5 include Ginna plant specific axial stress plots to substantiate the Ginna position that hoop stress is limiting in the area of interest.

Figure 1
Downhill Side Axial and Hoop Stress Distribution Below J-groove Weld Toe for Center Penetration Nozzle with Incidence Angle of 0°

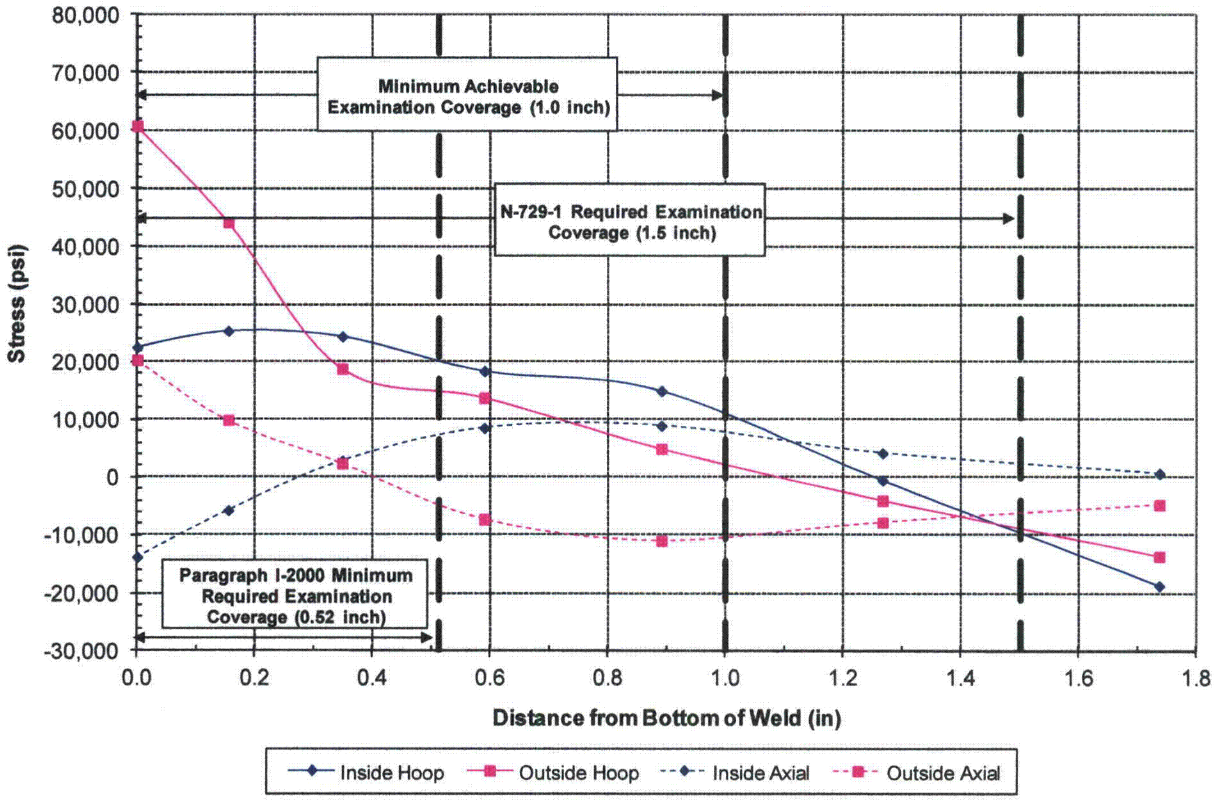


Figure 2
Downhill Side Axial and Hoop Stress Distribution Below J-groove Weld Toe for Penetration Nozzles with Incidence Angle of 13.7°

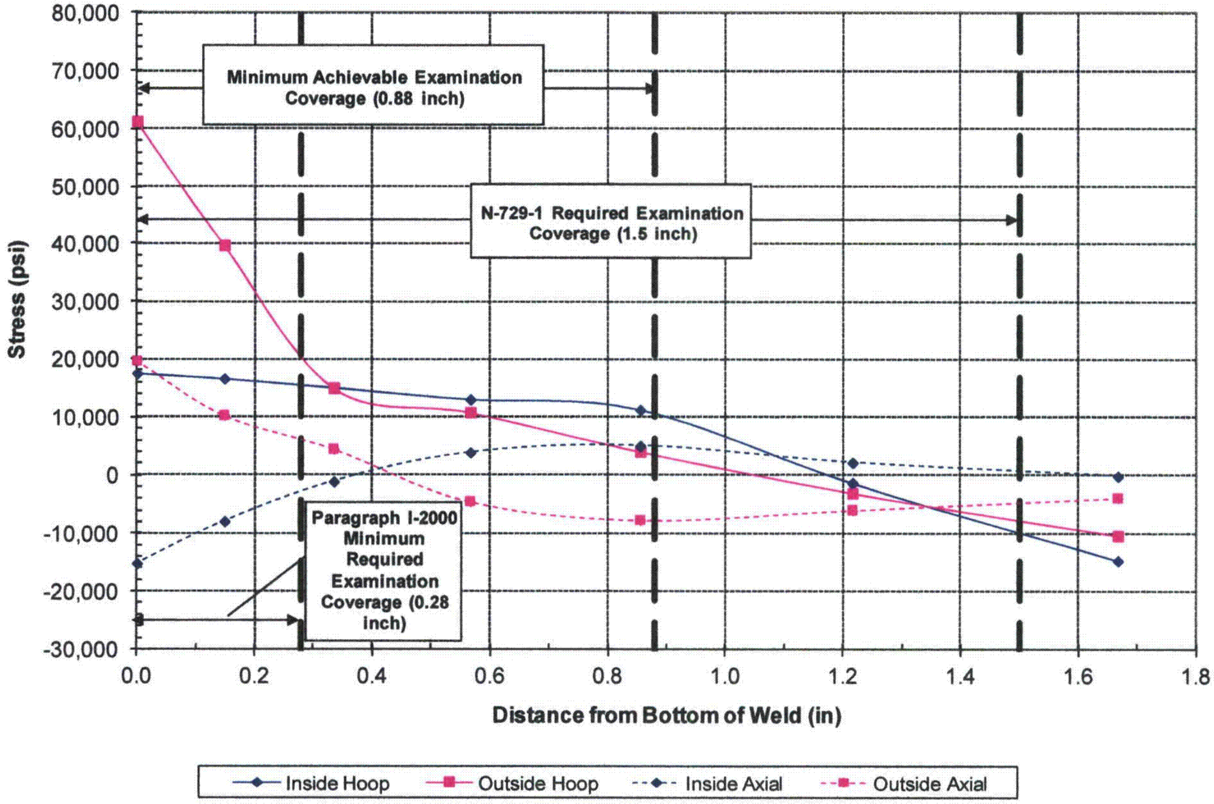
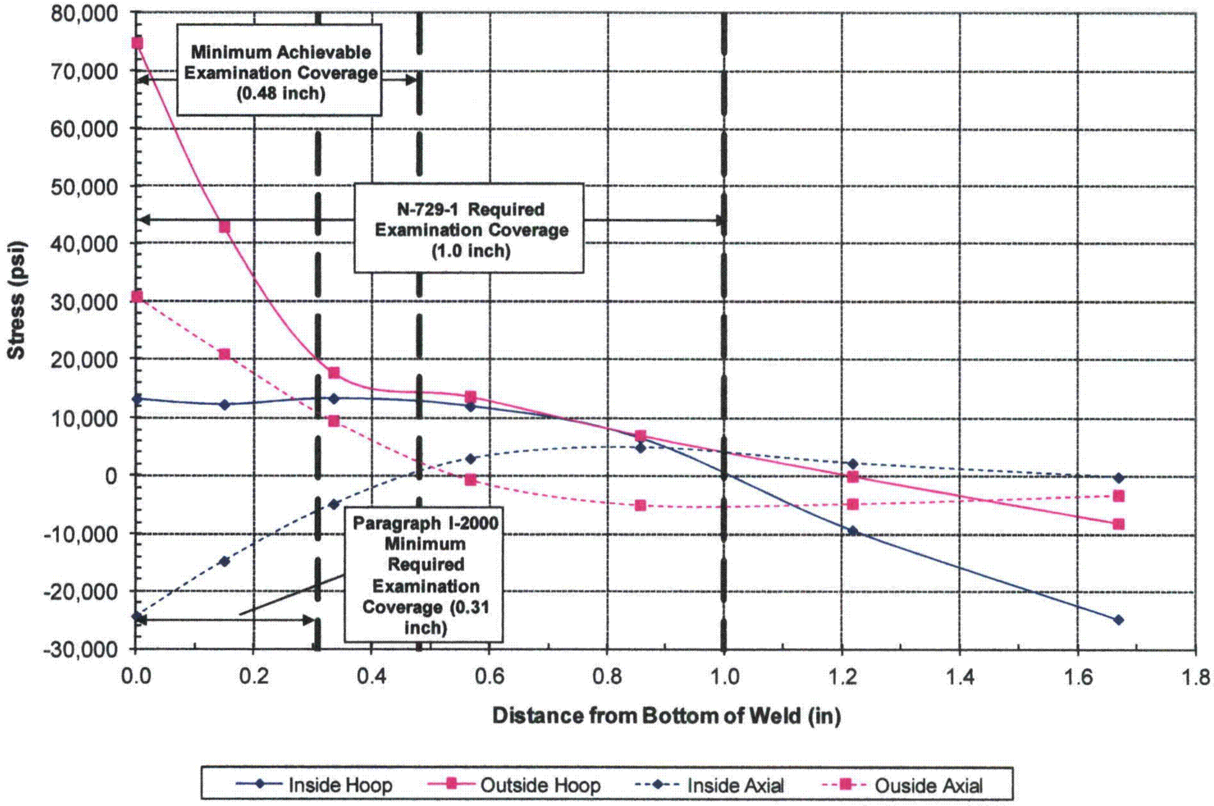


Figure 3
Downhill Side Axial and Hoop Stress Distribution Below J-groove Weld Toe for Penetration Nozzles with Incidence Angle of 31.9°



Note: For Penetration Numbers 10-13, 18-21 (incidence angles of 28.2° and 30°) which are bounded by hoop stress distribution shown in this figure, the N-729-1 required examination coverage is 1.5".

Figure 4
Downhill Side Axial and Hoop Stress Distribution Below J-groove Weld Toe for Penetration Nozzles with Incidence Angle of 37.0°

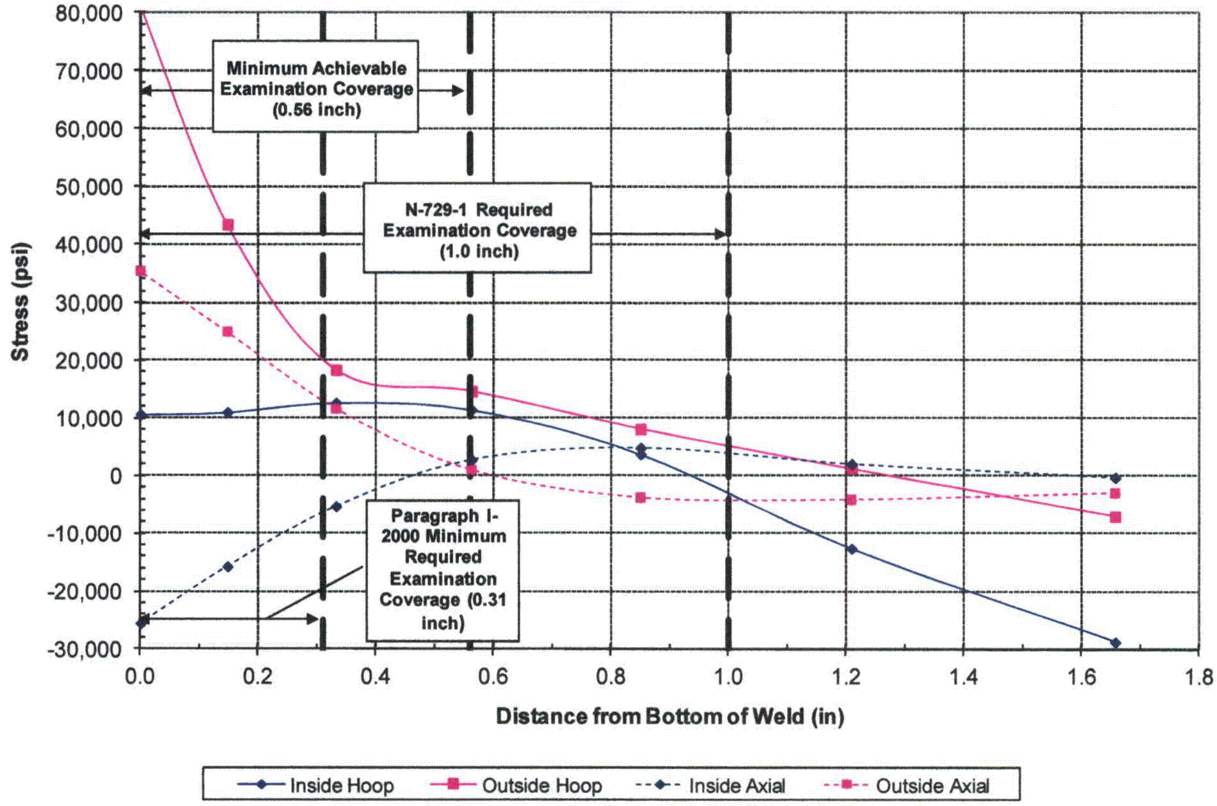
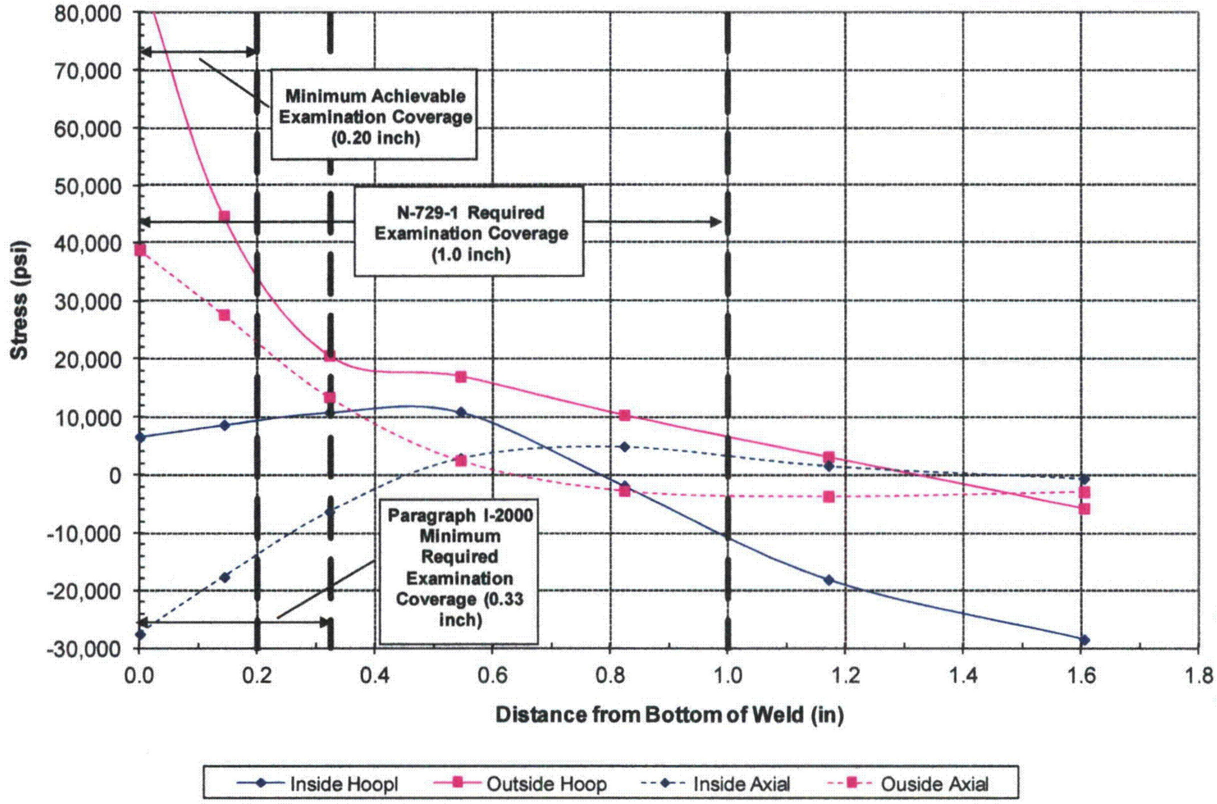


Figure 5
Downhill Side Axial and Hoop Stress Distribution Below J-groove Weld Toe for Penetration Nozzles with Incidence Angle of 43.5°



Note: There are only three penetration nozzles (penetration numbers 34, 35 and 37) with incidence angle of 43.5°. The achievable examination coverage for penetration nozzle numbers 34, 35 and 37 from Table 1 are 0.52", 0.20" and 0.40" respectively. Only the achievable examination coverage for penetration nozzle number 35 is below the Paragraph I-2000 required minimum examination coverage.

RAI-2

The licensee used a deterministic fracture mechanics analysis to justify the alternative examination coverage for penetration nozzle number 35. However, the proposed coverage of 0.2 inch is not sufficient to tolerate the uncertainties in the calculated residual stresses and the determination of the assumed crack length. The staff also has a concern with the proposed crack growth rate for Alloy 690 CRDM material (discussed in RAI-3). Hence, the NRC staff requests the licensee provide the basis for not performing a surface examination of the lower portion of each penetration nozzle necessary to meet the inspection requirements of 10 CFR 50.55a(g)(6)(ii)(D) and consider changing the regulatory basis of the relief request from 10 CFR 50.55a(a)(3)(i) to10 CFR 50.55a(a)(3)(ii). Up to date, all similar relief requests were granted under 10 CFR 50.55a(a)(3)(ii), because the NRC staff finds insufficient basis to grant relief under 10 CFR 50.55a(a)(3)(i), considering that surface examinations could be performed on each penetration nozzle to meet the current inspection requirements.

Response:

The EPRI Performance Demonstration Qualification Summary (PDQS) PDQS 1019 and PDQS 1025 require both axial and circumferential scanning with time of flight (TOF) ultrasonic (UT) techniques for proper detection, characterizing, and sizing of control rod drive mechanism (CRDM) nozzle flaws. Coverage of the UT axial scan for circumferential flaws can be credited. The following Table 1 shows the projected specific UT coverage for each direction on Nozzle 35.

Table 1

Penetration Nozzle number	Penetration nozzle incidence angle	UT Scan Coverage Below weld for axial flaws	UT Scan Coverage Below weld for circumferential flaws
35	43.5°	0.6"	0.2"

Ginna Station is requesting relief under 10 CFR 50.55a(a)(3)(ii).

The Reactor Pressure Vessel Head outside surface NDE Penetrant Testing (PT) will expose workers to between 500 – 700 mRem of dose per penetration. There also exists the potential for additional dose for additional preparation, cleaning or repeat PT exams in resolution of geometric indications due to material surface conditions that potentially could double personnel exposure. The Ginna Station replacement Reactor Vessel Head was designed and fabricated to the ASME Section III 1995 Edition, 1996 Addenda and to be compatable with the original vessel design which did not identify any requirements to extend nozzle material configurations to achieve Code Case N-721-1 specified coverage above and below the J welds. To obtain the current material volume requirements, the Reactor Vessel Head would need to be redesigned/modified to accommodate an increased inspection zone below the J-groove weld. Compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

RAI-3

The licensee used a crack growth rate with an improvement factor of 100 over Alloy 600 for Alloy 690 materials in its fracture mechanics analyses. The May 24, 2012, submittal states that NUREG/CR-7103, Volume 2, "Pacific Northwest National Laboratory Investigation of Stress Corrosion Cracking [SCC] in Nickel-Base Alloys," indicated similar crack growth results except for high levels of cold work. However, the NUREG states, "Representative [Alloy] 690 CRDM plant materials were studied to investigate the SCC crack-growth response in the as-received TT [thermally treated] and several modified conditions." To ensure that the plant-specific Alloy 690 material for the CRDMs did not receive significant cold work which is "representative" according to the NUREG, please provide your estimate of the cold work for the Ginna CRDM penetrations based on the fabrication and installation record of the Ginna CRDM penetrations to support that the Ginna CRDM penetrations did not receive significant cold work.

Response:

The Ginna replacement vessel closure head (RVCH) includes many improvements with regards to minimizing the potential for Primary Water Stress Corrosion Cracking (PWSCC). The Alloy 690 control rod drive mechanism (CRDM) nozzle material was manufactured by Valinox to a Babcock & Wilcox technical specification which met or exceeded the requirements of ASME Section II SB-167, section III NB-2000. In terms of manufacturing, hot extruded hollows, subsequently quenched from the solution anneal temperature, were thermally treated to obtain the desired grain size and carbide distribution designed to maximize resistance to PWSCC. The processing employed ensures that the thermally treated microstructure exhibits the continuous grain boundary carbide decoration and complete absence of carbide banding. The final yield strength after thermal treatment was 36 ksi. The CRDM tube material received no cold rolling operations. With regard to any cold work surface layers produced by final maching processes, Babcock and Wilcox performed an empirical and analytical evaluation where X-ray diffraction was used to determine the cold work layer depth that resulted from inside diameter and outside diameter machining and grinding processes. These dimensions were used as a basis for establishing electropolishing parameters to result in removal of the entire cold worked layer that resulted from machining and grinding on the wetted portions of the nozzle and J-groove weld. The electropolish process was used on the Ginna CRDM nozzle inside diameter and nozzle outside diameter prior to installation, and on the Ginna CRDM nozzle inside diameter, nozzle outside diameter, and J groove weld/nozzle area after nozzle installation.

A conservative assumption is that a maximum amount of 0.012" total cold worked thickness was created by the machining and grinding performed on each of R.E. Ginna's CRDM nozzles. The 0.012" total cold work is derived from the most limiting surface conditioning which was 0.006" induced from the machining process on the Outer Diameter and 0.006" which was induced from the drilling process on the Inner Diameter. It may also be conservatively assumed that a minimum amount of 0.024" of material was electropolished. This accounts for a change of 0.012" to the Inner Diameter and 0.012" to the Outer Diameter. Given that the nominal diameter of a Ginna CRDM nozzle is 4", with a nominal thickness of 0.625", the approximate Percentage of the Cold Worked material as compared to the entire thickness was calculated (see Enclosure 1). This calculation shows that the R.E. Ginna CRDM nozzles originally had 2% of their cross sectional area in the cold-worked condition but by electropolishing each CRDM nozzle, all the Cold Work induced by machining was effectively removed prior to nozzle installation. The CRDM nozzle and reactor vessel hole were machined to tight tolerances to achieve the

necessary alignment requirements for functionality. Thus no straightening, which would introduce additional cold work, was applied to any of the CRDM nozzles on the Ginna replacement RVCH. Therefore, prior to welding the CRDM nozzles were considered to have very small amount (< 2%) of cold work present.

The remaining source of cold work is introduced by the welding process. Given the complexity of the CRDM weld configuration this is difficult to determine. The only study known to CENG where this was calculated (by Finite Element methods) was performed under the EPRI Materials Reliability Program (MRP-245, EPRI 1016608), which was published in December 2008. These calculations showed equivalent plastic strain levels up to 1.6% in the Alloy 690 base metal for an outermost CRDM Nozzle location at the ID surface. It is recognized that these calculations were not intended to capture the higher levels of plastic strain at the HAZ adjacent to the J-groove weld on the Nozzle OD that are known to be associated with the remelting of base metal at the fusion line. To mitigate these stresses a smaller J groove weld size was used and all the J groove welds and HAZs received electropolishing after welding.

The Analysis Conclusion (Section 4.1.4) from MRP-245 states: "The calculated plastic strain levels (0.005 to 0.025 *or 0.5% to 2.5%*) are much lower than the bulk cold work levels of 20-30% that resulted in enhanced PWSCC crack growth rates in laboratory specimens. Therefore, it appears that the welding process for partial-penetration J-groove welded nozzles does not result in through-wall macroscopic plastic strain levels in the Alloy 690 base metal material that are sufficiently high to be relevant to the Alloy 690 crack growth rate tests performed using highly cold-worked Alloy 690 plate samples."

Thus, the relatively high crack growth rates observed in testing of Alloy 690 plate material with uniform 20 to 30% cold work throughout the entire cross sectional area as found in NUREG/CR-7103, Volume 2, are not applicable to the installed Ginna Alloy 690 CRDM nozzles which have been mitigated to achieve significantly lower levels of cold work. Consequently, the crack growth rate improvement factor of 100 over Alloy 600 for Alloy 690 materials in the fracture mechanics analyses originally proposed by Ginna in the May 24, 2012 submittal is credible.

References:

BWC-TR-2003-0023 CRDM Reliability Nozzle Report Dated March 4, 2004 Babcock & Wilcox Canada (proprietary)

Ginna Control Rod Drive Mechanism nozzle Certified Material Test Reports

NUREG/CR-7103, Volume 2, "Pacific Northwest National Laboratory Investigation of Stress Corrosion Cracking [SCC] in Nickel-Base Alloys

Materials Reliability Program: Material Production and Component Fabrication and Installation Practices for Alloy 690 Replacement Components in Pressurized Water Reactor Plants (MRP-245) EPRI Report No.: 1016608

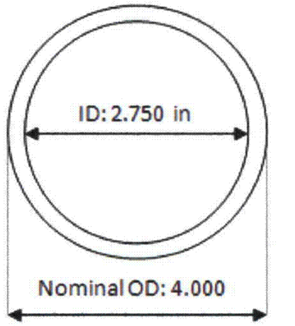
ENCLOSURE 1

Calculation of Initially Cold Worked Area Percentage Removed by Electropolishing

A_i: Initial CRDM Nozzle Cross Sectional Area (including cold worked surfaces)

A_{oi} = Outer Diameter Initial Cross Sectional Area

A_{ii} = Inner Diameter Initial Cross Sectional Area



Nominal Wall Thickness: 0.625 in

$A_{oi} = \pi r^2 = \pi(\frac{4}{2})^2 = 12.57 \text{ in}^2$

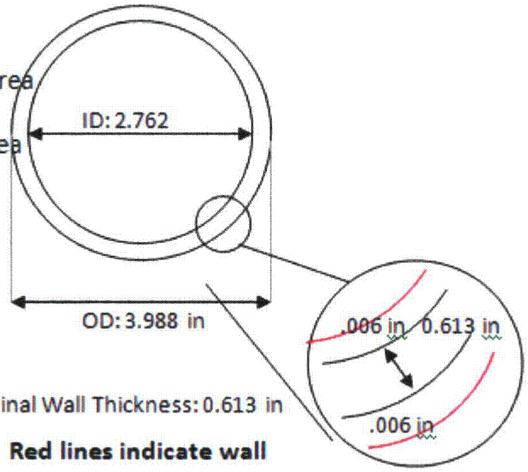
$A_{ii} = \pi r^2 = \pi(\frac{2.75}{2})^2 = 5.94 \text{ in}^2$

$A_i = A_{oi} - A_{ii} = 12.57-5.94 = 6.63 \text{ in}^2$

A_e: Final Cross Sectional Area (after cold worked surfaces removed by electropolishing)

A_{oe} = Outer Diameter Electropolished Cross Sectional Area

A_{ie} = Inner Diameter Electropolished Cross Sectional Area



Red lines indicate wall removed by electropolishing

$A_{oe} = \pi r^2 = \pi(\frac{3.988}{2})^2 = 12.49 \text{ in}^2$

$A_{ie} = \pi r^2 = \pi(\frac{2.762}{2})^2 = 5.99 \text{ in}^2$

$A_e = A_{oe} - A_{ie} = 12.49-5.99 = 6.50 \text{ in}^2$

Percent of Initial Area Cold Worked (subsequently removed by electropolishing)

$\% \text{ Initial Cold Worked Area} = \frac{A_i - A_e}{A_i} = \frac{6.63-6.50}{6.63} = 1.96\%$

RAI-4

Since the May 24, 2012, submittal did not specify the examination frequency, the staff assumed that the examination frequency of ASME Code Case N-729-1 will be followed. Please provide EFPYs operated so far for the Ginna CRDM penetration nozzles and specify the time for the next examination based on (1) whether prior examinations have identified flaws and (2) whether the amount of cold work requested in RAI-3 allows you to consider the plant-specific Alloy 690 material as PWSCC resistant. Please note that if insignificant cold work cannot be demonstrated for the Ginna CRDM penetration nozzles, the nozzles' classification of Item No. B4.40 of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code Code Case N-729-1, "Alternative Examination Requirements for PWR [pressurized water reactor] Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds," may not be justified.

Response:

The Ginna reactor vessel head was replaced during the 2003 refueling outage with alloy 690 improved materials. In compliance with code case N-729-1 B4.40 examination frequency for PWSCC resistant materials Ginna is performing the first in-service head inspection during the Fall 2012 refueling outage. Subsequent examinations to the Fall of 2012 refueling outage will also follow the examination frequency of ASME code case N-729-1. Ginna will have 8.52 effective full power years (EFPY) of operation on the replaced reactor head at the time of the Fall 2012 examination.

Ginna has performed reactor vessel baseline examinations which were performed after hydro testing and prior to operation. The relevant examinations to the CRDM area of interest consisted of ultrasonic and eddy current examinations of the CRDM nozzle and J weld material as well as PT examinations of the J weld. During these baseline examinations no defects were detected. There were ASME code Section XI code acceptable indications recorded from PT examinations as well as manufacturing geometrical indications resulting from the UT examinations. The baseline results will be used to increase non destructive examination personnel knowledge and allow comparison to subsequent in-service examinations.

The response to RAI #3 provides the required basis to credit the Ginna CRDM material and J weld material as PWSCC resistant material.