EPRI | ELECTRIC POWER RESEARCH INSTITUTE

2014-045 BWR Vessel & Internals Project (BWRVIP)

April 3, 2014

Document Control Desk
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Attention: Joseph Holonich

Subject: Project No. 704 – BWRVIP Response to NRC Request for Additional Information on BWRVIP-76, Revision 1

Reference: Letter from Joseph J. Holonich (NRC) to Dennis Madison (BWRVIP Chairman), "Request for Additional Information Regarding Electric Power Research Institute (EPRI) Proprietary Report, "BWRVIP-76, Revision 1: BWR Vessel and Internals Project, BWR Core Shroud Inspection and Evaluation Guidelines" (TAC NO. ME8317)," dated September 11, 2013.

Enclosed are five (5) copies of the BWRVIP proprietary response to the NRC Request for Additional Information (RAI) on the BWRVIP report entitled "BWRVIP-76, Revision 1: BWR Vessel and Internals Project, BWR Core Shroud Inspection and Evaluation Guidelines." The RAI was transmitted to the BWRVIP by the NRC letter referenced above.

Please note that the enclosed response contains proprietary information. A letter requesting that the response be withheld from public disclosure and an affidavit describing the basis for withholding this information are provided as Attachment 1. The response includes yellow shading to indicate the proprietary information. The proprietary information is also marked with the letters "TS" in the margin indicating the information is considered trade secrets in accordance with 10CFR2.390A.

Two (2) copies of a non-proprietary version of the BWRVIP response to the RAI are also enclosed. This non-proprietary response is identical to the enclosed proprietary response except that the proprietary information has been deleted.

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NRR

Additional copies were sent to the PM

If you have any questions on this subject please call Ron DiSabatino (Exelon, BWRVIP Assessment Committee Technical Chairman) at 610.765.5753.

Sincerely,

A. O. McGehee Dennis Madison

Andrew McGehee, EPRI, BWRVIP Program Manager
Dennis Madison, Southern Nuclear, BWRVIP Chairman

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Attachment 1

Kurt Edsinger
Director, PWR &
BWR Materials

April 3, 2014

Document Control Desk
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Request for Withholding of the following Proprietary Information Included in:

"BWRVIP Response to NRC Request for Information (RAI) on BWRVIP-76, Revision 1: BWR Vessel and Internals Project, BWR Core Shroud Inspection and Flaw Evaluation Guidelines,"
EPRI Technical Report 1022843.

To Whom It May Concern:

This is a request under 10 C.F.R. §2.390(a)(4) that the U.S. Nuclear Regulatory Commission ("NRC") withhold from public disclosure the report identified in the enclosed Affidavit consisting of the proprietary information owned by Electric Power Research Institute, Inc. ("EPRI") identified in the attached report. Proprietary and non-proprietary versions of the Response and the Affidavit in support of this request are enclosed.

EPRI desires to disclose the Proprietary Information in confidence to assist the NRC review of the enclosed submittal to the NRC. The Proprietary Information is not to be divulged to anyone outside of the NRC or to any of its contractors, nor shall any copies be made of the Proprietary Information provided herein. EPRI welcomes any discussions and/or questions relating to the information enclosed.

If you have any questions about the legal aspects of this request for withholding, please do not hesitate to contact me at (704) 704-595-2732. Questions on the content of the Report should be directed to Andy McGehee of EPRI at (704) 502-6440.

Sincerely,

/

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

AFFIDAVIT

RE: Request for Withholding of the Following Proprietary Information Included In:

"BWRVIP Response to NRC Request for Information (RAI) on BWRVIP-76, Revision 1: BWR Vessel and Internals Project, BWR Core Shroud Inspection and Flaw Evaluation Guidelines," EPRI Technical Report 1022843.

I, Kurt Edsinger, being duly sworn, depose and state as follows:

I am the Director of PWR and BWR Materials at Electric Power Research Institute, Inc. whose principal office is located at 3420 Hillview Avenue, Palo Alto, CA ("EPRI") and I have been specifically delegated responsibility for the above-listed report that contains EPRI Proprietary Information that is sought under this Affidavit to be withheld "Proprietary Information". I am authorized to apply to the U.S. Nuclear Regulatory Commission ("NRC") for the withholding of the Proprietary Information on behalf of EPRI.

EPRI Information is identified in yellow shading with double square brackets. [[This sentence is an example.]] Tables containing EPRI proprietary information are identified with double square brackets before and after the object. The proprietary information is also marked with the letters "TS" in the margin indicating the information is considered trade secrets in accordance with 10CFR2.390A.

EPRI requests that the Proprietary Information be withheld from the public on the following bases:

Withholding Based Upon Privileged And Confidential Trade Secrets Or Commercial Or Financial Information (see e.g., 10 C.F.R. § 2.390(a)(4)):

a. The Proprietary Information is owned by EPRI and has been held in confidence by EPRI. All entities accepting copies of the Proprietary Information do so subject to written agreements imposing an obligation upon the recipient to maintain the confidentiality of the Proprietary Information. The Proprietary Information is disclosed only to parties who agree, in writing, to preserve the confidentiality thereof.

b. EPRI considers the Proprietary Information contained therein to constitute trade secrets of EPRI. As such, EPRI holds the Information in confidence and disclosure thereof is strictly limited to individuals and entities who have agreed, in writing, to maintain the confidentiality of the Information.

c. The information sought to be withheld is considered to be proprietary for the following reasons. EPRI made a substantial economic investment to develop the Proprietary Information and, by prohibiting public disclosure, EPRI derives an economic benefit in the form of licensing royalties and other additional fees from the confidential nature of the Proprietary Information. If the Proprietary Information were publicly available to consultants and/or other businesses providing services in the electric and/or nuclear power industry, they would be able to use the Proprietary Information for their own commercial benefit and profit and without expending the substantial economic resources required of EPRI to develop the Proprietary Information.

d. EPRI's classification of the Proprietary Information as trade secrets is justified by the Uniform Trade Secrets Act which California adopted in 1984 and a version of which has been adopted by over forty states. The California Uniform Trade Secrets Act, California Civil Code §§3426 – 3426.11, defines a "trade secret" as follows:

"'Trade secret' means information, including a formula, pattern, compilation, program device, method, technique, or process, that:

(1) Derives independent economic value, actual or potential, from not being generally known to the public or to other persons who can obtain economic value from its disclosure or use; and

(2) Is the subject of efforts that are reasonable under the circumstances to maintain its secrecy."

e. The Proprietary Information contained therein are not generally known or available to the public. EPRI developed the Information only after making a determination that the Proprietary Information was not available from public sources. EPRI made a substantial investment of both money and employee hours in the development of the Proprietary Information. EPRI was required to devote these resources and effort to derive the Proprietary Information. As a result of such effort and cost, both in terms of dollars spent and dedicated employee time, the Proprietary Information is highly valuable to EPRI.

f. A public disclosure of the Proprietary Information would be highly likely to cause substantial harm to EPRI's competitive position and the ability of EPRI to license the Proprietary Information both domestically and internationally. The Proprietary Information can only be acquired and/or duplicated by others using an equivalent investment of time and effort.

I have read the foregoing and the matters stated herein are true and correct to the best of my knowledge, information and belief. I make this affidavit under penalty of perjury under the laws of the United States of America and under the laws of the State of California.

Executed at 3420 Hillview Avenue, Palo Alto, CA. being the premises and place of business of Electric Power Research Institute, Inc.

Date: 4/3/2014

Kurt Edsinger

(State of California)

Subscribed and sworn to (or affirmed) before me on this 3rd day of April, 2014 by Kurt Edsinger, proved to me on the basis of satisfactory evidence to be the person(s) who appeared before me.

Signature Berte A Dahl (Seal)

My Commission Expires 20th day of March, 2015

BERTE A. DAHL
COMM. # 1926383
NOTARY PUBLIC - CALIFORNIA
SANTA CLARA COUNTY
MY COMM. EXP. MAR. 20, 2015

Response to NRC Request for Additional Information (RAI) on
BWRVIP-76, Revision 1: BWR Vessel and Internals Project, BWR Core Shroud Inspection and Flaw Evaluation Guidelines

Non-Proprietary Version

BWRVIP Response to NRC Request for Information (RAI) on BWRVIP-76 Revision 1

RAI 1:

The input assumptions and underlying structural analyses documented in Appendix C and used to establish the reinspection intervals in Chapter 2 were based on input assumptions available and appropriate at the time they were performed (circa 1996). Do those input assumptions, particularly those associated with the amount of cracking assumed and the assumed location of the cracking, remain valid today given that more than 15 years of additional inspection and field data are available since the time the analyses were performed?

BWRVIP Response to RAI 1:

The BWRVIP has recently completed a survey of its membership with a focus on collection of core shroud field inspection data. All U.S. BWRs provided inspection data. Evaluation of these data against the input assumptions used in Appendix C of BWRVIP-76 found that not only do these assumptions remain valid, but in many cases they are very conservative and introduce substantial margins to the generic allowable inspection intervals calculated. The limit load and Linear Elastic Fracture Mechanics (LEFM) generic horizontal weld analyses described in Appendix C of BWRVIP-76 are significantly affected by assumptions related to flaw depth, intergranular stress corrosion cracking (IGSCC) crack growth rates (CGRs), and the number and distribution of discrete flaws. For each of these three assumptions, a summary comparison of the assumption against the available field inspection data is provided below.

Flaw Depth:

Analyses in Appendix C of BWRVIP-76 assume all cracking observed is through-wall. The field data shows that this is a very conservative assumption. Review of the UT data provided by U.S. BWRs shows that all average flaw depths reported for horizontal weld heat-affected zones (HAZs) are less than [[ ]] of the shroud thickness and that [[ ]] of the average flaw depths reported are less than one third the shroud thickness (see Figure 1). Further, Figure 2 illustrates the "surface area flawed" (SAF) for the U.S. fleet. SAF is a measure of the average flaw depth times the length of the HAZ reported as flawed and is a measure of the reduction in sectional modulus of the weld due to cracking. As seen in the figure, SAF values for horizontal welds are all less than approximately [[ ]] and for most horizontal welds the SAF is less than [[ ]]. As an example of the margins introduced by assuming that the cracking is through-wall, consider the case where limit load analysis is controlling. For limit load analysis, structural margin is directly proportional to the amount of sound metal remaining. Thus, it can be seen that the additional margin (i.e., conservatism in the calculation) introduced by the through-wall assumption is a factor of [[ ]] or more. **TS** **TS** **TS**

Crack Growth – Depth Direction:

An assumption of through-wall cracking effectively assumes very large crack deepening rates, such that through-thickness cracking occurs in a short time period following crack initiation. In contrast, available field inspection data are consistent with the analytical predictions that crack deepening rates dramatically slow as the crack front (the deepest point of the crack) extends into the shroud thickness [1]. Observed average flaw depths remain [[ ]] of the shroud wall thickness. It is also useful to consider the large structural margins that exist. Even with a relatively high assumed stress of 9 ksi, the average remaining shroud wall thickness needed to maintain structural integrity is less than 0.25-inches, less than 20% of the cross-sectional area for a 1.5-inch thick shroud. Thus, for structural margins to be challenged significant crack growth in the depth direction must be postulated. This occurrence is not predicted by analysis, nor supported by available field inspection data. TS

Crack Growth – Length Direction:

With regard to CGRs, in the length direction, analyses in Appendix C of BWRVIP-76 assume a crack lengthening rate of [[ ]]. BWRVIP-174 Revision 1 [2] documents a recent evaluation of CGRs obtained from the results of repeated UT examination of several shroud welds. These data indicate that, even for welds exposed to NWC conditions, actual crack lengthening rates are often substantially lower [[ ]]. While some individual cracks have been observed to grow at a rate exceeding [[ ]], the majority of cracks grow more slowly. Even for Normal W TS hemistry (NWC), a significant percentage of cracks show no growth and the median crack lengthening rate is less than [[ ]]. Mitigation by Hydrogen Water Chemistry – Medium (HWC-M), Noble Metal Chemical Application (NMCA), or Online Noble Metal Chemistry (OLNC) increases the percentage of cracks showing no growth and results in an additional factor of 2 reduction in crack lengthening rate. These data indicate that an assumption of crack lengthening at [[ ]] is appropriately conservative for weld locations not mitigated by HWC-M, NMCA, or OLNC. However, for mitigated welds, [[ ]] overpredicts crack growth by a factor of 2 or more. TS TS TS TS TS TS

Numbers and Distribution of Discrete Flaws:

The number and distribution of discrete flaws assumed in the analyses can affect both the LEFM and limit load analyses. For limit load, assuming larger numbers of discrete cracks (each with two actively growing crack tips) is conservative since the limit load reinspection intervals are directly related to crack growth. For LEFM analyses, assuming smaller numbers of discrete flaws is conservative. The field data from the BWRVIP survey were evaluated and no cases were identified in which the field data indicated that the crack numbers or distributions assumed in BWRVIP-76 resulted in significant non-conservatism when compared to the observed cracking.

A final noteworthy conservatism is that the inspection intervals in BWRVIP-76 were arbitrarily capped at 10 years. In most cases, the generic analyses described in Appendix C of BWRVIP-76 result in substantially longer intervals.

Based on these data, the BWRVIP concludes that the generic inspection intervals specified in BWRVIP-76 are very conservative, likely by an order of magnitude or more for most cases.

[[

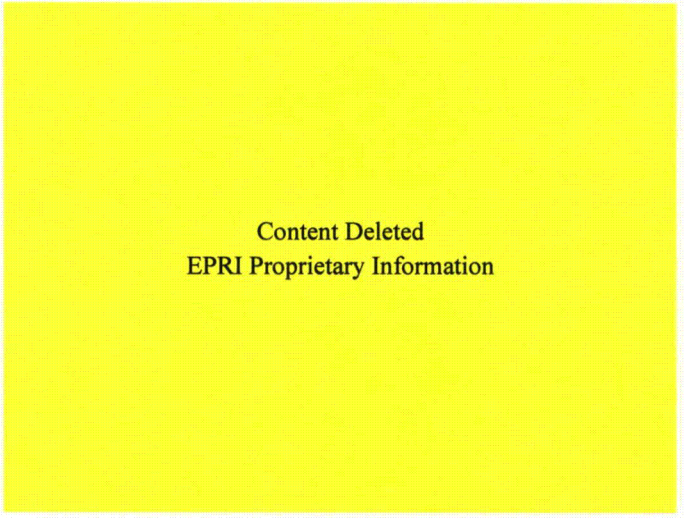

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Figure 1: Horizontal Weld HAZ Cumulative Distribution of Percent Average Flaw Depth

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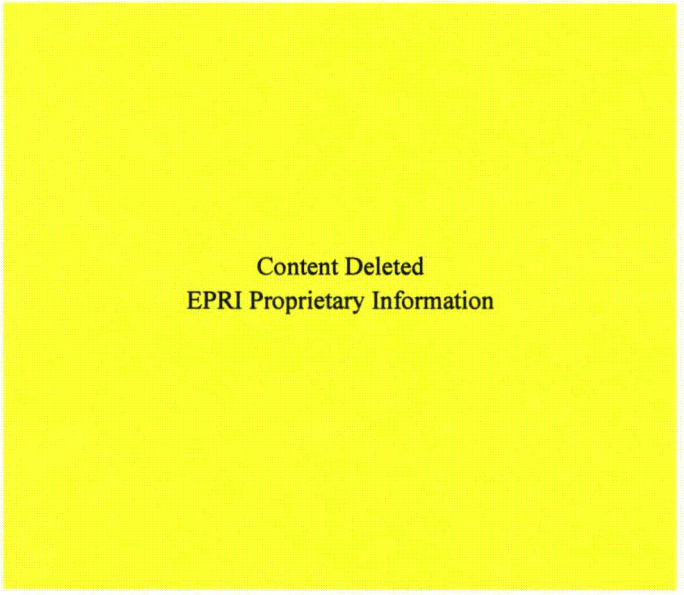

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Figure 2: Horizontal Weld HAZ Percent Flaw Length vs. Percent Average Flaw Depth

References:

[1] "BWRVIP-14-A: BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals," EPRI Report 1016569, September 2008.

[2] "BWRVIP-174, Revision 1: BWR Vessel and Internals Project, Review of BWR Core Shroud UT Re-Inspection Results for Plants Mitigated with NMCA and HWC," EPRI Technical Report 1019062, August 2009.