EPRI | ELECTRIC POWER RESEARCH INSTITUTE

DAVID J. MODEEN
Vice President and
Chief Nuclear Officer
Nuclear

November 2, 2006

Document Control Desk
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Project # 669

Subject: Request for Withholding Proprietary Documentation of Material:

White Paper: MRP Review of Implications of Wolf Creek Pressurizer Indications

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 information identified in the enclosed Affidavit consisting of the proprietary information owned by Electric Power Research Institute, Inc. ("EPRI") and identified above (the "Report"). Copies of the Report and the Affidavit in support of this request are enclosed.

EPRI desires to disclose, in confidence, the Report for informational purposes to assist the NRC. The Report 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 Report 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) 595-2173. Questions on the content of the Report should be directed to Christine King of EPRI at (650) 855-2605.

Sincerely,

ELECTRIC POWER RESEARCH INSTITUTE, INC.

David J. Modeen
Vice President & Chief Nuclear Officer

Encl: Affidavit

CHARLOTTE OFFICE
1300 West W.T. Harris Boulevard, Charlotte, NC 28262-8550 USA • 704.595.2000 • Fax 704.595.2860
Customer Service 800.313.3774 • www.epri.com

AFFIDAVIT

RE: Request for Withholding Proprietary Documentation of Material:

White Paper: MRP Review of Implications of Wolf Creek Pressurizer Indications

I, DAVID J. MODEEN, being duly sworn, depose and state as follows:

I am a Vice President and the Chief Nuclear Officer of Electric Power Research Institute, Inc. whose principal office is located at 3420 Hillview Avenue, Palo Alto, California ("EPRI") and I have been specifically delegated responsibility for the above-listed Report that is sought under this Affidavit to be withheld (the "Report"). I am authorized to apply to the U.S. Nuclear Regulatory Commission ("NRC") for the withholding of the Report on behalf of EPRI.

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

Withholding Based Upon Privileged And Confidential Trade Secrets Or Commercial Or Financial Information:

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

b. EPRI considers the Report and the proprietary information contained therein (the "Proprietary Information") to constitute trade secrets of EPRI. As such, EPRI holds the Report in confidence and disclosure thereof is strictly limited to individuals and entities who have agreed, in writing, to maintain the confidentiality of the Report. EPRI made a substantial economic investment to develop the Report, 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 Report. If the Report and 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 Report for their own commercial benefit and profit and without expending the substantial economic resources required of EPRI to develop the Report.

c. EPRI's classification of the Report and 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."

d. The Report and the Proprietary Information contained therein are not generally known or available to the public. EPRI developed the Report 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 Report. EPRI was required to devote these resources and effort over a period of several years to derive the Proprietary Information and the Report. As a result of such effort and cost, both in terms of dollars spent and dedicated employee time, the Report is highly valuable to EPRI.

e. 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 and Report 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, California being the premises and place of business of Electric Power Research Institute, Inc.

Date 12/13/06

David J. Modeen

State of California

County of Santa Clara } SS.

Subscribed and sworn to (or affirmed) before me this 13th day of December, 20 06, by

David J. Modeen
(Signer)
, personally known to me or proved to me on the basis of

satisfactory evidence to be the person(s) who appeared before me.

YORK HUANG
COMM. # 1598774
NOTARY PUBLIC-CALIFORNIA
SANTA CLARA COUNTY
MY COMM. EXP. JULY 31, 2009

(NOTARY'S SIGNATURE)

Attachment 1
MRP Review of Implications of Wolf Creek Pressurizer Indications
November 2, 2006

Executive Summary
The purpose of this white paper is to summarize the assumptions, analyses, and conclusions reached in the documentation supporting the recommendations provided in MRP-139. Additionally, a preliminary review of the recent pressurizer indications from Wolf Creek has been done to determine if changes should be made to the current MRP-139 inspection recommendations for pressurizer locations. A more detailed review with additional calculations may be completed in the future.

The existence of the indications reported at Wolf Creek is generally consistent with the conclusions of the analyses performed in support of the development of MRP-139. Key points from the analyses completed to support MRP-139 are:

- Circumferential flaws would tend to grow through wall before reaching critical uniform depth and thus self-reveal for visual or leakage detection
- Axial flaws were expected; however, circumferential flaws were predicted and analyzed and the inspection strategy requires inspection for circumferential flaws
- Probabilistic risk assessment supports the inspection frequencies required by MRP-139
- The time available to detect a flaw or leak ranges from 3.2 - 9.2 years for most pressurizer locations.
- Alloy 82/182 have been shown to be very ductile at normal operating temperature and have adequate toughness such that the whole cross-section of pipe becomes plastic prior to failure.
- Since the leak identified on the pressurizer relief at Tsuruga-2 in 2003, subsequent flaws have been identified during non-destructive examinations and had only partially penetrated through wall.
- The presence of multiple flaws in the surge line at Wolf Creek is consistent with analyses completed of locations that have undergone repairs, particularly from the ID surface.
- There is insufficient information to calculate crack growth rates based on the NDE data available since the previous non-PDI inspections may have missed these flaws.

Implementation of MRP-139 for the PZR DM welds by the PWR fleet as reflected in the summary below is proceeding on a schedule driven by the deadline imposed when industry executives approved MRP-139. MRP-139 requires each Alloy 82/182 location either be made inspectable or be mitigated. Relative to pressurizer Alloy 82/182 locations, 96% of the fleet will resolve (either inspect or mitigate) these locations by end of spring 2008 outage season. Specifically, 48% of the fleet will be resolved by end of 2006 and 81% of the fleet by end of 2007.

Summary of Pressurizer Locations and Associated Actions
Bare metal visual inspections of pressurizer DM weld locations have been conducted at all US PWRs. No evidence of leakage has been reported. As shown below, seven units with as-built conditions allowing volumetric inspection of the subject welds have completed those inspections before mitigation. These units range in chronological age (from initial operation) from near the oldest with A82/182 welds in these locations to the youngest unit in the fleet and are fairly well distributed over that range. The remaining units in the fleet require modification of the weld (typically a full structural weld overlay) in order to complete an acceptable PDI examination.

Inspections referenced below are volumetric inspections. Utilities inspecting after December 2007 will file deviations justifying their extension to accommodate outage schedules. The deviations from five (5) plants have been filed with the MRP and reviewed as acceptable in accordance with industry guidance.

69 Operating PWRs in the United States
19 PWRs do not have A82/182 PZR DM welds:

- 15 PWRs have no DM butt welds in their pressurizer
- 4 have replaced their pressurizers

50 PWRs have A82/182 DM welds in the pressurizer

- 14 have inspected volumetrically
  - 7 before mitigation
    - 2 inspected w/o mitigation (plans for mitigation not reported)
    - 2 inspected before mitigation via stress improvement
    - 3 inspected prior to mitigation via structural weld overlay
  - 7 after mitigation
- 35 plan to volumetrically inspect
  - 23 in 2007 after mitigation
  - 10 in spring 2008 after mitigation
  - 2 in fall 2008 after mitigation
    - 1 unit only has A82/182 in the surge nozzle
- 1 unit – still waiting for answer

- Additionally, 15 PWRs have LBB approved on the surge line with A82/182 DM welds
  - 2 have inspected w/o mitigation (an older unit and the youngest unit)
  - 5 will have surge SWOL complete by end of 2006
  - 6 to have SWOL complete by end of 2007
  - 2 to have SWOL complete by end of spring 2008

As shown in the table below, the flaws identified have predominantly been associated with pressurizer locations. Prior to 2003, this degradation was typically found via leakage. Beginning with the TMI surge line indication, the indications have been identified via non-destructive examination prior to through-wall penetration

Summary of Field Experience Through Spring 2006

Year Detected	Plant Name	Alloy 82/182 Location	Crack/Leak
1993	Palisades	Pzr PORV	Leak
1999	Ringhals 3	RV Hot Leg	Cracks
2000	Ringhals 4	RV Hot Leg	Crack
2000	Summer	RV Hot Leg	Leak & Cracks
2003	Tsuruga 2	Pzr Safety	Leak & Cracks
2003	TMI 1	Surge Line (HL end)	Crack
2004	Calvert Cliffs 2	Hot Leg & Cold Leg Drain Lines	Crack
2005	DC Cook 1	Pzr safety	Crack
2006	San Onofre 2	Pzr Spare & Pzr Safety	Cracks in 2 nozzles
2006	Davis Besse	Cold Leg drain	Crack
2006	Calvert Cliffs 1	Surge line weld at hot leg Hot leg drain Pzr Relief Valve	Cracks, including circumferential

Summary of Wolf Creek Indications

Nozzle	Reported Length (in.)[2]	Reported Depth (a/t)[2]	Aspect Ratio	Nom ID (in.)[3]	Nom. Wall (in.)[1]	Nom. Depth (in.)	Arc Length (deg)[4]	Last Inspection (non-PDI)
Relief	11.5	26%	21:1	5.71	1.4	0.36	155	Fall 2000
Safety C	3.75	23%	8:1	5.71	1.4	0.32	50	Fall 2000
Surge (1)	5.0	31%	9:1	11.88	1.45	0.45	39	Spring 1993
Surge (2)	2.75	25%	5:1	11.88	1.45	0.35	21	Spring 1993
Surge (3)	1.0	10%	2:1	11.88	1.45	0.14	8	Spring 1993
Total Surge	8.75						68	

1 – Nominal Wall taken from WC summary of prior UT exams dated 10/22/06
2 – Represent the length on the OD, Sizing estimates taken from "Results of UT Examination of Pressurizer Nozzle Butt welds at Wolf Creek Generating Station"
3 – From MRP-109, Actuals used in analysis, text boxes Figures 5-19 and 5-13
4 – Arc length is based on projecting flaw to ID surface.

The NDE methods used at Wolf Creek during this outage did not provide a profile of the flaws found. The depths reported above are the maximum depth; however, it is not expected that this depth exists across the entire crack face. Previous inspections may not have been successful in finding these flaws because the crack front did not exceed the NDE threshold for detection.

It should be noted that Wolf Creek reviewed fabrication history for each nozzle and reported the evidence of significant repairs on the surge and relief nozzles. Repairs were not documented for the C Safety nozzle. Given the typical ID of the relief and safety nozzles and the typical methods available for repairs during construction, it is unlikely that the nozzles would have experienced ID repairs.

MRP-139 Supporting Calculations

To analyze the safety significance of postulated flaws in Alloy 82/182 butt welds, MRP completed various deterministic calculations which included: critical flaw size, time to through wall leak or 75% through wall, and time between a 1 GPM leak and failure. Additionally, MRP evaluated the impact of various repair scenarios on the expected flaw initiation and growth.

As shown in the table below, only one of the Wolf Creek indications (Relief Nozzle) exceeds the critical circ flaw length for a through wall flaw. However, that indication was only 1/4 through-wall. All of the Wolf Creek indications are substantially below the critical depth for full circumference part-depth flaws. The aspect ratios for three of the five flaws at Wolf Creek exceed the maximum value (6:1) used in MRP Safety Assessment calculations.

Critical Flaw Size Assessment Summary Comparison[1]

Location	NSSS	Plant	ID OD (in.)[2]	Critical TW Circ Flaw Length (deg)	Critical 360° Part Depth a/t Ratio	Wolf Creek Flaw Indications: Length (deg)	Wolf Creek Flaw Indications: Depth a/t Ratio
PZR Surge line	W	F	EPRI PROPRIETARY MATERIAL			39 21 8	31% 25% 10%
	CE	K					
	B & W	C					
PZR Spray	W	H					---
	CE	R					
	B & W	A					
PZR Safety / Relief	W	E				R-155 S- 50	R- 26% S- 23%
	W	I				R-155 S- 50	R- 26% S- 23%
	CE	N					
	CE	P					
	B & W	A					

For all the Alloy 82/182 butt welds in PWRs, the results show that the pressurizer nozzles have the shortest predicted time for a crack to grow through-wall (or 75% through-wall) and the shortest time for a flaw that produces a 1 gpm leak to grow to critical flaw size. [EPRI PROPRIETARY MATERIAL][3]

[1] Extracted from Table 6-1, MRP-113
[2] Extracted exact ID/OD dimensions from MRP-109, text boxes in Figures in Section 5
[3] MRP-113, Section 6.3.1, page 6-5

Table 6-1 (Excerpt from MRP-113)
Crack Growth Analysis of Part-Circumferential Through-Wall Flaws: Westinghouse and CE Design Plants: Based on MRP-21 Crack Growth Rates

Location	NSSS	Plant	Time to Through-Wall 6:1 Aspect Ratio (years)	Time from 1 GPM to Critical Flaw Size (years)	Total Time
PZR - Surge Line	W	F	[EPRI PROPRIETARY MATERIAL]		
	CE	N			
PZR - Spray	W	H			
	CE	R			
PZR - Safety/Relief	W	I			
	CE	N			
	CE	P			

Table 6-2 (Excerpt from MRP-113)
Crack Growth Analysis of Part-Circumferential Through-Wall Flaws: Babcock & Wilcox Design Plants: Based on MRP-21 Crack Growth Rates

Location	NSSS	Plant	Time from Initiation to 75% Through-Wall (years)	Time from 1 GPM to Critical Flaw Size (years)	Total Time
PZR - Surge Line	B&W	C	[EPRI PROPRIETARY MATERIAL]		
PZR – Spray	B&W	A			
PZR – Relief	B&W	A			

(1) [EPRI PROPRIETARY MATERIAL]

Impact of using MRP-115 CGR (Without Stress Intensity Factor Threshold) instead of MRP-21 (MRP-113, Section 6.3.2)

MRP-115 crack growth rates do not include a stress intensity factor threshold and once finalized were evaluated for impact on the results of the butt weld analyses. [EPRI PROPRIETARY MATERIAL]

Effect of Repairs on Alloy 82/182 Butt Welds

Analyses of the final residual stress state of a well-performed thick-walled butt weld without weld repairs indicate that a generally favorable through wall stress profile would result with compressive stresses near the ID surface. Such conditions would tend to prevent PWSCC initiation and favor crack arrest if local initiation did occur. However, any repairs to the inside surface or deep part-circumferential repairs to the outside surface can result in through thickness welding residual and operating stress distributions capable of producing through-wall axial cracks and circumferential cracking. The focus of further analysis was on repairs completed on the ID Surface.[4]

- [EPRI PROPRIETARY MATERIAL]
- [EPRI PROPRIETARY MATERIAL]
- [EPRI PROPRIETARY MATERIAL]
    - [EPRI PROPRIETARY MATERIAL]
- [EPRI PROPRIETARY MATERIAL][5]

Therefore, stress conditions are more likely to support the initiation and propagation of circumferential flaws where ID and possibly deep localized OD repairs occurred during fabrication. Due to their small inner diameter, ID repairs are unlikely for the spray, safety, and relief nozzles.

[EPRI PROPRIETARY MATERIAL]

Based on this discussion, the presence of postulated multiple initiation sites for PWSCC in Alloy 600 weld metals was considered and does not result in an added safety concern. Since through-wall crack growth should dominate, it is expected that such behavior would lead to detectable leakage. [6]

Conclusions regarding MRP-139 Baseline Inspection Frequency

Based on the analysis completed, the MRP determined the appropriate augmented inspection frequency for 82/182 welds.

Total time to failure = Time (Initiation to Initial Flaw Size) [Set to zero] + Time (Initial Flaw Size to TW or 75% TW) + Time (TW Leak or 75% TW to 1 GPM) [Did not include in tabulated results] + Time (1 GPM to Critical)

Conservatively, the time available to detect a flaw or leak ranges from 3.2 -9.2 years for the governing plants, for most pressurizer locations. This is consistent with the baseline inspection schedule for pressurizers. There are 3 exceptions:

- [EPRI PROPRIETARY MATERIAL]

[4] MRP-114, Section 3.2
[5] MRP-113, Section 6.4.5
[6] MRP-113, Section 6.5.3

- [EPRI PROPRIETARY MATERIAL]
- [EPRI PROPRIETARY MATERIAL]

Repairs will likely have the largest impact on initiation times (i.e. significant repairs may cause cracks to initiate earlier in life than unrepaired locations). However, since the initiation time to initial flaw size was originally set to zero for inspection frequency evaluation, this impact of repairs has already been accounted for and there is no impact on MRP-139 recommendations. MRP focused the industry's attention on the pressurizer locations first due to the significance of the higher temperature and therefore higher probability to PWSCC initiation.

While the Wolf Creek surge line flaws have not been specifically evaluated, the multiple locations on the surge line seem to be consistent with our knowledge of flaw initiation and propagation in the presence of ID and some forms of OD repairs. If the flaws are allowed to continue to grow, it is expected that these flaws would go through wall and leak in sufficient time for appropriate corrective action to be taken. Thus, the leak before break analysis and method are still considered technically valid.

Therefore, the existence of the indications reported at Wolf Creek is generally consistent with the conclusions of the extensive analyses performed in support of the development of MRP-139. Although it is not possible to know the size and location of the limiting PZR DM butt weld flaw in the fleet due to inspection limitations until the current round of mitigation and baseline volumetric exams is complete (planned by Spring 2008 for nearly all plants), the regular BMV inspections being performed of these locations provide confidence that leaks won't go undetected. The evaluation above demonstrates to a reasonable degree of confidence that the most limiting, undetected flaw would tend to grow through wall before reaching critical uniform depth and thus reveal itself for visual or leakage detection. Therefore, the current baseline inspection regime being implemented by the PWR fleet does support safe operation of the fleet and will result in substantial reduction in risk of future PZR DM butt weld cracking due to the widespread implementation of mitigative strategies (weld overlays and stress improvement).