Niagara Mohawk

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April 28, 2000
NMP2L 1961

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

RE: Nine Mile Point Unit 2
Docket No. 50-410
NPF-69

Subject: ***Core Shroud Reinspection Results (TAC No. MA7284)***

Gentlemen:

By letter dated October 15, 1998, the NRC forwarded its safety evaluation concerning the results of the Nine Mile Point Unit 2 (NMP2) ultrasonic inspection of core shroud welds during the 1998 refueling outage (RFO6). The safety evaluation concluded that continued plant operation, without repair or intermediate inspection of the NMP2 core shroud, was acceptable for at least one operating cycle after RFO6. The NRC letter mentioned that Niagara Mohawk Power Corporation (NMPC) would be submitting the NMP2 core shroud reinspection plan for the next refueling outage (RFO7) at least three months before performing the reinspection and that the results of the reinspection would be submitted within 30 days of its completion.

By letter dated December 2, 1999, NMPC submitted the core shroud reinspection plan for RFO7, which occurred in March-April 2000. As outlined in that reinspection plan, only welds H4 and H5 were required to be reinspected during RFO7. This reinspection was performed using the General Electric (GE) OD Tracker on all accessible areas of the welds.

Attachment 1 to this letter provides the reinspection results. These results demonstrate that the average crack growth in welds H4 and H5 is well within the predicted growth range. Attachment 2 provides a summary of the evaluation performed using crack evaluation guidelines in BWRVIP-01 to justify the continued operation of NMP2. These evaluations demonstrated that

- Based on a bounding crack growth rate of $5X10^{-5}$ inch/hour, weld H4 is acceptable for at least one cycle of operation after RFO7.

- Based on a crack growth rate of $2.2X10^{-5}$ inch/hour, as allowed by BWRVIP-14, weld H5 is acceptable for at least three cycles of operation after RFO7.

NMPC is currently evaluating BWRVIP-76 (BWR Core Shroud Inspection and Flaw Evaluation Guidelines) for treatment of high fluence regions, uninspected regions, etc. and BWRVIP-62 (Technical Basis for Inspection Relief for BWR Internal Components with Hydrogen Injection) for

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potential credit for providing Nobel Chem/Hydrogen Water Chemistry protection and the resulting "factor of improvement" (FOI) for the welds. Noble Chem/Hydrogen Water Chemistry protection is expected to be provided from Fall 2000 onward. A preliminary evaluation, based on BWRVIP-76 and BWRVIP-62 requirements, indicates that it may be possible to demonstrate acceptability of weld H4 for two cycles of operation (until RFO9) without requiring reinspection in RFO8. NMPC recognizes that BWRVIP-76 is presently under review by the NRC. Accordingly, NMPC will submit a reinspection plan for weld H4 at least six months prior to RFO8.

Very truly yours,

Richard B. Abbott

Richard B. Abbott
Vice President Nuclear Engineering

RBA/IAA/tmk
Attachments

xc: Mr. H. J. Miller, NRC Regional Administrator, Region I
Ms. M. K. Gamberoni, Acting Section Chief PD-I, Section 1, NRR
Mr. G. K. Hunegs, NRC Senior Resident Inspector
Mr. P. S. Tam, Senior Project Manager, NRR
Records Management

ATTACHMENT 1

Core Shroud Weld Scan Coverage and Inspection Results

Attachment 1

Core Shroud Weld Scan Coverage and Inspection Results

The reinspection of welds H4 and H5 was conducted in accordance with the Boiling Water Reactor (BWR) Vessel and Internals Project Shroud Inspection Guidelines, BWRVIP-01 and BWRVIP-03. The Micro Tomo ™ data acquisition system, in conjunction with the GE OD Tracker remote scanner and a GE Tri-modal search unit, was used to conduct the examinations. The Tri-Modal search unit consisted of a 45^0 shear wave, a dual-element 60^0 longitudinal wave and dual-element OD/ID creeping wave transducers. The TomoView™ workstation was used for evaluation of ultrasonic data.

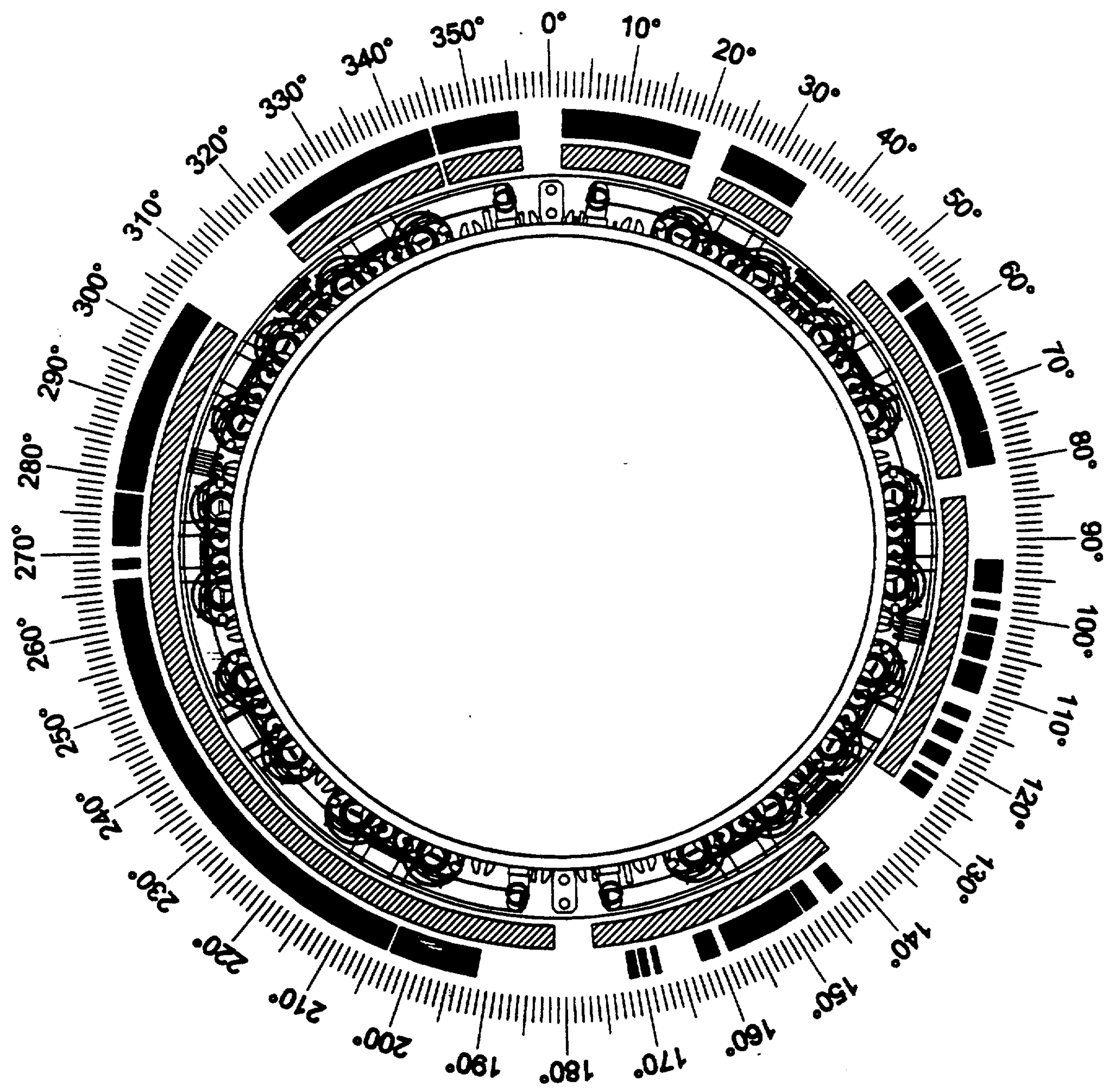
The table below presents a summary of the inspections performed in RFO7. Pages 2 and 3 of Attachment 1 provide the scan coverage for welds H4 and H5, respectively.

Weld No.	% of Weld Length Examined	% of Examined Length that is Flawed (See Note 1)	Maximum Depth of Flaw (inches)		Average Crack growth in Cycle 7 (inches)
			RFO6*	RFO7**	
H4	82.6	30.2 lower 75.0 upper	0.65	0.78	<0.1
H5	84.2	10.8 lower 46.2 upper	0.65	0.66	<0.1

Note 1: Lower and upper designations refer to flaws detected on lower and upper side of the welds.

* Refueling outage number 6
** Refueling outage number 7

Nine Mile Point -2
Shroud Weld H4
Scan Coverage

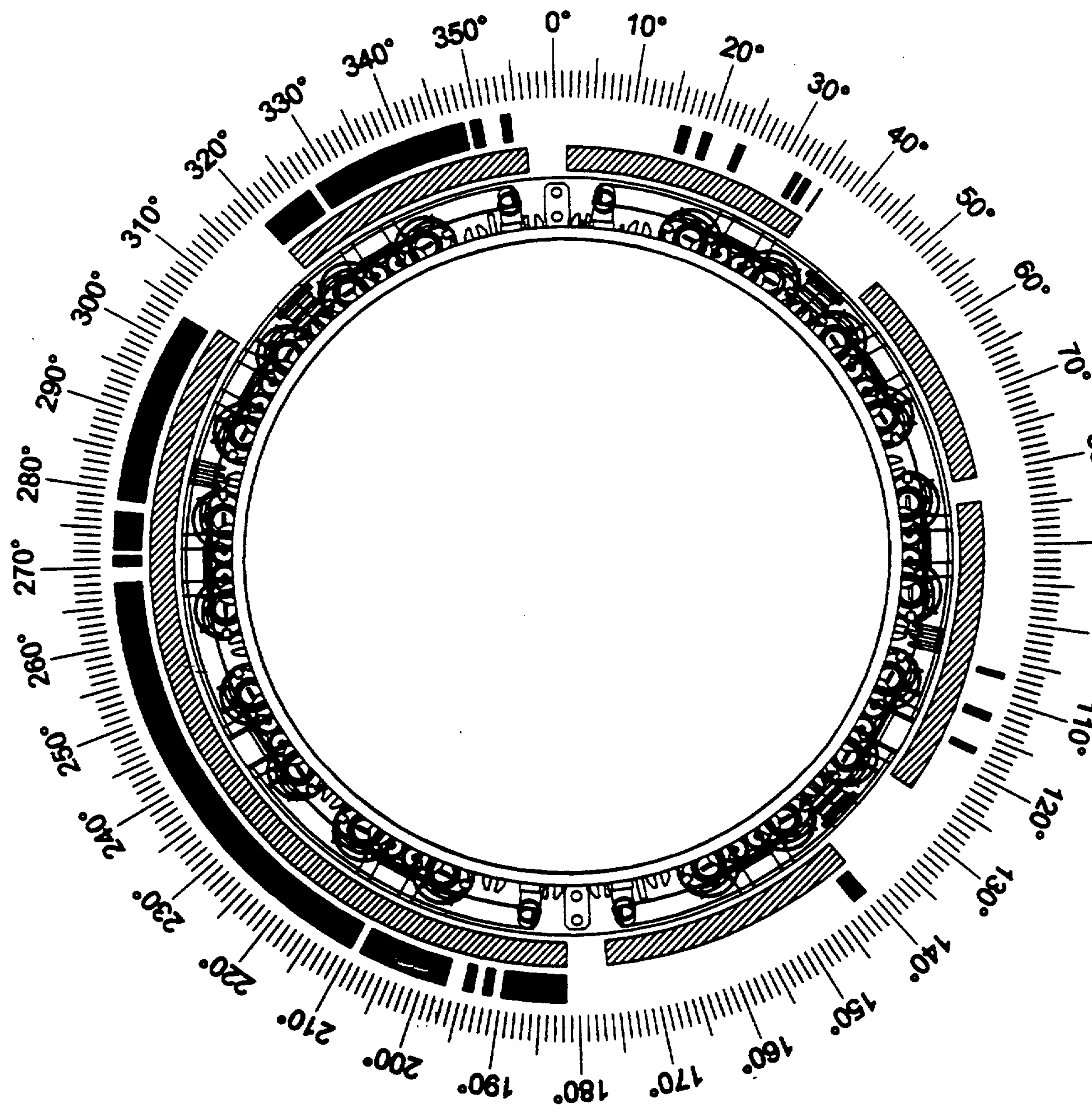


Area Covered By All Three Transducer Elements.

Areas With Indications.

T. Davis
File: NMP2001_1.DWG
March 16, 2000

Nine Mile Point -2
Shroud Weld H5
Scan Coverage



Area Covered By All Three Transducer Elements.

Areas With Indications.

T. Davis
File: NMP2001_1.DWG
March 16, 2000

ATTACHMENT 2

Structural Assessment of Shroud Welds H4 and H5 Based on RF07 Inspection Results

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Structural Assessment of Shroud Welds H4 and H5 Based on RF07 Inspection Results

1.0 BACKGROUND

Several indications were identified during inspection of the Nine Mile Point Unit 2 (NMP2) core shroud in refueling outage number 6 (RF06). As a result of the inspections, cracking (>10 percent of inspected length) was observed in horizontal welds H4 and H5. The indications were evaluated per General Electric (GE) Report GENE-B13-01920-63 (Reference 1) and the NMP2 shroud was found acceptable for continued plant operation for at least one cycle following RF06. This evaluation used a bounding crack growth rate of $5.0x10^{-5}$ inch/hour. Later, a detailed shroud neutron transport and uncertainty analysis indicated that at the end of cycle 8, the peak fluence for weld H4 would be $6.06x10^{20}$ neutrons/cm^2 (n/cm^2) and for weld H5 would be $1.4x10^{20}$ n/cm^2. When projected to the end of cycle 10, the fluence for weld H5 would be approximately $2.0x10^{20}$ n/cm^2. Reinspection of the H4 and H5 welds has been completed during refueling outage number 7 (RF07). The results of this inspection are documented in Attachment 1. This attachment (Attachment 2) provides the results of the structural assessment performed for welds H4 and H5 using RF07 inspection data.

2.0 ASSUMPTIONS/APPROACHES

A number of assumptions and approaches were used in the structural assessment of welds H4 and H5. These are described below:

1. The fluence prediction for weld H4 is documented in Reference 2. The predicted fluence will be above the Linear Elastic Fracture Mechanics (LEFM) threshold of $3.0x10^{20}$ n/cm^2 when projected to the end of cycle 8. Therefore, both LEFM and Limit Load evaluations were performed for this weld.

   For weld H5, Reference 2 predicted a fluence of $1.4x10^{20}$ n/cm^2 at the end of cycle 8. When projected to the end of cycle 10, the predicted fluence for weld H5 is approximately $2.0x10^{20}$ n/cm^2. This is well below the LEFM threshold of $3.0x10^{20}$ n/cm^2. Therefore, no LEFM evaluation is required for this weld.

2.0 ASSUMPTIONS/APPROACHES (Cont'd)

2. Due to fluence considerations, a bounding crack growth rate of 5.0×10^{-5} in/hr was used for weld H4 in both length and depth directions. For weld H5, fluence values when projected to the end of cycle 10 are low. Therefore, the evaluation was performed using a crack growth rate of 2.2×10^{-5} in/hr in depth and 5.0×10^{-5} in/hr in length as allowed by BWRVIP-14 (Reference 7). The BWRVIP-14 crack growth rate of 2.2×10^{-5} in/hr is applicable for fluences < 5.0×10^{20} n/cm^2 (E>1MeV) and corresponds to water chemistries with a conductivity of ≤ 0.15 microsiemens/cm^2 and an electro-chemical potential (ECP) of +200 mV.

3. Based on a conservative 24-month operating cycle and 95% availability factor, 16,000 hours of operation were assumed for one cycle.

4. For evaluation purposes, the nominally reported indication lengths calculated from the start and the end azimuthal values were increased by 0.364 inches at each end to account for length uncertainty. Additionally, these crack lengths were increased appropriately (either 0.5 degrees or 0.25% of measured flaw length, depending on whether multiple or single scan placement was used). These length evaluation factors conform to BWRVIP-03, Revision 2 (Reference 3).

5. An ultrasonic (UT) measurement uncertainty of 0.108 inches was used for crack depth per BWRVIP-03, Revision 2.

6. All uninspected weld lengths have been assumed to be cracked through-wall. Due to the amount of weld length scanned, and considering that the deepest flaw found at any weld was 0.78 inches of a 2.00 inch thick shroud, this assumption is considered very conservative. Thus, additional UT uncertainty and crack growth prediction were not added to the uninspected areas.

7. Neighboring flaws which experienced tip interaction effects were combined.

3.0 ANALYTICAL METHODOLOGY

The methodology used in this analysis is consistent with BWRVIP-01 (Reference 4) LEFM and Limit Load methodology. The dynamic loads used in the analysis were combined using a "square root of the sum of the squares" (SRSS) approach per Reference 5. The calculated membrane and bending stresses for normal/upset and emergency/faulted operating conditions are summarized in Table 3-1. The inspection data used in the analysis were taken from the RF07 OD Tracker UT data for welds H4 and H5.

3.0 ANALYTICAL METHODOLOGY (Cont'd)

For shroud welds H4 and H5, the RF06 analysis (Reference 1) was based on a conservative estimation of fluence greater than $3.0\text{x}10^{20}$ n/cm^2. A detailed shroud neutron transport and uncertainty analysis per Reference 2 indicates that at the end of cycle 8 the peak fluence for weld H4 will be $6.06\text{x}10^{20}$ n/cm^2, and that for weld H5 will be $1.4\text{x}10^{20}$ n/cm^2. When projected to the end of cycle 10, the fluence for weld H5 will be approximately $2.0\text{x}10^{20}$ n/cm^2. This is below the LEFM threshold of $3.0\text{x}10^{20}$ n/cm^2. Therefore, no LEFM evaluation for weld H5 is required. For weld H4, since fluence at the end of cycle 8 is projected to be greater than $3.0\text{x}10^{20}$ n/cm^2, both a Limit Load and LEFM evaluation is required.

Table 3-1 Membrane and Bending Stresses for Normal/Upset and Emergency/Faulted Conditions

Weld Number	Pressure Axial Stress (ksi)		Bending Moment Stress (ksi)	
	Upset	Faulted	Upset	Faulted
H4	0.32	0.71	1.19	1.85
H5	0.32	0.71	2.03	3.15

4.0 ANALYTICAL RESULTS

WELD H4

Using the assumptions listed in Section 2.0, the weld H4 LEFM and Limit Load analyses were performed using the Distributed Ligament Length (DLL) flaw evaluation program (Reference 6). The normal and upset stresses were found to be limiting. The stresses were calculated to be 328 psi (membrane) and 1190 psi (bending).

The LEFM evaluation was performed using a conservative compound crack approach similar to that in Section 4.4.1 of Reference 1. The LEFM evaluation used an average crack depth of 0.58 inches. Crack depth was averaged over the measured flawed lengths and each individual flawed segment depth was set equal to the peak UT depth for that segment. This averaged depth was increased by 0.908 inches (to account for crack growth during cycle 8 operation and for UT uncertainty) to arrive at the predicted flaw depth at the end of cycle 8. It should be noted that BWRVIP-01 (Reference 4) and BWRVIP-07 (Reference 8) do not provide specific guidance regarding the averaging technique. The averaging technique described above is conservative relative to the averaging technique described in BWRVIP-76 (Reference 9).

4.0 ANALYTICAL RESULTS (Cont'd)

The LEFM and Limit Load safety factors for weld H4 were determined to be 3.01 and 8.58, respectively, compared to the normal and upset allowable of 2.77. The calculated and required safety factors are shown in Table 4-1. Therefore, the cracking at weld H4 is acceptable for at least one cycle following RF07, using the crack growth assumptions listed in Section 2.0.

<u>WELD H5</u>

Using the assumptions listed in Section 2.0, the H5 limit load analysis was performed using the DLL flaw evaluation program. The normal and upset stresses were found to be limiting. The dynamic loads used in the analysis were combined using an SRSS approach. The stresses were calculated to be 328 psi (membrane) and 2030 psi (bending).

The Limit Load case was evaluated assuming three cycles of operation and a crack growth rate of $2.2x10^{-5}$ in/hr in depth. The Limit Load safety factor was determined to be 5.11, compared to the normal and upset allowable of 2.77. The calculated and required safety factors are shown in Table 4-1. Therefore, the cracking at weld H5 is acceptable for at least three additional operating cycles, using the crack growth assumptions listed in Section 2.0.

Table 4-1 Structural Margin Evaluation Results

Weld Number	Limit Load Safety Factors (SF)		LEFM Safety Factors (SF)	
	Calculated SF	Minimum Required SF*	Calculated SF For Compound Flaw	Minimum Required SF*
H4**	8.58	2.77	3.01	2.77
H5***	5.11	2.77	--	2.77

* Corresponds to normal and upset condition
** Based on one cycle of operation
*** Based on three cycles of operation

5.0 CONCLUSIONS:

The LEFM and Limit Load analysis performed for weld H4 indicates that the cracking is acceptable for at least one cycle of operation following RF07.

The Limit Load analysis performed for weld H5 indicates that the cracking is acceptable for at least three cycles of operation following RFO7.

6.0 REFERENCES:

1. Evaluation of Nine Mile Point Unit 2 Shroud cracking for at least one fuel cycle of operation following RF06, GE Report GENE-B13-01920-63, Revision 2.

2. Nine Mile Point Unit 2 Shroud Neutron Transport and Uncertainty Analysis, Report Number MPM-200623, dated February, 2000.

3. BWRVIP-03, Revision 2, "BWRVIP Vessel and Internals Project: Reactor Pressure Vessel and Internals Examination Guidelines", EPRI Report No. TR-105696, December 1999.

4. BWRVIP-01, Revision 2, "BWR Vessel and Internals Project, BWR Core Shroud Inspection and Flaw Evaluation Guidelines", EPRI Report No. TR-107079, October 1996.

5. Nine Mile Point Unit 2 NSSS New Loads Design Adequacy Evaluation Final Summary Report, GE document NEDC-31145, February 1986.

6. BWR Core Shroud Distributed Ligament Length Computer Program (Version 2.1), BWRVIP-20, December 1996.

7. BWRVIP-14, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals", EPRI Report No. TR-105873, March 1996.

8. BWRVIP-07, "BWR Vessel and Internals Project, Guidelines for Reinspection of BWR Core Shrouds," EPRI Report No. TR-105747, February 1996.

9. BWRVIP-76, "BWR Vessel and Internals Project, BWR Core Shroud Inspection and Flaw Evaluation Guidelines", EPRI Report No. TR-114232, November 1999.