

ENCLOSURE 1

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
NRC GENERIC LETTER 94-03,
"INTERGRANULAR STRESS CORROSION CRACKING OF
CORE SHROUDS IN BOILING WATER REACTORS"

UNIT 2 CORE SHROUD REINSPECTION RESULTS
B212R1 REFUELING OUTAGE

ENGINEERING SERVICE REQUEST (ESR) 54 - REVISION 0
EVALUATE RESULTS OF UNIT 2 CORE SHROUD B212R1 INSPECTIONS

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Form 1				ENGINEERING SERVICE REQUEST	
ESR # 9600154	Rev # 0	WR/JO #	Other Documents (ACR, FACTS, etc.) OTHER -GL94-03		
Plant/Unit BNP 2	Primary System # 1005	Primary System Name B21,B11-NUCLEAR BOILER (INC.RX VESSEL &		<input type="checkbox"/> Multiple Systems Affected	
Title EVALUATE RESULTS OF U2 CORE SHROUD B212R1 INSPECTIONS			Originator/Phone GORE, PHILLIP S /850-2318		
Problem/Proposed Solution/Justification Evaluate the results of the Unit 2 Core Shroud inspections performed during the B212R1 outage. This evaluation is needed to support the startup of Unit 2.					
DUE DATE 03-08-96			<input type="checkbox"/> Continued		
SCREENING					
Quality Class A Safety-Related	Is a 10CFR 50.59 Safety Review required per (plant specific procedure)? <input checked="" type="checkbox"/> Yes (See attached safety evaluation for signatures) <input type="checkbox"/> No (Concurrence of two QSRs required below) <input type="checkbox"/> N/A (Engineering Reply ESR)			Response Type EVAL Other	
1st QSR: _____ Date: _____			2nd QSR: _____ Date: _____		
Engineering Disciplines (Print Name, Sign, Date)			Engineering/Plant Programs (Print Name, Sign, Date)		
Mechanical <u>Philip Gore 3/8/96</u> System Eng <u>Philip Gore 3/8/96</u> System Eng _____ System Eng _____			RECEIVED BY BNP MAR 09 1996 NUCLEAR DOCUMENT CONTROL		
B N P RECIPIENT ID 003 CONTROLLED					

Form 1

ENGINEERING SERVICE REQUEST

ESR #

9600154

Rev #

0

Title

EVALUATE RESULTS OF U2 CORE SHROUD B212R1 INSPECTIONS

Plant Customers (Print Name, Sign, Date)

Specialty Reviews

Design Verification

C. Mallner
 [Signature] 3/8/96
 By Design Review

- ☐ NAS Before Approval/Implementation
☐ NAS Before Closeout
☐ PNSC Before Approval/Implementation
☐ NRC Before Implementation

Reference: _____

Reference: _____

Reference: _____

Problem Resolution:

BNP2 shroud can safely operate in the present condition for a least one fuel cycle without any operational changes or restrictions.

See attached evaluation.

☐ Continued

APPROVAL

Is this a modification which constitutes a reduction in design margin?

- ☐ Yes (PGM approval is required)
☒ No (Engineering Mgr signs for PGM)

Interim Approval Required?

☐ Yes ☐ No ☒ N/A

Responsible Engineer JOHN W, JR VOSS

Responsible Manager (Print Name, Sign, Date)

Plant General Manager (Print Name, Sign, Date)

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Attachments

A Letter from Carolina Power and Light Company to the U.S.Nuclear Regulatory Commission "Submittal of Unit 2 Core Shroud Reinspection Plans" dated November 2, 1995	8 pages
B Analysis Outputs	30 pages
C EPRI Crack Growth Assessment	5 pages

1.0 PURPOSE

This ESR Evaluation is required as part of Carolina Power and Light Company's commitment to USNRC Generic Letter 94-03 *"Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors"*. As such, this evaluation provides the following:

- Documentation of the inspections performed on the Core Shroud during B212R1.
- A basis for the continued use of the BNP2 Core Shroud for at least one additional operating cycle in the as-found condition without any operational changes or restrictions. This is accomplished by a review of the core shroud structural capacity to the criteria established by the BWRVIP (references 4.6, 4.7) and approved by the Nuclear Regulatory Commission.
- A basis for the determination of future shroud inspections.

2.0 CONCLUSIONS

- BNP2 shroud can safely operate in the present condition for at least one fuel cycle without any operational changes or restrictions.
- All reported cracking is typical IGSCC located in the heat affected zone of the welds.

3.0 BACKGROUND

In October, 1990, RICSIL 054 reported cracking near the circumferential seam weld at the core beltline area of the shroud in a GE BWR/4 located outside the United States. Based on recommendations contained in RICSIL 054, the BNP Unit 2 shroud was inspected during the 1991 refueling outage. No cracks were identified. The Unit 1 shroud was inspected in July, 1993, and a near 360° circumferential crack was confirmed on the inside diameter of the Top Guide Support Ring, at the weld to the shroud mid-section. The tapes of the Unit 2 shroud IVVI were re-examined based on the early July Unit 1 findings. Three small indications were noted. Unit 2 tapes were again examined in late September, based on lessons learned on Unit 1. One additional small indication was noted. Although this additional indication was bounded by the assumptions in the original evaluation, it was recognized that the quality of the 1991 tapes was insufficient to identify all of the types of cracks being confirmed on Unit 1. Engineering evaluation EER 93-0536 was issued to assess Unit 1 shroud structural integrity and to justify continued operation of Unit 2 until a detailed inspection could be performed during the Spring, 1994 RFO (B211R1).

The Unit 2 B211R1 shroud inspections were evaluated in engineering evaluation EER 94-0077. The evaluation concluded that structural integrity of the core shroud would be maintained, with full FSAR safety margins, for at least the next 600 days of hot operation, and for welds H1, H4, and H5, for at least 1200 days of hot operation based on analysis of the inspection results. Additionally, welds H2 and H3 were permanently repaired during B211R1 by the installation of a series of brackets about the outside circumference of the shroud.

The B212R1 inspection scope was submitted to the NRC on November 2, 1995 and is included in this report as Attachment A.

Details concerning the shroud design and fabrication can be found in reference 4.3.

4.0 DESIGN BASIS/INPUTS - REFERENCES

- 4.1 U.S. Nuclear Regulatory Commission Generic Letter, GL 94-03 *"Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors"* dated July 25, 1994
- 4.2 U.S. Nuclear Regulatory Commission Letter to Mr. R. A. Anderson of Carolina Power and Light Company dated January 3, 1995 *"Generic Letter 94-03, Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors, Brunswick Steam Electric Plant, Units 1 and 2 (TAC NOS. M90084 and M90085)"* including Enclosure 1 *"Safety Evaluation for Unit 1"* and Enclosure 2 *"Safety Evaluation for Unit 2"*
- 4.3 Engineering Evaluation Report, EER 94-0077, *"Evaluation of Unit 2 Core Shroud Indications and Operability Assessment."* Revision 0 dated 06/04/94
- 4.4 Engineering Evaluation Report, EER 93-0536, *"Evaluation of Unit 1 Core Shroud Indications and Operability Assessment of Unit 1 and 2"* Revision 2 dated 03/13/94
- 4.5 Engineering Service Request, ESR 95-00765, *"Unit 1 Core Shroud Reinspection Evaluation"* Revision 1 dated 05/15/95
- 4.6 GE Nuclear Energy document GE-NE-523-113-0894, *"BWR Core Shroud Inspection and Flaw Evaluation Guidelines"* Revision 1 dated March 1995
- 4.7 GE Nuclear Energy document GE-NE-523-113-0894 Supplement 1, *"BWR Core Shroud Distributed Ligament Length Computer Program"* dated September 1994
- 4.8 BWRVIP Inspection Committee document *"Reactor Pressure Vessel and Internals - Examination Guidelines (BWRVIP-03)"* TR-105696 dated September 1995
- 4.9 Structural Integrity Associates document RAM-94-092/SIR-94-029, *"Addendum to the Brunswick Unit 1 Screening Criteria"*, dated April 6, 1994.
- 4.10 CP&L Brunswick Nuclear Plant - Plant Operating Manual - Volume X - Period Test - OPT-90.1, *"In-Vessel Visual Examinations"*, Rev 15, dated 2/06/96
- 4.11 U.S. Nuclear Regulatory Commission Letter to Mr. J.T. Beckham, Chairman BWRVIP, dated June 16, 1995 *"Evaluation of BWR Core Shroud Inspection and Evaluation Guidelines, GENE-523-113-0894, Revision 1, dated March 1995, and BWRVIP Core Shroud NDE Uncertainty & Procedure Standard, dated November 22, 1994"*
- 4.12 GE Document GENE-B11-00682-1 Revision 1 *"Brunswick Nuclear Plant - Unit 2 - Shroud Examination Plan"* dated 2/2/96
- 4.13 Supplement 1 Report to PT90.1 - GE BNP B212R1 Inspection Summary dated February 1996

5.0 INSPECTION SUMMARY

A copy of the CP&L B212R1 shroud inspection plan which was submitted to the U.S. Nuclear Regulatory Commission is included in this report as Attachment A. Table 5.1 provides the B212R1 shroud inspection summary.

Table 5.1 - B212R1 Shroud Inspection Summary				
Weld ID	Inspection Method	% of Weld Length Examined	% of Examined Weld Length Flawed	Comment
H1	Ultrasonic	30.9 Upper 83.3 Lower	2.7 32.1	The 30.9% represents 100% of the readily accessible area. Access was limited due to the lugs and core spray downcomer piping. For the upper portion of the weld, three (3) indications were reported ranging in length from 0.99" to 2.00" and ranging in depth from 0.22" to 0.27". For the lower portion of the weld, thirty-seven (37) indications were reported ranging in length from 0.99" to 12.98" and ranging in depth from 0.05" to 0.56". See Reference 4.12 for the weld specific scan plan and Reference 4.13 for the GE examination summary sheets.
H2	No inspection performed	n/a	n/a	Shroud weld H2 has been permanently repaired by the addition of bolted clamps during B211R1.
H3	No inspection performed	n/a	n/a	Shroud weld H3 has been permanently repaired by the addition of bolted clamps during B211R1.
H4	Ultrasonic	see comment	see comment	Two (2) sections, which were previously examined in B211R1 and partially cracked, were inspected to assess crack depth growth. See Table 6.1 for B211R1 weld inspection summary and reference 4.3 for detailed results. Results indicated no detectable growth within the uncertainty band of the UT measurements. This is consistent with industry data on similar indications, and confirmed with EPRI developed crack growth predictor models, using actual BNP water chemistry data. (See Attachment C)
H5	No inspection performed	n/a	n/a	See Table 6.1 for B211R1 weld inspection summary and reference 4.3 for detailed results.

Table 5.1 - B212R1 Shroud Inspection Summary

Weld ID	Inspection Method	% of Weld Length Examined	% of Examined Weld Length Flawed	Comment
H6a	Ultrasonic	79.0	5.3	Eight (8) indications were reported ranging in length from 1.87" to 4.71" and ranging in depth from 0.08" to 0.27". See Reference 4.12 for the weld specific scan plan and Reference 4.13 for the GE examination summary sheets.
H6b	Ultrasonic	78.4	69.6	Thirty-nine (39) indications were reported ranging in length from 1.56" to 29.74" and ranging in depth from 0.02" to 0.77". See Reference 4.12 for the weld specific scan plan and Reference 4.13 for the GE examination summary sheets.
H7	Ultrasonic	75.6	10.9	Fifteen (15) indications were reported ranging in length from 1.49" to 5.24" and ranging in depth from 0.06" to 0.52". All indications were located above the weld in the stainless steel material. See Reference 4.12 for the weld specific scan plan and Reference 4.13 for the GE examination summary sheets.
H8	No inspection performed	n/a	n/a	BWRVIP developing inspection tools/techniques.
H9	Ultrasonic	≈ 98	0	Weld H9 data obtained during inspection of RPV Beltline "K" weld.
Shroud Support Legs	No inspection performed	n/a	n/a	BWRVIP developing inspection tools/techniques.
Clamps	VT-1 VT-3	n/a	n/a	4 clamps inspected, no anomalies reported.

Other Inspection Indications

During the B212R1 Core Spray inspections, a branched crack like indication was discovered adjacent to a Core Spray sparger support bracket to shroud weld. The bracket is located at 92½° azimuth and is the center support bracket between the two sparger arms. The indication branches into two legs. One leg of the indication is estimated at 1 inch in length and runs in the horizontal direction. The other leg of the indication is estimated at 1¼ inches in length and runs in the vertical direction. Based on the inspection information, this

crack most probably originated in a fabrication weld that was subsequently removed. Such cracking is typically expected to be shallow. BWRVIP document GENE-523-113-0894, Rev. 1, *BWR Core Shroud Inspection and Flaw Evaluation Guidelines* states "There are other welds and welded components attached to the shroud such as.....attachment welds for core spray piping". For other welded shroud attachments, the welded region is small enough that even if **through-wall** SCC were to develop, the safety consequences due to leakage from the core region into the shroud annulus region would be considerably less significant than the scenarios evaluated for circumferential welds. There would be no significant safety concerns resulting from cracking of these welds for any operating condition given that the structural margins of the circumferential welds are maintained." Therefore, this indication is considered bounded and no further analysis is required. This item has also been documented in ESR 96-00151.

6.0 STRUCTURAL EVALUATION SUMMARY

Core Shroud Evaluation Conservatisms

- *Assumed all areas uninspected are fully cracked through-wall and no credit was taken in analysis for these areas.*
- *Assumed all areas previously inspected by VT, one side only are fully cracked through wall and no credit was taken in the analysis for these areas.*
- *Used ASME Safety Factors in lieu of UFSAR Safety Factors in analysis.*

The analyses contained in this engineering evaluation used ASME Section XI safety factors. The ASME safety factors are 2.77 for normal operation (Level A) and upset (Level B) conditions and 1.39 for faulted (Level D) conditions. BSEP Updated FSAR specifies safety factors of 2.25 for normal/upset conditions and 1.125 for faulted conditions.
- *Used 5×10^{-5} in/hr crack growth rate in lieu of measured or predicted BNP crack growth rates.*

Inspection results from the Unit 1 H5 weld showed no measurable crack growth. Similar results were expected for the crack growth for the Unit 2 welds. Additionally, a weld specific crack growth analysis was performed by EPRI by applying the BWRVIP crack growth model to the BNP data for welds H4 (B211R1 data) and H6b (B212R1 data). The EPRI predicted crack growth rates varied from 4.84×10^{-6} in/hr for a shallow crack to $< 3.18 \times 10^{-9}$ in/hr for deeper flaws. Results of the reinspection of the H4 weld indicated that there was no measurable crack growth.
- *Used maximum depths for reported flaws for entire length of flaw in lieu of actual depths vs. length (profile) of flaws.*
- *UT consistently oversized the reported length on all flaws*
- *Assumed 600 days of operation for last cycle and next 2 cycles for all welds except H5.*
- *Assumed 100% capacity factor for analysis*
- *Did not take credit for fillet welds in the analysis*
- *Applied UT uncertainty for depth on all flaws where specific depth limit load analysis was run.*
- *Applied UT uncertainty for length as required.*
- *Grew crack lengths for 2 cycles to take credit for 1 additional cycle of operation.*

Safety Factors

The analyses contained in this engineering evaluation used safety factors consistent with Section XI of the ASME Code. For loadings during normal operation (Level A) and upset (Level B) conditions, the ASME Code recommended factor of safety of 2.77 was used. For faulted (Level D) conditions, a factor of safety of 1.39 was used. Section 3.9.5 "Reactor Pressure Vessel Internals" of the BSEP Updated FSAR specifies safety factors of 2.25 for normal/upset conditions and 1.125 for faulted conditions. **The ASME factors of safety used**

in this evaluation are conservative and provide for higher structural safety margins than established in the BSEP Updated FSAR.

Crack Growth

The B212R1 inspection plan specified ultrasonic inspection of two (2) known cracked sections of the H4 weld for which crack depth data was obtained during B211R1. This was done for the explicit purpose of assessing crack depth growth in the weld HAZ. Weld H4 was chosen since it has the highest neutron fluence (see Section 7.0) and relatively high ECP with marginal influence from hydrogen. Little, if any, change in depth was expected based on current understandings of weld residual stress and water chemistry influences on crack growth rates. Figure 1 provides a graphical representation of the comparison of the B212R1 data (south side) with the B211R1 data from the same location. A review of the B212R1 and B211R1 data (north and south sides) shows a maximum change in crack depth of 0.09". The crack depth measurements for the H4 weld were based on depth sizing uncertainties ranging from ± 0.1 " (B211R1) to ± 0.106 " (B212R1). The maximum depth delta of 0.09" between the two outages is well within the uncertainty band of the inspection equipment. A weld specific crack growth analysis was performed by EPRI (see Attachment C) by applying the BWRVIP crack growth model to the BNP data for welds H4 (B211R1 data) and H6b (B212R1 data). The tables below provide a summary of the information. Based on the inspection data and crack growth rate analyses, the EPRI predicted crack growth rates are 1 to 4 orders of magnitude less than the bounding rate assumed in the analysis.

EPRI Crack Growth Rate Estimates for H6b ID

Initial Maximum Depth	Crack Growth Rate (in/hr)
0.10	4.84E-06
0.26	3.88E-06
0.60	3.18E-09

See Attachment C for additional details concerning the EPRI Crack Growth Rate Analysis

EPRI Crack Growth Rate Estimates for H4 ID

Initial Maximum Depth	Crack Growth Rate (in/hr)
0.50	3.9E-06
0.58	6.3E-08
0.72	0
0.79	0
0.75	0
0.86	0

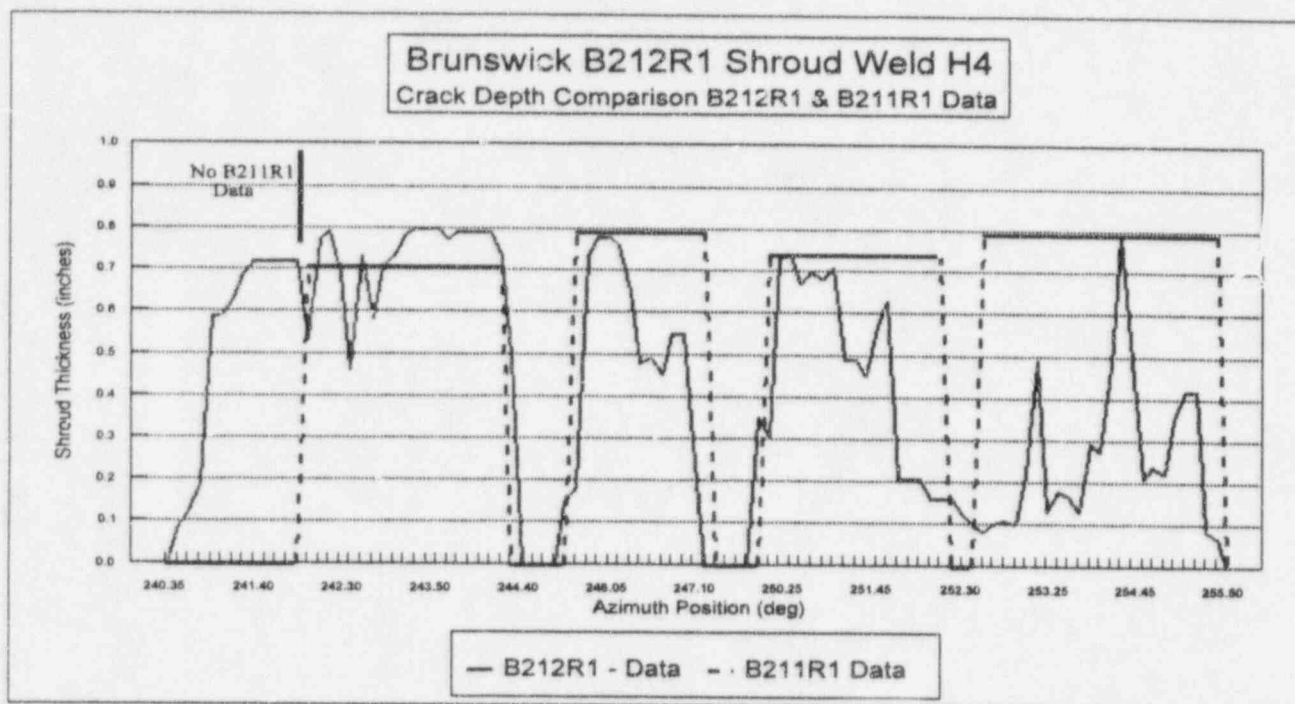


Figure 1

Welds H4 and H5

Generic Letter 94-03 (reference 4.1) baseline inspections were performed for welds H4 and H5 during B211R1 for 100% of the accessible weld areas with the primary inspection tooling. Little cracking was found in these welds during the B211R1 inspections (see Table 6.1). Structural integrity for these welds was demonstrated (reference 4.3) for 1200 days (fuel cycles 11 and 12). Based on this, welds H4 and H5 were not scheduled for reinspection during B212R1 with the exception for weld H4 to assess crack growth depth as previously stated.

Table 6.1 - B211R1 - H4 and H5 Inspection Results

Weld ID	Inspection Method	% of Weld Length Examined	% of Examined Weld Length Flawed	Comment
H4	Ultrasonic	78.0	26.1	Data from reference 4.3
H5	VT-1	92.8 - ID 30.6 - OD	13.6 - ID 6.8 - OD	Data from reference 4.3

The data used for the structural evaluation of the welds were taken from the inspections performed during B211R1. Table 6.1 shows the B211R1 inspection results. These welds were qualified by the ligament length method assuming all uninspected and partially cracked regions were fully cracked and using a crack growth rate of 5×10^{-5} in /hr.

Weld H4 was qualified for a total of 1800 days starting from the beginning of fuel cycle 11. Weld H5 was qualified for a total of 1400 days starting from the beginning of fuel cycle 11. **The only ligaments used in the analysis of weld H5 were those which were visually inspected from both sides (ID and OD).** As a result of this conservatism, the structural evaluation is based on 30.6% of the total circumferential length. A review of the data shows a significant portion (72.5%) of the ID is unflawed, however no additional ligament credit was taken. Additionally, a generic fuel cycle length of 600 days is used in this evaluation. Actual cycle 11 length was 581 days and the projected cycle lengths for cycles 12 and 13 are 550 days and 559 days respectively. The sum of these operating cycle days is 1690 days assuming a 100% capacity factor. Taking credit for the safety factor conservatism (ASME/BSEP UFSAR) would give a life cycle run time for weld H5 of 1723 days. Based on this and the conclusions drawn in the crack growth discussions, it is concluded that the structural evaluation for weld H5 meets the recommended 2 cycles of crack growth and provides for the required structural margin for continued unit operation for a least one additional fuel cycle. If more realistic crack growth rates (as measured on both Units 1 and 2) were used, significant additionally structural margin would be demonstrated.

B212R1 Shroud Weld Evaluation Flow Chart

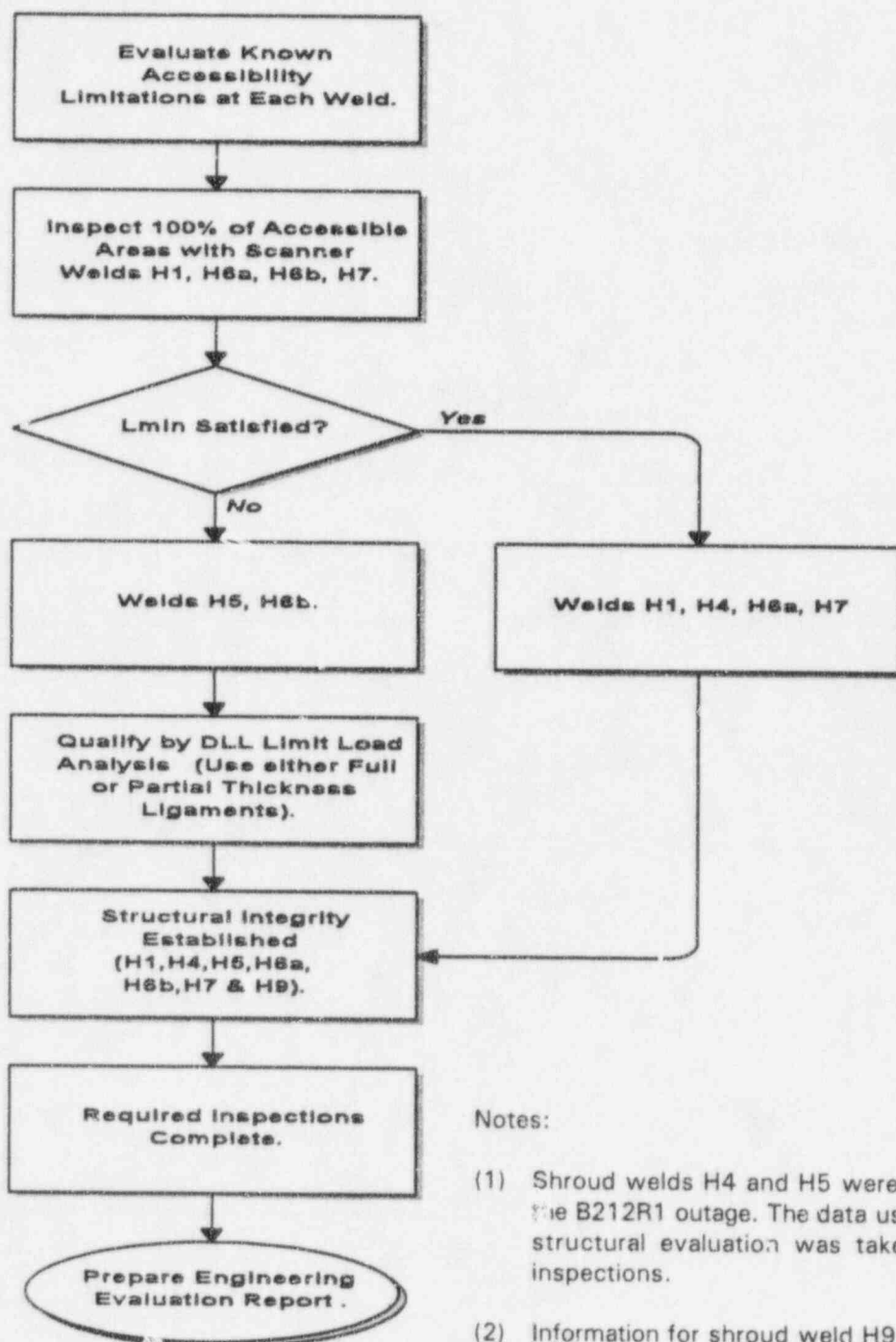


Figure 2

Full Thickness Ligament Evaluation Methodology (Welds H1, H4, H5, H6a, H6b, H7)

Step 1 - Collect Information

The full thickness ligament data was extracted from the verified GE inspection summary sheets and input into a Lotus 123 spreadsheet. All uninspected regions as well as partial thickness ligaments were assumed fully cracked. The following spreadsheet variables were also input for each weld location evaluated:

Variable	Comment
Shroud thickness (tn)	1.50" (No credit taken for any fillet welds)
Shroud outside diameter	189.5"; H1 177.5"; H4, H5, H6a, H6b 171.0"; H7
Crack Growth Rate	5×10^{-5} in/hr
Total Inspection Uncertainty	Reference 4.8. See spreadsheets (Attachment B) and/or Shroud Weld Evaluation Summary (Table 6.4) for specific values used.
Evaluation Period (1 fuel cycle assumed to be 600 days)	Used 2 cycles of crack growth
Lcalc (for Normal/Upset and Faulted)	Reference 4.9. See Attachment B spreadsheet outputs for values

From this information, the spreadsheet calculated the weld L_{min} value, the total full thickness ligament length at the end of the evaluation period and the full thickness ligament starting and stopping azimuths. Crack growth, inspection uncertainty and crack proximity were considered in the determination of the end of evaluation period full thickness ligament length.

Step 2 - Determine if Limit Load Analysis Required

The total full thickness ligament length at the end of the evaluation period (L_{eoe}) was compared to L_{min} . If L_{eoe} was greater than L_{min} , then the weld was considered structurally qualified for continued service for at least one fuel cycle. If L_{eoe} was less than L_{min} , then a detailed limit load analysis using the DLL computer program (reference 4.7) was performed.

Step 3 - Perform DLL analysis

End of evaluation period full thickness ligament data was input into the DLL computer program along with other required variables. See the DLL computer run outputs contain in Attachment B. Shroud stress values were obtained from reference 4.5.

Step 4 - Determine if Weld Structurally Qualified

If the required ASME safety margins were met, the weld was considered structurally qualified for continued service for at least one fuel cycle. If the required ASME safety margins were not met, then the process (Steps 1 - 4) was repeated with iteration on evaluation period down to 600 days for welds H1, H6a, H6b and H7 and 1200 days for welds H4 and H5. If a weld could not be structurally qualified by the full thickness ligament length method for the specified minimum evaluation period, then the partial thickness ligament analysis method was used.

Partial Thickness Ligament Evaluation Methodology (Weld H6b)

Step 1 - Collect Information

The partial thickness ligament depth data was extracted from the verified GE inspection summary sheets and input into a Lotus 123 spreadsheet. All uninspected regions were assumed fully cracked. The spreadsheet calculated the new ligament thickness at the end of the evaluation period (600 days). Additionally, the partial thickness ligament starting and stopping azimuths were calculated. Crack growth (5×10^{-5}) and inspection uncertainty (0.106") were considered in the determination of the end of evaluation period ligament depth.

Step 2 - Perform DLL analysis

End of evaluation period partial thickness ligament depth data was input into the DLL computer program along with the other required variables. See the DLL computer run output for weld H6b. Shroud stress values were obtained from reference 4.5.

Step 3 - Determine if Weld Structurally Qualified

If the required safety margins were met, the weld was considered structurally qualified for continued service for at least one fuel cycle.

**Shroud Circumferential Weld
Structural Evaluation - Safety Factors**

Table 6.2 - Safety Factors at End of Fuel Cycle 12 (600 days)

Normal/Upset			Faulted	
Weld ID	Calculated Safety Factor	ASME Safety Factor	Calculated Safety Factor	ASME Safety Factor
H1	54.58	2.77	26.10	1.39
H4	17.37	2.77	9.69	1.39
H5	3.23	2.77	2.37	1.39
H6a	31.48	2.77	18.98	1.39
H6b	5.99	2.77	3.65	1.39
H7	17.24	2.77	10.30	1.39

Table 6.3 - Safety Factors at End of Evaluation Period

Normal/Upset			Faulted	
Weld ID (evaluation period)	Calculated Safety Factor	ASME Safety Factor	Calculated Safety Factor	ASME Safety Factor
H1	27.29	2.77	13.05	1.39
H4	11.58	2.77	6.46	1.39
H5	2.77	2.77	2.03	1.39
H6a	15.74	2.77	9.49	1.39
H6b	5.99	2.77	3.65	1.39
H7	8.62	2.77	5.15	1.39

Table 6.4 - Evaluation Summary - Shroud Circumferential Welds

Weld ID	Evaluation Percentage ⁽¹⁾	Inspection ⁽²⁾ Uncertainty (in)	Evaluation Period (days)	Evaluation Method	Analysis Summary/Results
H1	30.9%U 83.3%L	0.0 (length)	1200	$L_{min}^{(4)}$ Satisfied	<ul style="list-style-type: none"> Acceptable for Continued Operation Weld H1 is not a safety significant weld. All cracks assumed through-wall Uninspected regions assumed fully cracked Based on conservative evaluations that were performed on the deepest flaw found from the upper and lower examination, the safety factors based on the upper data were greater than 3 times those for the lower data, therefore the lower exam data was used for the structural analysis.
H4	78.0%	0.372 (length)	1800 ⁽³⁾	$L_{min}^{(4)}$ Satisfied	<ul style="list-style-type: none"> Acceptable for Continued Operation UT inspection data from B211R1 All cracks assumed through-wall Uninspected regions assumed fully cracked
H5	30.6%	1.16 (length)	1400 ⁽³⁾ (1723)	Limit Load Analysis	<ul style="list-style-type: none"> Acceptable for Continued Operation Ligament data based on 2-sided visual examination. One sided visual inspection data assumed fully cracked All cracks assumed through-wall Uninspected regions assumed fully cracked
H6a	79.0%	0.0 (length)	1200	$L_{min}^{(4)}$ Satisfied	<ul style="list-style-type: none"> Acceptable for Continued Operation All cracks assumed through-wall Uninspected regions assumed fully cracked
H6b	78.4%	0.106 (depth)	600 ⁽⁵⁾	Limit Load Analysis	<ul style="list-style-type: none"> Acceptable for Continued Operation Partial ligaments analyzed
H7	75.6%	0.0 (length)	1200	$L_{min}^{(4)}$ Satisfied	<ul style="list-style-type: none"> Acceptable for Continued Operation All cracks assumed through-wall Uninspected regions assumed fully cracked
H9	≈ 98%	<ul style="list-style-type: none"> No indications requiring engineering evaluation were reported. No analysis required for weld H9 			

See next page for notes

Notes to Tables 6.4

- (1) Evaluation Percentage = The percentage of total weld circumference on which the structural evaluation is based. Remaining percentage is assumed fully cracked. For welds H1, H4, H6a, H6b and H7, the remaining percentage is the uninspected percentage. For weld H5, the remaining percentage is the sum of the single side VT inspection + uninspected regions.
- (2) Inspection uncertainty from reference 4.8. (Welds H1, H6a, H6b, H7 ; UT Demo 16; Scan Type 2A; Surface = ID/Near; Length transducer = 45° Shear; Depth transducer = 60° Longitudinal). Weld H6b was structurally qualified by taking credit for partial ligament thicknesses, therefore the uncertainty was applied to the depth measurements where partial ligament credit was taken.
- (3) Circumferential shroud welds H4 and H5 were not inspected during the B212R1 outage (2 sections of H4 were reinspected for crack depth growth during B212R1). The inspection data from the B211R1 outage was used in the structural evaluation. Per the guidelines given in reference 4.6, two (2) cycles of crack growth are used in the calculations to qualify the shroud weld for the next fuel cycle. In this evaluation, 600 days was used as the length of 1 fuel cycle. Since the data is from the B211R1 outage, 1800 days is used in the qualification calculation for H4 (600 days from B211R1 to B212R1 + 1200 days from B212R1 to B213R1). Based on this criteria and the weld inspection data from B211R1, weld H5 could only be qualified by the full thickness ligament method for a maximum run time of 1400 days (600 days from B211R1 to B212R1 + 800 days from B212R1 to B213R1). Actual run time over this period is projected as 1690 days. Taking credit for the safety factor conservatism (ASME/BSEP UFSAR) would give an evaluation period of 1723 days for weld H5 .
- (4) L_{min} = Minimum required ligament length for limit load single ligament analysis + (2 x Crack Growth for Evaluation Period) + Inspection Uncertainty. Since L_{min} at the end of the evaluation period is satisfied ($L_{eoe} > L_{min}$) a detailed limit load analysis is not required to show structural acceptance. A limit load analysis was performed for these welds in order to determine the safety factors used in this report.
- (5) Circumferential shroud weld H6b was analyzed using partial ligament thickness. Measured thickness data was reduced to account for growth and uncertainty. The crack growth calculation used a run time of 600 days (1 fuel cycle). Actual projected length for fuel cycle 12 is 550 days.

7.0 SHROUD FLUENCE SUMMARY

Based on current industry evaluation guidelines, in order to ensure structural integrity, a linear elastic fracture mechanics analysis (LEFM) must be performed when the total neutron fluence accumulation at any shroud circumferential weld reaches 3×10^{20} n/cm², E > 1MeV. **No BNP2 shroud weld will reach the fluence threshold level (3×10^{20} n/cm², E > 1MeV) for LEFM analysis during the next fuel cycle.** The only welds expected to reach this threshold level during the current operating license of BNP2 are H4 and H5. The following table gives the projected neutron fluence levels for each shroud weld at the end of the next fuel cycle (600 days). These projections are based on the flux data from reference 4.4.

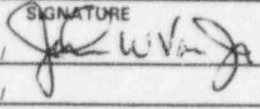

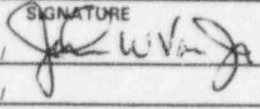

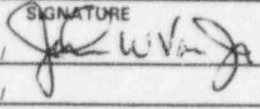

Weld ID	Neutron Fluence (n/cm ²) End of Fuel Cycle 12	Flux Rate (n/cm ² yr)
H1	1.3E+18	1.00E+17
H4	2.9E+20	2.30E+19
H5	1.6E+20	1.24E+19
H6a	9.3E+18	7.41E+17
H6b	8.8E+18	7.00E+17
H7	1.3E+18	1.00E+17

Note: Flux rates taken at weld ID.

8.0 SAFETY ANALYSIS

ATTACHMENT B Guideline for 10 CFR 50.59 Safety Evaluations

ATTACHMENT 1 10 CFR 50.59 Safety Evaluation Screen

ACTIVITY NO.	REV.																									
<p>1. DOES THE ACTIVITY REQUIRE A CHANGE TO THE OPERATING LICENSE OR TECHNICAL SPECIFICATION? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO</p> <p>Basis: ESR 96-00154 is an engineering evaluation report which documents the structural qualification of the Core Shroud based on the inspections performed during the B212R1 outage. No physical plant modifications or operational restrictions are required as a result of this ESR. Therefore, this ESR does not require a change to the operating license or technical specification.</p> <p>Note: If Yes, and the scope of the activity is limited to a Technical Specification/Operating Licensing change, then complete Section #6 of this form, and process per plant procedure. If the scope of the activity is not limited to a Tech. Spec. or OL change, in addition to processing a Tech. Spec. or OL change request, continue the screening process. If No, continue the screening process.</p>																										
<p>2. IS THE ACTIVITY <u>FULLY</u> BOUNDED BY A PREVIOUSLY PERFORMED 10 CFR 50.59 SAFETY EVALUATION? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Evaluation No. The most recent 10CFR 50.59 Safety Evaluation is contained in EER-940077. The previous plant specific evaluations were referenced to one fuel cycle. The conclusions from ESR 96-00154 show that the required UFSAR safety margins are maintained for at least one additional fuel cycle (cycle 12). Therefore the previous safety evaluations are considered bounding. Additionally, a generic safety assessment of shroud weld failures was provided by the BWROG in 1994 "BWR Shroud Cracking Generic Safety Assessment", GENE-523-A107P-0794, Revision 1, August 1994. A BNP plant specific assessment was provided in response to Generic Letter 94-03.</p> <p>Note: If Yes, attach a copy or provide document number for retrieval capability of the previously performed 10 CFR 50.59 Safety Evaluation and complete Section 6 of this form. If No, continue the screening process.</p>																										
<p>3. DOES THE ACTIVITY MAKE CHANGES TO THE FACILITY AS DESCRIBED IN THE SAR? <input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Basis:</p> <p>List SAR Items/Sections reviewed:</p>																										
<p>4. DOES THE ACTIVITY MAKE CHANGES TO PROCEDURES AS DESCRIBED IN THE SAR? <input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Basis:</p> <p>List SAR Items/Sections reviewed:</p>																										
<p>5. DOES THE ACTIVITY INVOLVE A TEST OR EXPERIMENT NOT DESCRIBED IN THE SAR? <input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Basis:</p> <p>List SAR Items/Sections reviewed:</p>																										
<p>NOTE: If any question 3 through 5 is answered YES, then mark Section #6 Not Applicable (N/A) and complete Unreviewed Safety Question Determination, otherwise complete Section #6.</p>																										
<table border="0"><thead><tr><th>6.</th><th>DISCIPLINE</th><th>PRINT NAME</th><th>SIGNATURE</th><th>Date:</th></tr></thead><tbody><tr><td>1st QSR:</td><td>Structural</td><td>John W. Voss, Jr</td><td></td><td>3/8/96</td></tr><tr><td>Other QSR:</td><td></td><td></td><td></td><td></td></tr><tr><td>Other QSR:</td><td></td><td></td><td></td><td></td></tr><tr><td>2nd QSR:</td><td>Mechanical</td><td>C. Muller</td><td></td><td>3/8/96</td></tr></tbody></table> <p>Attach additional sheets if needed.</p>		6.	DISCIPLINE	PRINT NAME	SIGNATURE	Date:	1st QSR:	Structural	John W. Voss, Jr		3/8/96	Other QSR:					Other QSR:					2nd QSR:	Mechanical	C. Muller		3/8/96
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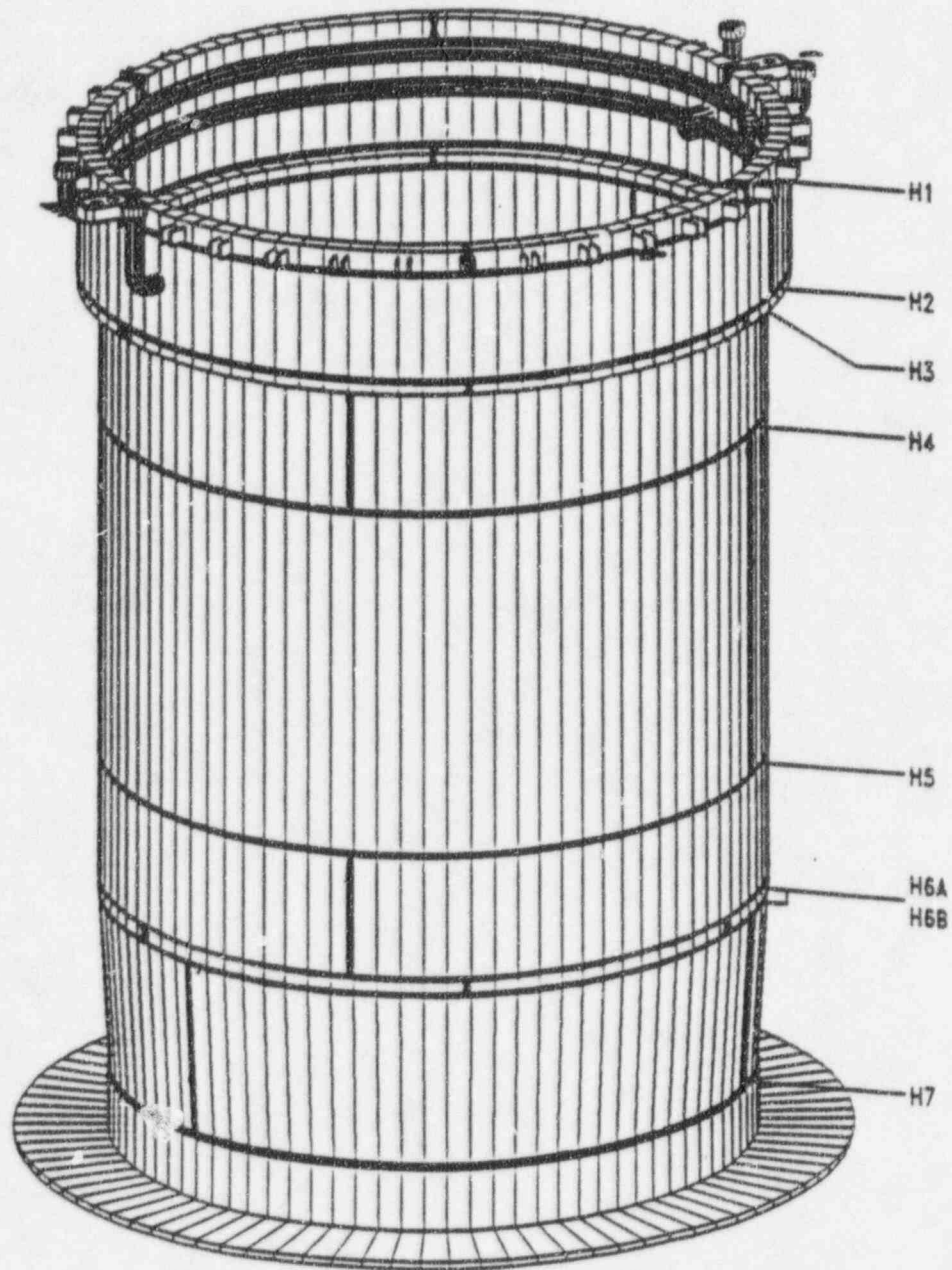


Figure 3 - Reactor Shroud Three-Dimensional View

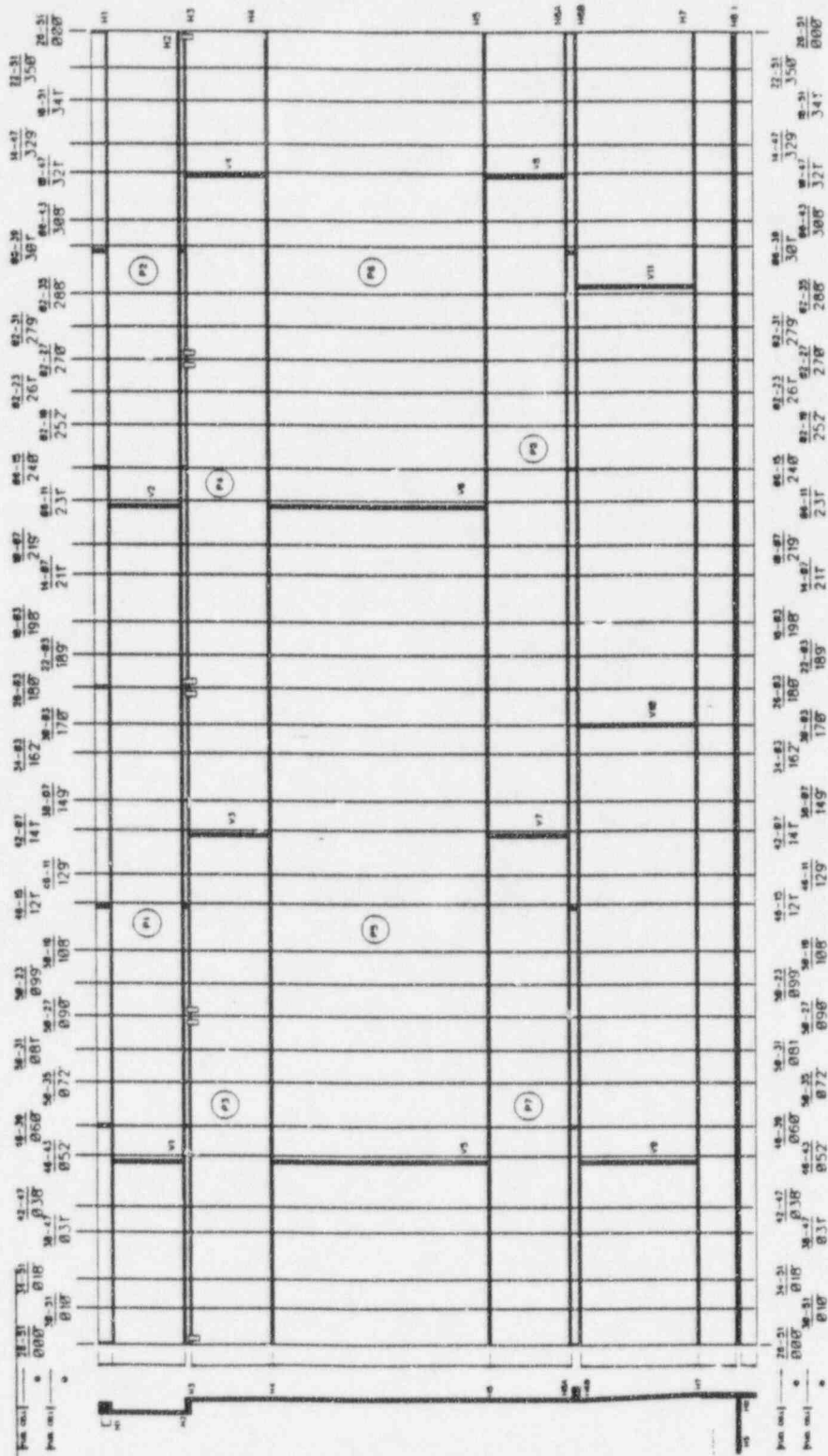
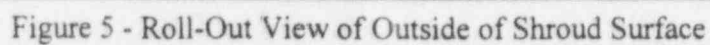


Figure 4 - Roll-Out View of Inside Shroud Surface



Core Shroud Reinspection Plan

**Unit 2
B212R1 Outage**

February 1996

Recommended by: W. Blum W. H. H. M. Date: 10/30/95

Approved by: G. A. G. W. B. S. Date: 11/2/95

Core Shroud Reinspection Plan Unit 2 B212R1 Outage February 1996

EXECUTIVE SUMMARY

The scope of reinspection for the Unit 2 core shroud is based on the results of previous inspections performed on both Unit 1 and Unit 2, follow-up actions and commitments established from the last inspection documented in Engineering Evaluation Report 94-0077, guidance on shroud inspections contained in NRC Generic Letter 94-03 and draft 4 of the BWRVIP "Guidelines for Reinspection of BWR Core Shrouds" dated September 15, 1995.

The reinspection scope focuses on three objectives: re-examination of selected areas to determine crack growth, examination of a sample of the installed clamps to verify no inservice degradation, and utilization of specifically developed tooling to examine accessible portions of certain welds that were previously inaccessible. Inspection of the core shroud in Unit 2 during May 1994 was performed prior to the issuance of Generic Letter 94-03. The inspection was also performed utilizing prototype UT tooling under development. Reliability problems arose, and use of the tooling had to be abandoned. The UT equipment commonly used for core shroud inspections will not work on the Brunswick Plant shrouds because of interference from the installed clamps on welds H2 and H3. BNP is developing specialized UT tooling to inspect certain welds. Specifically, UT examinations will be performed on 100% of the accessible areas of weld H1. UT will also be performed on areas not previously inspected on welds H6A, and H5B and H7. Additionally, UT will be repeated at selected areas on weld H4 to assess crack growth during the cycle.

Additional inspections will be performed if measurements indicate that crack growth is greater than anticipated. Predictions from crack growth models (GE PLEDGE) and plant specific data from the Crack Arrest Verification System (CAVS), indicate that little, if any, crack growth is expected. This is consistent with predictions and actual results from Unit 1.

UT inspections will be conducted utilizing pulse echo technology. Equipment and procedures for UT, and for any supplemental VT, will be qualified in accordance with the inspection guidelines of the BWRVIP. The NDE uncertainty will be determined in qualification testing by the inspection vendor. These qualifications will follow the BWRVIP inspection guidelines.

Two of the twelve clamps installed on welds H2 and H3 during the Spring 1994 outage will be VT inspected to insure that no adverse degradation has occurred during the operating cycle. An engineering evaluation of the inspection results will be performed using the flaw evaluation

guidance issued by the BWRVIP in Core Shroud Inspection and Evaluation Guidelines, or other accepted industry criteria.

CP&L is working closely with the BWRVIP to evaluate field information and incorporate "lessons learned" into the inspection program. Inspection of core shroud support legs, and other vessel attachments and internals, will be performed consistent with the guidance provided by the BWRVIP in the future.

UNIT 2 CORE SHROUD INSPECTION PLAN

The scope of this inspection plan along with previous inspections meets the intent of requested licensee action item 3 of Generic Letter 94-03. This action item requires an inspection plan for all shroud welds or justification for not inspecting certain welds, and requires use of technology and industry experience to perform inspections that will consistently detect IGSCC.

The inspection plan scope has been developed from Generic Letter 94-03, the proposed BWRVIP "Guidelines for Reinspection of Core Shroud Welds" and from knowledge gained from the previous inspections of BNP Units 1 and 2. The inspection plan for the core shroud focuses on application of improved inspection techniques for welds where internal surfaces were not accessible, and on reinspection of certain areas to determine crack growth rates. UT inspection tooling commonly used in the industry will not perform adequately on the BNP core shrouds due to interference from the clamps installed on the H2 and H3 welds. BNP is developing specialized tooling to inspect the welds that cannot be inspected with conventional tooling.

Weld H1 was VT inspected at selected outside surface locations in 1994. UT will be performed during the B212R1 outage on 100% of the accessible areas of weld H1 and its associated fillet weld. Weld H1 is a ring weld with "end grain" exposure and significant cold work. Welds H2 and H3 will not be inspected since their structural function was replaced by clamps in 1994.

Weld H4 will be reinspected in two places to determine crack growth rates. Weld H5 is not scheduled for reinspection, since relatively little cracking was found during the previous inspection, and since conditions at weld H4 (weld geometry, ECP, fluence, etc.) closely approximate those at H5.

The accessible outside areas of welds H6A, H6B and H7 were VT inspected in 1994. Inspection of welds H6A and H6B and their associated fillet welds will be supplemented by UT inspection at six locations between jet pump pairs. Access is limited to these six areas due to the proximity of the jet pump sensing lines. All accessible areas of weld H7 will be UT inspected.

Weld H8 and the shroud support legs below the core plate will not be inspected this outage because equipment and techniques are still being developed for these inspections. These areas will be inspected consistent with guidance provided by the BWRVIP in the future.

Although weld H9 is not currently required to be inspected by the BWRVIP guidelines, data may be available for the H9 weld due to its proximity to a weld that is included in the vessel beltline inspection program.

Two of the twelve repair clamps will be VT inspected to assure no degradation has occurred during the last cycle of operation.

Details of the scope of inspection for each weld and for the clamps are provided in Table 1.

INSPECTION SCOPE EXPANSION

Based on the results of the Brunswick Plant Unit 2 Core Shroud Reinspection Plan, additional inspections of the core shroud (including repair clamps) will be performed, if required to demonstrate core shroud integrity. CP&L will address any scope expansion in our submittal of the inspection results to the NRC Staff. No such expansion is anticipated, based on the operational history during the last cycle, and the results from Unit 1.

EVALUATION

An engineering evaluation of the results of the inspection will be performed, using the flaw evaluation guidance issued by the BWRVIP in the Core Shroud Inspection and Evaluation Guidelines, or other accepted industry criteria. CP&L will submit the inspection results in accordance with the guidance of NRC Generic Letter 94-03.

TABLE 1

Unit 2 Outage - Core Shroud Reinspection

WELD	REINSPECTION METHOD*	COMMENTS
H1	UT	100% of accessible areas.
H2	N/A	None. (Weld is structurally replaced by installed clamps).
H3	N/A	None. (Weld is structurally replaced by installed clamps).
H4	UT	Two locations to assess crack growth (100% of accessible areas were inspected during the B211R1 Outage).
H5	None planned	Conditions at weld H4 (weld geometry, ECP, fluence, etc.) closely approximate weld H5.
H6A	UT	Six (6) areas between jet pump pairs.
H6B	UT	Six (6) areas between jet pump pairs.
H7	UT	100% of accessible areas between jet pump pairs.
H8	None planned	BWRVIP developing inspection tools/techniques.
H9	UT	Data may be available as a by-product of the vessel beltline inspection program. (from OD as part of vessel beltline inspection)
Shroud support legs	None planned	BWRVIP developing inspection tools/techniques.
Two Clamps	VT	VT-3 clamps & hardware for general appearance and missing parts. VT-1 integrity of tack welds.

* NDE methods to be qualified in accordance with "BWRVIP Reactor Pressure Vessel and Internals Examination Guidelines" issued by the BWRVIP.

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
NRC DOCKET NO. 50-324
OPERATING LICENSE NO. DPR-62
SUBMITTAL OF UNIT 2 CORE SHROUD REINSPECTION PLANS

LIST OF REGULATORY COMMITMENTS

The following table identifies those actions committed to by Carolina Power & Light Company in this document. Any other actions discussed in the submittal represent intended or planned actions by Carolina Power & Light Company. They are described to the NRC for the NRC's information and are not regulatory commitments. Please notify the Manager-Regulatory Affairs at the Brunswick Nuclear Plant of any questions regarding this document or any associated regulatory commitments.

Commitment	Committed date or outage
1. Submit the B212R1 core shroud reinspection results.	30 days after completion of inspections

Shroud in	1.5 in
OD =	189.5 in
Crack Growth Rate =	5E-05 in/hr
Total Inspection Uncertainty =	0.00 in

Prepared By: _____ date _____

Verified By: _____

[illegible]

EOE Lig. Length (in) = 226.0

NOTES

- ESR 96-00154, Revision 0, Attachment B

B 1 of B 30

B212R1 Shourd Weld H1 Lower Normal/Upset
 DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)
 DATE OF CURRENT ANALYSIS: 03/05/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 192. psi
 Bending Stress, Pb = 483. psi
 Safety Factor, SF = 2.77
 Mean Radius, Rm = 94.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 1.9E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	51.6	53.5	1.500
2	77.1	80.8	1.500
3	85.6	87.5	1.500
4	91.6	95.3	1.500
5	103.1	106.8	1.500
6	110.4	114.1	1.500
7	118.9	126.2	1.500
8	149.2	165.1	1.500
9	198.9	203.2	1.500
10	203.5	214.7	1.500
11	232.8	239.2	1.500
12	249.2	252.3	1.500
13	255.3	288.6	1.500
14	292.2	294.1	1.500
15	309.2	344.5	1.500

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb* [psi]	SAFETY FACTOR	RESULT
0	8.844E+08	21239.	31.75	ACCEPTABLE
5.0	9.217E+08	22137.	33.08	ACCEPTABLE
10.0	9.409E+08	22597.	33.76	ACCEPTABLE
15.0	9.423E+08	22630.	33.81	ACCEPTABLE
20.0	9.813E+08	23568.	35.20	ACCEPTABLE
25.0	9.843E+08	23639.	35.31	ACCEPTABLE
30.0	1.022E+09	24555.	36.66	ACCEPTABLE
35.0	1.045E+09	25094.	37.46	ACCEPTABLE
40.0	1.060E+09	25456.	38.00	ACCEPTABLE
45.0	1.067E+09	25624.	38.25	ACCEPTABLE
50.0	1.066E+09	25597.	38.21	ACCEPTABLE
55.0	1.057E+09	25375.	37.88	ACCEPTABLE
60.0	1.039E+09	24961.	37.26	ACCEPTABLE
65.0	1.014E+09	24356.	36.37	ACCEPTABLE
70.0	9.876E+08	23718.	35.42	ACCEPTABLE
75.0	9.551E+08	22938.	34.27	ACCEPTABLE
80.0	9.147E+08	21969.	32.83	ACCEPTABLE
85.0	8.789E+08	21107.	31.55	ACCEPTABLE
90.0	8.442E+08	20276.	30.32	ACCEPTABLE
95.0	8.189E+08	19668.	29.42	ACCEPTABLE
100.0	7.937E+08	19061.	28.52	ACCEPTABLE
105.0	7.711E+08	18518.	27.72	ACCEPTABLE
110.0	7.590E+08	18227.	27.29	ACCEPTABLE

115.0	7.603E+08	18260.	27.34	ACCEPTABLE
120.0	7.706E+08	18506.	27.70	ACCEPTABLE
125.0	7.703E+08	18499.	27.69	ACCEPTABLE
130.0	7.686E+09	18460.	27.63	ACCEPTABLE
135.0	7.740E+08	18590.	27.82	ACCEPTABLE
140.0	7.789E+08	18707.	28.00	ACCEPTABLE
145.0	7.760E+08	18637.	27.89	ACCEPTABLE
150.0	7.909E+08	18995.	28.43	ACCEPTABLE
155.0	8.216E+08	19732.	29.52	ACCEPTABLE
160.0	8.422E+08	20226.	30.25	ACCEPTABLE
165.0	8.563E+08	20566.	30.75	ACCEPTABLE
170.0	8.647E+08	20766.	31.05	ACCEPTABLE
175.0	8.793E+08	21117.	31.57	ACCEPTABLE
180.0	8.844E+08	21239.	31.75	ACCEPTABLE
185.0	9.217E+08	22137.	33.08	ACCEPTABLE
190.0	9.409E+08	22597.	33.76	ACCEPTABLE
195.0	9.423E+08	22630.	33.81	ACCEPTABLE
200.0	9.813E+08	23568.	35.20	ACCEPTABLE
205.0	9.843E+08	23639.	35.31	ACCEPTABLE
210.0	1.022E+09	24555.	36.66	ACCEPTABLE
215.0	1.045E+09	25094.	37.46	ACCEPTABLE
220.0	1.060E+09	25456.	38.00	ACCEPTABLE
225.0	1.067E+09	25624.	38.25	ACCEPTABLE
230.0	1.066E+09	25597.	38.21	ACCEPTABLE
235.0	1.057E+09	25375.	37.88	ACCEPTABLE
240.0	1.039E+09	24961.	37.26	ACCEPTABLE
245.0	1.014E+09	24356.	36.37	ACCEPTABLE
250.0	9.876E+08	23718.	35.42	ACCEPTABLE
255.0	9.551E+08	22938.	34.27	ACCEPTABLE
260.0	9.147E+08	21969.	32.83	ACCEPTABLE
265.0	8.789E+08	21107.	31.55	ACCEPTABLE
270.0	8.442E+08	20276.	30.32	ACCEPTABLE
275.0	8.189E+08	19668.	29.42	ACCEPTABLE
280.0	7.937E+08	19061.	28.52	ACCEPTABLE
285.0	7.711E+08	18518.	27.72	ACCEPTABLE
290.0	7.590E+08	18227.	27.29	ACCEPTABLE
295.0	7.603E+08	18260.	27.34	ACCEPTABLE
300.0	7.706E+08	18506.	27.70	ACCEPTABLE
305.0	7.703E+08	18499.	27.69	ACCEPTABLE
310.0	7.686E+08	18460.	27.63	ACCEPTABLE
315.0	7.740E+08	18590.	27.82	ACCEPTABLE
320.0	7.789E+08	18707.	28.00	ACCEPTABLE
325.0	7.760E+08	18637.	27.89	ACCEPTABLE
330.0	7.909E+08	18995.	28.43	ACCEPTABLE
335.0	8.216E+08	19732.	29.52	ACCEPTABLE
340.0	8.422E+08	20226.	30.25	ACCEPTABLE
345.0	8.563E+08	20566.	30.75	ACCEPTABLE
350.0	8.647E+08	20766.	31.05	ACCEPTABLE
355.0	8.793E+08	21117.	31.57	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 27.29 AT 110.0 DEGREES.

B212R1 Shroud Weld H1 Lower Faulted
 DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)
 DATE OF CURRENT ANALYSIS: 03/05/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 798. psi
 Bending Stress, Pb = 642. psi
 Safety Factor, SF = 1.39
 Mean Radius, Rm = 94.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 1.9E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	51.6	53.5	1.500
2	77.1	80.8	1.500
3	85.6	87.5	1.500
4	91.6	95.3	1.500
5	103.1	106.8	1.500
6	110.4	114.1	1.500
7	118.9	126.2	1.500
8	149.2	165.1	1.500
9	198.9	203.2	1.500
10	204.5	214.7	1.500
11	232.8	239.2	1.500
12	249.2	252.3	1.500
13	255.3	288.6	1.500
14	292.2	294.1	1.500
15	309.2	344.5	1.500

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb ⁺ [psi]	SAFETY FACTOR	RESULT
0.0	9.092E+08	21836.	15.72	ACCEPTABLE
5.0	9.480E+08	22767.	16.36	ACCEPTABLE
10.0	9.704E+08	23306.	16.74	ACCEPTABLE
15.0	9.730E+08	23369.	16.78	ACCEPTABLE
20.0	1.013E+09	24322.	17.44	ACCEPTABLE
25.0	1.018E+09	24450.	17.53	ACCEPTABLE
30.0	1.057E+09	25379.	18.18	ACCEPTABLE
35.0	1.077E+09	25863.	18.51	ACCEPTABLE
40.0	1.089E+09	26150.	18.71	ACCEPTABLE
45.0	1.093E+09	26238.	18.77	ACCEPTABLE
50.0	1.088E+09	26126.	18.70	ACCEPTABLE
55.0	1.075E+09	25816.	18.48	ACCEPTABLE
60.0	1.054E+09	25309.	18.13	ACCEPTABLE
65.0	1.020E+09	24487.	17.56	ACCEPTABLE
70.0	9.957E+08	23914.	17.16	ACCEPTABLE
75.0	9.592E+08	23036.	16.55	ACCEPTABLE
80.0	9.164E+08	22008.	15.84	ACCEPTABLE
85.0	8.772E+08	21067.	15.18	ACCEPTABLE
90.0	8.410E+08	20197.	14.58	ACCEPTABLE
95.0	8.132E+08	19530.	14.12	ACCEPTABLE
100.0	7.863E+08	18885.	13.67	ACCEPTABLE
105.0	7.668E+08	18416.	13.34	ACCEPTABLE
110.0	7.492E+08	17993.	13.05	ACCEPTABLE

115.0	7.552E+08	18138.	13.15	ACCEPTABLE
120.0	7.568E+08	18176.	13.18	ACCEPTABLE
125.0	7.527E+08	18077.	13.11	ACCEPTABLE
130.0	7.503E+08	18019.	13.07	ACCEPTABLE
135.0	7.572E+08	18186.	13.18	ACCEPTABLE
140.0	7.660E+08	18396.	13.33	ACCEPTABLE
145.0	7.647E+08	18364.	13.31	ACCEPTABLE
150.0	7.796E+08	18723.	13.56	ACCEPTABLE
155.0	8.079E+08	19403.	14.03	ACCEPTABLE
160.0	8.246E+08	19804.	14.31	ACCEPTABLE
165.0	8.350E+08	20054.	14.48	ACCEPTABLE
170.0	8.412E+08	20203.	14.58	ACCEPTABLE
175.0	8.544E+08	20520.	14.80	ACCEPTABLE
180.0	8.588E+08	20626.	14.88	ACCEPTABLE
185.0	8.942E+08	21475.	15.47	ACCEPTABLE
190.0	9.101E+08	21857.	15.73	ACCEPTABLE
195.0	9.109E+08	21876.	15.75	ACCEPTABLE
200.0	9.488E+08	22785.	16.38	ACCEPTABLE
205.0	9.500E+08	22815.	16.40	ACCEPTABLE
210.0	9.876E+08	23718.	17.02	ACCEPTABLE
215.0	1.012E+09	24298.	17.43	ACCEPTABLE
220.0	1.030E+09	24732.	17.73	ACCEPTABLE
225.0	1.040E+09	24978.	17.90	ACCEPTABLE
230.0	1.042E+09	25034.	17.94	ACCEPTABLE
235.0	1.037E+09	24899.	17.85	ACCEPTABLE
240.0	1.023E+09	24575.	17.62	ACCEPTABLE
245.0	1.002E+09	24064.	17.27	ACCEPTABLE
250.0	9.778E+08	23484.	16.86	ACCEPTABLE
255.0	9.494E+08	22801.	16.39	ACCEPTABLE
260.0	9.137E+08	21944.	15.79	ACCEPTABLE
265.0	8.797E+08	21126.	15.23	ACCEPTABLE
270.0	8.467E+08	20335.	14.68	ACCEPTABLE
275.0	8.230E+08	19766.	14.28	ACCEPTABLE
280.0	7.967E+08	19135.	13.84	ACCEPTABLE
285.0	7.784E+08	18695.	13.54	ACCEPTABLE
290.0	7.679E+08	18442.	13.36	ACCEPTABLE
295.0	7.693E+08	18475.	13.38	ACCEPTABLE
300.0	7.827E+08	18797.	13.61	ACCEPTABLE
305.0	7.863E+08	18884.	13.67	ACCEPTABLE
310.0	7.862E+08	18882.	13.67	ACCEPTABLE
315.0	7.893E+08	18956.	13.72	ACCEPTABLE
320.0	7.903E+08	18979.	13.73	ACCEPTABLE
325.0	7.866E+08	18890.	13.67	ACCEPTABLE
330.0	8.015E+08	19249.	13.92	ACCEPTABLE
335.0	8.338E+08	20024.	14.46	ACCEPTABLE
340.0	8.582E+08	20611.	14.87	ACCEPTABLE
345.0	8.762E+08	21042.	15.17	ACCEPTABLE
350.0	8.874E+08	21313.	15.35	ACCEPTABLE
355.0	9.027E+08	21680.	15.61	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 13.05 AT 110.0 DEGREES.

B212R1 Shroud Weld H1 Upset

DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)

DATE OF CURRENT ANALYSIS: 03/07/1996

SUMMARY OF INPUTS:

Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 192. psi
 Bending Stress, Pb = 483. psi
 Safety Factor, SF = 2.77
 Mean Radius, Rm = 94.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 1.9E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	0	360.0	.114

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb* [psi]	SAFETY FACTOR	RESULT
0.0	2.036E+08	4891.	7.53	ACCEPTABLE
5.0	2.036E+08	4891.	7.53	ACCEPTABLE
10.0	2.036E+08	4891.	7.53	ACCEPTABLE
15.0	2.036E+08	4891.	7.53	ACCEPTABLE
20.0	2.036E+08	4891.	7.53	ACCEPTABLE
25.0	2.036E+08	4891.	7.53	ACCEPTABLE
30.0	2.036E+08	4891.	7.53	ACCEPTABLE
35.0	2.036E+08	4891.	7.53	ACCEPTABLE
40.0	2.036E+08	4891.	7.53	ACCEPTABLE
45.0	2.036E+08	4891.	7.53	ACCEPTABLE
50.0	2.036E+08	4891.	7.53	ACCEPTABLE
55.0	2.036E+08	4891.	7.53	ACCEPTABLE
60.0	2.036E+08	4891.	7.53	ACCEPTABLE
65.0	2.036E+08	4891.	7.53	ACCEPTABLE
70.0	2.036E+08	4891.	7.53	ACCEPTABLE
75.0	2.036E+08	4891.	7.53	ACCEPTABLE
80.0	2.036E+08	4891.	7.53	ACCEPTABLE
85.0	2.036E+08	4891.	7.53	ACCEPTABLE
90.0	2.036E+08	4891.	7.53	ACCEPTABLE
95.0	2.036E+08	4891.	7.53	ACCEPTABLE
100.0	2.036E+08	4891.	7.53	ACCEPTABLE
105.0	2.036E+08	4891.	7.53	ACCEPTABLE
110.0	2.036E+08	4891.	7.53	ACCEPTABLE
115.0	2.036E+08	4891.	7.53	ACCEPTABLE
120.0	2.036E+08	4891.	7.53	ACCEPTABLE
125.0	2.036E+08	4891.	7.53	ACCEPTABLE
130.0	2.036E+08	4891.	7.53	ACCEPTABLE
135.0	2.036E+08	4891.	7.53	ACCEPTABLE
140.0	2.036E+08	4891.	7.53	ACCEPTABLE
145.0	2.036E+08	4891.	7.53	ACCEPTABLE
150.0	2.036E+08	4891.	7.53	ACCEPTABLE
155.0	2.036E+08	4891.	7.53	ACCEPTABLE
160.0	2.036E+08	4891.	7.53	ACCEPTABLE
165.0	2.036E+08	4891.	7.53	ACCEPTABLE
170.0	2.036E+08	4891.	7.53	ACCEPTABLE
175.0	2.036E+08	4891.	7.53	ACCEPTABLE
180.0	2.036E+08	4891.	7.53	ACCEPTABLE

185.0	2.036E+08	4891.	7.53	ACCEPTABLE
190.0	2.036E+08	4891.	7.53	ACCEPTABLE
195.0	2.036E+08	4891.	7.53	ACCEPTABLE
200.0	2.036E+08	4891.	7.53	ACCEPTABLE
205.0	2.036E+08	4891.	7.53	ACCEPTABLE
210.0	2.036E+08	4891.	7.53	ACCEPTABLE
215.0	2.036E+08	4891.	7.53	ACCEPTABLE
220.0	2.036E+08	4891.	7.53	ACCEPTABLE
225.0	2.036E+08	4891.	7.53	ACCEPTABLE
230.0	2.036E+08	4891.	7.53	ACCEPTABLE
235.0	2.036E+08	4891.	7.53	ACCEPTABLE
240.0	2.036E+08	4891.	7.53	ACCEPTABLE
245.0	2.036E+08	4891.	7.53	ACCEPTABLE
250.0	2.036E+08	4891.	7.53	ACCEPTABLE
255.0	2.036E+08	4891.	7.53	ACCEPTABLE
260.0	2.036E+08	4891.	7.53	ACCEPTABLE
265.0	2.036E+08	4891.	7.53	ACCEPTABLE
270.0	2.036E+08	4891.	7.53	ACCEPTABLE
275.0	2.036E+08	4891.	7.53	ACCEPTABLE
280.0	2.036E+08	4891.	7.53	ACCEPTABLE
285.0	2.036E+08	4891.	7.53	ACCEPTABLE
290.0	2.036E+08	4891.	7.53	ACCEPTABLE
295.0	2.036E+08	4891.	7.53	ACCEPTABLE
300.0	2.036E+08	4891.	7.53	ACCEPTABLE
305.0	2.036E+08	4891.	7.53	ACCEPTABLE
310.0	2.036E+08	4891.	7.53	ACCEPTABLE
315.0	2.036E+08	4891.	7.53	ACCEPTABLE
320.0	2.036E+08	4891.	7.53	ACCEPTABLE
325.0	2.036E+08	4891.	7.53	ACCEPTABLE
330.0	2.036E+08	4891.	7.53	ACCEPTABLE
335.0	2.036E+08	4891.	7.53	ACCEPTABLE
340.0	2.036E+08	4891.	7.53	ACCEPTABLE
345.0	2.036E+08	4891.	7.53	ACCEPTABLE
350.0	2.036E+08	4891.	7.53	ACCEPTABLE
355.0	2.036E+08	4891.	7.53	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 7.53 AT 80.0 DEGREES.

B212R1 Shroud Weld H1 Faulted

DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)

DATE OF CURRENT ANALYSIS: 03/07/1996

SUMMARY OF INPUTS:

Angle increment = 1.0 deg. (COARSE)

Membrane Stress, Pm = 798. psi

Bending Stress, Pb = 642. psi

Safety Factor, SF = 1.39

Mean Radius, Rm = 94.00 inches

Wall Thickness, t = 1.500 inches

Material = 304 SS

Stress Intensity, Sm = 16900. psi

Fluence = 1.9E+19 n/cm²

(Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	0	360.0	.114

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb ¹ [psi]	SAFETY FACTOR	RESULT
0	1.926E+08	4625.	3.77	ACCEPTABLE
5.0	1.926E+08	4625.	3.77	ACCEPTABLE
10.0	1.926E+08	4625.	3.77	ACCEPTABLE
15.0	1.926E+08	4625.	3.77	ACCEPTABLE
20.0	1.926E+08	4625.	3.77	ACCEPTABLE
25.0	1.926E+08	4625.	3.77	ACCEPTABLE
30.0	1.926E+08	4625.	3.77	ACCEPTABLE
35.0	1.926E+08	4625.	3.77	ACCEPTABLE
40.0	1.926E+08	4625.	3.77	ACCEPTABLE
45.0	1.926E+08	4625.	3.77	ACCEPTABLE
50.0	1.926E+08	4625.	3.77	ACCEPTABLE
55.0	1.926E+08	4625.	3.77	ACCEPTABLE
60.0	1.926E+08	4625.	3.77	ACCEPTABLE
65.0	1.926E+08	4625.	3.77	ACCEPTABLE
70.0	1.926E+08	4625.	3.77	ACCEPTABLE
75.0	1.926E+08	4625.	3.77	ACCEPTABLE
80.0	1.926E+08	4625.	3.77	ACCEPTABLE
85.0	1.926E+08	4625.	3.77	ACCEPTABLE
90.0	1.926E+08	4625.	3.77	ACCEPTABLE
95.0	1.926E+08	4625.	3.77	ACCEPTABLE
100.0	1.926E+08	4625.	3.77	ACCEPTABLE
105.0	1.926E+08	4625.	3.77	ACCEPTABLE
110.0	1.926E+08	4625.	3.77	ACCEPTABLE
115.0	1.926E+08	4625.	3.77	ACCEPTABLE
120.0	1.926E+08	4625.	3.77	ACCEPTABLE
125.0	1.926E+08	4625.	3.77	ACCEPTABLE
130.0	1.926E+08	4625.	3.77	ACCEPTABLE
135.0	1.926E+08	4625.	3.77	ACCEPTABLE
140.0	1.926E+08	4625.	3.77	ACCEPTABLE
145.0	1.926E+08	4625.	3.77	ACCEPTABLE
150.0	1.926E+08	4625.	3.77	ACCEPTABLE
155.0	1.926E+08	4625.	3.77	ACCEPTABLE
160.0	1.926E+08	4625.	3.77	ACCEPTABLE
165.0	1.926E+08	4625.	3.77	ACCEPTABLE
170.0	1.926E+08	4625.	3.77	ACCEPTABLE
175.0	1.926E+08	4625.	3.77	ACCEPTABLE
180.0	1.926E+08	4625.	3.77	ACCEPTABLE

185.0	1.926E+08	4625.	3.77	ACCEPTABLE
190.0	1.926E+08	4625.	3.77	ACCEPTABLE
195.0	1.926E+08	4625.	3.77	ACCEPTABLE
200.0	1.926E+08	4625.	3.77	ACCEPTABLE
205.0	1.926E+08	4625.	3.77	ACCEPTABLE
210.0	1.926E+08	4625.	3.77	ACCEPTABLE
215.0	1.926E+08	4625.	3.77	ACCEPTABLE
220.0	1.926E+08	4625.	3.77	ACCEPTABLE
225.0	1.926E+08	4625.	3.77	ACCEPTABLE
230.0	1.926E+08	4625.	3.77	ACCEPTABLE
235.0	1.926E+08	4625.	3.77	ACCEPTABLE
240.0	1.926E+08	4625.	3.77	ACCEPTABLE
245.0	1.926E+08	4625.	3.77	ACCEPTABLE
250.0	1.926E+08	4625.	3.77	ACCEPTABLE
255.0	1.926E+08	4625.	3.77	ACCEPTABLE
260.0	1.926E+08	4625.	3.77	ACCEPTABLE
265.0	1.926E+08	4625.	3.77	ACCEPTABLE
270.0	1.926E+08	4625.	3.77	ACCEPTABLE
275.0	1.926E+08	4625.	3.77	ACCEPTABLE
280.0	1.926E+08	4625.	3.77	ACCEPTABLE
285.0	1.926E+08	4625.	3.77	ACCEPTABLE
290.0	1.926E+08	4625.	3.77	ACCEPTABLE
295.0	1.926E+08	4625.	3.77	ACCEPTABLE
300.0	1.926E+08	4625.	3.77	ACCEPTABLE
305.0	1.926E+08	4625.	3.77	ACCEPTABLE
310.0	1.926E+08	4625.	3.77	ACCEPTABLE
315.0	1.926E+08	4625.	3.77	ACCEPTABLE
320.0	1.926E+08	4625.	3.77	ACCEPTABLE
325.0	1.926E+08	4625.	3.77	ACCEPTABLE
330.0	1.926E+08	4625.	3.77	ACCEPTABLE
335.0	1.926E+08	4625.	3.77	ACCEPTABLE
340.0	1.926E+08	4625.	3.77	ACCEPTABLE
345.0	1.926E+08	4625.	3.77	ACCEPTABLE
350.0	1.926E+08	4625.	3.77	ACCEPTABLE
355.0	1.926E+08	4625.	3.77	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 3.77 AT 85.0 DEGREES.

Shroud Circumferential Weld Structural Evaluation Ligament Length Determination

Plant ID:	BNP2
Weld ID:	H4
Data ID:	B211R1

Shroud in	1.5 in
OD =	177.5 in
Crack Growth Rate =	5E-05 in/hr
Total Inspection Uncertainty =	0.74 in

Eval. Period = 1800 days
Lcalc = 185 in (upset/norm)
Lcalc = 180 in (faulted)
Lmin = 190.1 in

Prepared By: _____ date _____

Verified By: _____

[illegible]

Existing Ligament Length (in) = 318.9

[illegible]

EOE Lig.Length (in) = 233.3

[illegible][illegible][illegible][illegible]

Since EOE Ligament Length $> L_{min}$, a detailed limit load analysis is not required.

NOTES

- (1) B211R1 Ligament Data from LER-940077 and GE Examination Summary Sheets
- (2) Total Ligament uncertainty (0.744") from reference 8 (demo 1)
- (3) Crack growth is applied at each end of ligament
- (4) Days to Fully Cracked = days till ligament length is zero (actually $3.744'' = \text{uncertainty} + \text{ASME crack proximity rule}$) for each ligament.
- (5) High Flux Zone = plus or minus 15 degrees from azimuths 45, 135, 225 and 315 (ie 30-60 etc.)
- (6) Weld H4 will not reach LEFM threshold level for neutron embrittlement (3×10^{-20}) within fuel cycle 12
- (7) $1 \text{ deg} = 1.54898 \text{ in}$
- (8) Uninspected regions assumed fully cracked. All cracks assumed through-wall
- (9) $L_{\text{calc}} = \text{minimum required ligament length for limit load concerns - reference Structural Integrity report SIR-94-029 Rev. 0}$
- (10) $L_{\text{min}} = L_{\text{calc}} + 2(\text{Crack Growth in Evaluation Period}) + \text{Total Inspection Uncertainty}$

ESR 96-00154, Revision 0, Attachment B

B6 of B30

B212R1 Shroud Weld H4 Normal/Upset Evaluation (data from B211R1)
 DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)
 DATE OF CURRENT ANALYSIS: 02/28/1996

SUMMARY OF INPUTS:

Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 173. psi
 Bending Stress, Pb = 1006. psi
 Safety Factor, SF = 2.77
 Mean Radius, Rm = 88.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 2.2E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	60.0	91.7	1.500
2	103.6	106.5	1.500
3	114.9	120.0	1.500
4	150.0	173.4	1.500
5	201.9	206.9	1.500
6	257.1	259.6	1.500
7	265.8	274.0	1.500
8	277.4	297.6	1.500
9	334.0	339.0	1.500

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb [psi]	SAFETY FACTOR	RESULT
0	7.577E+08	20764.	17.76	ACCEPTABLE
5.0	7.544E+08	20672.	17.68	ACCEPTABLE
10.0	7.452E+08	20422.	17.47	ACCEPTABLE
15.0	7.305E+08	20017.	17.12	ACCEPTABLE
20.0	7.101E+08	19459.	16.65	ACCEPTABLE
25.0	6.899E+08	18905.	16.18	ACCEPTABLE
30.0	6.783E+08	18586.	15.91	ACCEPTABLE
35.0	6.736E+08	18460.	15.80	ACCEPTABLE
40.0	6.656E+08	18238.	15.62	ACCEPTABLE
45.0	6.524E+08	17878.	15.31	ACCEPTABLE
50.0	6.382E+08	17488.	14.98	ACCEPTABLE
55.0	6.307E+08	17284.	14.81	ACCEPTABLE
60.0	6.191E+08	16966.	14.54	ACCEPTABLE
65.0	6.028E+08	16519.	14.16	ACCEPTABLE
70.0	5.819E+08	15947.	13.67	ACCEPTABLE
75.0	5.566E+08	15253.	13.08	ACCEPTABLE
80.0	5.294E+08	14507.	12.45	ACCEPTABLE
85.0	5.055E+08	13851.	11.90	ACCEPTABLE
90.0	4.949E+08	13561.	11.65	ACCEPTABLE
95.0	4.925E+08	13497.	11.59	ACCEPTABLE
100.0	5.011E+08	13730.	11.79	ACCEPTABLE
105.0	5.068E+08	13889.	11.93	ACCEPTABLE
110.0	5.158E+08	14133.	12.13	ACCEPTABLE
115.0	5.343E+08	14642.	12.57	ACCEPTABLE
120.0	5.560E+08	15235.	13.07	ACCEPTABLE
125.0	5.733E+08	15711.	13.47	ACCEPTABLE
130.0	5.864E+08	16068.	13.78	ACCEPTABLE
135.0	6.050E+08	16579.	14.21	ACCEPTABLE
140.0	6.338E+08	17369.	14.88	ACCEPTABLE

145.0	6.599E+08	18082.	15.48	ACCEPTABLE
150.0	6.808E+08	18657.	15.97	ACCEPTABLE
155.0	6.966E+08	19090.	16.34	ACCEPTABLE
160.0	7.120E+08	19510.	16.70	ACCEPTABLE
165.0	7.346E+08	20131.	17.22	ACCEPTABLE
170.0	7.502E+08	20559.	17.58	ACCEPTABLE
175.0	7.601E+08	20830.	17.81	ACCEPTABLE
180.0	7.643E+08	20943.	17.91	ACCEPTABLE
185.0	7.626E+08	20896.	17.87	ACCEPTABLE
190.0	7.551E+08	20691.	17.70	ACCEPTABLE
195.0	7.418E+08	20328.	17.39	ACCEPTABLE
200.0	7.229E+08	19810.	16.95	ACCEPTABLE
205.0	6.899E+08	18905.	16.18	ACCEPTABLE
210.0	6.783E+08	18586.	15.91	ACCEPTABLE
215.0	6.859E+08	18795.	16.09	ACCEPTABLE
220.0	6.763E+08	18532.	15.87	ACCEPTABLE
225.0	6.616E+08	18129.	15.52	ACCEPTABLE
230.0	6.382E+08	17488.	14.98	ACCEPTABLE
235.0	6.383E+08	17490.	14.98	ACCEPTABLE
240.0	6.250E+08	17126.	14.67	ACCEPTABLE
245.0	6.069E+08	16632.	14.25	ACCEPTABLE
250.0	5.843E+08	16010.	13.73	ACCEPTABLE
255.0	5.572E+08	15267.	13.10	ACCEPTABLE
260.0	5.285E+08	14482.	12.43	ACCEPTABLE
265.0	5.026E+08	13773.	11.83	ACCEPTABLE
270.0	4.920E+08	13483.	11.58	ACCEPTABLE
275.0	4.925E+08	13497.	11.59	ACCEPTABLE
280.0	5.005E+08	13716.	11.78	ACCEPTABLE
285.0	5.068E+08	13889.	11.93	ACCEPTABLE
290.0	5.158E+08	14133.	12.13	ACCEPTABLE
295.0	5.343E+08	14642.	12.57	ACCEPTABLE
300.0	5.597E+08	15337.	13.16	ACCEPTABLE
305.0	5.788E+08	15862.	13.60	ACCEPTABLE
310.0	5.936E+08	16266.	13.94	ACCEPTABLE
315.0	6.050E+08	16579.	14.21	ACCEPTABLE
320.0	6.400E+08	17538.	15.02	ACCEPTABLE
325.0	6.643E+08	18204.	15.59	ACCEPTABLE
330.0	6.835E+08	18730.	16.03	ACCEPTABLE
335.0	6.975E+08	19115.	16.36	ACCEPTABLE
340.0	7.134E+08	19550.	16.73	ACCEPTABLE
345.0	7.334E+08	20096.	17.19	ACCEPTABLE
350.0	7.472E+08	20475.	17.51	ACCEPTABLE
355.0	7.553E+08	20698.	17.70	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 11.58 AT 270.0 DEGREES.

B212R1 Shroud Weld H4 Faulted Evaluation (data from B211R1)
 DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)
 DATE OF CURRENT ANALYSIS: 02/28/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 822. psi
 Bending Stress, Pb = 1377. psi
 Safety Factor, SF = 1.39
 Mean Radius, Rm = 88.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 2.2E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	60.0	91.7	1.500
2	103.6	106.5	1.500
3	114.9	120.0	1.500
4	150.0	173.4	1.500
5	201.9	206.9	1.500
6	257.1	259.6	1.500
7	265.8	274.0	1.500
8	277.4	297.6	1.500
9	334.0	339.0	1.500

LIMIT LOAD RESULTS:

ALPHA [deg.]	MOMENT [in-lbs]	Pb' [psi]	SAFETY FACTOR	RESULT
0	7.437E+08	20379.	9.64	ACCEPTABLE
5.0	7.370E+08	20195.	9.56	ACCEPTABLE
10.0	7.247E+08	19859.	9.40	ACCEPTABLE
15.0	7.069E+08	19370.	9.18	ACCEPTABLE
20.0	6.837E+08	18735.	8.89	ACCEPTABLE
25.0	6.635E+08	18181.	8.64	ACCEPTABLE
30.0	6.518E+08	17862.	8.50	ACCEPTABLE
35.0	6.483E+08	17766.	8.45	ACCEPTABLE
40.0	6.432E+08	17625.	8.39	ACCEPTABLE
45.0	6.331E+08	17349.	8.26	ACCEPTABLE
50.0	6.201E+08	16994.	8.10	ACCEPTABLE
55.0	6.147E+08	16844.	8.03	ACCEPTABLE
60.0	6.064E+08	16618.	7.93	ACCEPTABLE
65.0	5.936E+08	16266.	7.77	ACCEPTABLE
70.0	5.762E+08	15790.	7.55	ACCEPTABLE
75.0	5.545E+08	15194.	7.28	ACCEPTABLE
80.0	5.294E+08	14507.	6.97	ACCEPTABLE
85.0	5.076E+08	13910.	6.70	ACCEPTABLE
90.0	4.970E+08	13620.	6.57	ACCEPTABLE
95.0	4.961E+08	13595.	6.56	ACCEPTABLE
100.0	5.005E+08	13716.	6.61	ACCEPTABLE
105.0	5.047E+08	13830.	6.66	ACCEPTABLE
110.0	5.115E+08	14016.	6.75	ACCEPTABLE
115.0	5.293E+08	14505.	6.97	ACCEPTABLE
120.0	5.474E+08	15000.	7.20	ACCEPTABLE
125.0	5.613E+08	15382.	7.37	ACCEPTABLE
130.0	5.716E+08	15665.	7.50	ACCEPTABLE
135.0	5.903E+08	15776.	7.73	ACCEPTABLE
140.0	6.205E+08	17002.	8.11	ACCEPTABLE

145.0	6.499E+08	17809.	8.47	ACCEPTABLE
150.0	6.744E+08	18481.	8.78	ACCEPTABLE
155.0	6.938E+08	19011.	9.02	ACCEPTABLE
160.0	7.098E+08	19452.	9.22	ACCEPTABLE
165.0	7.361E+08	20170.	9.55	ACCEPTABLE
170.0	7.553E+08	20696.	9.79	ACCEPTABLE
175.0	7.687E+08	21064.	9.95	ACCEPTABLE
180.0	7.763E+08	21272.	10.05	ACCEPTABLE
185.0	7.780E+08	21318.	10.07	ACCEPTABLE
190.0	7.737E+08	21202.	10.02	ACCEPTABLE
195.0	7.636E+08	20925.	9.89	ACCEPTABLE
200.0	7.477E+08	20488.	9.69	ACCEPTABLE
205.0	7.158E+08	19614.	9.29	ACCEPTABLE
210.0	7.041E+08	19295.	9.15	ACCEPTABLE
215.0	7.095E+08	19441.	9.21	ACCEPTABLE
220.0	6.969E+08	19096.	9.06	ACCEPTABLE
225.0	6.790E+08	18605.	8.83	ACCEPTABLE
230.0	6.555E+08	17964.	8.54	ACCEPTABLE
235.0	6.523E+08	17876.	8.50	ACCEPTABLE
240.0	6.356E+08	17418.	8.29	ACCEPTABLE
245.0	6.141E+08	16827.	8.03	ACCEPTABLE
250.0	5.878E+08	16109.	7.70	ACCEPTABLE
255.0	5.566E+08	15253.	7.31	ACCEPTABLE
260.0	5.256E+08	14403.	6.92	ACCEPTABLE
265.0	4.990E+08	13675.	6.59	ACCEPTABLE
270.0	4.901E+08	13429.	6.48	ACCEPTABLE
275.0	4.882E+08	13379.	6.45	ACCEPTABLE
280.0	4.984E+08	13657.	6.58	ACCEPTABLE
285.0	5.076E+08	13909.	6.70	ACCEPTABLE
290.0	5.210E+08	14276.	6.87	ACCEPTABLE
295.0	5.379E+08	14740.	7.08	ACCEPTABLE
300.0	5.661E+08	15513.	7.43	ACCEPTABLE
305.0	5.888E+08	16134.	7.71	ACCEPTABLE
310.0	6.070E+08	16633.	7.94	ACCEPTABLE
315.0	6.191E+08	16965.	8.09	ACCEPTABLE
320.0	6.514E+08	17849.	8.49	ACCEPTABLE
325.0	6.721E+08	18419.	8.75	ACCEPTABLE
330.0	6.878E+08	18848.	8.95	ACCEPTABLE
335.0	6.983E+08	19134.	9.08	ACCEPTABLE
340.0	7.141E+08	19569.	9.27	ACCEPTABLE
345.0	7.298E+08	19998.	9.47	ACCEPTABLE
350.0	7.401E+08	20280.	9.60	ACCEPTABLE
355.0	7.447E+08	20407.	9.65	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 6.46 AT 275.0 DEGREES.

Shroud Circumferential Weld Structural Evaluation Ligament Length Determination

Plant ID:	BNP2
Weld ID:	H5
Data ID:	B211R1

Shroud in	1.5 in
OD =	177.5 in
Crack Growth Rate =	5E-05 in/cr
Total Inspection Uncertainty =	2.32 in

Eval. Period = 1400 days
Lcalc = 214 in (upset/norm)
Lcalc = 202 in (faulted)
Lmin = 219.7 in

Prepared By: _____ date _____

Verified By: _____

[illegible]

Existing Ligament Length (in) = 139.4

[illegible]

EOE Lig. Length (in) =	79.0
------------------------	------

[illegible][illegible][illegible]

Since EOE Ligament Length $< L_{min}$, a detailed limit load analysis is required (DLL computer program).

NOTES

- (1) Ligament Data from B211R1 data & GE Examination Summary Sheets
- (2) Total Ligament uncertainty = $[1.16^* \times 2]$ (reference: BWRVIP-03)
- (3) Crack growth is applied at each end of ligament
- (4) Calculation for End of Evaluation Ligament Data includes uncertainty in azimuth and length - 1/2 total uncertainty from each end
- (5) Days to Fully Cracked = days till ligament length is zero (actually $5.32^* = \text{uncertainty} + \text{ASME crack proximity rule}$) for each ligament.
- (6) High Flux Zone = plus or minus 15 degrees from azimuths 45, 135, 225 and 315 (ie 30-60 etc.)
Weld H5 will not reach LEFM threshold level for neutron embrittlement (3×10^{-20}) until 24 EFPY. It will not be considered in this evaluation.
- (7) $1 \text{ deg} = 1.54898 \text{ in}$
- (8) Uninspected regions assumed fully cracked. All cracks assumed through-wall
- (9) $L_{calc} = \text{minimum required ligament length for limit load concerns - reference Structural Integrity report SIR-94-029 Rev. 0}$
- (10) $L_{min} = L_{calc} + 2(\text{Crack Growth in Evaluation Period}) + \text{Total Inspection Uncertainty}$

B212R1 Shroud Weld H5 Normal/Upset

DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)

DATE OF CURRENT ANALYSIS: 03/05/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 149. psi
 Bending Stress, Pb = 1814. psi
 Safety Factor, SF = 2.77
 Mean Radius, Rm = 88.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 2.2E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	1.8	10.2	1.500
2	14.8	18.2	1.500
3	42.8	48.2	1.500
4	71.8	78.2	1.500
5	101.8	108.2	1.500
6	131.8	138.2	1.500
7	221.8	224.2	1.500
8	281.8	288.2	1.500
9	351.8	358.2	1.500

LIMIT LOAD RESULTS:

ALPHA [deg.]	MOMENT [in-lbs]	Pb' [psi]	SAFETY FACTOR	RESULT
0	3.285E+08	9001.	4.66	ACCEPTABLE
5.0	3.398E+08	9312.	4.82	ACCEPTABLE
10.0	3.486E+08	9553.	4.94	ACCEPTABLE
15.0	3.546E+08	9716.	5.03	ACCEPTABLE
20.0	3.562E+08	9761.	5.05	ACCEPTABLE
25.0	3.551E+08	9732.	5.03	ACCEPTABLE
30.0	3.535E+08	9686.	5.01	ACCEPTABLE
35.0	3.575E+08	9795.	5.07	ACCEPTABLE
40.0	3.587E+08	9830.	5.08	ACCEPTABLE
45.0	3.573E+08	9790.	5.06	ACCEPTABLE
50.0	3.531E+08	9676.	5.01	ACCEPTABLE
55.0	3.462E+08	9488.	4.91	ACCEPTABLE
60.0	3.231E+08	8855.	4.59	ACCEPTABLE
65.0	3.276E+08	8978.	4.65	ACCEPTABLE
70.0	3.157E+08	8652.	4.48	ACCEPTABLE
75.0	2.938E+08	8051.	4.18	ACCEPTABLE
80.0	3.035E+08	8316.	4.31	ACCEPTABLE
85.0	3.032E+08	8308.	4.31	ACCEPTABLE
90.0	3.006E+08	8237.	4.27	ACCEPTABLE
95.0	2.957E+08	8103.	4.20	ACCEPTABLE
100.0	2.886E+08	7908.	4.10	ACCEPTABLE
105.0	2.793E+08	7652.	3.97	ACCEPTABLE
110.0	2.678E+08	7338.	3.81	ACCEPTABLE
115.0	2.543E+08	6969.	3.63	ACCEPTABLE
120.0	2.389E+08	6546.	3.41	ACCEPTABLE
125.0	2.095E+08	5740.	3.00	ACCEPTABLE
130.0	2.204E+08	6040.	3.15	ACCEPTABLE
135.0	2.159E+08	5917.	3.09	ACCEPTABLE
140.0	2.098E+08	5749.	3.00	ACCEPTABLE

145.0	1.931E+08	5291.	2.77	ACCEPTABLE
150.0	2.139E+08	5861.	3.06	ACCEPTABLE
155.0	2.222E+08	6088.	3.18	ACCEPTABLE
160.0	2.288E+08	6269.	3.27	ACCEPTABLE
165.0	2.399E+08	6574.	3.43	ACCEPTABLE
170.0	2.598E+08	7118.	3.70	ACCEPTABLE
175.0	2.795E+08	7658.	3.98	ACCEPTABLE
180.0	2.971E+08	8140.	4.22	ACCEPTABLE
185.0	3.150E+08	8632.	4.47	ACCEPTABLE
190.0	3.306E+08	9059.	4.69	ACCEPTABLE
195.0	3.436E+08	9417.	4.87	ACCEPTABLE
200.0	3.541E+08	9703.	5.02	ACCEPTABLE
205.0	3.618E+08	9915.	5.13	ACCEPTABLE
210.0	3.668E+08	10052.	5.20	ACCEPTABLE
215.0	3.690E+08	10112.	5.23	ACCEPTABLE
220.0	3.684E+08	10095.	5.22	ACCEPTABLE
225.0	3.677E+08	10075.	5.21	ACCEPTABLE
230.0	3.711E+08	10170.	5.26	ACCEPTABLE
235.0	3.711E+08	10168.	5.26	ACCEPTABLE
240.0	3.682E+08	10088.	5.22	ACCEPTABLE
245.0	3.625E+08	9932.	5.14	ACCEPTABLE
250.0	3.540E+08	9700.	5.02	ACCEPTABLE
255.0	3.343E+08	9160.	4.74	ACCEPTABLE
260.0	3.395E+08	9303.	4.82	ACCEPTABLE
265.0	3.326E+08	9115.	4.72	ACCEPTABLE
270.0	3.253E+08	8914.	4.62	ACCEPTABLE
275.0	3.265E+08	8947.	4.63	ACCEPTABLE
280.0	3.259E+08	8931.	4.63	ACCEPTABLE
285.0	3.228E+08	8846.	4.58	ACCEPTABLE
290.0	3.173E+08	8694.	4.50	ACCEPTABLE
295.0	3.093E+08	8476.	4.39	ACCEPTABLE
300.0	2.990E+08	8194.	4.25	ACCEPTABLE
305.0	2.720E+08	7453.	3.87	ACCEPTABLE
310.0	2.796E+08	7661.	3.98	ACCEPTABLE
315.0	2.699E+08	7395.	3.84	ACCEPTABLE
320.0	2.598E+08	7120.	3.70	ACCEPTABLE
325.0	2.454E+08	6724.	3.50	ACCEPTABLE
330.0	2.622E+08	7185.	3.74	ACCEPTABLE
335.0	2.645E+08	7249.	3.77	ACCEPTABLE
340.0	2.667E+08	7309.	3.80	ACCEPTABLE
345.0	2.804E+08	7684.	3.99	ACCEPTABLE
350.0	2.983E+08	8175.	4.24	ACCEPTABLE
355.0	3.146E+08	8620.	4.47	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 2.77 AT 145.0 DEGREES.

B212R1 Shroud Weld H5 Faulted

DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)

DATE OF CURRENT ANALYSIS: 03/05/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 799. psi
 Bending Stress, Pb = 2559. psi
 Safety Factor, SF = 1.39
 Mean Radius, Rm = 88.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 2.2E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	1.8	10.2	1.500
2	14.8	18.2	1.500
3	42.8	48.2	1.500
4	71.8	78.2	1.500
5	101.8	108.2	1.500
6	131.8	138.2	1.500
7	221.8	224.2	1.500
8	281.8	288.2	1.500
9	351.8	358.2	1.500

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb' [psi]	SAFETY FACTOR	RESULT
0.0	3.171E+08	8690.	2.83	ACCEPTABLE
5.0	3.320E+08	9097.	2.95	ACCEPTABLE
10.0	3.443E+08	9435.	3.05	ACCEPTABLE
15.0	3.540E+08	9701.	3.13	ACCEPTABLE
20.0	3.598E+08	9859.	3.17	ACCEPTABLE
25.0	3.623E+08	9927.	3.19	ACCEPTABLE
30.0	3.627E+08	9939.	3.20	ACCEPTABLE
35.0	3.667E+08	10048.	3.23	ACCEPTABLE
40.0	3.679E+08	10080.	3.24	ACCEPTABLE
45.0	3.677E+08	10075.	3.24	ACCEPTABLE
50.0	3.668E+08	10052.	3.23	ACCEPTABLE
55.0	3.632E+08	9953.	3.20	ACCEPTABLE
60.0	3.568E+08	9778.	3.15	ACCEPTABLE
65.0	3.477E+08	9528.	3.08	ACCEPTABLE
70.0	3.360E+08	9206.	2.98	ACCEPTABLE
75.0	3.144E+08	8614.	2.80	ACCEPTABLE
80.0	3.221E+08	8827.	2.87	ACCEPTABLE
85.0	3.186E+08	8730.	2.84	ACCEPTABLE
90.0	3.133E+08	8585.	2.79	ACCEPTABLE
95.0	3.118E+08	8543.	2.78	ACCEPTABLE
100.0	3.079E+08	8437.	2.75	ACCEPTABLE
105.0	3.016E+08	8266.	2.70	ACCEPTABLE
110.0	2.931E+08	8032.	2.63	ACCEPTABLE
115.0	2.823E+08	7737.	2.54	ACCEPTABLE
120.0	2.694E+08	7383.	2.44	ACCEPTABLE
125.0	2.410E+08	6603.	2.20	ACCEPTABLE
130.0	2.505E+08	6864.	2.28	ACCEPTABLE
135.0	2.434E+08	6671.	2.22	ACCEPTABLE
140.0	2.351E+08	6442.	2.16	ACCEPTABLE

145.0	2.195E+08	6015.	2.03	ACCEPTABLE
150.0	2.386E+08	6539.	2.19	ACCEPTABLE
155.0	2.440E+08	6685.	2.23	ACCEPTABLE
160.0	2.461E+08	6798.	2.26	ACCEPTABLE
165.0	2.605E+08	7138.	2.36	ACCEPTABLE
170.0	2.803E+08	7681.	2.53	ACCEPTABLE
175.0	2.998E+08	8217.	2.68	ACCEPTABLE
180.0	3.171E+08	8690.	2.83	ACCEPTABLE
185.0	3.320E+08	9097.	2.95	ACCEPTABLE
190.0	3.443E+08	9435.	3.05	ACCEPTABLE
195.0	3.540E+08	9701.	3.13	ACCEPTABLE
200.0	3.598E+08	9859.	3.17	ACCEPTABLE
205.0	3.623E+08	9927.	3.19	ACCEPTABLE
210.0	3.627E+08	9939.	3.20	ACCEPTABLE
215.0	3.667E+08	10048.	3.23	ACCEPTABLE
220.0	3.679E+08	10080.	3.24	ACCEPTABLE
225.0	3.677E+08	10075.	3.24	ACCEPTABLE
230.0	3.668E+08	10052.	3.23	ACCEPTABLE
235.0	3.632E+08	9953.	3.20	ACCEPTABLE
240.0	3.568E+08	9778.	3.15	ACCEPTABLE
245.0	3.477E+08	9528.	3.08	ACCEPTABLE
250.0	3.360E+08	9206.	2.98	ACCEPTABLE
255.0	3.144E+08	8614.	2.80	ACCEPTABLE
260.0	3.221E+08	8827.	2.87	ACCEPTABLE
265.0	3.186E+08	8730.	2.84	ACCEPTABLE
270.0	3.133E+08	8585.	2.79	ACCEPTABLE
275.0	3.118E+08	8543.	2.78	ACCEPTABLE
280.0	3.079E+08	8437.	2.75	ACCEPTABLE
285.0	3.016E+08	8266.	2.70	ACCEPTABLE
290.0	2.931E+08	8032.	2.63	ACCEPTABLE
295.0	2.823E+08	7737.	2.54	ACCEPTABLE
300.0	2.694E+08	7383.	2.44	ACCEPTABLE
305.0	2.410E+08	6603.	2.20	ACCEPTABLE
310.0	2.505E+08	6864.	2.28	ACCEPTABLE
315.0	2.434E+08	6671.	2.22	ACCEPTABLE
320.0	2.351E+08	6442.	2.16	ACCEPTABLE
325.0	2.195E+08	6015.	2.03	ACCEPTABLE
330.0	2.386E+08	6539.	2.19	ACCEPTABLE
335.0	2.440E+08	6685.	2.23	ACCEPTABLE
340.0	2.461E+08	6798.	2.26	ACCEPTABLE
345.0	2.605E+08	7138.	2.36	ACCEPTABLE
350.0	2.803E+08	7681.	2.53	ACCEPTABLE
355.0	2.998E+08	8217.	2.68	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 2.03 AT 145.0 DEGREES.

Plant ID:	BNP2
Weld ID:	H6A
Data ID:	B212R1

Shroud in	1.5 in
OD =	177.5 in
Crack Growth Rate =	5E-05 in/hr
Total Inspection Uncertainty =	0.00 in

Prepared By: _____ date _____

Verified By: _____

[illegible][illegible][illegible][illegible][illegible]

NOTES

- (1) Ligament Data from B212RTGE Examination Summary Sheet
- (2) Crack growth is applied at each end of ligament
- (3) Calculation for End of Evaluation Ligament Data includes uncertainty if applicable
- (4) Days to Fully Cracked = days till ligament length is zero (actually = uncertainty + ASME crack proximity rule) for each ligament.
- (5) High Flux Zone = plus or minus 15 degrees from azimuths 45, 135, 225 and 315 (ie 30-60 etc.)
- (6) Weld H6A will not reach LEFM threshold level for neutron embrittlement (3×10^{-20}) within current operating license.
- (7) $1 \text{ deg} = 1.54898 \text{ in}$
- (8) Uninspected regions assumed fully cracked. All cracks assumed through-wall
- (9) L_{calc} = minimum required ligament length for limit load concerns - reference Structural Integrity report SIR-94-029 Rev. 0
- (10) $L_{min} = L_{calc} + 2(\text{Crack Growth in Evaluation Period}) + \text{Total Inspection Uncertainty}$

B212R1 Shroud Weld H6a Normal/Upset Evaluation
 DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)
 DATE OF CURRENT ANALYSIS: 02/28/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 320. psi
 Bending Stress, Pb = 2162. psi
 Safety Factor, SF = 2.77
 Mean Radius, Rm = 88.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 1.9E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	19.0	75.4	1.500
2	88.2	143.3	1.500
3	146.9	185.6	1.500
4	197.2	217.4	1.500
5	227.6	26.9	1.500
6	267.0	336.7	1.500

LIMIT LOAD RESULTS:

ALPHA [deg.]	MOMENT [in-lbs]	Pb' [psi]	SAFETY FACTOR	RESULT
7.0	1.933E+09	52972.	21.47	ACCEPTABLE
5.0	1.922E+09	52665.	21.35	ACCEPTABLE
10.0	1.896E+09	51957.	21.06	ACCEPTABLE
15.0	1.856E+09	50854.	20.62	ACCEPTABLE
20.0	1.802E+09	49368.	20.02	ACCEPTABLE
25.0	1.746E+09	47846.	19.41	ACCEPTABLE
30.0	1.695E+09	46450.	18.84	ACCEPTABLE
35.0	1.649E+09	45193.	18.34	ACCEPTABLE
40.0	1.609E+09	44083.	17.89	ACCEPTABLE
45.0	1.573E+09	43094.	17.49	ACCEPTABLE
50.0	1.536E+09	42081.	17.08	ACCEPTABLE
55.0	1.506E+09	41264.	16.75	ACCEPTABLE
60.0	1.482E+09	40624.	16.50	ACCEPTABLE
65.0	1.466E+09	40165.	16.31	ACCEPTABLE
70.0	1.456E+09	39891.	16.20	ACCEPTABLE
75.0	1.453E+09	39805.	16.17	ACCEPTABLE
80.0	1.453E+09	39828.	16.18	ACCEPTABLE
85.0	1.442E+09	39713.	16.05	ACCEPTABLE
90.0	1.430E+09	39181.	15.92	ACCEPTABLE
95.0	1.418E+09	38870.	15.79	ACCEPTABLE
100.0	1.414E+09	38755.	15.74	ACCEPTABLE
105.0	1.417E+09	38836.	15.78	ACCEPTABLE
110.0	1.427E+09	39112.	15.89	ACCEPTABLE
115.0	1.444E+09	39582.	16.08	ACCEPTABLE
120.0	1.469E+09	40241.	16.34	ACCEPTABLE
125.0	1.499E+09	41086.	16.68	ACCEPTABLE
130.0	1.537E+09	42109.	17.09	ACCEPTABLE
135.0	1.580E+09	43302.	17.58	ACCEPTABLE
140.0	1.630E+09	44657.	18.12	ACCEPTABLE
145.0	1.681E+09	46051.	18.68	ACCEPTABLE
150.0	1.735E+09	47550.	19.29	ACCEPTABLE
155.0	1.794E+09	49172.	19.94	ACCEPTABLE

160.0	1.842E+09	50474.	20.47	ACCEPTABLE
165.0	1.875E+09	51392.	20.83	ACCEPTABLE
170.0	1.895E+09	51919.	21.05	ACCEPTABLE
175.0	1.900E+09	52069.	21.11	ACCEPTABLE
180.0	1.904E+09	52165.	21.15	ACCEPTABLE
185.0	1.899E+09	52044.	21.10	ACCEPTABLE
190.0	1.880E+09	51527.	20.89	ACCEPTABLE
195.0	1.847E+09	50618.	20.52	ACCEPTABLE
200.0	1.800E+09	49324.	20.09	ACCEPTABLE
205.0	1.744E+09	47787.	19.38	ACCEPTABLE
210.0	1.693E+09	46391.	18.82	ACCEPTABLE
215.0	1.647E+09	45134.	18.31	ACCEPTABLE
220.0	1.607E+09	44024.	17.87	ACCEPTABLE
225.0	1.567E+09	42932.	17.43	ACCEPTABLE
230.0	1.531E+09	41944.	17.03	ACCEPTABLE
235.0	1.501E+09	41127.	16.70	ACCEPTABLE
240.0	1.477E+09	40486.	16.44	ACCEPTABLE
245.0	1.461E+09	40027.	16.26	ACCEPTABLE
250.0	1.451E+09	39754.	16.15	ACCEPTABLE
255.0	1.448E+09	39667.	16.11	ACCEPTABLE
260.0	1.447E+09	39656.	16.11	ACCEPTABLE
265.0	1.443E+09	39542.	16.06	ACCEPTABLE
270.0	1.430E+09	39181.	15.92	ACCEPTABLE
275.0	1.418E+09	38870.	15.79	ACCEPTABLE
280.0	1.414E+09	38755.	15.74	ACCEPTABLE
285.0	1.417E+09	38836.	15.78	ACCEPTABLE
290.0	1.427E+09	39112.	15.89	ACCEPTABLE
295.0	1.444E+09	39582.	16.08	ACCEPTABLE
300.0	1.469E+09	40241.	16.34	ACCEPTABLE
305.0	1.499E+09	41086.	16.68	ACCEPTABLE
310.0	1.537E+09	42109.	17.09	ACCEPTABLE
315.0	1.580E+09	43302.	17.58	ACCEPTABLE
320.0	1.630E+09	44657.	18.12	ACCEPTABLE
325.0	1.685E+09	46154.	18.73	ACCEPTABLE
330.0	1.739E+09	47648.	19.33	ACCEPTABLE
335.0	1.798E+09	49275.	19.98	ACCEPTABLE
340.0	1.853E+09	50788.	20.59	ACCEPTABLE
345.0	1.894E+09	51899.	21.04	ACCEPTABLE
350.0	1.920E+09	52615.	21.33	ACCEPTABLE
355.0	1.932E+09	52931.	21.45	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 15.74 AT 100.0 DEGREES.

B212R1 Shroud Weld H6a Faulted Evaluation
 DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)
 DATE OF CURRENT ANALYSIS: 02/28/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 1079. psi
 Bending Stress, Pb = 3109. psi
 Safety Factor, SF = 1.39
 Mean Radius, Rm = 88.00 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 1.9E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	19.0	75.4	1.500
2	88.2	143.3	1.500
3	146.9	156.6	1.500
4	197.2	223.4	1.500
5	227.6	240.9	1.500
6	267.0	336.7	1.500

LIMIT LOAD RESULTS:

ALPHA [deg.]	MOMENT [in-lbs]	Pb [psi]	SAFETY FACTOR	RESULT
0	1.932E+09	52935.	12.90	ACCEPTABLE
5.0	1.920E+09	52627.	12.82	ACCEPTABLE
10.0	1.895E+09	51918.	12.65	ACCEPTABLE
15.0	1.854E+09	50814.	12.39	ACCEPTABLE
20.0	1.799E+09	49309.	12.03	ACCEPTABLE
25.0	1.744E+09	47787.	11.67	ACCEPTABLE
30.0	1.693E+09	46391.	11.33	ACCEPTABLE
35.0	1.647E+09	45134.	11.03	ACCEPTABLE
40.0	1.607E+09	44024.	10.77	ACCEPTABLE
45.0	1.572E+09	43069.	10.54	ACCEPTABLE
50.0	1.538E+09	42140.	10.32	ACCEPTABLE
55.0	1.508E+09	41323.	10.12	ACCEPTABLE
60.0	1.485E+09	40683.	9.97	ACCEPTABLE
65.0	1.468E+09	40224.	9.86	ACCEPTABLE
70.0	1.458E+09	39950.	9.80	ACCEPTABLE
75.0	1.455E+09	39864.	9.78	ACCEPTABLE
80.0	1.450E+09	39724.	9.74	ACCEPTABLE
85.0	1.438E+09	39395.	9.66	ACCEPTABLE
90.0	1.427E+09	39117.	9.60	ACCEPTABLE
95.0	1.415E+09	38772.	9.52	ACCEPTABLE
100.0	1.411E+09	38657.	9.49	ACCEPTABLE
105.0	1.414E+09	38738.	9.51	ACCEPTABLE
110.0	1.424E+09	39014.	9.57	ACCEPTABLE
115.0	1.441E+09	39484.	9.69	ACCEPTABLE
120.0	1.465E+09	40143.	9.84	ACCEPTABLE
125.0	1.496E+09	40988.	10.04	ACCEPTABLE
130.0	1.533E+09	42011.	10.29	ACCEPTABLE
135.0	1.577E+09	43204.	10.57	ACCEPTABLE
140.0	1.626E+09	44559.	10.90	ACCEPTABLE
145.0	1.678E+09	45972.	11.23	ACCEPTABLE
150.0	1.732E+09	47471.	11.59	ACCEPTABLE
155.0	1.787E+09	48981.	11.95	ACCEPTABLE

160.0	1.830E+09	50137.	12.23	ACCEPTABLE
165.0	1.858E+09	50912.	12.41	ACCEPTABLE
170.0	1.872E+09	51300.	12.51	ACCEPTABLE
175.0	1.866E+09	51135.	12.47	ACCEPTABLE
180.0	1.870E+09	51231.	12.49	ACCEPTABLE
185.0	1.879E+09	51480.	12.55	ACCEPTABLE
190.0	1.865E+09	51104.	12.46	ACCEPTABLE
195.0	1.837E+09	50339.	12.28	ACCEPTABLE
200.0	1.795E+09	49191.	12.00	ACCEPTABLE
205.0	1.742E+09	47728.	11.65	ACCEPTABLE
210.0	1.691E+09	46332.	11.32	ACCEPTABLE
215.0	1.645E+09	45075.	11.02	ACCEPTABLE
220.0	1.604E+09	43965.	10.76	ACCEPTABLE
225.0	1.563E+09	42833.	10.49	ACCEPTABLE
230.0	1.527E+09	41846.	10.25	ACCEPTABLE
235.0	1.497E+09	41028.	10.05	ACCEPTABLE
240.0	1.474E+09	40388.	9.90	ACCEPTABLE
245.0	1.457E+09	39929.	9.79	ACCEPTABLE
250.0	1.447E+09	39655.	9.73	ACCEPTABLE
255.0	1.444E+09	39569.	9.71	ACCEPTABLE
260.0	1.435E+09	39323.	9.65	ACCEPTABLE
265.0	1.436E+09	39351.	9.65	ACCEPTABLE
270.0	1.427E+09	39142.	9.60	ACCEPTABLE
275.0	1.417E+09	38831.	9.53	ACCEPTABLE
280.0	1.413E+09	38716.	9.50	ACCEPTABLE
285.0	1.416E+09	38796.	9.52	ACCEPTABLE
290.0	1.426E+09	39073.	9.59	ACCEPTABLE
295.0	1.443E+09	39543.	9.70	ACCEPTABLE
300.0	1.467E+09	40202.	9.86	ACCEPTABLE
305.0	1.498E+09	41047.	10.06	ACCEPTABLE
310.0	1.535E+09	42070.	10.30	ACCEPTABLE
315.0	1.579E+09	43263.	10.59	ACCEPTABLE
320.0	1.628E+09	44618.	10.91	ACCEPTABLE
325.0	1.683E+09	46124.	11.27	ACCEPTABLE
330.0	1.739E+09	47648.	11.63	ACCEPTABLE
335.0	1.798E+09	49275.	12.02	ACCEPTABLE
340.0	1.853E+09	50788.	12.38	ACCEPTABLE
345.0	1.894E+09	51899.	12.65	ACCEPTABLE
350.0	1.920E+09	52615.	12.82	ACCEPTABLE
355.0	1.932E+09	52931.	12.90	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 9.49 AT 100.0 DEGREES.

Shroud to	1.5 in
OD =	177.5 in
Crack Growth Rate =	5E-05 in/hr
Total Inspection Uncertainty =	0.00 in

Prepared By: _____ date _____

Verified By: _____

Existing L₅₀ament Length (in) = 134.9

EOE Lig. Length (in) = 88.4

No	Yes
Yes	Yes
Yes	Yes
No	No
No	No
No	No
No	No
Yes	Yes
Yes	Yes
No	No

205.3	211.4
213.8	219.3
261.7	272.7
301.2	303.3
305.8	312.7
332.9	340.8

This Table	Not Applicable for
Weld H6B	

Since EOE Ligament Length $< L_{min}$, a detailed limit load analysis is required (DLL computer program).

(1) Ligament Data from B212r1GE Examination Summary Sheet

(2) Crack growth is applied at each end of ligament

(3) Calculation for End of Evaluation Ligament Data includes uncertainty if applicable.

(4) Days to Fully Cracked = days till ligament length is zero (actually = uncertainty + ASME crack proximity rule) for each ligament.

(5) High Flux Zone = plus or minus 15 degrees from azimuths 45, 135, 225 and 315 (ie 30-60 etc.)

Weld HSB will not reach LEFM threshold level for neutron embrittlement (3×10^{-20}) within current operating license.

(7) $1deg = 1.54898$ in

(8) Uninspected regions assumed fully cracked. All cracks assumed through-wall

$L_{calc} =$ minimum required ligament length for limit load concerns - reference Structural Integrity report SIR-94-029 Rev. 0

(10) $L_{min} = L_{calc} + 2(Crack Growth in Evaluation Period) + Total Inspection Uncertainty$

Indication Number	Start Angle	Finish Angle	Measured Thickness	EDE Thickness	Comments	Angle Cheek	DLL Input	Length (inches)
N/A	0.00	14.19	N/A	0.000	Uninspected	O.K.		
1	14.19	14.84	1.150	0.324		O.K.	14.19.14.84.0.324	
1	1.84	15.49	1.120	0.294		O.K.	14.84.15.49.0.294	
1	15.49	16.14	0.750	0.000	Cracked	O.K.		
1	16.14	16.79	0.750	0.000	Cracked	O.K.		
1	16.79	17.44	1.250	0.424		O.K.	16.79.17.44.0.424	
1	17.44	18.09	1.150	0.334		O.K.	17.44.18.09.0.334	
1	18.09	18.74	1.370	0.544		O.K.	18.09.18.74.0.544	
1	18.74	19.39	0.930	0.100		O.K.	18.74.19.39.0.104	
1	19.39	20.04	1.240	0.434		O.K.	19.39.20.04.0.414	
1	20.04	20.69	0.940	0.114		O.K.	20.04.20.69.0.114	
1	20.69	21.34	1.030	0.204		O.K.	20.69.21.34.0.204	
1	21.34	21.49	1.330	0.504		O.K.	21.34.21.49.0.504	
N/A	21.49	23.31	1.500	0.674		O.K.	21.49.23.31.1.500	2.72
2	23.31	23.96	0.970	0.144		O.K.	23.31.23.96.0.144	
2	23.96	24.61	1.040	0.214		O.K.	23.96.24.61.0.214	
2	24.61	25.26	1.300	0.474		O.K.	24.61.25.26.0.474	
2	25.26	25.91	0.880	0.154		O.K.	25.26.25.91.0.154	
2	25.91	26.56	0.900	0.074		O.K.	25.91.26.56.0.074	
2	26.56	27.21	0.730	0.000	Cracked	O.K.		
2	27.21	27.83	0.750	0.000	Cracked	O.K.		
2	27.83	28.51	1.500	0.674		O.K.	27.83.28.51.1.500	1.01
2	28.51	29.16	1.060	0.214		O.K.	28.51.29.16.0.234	
2	29.16	29.81	1.260	0.434		O.K.	29.16.29.81.0.434	
2	29.81	30.46	1.250	0.424		O.K.	29.81.30.46.0.424	
2	30.46	31.11	1.290	0.464		O.K.	30.46.31.11.0.464	
2	31.11	31.77	0.890	0.054		O.K.	31.11.31.77.0.054	
N/A	31.77	33.19	1.500	0.674		O.K.	31.77.33.19.1.500	2.94
3	33.19	33.84	0.960	0.134		O.K.	33.19.33.84.0.134	
3	33.84	34.49	1.000	0.174		O.K.	33.84.34.49.0.174	
3	34.49	35.14	1.250	0.424		O.K.	34.49.35.14.0.424	
3	35.14	35.79	1.230	0.404		O.K.	35.14.35.79.0.404	
3	35.79	36.44	1.300	0.474		O.K.	35.79.36.44.0.474	
3	36.44	37.09	1.470	0.594		O.K.	36.44.37.09.0.594	
3	37.09	37.74	1.500	0.674		O.K.	37.09.37.74.1.500	0.97
N/A	37.74	41.10	1.500	1.500		O.K.	37.74.41.10.1.500	5.21
4	41.10	41.75	1.370	0.544		O.K.	41.10.41.75.0.544	
4	41.75	42.40	1.450	0.624		O.K.	41.75.42.40.0.624	
4	42.40	43.05	1.410	0.584		O.K.	42.40.43.05.0.584	
4	43.05	43.70	1.410	0.584		O.K.	43.05.43.70.0.584	
4	43.70	44.35	1.500	0.674		O.K.	43.70.44.35.1.500	0.97
4	44.35	45.00	1.460	0.634		O.K.	44.35.45.00.0.634	
4	45.00	45.65	1.380	0.554		O.K.	45.00.45.65.0.554	
4	45.65	46.30	1.370	0.544		O.K.	45.65.46.30.0.544	
4	46.30	46.95	1.100	0.274		O.K.	46.30.46.95.0.274	
4	46.95	47.60	1.170	0.344		O.K.	46.95.47.60.0.344	
4	47.60	48.25	1.500	0.674		O.K.	47.60.48.25.1.500	0.97
4	48.25	48.90	1.500	0.674		O.K.	48.25.48.90.1.500	0.21
N/A	48.90	53.19	1.500	1.500		O.K.	48.90.53.19.1.500	7.18
5	53.19	53.84	1.420	0.594		O.K.	53.19.53.84.0.594	
5	53.84	54.49	1.280	0.454		O.K.	53.84.54.49.0.454	
5	54.49	55.14	1.380	0.554		O.K.	54.49.55.14.0.554	
5	55.14	55.79	1.280	0.454		O.K.	55.14.55.79.0.454	
5	55.79	56.44	1.270	0.444		O.K.	55.79.56.44.0.444	
N/A	56.44	60.19	1.500	1.500		O.K.	56.44.60.19.1.500	5.60
6	60.19	60.84	1.500	0.674		O.K.	60.19.60.84.1.500	0.97
6	60.84	61.49	1.280	0.454		O.K.	60.84.61.49.0.454	
6	61.49	62.14	1.430	0.604		O.K.	61.49.62.14.0.604	
7	62.14	62.84	1.500	0.674		O.K.	62.14.62.84.1.500	0.97
7	62.84	63.49	1.000	0.174		O.K.	62.84.63.49.0.174	
7	63.49	64.14	1.500	0.674		O.K.	63.49.64.14.1.500	0.30
8	64.14	64.79	1.500	0.674		O.K.	64.14.64.79.1.500	0.97
8	64.79	65.44	1.400	0.574		O.K.	64.79.65.44.0.574	
8	65.44	66.09	1.250	0.404		O.K.	65.44.66.09.0.424	
8	66.09	66.74	1.360	0.534		O.K.	66.09.66.74.0.534	
8	66.74	67.39	1.250	0.424		O.K.	66.74.67.39.0.424	
8	67.39	68.04	1.000	0.174		O.K.	67.39.68.04.0.174	
8	68.04	68.69	1.400	0.574		O.K.	68.04.68.69.0.574	
8	68.69	69.34	1.280	0.454		O.K.	68.69.69.34.0.454	
8	69.34	70.00	1.500	0.674		O.K.	69.34.70.00.1.500	0.97
8	70.00	70.65	0.890	0.154		O.K.	70.00.70.65.0.154	
8	70.65	71.30	1.320	0.484		O.K.	70.65.71.30.0.484	
9	71.30	71.95	1.500	0.674		O.K.	71.30.71.95.1.500	0.58
10	71.95	72.60	1.310	0.484		O.K.	71.95.72.60.0.484	
10	72.60	73.25	1.200	0.374		O.K.	72.60.73.25.0.374	
10	73.25	73.90	1.220	0.394		O.K.	73.25.73.90.0.394	
11	73.90	74.55	1.430	0.604		O.K.	73.90.74.55.0.604	
11	74.55	75.20	1.210	0.384		O.K.	74.55.75.20.0.384	
11	75.20	75.85	1.400	0.574		O.K.	75.20.75.85.0.574	
11	75.85	76.50	1.280	0.454		O.K.	75.85.76.50.0.454	
11	76.50	77.15	1.240	0.414		O.K.	76.50.77.15.0.414	
11	77.15	77.80	1.320	0.494		O.K.	77.15.77.80.0.494	
11	77.80	78.45	1.190	0.364		O.K.	77.80.78.45.0.364	
11	78.45	79.10	1.180	0.354		O.K.	78.45.79.10.0.354	
11	79.10	79.75	1.120	0.294		O.K.	79.10.79.75.0.294	
11	79.75	80.40	1.500	0.674		O.K.	79.75.80.40.1.500	0.97
11	80.40	81.05	1.500	0.674		O.K.	80.40.81.05.1.500	0.75
12	81.05	81.70	1.500	0.674		O.K.	81.05.81.70.1.500	0.97
12	81.70	82.35	1.500	0.674		O.K.	81.70.82.35.1.500	0.97
12	82.35	83.00	1.500	0.674		O.K.	82.35.83.00.1.500	0.97

1.54885

12	82.79	83.44	1.200	0.464	O.K.	82.79 83.44 0.464	
12	83.44	84.09	1.260	0.434	O.K.	83.44 84.09 0.434	
12	84.09	84.74	1.260	0.434	O.K.	84.09 84.74 0.434	
12	84.74	85.39	1.340	0.514	O.K.	84.74 85.39 0.514	
12	85.39	86.04	1.300	0.474	O.K.	85.39 86.04 0.474	
12	86.04	86.69	1.350	0.524	O.K.	86.04 86.69 0.524	
12	86.69	87.34	1.300	0.474	O.K.	86.69 87.34 0.474	
12	87.34	87.99	1.330	0.504	O.K.	87.34 87.99 0.504	
12	87.99	88.64	1.380	0.554	O.K.	87.99 88.64 0.554	
12	88.64	89.29	1.310	0.484	O.K.	88.64 89.29 0.484	
12	89.29	89.94	1.500	0.674	O.K.	89.29 89.94 1.500	0.97
12	89.94	90.59	1.500	0.674	O.K.	89.94 90.59 1.500	0.97
12	90.59	91.24	1.480	0.654	O.K.	90.59 91.24 0.654	
12	91.24	91.89	1.260	0.434	O.K.	91.24 91.89 0.434	
12	91.89	92.54	1.500	0.674	O.K.	91.89 92.54 1.500	0.97
12	92.54	93.19	1.260	0.434	O.K.	92.54 93.19 0.434	
13	93.19	93.84	1.400	0.574	O.K.	93.19 93.84 0.574	
13	93.84	94.49	0.990	0.164	O.K.	93.84 94.49 0.164	
13	94.49	95.14	0.980	0.154	O.K.	94.49 95.14 0.154	
13	95.14	95.79	0.980	0.154	O.K.	95.14 95.79 0.154	
13	95.79	96.44	1.090	0.264	O.K.	95.79 96.44 0.264	
13	96.44	97.09	1.370	0.544	O.K.	96.44 97.09 0.544	
13	97.09	97.74	1.230	0.404	O.K.	97.09 97.74 0.404	
13	97.74	98.39	1.190	0.364	O.K.	97.74 98.39 0.364	
13	98.39	99.04	0.900	0.144	O.K.	98.39 99.04 0.144	
13	99.04	99.69	0.780	0.100	O.K.		
13	99.69	100.34	0.810	0.100	O.K.		
13	100.34	100.99	1.000	0.174	O.K.	100.34 100.99 0.174	
13	100.99	101.64	1.260	0.434	O.K.	100.99 101.64 0.434	
13	101.64	102.29	1.250	0.424	O.K.	101.64 102.29 0.424	
13	102.29	102.94	1.280	0.454	O.K.	102.29 102.94 0.454	
13	102.94	103.59	1.350	0.524	O.K.	102.94 103.59 0.524	0.97
13	103.59	104.24	1.500	0.674	O.K.	103.59 104.24 1.500	
13	104.24	104.89	1.390	0.584	O.K.	104.24 104.89 0.584	
13	104.89	105.54	1.380	0.564	O.K.	104.89 105.54 0.564	
13	105.54	106.19	1.500	0.674	O.K.	105.54 106.19 1.500	0.97
13	106.19	106.84	1.380	0.534	O.K.	106.19 106.84 0.534	
14	106.84	107.49	1.250	0.424	O.K.	106.84 107.49 0.424	
14	107.49	108.14	0.900	0.144	O.K.	107.49 108.14 0.144	
14	108.14	108.79	0.850	0.124	O.K.	108.14 108.79 0.124	
14	108.79	109.44	0.930	0.154	O.K.	108.79 109.44 0.154	
14	109.44	110.09	1.500	0.674	O.K.	109.44 110.09 1.500	0.97
14	110.09	110.74	1.250	0.424	O.K.	110.09 110.74 0.424	
14	110.74	111.39	1.290	0.464	O.K.	110.74 111.39 0.464	
14	111.39	112.04	1.310	0.484	O.K.	111.39 112.04 0.484	
14	112.04	112.69	1.100	0.274	O.K.	112.04 112.69 0.274	
14	112.69	113.34	1.290	0.464	O.K.	112.69 113.34 0.464	
15	113.34	113.99	1.330	0.504	O.K.	113.34 113.99 0.504	
15	113.99	114.64	1.260	0.434	O.K.	113.99 114.64 0.434	
15	114.64	115.29	0.900	0.144	O.K.	114.64 115.29 0.144	
15	115.29	115.94	1.050	0.224	O.K.	115.29 115.94 0.224	
15	115.94	116.59	0.760	0.100	O.K.		
15	116.59	117.24	1.120	0.284	O.K.	116.59 117.24 0.284	
15	117.24	117.89	1.070	0.244	O.K.	117.24 117.89 0.244	
15	117.89	118.54	1.080	0.254	O.K.	117.89 118.54 0.254	
15	118.54	119.19	1.530	0.674	O.K.	118.54 119.19 1.530	1.18
15	119.19	119.84	1.250	0.424	O.K.	119.19 119.84 0.424	
15	119.84	120.49	1.380	0.554	O.K.	119.84 120.49 0.554	
15	120.49	121.14	1.000	0.174	O.K.	120.49 121.14 0.174	
15	121.14	121.79	0.870	0.144	O.K.	121.14 121.79 0.144	
15	121.79	122.44	0.840	0.144	O.K.	121.79 122.44 0.144	
15	122.44	123.09	1.270	0.444	O.K.	122.44 123.09 0.444	
15	123.09	123.74	1.380	0.534	O.K.	123.09 123.74 0.534	
15	123.74	124.39	0.790	0.100	O.K.		
15	124.39	125.04	1.310	0.484	O.K.	124.39 125.04 0.484	
15	125.04	125.69	0.970	0.144	O.K.	125.04 125.69 0.144	
15	125.69	126.34	1.210	0.384	O.K.	125.69 126.34 0.384	
15	126.34	126.99	1.000	0.174	O.K.	126.34 126.99 0.174	
15	126.99	127.64	1.250	0.424	O.K.	126.99 127.64 0.424	
15	127.64	128.29	0.900	0.144	O.K.	127.64 128.29 0.144	
15	128.29	128.94	1.170	0.364	O.K.	128.29 128.94 0.364	
15	128.94	129.59	1.240	0.414	O.K.	128.94 129.59 0.414	
15	129.59	130.24	1.190	0.364	O.K.	129.59 130.24 0.364	
15	130.24	130.89	1.170	0.344	O.K.	130.24 130.89 0.344	
15	130.89	131.54	0.880	0.154	O.K.	130.89 131.54 0.154	
15	131.54	132.19	1.330	0.504	O.K.	131.54 132.19 0.504	
15	132.19	132.84	1.050	0.314	O.K.	132.19 132.84 0.314	
15	132.84	133.49	1.390	0.564	O.K.	132.84 133.49 0.564	
15	133.49	134.14	1.310	0.484	O.K.	133.49 134.14 0.484	
15	134.14	134.79	0.930	0.154	O.K.	134.14 134.79 0.154	
15	134.79	135.44	0.980	0.154	O.K.	134.79 135.44 0.154	
15	135.44	136.09	1.240	0.414	O.K.	135.44 136.09 0.414	
15	136.09	136.74	1.210	0.384	O.K.	136.09 136.74 0.384	
15	136.74	137.39	1.280	0.454	O.K.	136.74 137.39 0.454	
15	137.39	138.04	1.350	0.524	O.K.	137.39 138.04 0.524	
15	138.04	138.69	1.220	0.394	O.K.	138.04 138.69 0.394	
15	138.69	139.34	1.210	0.384	O.K.	138.69 139.34 0.384	
15	139.34	140.00	1.230	0.404	O.K.	139.34 140.00 0.404	
15	140.00	140.64	1.110	0.354	O.K.	140.00 140.64 0.354	
15	140.64	141.29	1.500	0.674	O.K.	140.64 141.29 0.674	0.97
15	141.29	141.94	1.500	0.674	O.K.	141.29 141.94 0.674	0.82
15	141.94	142.59	1.500	0.674	O.K.	141.94 142.59 0.674	0.97
15	142.59	143.24	1.250	0.424	O.K.	142.59 143.24 0.424	

16	143.45	144.14	1.290	0.464	OK	143.45	144.14	1.290	0.464	OK
17	144.14	144.75	1.420	0.584	OK	144.14	144.75	1.420	0.584	OK
18	144.75	145.36	1.550	0.704	OK	144.75	145.36	1.550	0.704	OK
19	145.36	145.97	1.680	0.824	OK	145.36	145.97	1.680	0.824	OK
20	145.97	146.58	1.810	0.944	OK	145.97	146.58	1.810	0.944	OK
21	146.58	147.19	1.940	1.064	OK	146.58	147.19	1.940	1.064	OK
22	147.19	147.80	2.070	1.184	OK	147.19	147.80	2.070	1.184	OK
23	147.80	148.41	2.200	1.304	OK	147.80	148.41	2.200	1.304	OK
24	148.41	149.02	2.330	1.424	OK	148.41	149.02	2.330	1.424	OK
25	149.02	149.63	2.460	1.544	OK	149.02	149.63	2.460	1.544	OK
26	149.63	150.24	2.590	1.664	OK	149.63	150.24	2.590	1.664	OK
27	150.24	150.85	2.720	1.784	OK	150.24	150.85	2.720	1.784	OK
28	150.85	151.46	2.850	1.904	OK	150.85	151.46	2.850	1.904	OK
29	151.46	152.07	2.980	2.024	OK	151.46	152.07	2.980	2.024	OK
30	152.07	152.68	3.110	2.144	OK	152.07	152.68	3.110	2.144	OK
31	152.68	153.29	3.240	2.264	OK	152.68	153.29	3.240	2.264	OK
32	153.29	153.90	3.370	2.384	OK	153.29	153.90	3.370	2.384	OK
33	153.90	154.51	3.500	2.504	OK	153.90	154.51	3.500	2.504	OK
34	154.51	155.12	3.630	2.624	OK	154.51	155.12	3.630	2.624	OK
35	155.12	155.73	3.760	2.744	OK	155.12	155.73	3.760	2.744	OK
36	155.73	156.34	3.890	2.864	OK	155.73	156.34	3.890	2.864	OK
37	156.34	156.95	4.020	2.984	OK	156.34	156.95	4.020	2.984	OK
38	156.95	157.56	4.150	3.104	OK	156.95	157.56	4.150	3.104	OK
39	157.56	158.17	4.280	3.224	OK	157.56	158.17	4.280	3.224	OK
40	158.17	158.78	4.410	3.344	OK	158.17	158.78	4.410	3.344	OK
41	158.78	159.39	4.540	3.464	OK	158.78	159.39	4.540	3.464	OK
42	159.39	160.00	4.670	3.584	OK	159.39	160.00	4.670	3.584	OK
43	160.00	160.61	4.800	3.704	OK	160.00	160.61	4.800	3.704	OK
44	160.61	161.22	4.930	3.824	OK	160.61	161.22	4.930	3.824	OK
45	161.22	161.83	5.060	3.944	OK	161.22	161.83	5.060	3.944	OK
46	161.83	162.44	5.190	4.064	OK	161.83	162.44	5.190	4.064	OK
47	162.44	163.05	5.320	4.184	OK	162.44	163.05	5.320	4.184	OK
48	163.05	163.66	5.450	4.304	OK	163.05	163.66	5.450	4.304	OK
49	163.66	164.27	5.580	4.424	OK	163.66	164.27	5.580	4.424	OK
50	164.27	164.88	5.710	4.544	OK	164.27	164.88	5.710	4.544	OK
51	164.88	165.49	5.840	4.664	OK	164.88	165.49	5.840	4.664	OK
52	165.49	166.10	5.970	4.784	OK	165.49	166.10	5.970	4.784	OK
53	166.10	166.71	6.100	4.904	OK	166.10	166.71	6.100	4.904	OK
54	166.71	167.32	6.230	5.024	OK	166.71	167.32	6.230	5.024	OK
55	167.32	167.93	6.360	5.144	OK	167.32	167.93	6.360	5.144	OK
56	167.93	168.54	6.490	5.264	OK	167.93	168.54	6.490	5.264	OK
57	168.54	169.15	6.620	5.384	OK	168.54	169.15	6.620	5.384	OK
58	169.15	169.76	6.750	5.504	OK	169.15	169.76	6.750	5.504	OK
59	169.76	170.37	6.880	5.624	OK	169.76	170.37	6.880	5.624	OK
60	170.37	170.98	7.010	5.744	OK	170.37	170.98	7.010	5.744	OK
61	170.98	171.59	7.140	5.864	OK	170.98	171.59	7.140	5.864	OK
62	171.59	172.20	7.270	5.984	OK	171.59	172.20	7.270	5.984	OK
63	172.20	172.81	7.400	6.104	OK	172.20	172.81	7.400	6.104	OK
64	172.81	173.42	7.530	6.224	OK	172.81	173.42	7.530	6.224	OK
65	173.42	174.03	7.660	6.344	OK	173.42	174.03	7.660	6.344	OK
66	174.03	174.64	7.790	6.464	OK	174.03	174.64	7.790	6.464	OK
67	174.64	175.25	7.920	6.584	OK	174.64	175.25	7.920	6.584	OK
68	175.25	175.86	8.050	6.704	OK	175.25	175.86	8.050	6.704	OK
69	175.86	176.47	8.180	6.824	OK	175.86	176.47	8.180	6.824	OK
70	176.47	177.08	8.310	6.944	OK	176.47	177.08	8.310	6.944	OK
71	177.08	177.69	8.440	7.064	OK	177.08	177.69	8.440	7.064	OK
72	177.69	178.30	8.570	7.184	OK	177.69	178.30	8.570	7.184	OK
73	178.30	178.91	8.700	7.304	OK	178.30	178.91	8.700	7.304	OK
74	178.91	179.52	8.830	7.424	OK	178.91	179.52	8.830	7.424	OK
75	179.52	180.13	8.960	7.544	OK	179.52	180.13	8.960	7.544	OK
76	180.13	180.74	9.090	7.664	OK	180.13	180.74	9.090	7.664	OK
77	180.74	181.35	9.220	7.784	OK	180.74	181.35	9.220	7.784	OK
78	181.35	181.96	9.350	7.904	OK	181.35	181.96	9.350	7.904	OK
79	181.96	182.57	9.480	8.024	OK	181.96	182.57	9.480	8.024	OK
80	182.57	183.18	9.610	8.144	OK	182.57	183.18	9.610	8.144	OK
81	183.18	183.79	9.740	8.264	OK	183.18	183.79	9.740	8.264	OK
82	183.79	184.40	9.870	8.384	OK	183.79	184.40	9.870	8.384	OK
83	184.40	185.01	10.000	8.504	OK	184.40	185.01	10.000	8.504	OK
84	185.01	185.62	10.130	8.624	OK	185.01	185.62	10.130	8.624	OK
85	185.62	186.23	10.260	8.744	OK	185.62	186.23	10.260	8.744	OK
86	186.23	186.84	10.390	8.864	OK	186.23	186.84	10.390	8.864	OK
87	186.84	187.45	10.520	8.984	OK	186.84	187.45	10.520	8.984	OK
88	187.45	188.06	10.650	9.104	OK	187.45	188.06	10.650	9.104	OK
89	188.06	188.67	10.780	9.224	OK	188.06	188.67	10.780	9.224	OK
90	188.67	189.28	10.910	9.344	OK	188.67	189.28	10.910	9.344	OK
91	189.28	189.89	11.040	9.464	OK	189.28	189.89	11.040	9.464	OK
92	189.89	190.50	11.170	9.584	OK	189.89	190.50	11.170	9.584	OK
93	190.50	191.11	11.300	9.704	OK	190.50	191.11	11.300	9.704	OK
94	191.11	191.72	11.430	9.824	OK	191.11	191.72	11.430	9.824	OK
95	191.72	192.33	11.560	9.944	OK	191.72	192.33	11.560	9.944	OK
96	192.33	192.94	11.690	10.064	OK	192.33	192.94	11.690	10.064	OK
97	192.94	193.55	11.820	10.184	OK	192.94	193.55	11.820	10.184	OK
98	193.55	194.16	11.950	10.304	OK	193.55	194.16	11.950	10.304	OK
99	194.16	194.77	12.080	10.424	OK	194.16	194.77	12.080	10.424	OK
100	194.77	195.38	12.210	10.544	OK	194.77	195.38	12.210	10.544	OK
101	195.38	195.99	12.340	10.664	OK	195.38	195.99	12.340	10.664	OK
102	195.99	196.60	12.470	10.784	OK	195.99	196.60	12.470	10.784	OK
103	196.60	197.21	12.600	10.904	OK	196.60	197.21	12.600	10.904	OK
104	197.21	197.82	12.730	11.024	OK	197.21	197.82	12.730	11.024	OK
105	197.82	198.43	12.860	11.144	OK	197.82	198.43	12.860	11.144	OK
106	198.43	199.04	12.990	11.264	OK	198.43	199.04	12.990	11.264	OK
107	199.04	199.65	13.120	11.384	OK	199.04	199.65	13.120	11.384	OK
108	199.65	200.26	13.250	11.504	OK	199.65	200.26	13.250	11.504	OK
109	200.26	200.87	13.380	11.624	OK	200.26	200.87	13.380	11.624	OK
110	200.87	201.48	13.510	11.744	OK	200.87	201.48	13.510	11.744	OK
111	201.48	202.09	13.640	11.864	OK	201.48	202.09	13.640	11.864	OK
112	202.09	202.70	13.770	11.984	OK	202.09	202.70	13.770	11.984	OK
113	202.70	203.31	13.900	12.104	OK	202.70	203.31	13.900	12.104	OK
114	203.31	203.92	14.030	12.224	OK	203.31	203.92	14.030	12.224	OK
115	203.92	204.53	14.160	12.344	OK	203.92	204.53	14.160	12.344	OK
116	204.53	205.14	14.290	12.464	OK	204.53	205.14	14.290	12.464	OK
117	205.14	205.75	14.420	12.584	OK	205.14	205.75	14.420	12.584	OK
118	205.75	206.36	14.550	12.704	OK	205.75	206.36	14.550	12.704	OK
119	206.36	206.97	14.680	12.824	OK	206.36	206.97	14.680	12.824	OK
120	206.97	207.58	14.810	12.944	OK	206.97	207.58	14.810	12.944	OK
121	207.58	208.19	14.940	13.064	OK	207.58	208.19	14.940	13.064	OK
122	208.19	208.80	15.070	13.184	OK	208.19	208.80	15.070	13.184	OK
123	208.80	209.41	15.200	13.304	OK	208.80	209.41	15.200	13.304	OK
124	209.41	210.02	15.330	13.424	OK	209.41	210.02	15.330	13.424	OK
125	210.02	210.63	15.460	13.544	OK	210.02	210.63	15.460	13.544	OK
126	210.63	211.24	15.590	13.664	OK	210.63	211.24	15.590	13.664	OK
127	211.24	211.85	15.720	13.784	OK	211.24	211.85	15.72		

31	260.71	261.36	0.654	OK	260.71 261.36 0.654	0.87
32	261.36	262.01	0.654	OK	261.36 262.01 0.654	16.70
33	262.01	273.20	1.500	OK	262.01 273.20 1.500	0.67
34	273.20	273.85	0.654	OK	273.20 273.85 0.654	
35	273.85	274.50	0.654	OK	273.85 274.50 0.654	
36	274.50	275.15	0.654	OK	274.50 275.15 0.654	
37	275.15	275.80	0.654	OK	275.15 275.80 0.654	
38	275.80	276.45	0.654	OK	275.80 276.45 0.654	
39	276.45	277.10	0.654	OK	276.45 277.10 0.654	
40	277.10	277.75	0.654	OK	277.10 277.75 0.654	
41	277.75	278.40	0.654	OK	277.75 278.40 0.654	
42	278.40	279.05	0.654	OK	278.40 279.05 0.654	
43	279.05	279.70	0.654	OK	279.05 279.70 0.654	
44	279.70	280.35	0.654	OK	279.70 280.35 0.654	
45	280.35	281.00	0.654	OK	280.35 281.00 0.654	
46	281.00	281.65	0.654	OK	281.00 281.65 0.654	
47	281.65	282.30	0.654	OK	281.65 282.30 0.654	
48	282.30	282.95	0.654	OK	282.30 282.95 0.654	
49	282.95	283.60	0.654	OK	282.95 283.60 0.654	
50	283.60	284.25	0.654	OK	283.60 284.25 0.654	
51	284.25	284.90	0.654	OK	284.25 284.90 0.654	
52	284.90	285.55	0.654	OK	284.90 285.55 0.654	
53	285.55	286.20	0.654	OK	285.55 286.20 0.654	
54	286.20	286.85	0.654	OK	286.20 286.85 0.654	
55	286.85	287.50	0.654	OK	286.85 287.50 0.654	
56	287.50	288.15	0.654	OK	287.50 288.15 0.654	
57	288.15	288.80	0.654	OK	288.15 288.80 0.654	
58	288.80	289.45	0.654	OK	288.80 289.45 0.654	
59	289.45	290.10	0.654	OK	289.45 290.10 0.654	
60	290.10	290.75	0.654	OK	290.10 290.75 0.654	
61	290.75	291.40	0.654	OK	290.75 291.40 0.654	
62	291.40	292.05	0.654	OK	291.40 292.05 0.654	
63	292.05	292.70	0.654	OK	292.05 292.70 0.654	
64	292.70	293.35	0.654	OK	292.70 293.35 0.654	
65	293.35	294.00	0.654	OK	293.35 294.00 0.654	
66	294.00	294.65	0.654	OK	294.00 294.65 0.654	
67	294.65	295.30	0.654	OK	294.65 295.30 0.654	
68	295.30	295.95	0.654	OK	295.30 295.95 0.654	
69	295.95	296.60	0.654	OK	295.95 296.60 0.654	
70	296.60	297.25	0.654	OK	296.60 297.25 0.654	
71	297.25	297.90	0.654	OK	297.25 297.90 0.654	
72	297.90	298.55	0.654	OK	297.90 298.55 0.654	
73	298.55	299.20	0.654	OK	298.55 299.20 0.654	
74	299.20	299.85	0.654	OK	299.20 299.85 0.654	
75	299.85	300.50	0.654	OK	299.85 300.50 0.654	
76	300.50	301.15	0.654	OK	300.50 301.15 0.654	
77	301.15	301.80	0.654	OK	301.15 301.80 0.654	
78	301.80	302.45	0.654	OK	301.80 302.45 0.654	
79	302.45	303.10	0.654	OK	302.45 303.10 0.654	
80	303.10	303.75	0.654	OK	303.10 303.75 0.654	
81	303.75	304.40	0.654	OK	303.75 304.40 0.654	
82	304.40	305.05	0.654	OK	304.40 305.05 0.654	
83	305.05	305.70	0.654	OK	305.05 305.70 0.654	
84	305.70	306.35	0.654	OK	305.70 306.35 0.654	
85	306.35	307.00	0.654	OK	306.35 307.00 0.654	
86	307.00	307.65	0.654	OK	307.00 307.65 0.654	
87	307.65	308.30	0.654	OK	307.65 308.30 0.654	
88	308.30	308.95	0.654	OK	308.30 308.95 0.654	
89	308.95	309.60	0.654	OK	308.95 309.60 0.654	
90	309.60	310.25	0.654	OK	309.60 310.25 0.654	
91	310.25	310.90	0.654	OK	310.25 310.90 0.654	
92	310.90	311.55	0.654	OK	310.90 311.55 0.654	
93	311.55	312.20	0.654	OK	311.55 312.20 0.654	
94	312.20	312.85	0.654	OK	312.20 312.85 0.654	
95	312.85	313.50	0.654	OK	312.85 313.50 0.654	
96	313.50	314.15	0.654	OK	313.50 314.15 0.654	
97	314.15	314.80	0.654	OK	314.15 314.80 0.654	
98	314.80	315.45	0.654	OK	314.80 315.45 0.654	
99	315.45	316.10	0.654	OK	315.45 316.10 0.654	
100	316.10	316.75	0.654	OK	316.10 316.75 0.654	
101	316.75	317.40	0.654	OK	316.75 317.40 0.654	
102	317.40	318.05	0.654	OK	317.40 318.05 0.654	
103	318.05	318.70	0.654	OK	318.05 318.70 0.654	
104	318.70	319.35	0.654	OK	318.70 319.35 0.654	
105	319.35	320.00	0.654	OK	319.35 320.00 0.654	
106	320.00	320.65	0.654	OK	320.00 320.65 0.654	
107	320.65	321.30	0.654	OK	320.65 321.30 0.654	
108	321.30	321.95	0.654	OK	321.30 321.95 0.654	
109	321.95	322.60	0.654	OK	321.95 322.60 0.654	
110	322.60	323.25	0.654	OK	322.60 323.25 0.654	
111	323.25	323.90	0.654	OK	323.25 323.90 0.654	
112	323.90	324.55	0.654	OK	323.90 324.55 0.654	
113	324.55	325.20	0.654	OK	324.55 325.20 0.654	
114	325.20	325.85	0.654	OK	325.20 325.85 0.654	
115	325.85	326.50	0.654	OK	325.85 326.50 0.654	
116	326.50	327.15	0.654	OK	326.50 327.15 0.654	
117	327.15	327.80	0.654	OK	327.15 327.80 0.654	
118	327.80	328.45	0.654	OK	327.80 328.45 0.654	
119	328.45	329.10	0.654	OK	328.45 329.10 0.654	
120	329.10	329.75	0.654	OK	329.10 329.75 0.654	
121	329.75	330.40	0.654	OK	329.75 330.40 0.654	
122	330.40	331.05	0.654	OK	330.40 331.05 0.654	
123	331.05	331.70	0.654	OK	331.05 331.70 0.654	
124	331.70	332.35	0.654	OK	331.70 332.35 0.654	
125	332.35	333.00	0.654	OK	332.35 333.00 0.654	
126	333.00	333.65	0.654	OK	333.00 333.65 0.654	
127	333.65	334.30	0.654	OK	333.65 334.30 0.654	
128	334.30	334.95	0.654	OK	334.30 334.95 0.654	
129	334.95	335.60	0.654	OK	334.95 335.60 0.654	
130	335.60	336.25	0.654	OK	335.60 336.25 0.654	
131	336.25	336.90	0.654	OK	336.25 336.90 0.654	
132	336.90	337.55	0.654	OK	336.90 337.55 0.654	
133	337.55	338.20	0.654	OK	337.55 338.20 0.654	
134	338.20	338.85	0.654	OK	338.20 338.85 0.654	
135	338.85	339.50	0.654	OK	338.85 339.50 0.654	
136	339.50	340.15	0.654	OK	339.50 340.15 0.654	
137	340.15	340.80	0.654	OK	340.15 340.80 0.654	
138	340.80	341.45	0.654	OK	340.80 341.45 0.654	
139	341.45	342.10	0.654	OK	341.45 342.10 0.654	
140	342.10	342.75	0.654	OK	342.10 342.75 0.654	
141	342.75	343.40	0.654	OK	342.75 343.40 0.654	
142	343.40	344.05	0.654	OK	343.40 344.05 0.654	
143	344.05	344.70	0.654	OK	344.05 344.70 0.654	
144	344.70	345.35	0.654	OK	344.70 345.35 0.654	
145	345.35	346.00	0.654	OK	345.35 346.00 0.654	
146	346.00	346.65	0.654	OK	346.00 346.65 0.654	
147	346.65	347.30	0.654	OK	346.65 347.30 0.654	
148	347.30	347.95	0.654	OK	347.30 347.95 0.654	
149	347.95	348.60	0.654	OK	347.95 348.60 0.654	
150	348.60	349.25	0.654	OK	348.60 349.25 0.654	
151	349.25	349.90	0.654	OK	349.25 349.90 0.654	
152	349.90	350.55	0.654	OK	349.90 350.55 0.654	
153	350.55	351.20	0.654	OK	350.55 351.20 0.654	
154	351.20	351.85	0.654	OK	351.20 351.85 0.654	
155	351.85	352.50	0.654	OK	351.85 352.50 0.654	
156	352.50	353.15	0.654	OK	352.50 353.15 0.654	
157	353.15	353.80	0.654	OK	353.15 353.80 0.654	
158	353.80	354.45	0.654	OK	353.80 354.45 0.654	
159	354.45	355.10	0.654	OK	354.45 355.10 0.654	
160	355.10	355.75	0.654	OK	355.10 355.75 0.654	
161	355.75	356.40	0.654	OK	355.75 356.40 0.654	
162	356.40	357.05	0.654	OK	356.40 357.05 0.654	
163	357.05	357.70	0.654	OK	357.05 357.70 0.654	
164	357.70	358.35	0.654	OK	357.70 358.35 0.654	
165	358.35	359.00	0.654	OK	358.35 359.00 0.654	
166	359.00	359.65	0.654	OK	359.00 359.65 0.654	
167	359.65	360.30	0.654	OK	359.65 360.30 0.654	
168	360.30	360.95	0.654	OK	360.30 360.95 0.654	
169	360.95	361.60	0.654	OK	360.95 361.60 0.654	
170	361.60	362.25	0.654	OK	361.60 362.25 0.654	
171	362.25	362.90	0.654	OK	362.25 362.90 0.654	
172	362.90	363.55	0.654	OK	362.90 363.55 0.654	
173	363.55	364.20	0.654	OK	363.55 364.20 0.654	
174	364.20	364.85	0.654	OK	364.20 364.85 0.654	
175	364.85	365.50	0.654	OK	364.85 365.50 0.654	
176	365.50	366.15	0.654	OK	365.50 366.15 0.654	
177	366.15	366.80	0.654	OK	366.15 366.80 0.654	
178	366.80	367.45	0.654	OK	366.80 367.45 0.654	
179	367.45	368.10	0.654	OK	367.45 368.10 0.654	
180	368.10	368.75	0.654	OK	368.10 368.75 0.654	
181	368.75	369.40	0.654	OK	368.75 369.40 0.654	
182	369.40	370.05	0.654	OK	369.40 370.05 0.654	
183	370.05	370.70	0.654	OK	370.05 370.70 0.654	
184	370.70	371.35	0.654	OK	370.70 371.35 0.65	

B212R1 Shroud Weld H6b Normal/Upset Evaluation
 DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 02/27/94)
 DATE OF CURRENT ANALYSIS: 02/28/1996

SUMMARY OF INPUTS:

Angle increment = 1.0 deg. (C)ARSE
 Membrane Stress, Pm = 309. psi
 Bending Stress, Pb = 2375. psi
 Safety Factor, SF = 2.77
 Mean Radius, Rm = 88.75 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 1.0E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	14.2	14.8	.324
2	14.8	15.5	.294
3	16.8	17.4	.424
4	17.4	18.1	.334
5	18.1	18.7	.544
6	18.7	19.4	.104
7	19.4	20.0	.414
8	20.0	20.7	.114
9	20.7	21.3	.204
10	21.3	21.5	.504
11	21.5	23.3	.674
12	23.3	24.0	.144
13	24.0	24.6	.214
14	24.6	25.3	.474
15	25.3	25.9	.154
16	25.9	26.6	.074
17	27.8	28.5	.674
18	28.5	29.2	.234
19	29.2	29.8	.434
20	29.8	30.5	.424
21	30.5	31.1	.464
22	31.1	31.2	.054
23	31.2	33.2	.674
24	33.2	33.8	.134
25	33.8	34.5	.174
26	34.5	35.1	.424
27	35.1	35.8	.404
28	35.8	36.4	.474
29	36.4	37.1	.594
30	37.1	37.8	.594
31	37.8	40.6	1.500
32	40.6	41.1	.544
33	41.1	41.8	.544
34	41.8	42.4	.624
35	42.4	43.0	.584
36	43.0	43.7	.584
37	43.7	44.3	.674
38	44.3	45.0	.634
39	45.0	45.7	.554
40	45.7	46.3	.544
41	46.3	47.0	.274
42	47.0	47.6	.344
43	47.6	48.9	.344
44	48.9	52.7	1.500
45	52.7	53.2	.594
46	53.2	53.8	.594

47	53.8	54.5	.454
48	54.5	55.1	.554
49	55.1	55.8	.454
50	55.8	56.4	.444
51	56.4	59.7	1.500
52	59.7	60.8	.454
53	60.8	61.5	.454
54	61.5	62.2	.604
55	62.2	62.8	.674
56	62.8	63.5	.174
57	63.5	63.7	.674
58	63.7	64.3	.674
59	64.3	65.0	.574
60	65.0	65.6	.424
61	65.6	66.3	.534
62	66.3	66.9	.424
63	66.9	67.6	.174
64	67.6	68.2	.574
65	68.2	68.8	.454
66	68.8	69.5	.674
67	69.5	70.1	.164
68	70.1	70.8	.494
69	70.8	71.2	.674
70	71.2	71.8	.484
71	71.8	72.5	.374
72	72.5	73.2	.394
73	73.2	73.8	.604
74	73.8	74.5	.384
75	74.5	75.1	.574
76	75.1	75.8	.454
77	75.8	76.4	.414
78	76.4	77.1	.494
79	77.1	77.7	.364
80	77.7	78.4	.334
81	78.4	79.0	.294
82	79.0	79.7	.674
83	79.7	80.2	.674
84	80.2	80.8	.674
85	80.8	81.5	.674
86	81.5	82.1	.674
87	82.1	82.8	.674
88	82.8	83.4	.464
89	83.4	84.1	.434
90	84.1	84.7	.434
91	84.7	85.4	.514
92	85.4	86.0	.474
93	86.0	86.7	.524
94	86.7	87.3	.474
95	87.3	88.0	.504
96	88.0	88.6	.554
97	88.6	89.3	.484
98	89.3	89.9	.674
99	89.9	90.6	.674
100	90.6	91.2	.654
101	91.2	91.9	.434
102	91.9	92.5	.674
103	92.5	93.2	.434
104	93.2	93.8	.574
105	93.8	94.5	.164
106	94.5	95.1	.034
107	95.1	95.8	.154
108	95.8	96.4	.264
109	96.4	97.1	.544
110	97.1	97.7	.404
111	97.7	98.4	.364
112	98.4	99.0	.074

113	100.3	101.0	.174
114	101.0	101.6	.434
115	101.6	102.3	.424
116	102.3	102.9	.454
117	102.9	103.6	.524
118	103.6	104.2	.674
119	104.2	104.9	.564
120	104.9	105.5	.564
121	105.5	106.2	.674
122	106.2	106.8	.534
123	106.8	107.5	.424
124	107.5	108.1	.074
125	108.1	108.8	.024
126	108.8	109.4	.104
127	109.4	110.1	.674
128	110.1	110.7	.424
129	110.7	111.4	.464
130	111.4	112.0	.484
131	112.0	112.7	.274
132	112.7	113.2	.464
133	113.2	113.8	.504
134	113.8	114.5	.434
135	114.5	115.1	.074
136	115.1	115.8	.224
137	116.4	117.1	.294
138	117.1	117.7	.244
139	117.7	118.4	.254
140	118.4	119.2	.674
141	119.2	119.8	.424
142	119.8	120.5	.554
143	120.5	121.1	.174
144	121.1	121.8	.044
145	121.8	122.4	.014
146	122.4	123.1	.444
147	123.1	123.7	.534
148	124.4	125.0	.484
149	125.0	125.7	.144
150	125.7	126.3	.384
151	126.3	127.0	.174
152	127.0	127.6	.424
153	127.6	128.3	.074
154	128.3	128.9	.364
155	128.9	129.6	.414
156	129.6	130.2	.364
157	130.2	130.9	.344
158	130.9	131.5	.054
159	131.5	132.2	.504
160	132.2	133.2	.534
161	133.2	133.8	.564
162	133.8	134.5	.484
163	134.5	135.1	.104
164	135.1	135.8	.154
165	135.8	136.4	.414
166	136.4	137.1	.384
167	137.1	137.7	.454
168	137.7	138.4	.524
169	138.4	139.0	.394
170	139.0	139.7	.384
171	139.7	140.3	.404
172	140.3	141.0	.284
173	141.0	141.6	.674
174	141.6	142.2	.674
175	142.2	142.8	.674
176	142.8	143.5	.424
177	143.5	144.1	.464
178	144.1	144.8	.594

179	144.8	145.4	.464
180	145.4	146.1	.234
181	146.1	146.7	.554
182	146.7	147.4	.554
183	147.4	148.0	.124
184	148.0	148.7	.184
185	148.7	149.3	.174
186	149.3	150.0	.104
187	150.0	150.6	.494
188	150.6	151.2	.324
189	151.2	151.8	.674
190	151.8	152.5	.554
191	152.5	153.1	.034
192	153.1	153.8	.674
193	196.2	196.9	.244
194	196.9	197.5	.254
195	197.5	198.1	.314
196	198.1	198.8	.344
197	198.8	199.4	.544
198	199.4	200.1	.324
199	200.1	200.8	.144
200	200.8	201.4	.264
201	201.4	202.1	.154
202	202.1	202.7	.304
203	202.7	203.8	.284
204	203.8	204.4	.194
205	204.4	204.8	.194
206	204.8	205.3	.194
207	205.3	211.4	1.500
208	211.4	212.5	.484
209	212.5	213.2	.484
210	213.2	213.8	.524
211	213.8	219.3	1.500
212	219.3	220.4	.574
213	220.4	221.1	.574
214	221.1	221.7	.674
215	221.7	222.8	.674
216	222.8	223.4	.674
217	223.4	224.1	.674
218	224.1	224.8	.534
219	224.8	225.4	.674
220	225.4	225.8	.674
221	225.8	226.5	.674
222	226.5	227.1	.134
223	227.1	227.8	.254
224	227.8	228.4	.274
225	228.4	229.1	.324
226	229.1	229.7	.524
227	229.7	230.4	.094
228	230.4	231.0	.224
229	231.0	231.7	.674
230	231.7	233.2	.674
231	233.2	233.9	.204
232	233.9	234.5	.034
233	235.1	235.8	.094
234	237.1	238.3	.674
235	238.3	238.9	.674
236	238.9	239.6	.674
237	239.6	240.2	.574
238	240.2	240.9	.524
239	240.9	241.5	.394
240	241.5	242.3	.154
241	242.3	242.9	.674
242	242.9	243.6	.424
243	243.6	244.2	.674
244	244.2	245.8	.674

245	245.8	246.5	.674
246	246.5	247.1	.414
247	247.1	247.8	.494
248	247.8	248.0	.674
249	248.0	248.6	.404
250	248.6	249.3	.554
251	249.3	249.9	.434
252	249.9	250.6	.514
253	250.6	250.9	.554
254	250.9	251.5	.674
255	251.5	252.2	.124
256	252.2	252.8	.004
257	252.8	253.2	.674
258	253.2	253.9	.074
259	254.5	255.1	.014
260	255.1	255.8	.414
261	255.8	256.5	.104
262	256.5	258.8	.674
263	258.8	259.4	.674
264	259.4	260.1	.464
265	260.7	261.4	.074
266	261.4	261.7	.074
267	261.7	272.7	1.500
268	272.7	273.9	.574
269	273.9	274.5	.574
270	274.5	275.1	.574
271	275.1	275.8	.574
272	275.8	276.5	.494
273	276.5	277.1	.674
274	277.1	278.8	.674
275	278.8	279.4	.674
276	279.4	280.1	.204
277	280.1	280.7	.424
278	281.4	282.0	.104
279	282.0	282.7	.474
280	282.7	283.3	.674
281	283.3	284.0	.674
282	284.0	284.6	.524
283	284.6	285.3	.074
284	285.9	286.6	.294
285	287.2	287.9	.404
286	287.9	288.5	.114
287	288.5	288.9	.534
288	288.9	289.5	.594
289	289.5	290.2	.494
290	290.2	290.8	.364
291	290.8	291.5	.014
292	291.5	292.1	.024
293	292.1	292.8	.674
294	292.8	293.2	.334
295	293.2	293.9	.574
296	293.9	294.5	.244
297	295.8	296.5	.074
298	296.5	297.1	.204
299	297.1	297.8	.034
300	297.8	298.4	.254
301	299.0	299.7	.454
302	299.7	300.4	.514
303	300.4	301.0	.454
304	301.0	301.6	.624
305	301.6	303.3	1.500
306	303.3	304.5	.384
307	304.5	305.1	.344
308	305.1	305.8	.344
309	305.8	312.7	1.500
310	312.7	313.2	.174

311	313.2	313.9	.174
312	313.9	314.5	.074
313	314.5	315.1	.114
314	315.1	315.8	.084
315	315.8	316.5	.154
316	316.5	317.1	.114
317	317.1	317.8	.114
318	317.8	318.4	.014
319	318.4	319.0	.054
320	319.0	319.7	.454
321	319.7	320.4	.534
322	320.4	321.0	.484
323	321.0	321.6	.474
324	321.6	322.3	.574
325	322.3	323.0	.574
326	323.0	323.6	.374
327	324.9	325.5	.064
328	325.5	326.2	.044
329	326.2	326.9	.404
330	328.8	329.5	.064
331	329.5	330.1	.064
332	331.4	332.0	.144
333	332.0	332.7	.154
334	332.7	332.9	.154
335	332.9	341.8	1.500
336	340.8	341.3	.674

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb' [psi]	SAFETY FACTOR	RESULT
0.0	7.899E+08	21282.	8.04	ACCEPTABLE
5.0	7.775E+08	20947.	7.92	ACCEPTABLE
10.0	7.768E+08	20929.	7.91	ACCEPTABLE
15.0	7.646E+08	20599.	7.79	ACCEPTABLE
20.0	7.465E+08	20113.	7.61	ACCEPTABLE
25.0	7.227E+08	19470.	7.37	ACCEPTABLE
30.0	6.986E+08	18821.	7.13	ACCEPTABLE
35.0	6.762E+08	18217.	6.90	ACCEPTABLE
40.0	6.574E+08	17713.	6.71	ACCEPTABLE
45.0	6.440E+08	17349.	6.58	ACCEPTABLE
50.0	6.322E+08	17031.	6.46	ACCEPTABLE
55.0	6.178E+08	16645.	6.32	ACCEPTABLE
60.0	6.097E+08	16425.	6.23	ACCEPTABLE
65.0	6.057E+08	16318.	6.19	ACCEPTABLE
70.0	5.950E+08	16031.	6.09	ACCEPTABLE
75.0	6.006E+08	16181.	6.14	ACCEPTABLE
80.0	6.087E+08	16399.	6.22	ACCEPTABLE
85.0	6.195E+08	16691.	6.33	ACCEPTABLE
90.0	6.337E+08	17072.	6.48	ACCEPTABLE
95.0	6.517E+08	17557.	6.66	ACCEPTABLE
100.0	6.701E+08	18054.	6.84	ACCEPTABLE
105.0	6.873E+08	18517.	7.01	ACCEPTABLE
110.0	7.035E+08	18954.	7.18	ACCEPTABLE
115.0	7.164E+08	19300.	7.31	ACCEPTABLE
120.0	7.307E+08	19686.	7.45	ACCEPTABLE
125.0	7.441E+08	20046.	7.58	ACCEPTABLE
130.0	7.560E+08	20368.	7.70	ACCEPTABLE
135.0	7.690E+08	20718.	7.83	ACCEPTABLE
140.0	7.886E+08	21247.	8.03	ACCEPTABLE
145.0	8.062E+08	21720.	8.21	ACCEPTABLE
150.0	8.180E+08	22039.	8.33	ACCEPTABLE
155.0	8.237E+08	22191.	8.38	ACCEPTABLE

160.0	8.230E+08	22174.	8.38	ACCEPTABLE
165.0	8.161E+08	21988.	8.31	ACCEPTABLE
170.0	8.031E+08	21636.	8.18	ACCEPTABLE
175.0	7.882E+08	21236.	8.03	ACCEPTABLE
180.0	7.526E+08	20276.	7.67	ACCEPTABLE
185.0	7.465E+08	20111.	7.61	ACCEPTABLE
190.0	7.482E+08	20158.	7.63	ACCEPTABLE
195.0	7.416E+08	19980.	7.56	ACCEPTABLE
200.0	7.294E+08	19650.	7.44	ACCEPTABLE
205.0	7.116E+08	19171.	7.26	ACCEPTABLE
210.0	6.885E+08	18550.	7.03	ACCEPTABLE
215.0	6.729E+08	18129.	6.87	ACCEPTABLE
220.0	6.543E+08	17627.	6.68	ACCEPTABLE
225.0	6.383E+08	17197.	6.52	ACCEPTABLE
230.0	6.240E+08	16813.	6.38	ACCEPTABLE
235.0	6.097E+08	16426.	6.23	ACCEPTABLE
240.0	6.001E+08	16167.	6.14	ACCEPTABLE
245.0	5.921E+08	15953.	6.06	ACCEPTABLE
250.0	5.856E+08	15778.	5.99	ACCEPTABLE
255.0	5.902E+08	15901.	6.04	ACCEPTABLE
260.0	6.005E+08	16179.	6.14	ACCEPTABLE
265.0	6.115E+08	16476.	6.25	ACCEPTABLE
270.0	6.292E+08	16953.	6.43	ACCEPTABLE
275.0	6.483E+08	17466.	6.62	ACCEPTABLE
280.0	6.654E+08	17926.	6.79	ACCEPTABLE
285.0	6.825E+08	18387.	6.97	ACCEPTABLE
290.0	6.970E+08	18779.	7.11	ACCEPTABLE
295.0	7.095E+08	19115.	7.24	ACCEPTABLE
300.0	7.260E+08	19560.	7.40	ACCEPTABLE
305.0	7.421E+08	19994.	7.56	ACCEPTABLE
310.0	7.593E+08	20456.	7.74	ACCEPTABLE
315.0	7.767E+08	20925.	7.91	ACCEPTABLE
320.0	7.952E+08	21423.	8.10	ACCEPTABLE
325.0	8.110E+08	21851.	8.26	ACCEPTABLE
330.0	8.241E+08	22202.	8.39	ACCEPTABLE
335.0	8.339E+08	22466.	8.49	ACCEPTABLE
340.0	8.383E+08	22585.	8.53	ACCEPTABLE
345.0	8.364E+08	22533.	8.51	ACCEPTABLE
350.0	8.280E+08	22309.	8.43	ACCEPTABLE
355.0	8.134E+08	21915.	8.28	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 5.99 AT 250.0 DEGREES.

B212R1 Shroud Weld H6b Faulted Evaluation
 DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 02/27/94)
 DATE OF CURRENT ANALYSIS: 02/28/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, P_m = 1099. psi
 Bending Stress, P_b = 3423. psi
 Safety Factor, SF = 1.39
 Mean Radius, R_m = 88.75 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, S_m = 16900. psi
 Fluence = $1.9E+19$ n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	14.2	14.8	.324
2	14.8	15.5	.294
3	16.8	17.4	.424
4	17.4	18.1	.334
5	18.1	18.7	.544
6	18.7	19.4	.104
7	19.4	20.0	.414
8	20.0	20.7	.114
9	20.7	21.3	.204
10	21.3	21.5	.504
11	21.5	23.3	.674
12	23.3	24.0	.144
13	24.0	24.6	.214
14	24.6	25.3	.474
15	25.3	25.9	.154
16	25.9	26.6	.074
17	27.8	28.5	.674
18	28.5	29.2	.234
19	29.2	29.8	.434
20	29.8	30.5	.424
21	30.5	31.1	.464
22	31.1	31.2	.054
23	31.2	33.2	.674
24	33.2	33.8	.134
25	33.8	34.5	.174
26	34.5	35.1	.424
27	35.1	35.8	.404
28	35.8	36.4	.474
29	36.4	37.1	.594
30	37.1	37.8	.594
31	37.8	40.6	1.500
32	40.6	41.1	.544
33	41.1	41.8	.544
34	41.8	42.4	.624
35	42.4	43.0	.584
36	43.0	43.7	.584
37	43.7	44.3	.674
38	44.3	45.0	.634
39	45.0	45.7	.554
40	45.7	46.3	.544
41	46.3	47.0	.274
42	47.0	47.6	.344
43	47.6	48.9	.344
44	48.9	52.7	1.500
45	52.7	53.2	.594
46	53.2	53.8	.594

47	53.8	54.5	.454
48	54.5	55.1	.554
49	55.1	55.8	.454
50	55.8	56.4	.444
51	56.4	59.7	1.500
52	59.7	60.6	.454
53	60.8	61.5	.454
54	61.5	62.2	.604
55	62.2	62.8	.674
56	62.8	63.5	.174
57	63.5	63.7	.674
58	63.7	64.3	.674
59	64.3	65.0	.574
60	65.0	65.6	.424
61	65.6	66.3	.534
62	66.3	66.9	.424
63	66.9	67.6	.174
64	67.6	68.2	.574
65	68.2	68.8	.454
66	68.8	69.5	.674
67	69.5	70.1	.164
68	70.1	70.8	.494
69	70.8	71.2	.674
70	71.2	71.8	.484
71	71.8	72.5	.374
72	72.5	73.2	.394
73	73.2	73.8	.604
74	73.8	74.5	.384
75	74.5	75.1	.574
76	75.1	75.8	.454
77	75.8	76.4	.414
78	76.4	77.1	.494
79	77.1	77.7	.364
80	77.7	78.4	.334
81	78.4	79.0	.294
82	79.0	79.7	.674
83	79.7	80.2	.674
84	80.2	80.8	.674
85	80.8	81.5	.674
86	81.5	82.1	.674
87	82.1	82.8	.674
88	82.8	83.4	.464
89	83.4	84.1	.434
90	84.1	84.7	.434
91	84.7	85.4	.514
92	85.4	86.0	.474
93	86.0	86.7	.524
94	86.7	87.3	.474
95	87.3	88.0	.504
96	88.0	88.6	.554
97	88.6	89.3	.484
98	89.3	89.9	.674
99	89.9	90.6	.674
100	90.6	91.2	.654
101	91.2	91.9	.434
102	91.9	92.5	.674
103	92.5	93.2	.434
104	93.2	93.8	.574
105	93.8	94.5	.164
106	94.5	95.1	.034
107	95.1	95.8	.154
108	95.8	96.4	.264
109	96.4	97.1	.544
110	97.1	97.7	.404
111	97.7	98.4	.364
112	98.4	99.0	.074

113	100.3	101.0	.174
114	101.0	101.6	.434
115	101.6	102.3	.424
116	102.3	102.9	.454
117	102.9	103.6	.524
118	103.6	104.2	.674
119	104.2	104.9	.564
120	104.9	105.5	.564
121	105.5	106.2	.674
122	106.2	106.8	.534
123	106.8	107.5	.424
124	107.5	108.1	.074
125	108.1	108.8	.024
126	108.8	109.4	.104
127	109.4	110.1	.674
128	110.1	110.7	.424
129	110.7	111.4	.464
130	111.4	112.0	.484
131	112.0	112.7	.274
132	112.7	113.2	.464
133	113.2	113.8	.504
134	113.8	114.5	.434
135	114.5	115.1	.074
136	115.1	115.8	.224
137	116.4	117.1	.294
138	117.1	117.7	.244
139	117.7	118.4	.254
140	118.4	119.2	.674
141	119.2	119.8	.424
142	119.8	120.5	.554
143	120.5	121.1	.174
144	121.1	121.8	.044
145	121.8	122.4	.014
146	122.4	123.1	.444
147	123.1	123.7	.534
148	124.4	125.0	.484
149	125.0	125.7	.144
150	125.7	126.3	.384
151	126.3	127.0	.174
152	127.0	127.6	.424
153	127.6	128.3	.074
154	128.3	128.9	.364
155	128.9	129.6	.414
156	129.6	130.2	.364
157	130.2	130.9	.344
158	130.9	131.5	.054
159	131.5	132.2	.504
160	132.2	133.2	.534
161	133.2	133.8	.564
162	133.8	134.5	.484
163	134.5	135.1	.104
164	135.1	135.8	.154
165	135.8	136.4	.414
166	136.4	137.1	.384
167	137.1	137.7	.454
168	137.7	138.4	.524
169	138.4	139.0	.394
170	139.0	139.7	.384
171	139.7	140.3	.404
172	140.3	141.0	.284
173	141.0	141.6	.674
174	141.6	142.2	.674
175	142.2	142.8	.674
176	142.8	143.5	.424
177	143.5	144.1	.464
178	144.1	144.8	.594

179	144.8	145.4	.464
180	145.4	146.1	.234
181	146.1	146.7	.554
182	146.7	147.4	.554
183	147.4	148.0	.124
184	148.0	148.7	.184
185	148.7	149.3	.174
186	149.3	150.0	.104
187	150.0	150.6	.494
188	150.6	151.2	.324
189	151.2	151.8	.674
190	151.8	152.5	.554
191	152.5	153.1	.034
192	153.1	153.8	.674
193	156.2	156.9	.244
194	156.9	157.5	.254
195	157.5	158.1	.314
196	158.1	158.8	.344
197	158.8	159.4	.544
198	159.4	160.1	.324
199	160.1	160.8	.144
200	160.8	161.4	.264
201	161.4	162.1	.154
202	162.1	162.7	.304
203	162.7	163.8	.284
204	163.8	164.4	.194
205	164.4	164.8	.194
206	164.8	165.3	.194
207	165.3	166.4	1.500
208	166.4	167.5	.484
209	167.5	168.2	.484
210	168.2	169.3	.524
211	169.3	170.3	1.500
212	170.3	171.4	.574
213	171.4	172.1	.574
214	172.1	172.7	.674
215	172.7	173.8	.674
216	173.8	174.4	.674
217	174.4	175.1	.674
218	175.1	176.8	.534
219	176.8	177.4	.674
220	177.4	178.8	.674
221	178.8	179.5	.674
222	179.5	180.1	.134
223	180.1	180.8	.254
224	180.8	181.4	.274
225	181.4	182.1	.324
226	182.1	182.7	.524
227	182.7	183.4	.094
228	183.4	184.0	.224
229	184.0	184.7	.674
230	184.7	185.2	.674
231	185.2	185.9	.204
232	185.9	186.5	.034
233	186.5	187.8	.094
234	187.8	188.3	.674
235	188.3	188.9	.674
236	188.9	189.6	.674
237	189.6	190.2	.574
238	190.2	190.9	.524
239	190.9	191.5	.394
240	191.5	192.3	.154
241	192.3	192.9	.674
242	192.9	193.6	.424
243	193.6	194.2	.674
244	194.2	195.8	.674

245	245.8	246.5	.674
246	246.5	247.1	.414
247	247.1	247.8	.494
248	247.8	248.0	.674
249	248.0	248.6	.404
250	248.6	249.3	.554
251	249.3	249.9	.434
252	249.9	250.6	.514
253	250.6	250.9	.554
254	250.9	251.5	.674
255	251.5	252.2	.124
256	252.2	252.8	.004
257	252.8	253.2	.674
258	253.2	253.9	.074
259	254.5	255.1	.014
260	255.1	255.8	.414
261	255.8	256.5	.104
262	256.5	258.8	.674
263	258.8	259.4	.174
264	259.4	260.1	.144
265	260.7	261.4	.014
266	261.4	261.7	.074
267	261.7	272.7	1.500
268	272.7	273.9	.574
269	273.9	274.5	.574
270	274.5	275.1	.574
271	275.1	275.8	.574
272	275.8	276.5	.494
273	276.5	277.1	.674
274	277.1	278.8	.674
275	278.8	279.4	.674
276	279.4	280.1	.204
277	280.1	280.7	.424
278	281.4	282.0	.104
279	282.0	282.7	.474
280	282.7	283.3	.674
281	283.3	284.0	.674
282	284.0	284.6	.524
283	284.6	285.3	.074
284	285.9	286.6	.294
285	287.2	287.9	.404
286	287.9	288.5	.114
287	288.5	288.9	.534
288	288.9	289.5	.594
289	289.5	290.2	.494
290	290.2	290.8	.364
291	290.8	291.5	.014
292	291.5	292.1	.024
293	292.1	292.8	.674
294	292.8	293.2	.334
295	293.2	293.9	.574
296	293.9	294.5	.244
297	295.8	296.5	.074
298	296.5	297.1	.204
299	297.1	297.8	.034
300	297.8	298.4	.254
301	299.0	299.7	.454
302	299.7	300.4	.514
303	300.4	301.0	.454
304	301.0	301.6	.624
305	301.6	303.3	1.500
306	303.3	304.5	.384
307	304.5	305.1	.344
308	305.1	305.8	.344
309	305.8	312.7	1.500
310	312.7	313.2	.174

311	313.2	313.9	.174
312	313.9	314.5	.074
313	314.5	315.1	.114
314	315.1	315.8	.084
315	315.8	316.5	.154
316	316.5	317.1	.114
317	317.1	317.8	.114
318	317.8	318.4	.014
319	318.4	319.0	.054
320	319.0	319.7	.454
321	319.7	320.4	.534
322	320.4	321.0	.484
323	321.0	321.6	.474
324	321.6	322.3	.574
325	322.3	323.0	.574
326	323.0	323.6	.374
327	324.9	325.5	.064
328	325.5	326.2	.044
329	326.2	326.9	.404
330	328.8	329.5	.064
331	329.5	330.1	.064
332	331.4	332.0	.144
333	332.0	332.7	.154
334	332.7	332.9	.154
335	332.9	341.8	1.500
336	340.8	341.3	.674

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb' [psi]	SAFETY FACTOR	RESULT
0.0	8.197E+06	22083.	5.13	ACCEPTABLE
5.0	7.952E+08	21423.	4.98	ACCEPTABLE
10.0	7.936E+08	21381.	4.97	ACCEPTABLE
15.0	7.773E+08	20942.	4.87	ACCEPTABLE
20.0	7.551E+08	20345.	4.74	ACCEPTABLE
25.0	7.280E+08	19612.	4.58	ACCEPTABLE
30.0	7.025E+08	18927.	4.43	ACCEPTABLE
35.0	6.774E+08	18249.	4.28	ACCEPTABLE
40.0	6.576E+08	17716.	4.16	ACCEPTABLE
45.0	6.451E+08	17379.	4.09	ACCEPTABLE
50.0	6.345E+08	17095.	4.02	ACCEPTABLE
55.0	6.234E+08	16794.	3.96	ACCEPTABLE
60.0	6.173E+08	16632.	3.92	ACCEPTABLE
65.0	6.110E+08	16462.	3.88	ACCEPTABLE
70.0	6.103E+08	16443.	3.88	ACCEPTABLE
75.0	6.094E+08	16419.	3.87	ACCEPTABLE
80.0	6.144E+08	16552.	3.90	ACCEPTABLE
85.0	6.230E+08	16785.	3.95	ACCEPTABLE
90.0	6.349E+08	17105.	4.03	ACCEPTABLE
95.0	6.500E+08	17511.	4.12	ACCEPTABLE
100.0	6.675E+08	17951.	4.22	ACCEPTABLE
105.0	6.856E+08	18470.	4.33	ACCEPTABLE
110.0	7.027E+08	18932.	4.43	ACCEPTABLE
115.0	7.183E+08	19352.	4.52	ACCEPTABLE
120.0	7.311E+08	19696.	4.60	ACCEPTABLE
125.0	7.415E+08	19977.	4.66	ACCEPTABLE
130.0	7.522E+08	20266.	4.72	ACCEPTABLE
135.0	7.613E+08	20512.	4.78	ACCEPTABLE
140.0	7.749E+08	20877.	4.86	ACCEPTABLE
145.0	7.898E+08	21277.	4.95	ACCEPTABLE
150.0	7.961E+08	21448.	4.99	ACCEPTABLE
155.0	7.964E+08	21455.	4.99	ACCEPTABLE

160.0	7.906E+08	21299	4.95	ACCEPTABLE
165.0	7.825E+08	21082	4.91	ACCEPTABLE
170.0	7.588E+08	20442	4.76	ACCEPTABLE
175.0	7.482E+08	20159	4.70	ACCEPTABLE
180.0	7.420E+08	19991	4.66	ACCEPTABLE
185.0	7.131E+08	19213	4.49	ACCEPTABLE
190.0	7.090E+08	19101	4.47	ACCEPTABLE
195.0	7.176E+08	19334	4.52	ACCEPTABLE
200.0	7.105E+08	19142	4.48	ACCEPTABLE
205.0	6.980E+08	18805	4.40	ACCEPTABLE
210.0	6.826E+08	18391	4.31	ACCEPTABLE
215.0	6.655E+08	17929	4.21	ACCEPTABLE
220.0	6.485E+08	17471	4.11	ACCEPTABLE
225.0	6.309E+08	16998	4.00	ACCEPTABLE
230.0	6.137E+08	16535	3.90	ACCEPTABLE
235.0	5.991E+08	16141	3.81	ACCEPTABLE
240.0	5.878E+08	15835	3.74	ACCEPTABLE
245.0	5.775E+08	15559	3.68	ACCEPTABLE
250.0	5.719E+08	15408	3.65	ACCEPTABLE
255.0	5.773E+08	15552	3.68	ACCEPTABLE
260.0	5.910E+08	15922	3.76	ACCEPTABLE
265.0	6.046E+08	16288	3.84	ACCEPTABLE
270.0	6.218E+08	16752	3.95	ACCEPTABLE
275.0	6.385E+08	17203	4.05	ACCEPTABLE
280.0	6.541E+08	17623	4.14	ACCEPTABLE
285.0	6.692E+08	18029	4.23	ACCEPTABLE
290.0	6.829E+08	18399	4.31	ACCEPTABLE
295.0	6.993E+08	18839	4.41	ACCEPTABLE
300.0	7.191E+08	19373	4.53	ACCEPTABLE
305.0	7.383E+08	19891	4.64	ACCEPTABLE
310.0	7.585E+08	20434	4.76	ACCEPTABLE
315.0	7.780E+08	20962	4.88	ACCEPTABLE
320.0	7.942E+08	21398	4.98	ACCEPTABLE
325.0	8.084E+08	21780	5.06	ACCEPTABLE
330.0	8.187E+08	22062	5.12	ACCEPTABLE
335.0	8.344E+08	22481	5.21	ACCEPTABLE
340.0	8.427E+08	22703	5.26	ACCEPTABLE
345.0	8.443E+08	22748	5.27	ACCEPTABLE
350.0	8.396E+08	22619	5.25	ACCEPTABLE
355.0	8.284E+08	22319	5.18	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 3.65 AT 250.0 DEGREES.

Plant ID:	BNP2
Weld ID:	H7
Data ID:	B212R1

Shroud In	1.5 in
OD =	171 in
owth Rate =	5E-05 in/
ncertainty =	0.00 in

Eval. Period = 1200 days
Lcalc = 246 in (upset/norm)
Lcalc = 222 in (faulted)
Lmin = 248.9 in

Prepared By: _____ date _____

Verified By: _____

[illegible][illegible][illegible][illegible][illegible]

NOTES

- (1) Ligament Data from B212R GE Examination Summary Sheet
- (2) Crack growth is applied at each end of ligament
- (3) Calculation for End of Evaluation Ligament Data includes uncertainty if applicable
- (4) Days to Fully Cracked = days till ligament length is zero (actually = uncertainty + ASME crack proximity rule) for each ligament.
- (5) High Flux Zone = plus or minus 15 degrees from azimuths 45, 135, 225 and 315 (ie 30-60 etc.)
- Weld H7 will not reach LEFM threshold level for neutron embrittlement (3×10^{-20}) within current operating license.
- (6) 1deg = 1.49226 in
- (7) Uninspected regions assumed fully cracked. All cracks assumed through-wall
- (8) Lcalc = minimum required ligament length for limit load concerns - reference Structural Integrity report SIR-94-029 Rev. 0
- (9) Lmin = Lcalc + 2(Crack Growth in Evaluation Period) + Total Inspection Uncertainty

B212R1 Shroud Weld W7 Normal

DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)

DATE OF CURRENT ANALYSIS: 03/07/1996

SUMMARY OF INPUTS:

 Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 388. psi
 Bending Stress, Pb = 2945. psi
 Safety Factor, SF = 2.77
 Mean Radius, Rm = 84.75 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 1.9E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	17.3	152.4	1.500
2	197.5	200.0	1.500
3	215.0	220.7	1.500
4	229.2	235.2	1.500
5	258.7	290.7	1.500
6	295.2	305.8	1.500
7	309.2	322.2	1.500
8	325.7	330.7	1.500

LIMIT LOAD RESULTS:

ALPHA [deg.]	MOMENT [in-lbs]	Pb' [psi]	SAFETY FACTOR	RESULT
0	1.260E+09	37212.	11.28	ACCEPTABLE
5.0	1.278E+09	37758.	11.45	ACCEPTABLE
10.0	1.300E+09	38397.	11.64	ACCEPTABLE
15.0	1.332E+09	39358.	11.92	ACCEPTABLE
20.0	1.343E+09	39669.	12.02	ACCEPTABLE
25.0	1.343E+09	39678.	12.02	ACCEPTABLE
30.0	1.333E+09	39385.	11.93	ACCEPTABLE
35.0	1.314E+09	38811.	11.76	ACCEPTABLE
40.0	1.291E+09	38187.	11.57	ACCEPTABLE
45.0	1.259E+09	37208.	11.28	ACCEPTABLE
50.0	1.234E+09	36451.	11.05	ACCEPTABLE
55.0	1.202E+09	35498.	10.77	ACCEPTABLE
60.0	1.173E+09	34648.	10.51	ACCEPTABLE
65.0	1.141E+09	33715.	10.23	ACCEPTABLE
70.0	1.100E+09	32491.	9.86	ACCEPTABLE
75.0	1.057E+09	31214.	9.48	ACCEPTABLE
80.0	1.022E+09	30187.	9.17	ACCEPTABLE
85.0	9.957E+08	29418.	8.94	ACCEPTABLE
90.0	9.786E+08	28912.	8.79	ACCEPTABLE
95.0	9.705E+08	28672.	8.72	ACCEPTABLE
100.0	9.715E+08	28702.	8.73	ACCEPTABLE
105.0	9.796E+08	28941.	8.80	ACCEPTABLE
110.0	9.869E+08	29159.	8.86	ACCEPTABLE
115.0	1.007E+09	29740.	9.04	ACCEPTABLE
120.0	1.029E+09	30403.	9.24	ACCEPTABLE
125.0	1.059E+09	31295.	9.51	ACCEPTABLE
130.0	1.098E+09	32428.	9.85	ACCEPTABLE
135.0	1.144E+09	33791.	10.25	ACCEPTABLE
140.0	1.189E+09	35118.	10.65	ACCEPTABLE
145.0	1.225E+09	36198.	10.98	ACCEPTABLE

150.0	1.252E+09	37002.	11.22	ACCEPTABLE
155.0	1.270E+09	37524.	11.37	ACCEPTABLE
160.0	1.278E+09	37761.	11.45	ACCEPTABLE
165.0	1.271E+09	37563.	11.39	ACCEPTABLE
170.0	1.280E+09	37813.	11.46	ACCEPTABLE
175.0	1.292E+09	38164.	11.57	ACCEPTABLE
180.0	1.307E+09	38615.	11.70	ACCEPTABLE
185.0	1.325E+09	39161.	11.87	ACCEPTABLE
190.0	1.358E+09	40134.	12.16	ACCEPTABLE
195.0	1.374E+09	40585.	12.29	ACCEPTABLE
200.0	1.378E+09	40727.	12.34	ACCEPTABLE
205.0	1.373E+09	40558.	12.29	ACCEPTABLE
210.0	1.357E+09	40081.	12.14	ACCEPTABLE
215.0	1.334E+09	39413.	11.94	ACCEPTABLE
220.0	1.307E+09	38617.	11.70	ACCEPTABLE
225.0	1.271E+09	37541.	11.38	ACCEPTABLE
230.0	1.242E+09	36686.	11.12	ACCEPTABLE
235.0	1.206E+09	35636.	10.81	ACCEPTABLE
240.0	1.175E+09	34726.	10.54	ACCEPTABLE
245.0	1.136E+09	33558.	10.18	ACCEPTABLE
250.0	1.088E+09	32158.	9.76	ACCEPTABLE
255.0	1.045E+09	30881.	9.38	ACCEPTABLE
260.0	1.010E+09	29854.	9.07	ACCEPTABLE
265.0	9.844E+08	29085.	8.84	ACCEPTABLE
270.0	9.673E+08	28579.	8.69	ACCEPTABLE
275.0	9.592E+08	28339.	8.62	ACCEPTABLE
280.0	9.602E+08	28369.	8.63	ACCEPTABLE
285.0	9.609E+08	28390.	8.63	ACCEPTABLE
290.0	9.717E+08	28709.	8.73	ACCEPTABLE
295.0	9.942E+08	29374.	8.93	ACCEPTABLE
300.0	1.011E+09	29877.	9.08	ACCEPTABLE
305.0	1.041E+09	30769.	9.35	ACCEPTABLE
310.0	1.083E+09	32005.	9.72	ACCEPTABLE
315.0	1.125E+09	33227.	10.09	ACCEPTABLE
320.0	1.164E+09	34385.	10.43	ACCEPTABLE
325.0	1.194E+09	35282.	10.70	ACCEPTABLE
330.0	1.215E+09	35909.	10.89	ACCEPTABLE
335.0	1.227E+09	36264.	11.00	ACCEPTABLE
340.0	1.219E+09	36015.	10.92	ACCEPTABLE
345.0	1.224E+09	36161.	10.97	ACCEPTABLE
350.0	1.232E+09	36410.	11.04	ACCEPTABLE
355.0	1.244E+09	36761.	11.15	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 8.62 AT 275.0 DEGREES.

B212R1 Shroud Weld H7 Faulted

DLL: DISTRIBUTED LIGAMENT LENGTH EVALUATION (REVISION: 10/07/94)

DATE OF CURRENT ANALYSIS: 03/07/1996

SUMMARY OF INPUTS:

Angle increment = 1.0 deg. (COARSE)
 Membrane Stress, Pm = 1235. psi
 Bending Stress, Pb = 4430. psi
 Safety Factor, Sr = 1.39
 Mean Radius, Rm = 84.75 inches
 Wall Thickness, t = 1.500 inches
 Material = 304 SS
 Stress Intensity, Sm = 16900. psi
 Fluence = 1.9E+19 n/cm²
 (Thus, LEFM evaluation not applicable)

REGION	THETA1 [deg.]	THETA2 [deg.]	THICKNESS [inches]
1	17.3	152.4	1.500
2	197.5	200.0	1.500
3	215.0	220.7	1.500
4	229.2	235.2	1.500
5	258.7	290.7	1.500
6	295.2	305.8	1.500
7	309.2	322.2	1.500
8	325.7	330.7	1.500

LIMIT LOAD RESULTS:

ALPHA [deg]	MOMENT [in-lbs]	Pb' [psi]	SAFETY FACTOR	RESULT
0	1.235E+09	36488.	6.66	ACCEPTABLE
5.0	1.254E+09	37034.	6.76	ACCEPTABLE
10.0	1.275E+09	37673.	6.87	ACCEPTABLE
15.0	1.298E+09	38353.	6.99	ACCEPTABLE
20.0	1.313E+09	38786.	7.06	ACCEPTABLE
25.0	1.317E+09	38924.	7.09	ACCEPTABLE
30.0	1.312E+09	38766.	7.06	ACCEPTABLE
35.0	1.297E+09	38313.	6.98	ACCEPTABLE
40.0	1.278E+09	37764.	6.88	ACCEPTABLE
45.0	1.253E+09	37012.	6.75	ACCEPTABLE
50.0	1.224E+09	36172.	6.60	ACCEPTABLE
55.0	1.196E+09	35346.	6.46	ACCEPTABLE
60.0	1.165E+09	34432.	6.30	ACCEPTABLE
65.0	1.141E+09	33715.	6.17	ACCEPTABLE
70.0	1.105E+09	32653.	5.98	ACCEPTABLE
75.0	1.061E+09	31352.	5.75	ACCEPTABLE
80.0	1.026E+09	30325.	5.57	ACCEPTABLE
85.0	1.000E+09	29555.	5.44	ACCEPTABLE
90.0	9.832E+08	29049.	5.35	ACCEPTABLE
95.0	9.751E+08	28810.	5.30	ACCEPTABLE
100.0	9.761E+08	28839.	5.31	ACCEPTABLE
105.0	9.880E+08	29191.	5.37	ACCEPTABLE
110.0	9.995E+08	29531.	5.43	ACCEPTABLE
115.0	1.019E+09	30112.	5.53	ACCEPTABLE
120.0	1.044E+09	30852.	5.66	ACCEPTABLE
125.0	1.074E+09	31744.	5.82	ACCEPTABLE
130.0	1.113E+09	32877.	6.02	ACCEPTABLE
135.0	1.152E+09	34044.	6.23	ACCEPTABLE
140.0	1.204E+09	35570.	6.50	ACCEPTABLE
145.0	1.245E+09	36790.	6.71	ACCEPTABLE

150.0	1.277E+09	37729.	6.88	ACCEPTABLE
155.0	1.299E+09	38382.	6.99	ACCEPTABLE
160.0	1.311E+09	38742.	7.06	ACCEPTABLE
165.0	1.317E+09	38903.	7.09	ACCEPTABLE
170.0	1.325E+09	39153.	7.13	ACCEPTABLE
175.0	1.337E+09	39504.	7.19	ACCEPTABLE
180.0	1.352E+09	39955.	7.27	ACCEPTABLE
185.0	1.371E+09	40501.	7.37	ACCEPTABLE
190.0	1.391E+09	41092.	7.47	ACCEPTABLE
195.0	1.402E+09	41417.	7.53	ACCEPTABLE
200.0	1.402E+09	41427.	7.53	ACCEPTABLE
205.0	1.392E+09	41122.	7.48	ACCEPTABLE
210.0	1.371E+09	40504.	7.37	ACCEPTABLE
215.0	1.346E+09	39779.	7.24	ACCEPTABLE
220.0	1.315E+09	38837.	7.07	ACCEPTABLE
225.0	1.279E+09	37796.	6.89	ACCEPTABLE
230.0	1.244E+09	36760.	6.71	ACCEPTABLE
235.0	1.207E+09	35675.	6.52	ACCEPTABLE
240.0	1.173E+09	34648.	6.33	ACCEPTABLE
245.0	1.128E+09	33337.	6.10	ACCEPTABLE
250.0	1.075E+09	31747.	5.82	ACCEPTABLE
255.0	1.031E+09	30471.	5.60	ACCEPTABLE
260.0	9.966E+08	29444.	5.42	ACCEPTABLE
265.0	9.705E+08	28674.	5.28	ACCEPTABLE
270.0	9.534E+08	28168.	5.19	ACCEPTABLE
275.0	9.453E+08	27929.	5.15	ACCEPTABLE
280.0	9.498E+08	28061.	5.17	ACCEPTABLE
285.0	9.523E+08	28136.	5.18	ACCEPTABLE
290.0	9.632E+08	28456.	5.24	ACCEPTABLE
295.0	9.796E+08	28941.	5.33	ACCEPTABLE
300.0	1.001E+09	29585.	5.44	ACCEPTABLE
305.0	1.032E+09	30477.	5.60	ACCEPTABLE
310.0	1.062E+09	31365.	5.75	ACCEPTABLE
315.0	1.107E+09	32719.	5.99	ACCEPTABLE
320.0	1.142E+09	33738.	6.37	ACCEPTABLE
325.0	1.168E+09	34501.	6.31	ACCEPTABLE
330.0	1.185E+09	35002.	6.40	ACCEPTABLE
335.0	1.193E+09	35235.	6.44	ACCEPTABLE
340.0	1.194E+09	35292.	6.45	ACCEPTABLE
345.0	1.199E+09	35436.	6.47	ACCEPTABLE
350.0	1.208E+09	35686.	6.52	ACCEPTABLE
355.0	1.220E+09	36037.	6.58	ACCEPTABLE

ACCEPTABLE! MINIMUM SAFETY FACTOR = 5.15 AT 275.0 DEGREES.

ATTACHMENT 3
Page 1 of 1
illegible Record Acceptance Form

Originator requests acceptance of this document and accepts responsibility for the illegible condition of this data.

Document Identity ESR 96-00154 Rev 0

NOTE: The identity of the illegible record or illegible page(s) within the record shall be provided by the originator of this form by identifying and inserting this form preceding the illegible data. In cases where the entire record is considered illegible, this form precedes the record. Please complete Part A or B.

XX
XX

PART A

The attached record is suitable for microfilming because:

It is non-Q or non-vital records or the data which is relevant to the identification of the item is legible and/or the data can be provided from other sources.

Signed: Larry Yemma
Title: Supervisor Date: 1 3/9/96

XX
XX

PART B

The attached record is the most legible copy available and may be retained in the RFR.

Originating Supervisor Date

Reviewed: _____
Manager - Nuclear Records Date
Management/Nuclear Document Control

BWRVIPBWR Vessel &
Internals Project

Post-It Fax Note 7671		Date 2/11/96
To Joan Bozeman	From Raj Pathania	
Co/Dept CAC	Co.	
Phone #	Phone # 415-855-2998	
Fax # 910-457-2800	Fax #	

MEMORANDUM

March 1, 1996

TO: Vaughn Wagoner, CP&L

FROM: Raj Pathania, EPRI *RP*

SUBJECT: Application of the BWRVIP Crack Growth Model to Estimate Crack Growth Rate of H6B Core Shroud Indications in BNP-2

The crack growth rates of ID initiated cracks in the H6B weld at BNP-2 were estimated for the next cycle using the BWRVIP crack growth model described in TR-105873. The following chemistry conditions were assumed for the next cycle after reviewing the data for the previous cycle provided by Joan Bozeman. Calculations can easily be performed for other assumed conditions.

Table 1: Assumed Chemistry for the Next Cycle

Duration (months)	FW H2 (ppm)	ECP (mV SHE)	Cond. ($\mu\text{S}/\text{cm}$)
1	0	190	0.2
4	0.5	-10	0.15
13	1	-240	0.1

Crack growth rate is a function of the initial crack depth (which affects the stress intensity K). Therefore crack growth rates were calculated for three initial crack depths of 0.1, 0.26 and 0.63 in. These represent a shallow indication, an average of all the indications and an average of the deepest indication #26. The results are shown below:

Table 2: Crack Growth Rates for H6B ID Indications

Initial Crack Depth (in)	Crack Growth Rate (in/h)
0.1	4.84E-6
0.26	3.88E-6
0.6	3.18E-9

The results show that the crack growth rates are well below the NRC rate of $5\text{E}-5$ in/h. Figure 1 shows how crack depth and K change with time for a 0.26 in deep

crack. It is important to note that the crack growth rate is not constant but decreases as the crack grows because of decreasing K provided the chemistry is constant. Conductivity and ECP increases result in increases in crack growth rate.

Methodology

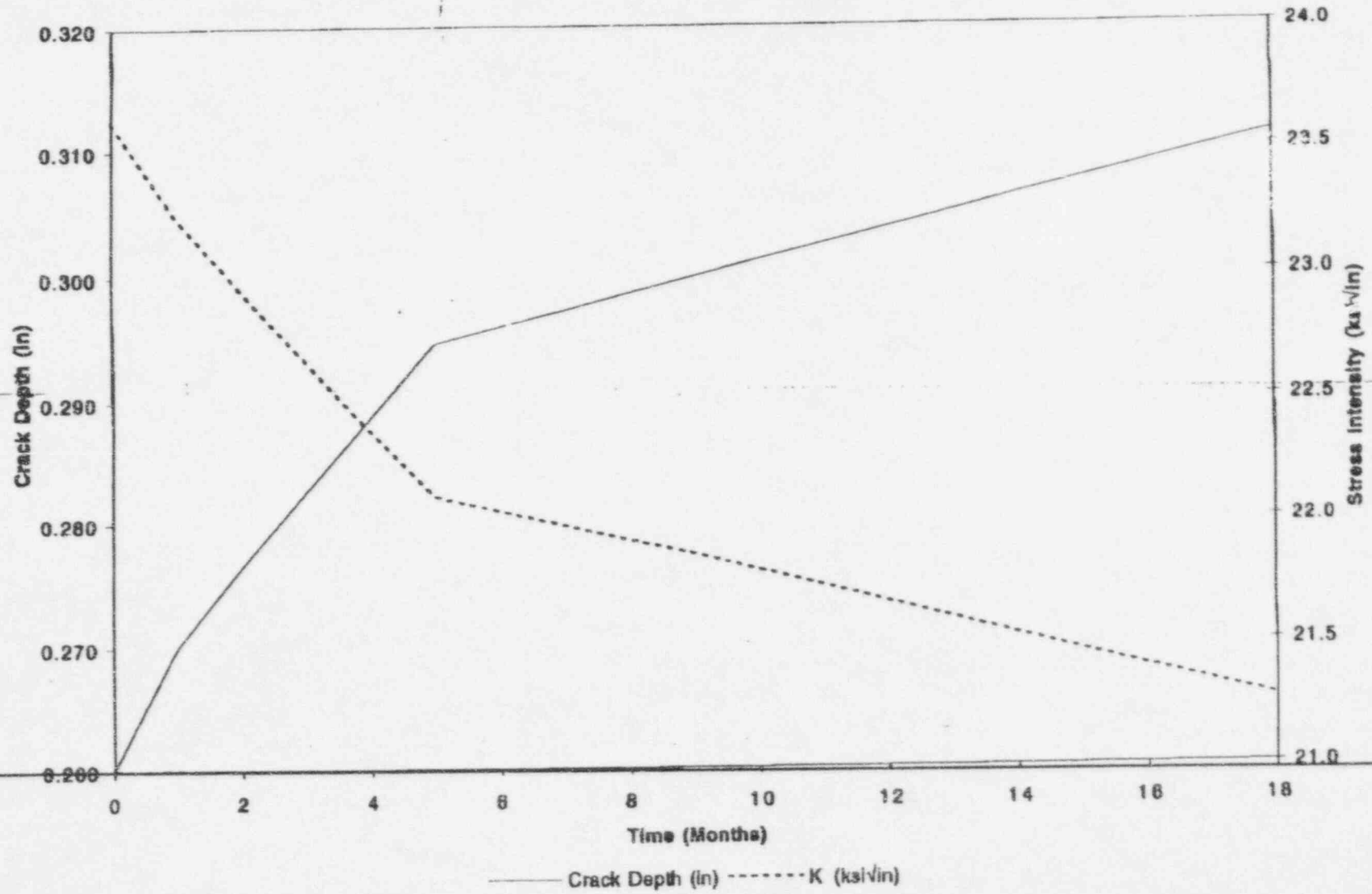
1. The 95th percentile crack growth model described in TR-105873 was used. This a factor of 10.3 greater than the best fit model (equation 3-2) for type 304 in the report.
2. The K-distribution was as shown in Figure 5-3 of TR-105873.
3. The ECPs were estimated by Kathleen Ramp assuming that Hatch 2 results from the 1D plant radiolysis study by GE (TR-106068, BWRVIP-13) were applicable to Brunswick since the plants are similarly designed.

Please call me if you have any questions.

c: Joan Bozeman	CP&L
Warren Bilanin	EPRI
Kathleen Ramp	EPRI
Martin Pytel	EPRI

FIGURE: 1

Thickness = 1.5; Stress = Residual Stress + Cold Tensile



BWRVIPBWR Vessel &
Internals Project

Post-It® Fax Note 7671		Date 3/1/96	# of pages 2
To Joan Bozeman	From Raj Pathania		
Co/Dept CP&L	Co.		
Phone 615-855-2207			

MEMORANDUM

March 5, 1996

TO: Joan Bozeman, CP&L

FROM: Raj Pathania, EPRI RP

SUBJECT: Application of BWRVIP Crack Growth Model to Estimate Crack Growth Rate of H4 ID Indications in BNP-2

As requested I estimated the crack growth rate of several indications on the ID of the H4 shroud welds between 1994 and 1996 and compared the model predictions with repeat UT measurements. The BWRVIP model predicts essentially no measurable growth in these indications in the last cycle. This result is consistent with the repeat UT measurements which showed little change when UT uncertainty is taken into account. If similar chemistry is maintained in the next cycle the change in the crack depth should again be less than the UT uncertainty.

I assumed that the chemistry during the last cycle was the same as that in my memo of March 1 to Vaughn Wagoner which was based on data provided by you. I also assumed that the ECP at the H4 weld ID was the same as that at the H5 weld ID. This assumption is supported by the calculations reported in Radiolysis Modeling report (TR-106068, BWRVIP-13). The feedwater H2 vs. ECP relationship was the same as that in the BWRVIP Crack Growth report (TR-105873) for H5 ID. The estimated ECPs are shown below:

Table 1: Assumed Chemistry from 1994-96

Duration (months)	FW H2 (ppm)	ECP(mV SHE) H4 ID	Cond. (µS/cm)
1	0	100	0.2
4	0.5	-180	0.15
13	1	-400	0.1

13

1

-400

0.13

0.1

2

Crack growth rates and crack extensions were estimated for 7 indications and compared with the UT measurements (Table 2). For several indications UT showed negative growth of upto -0.09 in. which results from UT uncertainty. Similar observations were reported from KKM in the Crack Growth report where negative growths of upto -0.1 in were reported for some indications. This leads one to the conclusion that crack depth changes of less than 0.1 in are within the UT uncertainty and should not be considered significant. The crack depths in

MAR 5 '96 18:45 FROM EPRI

PAGE.002

2

Table 2 are maximum depths that you provided. The results show that there was negligible crack growth in the last cycle for these indications particularly the deeper ones. The table also shows that the crack growth rate decreases because of decreasing stress intensity as the crack grows deeper. The estimated crack extensions are well below the UT uncertainty. Calculations can also be done using average depth for each indication rather than the maximum but I expect the conclusions will be similar.

Table 2: Crack Growth Rate Estimates for H4 ID

Ind. No.	Initial max depth, in	Crack Growth Rate, in/hr	Crack Growth in (Calc.)	Crack Growth in (Msd.)
5	0.5	3.9E-06	0.005	0.06
6	0.58	6.3E-08	0.001	-0.09
7	0.86	0	0	-0.06
12	0.72	0	0	0.08
13	0.79	0	0	0.01
14	0.75	0	0	0
15	0.79	0	0	-0.09

Please call me if you have any questions.

C. Vaughn Wagoner CP&L
Warren Bilanin
Joe Gilman



Carolina Power & Light Company
PO Box 10429
Southport NC 28461-0429

William R. Campbell
Vice President
Brunswick Nuclear Plant

November 2, 1995

SERIAL: BSEP 95-0570

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

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
SUBMITTAL OF UNIT 2 CORE SHROUD REINSPECTION PLANS

Gentlemen:

The purpose of this letter is to provide to the Nuclear Regulatory Commission (NRC) the latest plans for reinspection of the core shroud for the Brunswick Steam Electric Plant (BSEP), Unit 2. These reinspections are planned for the upcoming B212R1 refueling outage which is presently scheduled to begin on February 2, 1996.

On July 25, 1994, the NRC staff issued NRC Generic Letter 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors." The generic letter requested that licensees submit plans for inspections of the core shroud at least 3 months prior to performing such inspections. Although the generic letter does not address reinspection plans, Carolina Power & Light Company's (CP&L) is submitting the Unit 2 reinspection plans using the generic letter as guidance. Enclosure 1 of this letter provides the Unit 2 reinspection scope and associated technical bases. The results of these reinspections will be submitted to the NRC within 30 days following completion of the inspections.

Please refer any questions regarding this submittal to Mr. George Honma at (910) 457-2741.

Sincerely,

William R. Campbell

WRM/wrm

Enclosure

cc: Mr. S. D. Ebnetter, Regional Administrator, Region II
Mr. D. C. Trimble, Jr., NRR Project Manager - Brunswick Units 1 and 2
Mr. C. A. Patterson, NRC Senior Resident Inspector - Brunswick Units 1 and 2
The Honorable H. Wells, Chairman - North Carolina Utilities Commission



Carolina Power & Light Company
PO Box 10429
Southport NC 28461-0429

William R. Campbell
Vice President
Brunswick Nuclear Plant

November 2, 1995

SERIAL: BSEP 95-0570

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

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DOCKET NO. 50-324/LICENSE NO. DPR-62
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Please refer any questions regarding this submittal to Mr. George Honma at (910) 457-2741.

Sincerely,

William R. Campbell

WRM/wrm

Enclosure

cc: Mr. S. D. Ebner, Regional Administrator, Region II
Mr. D. C. Trimble, Jr., NRR Project Manager - Brunswick Units 1 and 2
Mr. C. A. Patterson, NRC Senior Resident Inspector - Brunswick Units 1 and 2
The Honorable H. Wells, Chairman - North Carolina Utilities Commission

ENCLOSURE 1

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
SUBMITTAL OF UNIT 2 CORE SHROUD REINSPECTION PLANS