Florida Power & Light Company, 6501 S. Ocean Drive, Jensen Beach, FL 34957

FPL

April 14, 2003

L-2003-092
10 CFR 50.4
10 CFR 50.55a

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

Re: St. Lucie Units 1 and 2
Docket Nos. 50-335 and 50-389
Inservice Inspection Plans
Unit 1 Third and Unit 2 Second Ten-Year Intervals
Unit 1 Relief Request 21 and Unit 2 Relief Request 31
Request for Additional Information Response

By letter L-2001-262 dated November 21, 2001 and supplemented by L-2002-178 dated September 26, 2002, Florida Power and Light Company (FPL) requested approval of Relief Requests 20 and 30 pursuant to 10 CFR 50.55a (a)(3)(i) and Relief Requests 21 and 31 pursuant to 10 CFR 50.55a(g)(5)(iii). For Relief Requests 21 and 31, FPL had determined that pursuant to 10 CFR 50.55a(g)(5)(iii) it would be impractical to characterize the flaws by non-destructive examination (NDE) and it would be impractical to show the flaws do not extend into the ferritic base material.

By letter dated January 30, 2003, the NRC provided FPL a request for additional information (RAI) to assist the NRC in completing its review of Relief Requests 21 and 31. The RAI was discussed with FPL on January 14, 2003. It was agreed that in the response to request 2, it would not be necessary for FPL to submit the actual calculations. FPL would provide a summary and the results of the supporting Framatone calculations to address the areas of interest. In a call on January 31, 2001 the NRC PM adjusted the expected response submittal date to the March-April timeframe as discussed in the January 14, 2003 conference call.

Unit 2 Relief Requests 30 and 31 are needed to support potential corrective actions resulting from the NRC Order EA-03-009 reactor pressure vessel head (RPVH) inspections. The RPVH inspections will be performed during the upcoming St. Lucie Unit 2 spring 2003 refueling outage (SL2-14).

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Please contact George Madden at 772-467-7155 if there are any additional questions about this submittal.

Very truly yours,

William Jefferson, Jr.
Vice President
St. Lucie Plant

WJ/GRM

Attachment

St. Lucie Units 1 and 2
Request For Additional Information Response
Inservice Inspection Program
Relief Request Nos. 21 and 31, Revision 2

NRC Request 1:

Please comment on successive inspection plans for new Reactor Pressure Vessel (RPV) to control element drive mechanism (CEDM) tube pressure retaining welds, which are deposited approximately mid-wall of the RPV head. The discussion should include the types of nondestructive examination (NDE) that are going to be performed and the frequency. If successive inspections are not going to be performed, provide the technical justification and basis for not performing a successive/repetitive inspection on the new pressure boundary welds.

FPL Response 1:

This request was superceded by the interim inspection requirements for reactor pressure vessel heads repairs delineated in footnote 3 of the immediately effective NRC Order EA-03-009 issued on February 11, 2003. The order specifies the frequency and authorized inspection techniques including the methods for requesting relaxation of the requirements. It is anticipated that the weld will be inspected by ultrasonic testing.

NRC Request 2:

Relief Request Nos. 21 and 31 indicate that calculations, analyses and evaluations discussed within provide the technical basis why this repair methodology provides an acceptable level of quality and safety. Please submit the calculations, analyses and evaluations discussed below from Relief Request Nos. 21 and 31:

a) American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI stress calculations will be performed to show the flaws are acceptable for a number of years (Addressed in Calculations 3 and 6)
b) An analysis of the new pressure boundary welds will be performed using a 3-dimensional model of a CEDM nozzle located at the most severe hillside orientation (Addressed in Calculations 1, 2, 4 and 5).
c) A primary stress analysis for design conditions will be performed. A maximum Primary General Membrane Stress Intensity (P_m) will be calculated and shown to be less than the maximum allowed by the ASME Code (Addressed in Calculations 2 and 5).
d) The maximum cumulative fatigue usage factor will be calculated, and allowable years of future plant operation will be based on the maximum allowed ASME Code usage factor criterion of 1.0 (Addressed in Calculations 2 and 5).

e) A fracture mechanics evaluation will be performed to determine if degraded J-groove weld material could be left in the vessel, with no examination to size any flaws that might remain following the repair (Addressed in Calculations 3 and 6).

f) Residual stresses will not be included in the flaw evaluations since it will be demonstrated by analysis that these stresses are compressive in the low alloy steel base metal (Addressed in Calculations 3 and 6)..

g) Flaw evaluations will be performed for a postulated radial corner crack on the uphill side of the RPV head penetration, where stresses are the highest and radial distance from the inside corner to the low alloy steel base metal (crack depth) is the greatest (Addressed in Calculations 3 and 6)..

h) Fatigue crack growth, calculated for the remaining operational life, should be small, and the final flaw size will be shown to meet the fracture toughness requirements of the ASME Code using an upper shelf value of 200ksi√in for ferritic materials (Addressed in Calculations 3 and 6).

FPL Response 2:

As discussed during the January 14, 2003 conference call among FPL, the NRC, and FPL's contractor Framatone, it was agreed that in the response to request 2, it would not be necessary for FPL to submit the actual calculations. FPL would provide a summary discussion and the results of the supporting Framatone calculations to address the areas of NRC interest. A summary of the three calculations performed for each unit and results for the eight areas requested by the NRC for both Units 1 and 2 follows.

CALCULATION	TITLE
1	St. Lucie Unit 1 CEDM Nozzle Weld Anomaly Flaw Evaluation Summary
2	St. Lucie Unit 1 Temperbead Bore Weld Analysis Summary – ASME Section III Criteria
3	St. Lucie Unit 1 CEDM Nozzle Original J-Groove Weld Flaw Evaluation Summary
4	St. Lucie Unit 2 CEDM Nozzle Weld Anomaly Flaw Evaluation Summary
5	St. Lucie Unit 2 Temperbead Bore Weld Analysis Summary – ASME Section III Criteria
6	St. Lucie Unit 2 CEDM Nozzle Original J-Groove Weld Flaw Evaluation Summary

Calculation 1

St. Lucie Unit 1
CEDM Nozzle Weld Anomaly Flaw Evaluation Summary

A fracture mechanics analysis was performed to evaluate a 0.100 inch semi-circular flaw extending 360 degrees around the circumference at the "triple point" location where the Alloy 600 (original nozzle), the Alloy 52 weld, and the low alloy steel head meet. The flaw is assumed to propagate in each of the two directions on the uphill and downhill sides of the nozzle. Flaw acceptance is based on the 1989 ASME Code Section XI criteria for applied stress intensity (IWB-3612) and limit load (IWB-3642). The results are summarized below and the flaw propagation paths are shown on Figure 1-1.

The flaw evaluation results for 25 years of fatigue crack growth (FCG) are as follows.

Flaw Propagation Paths 1, 3, 6, and 8

a) FCG analysis of a continuous external circumferential flaw in weld:

Initial flaw size	a_i = 0.100 in.
Maximum final flaw size	a_f = 0.105 in.
Maximum stress intensity factor	K_I = 13.2 ksi$\sqrt{in}$
Fracture toughness	K_{Ia} = 200 ksi$\sqrt{in}$
Fracture toughness margin	K_{Ia}/K_I = 15.2> $\sqrt{10}$=3.16

b) Limit load analysis for a continuous external circumferential flaw in weld:

Bounding axial tube load	P = 21,476 lbs
Limit load	P_O = 111,351 lbs
Limit load margins	P_O / P =5.18 > 3.0

c) FCG analysis of a semi-circular external axial flaw in weld:

Initial flaw size	a_i = 0.100 in.
Maximum final flaw size	a_f = 0.106 in.
Maximum stress intensity factor	K_I = 15.0 ksi$\sqrt{in}$
Fracture toughness	K_{Ia} = 200 ksi$\sqrt{in}$
Fracture toughness margin	K_{Ia}/K_I = 13.3 > $\sqrt{10}$=3.16

Flaw Propagation Paths 2 and 7

FCG analysis of a semi-circular surface flaw at weld/head interface:

Initial flaw size	a_i = 0.100 in.
Maximum final flaw size	a_f = 0.107 in.
Maximum stress intensity factor	K_I = 12.6 ksi$\sqrt{in}$
Fracture toughness	K_{Ia} = 200 ksi$\sqrt{in}$
Fracture toughness margin	$K_{Ia}/K_I = 15.9 > \sqrt{10} = 3.16$

Therefore, the ASME Section XI requirements were met.

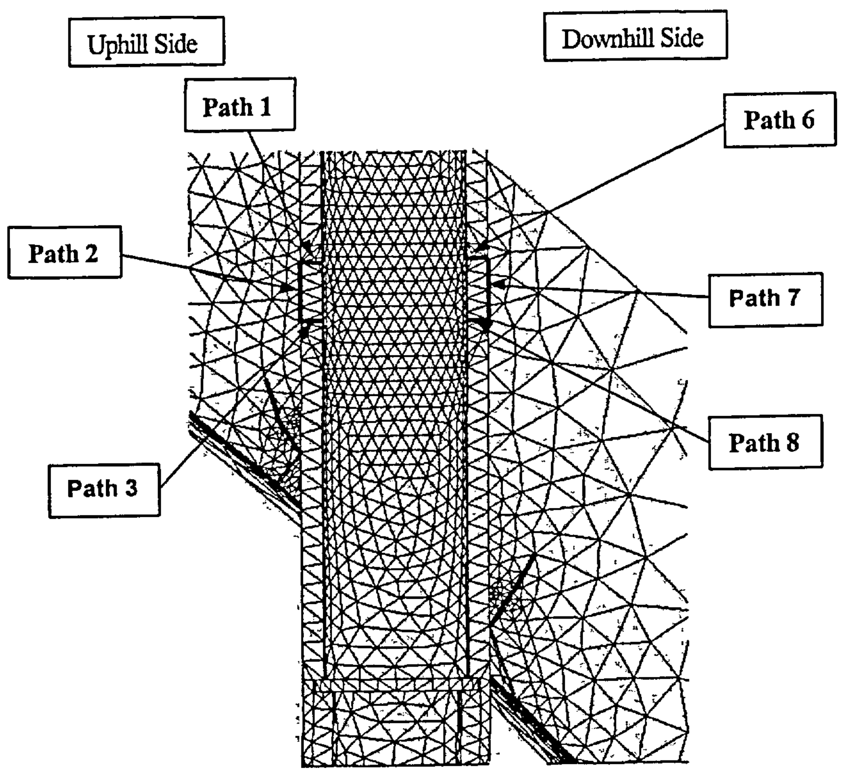

Figure 1-1: Crack Propagation Paths on the Finite Element Stress Model

Note: Paths 1, 2, and 3 are located on the uphill side of the nozzle and Paths 6, 7, and 8 are on the downhill side.

Calculation 2

St. Lucie Unit 1
Temperbead Bore Weld Analysis Summary – ASME Section III Criteria

A 3-D ANSYS finite element model of the most severe hillside penetration was developed to analyze the PSL CRDM nozzle temperbead weld repair to the 1989 ASME Section III criteria. Thermal stresses were determined for the appropriate design transients and a fatigue analysis was performed. Also, design, emergency, faulted, and test conditions cases were evaluated and compared against the appropriate ASME Section III stress limits. The ASME Section III requirements were met. Below is a summary.

Design Conditions

ASME Section III criteria contained in NB 3221.1, NB 3221.2 and NB 3221.3 were checked and had significant margins to allowable values. The reactor vessel head was the location that had stresses with the least margin to the allowable and is listed below.

General Primary Stress Intensity (NB-3221.1) = 15.1 ksi < 1.0 Sm = 26.7 ksi

Local Membrane Stress Intensity (NB-3221.2) = 23.6 ksi < 1.5 Sm = 40.1 ksi

Primary Membrane + Primary Bending Stress Intensity (NB-3221.3) = 26.9 ksi < 1.5 Sm = 40.1 ksi

Emergency (Level C) and Faulted (Level D) and Test Conditions

Had larger margins of safety than Design Condition case.

Primary + Secondary Stress Intensity

Primary + Secondary Stress Intensity (NB3222.4) = 56.6 ksi < 3 Sm = 80.0 ksi

Fatigue Analysis

Cumulative fatigue usage factor = 0.430 < 1.0 (ASME Criteria)

NOTE: This is for 40 years of design transient cycles.

Calculation 3

St. Lucie Unit 1
CEDM Nozzle Original J-Groove Weld Flaw Evaluation Summary

A fracture mechanics analysis has been performed to evaluate a postulated large radial crack in the remnants of the original J-groove weld (and butter) at the CEDM nozzle reactor vessel head penetration. Results of this analysis are summarized below for the controlling transient.

Remaining Transient

Temperature	T = 532 °F
Initial flaw size	a_i = 0.795 in.
Final flaw size after 20 years	a_f = 1.231 in.
Flaw growth	$a_f - a_i$ = 0.436 in.
Stress intensity factor at final flaw size	K_I = 63.15 ksi$\sqrt{in}$
Fracture toughness	K_{Ia} = 200.0 ksi$\sqrt{in}$
Safety margin	$K_{Ia} / K_I = 3.17 > \sqrt{10} = 3.16$

Residual Stress

The residual stresses, calculated by Dominion, show the residual hoop stress changes from tensile to compressive in the buttering and continue to be compressive into the ferritic low alloy steel reactor vessel head.

Conclusion

Based on an evaluation of fatigue crack growth into the low alloy steel head, it has been demonstrated that a postulated radial crack in the Alloy 182 J-groove weld would be acceptable for 20 years of operation, considering the following transients:

Transient	Frequency	
Heatup and Cooldown	12.5	cycles/year
Plant Loading and Unloading	50.0	cycles/year
Remaining Transients	62.0	cycles/year
Leak Test	5.0	cycles/year
Loss of Secondary Pressure	5.0	cycles

Calculation 4

St. Lucie Unit 2
CEDM Nozzle Weld Anomaly Flaw Evaluation Summary

A fracture mechanics analysis was performed to evaluate a 0.100 inch semi-circular flaw extending 360 degrees around the circumference at the "triple point" location where the Alloy 600 (original nozzle), the Alloy 52 weld, and the low alloy steel head meet. The flaw is assumed to propagate in each of the three directions on the uphill and downhill sides of the nozzle. Flaw acceptance is based on the 1989 ASME Code Section XI criteria for applied stress intensity (IWB-3612) and limit load (IWB-3642). The results are summarized below and the flaw propagation paths are shown on Figure 4-1.

The flaw evaluation results for 24 years of fatigue crack growth (FCG) are as follows.

Flaw Propagation Paths 1, 3, 6, and 8

a) FCG analysis of a continuous external circumferential flaw in weld:

Initial flaw size	$a_i = 0.100$ in.
Maximum final flaw size	$a_f = 0.100$ in. (compressive
Maximum stress intensity factor	$K_I = 0$ ksi$\sqrt{in}$ stress field)
Fracture toughness	$K_{Ia} = 200$ ksi$\sqrt{in}$
Fracture toughness margin	$K_{Ia} / K_I > \sqrt{10} = 3.16$

b) Limit load analysis for a continuous external circumferential flaw in weld:

Bounding axial tube load	$P = 21,202$ lbs
Limit load	$P_O = 153,481$ lbs
Limit load margins	$P_O / P = 7.24 > 3.0$

c) FCG analysis of a semi-circular external axial flaw in weld:

Initial flaw size	$a_i = 0.100$ in.

Radial Growth

Maximum final flaw size	$a_f = 0.106$ in.
Maximum stress intensity factor	$K_I = 22.7$ ksi$\sqrt{in}$
Fracture toughness	$K_{Ia} = 200$ ksi$\sqrt{in}$
Fracture toughness margin	$K_{Ia} / K_I = 8.81 > \sqrt{10} = 3.16$

Axial Growth

Maximum final flaw size	$a_f = 0.116$ in.
Maximum stress intensity factor	$K_I = 29.9\ ksi\sqrt{in}$
Fracture toughness	$K_{Ia} = 200\ ksi\sqrt{in}$
Fracture toughness margin	$K_{Ia} / K_I = 6.69 > \sqrt{10} = 3.16$

Flaw Propagation Paths 2 and 7

FCG analysis of a semi-circular surface flaw at weld/head interface:

Initial flaw size	$a_i = 0.100$ in.
Maximum final flaw size	$a_f = 0.116$ in.
Maximum stress intensity factor	$K_I = 63.1\ ksi\sqrt{in}$
Fracture toughness	$K_{Ia} = 200\ ksi\sqrt{in}$
Fracture toughness margin	$K_{Ia} / K_I = 3.17 > \sqrt{10} = 3.16$

Therefore, the ASME Section XI requirements were met.

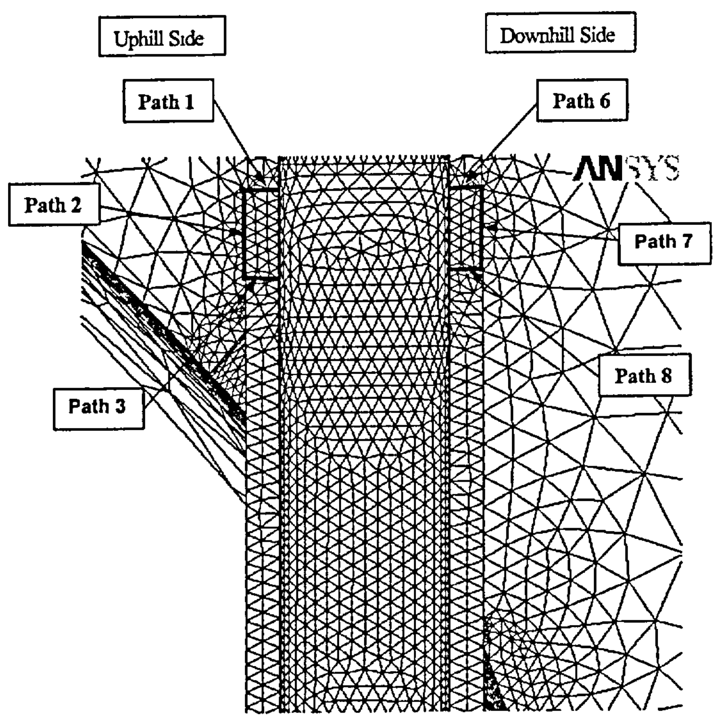

Figure 4-1: Crack Propagation Paths on the Finite Element Stress Model

Note: Paths 1, 2, and 3 are located on the uphill side of the nozzle and Paths 6, 7, and 8 are on the downhill side.

Calculation 5

St. Lucie Unit 2
Temperbead Bore Weld Analysis Summary – ASME Section III Criteria

A 3-D ANSYS finite element model of the most severe hillside penetration was developed to analyze the PSL CEDM nozzle temperbead weld repair to the 1989 ASME Section III criteria. Thermal stresses were determined for the appropriate design transients and a fatigue analysis was performed. Also, design, emergency, faulted, and test conditions cases were evaluated and compared against the appropriate ASME Section III stress limits. The ASME Section III requirements were met. Below is a summary:

Design Conditions

ASME Section III criteria contained in NB 3221.1, NB 3221.2 and NB 3221.3 were checked and were within the allowable values. The reactor vessel head was the location that had stresses with the least margin to the allowable and are listed below.

General Primary Stress Intensity (NB-3221.1) = 14.74 ksi < 1.0 Sm = 26.7 ksi

Local Membrane Stress Intensity (NB-3221.2) = 26.77 ksi < 1.5 Sm = 40.1 ksi

Primary Membrane + Primary Bending Stress Intensity (NB-3221.3) = 38.12 ksi < 1.5 Sm = 40.1 ksi

Emergency (Level C) and Faulted (Level D) and Test Conditions

Had larger margins of safety than Design Condition case.

Primary + Secondary Stress Intensity

Primary + Secondary Stress Intensity (NB3222.4) = 66.17 ksi < 3 Sm= 80.0 ksi

Fatigue Analysis

Cumulative fatigue usage factor = 0.234 < 1.0 (ASME Criteria)

NOTE: This is for 9 years of design transient cycles which results in 38 years of design transient cycles with a cumulative fatigue usage factor of 1.0

Calculation 6

St. Lucie Unit 2
CEDM Nozzle Original J-Groove Weld Flaw Evaluation Summary

A fracture mechanics analysis has been performed to evaluate a postulated large radial crack in the remnants of the original J-groove weld and butter at the CEDM nozzle reactor vessel head penetration. Results of this analysis are summarized below for the controlling transient.

Remaining Transient

Temperature	$T = 546^{\circ}F$
Initial flaw size	$a_I = 0.950$ in.
Final flaw size after 14 years	$a_f = 1.108$ in.
Flaw growth	$a_f - a_I = 0.158$ in.
Stress intensity factor at final flaw size	$K_I = 63.25$ ksi$\sqrt{in}$
Fracture toughness	$K_{Ia} = 200.0$ ksi$\sqrt{in}$
Safety margin	$K_{Ia} / K_I = 3.16 = \sqrt{10} = 3.16$

Residual Stress

The residual stresses, calculated by Dominion, show the residual hoop stress changes from tensile to compressive at a depth of approximately 3/8 in. or less from the buttering to reactor vessel head fusion line, into the ferritic low alloy steel reactor vessel head. This depth to the compressive zone was taken into account in the flaw evaluation by increasing the initial size of the postulated flaw beyond the butter and into the head by this amount.

Conclusion

Based on an evaluation of fatigue crack growth into the low alloy steel head, it has been demonstrated that a postulated radial crack in the Alloy 182 J-groove weld would be acceptable for 14 years of operation, considering the following transients:

Transient	Frequency
Heatup and Cooldown	12.5 cycles/year
Plant Loading and Unloading	50.0 cycles/year
Remaining Transients	62.0 cycles/year
Leak Test	5.0 cycles/year
Loss of Secondary Pressure	5.0 cycles