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

FPL

June 14, 2002

L-2002-110
10 CFR 50.4

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

RE: St. Lucie Unit 1
Docket No. 50-335
Request for Additional Information Response
Replacement of RCS Hot Leg Instrument Nozzle RC-126

By letter L-2001 131 dated May 24, 2001, Florida Power & Light Company (FPL) submitted information regarding replacement of reactor coolant system (RCS) hot leg instrument nozzle RC-126 on St. Lucie Unit 1 during the spring 2001 refueling outage (SL1-18). The nozzle was replaced using a half-nozzle technique, which FPL concluded was bounded by the analytical evaluation and evaluation procedures contained in Combustion Engineering Owners Group (CEOG) topical report CE NPSD-1198-P, *Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs.*

By letter dated April 10, 2002 (received April 18, 2002), the NRC notified FPL that based on their review of the FPL submittal the staff required additional information to complete their review. The NRC request for additional information (RAI) requested a response within 60 days of receipt.

Attached please find the FPL response to the NRC RAI dated April 10, 2002. Please contact George Madden at 772-467-7155 if there are any questions about the response.

Very truly yours,

Donald E. Jernigan
Vice President
St. Lucie Plant

Attachment

DEJ/GRM

TAC No. MB2224

A047

Response to NRC Request for Additional Information
<u>Replacement of RCS Hot Leg Instrument Nozzle RC-126 for St. Lucie Unit 1</u>

By letter L-2002-131 dated May 24, 2001[1], FPL determined that Combustion Engineering Owners Group proprietary topical report, CE NPSD-1198-P[2] bounds the half-nozzle replacement of RCS hot leg instrument nozzle RC-126, at St. Lucie Unit 1. In order for the NRC to verify this conclusion, the NRC requested additional information in a letter dated April 10, 2002[3].

Florida Power and Light Company (FPL) hereby supplies the additional information requested with respect to St. Lucie Unit 1 hot leg instrument nozzle RC-126.

NRC Question 1: *To confirm that the amount of corrosion is bounded by the topical report:*

a. *Will St. Lucie future operations* be bounded by the assumptions stated in Section 2.3, Item (5) of the topical report?

b. *Provide your plans for periodically reassessing that plant operation continues to be bounded by the assumptions of the topical report, or justify why this is not necessary.*

FPL Response to NRC Question 1.a: FPL's planned operation schedule for St. Lucie Unit 1 is bounded by the assumption in section 2.3, item (5) of the topical report, since the report assumes a lower percentage of operation and higher refueling time than is projected to occur at St. Lucie Unit 1. The St. Lucie Unit 1 planned outage duration on our approved operating schedule is 30 days or less for an approximate 18-month cycle. The 1999 (SL1-16) and 2001 (SL1-17) refueling outages were both less than 30 days. That results in a higher % of operation of approximately 92% and a lower refueling time of approximately 6%. The startup time is assumed to be approximately 2% or less as stated in the topical report. Since the bulk of the corrosion occurs at the low temperature aerated shut down condition or refueling time in the operation dependant corrosion model in Section 2.3 and 2.4 of the topical report, a higher percentage time of operation will result in less corrosion and therefore the St. Lucie Unit 1 operation should be bounded by the assumption in Section 2.3, item (5) of the topical report.

FPL Response to NRC Question 1.b: FPL has no plans to periodically reassess the plant operation assumptions made in section 2.3 of the topical report based on the justifications below.

Non Operation Dependant Corrosion Evaluation: Section 2.5 of the topical report identifies a more realistic estimate of corrosion that will occur in the crevice of a half nozzle replacement and is not dependant on operating schedules. This estimate is made based on the borated RCS solution being confined in a crevice and assumes that the crevice will fill with corrosion deposit and eventually stifle the corrosion degradation. This assumption is made because the corrosion products occupy a greater volume than the non-corroded base metal from which they originated. For this more realistic corrosion evaluation, the lifetime hole diameter corrosion (increase in hole diameter) is estimated to be approximately 0.025", which is significantly less than the ASME Code allowed increase noted in the topical report. Based on this realistic corrosion evaluation, there is no need to reassess the plant operation assumptions in section 2.3 of the topical report.

Operation Dependant Corrosion Evaluation: Section 2.3.4 of the topical report describes an operation dependant corrosion rate. Section 2.4 of the topical report, calculates the corresponding estimated half nozzle replacement life time for the most limiting hot leg nozzle configuration to be 76.1 years from the point of installation based on the most limiting corrosion allowance in equation (2) and the operation corrosion rate applied in equation (4). The St. Lucie Unit 1 hot leg nozzle configuration has an allowable increase in diameter determined by equation (2) in Section 2.4 of the topical report of 0.273" and is therefore bounded by the results in the topical report. Using the allowable increase in diameter applicable for the St. Lucie Unit 1 hot leg nozzle of 0.273", the repair lifetime would be significantly longer (approximately 89 years) from the April 2001 installation date. This assessment reasonably bounds the 15 years of remaining license and 35 years for a 20-year license renewal period.

The corrosion rate in Sections 2.3.4 and 2.4 of the topical report is for carbon/low alloy steel that is exposed to the bulk reactor coolant system (RCS) fluid and not to solutions confined in a crevice where the volume of the solution is such that the solution cannot be replenished (or refreshed). Therefore, this corrosion rate is extremely conservative since it is assumed to be continuous throughout the remainder of the plant lifetime. The estimated corrosion rate is actually a composite of 3 corrosion rates (Section 2.3.4 of the topical report), which are determined from the type of operation the plant experiences. The first rate is for high temperature de-aerated power operation (assumed to be 88% of the time). The second rate is for the start up period with aerated RCS fluid in the crevice (assumed to be 2% of the time). The aerated start up period is assumed to remain fixed at 2% since there are procedure and chemical controls are in place to reduce RCS oxygen content in preparation for startup. Although it is possible for startup to be delayed, the aerated condition does not continue through the entire startup period. The third rate applies to periods when the plant is shut down or in refueling with aerated RCS fluid (assumed to be 10% of the time) and provides the bulk of the corrosion rate.

Since future operation schedules can not be assured, an estimate of the effect of reduced operation is provided by determining the maximum allowable non-operating period over the next 35 years before the nozzle allowable increase in diameter is reached. The estimate is determined using equation 4 in Section 2.4 of the topical report, the St. Lucie Unit 1 hot leg nozzle allowable increase in diameter of 0.273", and the operation dependant corrosion rate equation 1 in Section 2.3.4 of the topical report.

The upper limit on shutdown/refueling time is 41%, with operation being 57% of the time, and the startup time fixed at 2%, before the corrosion limit would be reach within a remaining 35 year period. Since operation 57% of the time is well below the St. Lucie Unit 1 lifetime operations history of >86% and industry normal operation, it is reasonable to assume that this limit will not be reached.

NRC Question 2: *To confirm that the amount of flaw growth is bounded by the topical report, were the initial flaw size and the number of Unit 1 transients (both heatup/cooldown and plant leak tests) bounded by the assumptions in Section 3.3 of the topical report?*

FPL Response to NRC Question 2: The initial assumed flaw size for the hot leg nozzle applications in the topical report (listed in Section 3.3, page 23), approximates the maximum depth of the alloy 600 weld material in the hot leg pipe joint preparation for the hot leg nozzle. This assumed flaw size is applicable to the St. Lucie Unit 1 hot leg nozzles. The flaw size bounds the nominal depth dimension of the alloy 600 weld material in the hot leg pipe joint preparation for the hot leg nozzles including the nozzle identified as RC-126.

The number of transients listed in section 3.3, page 23 of the topical report (both heatup/cooldown and plant leak tests) applied to the initial assumed flaw for flaw growth analysis is bounded by the number of transient events assumed for the 40 year design life of the Unit 1 reactor coolant system. Evaluation for a 60-year design life concluded that the number of design transient cycles assumed, in the 40-year design, enveloped the 60 year plant design life and would continue to be monitored as feedback for the assumptions and conclusions. In addition, the transients that are applicable to the fatigue growth of the assumed flaw are only those that are applied after the flaw has reached the carbon steel pipe surface (assumed to be at the point of discovery of the leak from the nozzle annulus).

NRC Question 3: *Confirm that the Unit 1 half-nozzle repair meets ASME Code Section XI requirements for weld repair procedures, weld heat treatment procedures, post-weld inspection, and removal of defect (i.e., Section XI, IWB-3142.4 or IWB-3142.5). If Section XI requirements are not satisfied, identify proposed alternatives per 10 CFR 50.55a.*

FPL Response to NRC Question 3:

Weld Repair Procedures - The RC-126 half nozzle was a replacement of the ¾" nozzle and relocation of the pressure boundary weld of the nozzle to the exterior surface of the hot leg. The nozzle replacement was performed in accordance with the St. Lucie Plant Repair and Replacement Program, which currently specifies the 1989 Edition, no Addenda, of ASME Section XI and was therefore performed under Article

IWA-7000 (Replacement). As allowed by Section XI, Article IWA-7210, IWA-4110(b), and IWA-4120(a), the design report specified the ASME Section III, 1971 Edition, Summer of 1972 Addenda and was reconciled to the original Construction Code. The weld procedures for the RC-126 nozzle replacement weld were reviewed and determined to meet the qualification and fabrication requirements of ASME Section III for class 1 components and ASME Section IX, Welding and Brazing Qualifications.

Weld Heat Treatment Procedures - No post weld heat treatment (PWHT) was required to perform the replacement of the hot leg nozzle. The hot leg material is SA-516 Gr. 70. Per ASME Section IX, Welding and Brazing Qualifications, SA-516 is a P No. 1, Group No. 2 for determination of weld qualifications and heat treatment requirements. Per the original Construction Code, ASME Section III, Table NB-4622.7(b)-1, welds in P No. 1 materials are exempt from mandatory PWHT provided that the nominal thickness of the weld is ¾" or less and a 200°F minimum preheat is used. The partial penetration and reinforcing fillet weld used to join the hot leg pipe to the replacement nozzle was less than 5/8" and a 200°F minimum preheat was specified in the weld procedure.

Post-Weld Inspection - The post weld inspection was performed in accordance with ASME Section III NB-5245 for partial penetration welds. The weld surface was progressively examined by dye penetrant (PT) at the half thickness and upon completion of the full weld thickness. Due to the ¾" size of the nozzle, the replacement was exempt from a pressure test per ASME Section XI Article IWA-7400. Therefore, a system leak test was performed at normal operating pressure.

Removal Of Defect (i.e., Section XI, IWB-3142.4 or IWB-3142.5) - The half nozzle replacement technique for the ¾" hot leg nozzle is performed under ASME Section XI Article IWA-7000 and acceptance is per IWB-3142.5. The replacement technique is identified as a half nozzle replacement, where the original nozzle is removed to a depth of approximately 1" from the OD component surface and the replacement nozzle is inserted and the pressure boundary weld is made to the OD of the component. The replacement nozzle has the pressure boundary weld to the hot leg on the OD surface of the hot leg. The remaining nozzle remnant and the ID attachment weld are abandoned and not accounted for in any design calculations as providing strength. The abandoned nozzle remnant, attachment weld, and weld butter or clad are treated as if the material was not present with an ASME area reinforcement calculation per ASME NB-3332.2 as provided in FPL letter L-2001-131 (Endnote 1).

The ASME Code logic for 1" and under nozzle replacements (including the half nozzle replacement of the ¾" RC-126 nozzle) is as follows:

The RC-126 hot leg leaking nozzle was identified visually during a maintenance activity (modification of the hot leg insulation after shut down). Because of the size of these 1" and under RCS instrument nozzles, they are exempt from specific examination requirements per IWB-1220. However these 1" and under nozzles are still captured under a system leak test, Category B-P in table IWB-2500-1. For discussion purposes, it can be assumed that the discovery starts with a failed Category B-P system leak test and the acceptance per IWB-3522. This logic is applicable for all 1" NPS and under RCS alloy 600 penetrations.

IWB-3522 states that the relevant condition (leakage) shall require correction to meet IWB-3142 and IWA-5250 prior to restart.

IWB-3142.5 applies because the nozzle is being replaced and the relevant condition of leakage is corrected by replacing the nozzle and pressure boundary weld by moving the pressure boundary weld to the outside of the hot leg pipe (or other component as applicable). The remaining stub and weld ligament of the old (replaced) nozzle is abandoned in place and essentially becomes an internal attachment to the hot leg (or other component as applicable) much like the cladding which also is not included in the design calculations as adding strength to the hot leg.

IWB-3522 also directs the owner to IWA-5250 for corrective measures. IWA-5250 (a)(3) says that repairs or replacements shall be performed in accordance with IWA-4000 (repairs) or IWA-7000 (replacements) respectively. FPL chose IWA-7000 since this is a replacement.

Working within Article IWA-7000 (Replacement), IWA-7120 states, "The Owner shall be responsible for providing the following: a) A replacement program required by IWA-7130 and b) specification requirements for the design...for the replacement." This includes specifying the applicable edition of the construction code required by IWA-7200.

The Section XI IWA-7200 Applicable Requirements and IWA-7210, Code Applicability, specifies that (a) Replacements shall be performed in accordance with the Edition and Addenda of Section XI as stated in the Inservice Inspection (ISI) Program. The 1989 Edition of Section XI identified in the St. Lucie ISI program was properly specified for this replacement. Additionally (b) states that the original code of construction and design requirements shall be followed, unless the following alternative is adopted (Article IWA-7210(c)):

(c) "Alternatively, an item to be used for replacement may meet all or portions of the requirements of later editions of the Construction Code or Section III, provided that the following requirements are met.

(1) The requirements affecting the design, fabrication, and examination of the replacement are reconciled with the Owner's through the Stress Analysis Report, Design Report, or other suitable method that demonstrates the item is satisfactory for the specified design and operating conditions.

(2) Mechanical interfaces, fits, and tolerances that provide satisfactory performance are compatible with system and component requirements.

(3) Materials are compatible with the installation and system requirements."

All aspects of IWA-7210 are addressed in the engineering package prepared by FPL for this replacement, which identifies the St. Lucie ISI Program, St. Lucie Plant Repair and Replacement Program, applicable construction codes, and vendor design reports, including any required design reconciliation.

IWA-7400 also indicates that piping, valves, fittings NPS 1" and smaller are exempt from the requirements of Section XI Article IWA-7000 and that the design shall be consistent with the original construction code, but that a detailed stress analysis and considerations of secondary stress is not required. However, FPL did have a stress report prepared since the replacement involved a relocation of the pressure boundary weld and abandonment of the attachment weld and nozzle remnant. Therefore, the replacement is performed in accordance with the design code and specification called out in the engineering package prepared by FPL.

This concludes the ASME Code Section XI required actions for this replacement.

Additional Engineering Justification:

Although the ASME Section XI requirements are satisfied by the replacement of the 1" and under instrument nozzle, "good engineering practice" suggests that the following items deserve additional justification.

1) Corrosion of the exposed carbon steel in the instrument nozzle annular region.
2) Propagation of the primary water stress corrosion cracking (PWSCC) flaw by fatigue growth in the abandoned nozzle remnant and its effect on the attached component.
3) Additional or follow on inspection
4) Submittal of the flaw evaluation to the NRC per IWB-3610(e).

Corrosion of Exposed Carbon Steel Base Material:

The issue of boric acid corrosion of the exposed carbon steel in the annular surface that results from a split or half nozzle is addressed by Sections 2.0 through 2.6 of CEOG topical report CE NPSD-1198-P, with plant specific clarifications provided in the response to Question 1 above.

Propagation of the PWSCC Flaw:

The failure of the existing nozzle by PWSCC in the stressed region directly adjacent to the internal "J" weld is well documented in CEOG reports and referenced in report CE NPSD-1198-P. This cracking has been confirmed to be axial in the nozzle material in these small 1" and under penetrations when examined by eddy current inspection (ECT). Specifically, ECT characterized the nozzle RC-126 leak path as an axial indication in the nozzle remnant that was abandoned. PWSCC is not known to propagate into the surrounding carbon steel, however the flaw is postulated to have already grown to the carbon steel surface at the time of the replacement. The replacement design neglects the area of the abandoned/replaced internal "J" weld and weld butter in the pressure/stress calculation and the abandoned alloy 600 weld and butter area is effectively reduced to cladding. Following the guidance in IWB 3610 (b)(1), Category 1 flaws that lie entirely in cladding need not be evaluated. However, to provide a complete justification, owners of CE designed plants, through the CEOG wanted to document the position by submitting report CE NPSD-1198-P to the NRC for review and acceptance. Section 3.1 through 3.4 of CE NPSD-1198-P evaluates that the flaw, which is presumed to have already grown by PWSCC to the edge of the alloy 600 weld and carbon steel interface, will not propagate into the component by fatigue to an unacceptable size. This evaluation (although not required) is performed following the guidance of IWB-3142.4. The CE NPSD-1198-P shows that the postulated flaw is acceptable and the component is justified for continued service for the number of design transients listed in section 3.3, page 23, of the topical report (both heatup/cooldown and plant leak tests). The response to question 2 above indicates that this analysis is applicable for a 60-year design life at St. Lucie Unit 1.

Additional or Successive Inspections:

IWB-3142.4 (although not required since IWB-3142-5, replacement was chosen) was used as guidance for determining additional inspection requirements. IWB-3142.4 indicates that successive examination would be directed by IWB-2420 (b). This small-bore nozzle is exempt from Section XI for anything other than the Category B-P system leak tests. However, in the early implementation of the half nozzle replacements, several Utilities committed to augmented examination of the half nozzle area. Section 2.6 of CE NPSD-1198-P addresses this issue by noting the plants that are or have performed various follow-up examinations. St. Lucie Unit 2 used the half nozzle replacement in the pressurizer in 1994, and performed 2 of 3 augmented ultrasonic examinations (UT) of the postulated flaw (in 1997 and 2001) for the detection of flaw growth. This was a conservative approach since this replacement design was new to FPL and the industry. No growth of the flaw could be identified by the St. Lucie Unit 2 UT examinations. The CE NPSD-1198-P report concluded, in Section 2.6, that half nozzle replacements have been in PWR service with years of operating service without any indications of general corrosion of the alloy steel surface. The St. Lucie 2 pressurizer nozzle UT examination results confirm that the fatigue crack growth evaluation in Section 3.3 of the topical report is conservative. Therefore FPL concludes that the evaluation in CE NPSD-1198-P and the augmented examinations on the St. Lucie Unit 2 pressurizer nozzles and the continued leak inspections performed on these small bore nozzles every refueling outage provide a sufficient justification that additional ASME Code augmented examinations suggested by IWB-2420(b) are not required.

Submittal of the Flaw Evaluation to the NRC per IWB-3610(e):

The use of the half nozzle replacement leaves a flaw behind in the abandoned nozzle remnant and internal "J" weld. This flaw is evaluated in CE NPSD-1198-P using the applicable ASME Section XI methods (IWB-3600) and FPL uses the report as acceptance criteria. In the case of the hot leg nozzle replacement the hot leg material is less than 4" and therefore IWB-3620 would apply. IWB-3620 directs you back to IWB-3610. IWB-3610(e) states that the (flaw) evaluation procedures shall be subject to approval by the regulatory authority (NRC) having jurisdiction at the plant site.

Therefore, the Combustion Engineering Owners Group submitted CE NPSD-1198-P report using the guidance of IWB-3610(e) for generic evaluation to preclude individual utilities from having to perform plant specific flaw evaluation for these exempt nozzle replacements. The NRC has since issued a safety evaluation[4] noting that licensees need to assess some plant specific validations relative to the topical report, which have been addressed in FPL Letter L-2001-131 (Endnote 1) and this response to the request for additional information.

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[1] FPL letter L-2001-131, "St. Lucie Unit 1 Docket No. 50-335, In-Service-Inspection Program Third Ten-Year Interval Replacement of RCS Hot Leg Instrument Nozzle RC-126, " R. S. Kundalkar to NRC, May 24, 2001.

[2] CE NPSD-1198-P, Rev.00, Low Alloy Steel Component Corrosion Analyses Supporting Small Diameter Alloy 600/690 Nozzle Repair/Replacement Programs, CEOG Task 1131, February 2001(Note this proprietary report was submitted for generic NRC approval on Februalry 15, 2001 by CEOG letter CEOG-01-052).

[3] NRC letter, "St. Lucie Plant, Unit 1- Request for Additional Information Regarding the Placement of Reactor Coolant System Hot Leg Instrument Nozzle RC-126 (TAC No. MB2224)," Brendan T. Moroney (NRC) to J. A. Stall, April 10, 2002.

[4] NRC letter, "Safety Evaluation of Topical Report CE NPSD-1198-P, Revision 00, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs," (TAC No. MB1240)," Stuart A. Richards (NRC) to Richard Bernier, (Chairman CE Owners Group), February 8, 2002.