UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 31, 2011

Mr. Mano Nazar
Senior Vice President, Nuclear and
Chief Nuclear Officer
Florida Power and Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

SUBJECT: ST. LUCIE UNIT 1 - FOURTH 10-YEAR INTERVAL INSERVICE INSPECTION PROGRAM PLAN RELIEF REQUEST NO. 6 (TAC NO. ME3501)

Dear Mr. Nazar:

By letter dated January 15, 2010, Florida Power and Light Company (the licensee) submitted Relief Request No. 6 for St. Lucie Unit 1, requesting relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Subarticle IWB-3132.3, "Acceptance by Repair/Replacement Activity." Pursuant to Title 10 of the *Code Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), the licensee proposed to use the half-nozzle technique as an alternative to the requirement to remove the remnant nozzle and its attachment weld that contains the flaw.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's proposed alternative and has concluded that the proposed alternative provides an acceptable level of safety and quality. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the proposed alternative is authorized for the remainder of the fourth 10-year inservice inspection interval at St. Lucie Unit 1, which began on February 11, 2008, and ends on February 10, 2018.

Further details on the bases for the NRC staff's conclusions are contained in the enclosed safety evaluation. If you have any questions regarding this matter, please contact Tracy Orf at (301) 415-2788 or by email at tracy.orf@nrc.gov.

Sincerely,

Douglas A. Broaddus, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-335

Enclosure: Safety Evaluation

cc w/enclosure: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ON THE FOURTH 10-YEAR INSERVICE INSPECTION INTERVAL

REQUEST FOR RELIEF

FLORIDA POWER AND LIGHT COMPANY

ST. LUCIE NUCLEAR POWER PLANT, UNIT 1

DOCKET NO. 50-335

1.0 INTRODUCTION

By letter dated January 15, 2010, Florida Power and Light Company (the licensee) submitted Relief Request (RR) No. 6 for St. Lucie Unit 1, requesting relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, Sub-article IWB-3132.3, "Acceptance by Repair or Replacement Activity." Pursuant to Title 10 of the *Code Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), the licensee is proposing an alternative that uses the "half-nozzle" technique to repair 1 leaking Alloy 600 small-bore nozzle and as a preventive measure to replace 18 nonleaking Alloy 600 small-bore nozzles welded to the reactor coolant system (RCS) piping hot legs at St. Lucie Unit 1. The reason for submitting RR-6 is to extend the U.S. Nuclear Regulatory Commission's (NRC) approval of the previous RR-26 for the third 10-year inservice inspection (ISI) interval into the fourth 10-year ISI interval.

The current RR-6 is essentially the same as the previous RR-26. RR-26, the licensee's response to two NRC requests for additional information, and the NRC's associated safety evaluation (SE) are documented in References 1 through 4.

2.0 REGULATORY REQUIREMENTS

Paragraph 10 CFR 50.55a(g) specifies that inservice inspection of nuclear power plant components shall be performed in accordance with the requirements of the ASME Code, Section XI, except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). As stated in 10 CFR 50.55a(g)(6)(i), the Commission may grant such relief and may impose such alternative requirements as it determines is authorized by law and will not endanger life or property or the common defense and security and is otherwise in the public interest, given the consideration of the burden upon the licensee. As stated in 10 CFR 50.55a(a)(3), alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the NRC, if (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

ENCLOSURE

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements of the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b), 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Components Affected

Code Class: Class 1
Component: Small-bore Alloy 600 hot leg nozzle welds
System: Reactor Coolant System Piping

The components for which relief is requested are listed in Table 1 below.

Table 1. Small-Bore Alloy 600 Hot Leg Nozzle Welds Repaired or Replaced by "Half-Nozzle" Technique

Component Tag ID	Hot Leg	Replacement Date	Replacement Method	Reason for Replacement	Flaw Left in-place
PDT-1121D	B	2001	Half-Nozzle Technique	Leakage	Yes
TE-1112HA	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
TE-1112HB	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
TE-1112HC	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
TE-1112HD	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
TE-1111X	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
TE-1122HA	B	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
TE-1122HB	B	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
TE-1122HC	B	2005	Half-Nozzle Technique	Preventive (No Leakage)	No

Component Tag ID	Hot Leg	Replacement Date	Replacement Method	Reason for Replacement	Flaw Left in-place
TE-1122HD	B	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
TE-1121X	B	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
PDT-1111A	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
PDT-1111B	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
PDT-1111C	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
PDT-1111D	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
PDT-1121A	B	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
PDT-1121B	B	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
PDT-1121C	B	2005	Half-Nozzle Technique	Preventive (No Leakage)	No
RC-143	A	2005	Half-Nozzle Technique	Preventive (No Leakage)	No

The licensee stated that the small-bore nozzle with Tag ID No. PDT-1121D in Table 1 had evidence of leakage during the spring 2001 refueling outage and it was repaired in April 2001 with "half-nozzle" technique leaving the flaw in-place. All other subject nozzles listed in Table 1 were replaced with "half-nozzle" technique as a preventive measure in the fall 2005 refueling outage. The base material of the hot leg is SA-516, Gr. 70. The diameter of small-bore nozzles is 0.997 inch.

3.2 Applicable Code Edition and Addenda

The licensee stated that the code of record for the fourth 10-year ISI interval at St. Lucie Unit 1 is the 2001 Edition through 2003 Addenda of the ASME Code, Section XI.

3.3 Applicable Code Requirement

For applicable code requirement, the licensee referenced the 2001 Edition through 2003 Addenda of the ASME Code, Section XI, Sub-Article IWB-3132.2, "Acceptance by Repair or Replacement Activity," which states that a component with flaws that exceed the acceptance standards of Table IWB-3410-1 is unacceptable for continued service. The component shall be corrected by a repair or replacement activity to the extent necessary to meet the acceptance standards of Article IWB-3000.

3.4 Licensee's Proposed Alternative

The licensee stated that the "half-nozzle" technique was used for (a) repair of a leaking small-bore nozzle and (b) as a preventive measure for replacement of nonleaking small-bore nozzles welded to the reactor coolant piping hot legs. The "half-nozzle" technique was performed in accordance with the NRC-approved Westinghouse proprietary topical report WCAP-15973-P-A, Rev. 1, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair or Replacement Programs," (WCAP-15973), and only applicable to Combustion Engineering (CE) plants. The "half-nozzle" technique is considered an alternative to the ASME Code, Section XI, requirements and the use of the alternative requires NRC approval.

The licensee stated that nozzles were cut outboard of the partial penetration weld, approximately mid-wall of the hot leg piping. The external cut sections of the Alloy 600 nozzles were replaced with short sections (half-nozzles) of Alloy 690 material that were welded to the exterior surface of the hot leg pipe. The attachment weld was relocated from the interior surface of the hot leg pipe to the exterior surface of the hot leg pipe. The remainder of the Alloy 600 nozzles, including the original fabrication partial penetration welds, was left in-tact in the hot leg pipe. The licensee stated that the through-wall flaw in the leaking nozzle (remainder Alloy 600 base metal including the original fabrication partial penetration weld) is left in place.

3.5 Licensee's Basis for Use of Proposed Alternative

The licensee stated that during original fabrication of the piping, Alloy 600 small-bore nozzles were welded to the interior of the hot leg of the RCS piping using partial penetration welds. Industry experience has shown that cracks may develop in the nozzle base metal or in the weld metal joining the nozzles to the hot leg pipe and lead to leakage of the reactor coolant fluid. The cracks are believed to be caused by primary water stress corrosion cracking. The exact leak path, through the weld or through the base metal or both, cannot be determined. The licensee stated that the removal of all possible leak paths requires accessing the internal surface of the RCS piping and grinding out the attachment weld and any remaining nozzle base metal. Grinding on the internal surface of the hot leg piping increases the possibility of introducing foreign material that could damage the fuel cladding. Such an activity results in high radiation exposure to the personnel involved.

The basis for the alternative relies mainly on the analysis results from the WCAP-15973 and the NRC's associated SE, dated January 12, 2005. It evaluates the effect of component corrosion resulting from primary coolant (borated water) in the crevice region on component integrity—small gaps of 1/8 inch or less remain between the remnants of the Alloy 600 nozzles and the new Alloy 690 nozzles. The crevice regions are not clad. Therefore, the low alloy and carbon steels are exposed to borated water. Furthermore, WCAP-15973 evaluates the effects of propagation of the flaws left in place by fatigue crack growth and stress corrosion cracking mechanisms.

The licensee stated that the results of the bounding analyses in WCAP-15973 for the maximum material degradation show the quantity of material lost does not exceed the ASME Code limits. The report also provides results of fatigue crack growth evaluations and crack stability analyses for hot leg pipe nozzles. The results indicate that the ASME Code acceptance criteria for crack

growth and crack stability are met. Further, available laboratory data and field experience indicate that continued propagation of cracks into the carbon and low alloy steels by stress corrosion mechanism is unlikely.

The licensee stated that WCAP-15973 demonstrates that the carbon and low alloy steel hot leg piping at St. Lucie Unit 1 will not be unacceptably degraded by general corrosion as a result of replacing small diameter Alloy 600 nozzles. Although some minor corrosion may occur in the crevice region of the replaced nozzles, the degradation of the hot leg pipe will not proceed to the point where the ASME Code requirements will be exceeded before the end of plant life including the period of extended operation.

Furthermore, the licensee performed plant-specific assessments of general corrosion, thermal-fatigue crack growth, and stress corrosion cracking growth as requested in the NRC's SE of WCAP-15973.

In relation to plant-specific calculations in Section 4.1, No. 1, of the NRC's SE of WCAP-15973, the licensee stated that the limiting diameter of 1.270 inches identified in Reference 12 of WCAP-15973, is applicable to St. Lucie Unit 1. The base material of the hot leg, the corrosive environment, the operating temperatures, and the hot leg nozzle design are equivalent to that described in WCAP-15973 as shown in Table 2 of RR-6.

In relation to plant-specific calculations in Section 4.1, No. 2, of the NRC's SE of WCAP-15973, the licensee stated that the percentage of total plant time spent at each temperature condition at St. Lucie Unit 1, from January 1, 1999, to December 31, 2008, include: 93 percent for high temperature conditions, 2 percent for intermediate temperature conditions, and 5 percent for low temperature conditions. The overall general corrosion rate was determined using the corrosion rate at temperature data and equation 1 of WCAP-15973, and the St. Lucie Unit 1, corrosion rate at temperature data from January 1, 1999, to December 31, 2008. The licensee stated that the overall corrosion rate was calculated as 1.15 mils per year (mpy).

In relation to plant-specific calculations in Section 4.1, No. 3, of the NRC's SE of WCAP-15973, the licensee stated that the corrosion rate for CE plants is based on a time split of 88 percent at operating conditions, 2 percent at intermediate temperature startup conditions, and 10 percent at low temperature outage conditions. An assessment of operating data for St. Lucie Unit 1, from January 1, 1999, to December 31, 2008, shows 5 percent of plant time at low temperature outage conditions. Therefore, the licensee stated that volumetric inspection of the area is not required.

In relation to plant-specific calculations in Section 4.1, No. 4, of the NRC's SE of WCAP-15973, the licensee stated that the first "half-nozzle" repair was made in April 2001. The plant license was renewed and it expires on March 1, 2036. The first "half-nozzle" repair can be expected to see 35 years of service. Therefore, the corrosion rate of 1.15 mpy for 35 years results in a material loss of 40.25 mils.

In relation to plant-specific calculations in Section 4.1, No. 5, of the NRC's SE of WCAP-15973, the licensee stated that the calculated material loss was 40.25 mils. Doubling the loss to account for a diametrical change and adding the nozzle diameter of 0.997 inch results in a diameter of 1.08 inches after 35 years of service. A diameter of 1.08 inches is less than the

limiting diameter of 1.270 inches identified in Reference 12 of proprietary WCAP-15973 applicable to St. Lucie Unit 1.

In relation to criteria in Section 4.2, No. 1, of the NRC's SE of WCAP-15973, the licensee stated that a review of drawings of the existing nozzles on the hot leg piping shows that the existing nozzles have essentially the same dimensions as were used in proprietary Calculation Report CN-CI-02-71, Rev. 1, "Evaluation of Fatigue Crack Growth Associated with Small Diameter Nozzles for St. Lucie 1 & 2" (CN-CI-02-71), as shown in Table 2 of RR-6. Table 2 of RR-6 demonstrates that the Alloy 600 small-bore nozzles at St. Lucie Unit 1, are bounded by the nozzles used in CN-CI-02-71. Furthermore, St. Lucie Unit 1, is bounded by the linear elastic fracture mechanic (LEFM) analysis in CN-CI-02-71 since the estimated St. Lucie Unit 1, hot leg pipe reference temperature for nil-ductility transition (RT_{NDT}) is 30 °F versus the 60 °F value used in proprietary WCAP-15973. The actual RT_{NDT} was not determined for the St. Lucie Unit 1 hot leg piping since this determination was not required at the time of procurement of the piping. However, Charpy V-notch tests were performed on the hot leg piping that can be used to justify an estimated RT_{NDT}. The licensee stated that the bounding value used in WCAP-15973 is 60 °F.

In relation to criteria in Section 4.2, No. 2, of the NRC's SE of WCAP-15973, the licensee stated that during the 2005 refueling outage, the St. Lucie Unit 1, pressurizer was replaced with a new pressurizer, which has new small-bore nozzles manufactured from Alloy 690. The hot leg piping does not see the transients experienced by the pressurizer. The remainder of the RCS including the hot leg is limited to a 100 °F per hour by Technical Specifications (TS). Therefore, the licensee stated that the evaluation of the pressurizer limiting curves is considered not applicable.

In relation to criteria in Section 4.2, No. 3, of the NRC's SE of WCAP-15973, the licensee stated that the Charpy upper shelf energy (USE) data supports an elastic-plastic fracture mechanics (EPFM) analysis of a pressurizer lower shell axial flaw and not the hot leg piping as described in Section 6.3.2.2 of CN-CI-02-71. Therefore, the licensee stated that the evaluation of Charpy USE is considered not applicable for nozzle attachments to the hot leg piping.

In relation to conditions in Section 4.3, No. 1, of the NRC's SE of WCAP-15973, the licensee stated that hydrogen overpressure is typically maintained in the RCS between 25 pounds per square inch gauge (psig) and 35 psig. Contaminant concentrations for dissolved oxygen, halide ions, and sulfate are maintained at less than 5 parts per billion (ppb). All of these values are steady state values. The RCS water is analyzed for dissolved oxygen and halides three times per week with no interval between analyses exceeding 72 hours. Analysis for dissolved oxygen is not required when the RCS average temperature, T_{avg}, is less than or equal to 250 °F. Analysis for halides is not required when all fuel is removed from the reactor vessel and the RCS T_{avg} is less than 140 °F. The RCS water is analyzed for sulfate ions at least once per 7 days. The licensee stated that the analysis results for the last two cycles were reviewed and no transients were identified.

In relation to conditions in Section 4.3, No. 2, of the NRC's SE of WCAP-15973, the licensee stated that the contaminant limits have been maintained at steady state operation during the past two cycles.

The licensee stated that a plant-specific evaluation of the subject small-bore nozzles located in the hot leg piping for St. Lucie Unit 1 has been completed. Postulated flaws were assessed for flaw growth and flaw stability as specified in the ASME Code, Section XI. The results demonstrate compliance with the requirements of the ASME Code, Section XI. Furthermore, the licensee stated that based on the results of analysis in WCAP-15973, the licensee letter (L-2002-222) to the NRC dated November 27, 2002, and proprietary Calculation Report CN-CI-02-69, Rev. 0 (CN-CI-02-69), the proposed alternative would not result in a reduction of the level of quality and safety.

3.6 Duration of Relief

RR-6 is submitted for the fourth 10-year ISI interval of St. Lucie Unit 1.

4.0 STAFF EVALUATION

The NRC staff has evaluated the information provided in RR-6 dated January 15, 2010, in support of the repair of one leaking Alloy 600 small-bore nozzle in the spring 2001 refueling outage and as a preventive measure the replacement of 18 nonleaking Alloy 600 small-bore nozzles in the fall 2005 refueling outage of St. Lucie Unit 1. The subject small-bore nozzles are welded to the RCS piping hot legs. The licensee submitted RR-6 to extend the NRC approval of the previously NRC approved RR-26 for the third 10-year ISI interval into the fourth 10-year ISI interval.

For the aforementioned repair or preventive replacement activities, the licensee implemented "half-nozzle" technique presented in WCAP-15973. WCAP-15973 is only applicable to Alloy 600 nozzles and/or Alloy 82/182 welds in the reactor coolant pressure boundary of CE plants that are leaking and/or as mitigation measure for nonleaking nozzles. The "half-nozzle" technique is an alternative to the ASME Code, Section XI, Sub-Article IWB-3132.2, requirements, as the technique does not reduce the flaw to an acceptable size. Therefore, the NRC approval in accordance with 10 CFR 50.55a is required for its implementation.

The NRC's SE of WCAP-15973 defined the basis for acceptance of WCAP-15973. The NRC's SE of WCAP-15973 stated that it is acceptable for licensees to reference WCAP-15973 methodology in licensing applications for CE designed pressurized-water reactors to the extent specified and under the limitations delineated in the NRC's SE of WCAP-15973. The NRC's SE of WCAP-15973 also indicated that the methodology in WCAP-15973 accomplishes the following objectives with respect to implementing the repair or replacement activity using "half-nozzle" technique.

1. Provides an acceptable method for calculating the overall general and/or crevice corrosion rate for the internal surfaces of the low-alloy or carbon steel materials that will now be exposed to the reactor coolant and for calculating the amount of time the ferritic portions of the piping would be acceptable if corrosive wall thinning had occurred.

2. Provides an acceptable method of calculating the thermal-fatigue crack-growth life of existing flaws in the Alloy 600 nozzles and/or Alloy 82/182 weld material into the ferritic portion of the piping.

3. Provides acceptable bases and arguments for concluding that unacceptable growth of the existing flaw by stress corrosion into the piping is improbable.

In addition, the NRC's SE of WCAP-15973 requested licensees using WCAP-15973 to perform plant-specific engineering evaluations and provide plant-specific information as outlined in the NRC's SE of WCAP-15973. The plant-specific calculations are divided into three categories including general corrosion assessment, thermal-fatigue crack growth assessment, and stress corrosion cracking growth assessment, with each category containing several specific subjects.

The staff's review of licensee's responses to the plant-specific information is summarized below.

General corrosion assessment

Section 4.1 of the NRC's SE of WCAP-15973 directed licensees to address the following five plant-specific calculations. The results of this assessment will be used to confirm that the ferritic portions of the piping within the scope of WCAP-15973 will be acceptable for service throughout the licensed period of their plants (40 years if the normal licensing basis plant life is used or 60 years if the facility is approved for extension of the operating license). The NRC's SE of WCAP-15973 conclude that plant-specific engineering assessment would be sufficient to satisfy the acceptability by analysis provisions of Section XI of the ASME Code for defects induced by general corrosion or crevice corrosion.

Calculation No. 1, Section 4.1, of the NRC's SE of WCAP-15973 stated, "Calculate the minimum acceptable wall thinning thickness for the ferritic piping that will adjoin to the half-nozzle repair." The licensee stated that Section 2.4 of WCAP-15973 applies to St. Lucie Unit 1. The limiting diameter (maximum acceptable nozzle bore-hole diameter) of 1.270 inches identified in Reference 12 of WCAP-15973 is applicable to St. Lucie Unit 1. The licensee's calculated material loss or diametrical change for St. Lucie Unit 1 would result in a diameter of 1.08 inches after 35 years of service (the remaining licensing basis plant life from the time of initial repair in 2001). A diameter 1.08 inches is less than the limiting diameter of 1.270 inches. The staff finds the licensee's calculated material loss is below the maximum acceptable nozzle bore-hole diameter, therefore, it is acceptable.

Calculation No. 2, Section 4.1, of the NRC's SE of WCAP-15973 stated, "Calculate the overall general corrosion rate for the ferritic materials based on the calculation methods in proprietary WCAP-15973 the general corrosion rates listed in proprietary WCAP-15973 for normal operations, startup conditions (including hot standby conditions), and cold shutdown conditions, and the respective plant-specific times (in percentage of total plant life) at each of the operating modes." The licensee stated that the overall general corrosion rate was calculated using the St. Lucie Unit 1 data from January 1, 1999, to December 31, 2008. Table 2 below shows both the percentage of total plant time spent at each of the temperature conditions during this time period and the corrosion rate for each temperature condition taken from WCAP-15973.

The licensee stated that the overall general corrosion rate was determined to be 1.15 mpy, which is less than the maximum (allowable) corrosion rate, 1.53 mpy, identified in WCAP-15973. The staff finds the licensee's overall corrosion rate determination acceptable because (a) the allowable limit is not exceeded and (b) the data from January 1, 1999, to December 31, 2008 were used.

Table 2. Operating Data Provided for St. Lucie Unit 1.

Temperature Conditions	**Licensee Provided Total Plant-Specific Time Spent (Jan 1, 1999, - Dec 31, 2008) (percent, %)**	**Allowable Time Split for Plant Operation in Accordance with WCAP-15973 (percent, %)**	**Corrosion Rate in Accordance with WCAP-15973 (mils per year, mpy)**
High Temperature (Normal Operations)	93	88	0.4
Intermediate temperature (Startups)	2	2	19.0
Low temperature (Shutdowns)	5	10	8.0

Calculation No. 3, Section 4.1, of the NRC's SE of WCAP-15973 stated, "Track the time at cold shutdown conditions to determine whether this time does not exceed the assumptions made in the analysis. If these assumptions are exceeded, the licensees shall provide a revised analysis to the NRC, and provide a discussion on whether volumetric inspection of the area is required." The licensee stated that at St. Lucie Unit 1, the total plant time spent from January 1, 1999, to December 31, 2008, at low temperature (shutdowns) is 5 percent. This value is lower than the allowable value of 10 percent (i.e., the value considered in the analysis for low temperature (shutdowns) in WCAP-15973). The staff finds the licensee satisfied the condition required in WCAP-15973.

Calculation No. 4, Section 4.1, of the NRC's SE of WCAP-15973 stated, "Calculating the amount of general corrosion-based thinning for the piping over the life of the plant, as based on the overall general corrosion rate calculated in Step 2 and the thickness of the ferritic piping that will adjoin to the half nozzle repair." The licensee stated that the first half-nozzle repair made on the leaking Alloy 600 small-bore nozzle at St. Lucie Unit 1, in April 2001 is expected to see 35 years of service. The St. Lucie Unit 1 license was renewed until March 1, 2036. The licensee stated that the general corrosion rate of 1.15 mpy for 35 years results in a material loss of 40.25 mils. The staff finds the calculation acceptable because the licensee used the overall general corrosion rate over the 35 years plant life.

Calculation No. 5, Section 4.1, of the NRC's SE of WCAP-15973 stated, "Determine whether the piping is acceptable over the remaining life of the plant by comparing the worst case remaining wall thickness to the minimum acceptable wall thickness for the pipe." The licensee stated that doubling the material loss of 40.25 mils to account for a diametrical change and adding the diameter of nozzle 0.997 inch results in a diameter of 1.08 inches after 35 years of service. The licensee concluded that diameter of 1.08 inches is less than the limiting diameter of 1.27 inches, thus, the piping is acceptable. The staff finds licensee's conclusion acceptable because the computed worst case diameter is less than the limiting diameter identified in Reference 12 of WCAP-15973.

Thermal-fatigue crack growth assessment

The NRC's SE of WCAP-15973 stated that the WCAP-15973 methodology for calculating the thermal-fatigue repair life of the existing flaws in the original weld metal was consistent with the

methods of the ASME Code, Section XI, Appendix A. Moreover, Section 4.2 of the NRC's SE of WCAP-15973 required licensees to provide responses to the following three plant-specific criteria.

Criterion No. 1, Section 4.2, of the NRC's SE of WCAP-15973 specified licensees must demonstrate, "The geometry of the leaking penetration is bounded by the corresponding penetration reported in CN-CI-02-71." The licensee stated that a review of original drawings of the subject nozzles and Table 2 of RR-6 demonstrates that the Alloy 600 small-bore nozzles at St. Lucie Unit 1 are bounded by the nozzles used in CN-CI-02-71. Furthermore, St. Lucie Unit 1 is bounded by the linear elastic fracture mechanics (LEFM) analysis in CN-CI-02-71 since the estimated St. Lucie Unit 1 hot leg pipe reference temperature for RT_{NDT} is 30 °F versus the 60 °F value used in WCAP-15973. The licensee stated that the actual RT_{NDT} was not determined for the St. Lucie Unit 1 hot leg piping since this determination was not required at the time of procurement of the piping. To justify the use of an estimated RT_{NDT}, Charpy V-notch tests were performed on the hot leg piping. The staff finds the licensee's demonstration acceptable from the information provided in Table 2 of RR-6 and the supplemental Charpy V-notch tests performed to justify estimated RT_{NDT}.

Criterion No. 2, Section 4.2, of the NRC's SE of WCAP-15973 specified licensees must demonstrate, "The plant-specific pressure and temperature profiles in the pressurizer water space for the limiting curves (cooldown curves) do not exceed the analyzed profiles shown in figure 6-2 (a) of CN-CI-02-71, as stated in Section 3.2.3 of the NRC's SE of WCAP-15973." The licensee stated that the St. Lucie Unit 1, pressurizer was replaced during the 2005 refueling outage with a new pressurizer having Alloy 690 small-bore nozzles. The hot leg piping does not see the transients experienced by the pressurizer. The remainder of RCS including the hot leg piping is limited by the plant TSs to a 100 °F per hour rate of change. Therefore, the evaluation of the pressurizer limiting curves is no longer applicable for St. Lucie Unit 1 pressurizer. The staff finds the licensee's response acceptable because the hot leg piping does not experience the transients.

Criterion No. 3, Section 4.2, of the NRC's SE of WCAP-15973 specified licensee must demonstrate, "The plant-specific Charpy USE data shows a USE value of at least 70 ft-lb to bound the USE value used in the analysis. If the plant-specific Charpy USE data does not exist and the licensee plans to use Charpy USE data from other plants' pressurizers and hot leg piping, then justification (e.g., based on statistical or lower bound analysis) has to be provided." The licensee stated that the Charpy USE data supports an EPFM analysis of a pressurizer lower shell axial flaw and not the hot leg piping as described in section 6.3.2.2 of CN-CI-02-71. Therefore, the evaluation of Charpy USE is considered not applicable for the subject nozzle attachments to the hot leg piping at St. Lucie Unit 1. The staff finds the licensee's response acceptable, because the hot leg pipe is bounded by the LEFM analysis, and the LEFM methodology was found acceptable to the staff in determining final crack stability as discussed in the NRC's SE of WCAP-15973.

Stress corrosion crack growth assessment

The NRC's SE of WCAP-15973 stated that the stress corrosion assessment method of WCAP-15973 may be used as the bases for concluding that existing flaws in the weld metal will not grow by stress corrosion provided that licensees meet the following two conditions.

Condition No. 1, Section 4.3, of the NRC's SE of WCAP-15973 stated, "Conduct appropriate plant chemistry reviews and demonstrate that a sufficient level of hydrogen overpressure has been implemented for the RCS, and that the contaminant concentrations in the reactor coolant have been typically maintained at levels below 10 parts per billion (ppb) for dissolved oxygen, 150 ppb for halide ions, and 150 ppb for sulfate ions." The licensee stated that contaminant concentrations at St. Lucie Unit 1, for dissolved oxygen, halide ions, and sulfate ions are maintained at less than 5 ppb. The staff notes that the licensee analyzes the RCS water for dissolved oxygen and halides three times per week with no interval between analyses to exceed 72 hours. The licensee analyzes the RCS water for sulfate ions at least once per 7 days. The licensee stated that for RCS T_{avg} less than or equal to 250 °F, the analysis of RCS water for dissolved oxygen is not required. Analysis for halides is not required when all fuel is removed from the reactor vessel and the RCS T_{avg} is less than 140 °F. The licensee stated that the analysis results for the last two cycles were reviewed and no transients were identified. Based on the NRC staff's assessment given in Section 3.3 of the NRC's SE of WCAP-15973, the staff concurs that the probability for growing the existing flaws by stress corrosion into carbon or low alloy steels will be low as long as concentrations of dissolved oxygen, halide, sulfate, or other harmful contaminants are sufficiently controlled at the plants, and as long as hydrogen water chemistry is implemented at the plants. The staff finds the appropriate plant chemistry has been conducted and the contaminant concentrations at St. Lucie Unit 1 have been maintained below the allowable levels. Moreover, the hydrogen overpressure is typically maintained in the RCS between 25 psig and 35 psig at St. Lucie Unit 1.

Condition No. 2, Section 4.3, of the NRC's SE of WCAP-15973 stated, "During the outage in which the half nozzle repair is scheduled to be implemented, licensees adopting the WCAP-15973 stress corrosion crack growth arguments will need to review their plant-specific RCS coolant chemistry histories over the last two operating cycles for their plants, and confirm that these conditions have been met over the last two operating cycles." The licensee confirms that the plant-specific RCS coolant chemistry histories were reviewed over the last two operating cycles and the subject contaminant limits had been maintained at steady state operation at St. Lucie Unit 1.

In relation to fatigue crack growth and crack stability evaluations to justify leaving the through-wall flaw in the hot leg pipe nozzles, the licensee stated that the results of the bounding analyses in WCAP-15973 and CN-CI-02-71 indicate that the ASME Code acceptance criteria for crack growth and crack stability are met. Table 2 of RR-6 demonstrates that the Alloy 600 small-bore nozzles at St. Lucie Unit 1 are bounded by the nozzles used in CN-CI-02-71. The staff finds the licensee's analyses acceptable because the licensee demonstrated that the subject nozzles at St. Lucie Unit 1 are bounded by the corresponding penetration reported in CN-CI-02-71.

The licensee's responses in the areas of general corrosion assessment, thermal-fatigue crack growth assessment, and stress corrosion cracking growth assessment demonstrate that the plant-specific conditions continue to meet the criteria in WCAP-15793 and support the licensee's use of WCAP-15973 as a basis for RR-6. The staff finds that the licensee's flaw-growth calculation of existing and postulated flaws in the J-groove attachment welds demonstrated that the flaws will not affect the structural integrity of the hot leg piping. In addition, the staff finds that the corrosion of the exposed ferritic portion of the repaired nozzle penetration in the hot leg piping is within allowable levels per WCAP-15973. Therefore, the staff

finds that the licensee's proposed alternative to the requirements of the ASME Code, Section XI, Sub-Article IWB-3132.2, provides an acceptable level of quality and safety.

5.0 CONCLUSION

On the basis of review and evaluation of the licensee's submittal, the NRC staff concludes that continued use of the proposed alternative would provide an acceptable level of quality and safety. The licensee has demonstrated that its general corrosion assessment, thermal-fatigue crack growth assessment, and stress corrosion crack growth assessment have addressed and satisfied the calculations, criteria, and conditions in the NRC's SE of WCAP-15973. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes RR-6 for the continued use of the half-nozzle repair of the Alloy 600 small-bore nozzles (shown in Table 1) welded to the RCS piping hot legs at St. Lucie Unit 1. The relief is authorized for the fourth 10-year ISI interval.

All other ASME Code, Section XI, requirements for which relief was not specifically requested and authorized herein by the NRC staff remain applicable, including the third party review by the Authorized Nuclear Inservice Inspector.

6.0 REFERENCES

1. Florida Power and Light Company letter, L-2005-099, dated April 29, 2005, to the NRC, "St. Lucie Unit 1, Docket No. 50-335, Inservice Inspection Plan, Third 10-Year Interval, Relief Request 26: Repair of Alloy 600 Small-Bore Nozzles Without Flaw Removal," Agencywide Documents Access and Management System (ADAMS) Accession No. ML051310170.

2. Florida Power and Light Company letter, L-2005-189, dated August 25, 2005, to the NRC, "St. Lucie Unit 1, Docket No. 50-335, Inservice Inspection Plan, Third 10-Year Interval, Request for Additional Information Relief Request 26: Repair of Alloy 600 Small-Bore Nozzles Without Flaw Removal," ADAMS Accession No. ML052420490.

3. Florida Power and Light Company letter, L-2005-220, dated October 13, 2005, to the NRC, "St. Lucie Unit 1, Docket No. 50-335, Inservice Inspection Plan, Third 10 -Year Interval, Request for Additional Information Relief Request 26: Repair of Alloy 600 Small-Bore Nozzles Without Flaw Removal," ADAMS Accession No. ML052900402.

4. The NRC safety evaluation letter dated November 22, 2005, to Florida Power and Light Company, "Safety Evaluation for St. Lucie Unit 1, Proposed Alternative Repair Request for Reactor Coolant Piping Hot Leg Alloy 600 Small-Bore Nozzles; Relief Request Number 26 (TAC No. MC6944)," ADAMS Accession No. ML053140196.

Principle Contributor: Ali Rezai

Date: January 31, 2011

January 31, 2011

Mr. Mano Nazar
Senior Vice President, Nuclear and
Chief Nuclear Officer
Florida Power and Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

SUBJECT: ST. LUCIE UNIT 1 - FOURTH 10-YEAR INTERVAL INSERVICE INSPECTION PROGRAM PLAN RELIEF REQUEST NO. 6 (TAC NO. ME3501)

Dear Mr. Nazar:

By letter dated January 15, 2010, Florida Power and Light Company (the licensee) submitted Relief Request No. 6 for St. Lucie Unit 1, requesting relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Subarticle IWB-3132.3, "Acceptance by Repair/Replacement Activity." Pursuant to Title 10 of the *Code Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), the licensee proposed to use the half-nozzle technique as an alternative to the requirement to remove the remnant nozzle and its attachment weld that contains the flaw.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's proposed alternative and has concluded that the proposed alternative provides an acceptable level of safety and quality. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the proposed alternative is authorized for the remainder of the fourth 10-year inservice inspection interval at St. Lucie Unit 1, which began on February 11, 2008, and ends on February 10, 2018.

Further details on the bases for the NRC staff's conclusions are contained in the enclosed safety evaluation. If you have any questions regarding this matter, please contact Tracy Orf at (301) 415-2788 or by email at tracy.orf@nrc.gov.

Sincerely,

/RA/

Douglas A. Broaddus, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-335

Enclosure: Safety Evaluation

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