May 23, 2003

Mr. J. A. Stall
Senior Vice President, Nuclear and
Chief Nuclear Officer
Florida Power and Light Company
P.O. Box 14000
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SUBJECT: SAINT LUCIE NUCLEAR PLANT, UNITS 1 AND 2 - RELIEF REQUESTS NOS. 23 AND 33 REGARDING SLEEVED FULL-NOZZLE REPAIR OF ALLOY 600 SMALL BORE NOZZLES WITHOUT FLAW REMOVAL (TAC NOS. MB7199 AND MB7200)

Dear Mr. Stall:

By a letter dated January 8, 2003, as supplemented in a letter dated April 23, 2003, Florida Power and Light Company (the licensee), submitted Relief Requests 23 and 33 for Saint Lucie, Units 1 and 2, respectively, requesting relief from the American Society of Mechanical Engineers (ASME) Section XI requirements for repair/replacement of Alloy 600 small bore nozzles. Pursuant to Title 10 of the *Code of Federal Regulation* (10 CFR) Section 50.55a(a)(3)(ii), the requests proposed using repair techniques for Alloy 600 small bore nozzles without removing the flaws. Two repair techniques were proposed - a half-nozzle repair and a sleeved full-nozzle repair. The U.S. Nuclear Regulatory Commission (NRC) granted relief for use of the half-nozzle technique in a letter dated May 9, 2003. This letter addresses use of the sleeved full-nozzle technique.

The NRC staff has reviewed the licensee's proposed alternative and has concluded that performance of an ASME Code repair/replacement of Alloy 600 small bore nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. In addition, the licensee's proposed alternative provides reasonable assurance of structural integrity for one operating cycle. Therefore, relief is granted pursuant to 10 CFR 50.55a(a)(3)(ii) for one 18-month operating cycle, which began October 2002 for Unit 1 and begins May 2003 for Unit 2. For use of the sleeved full-nozzle repair on a permanent basis, the licensee needs to submit a separate relief request for NRC approval. The required conditions for implementing the sleeved full-nozzle repairs on a permanent basis will be provided in the NRC staff's safety evaluation (SE) of the Westinghouse Topical Report WCAP-15973-P, Revision 00, which is currently under NRC staff review.

Further details on the bases for the NRC staff's conclusions are contained in the enclosed SE. If you have any questions regarding this issue, please feel free to contact Brendan Moroney at (301) 415-3974 or Eva Brown at (301) 415-2315.

Sincerely,

/***RA***/

Allen G. Howe, Chief, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-335 and 50-389

Enclosure: Safety Evaluation

cc w/enclosure: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION PROGRAM

RELIEF REQUESTS NOS. 23 AND 33

FLORIDA POWER AND LIGHT COMPANY, ET AL.

SAINT LUCIE NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-335 AND 50 -389

1.0 INTRODUCTION

By letter dated January 8, 2003 (Reference 1), as supplemented in a letter dated April 23, 2003, the Florida Power & Light Company, et al. (FPL, the licensee) submitted Relief Requests 23 and 33 for relief from the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, for Inservice Inspection (ISI) and Repair and Replacement Programs, for Saint Lucie (STL) Units 1 and 2, respectively. Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(ii), the licensee has requested relief from the ASME Code, Section XI requirements for repair/replacement of Alloy 600 small bore nozzles at STL Units 1 and 2. Specifically, the licensee proposed to use a sleeved full-nozzle repair technique without removing the flaws as an alternative to the ASME Code requirements of paragraph IWB-3132.3. IWB-3132.3 requires that the component or the portion of the component containing the flaws be replaced.

Industry experience has shown that cracks may develop in small bore Alloy 600 nozzles such as instrument nozzles in pressurizers and hot leg piping, which may lead to leaking of the nozzles. These cracks are caused by primary water stress corrosion cracking (PWSCC) and have been found in a number of pressurized-water reactors. Because of hardship and unusual difficulty associated with removing the flaws in the degraded small bore Alloy 600 nozzles, the licensee proposed to use repair techniques without removing the flaws.

2.0 REGULATORY EVALUATION

Section 50.55a(g) of 10 CFR, states that nuclear power facility components must meet the requirements contained in applicable editions of the ASME Code. However, for some instances, the implementation of an ASME Code repair or replacement may not be practical. Pursuant to 10 CFR 50.55a(a)(3), alternatives to the ASME Code requirements may be used, when authorized by the U.S. Nuclear Regulatory Commission (NRC), if the applicant demonstrates that (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. To perform a noncode repair/replacement, the licensee needs to submit a request for NRC approval of relief

Enclosure

from certain ASME Code requirements. Pursuant to Section 50.55a(g)(4) of 10 CFR Part 50, ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, “Rules for ISI of Nuclear Power Plant Components,” to the extent practical within the limitations of design, geometry, and materials of construction of the 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 in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in Section 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

The applicable code of record for the second 10-year ISI for STL, Units 1 and 2 is the 1989 Edition of the ASME Code, Section XI, no addenda.

3.0 TECHNICAL EVALUATION

This safety evaluation (SE) documents the NRC staff’s evaluation of the licensee’s proposed use of the sleeved full-nozzle technique for repair/replacement of the small bore Alloy 600 nozzles in the pressurizers and hot-leg piping at STL. The issues of corrosion of ferritic materials, stress corrosion cracking and fatigue crack growth associated with the Alloy 600 small bore nozzle repair are discussed in the Westinghouse Topical Report, WCAP-15973-P, Revision 00 (Reference 2). As discussed in this SE, the operation of the sleeved full-nozzle repair is approved for one operating cycle. In Reference 3, the NRC has approved the operation of a similar repair using a half-nozzle technique without removing the flaws. The NRC staff is currently assessing the requirements that would allow the operation of half-nozzle repairs on a permanent basis. The required conditions for operation of the half-nozzle repairs on a permanent basis will be provided in the NRC staff’s SE of Reference 2, which is currently under review. Since the issues of concerns resulting from repairs using either a half-nozzle technique or a sleeved full-nozzle technique are similar, the required conditions for operation stipulated in the NRC staff’s SE of Reference 2 are also applicable to sleeved full-nozzle repairs.

3.1 RELIEF REQUESTS NOS. 23 AND 33

3.1.1 Component Identification

Small bore Alloy 600 nozzles in pressurizers and reactor coolant hot leg piping at STL Units 1 and 2.

3.1.2 Code Requirements for which Relief is Requested

ASME Code Section XI, 1989 Edition with no addenda. The ASME Code Section XI requires that repairs or replacement of ASME Code Class components be performed in accordance with the rules delineated in the ASME Code. Relief is requested from the requirements of paragraph IWB-3132.3 (Acceptance by Replacements) of ASME Code Section XI. The acceptance standards in IWB-3132.3 require that the component or the portion of the component containing the flaws be replaced. The licensee’s proposed sleeved full-nozzle repairs do not remove the portion of the component containing the flaws.

3.1.3 Licensee's Proposed Alternative to Code

The licensee's proposed alternative program is based on the use of the sleeved full-nozzle repair technique. In the sleeved full-nozzle technique, the existing attachment weld and any cracks in the weld are left in place. The sleeved full-nozzle repair will relocate the primary pressure boundary from the internal surface to the external surface of the pressurizer and reactor coolant hot-leg piping. This is achieved by removing the Alloy 600 nozzle, but not the attachment weld, and replacing it with an Alloy 690 sleeve (liner) and an Alloy 690 full-length nozzle. The Alloy 690 nozzle/sleeve is welded to either the external surface of the pressure boundary or to an external Alloy 690 temper bead weld build-up pad with a partial penetration and reinforcing fillet weld.

3.1.4 Licensee's Basis for Relief

The small bore Alloy 600 nozzles were typically welded to the interior surface of the pressurizers and the reactor coolant hot leg piping using Alloy 82/182 weld material. Alloy 600 and Alloy 82/182 materials are susceptible to PWSCC. Therefore, cracks may initiate from the nozzle base metal and/or in the weld metal joining the nozzle to the pressurizer or reactor coolant piping. Industry experience has shown that such cracking may lead to primary coolant leakage. To remove all of the cracks during repair would require access to the interior surface of the pressurizer or hot-leg piping in order to perform grinding of the affected nozzle base metal and the attachment welds. These activities will expose personnel to a high-radiation environment and potential safety hazards.

The licensee performed a plant-specific fatigue crack-growth evaluation since the cracks left inside may propagate into the ferritic material of the pressurizer or hot-leg piping. The results of the licensee's fatigue crack-growth evaluation showed that the cracks in the attachment weld will not propagate through the reactor coolant pressure boundary, because the calculated crack growth is small and the presence of these cracks would not impact the structural integrity of the pressurizer and the hot-leg piping. Therefore, the licensee determined that to comply with the subject ASME Code requirement of removing the flaws would result in hardship and unusual difficulty without a compensating increase in the level of quality or safety.

3.1.5 Staff Evaluation

In support of the relief request, the licensee provided, in Reference 5, a structural analysis to demonstrate the structural integrity of the proposed replacement, and to demonstrate by analysis that the proposed repair methodology meets the current licensing basis design rules for ASME Section III, Class 1 components (1971 Edition and Addenda through summer 1972). This full length nozzle repair consists of replacing the entire Alloy 600 nozzle and internal "J" weld with an Alloy 690 full-length nozzle and an Alloy 690 corrosion liner (sleeve). The original bore diameter in the component wall is enlarged along its full length in the component wall to accommodate the replacement liner/nozzle combination. The Alloy 690 corrosion liner is rolled in the interior surface of the penetration for a minimum length of 2 inches. The purpose of the liner is to provide protection against corrosion of the component wall. However, as discussed below this may not be achieved when the cracks in the attachment weld are not removed.
The Alloy 690 nozzle is welded to the external surface of the component or to an external Alloy 690 temper bead weld build-up pad by a partial penetration and reinforcing fillet weld.

The weld is designed and fabricated in accordance with ASME Section III, Subsection NB, rules for partial penetration welds. To demonstrate compliance with ASME Section III, Subsection NB, the licensee described in Reference 4 the analysis of the external weld region using a finite element model consisting of the component wall, the full-length nozzle and the external surface partial penetration weld which attaches the nozzle to the component. The results of this analysis were shown to comply with the ASME Section III design criteria for pressure boundary integrity, for both strength and fatigue.

The Alloy 690 sleeved full-nozzles will be welded to the external component surfaces in accordance with ASME Section III, Subsection NB, rules. In Reference 4, the licensee stated that the post-weld inspection of the half-nozzle repairs will be performed in accordance with the requirements of ASME Section III NB-5245 for partial penetration welds. The NRC staff finds this is also acceptable for the post-weld inspection of the sleeved full-nozzle repairs because it conforms with the plant licensing basis.

Based on review of the information provided, the NRC staff concludes that the licensee has provided a reasonable basis to support the structural integrity of the sleeved full-nozzle repair for one operating cycle, without adversely affecting the health and safety of the public.

There are two concerns resulting from the sleeved full-nozzle repair which are similar to that resulting from half-nozzle repair. The first concern is the effect of corrosion of the ferritic materials due to the exposure of the low Alloy and carbon steel to the borated primary coolant. In the sleeved full-nozzle repair, the liner (sleeve) is designed to provide protection against corrosion of the component interior wall. However, corrosion on a local scale will occur when any cracks left in the attachment weld start to propagate into the adjacent carbon and low alloy steels or in areas where tight bonding between the liner and interior surface of the component is not formed or subsequently relaxed. Industry experience with rolled components has shown that there is a potential for the borated coolant to leak into the space between the sleeve and the ferritic material after a short period of service. The potential for general corrosion of the ferritic material was evaluated in Reference 2. The general corrosion was estimated to be about 1.53 mils per year. Based on this rate, the degradation of the ferritic material will not exceed the ASME Code allowable at the end of the plant life. Accelerated boric acid corrosion is not considered in the licensee’s evaluation because free oxygen does not exist in the closed environment and there is no known mechanism for concentrating boric acid in the crevice region of the nozzle and the ferritic vessel or hot-leg piping. However, Reference 2 is still under evaluation; thus, approval of the sleeved full-nozzle repair for the life of the plant cannot be authorized at this time. Nevertheless, the NRC staff has determined that the results of the licensee’s corrosion analysis provide adequate safety margin to support the operation of the sleeved full-nozzle repair for one operating cycle.

The second concern is the potential for the cracks left in the attachment weld to propagate into the adjacent carbon and low Alloy steels by means of fatigue crack growth mechanism. The licensee performed a plant-specific evaluation of fatigue crack growth for STL Units 1 and 2. The calculations are documented in Westinghouse Electric Company LLC Calculation Note Number CN-CI-02-69, Revision 0 (Reference 6). The results of the calculations show that the flaws left in place after small bore nozzle repair/replacement are acceptable because the final flaw sizes at the end of plant life will not exceed the ASME Code allowable. The NRC staff has issued a request of additional information (RAI) regarding the details of the methodology used in the fatigue crack growth evaluation and the fatigue analysis in Reference 5. Although the review of the April 23, 2003, RAI reply is not complete, the NRC staff has determined that there is enough safety margin in the licensee's calculations to support the operation of the sleeved full-nozzle repair for one operating cycle. The NRC staff will complete the review of the licensee's responses to the RAI in its assessment of a future relief request by the licensee for the operation of the sleeved full-nozzle repair on a permanent basis.

In view of the recent event of significant corrosion of the reactor vessel head at Davis-Besse, the NRC staff is evaluating several issues associated with the long-term implementation of the sleeved full-nozzle repair, such as the effect of water chemistry on crack growth and the need for periodic volumetric inspections similar to inspections performed at Arkansas Nuclear One, Unit 1, to ensure that there is no occurrence of significant corrosion and fatigue crack growth in the ferritic materials of pressurizer and hot-leg piping.

For implementation of the sleeved full-nozzle repair on a permanent basis, the licensee must submit for NRC approval, a separate relief request which includes the responses to the NRC staff's RAI. As discussed above, the required conditions for implementation of the sleeved full-nozzle repair on a permanent basis will be provided in the NRC staff's safety evaluation of Reference 2, which is currently under review.

4.0 CONCLUSION

Based on its review of the licensee's submittal, the NRC staff has determined that the licensee's proposed sleeved full-nozzle repair is acceptable for one cycle of operation. The NRC staff has also determined that the performance of ASME Code repair/replacement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety, since an immediate ASME Code repair would result in potentially excessive radiation exposure and safety hazards to personnel. Furthermore, there is reasonable assurance that flaws left in place will not impact the structural integrity of the primary pressure boundary. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the NRC staff authorizes the licensee's proposed alternative, as described in Section 3.1.3, for one operating cycle of STL Units 1 and 2. All other ASME Code, Section XI requirements for which relief was not specifically requested by the licensee and approved in this safety evaluation remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

5.0 REFERENCES

1. Letter dated January 8, 2003, from D. E. Jernigan, FPL, to the NRC Document Control Desk, with Attachment.

2. Westinghouse Topical Report, WCAP-15973-P, Revision 00 (CE NPSD-1198-P, Revision 01) "Low-Alloy Steel Component Corrosion Analysis Supporting Small-diameter Alloy 600/690 Nozzle Repair/Replacement Programs."

3. Letter dated May 9, 2003, from the NRC to J. A. Stall, FPL.

4. Letter dated June 14, 2002, from D. E. Jernigan, FPL, to the NRC Document Control Desk.

5. Asea Brown Boveri-Combustion Engineering Report CR-9417-CSE95-1102, Revision 02, “Structural Analysis of Replacement Instrumentation Nozzles and Heater Sleeves for Florida Power and Light - St. Lucie #1&2 Pressurizer, #1&2 Piping, and #2 Steam Generator,” January 19, 1996.

6. Westinghouse Electric Company LLC Calculation Note Number CN-CI-02-69, Revision 0, “Evaluation of Fatigue Crack Growth Associated with Small Diameter Nozzles for St. Lucie 1 & 2,” dated October 9, 2002.

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Date: May 23, 2003

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ST. LUCIE PLANT

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