October 31, 2003

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

SUBJECT: TURKEY POINT UNIT 4 - RELAXATION OF THE REQUIREMENTS OF ORDER (EA-03-009) REGARDING REACTOR PRESSURE VESSEL HEAD INSPECTIONS (TAC NO. MC1082)

Dear Mr. Stall:

The U.S. Nuclear Regulatory Commission (NRC) has approved your request for relaxation of the requirements of Order EA-03-009, Paragraph C.(1)(b)(i) requiring specific inspections of the reactor pressure vessel (RPV) and associated penetration nozzles at pressurized water reactors, for Turkey Point Unit 4. This Relaxation is in response to your two letters dated October 21, 2003, as supplemented by letters dated October 23 and 31, 2003. Florida Power and Light has requested Relaxation for Turkey Point Unit 4, of the requirements to perform the prescribed ultrasonic testing (UT) inside the tube from 2 inches above the J-groove weld to the bottom of the penetration for one RPV head penetration. Specifically, you requested to perform an UT examination, with less than full coverage, for RPV penetration #11. The area on this nozzle with less than full coverage is greater than or equal to 0.62 inches below the J-groove weld to the bottom of the nozzle. You also requested a reduction of the examination coverage area for this and 52 nozzles.

The NRC staff has completed its review and concludes that you have demonstrated that compliance with the Order for the RPV nozzles specified would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV, paragraph F of Order EA-03-009, the NRC staff finds there is good cause shown to relax the Order and authorizes the proposed relaxation and alternative inspection for the identified RPV head penetration nozzles at TP4, for the one operating cycle subject to the following conditions:

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

Be aware that when vessel head inspections are performed using American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) requirements, acceptance criteria, or qualified personnel, those activities and all related activities fall within the jurisdiction of the ASME Code. Therefore, Order-related inspection activities may be subject to third party review, including those by the Authorized Nuclear Inservice Inspector.
If there are any questions concerning this approval, please to contact Ms. Eva Brown at (301) 415-2315.

Sincerely,

/RA by E. Leeds for/

Edwin M. Hackett, Director
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-251

Enclosure: As stated

cc w/encl: See next page

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Mr. J. A. Stall
Florida Power and Light Company

TURKEY POINT PLANT

cc:
M. S. Ross, Attorney
Florida Power & Light Company
P.O. Box 14000
Juno Beach, FL 33408-0420

T. O. Jones, Site Vice President
Turkey Point Nuclear Plant
Florida Power and Light Company
9760 SW. 344th Street
Florida City, FL 33035

County Manager
Miami-Dade County
111 NW 1 Street, 29th Floor
Miami, Florida 33128

Senior Resident Inspector
Turkey Point Nuclear Plant
U.S. Nuclear Regulatory Commission
9762 SW. 344th Street
Florida City, Florida 33035

Mr. William A. Passetti, Chief
Department of Health
Bureau of Radiation Control
2020 Capital Circle, SE, Bin #C21
Tallahassee, Florida 32399-1741

Mr. Craig Fugate, Director
Division of Emergency Preparedness
Department of Community Affairs
2740 Centerview Drive
Tallahassee, Florida 32399-2100

Attorney General
Department of Legal Affairs
The Capitol
Tallahassee, Florida 32304

Michael O. Pearce
Plant General Manager
Turkey Point Nuclear Plant
Florida Power and Light Company
9760 SW. 344th Street
Florida City, FL 33035

Walter Parker
Licensing Manager
Turkey Point Nuclear Plant
9760 SW 344th Street
Florida City, FL 33035

Vice President, Nuclear Operations Support
P.O. Box 14000
Juno Beach, FL 33408-0420

Mr. Rajiv S. Kundalkar
Vice President - Nuclear Engineering
Florida Power & Light Company
P.O. Box 14000
Juno Beach, FL 33408-0420

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ORDER (EA-03-009) RELAXATION REQUEST

REACTOR PRESSURE VESSEL HEAD INSPECTIONS

FLORIDA POWER AND LIGHT

TURKEY POINT NUCLEAR PLANT, UNIT 4

DOCKET NO. 50-251

1.0 INTRODUCTION

By letter dated October 21, 2003, as supplemented by two letters dated October 21 and 31, 2003, Florida Power and Light (the licensee), submitted a request for relaxation, in accordance with Section IV, paragraph F(2) of Order EA-03-009 for Turkey Point Unit 4 (TP4), of the requirements contained in Section IV, paragraph C.(1)(b)(i) of Order EA-03-009 issued by the U.S. Nuclear Regulatory Commission (NRC) staff on February 11, 2003. Relaxation was requested for the October 2003 Unit 4 Refueling Outage and any reinspection in which NRC Order EA-03-009 is in effect.

2.0 REGULATORY EVALUATION

The NRC issued Order EA-03-009, on February 11, 2003, as amended on March 14, 2003, which requires specific examinations of the RPV head and vessel head penetration (VHP) nozzles of all pressurized water reactor plants. Section IV, paragraph F, of the Order states that requests for relaxation of the Order associated with specific penetration nozzles will be evaluated by the NRC staff using the procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers Code in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(a)(3). Section IV, paragraph F, of the Order states that a request for relaxation regarding inspection of specific nozzles shall address the following criteria: (1) the proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or (2) compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For TP4 and similar plants determined to have a high susceptibility to primary water stress-corrosion cracking in accordance with Section IV, paragraphs A and B, of the Order, the following inspections were required to be preformed every refueling outage in accordance with Section IV.C.(1)(b) of the Order:

Either:

(i) Ultrasonic testing of each RPV head penetration nozzle (i.e., nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, OR

(ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

3.0 TECHNICAL EVALUATION

3.1 Components for Which Relaxation is Requested

The licensee has requested relaxation from Section IV, paragraph C.(1)(b)(i) of the Order for 53 RPV head penetration nozzles which had an incomplete UT.

3.2 Order Requirements for Which Relaxation is Requested

Section IV.C.(1)(b) of Order EA-03-009 requires, in part, that the following inspections be performed every refueling outage for high susceptibility plants similar to TP4:

Either:

(i) Ultrasonic testing of each RPV head penetration nozzle (i.e., nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, OR

(ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

3.3 Licensee's Proposed Alternative

The proposed alternative is to perform a UT examination to include 2 inches above the weld to the lowest elevation possible or greater than 0.62 inches below the weld, whichever is greater.

3.4 Licensee's Basis for Relaxation

The licensee stated that additional efforts to achieve the Order-required examination area (below the weld) would result in a hardship due to unusual difficulty without a compensating increase in the level of quality and safety. The licensee stated that the 66 RPV head penetration nozzles at TP4 are used for a variety of functions and present a variety of examination conditions. In particular, the 45 RPV head penetration nozzles that are attached to active control rod drive mechanisms (CRDMs) have funnel-ended guide sleeves permanently attached inside the nozzles, which leaves only a narrow annulus available for inspection. There are six RPV head penetration nozzles attached to part-length CRDMs that have threaded drive

rods permanently retracted and pinned inside the RPV head penetration nozzles that hang down below the nozzle end and create an obstruction. There are two RPV head penetration nozzles, modified for the reactor vessel level measurement system, that have a guide sleeve installed and a welded end plate (that required removal for inspection). The licensee stated that these 53 RPV head penetration nozzles all require inspections with a UT blade probe. The remaining 13 RPV head penetration nozzles are open locations and have been UT inspected to the bottom of the nozzle using a rotating probe design. The licensee stated that the UT technology currently available for the TP4 RPV penetration nozzle inspections has led to some areas of missed inspection coverage greater than or equal to 0.62 inches below the weld.

The licensee also stated that the area of coverage obtained for RPV head penetration #11 was less than that required by the NRC Order. The coverage below the weld, in the nonpressure boundary portion of the RPV head penetration nozzle, did not extend to the bottom of the nozzle in full circumference. Specifically, the area of missed coverage is a 32° arc, starting 0.76 inches below the bottom of the J-groove weld. The licensee stated in their response dated October 23, 2003, that the area of missed coverage is a localized area which is likely due to localized blending of the material during manufacture of the nozzle or the result of a minor distortion during the welding fabrication. The imperfection in the localized area created the loss of contact between the nozzle and the UT probe.

The licensee stated that performing penetrant testing in accordance with Section IV, paragraph C.(1)(b)(ii) of the Order of the missed outside diameter (OD) areas of the penetration base material would be time and dose intensive without a compensating increase in safety. As described in Attachment 1 of the licensee's submittal dated October 21, 2003, the effect of not performing the inspection for which relaxation is requested is negligible on the level of quality and safety. The licensee indicated that there are no concerns with the structural integrity of the VHP nozzles from the unexamined portions of the nozzles addressed in their relaxation request, due to the low stresses in these portions of the nozzles and the consequently low crack growth rates.

3.5 Evaluation

The NRC staff's review of this request was based on criterion (2) of paragraph F of Section IV of the Order, which states:

> Compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The licensee has demonstrated that hardship or unusual difficulty that would result from implementing examinations to the bottom end of the identified RPV head nozzles. The hardship is due to nozzle configuration and probe limitations as well as hardware modifications needed and associated doses to reach inaccessible areas as stated by the licensee is as follows:

- The available circumferential UT blade probe inspection technique is not capable of interrogating the bottom triangular segment of the nozzle. This probe design was selected based on its ability to detect and size axial, off-axis, and circumferential flaws. It was also selected for its robustness and ability to obtain more consistent surface contact. The

deployment of the axial UT blade probes in addition to the currently deployed circumferential blade probe does not significantly increase coverage. The axial probe also has limitations, due to element size, that prohibit interrogation to the bottom of the nozzle. Deployment of both probes provides little additional information and no commensurate increase in safety.

- To employ a rotating UT probe, capable of interrogating all the material to the bottom of the nozzles in penetrations that were not open (thermal guide sleeves, part length drive rods or other permanently installed equipment), would require hardware changes to cut, remove, and replace interfering equipment in the RPV head penetrations. The modifications required would be time and dose intensive.

- Manual PTs [dye penetrant tests] of the missed OD areas of the penetration base material would be time and dose intensive without a compensating increase in safety. Access to the OD of the nozzles is limited by a "forest" of 45 thermal sleeves and 6 permanently installed part length CRDM drive rods that extend well below the nozzle ends. The dose estimate to perform manual PT surface examination of the 53 RPV head nozzle ends examined by blade probe UT would be approximately 15 man Rem. This estimate is based on the dose rates of the TP4 head compared to dose rates and actual surface examinations of the vent line at Turkey Point Units 3 and 4 and portions of 9 RPV head nozzle ends at St. Lucie Unit 2. The PT examination of the remaining 53 penetration base material OD would result in excessive dose without a resultant commensurate increase in safety.

The licensee's request to limit the examination of the nozzle base material inner surface to greater than 0.62 inches below the weld is supported by the licensee's analysis which demonstrated that no flaw below that portion of the nozzle would propagate to a level adjacent to the J-groove weld within an 18-month operating period. The licensee's flaw evaluation was performed postulating an axial flaw in the area of missed coverage below the weld using the method described in Westinghouse WCAP-16027-P, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Turkey Point Units 3 & 4" Revision (Rev.) 0. In the licensee's flaw evaluation, a through-wall flaw is postulated in the nozzle material from the bottom of the penetration to 0.62 inches from the bottom of the weld. The licensee stated that this is a conservative assumption since the inspected region extends 0.39 inches farther below the weld on the inner diameter (ID) surface of the nozzle. The licensee stated that the flaw evaluation in WCAP-16027-P, Rev. 0, is based on Turkey Point Units 3 and 4 specific stresses in the nozzle penetrations. Since the stresses in the region greater than 0.62 inches below the weld are too low to propagate an axial flaw, the WCAP-16027-P, Rev. 0, flaw evaluations started at ½-inch below the weld, and evaluated the time to propagate the flaw in the nozzle to the bottom of the weld (start of the pressure boundary portion of the nozzle material or toe of the J-groove weld). The licensee concluded that assuming a through-wall flaw below the weld, with the flaw end located at ½-inch below the weld (which is in the area of complete UT coverage), an axial flaw would take greater than 5 years of operation in any nozzle location to grow to the point of contact with the weld. This

time period is greater than the current inspection frequency of every refueling cycle (18 months for TP4) identified in Order EA-03-009.

The licensee's analysis in WCAP-16027-P, Rev. 0, used the crack growth formula in Electric Power Research Institute Report Material Reliability Program (MRP) report MRP-55, "Material Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material (MRP-55), Revision 1." The NRC staff has not yet made a determination on the acceptability of the subject industry report. Should the crack growth formula used by the licensee be found to be unacceptable, the licensee would need to revise its analysis to incorporate an acceptable crack growth formula as described below:

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

The licensee modified its alternative to include these conditions in its supplemental letter, dated October 23, 2003.

The licensee also provided the Turkey Point Unit 3 and 4 specific hoop stresses identified in WCAP-16027-P, Rev. 0, for the individual nozzle angles. These figures were previously submitted and approved in a safety evaluation supporting a similar Order relaxation for Turkey Point Unit 3 dated March 20, 2003 [ADAMS Accession No. ML030790501]. The figures show that the stress rapidly decreases as the distance from the weld toe increases.

The licensee stated that there are no concerns with the structural integrity of the TP4 RPV penetration nozzles that could be caused by axial cracking in the missed coverage areas in the nonpressure boundary portion of the nozzle material greater than 0.62 inches below the weld for a period of greater than 5 years of operation. The licensee's statement is based on the following considerations:

– UT inspection results show no indications in the nozzle areas examined from a minimum of 0.62 inches below the weld to 2 inches above the weld (100 percent coverage obtained in this region);

– Acceptable assessment of no "leak path" present into interference fit zone (100 percent coverage obtained as indicated in Table 1);

– Acceptable bare metal visual examination results of no leakage since the last refueling outage bare metal RPV head inspection and;

– Circumferential cracks in this portion of the penetration are of no safety significance and would be identified by the full UT ID inspection before a loose part could develop. A complete UT was performed on all nozzles from the ID for a distance from greater than 2 inches above the weld to the end of the nozzle (except the 0.1-inch localized area in nozzle #11) when the UT probe exits the nozzle. Any ID initiated circumferential flaw would be detected by this UT examination. If an OD initiated circumferential flaw existed, it would have to propagate through-wall to the ID and into the area that was examined by UT. Therefore, an OD initiated flaw would be detected before a loose part could be developed. TP4 has completed UT examinations of all nozzles and has not identified any circumferential or axial cracking. This includes the high stressed region adjacent to the weld. Therefore, it is unlikely that any flaws would initiate in this lower stressed bottom portion of the nozzle, which was not inspected.

The NRC staff finds that the licensee's bases listed above, concerning the absence of axial cracking in the missed coverage areas in the nonpressure boundary portion of the nozzle, are acceptable.

The safety issues that are addressed by the inspections mandated by Order EA-03-009 are degradation (corrosion) of the low-alloy steel RPV head and ejection of the VHP nozzles due to circumferential cracking of the nozzle above the J-groove weld. The following items provide reasonable assurance that these safety issues are addressed:

– The bare metal visual (BMV) examination performed by the licensee demonstrated the integrity of the RPV head and the absence of ongoing degradation of the head.

– The UT examination of the RPV head penetration nozzles from 2 inches above the J-groove weld to a minimum of 0.62 inches below the weld showed no indications. The licensee performed an acceptable assessment of no "leak path" present into the interference fit zone. This examination provides reasonable assurance that no circumferential cracking of the nozzle above the J-groove weld is present and no through wall leakage and degradation of the RPV head should occur.

– The licensee's analysis, showed that any flaw located within the unexamined portion of the nozzles (greater than 0.62 inches below the J-groove weld) would not propagate to a level adjacent to the weld within an 18-month operating period. This analysis provides reasonable assurance that there is a very low likelihood for a flaw in the unexamined area to grow through-wall and cause leakage and degrade the low-alloy steel RPV head prior to the next inspection.

Based upon (1) the uninspected areas being in a lower stress area, (2) verification of the integrity of the RPV head and the absence of on-going degradation as a result of the BMV inspections, (3) successful "leak path" results providing assurance of no circumferential cracking or through-wall leakage, and (4) the crack growth results indicating a very low likelihood for a flaw in the unexamined area to grow through-wall and cause leakage and degrade the low-alloy steel RPV head prior to the next inspection, the proposed alternative, as conditioned, provides reasonable assurance of the structural integrity of the RPV head.

Therefore, compliance with the requirements of the Order for the 53 nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety for the October 2003 outage and subsequent operating cycle.

4.0 CONCLUSION

The NRC staff concludes that examination of the 53 RPV head penetration nozzles in accordance with Section IV, paragraph C.(1)(b), of Order EA-03-009, would result in hardship without a compensating increase in the level of quality and safety. Further, the NRC staff concludes that the licensee's proposed alternative examination of the 53 RPV head penetration nozzles from 2 inches above the J-groove weld to a level at least 0.62 inches below the J-groove weld provides reasonable assurance of the structural integrity of the RPV head, VHP nozzles and welds. Therefore, pursuant to Section IV, paragraph F of Order EA-03-009, the NRC staff finds that there is good cause shown to relax the Order and authorizes the proposed relaxation and alternative inspection for the identified RPV head penetration nozzles at TP4, for the October 2003 refueling and one operating cycle subject to the following conditions:

– If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula.

– If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation.

– If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review.

– If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

Principal Contributor: Eric Reichelt, NRR

Date: October 31, 2003