October 30, 2001

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

SUBJECT: AGING MANAGEMENT OF CONCRETE- TURKEY POINT UNITS 3 AND 4 LICENSE RENEWAL SAFETY EVALUATION REPORT

Dear Mr. Stall:

By a letter dated August 17, 2001, the Nuclear Regulatory Commission (NRC) transmitted the Turkey Point Units 3 and 4 license renewal safety evaluation report (SER). Based on further review and internal discussions, the staff determined that it did not clearly understand Florida Power and Light's (FPL's) response to aging management of concrete structural components, which are above groundwater. The staff's position was briefly discussed with your staff in a conference call on October 22, 2001. The enclosure provides further clarification of the NRC staff's position on aging management of concrete, bases for this position, and the proposed corrections to the related Turkey Point SER sections.

Therefore, the staff will require that FPL supplement its commitments and response to RAI 3.6.2.1-2 for the aging management for concrete structures within the scope of license renewal. We intend to pursue the generic implications of this position and any clarifications warranted for the Generic Aging Lessons Learned (GALL) report with NEI in parallel with your response. In order to maintain the review schedule for the Turkey Point license renewal review, we request that you respond to this letter by November 16, 2001. If you have questions regarding this matter or wish to arrange a meeting to discuss the issue, please contact Raj Auluck at 301-415-1025.

Sincerely,

/***RA***/

Christopher I. Grimes, Branch Chief
License Renewal and Standardization Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

Enclosure: As stated

cc w/encl: See next page

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AGING MANAGEMENT OF CONCRETE- TURKEY POINT LICENSE RENEWAL SER

On the basis of applicable industry operating experience including plant inspections, reviews of construction deficiency reports, and relevant licensing event reports the staff stated in NUREG-1522 “Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures,”

> For the types of materials (normal weight, medium-strength concrete and mild steel) used in the building structures of nuclear power plants, it is evident that “concrete cracks and steel corrodes.”

Concrete structures and components in nuclear power plants are prone to various types of age-related degradation depending on the stresses and strains, due to normal and incidental loadings, as well as the environment to which they are subjected. Concrete structures subjected to sustained loading, such as crane or monorail operation, and/or sustained adverse environmental conditions, such as high temperatures, humidity, or chlorides, will degrade thereby potentially affecting the intended function of the components. These degradations to concrete structures are manifested through aging effects such as cracking, loss of material, and change in material properties. As these structures age, such aging effects accentuate. On the basis of industry-wide evidence, the American Concrete Institute (ACI) has published a number of documents (e.g., ACI 201.1R, “Guide for Making a Condition Survey of Concrete,” ACI 224.1R, “Causes, Evaluation and Repairs of Cracks in Concrete Structures,” and ACI349.3R, “Evaluation of Existing Nuclear Safety-Related Concrete Structures”) that identify the need to manage the aging of concrete structures. These reports and standards confirm the inherent characteristics of concrete structures to degrade with time, if not properly managed. Thus, the importance of periodic inspections of concrete structures, as a means to demonstrate that the effects of aging will be adequately managed such that their intended function will be maintained consistent with the current licensing basis for the period of extended operation, cannot be over emphasized. Timely repair or remedial action to arrest continuing or benign degradations will ensure the continued functionality of the structures and prevent accelerated aging.

Sections 3.6.1.1, “Containment Structure Concrete Components,” 3.6.1.4, “Containment Internal Structure Concrete Components,” 3.6.2.3, “Concrete Structural Components,” of the Turkey Point license renewal application (LRA) conclude that aging management is necessary only for concrete components below groundwater elevation and for masonry block walls. In response to a staff request for additional information regarding your ASME Section XI, Subsection IWL Inservice Inspection Program, which you credit as an aging management program in Appendix B of the LRA, you have modified your position regarding the monitoring of concrete structures to include periodic inspections of the containment structure concrete components located above groundwater elevation. Furthermore, in response to a staff request for additional information regarding the monitoring of concrete structures other than containment, you have proposed to use your inspections of containment structure concrete components above groundwater, through the ASME Section XI, Subsection IWL aging management program, as an indicator for the condition of both containment internal structural concrete components (3.6.1.4) and concrete structural components outside containment (3.6.2.3). The staff misunderstood the FPL response to mean that concrete structural components above groundwater elevation would be monitored by an aging management program similar to your ASME Section XI, Subsection IWL aging management program.

Subsequent communications between the staff and FPL have clarified your intent to not specifically manage concrete structures and components above groundwater unless inspections of the containment structure concrete components, through the ASME Section XI, Subsection IWL aging management program, indicate degradation. While this approach is an improvement over your original position not to manage concrete components above groundwater elevation as part of license renewal, the staff's position is that all concrete structures within the scope of license renewal require aging management for license renewal. The NRC staff intends to modify its SER with open items for Turkey Point to reflect the staff's position in the following five sections:

- Section 3.1.3 "Systems and Structural Monitoring Program"
- Section 3.6.1.1 "Containment Structure Concrete Components"
- Section 3.6.1.4 "Containment Internal Structural Components"
- Section 3.6.2.3 "Concrete Structural Components"
- Section 3.9.1.4 "ASME Section XI, Subsection IWL, Inservice Program"

The following discussion explains the staff's position.

For each of the three aging effects that you identify as plausible for concrete components (loss of material, cracking, change in material properties), the LRA identifies several aging mechanisms that may lead to these aging effects. For loss of material, the LRA lists freeze-thaw, abrasion and cavitation, elevated temperature, aggressive chemical attack, and corrosion of reinforcing and embedded/encased steel as potential aging mechanisms. For cracking, the LRA lists freeze-thaw, reactions with aggregates, fatigue, shrinkage, settlement, and elevated temperature as potential aging mechanisms. For change in material properties, the LRA lists leaching, creep, elevated temperature, irradiation embrittlement, and aggressive chemical attack as potential aging mechanisms.

Loss of material is both a plausible and applicable aging effect for Turkey Point concrete structural components located above groundwater resulting from aggressive chemical attack and/or abrasion and cavitation. Loss of material, as manifested by scaling, due to aggressive chemical attack and/or abrasion and cavitation was observed during a staff walkdown of Turkey Point in January of 1992. Appendix A of NUREG-1522 contains a summary of observed degradations of concrete and steel components at six plants visited by the staff during the 1991-1992 time-period. The walkdown description of Turkey Point Units 3 and 4 is provided in Section 5 of Appendix A. Plate 12 (page A-31) of NUREG-1522 shows significant peeling of paint and scaling of the Turkey Point Unit 3 containment dome. These observations indicate that loss of material as manifested by scaling is both a plausible and applicable aging effect for Turkey Point. Abrasion and cavitation, although most likely to occur in concrete structures exposed to flowing water, can also occur in concrete structures exposed to sustained heavy rainfall. Aggressive chemical attack, leading to corrosion of reinforcing steel, is also plausible for concrete structures exposed to chloride-laden moist air as well as concrete structures exposed to groundwater and saltwater flow or splash, which is expected in shoreline locations such as Turkey Point. Therefore, loss of material needs to be managed as part of a license renewal aging management program during the period of extended operation.

Cracking is both a plausible and applicable aging effect for Turkey Point concrete structural components located above groundwater resulting from reaction with aggregates, fatigue, shrinkage, and elevated temperature. The LRA identifies reactions with aggregates as a

potential aging mechanism leading to cracking and states, “Turkey Point concrete components were constructed using non-reactive aggregates whose acceptability was based on established industry standards and ASTM tests” and therefore, “reactions with aggregates is not an aging mechanism that can lead to cracking for concrete structural components.” However, the concrete structures of Turkey Point Units 3 and 4 were constructed using ACI 318-63, which did not contain a number of provisions of the current ACI 349-90 and later editions that are added to ensure durability and quality of concrete construction. For example, the American Society of Testing and Materials (ASTM) Standard C-289 for assessing the potential reactivity of aggregates was not available. Thus, cracking, due to reactions with aggregates, is both a plausible and applicable aging effect for Turkey Point. Fatigue, as an aging mechanism leading to cracking, is plausible for concrete structural components subjected to incidental loading, such as crane or monorail operation. The stresses from these loadings cannot be readily determined, as stated in Section 3.6.2.3 of the LRA, and therefore cracking due to fatigue is a plausible and applicable aging effect for Turkey Point. Shrinkage is also a plausible and applicable aging mechanism leading to cracking for concrete structural components exposed to high temperatures. The staff disputes FPL’s claim that 100% of concrete shrinkage occurs within 20 years. Shrinkage cracking is a continuous process. The ACI threshold limits, cited in the LRA, are the boundary beyond which concrete properties begin to change and are not related to the initiation of cracking. Cracking can occur at temperatures below the ACI threshold limits. Because the applicant has not demonstrated that elevated temperatures after 20 years will not lead to shrinkage cracking of concrete components, the staff considers cracking, as a result of this mechanism, to be both plausible and applicable.

Change in material properties is both a plausible and applicable aging effect for Turkey Point concrete structural components located above groundwater resulting from leaching, aggressive chemical attack, and elevated temperatures. Given a conducive environment, such as acidic rain/moisture, leaching is a plausible aging mechanism that can lead to change in material properties for concrete structural components. Leaching (or carbonation) is also an applicable aging mechanism for Turkey Point due to the close proximity of two fossil fuel coal plants. Aggressive chemical attack, leading to change in material properties, is also a plausible and applicable aging effect for those concrete components subjected to borated water leakage. Elevated temperature is also a plausible and applicable aging mechanism for those Turkey Point concrete components inside containment (primary shield walls, secondary shield walls, etc.). These structures are subjected to higher temperatures (above 100°F, normally less than 150°F, sometimes up to 200°F) and higher humidity (close to 100%) than concrete structures outside containment. High temperatures can lead to change in material properties and can also induce higher shrinkage (in addition to the normal drying shrinkage). Therefore, change in material properties needs to be managed as part of a license renewal aging management program during the period of extended operation.

While significant aging of concrete components may not have been discovered during the current period of operation, industry operating experience and performance characteristics of concrete, as discussed above, without sufficient justification to the contrary, require the staff to consider loss of material, cracking, and change in material properties as applicable aging effects. Unless adequate justification, disputing the potential for each of the aging mechanisms for each of these aging effects, is presented, then each of the aging effects will need to be managed for the period of extended operation. The absence of these aging effects, to date, for Turkey Point concrete components does not preclude their occurrence during the period of extended operation. As such, periodic inspections of the concrete structures, as part of a

license renewal aging management program, is necessary for the staff to make its findings consistent with 10 CFR 54.29.