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10 CFR § 50.73
L-2011-204

JUN 07 2011

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555-0001

Re: Turkey Point Units 3 and 4
Docket Nos. 50-250 and 50-251
Reportable Event: 2010-001-02
Spent Fuel Storage Design Feature Assumptions are Exceeded
Supplement

The attached Licensee Event Report 05000250/2010-001-02 supplement is submitted in accordance with 10 CFR 50.73(a)(2)(i)(B). This supplement revises the number of affected Boraflex neutron absorber panels reported previously. The net result is that one panel did not have to be reported as non-conforming and two panels are added. The change results from a revision to the reported results of Boraflex testing by a vendor.

If there are any questions, please call Mr. Robert Tomonto at 305-246-7327.

Very truly yours,

Michael Kiley
Vice President
Turkey Point Nuclear Plant

Attachment

cc: Regional Administrator, USNRC, Region II
Senior Resident Inspector, USNRC, Turkey Point Nuclear Plant

IE22
MRR

NRC FORM 366 (10-2010) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2013

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA/Privacy Section (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects.resourse@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

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4. TITLE

Spent Fuel Storage Design Feature Assumptions are Exceeded

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									Turkey Point Unit 4	05000251
3	9	2010	2010	- 001 -	02	6	7	2011	FACILITY NAME	DOCKET NUMBER

9. OPERATING MODE

1

10. POWER LEVEL

100%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*

- ☐ 20.2201(b)
- ☐ 20.2201(d)
- ☐ 20.2203(a)(1)
- ☐ 20.2203(a)(2)(i)
- ☐ 20.2203(a)(2)(ii)
- ☐ 20.2203(a)(2)(iii)
- ☐ 20.2203(a)(2)(iv)
- ☐ 20.2203(a)(2)(v)
- ☐ 20.2203(a)(2)(vi)
- ☐ 20.2203(a)(3)(i)
- ☐ 20.2203(a)(3)(ii)
- ☐ 20.2203(a)(4)
- ☐ 50.36(c)(1)(i)(A)
- ☐ 50.36(c)(1)(ii)(A)
- ☐ 50.36(c)(2)
- ☐ 50.46(a)(3)(ii)
- ☐ 50.73(a)(2)(i)(A)
- ☒ 50.73(a)(2)(i)(B)
- ☐ 50.73(a)(2)(i)(C)
- ☐ 50.73(a)(2)(ii)(A)
- ☐ 50.73(a)(2)(ii)(B)
- ☐ 50.73(a)(2)(iii)
- ☐ 50.73(a)(2)(iv)(A)
- ☐ 50.73(a)(2)(v)(A)
- ☐ 50.73(a)(2)(v)(B)
- ☐ 50.73(a)(2)(v)(C)
- ☐ 50.73(a)(2)(v)(D)
- ☐ 50.73(a)(2)(vii)
- ☐ 50.73(a)(2)(viii)(A)
- ☐ 50.73(a)(2)(viii)(B)
- ☐ 50.73(a)(2)(ix)(A)
- ☐ 50.73(a)(2)(x)
- ☐ 73.71(a)(4)
- ☐ 73.71(a)(5)
- ☐ OTHER

Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
Paul F. Czaya	305-246-7150

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

A condition prohibited by the Technical Specifications (TS 5.5.1.1.a) occurred in 2001 when the areal density of portions of the west panel in Unit 3 Region II Spent Fuel Pool (SFP) storage cell M-16 was determined to be less than the licensing basis analysis assumed minimum areal density of 0.006 gm-B_{10}/cm^2. The cause of the noncompliance with TS is Boraflex degradation. Interim measures were subsequently implemented to compensate for Boraflex degradation using empty storage spaces or rod cluster control assemblies to offset the Boraflex loss. A new licensing basis has been implemented that no longer relies on Boraflex as a neutron absorber in both Unit 3 and 4 SFPs. As a result of an extent of condition review, flow-damaged storage cells in both Unit 3 and 4 SFPs have been determined to not meet TS 5.5.1.1.c, which requires a nominal center-to-center spacing of 9.0 inches. The top of the cell walls in four Unit 3 and two Unit 4 SFP storage cells were discovered to be damaged in 2005. The cause is attributed to high cycle fatigue due to flow-induced vibration from the SFP cooling system discharge piping located above the affected cells. These cells have never been used to store fuel since they are inaccessible due to interference from the discharge piping. The affected and adjacent cells have been administratively removed from service. A license amendment request has been submitted to revise TS 5.5.3 regarding licensed fuel storage capacity.

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NARRATIVE

DESCRIPTION OF THE EVENT

On March 11, 2010, the Nuclear Regulatory Commission (NRC) advised Florida Power and Light Company (FPL) that Turkey Point Unit 3 was in noncompliance with Technical Specification (TS) 5.5.1.1.a. Evaluations of the Turkey Point Unit 3 Spent Fuel Pool (SFP) performed by FPL since 2001, after initial performance of neutron attenuation testing indicated significant Boraflex degradation, had concluded that the SFP maintained compliance with the TS. FPL failed to recognize that Turkey Point Unit 3 no longer complied with the Design Feature TS, and therefore, failed to report to the NRC the deviation from a licensing basis assumption associated with TS 5.5.1.1.a SFP criticality requirements.

On June 21, 2010, the NRC issued enforcement action regarding the noncompliance with TS 5.5.1.1.a and the failure to report. Upon further evaluation, FPL has determined that a supplement to this Licensee Event Report (LER), originally submitted on May 10, 2010, is required.

A condition prohibited by the TS occurred in 2001 when the areal density of a portion of the west panel in Unit 3 Region II SFP storage cell M16 was determined by FPL to measure less than the licensing basis analysis, which assumed uniform panel minimum areal density of 0.006 gm-B_{10}/cm^2. Although the average areal density of this panel was above the assumed uniform panel minimum areal density, the dissolution of the Boraflex was non-uniform and a portion of the panel was determined to have an areal density below the assumed minimum. This was a noncompliance with TS 5.5.1.1.a and is reportable in accordance with 10 CFR 50.73(a)(2)(i)(B). Additional Boraflex panels measured in 2004 and 2007 have also been determined to have portions of the panel not meet the assumed uniform minimum areal density. Condition Reports 2010-6254 and 567353 address the noncompliance.

Furthermore, on July 22, 2010, FPL was notified by the test vendor that recent improvements in the method used to calibrate $Boron_{10}$ Areal Density Gauge for Evaluating Racks (BADGER) equipment lead to the discovery that a correction factor used to account for physical differences between the un-attenuated region of the reference panel fuel cell and each of the other fuel cells subjected to BADGER measurement may not, in all instances, have provided conservative results. The net result is that one panel did not have to be reported as non-conforming in the prior LER supplement and two panels are added in this supplement.

Additionally, an extent of condition review of the condition of the SFP racks identified an additional condition prohibited by the TS regarding a few damaged SFP storage cells discovered in 2005. In 2005, it was discovered that four storage cells in the Unit 3 SFP and two cells in the Unit 4 SFP were affected by damaged cell walls. The damaged walls of the identified storage cells can no longer maintain the required separation that meets the nominal licensing basis center-to-center distance of 9.0 inches. This is a noncompliance with TS 5.5.1.1.c and reportable in accordance with 10 CFR 50.73(a)(2)(i)(B).

CAUSE OF THE EVENT

There are two related noncompliance issues. The first relates to the status of Boraflex and the other relates to damaged SFP storage cells.

In the first case, the cause of the noncompliance with TS 5.5.1.1.a is Boraflex degradation in Region II of the Unit 3 SFP, greater than assumed in the safety analysis, found in one panel in one storage cell in 2001 and in other panels in storage cells in 2004 and 2007.

Although the areal density of the Boraflex panels was known to be a critical design feature of the spent fuel racks, FPL had interpreted compliance with TS 5.5.1.1.a as when the combined areal density of the panels in a single cell continued to satisfy the K_{eff} requirements of TS 5.5.1.1.a. However, a noncompliance with TS 5.5.1.1.a occurs when the areal density of a single panel has degraded below the value assumed in the licensing basis analysis described in the Updated Final Safety Analysis Report (UFSAR).

In the second case, the cause of the noncompliance with TS 5.5.1.1.c and storage cell wall damage is due to the spent fuel pool cooling discharge flow directly above the affected storage rack locations. The failure mechanism is flow induced vibration.

ANALYSIS

Background

The Turkey Point Unit 3 SFP currently uses a two zone (Region) rack design. Region I was designed for storing fresh fuel (i.e., high reactivity fuel), while Region II was designed for storage of irradiated fuel (i.e., low reactivity fuel). The Region I and II racks use Boraflex as a neutron absorber.

Boraflex is a silicone-based polymer material that contains the neutron absorber Boron-10 in the form of small particles of boron carbide. When Boraflex is subjected to the high gamma doses and cooling water flow of a SFP environment, the polymer can degrade and Boron-10 is removed from the rack panel. The reduction in the amount of Boron-10 below the design basis areal density requirement can adversely affect the operability of those storage cells.

Turkey Point TS require that the spent fuel storage racks provide safe subcritical storage of fuel assemblies by providing sufficient poison to assure:

a) $K_{eff} < 1.0$ when flooded with unborated water, and
b) $K_{eff} \leq 0.95$ with a minimum soluble boron concentration of 650 PPM present.

10 CFR 50.68 establishes the K_{eff} requirements for SFP storage racks. TS 5.5.1.1 specifies design requirements for the SFP racks, as detailed in the UFSAR, to comply with 10 CFR 50.68 K_{eff} requirements. Further, TS 5.5.1.1.a states that the spent fuel pool shall be maintained with K_{eff} equivalent to less than 1.0 when flooded with unborated water, which includes a conservative allowance for uncertainties as described in UFSAR Appendix 14D. Associated Region II licensing basis analysis conservatively assumes a uniform minimal areal density to bound the effect of any actual Boraflex dissolution. Specifically, the licensing basis analysis assumes that every panel in every cell is assumed to be at the same dissolved B-10 areal

density of 0.006 gm-B_{10}/cm^2. In addition, TS 5.5.1.1.c requires a nominal 9.0 inch center-to-center distance for the Region II storage rack cells.

Discussion

The measured BADGER test results reported in 2001, 2004, and 2007 for the Region II Boraflex panels in the Unit 3 SFP show that the amount of dissolution at each axial location is dependent on the specific panel measured but a distribution of panels representative of Region II indicates that dissolution is non-uniform and occurs primarily at the bottom of the panels, decreasing towards mid-height, and then increasing to a lesser extent towards the top of the panels. This observation is supported by variation in the fraction of Region II panels with dissolution as a function of panel height.

Based on the characteristic nature of non-uniform dissolution and a measurement uncertainty of typically ±10%, it is reasonably conservative to assume that a portion of the panel is beyond the licensing basis analysis assumption of uniform panel minimum areal density of 0.006 gm-B_{10}/cm^2 when the measured average dissolution of the panel is 45% or more. The West panel of M16 in 2001, with 53.9% dissolution, was an outlier within the sample of Region II panels measured; however, this sample only represented approximately one percent of all Region II panels. Thus, there is a reasonable possibility that this situation may have occurred in another unmeasured location in 2001 given the large number of unmeasured panels. This possibility is supported by the observation of a few panels in 2004 and 2007 also showing significantly more dissolution than the norm as noted in the following table.

Panels with Measured Boraflex Dissolution of 45% or More

BADGER Test	Average Panel Dissolution
2001	M16W (-53.9%)
2004	R19E (-49.1%)
2007	L38E (-62.6%) M31E (-48.1%) N23E (-79.0%)

Therefore, it is likely that the extent of the condition exhibited by the West panel of storage cell M16 occurred at a limited number of other unmeasured locations in Region II in 2001, as noted above, and further, this condition increased in extent during 2004 and 2007 since Boraflex dissolution is progressive in nature.

This condition was not exhibited in the Unit 4 SFP because BADGER testing performed in 2010 showed that all panels including uncertainty were significantly above the minimum required areal density.

The Turkey Point Boraflex Management Program was based on two industry accepted tools; the RACKLIFE software package for predicting Boraflex degradation and the BADGER instrumentation for measuring Boraflex degradation. Both were developed under the auspices of EPRI to aid utilities in the management of Boraflex degradation.

The RACKLIFE code was routinely used to predict the expected degradation of Boraflex in terms of percent boron carbide (% B_4C) loss in each of the Region II panels prior to and during core off-loads, reloads and storage throughout the current operating fuel cycle. When a Boraflex panel was predicted to fall below an administrative limit of 0.0075 gm-B_{10}/cm^2, the associated storage cell was conservatively declared unusable, unless an alternative storage configuration compensating for the loss of Boraflex was used.

The identification of affected cells was controlled administratively via the implementation restrictions in the core reload control process and controlled transmittal of the information to the operator's Plant Curve Book. Fuel movement and storage of fuel in the SFP is controlled by plant operating procedures.

The continuing ability of the RACKLIFE code to predict Boraflex dissolution in order to effectively manage SFP storage had been periodically confirmed by in-situ Boraflex panel areal density measurements using the BADGER technique. This technique measures the attenuation of thermal neutrons passing through the panel to measure its % B-10 remaining and the presence of gaps/shrinkage in a select sample of Region II panels. The measured % B-10 remaining from the BADGER surveillance was then compared with the calculated % B_4C remaining in each of the sampled Boraflex panels from the RACKLIFE model. Comparison of the measured-to-predicted results for each BADGER test demonstrated that RACKLIFE was valid for the conservative prediction of Boraflex degradation at 50% for Region II.

Interim measures had been implemented to compensate for Boraflex degradation prior to reaching the design basis analysis areal density assumption of 0.006 gm-B_{10}/cm^2. Action was taken administratively at 0.0075 gm-B_{10}/cm^2 to prohibit fuel storage in affected cells or employ compensatory measures with storage configurations using empty storage spaces or rod cluster control assemblies (RCCA) to offset the Boraflex loss so that the TS 5.5.1.1.a K_{eff} requirement of $K_{eff} < 1.0$ unborated was maintained. Compensatory measures had not been taken for storage cell M31 because it was not identified as nonconforming at the time of testing in 2007 and was only recently identified after revision of the vendor's test reports due to correction for a software calibration error.

On January 27, 2006, FPL submitted a Boraflex Remedy license amendment request (LAR), using Metamic inserts, RCCAs, and administrative controls to remove reliance on Boraflex as a neutron absorber. The LAR was approved by the NRC and issued on July 17, 2007 as Amendment 234 for Unit 3. Implementation of Amendment 234 is complete.

The flow-damaged storage cells were also reviewed as part of the root cause analysis performed by FPL. It was concluded that the cause of cell wall failure is flow induced vibration, specifically, vortex shedding. The flow directly above the cells closest to the discharge pipe may have significant velocity components parallel to the plane of the cell walls. In vortex shedding, relative low in-plane flow velocity of water flowing parallel to a body of small characteristic dimension (cell wall thickness) may be sufficient to induce a condition of lateral vibration of the cell walls. The flow induced vibrations result in high cycle fatigue or creep. This phenomenon can occur at welds and even in sound metal. Failure requires years to accumulate the number of cycles.

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NARRATIVE

SAFETY SIGNIFICANCE

There was no adverse impact on nuclear safety for the noncompliance with TS 5.5.1.1.a as summarized below:

- There is conservative margin in the Turkey Point Boraflex Management Program which requires action to be taken to preserve reactivity margin well before significant Boraflex degradation can cause the SFP to challenge the K_{eff} limits and ensures that a $K_{eff} < 1.0$ is maintained in the SFP without credit for soluble boron.
- The typical panel remains well above the areal density limit assumed in the licensing basis analysis.
- There is inherent conservatism within the Boraflex Management Program to offset the uncertainties of panel measurement.
- No credit has been taken for soluble boron, thus preserving an independent, diverse and effective means of reactivity control.

There was no adverse impact on nuclear safety for the noncompliance with TS 5.5.1.1.c because the damaged cells have been excluded from use in storage of spent fuel due to inaccessibility caused by the spent fuel pool discharge piping located above them. Analyses of the Unit 3 flow-damaged rack, evaluating structural and seismic integrity, were performed in 2005. The results confirmed that the Unit 3 storage rack, which had significantly more damage than the Unit 4 rack, was structurally adequate and would maintain its integrity during seismic events even with the damaged cells. As the damage found in the Unit 4 rack was significantly less extensive, the analysis for Unit 3 was considered bounding for Unit 4.

CORRECTIVE ACTIONS

Corrective actions include the following:

1. Unit 3 License Amendment 234 to eliminate reliance on Boraflex as a neutron absorber has been implemented.
2. The flow-damaged and adjacent cells have been administratively removed from service.
3. A license amendment request was submitted to revise TS 5.5.3 regarding licensed fuel storage capacity.

FAILED COMPONENTS IDENTIFIED: None

PREVIOUS SIMILAR EVENTS None