FPL.

10 CFR 50.55a
L-2014-100
April 9, 2014

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

Re: Turkey Point Unit 3
Docket No. 50-250
Inservice Inspection Plan - Fifth Inspection Interval
Unit 3 Relief Request No. 1 – Response to Request for Additional Information

References:
1) Florida Power & Light Company letter L-2014-096, "Inservice Inspection Plan - Fifth Inspection Interval Unit 3 Relief Request No. 1", dated April 4, 2014
2) Email to Florida Power & Light Company, "Request for Additional Information Turkey Point Unit 3 Fifth Inspection Interval Relief Request No. 1 Revision 0 Repair of Pressurizer Stainless Steel Heater Sleeve Without Flaw Removal Docket No. 50-250", dated April 8, 2014

Pursuant to 10 CFR 50.55a(a)(3)(ii), Florida Power & Light Company (FPL) requested Nuclear Regulatory Commission (NRC) approval to use an alternative to a certain requirement in the ASME Boiler and Pressure Vessel Code, Section XI, in Reference 1. A NRC request for additional information (RAI) was forwarded to FPL in Reference 2. Attached is the FPL response to the Reference 2 RAI.

Please contact Robert Tomonto, Licensing Manager, at 305-246-7327 if you have any questions or require any additional information about this submission.

Very truly yours,

Thomas Conboy for Mike Kiley

Michael Kiley
Site Vice President
Turkey Point Nuclear Plant

Attachment: Response to Request for Additional Information Concerning Turkey Point Unit 3 Relief Request No. 1 for the 5th Inspection Interval

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

A047
NRR

Turkey Point Unit 3
Fifth Inspection Interval
Relief Request No. 1
Response to Request for Additional Information

---

By email dated April 8, 2014, the Nuclear Requlatory Commission (NRC) staff forwarded to the Florida Power & Light Company (FPL) a request for additional information (RAI) concerning FPL's request for relief from a certain provision of the ASME Boiler and Pressure Vessel Code. FPL submitted the request for relief by letter L-2014-096 dated April 4, 2014. The FPL response to the NRC RAI follows.

NRC RAI

By letter dated April 4, 2014, Florida Power & Light company (FPL, the licensee) requested approval to use an alternative to the American Society of Mechanical Engineers, Boiler and Pressure Vessel Code (ASME Code), Section XI, 2007 Edition, including Addenda through 2008. During the Turkey Point, Unit 3 refueling outage, the licensee observed evidence of leakage in the annulus between the outer surface of one heater sleeve and the pressurizer bottom head bore. The licensee specifically requested relief from the requirements of the ASME Code, Section XI, IWB-3142.3, "Acceptance by Corrective Measures or Repair/Replacement Activity," which states that a component containing relevant conditions is acceptable for continued service if the relevant conditions are corrected by a repair/ replacement activity or by corrective measures to the extent necessary to meet the acceptance standards of Table IWB-3410-1. The licensee stated that it had determined that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety, therefore requested relief pursuant to 10 CFR 50.55a(a)(3)(ii). The licensee proposed to perform a "half-nozzle" repair which relocates the pressure boundary weld to the outside of the pressurizer bottom head shell and thus leaves the flaw that caused the leakage in place, which is assumed to exist in the original J-groove weld attaching the heater sleeve to the pressurizer cladding. The licensee requested relief for one 18-month operating cycles. The licensee's relief request is supported by a qualitative assessment of the potential for the growth of an assumed flaw in the original J-groove weld into the pressurizer bottom head shell. In support of its qualitative assessment the licensee cited experience with previous fatigue flaw growth analyses for Combustion Engineering (CE) -design pressurizers that are documented in References 1 and 2.

The staff requires the following addition information to complete its review of the relief request:

NRC RAI 1

1. Under "Reason for Request," the relief request states manual nondestructive examination (NDE) was conducted from the sleeve bore using the eddy current

method after the heater was removed from the heater sleeve, and that the examination did not reveal any flaw in the sleeve, the licensee stated that therefore, the most likely location of the flaw is located in the stainless steel weld between the heater sleeve and the stainless steel cladding buildup.

Confirm that the entire length of the original pressurizer heater sleeve bore was examined with eddy current testing.

FPL Response to RAI 1

As part of the removal of the heater, the heater sleeve end connection and a few inches of the sleeve were removed, leaving approximately 4 ¼" of the heater sleeve that protruded from the pressurizer shell. The remaining heater sleeve was approximately 9" long. The entire length of the remaining sleeve was examined by the ECT method and no crack like indication was identified.

NRC RAI 2

2. Was the pressurizer shell bore visually examined after the lower portion of the original heater sleeve was removed, and if so was any corrosion or degradation of the carbon steel pressurizer bottom head noted in this area? If so describe the type and extent of degradation including the amount of material lost.

FPL Response to RAI 2

Upon completion of boring out the lower portion of the original heater sleeve, the carbon steel bore of the pressurizer was visually examined. There was no evidence of material loss due to corrosion identified.

NRC RAI 3

3. The qualitative flaw assessment relies on the assumption that the existing flaw is completely contained within the pressurizer stainless steel cladding, that crack growth from the cladding into the inside surface of the pressurizer lower head carbon steel material will not occur over the next fuel cycle, and that there are no flaw(s) existing driven by fatigue into the lower head carbon steel base material. However, the licensee stated that in the unlikely event that these assumptions are untrue, quantitative analysis of a similar configuration has demonstrated that a flaw starting

at the cladding to base metal interface can grow for a significant length of time and remain stable with appropriate factors of safety. To enable the staff to determine whether these quantitative analyses in Reference 1 and 2 would bound the Turkey Point 3 heater sleeve, the staff requires the following additional information:

a. To enable the staff to determine whether the driving force for crack growth and the stability determination of the final flaw in the Turkey Point, Unit 3 J-groove weld is bounded by the analyses in References 1 and 2:

    i. Provide the number and type of operating transients applicable for the life of the plant to the pressurizer heater sleeve J-groove weld, similar to the information contained in Table 4-3 of Reference 2. Discuss whether any of the transients applicable to the Turkey Point, Unit 3 heater sleeve would be significantly more severe that the corresponding transients evaluated in the fatigue crack growth analyses documented in References 1 and 2.

    ii. Identify the key parameters in determining the driving force for crack growth and final flaw stability of the postulated flaw in the Turkey Point, Unit 3 heater sleeve assembly, and demonstrate these parameters are bounded by the corresponding parameters of the CCNPP-1 heater sleeve assembly evaluated in Reference 1 and the generic heater sleeve assembly evaluated in Reference 2.

b. Demonstrate that the material resistance to fracture (J-R curve) of the Turkey Point, Unit 3 pressurizer bottom head is equal to or greater than the material resistance to fracture used in the crack stability evaluations in Reference 1 and 2.

FPL Response to RAI 3.a.i.

The transients for Combustion Engineering (CE) designs are generally similar to those for Westinghouse designs, since both are pressurized water reactors, and the CE design closely followed the Westinghouse design in its implementation. One of the key differences is that the CE design has many more heatup (HU) and cooldown (CD) transient cycles (500 versus 200) than the Westinghouse design. This makes the use of the CE design transients conservative for use in evaluating the Turkey Point plant.

The CE generic evaluation [Reference 1] reported that only two transients contribute to fatigue crack growth. They are 500 cycles of HU/CD and 200 cycles of operating basis earthquake (OBE). However, OBE is only applicable to the hot leg (i.e., it is not applicable to heater penetrations). The temperature changes ($\Delta T$) are 320°F and 220°F for insurge/outsurge in the HU/CD transients. The applicable transients for the Turkey Point pressurizer are identified in [Reference 3] for extended power uprate (EPU) conditions; they are listed here in Table 1. As shown in Table 1, the surge temperature change for HU/CD is 320°F with 200 cycles each, which is similar to the temperature change of the transients evaluated in [1].

**Table 1: Turkey Point Units 3 and 4 EPU Pressurizer $T_{hot}$ Comparisons [4]**

| Transients | Cycles | EPU[4] | | Original Design[5] | |
|---|---|---|---|---|---|
| | | Surge ΔT (°F) | Surge Flow Rate (gpm) | Surge ΔT[3] (°F) | Surge Flow Rate (gpm) |
| **Normal Conditions** | | | | | |
| Plant Heatup | 200 | (1) | 300 | 320 | 300 |
| Plant Cooldown | 200 | (1) | 300 | 320 | 300 |
| Plant Loading @5%/Min | 14500 | 101.6 | 159 | 125 | 375 |
| Unit Unload @5%/Min | 14500 | 48.0 | 204 | 125 | 435 |
| Small Step Load Increase | 2000 | 50.8 | 222 | 75 | 360 |
| Small Step Load Decrease | 2000 | 52.1 | 742 | 75 | 1245 |
| Large Step Load Decrease (95%) | 200 | 48.0 | 2794 | 135 | 7500 |
| Steady-State Fluctuations | | | | | |
| Initial[6] | 150000 | **100.1** | 325 | 75 | 3390 |
| Random[6] | 3000000 | **97.6** | 325 | 75 | 3390 |
| Boron Concentration Equalization | 29000 | (2) | (2) | 75 | 400 |
| Feedwater Cycling[7] | 2000 | **132.7** | 1350 | | |
| Turbine Roll Test | 10 | (2) | (2) | -21 | -377 |
| **Upset Conditions** | | | | | |
| Loss of Load | 80 | 48.0 | 10318 | 125 | 15000 |
| Loss of Power | 40 | 82.0 | 4406 | 125 | 3300 |
| Partial Loss of Flow | 80 | 105.8 | 895 | 170 | 4800 |
| Reactor Trip from Full Power | 400 | 98.1 | 693 | 135 | 300 |
| Inadvertent Auxiliary Spray | 10 | 103.7 | 465 | 125 | 450 |
| OBE | 50 | (2) | (2) | | 0 |

(1) This transient is unchanged or less severe than original transient
(2) There is no insurge during this transient. Therefore, the surge nozzle and lower head/shell will experience only the pressurizer water temperature transient. This transient will not cause significant thermal shock loads.
(3) Used in thermal stress calculations
(4) References 3 through 5
(5) References 10 through 12
(6) Steady-State fluctuations occur between 15% and 100% power per Table A.1-4 of Reference 3. The maximum ΔT at 15% power is listed here.
(7) Insurge assumed to occur at minimum $T_{HOT}$. This transient may be grouped with the Large Step Load Decrease transient in component fatigue evaluations.

FPL Response to RAI 3.a.ii.

As documented in the detailed flaw evaluation in reference 17 of [1], CD without insurge is used to calculate the maximum end of cooldown KI to compare with the KIC allowable for the stability evaluation. This transient cools down from 653°F to 200°F at 200°F/hr, then cools for 200°F to 120°F at 75°F/hr. HU/CD sequences with relatively large insurge/outsurge transients dominate fatigue crack growth. The temperature ranges are 320°F and 220°F for the HU/CD with insurge transients with 500 cycles.

Per reference 13 of [3], the pressurizer HU rate is limited to 100°F/hr and a maximum CD rate of 200°F. This is similar to, or less severe than, the CD without insurge in [1]. As listed in Table 1, the HU/CD surge $\Delta T$ is 320°F [3] with 200 cycles each. This is also very similar to the transients evaluated in [1]. Therefore, the transients are similar, but the numbers are conservatively high for the CE design.

FPL Response to RAI 3.b.

The pressurizer head is fabricated from SA-216 Gr. WCC cast steel, and the ASME Code KIC curve is directly applicable to this material. Over the years, a great deal of fracture toughness information has been obtained regarding this material, and a figure has been prepared to summarize the data as compared to the ASME Code reference KIC curve; see Figure 1. The fracture toughness was determined for nine heats of material, whose results are plotted [Reference 4]. Sufficient Charpy information was also obtained on these heats of material, and the NUREG-0800 method was used to estimate RTNDT, which was found to be 10°F for each heat. Figure 1 shows that the KIC curve is clearly appropriate for this steel.

Per [1], the KIC allowable for the pressurizer lower head (heater sleeves) at end of cooldown is 25.0 ksi-$\sqrt{in}$, with RTNDT = 30°F. The end of cooldown is 70°F, conservatively using the RTNDT of 30°F, T - RTNDT = 40°F. The KIC at 40°F from Figure 1 is approximately 70 ksi-$\sqrt{in}$, which is much higher than the KIC = 25.0 ksi-$\sqrt{in}$ used in [1]. Therefore, it is conservative to compare the CE stability evaluation in [1] to the Turkey Point plant.

**Figure 1: A216 Gr. WCC Fracture Toughness, KIC [4]**

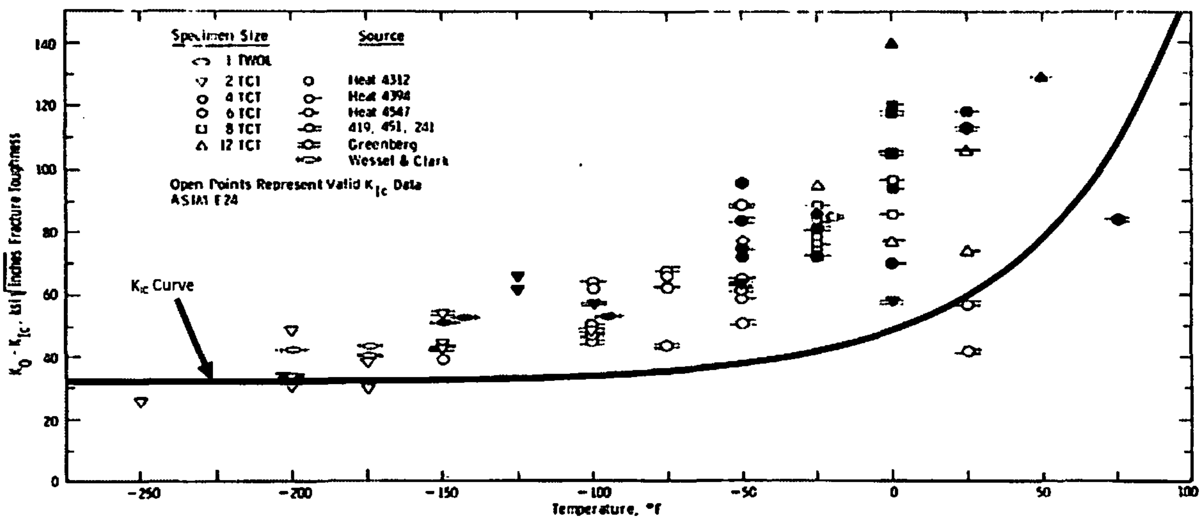


Fig. 19—Curve showing both valid and invalid toughness data for 9 heats of A216 (WCC Grade) cast steel

NRC RAI 4

4. FPL concluded the leak occurred since the last inspection, since no leakage was observed during the previous refueling outage. However, since the original heater sleeve was roll expanded into the pressurizer bottom head shell, discuss the possibility that throughwall cracking of the J-groove weld may have occurred in earlier fuel cycles, since the tight fit might delay boric acid leakage from reaching the outer surface of the bottom head. If so, revise the qualitative assessment of flaw growth accordingly since the original postulated weld flaw would have had additional cycles to grow into the cladding and pressurizer bottom head.

FPL Response to RAI 4

The roll expansion of the pressurizer heater sleeve is to limit the loads on the existing internal weld much like an interference fit of a nozzle. While the roll expansion provides support for the nozzle it is not expected to provide a water tight seal against the pressure and dilation stresses of the reactor coolant system (RCS). INPO OE7490 and LER 95-007-01 (Docket No. 50-280) describes similar designed and installed pressurizer instrument nozzles with roll expansion which also exhibited leakage. This OE, the Turkey Point experience, as well as the interference fit penetrations in reactor vessel upper heads, suggest that the breach of an ID partial penetration pressure boundary weld will result in leakage.

As stated in the relief request, the cladding is subject to a post weld stress relief. The stresses in the clad are significantly reduced, if not compressive. It is reasonable to assume that a flaw that progressed through the pressure boundary weld to produce the leak, would take additional cycles to progress through the layer of clad (3/16" minimum) that separates the existing pressure boundary weld and the carbon steel base metal. However, the assessments in References 1 and 2 both consider fatigue crack growth extension into the ferritic base metal before assessing the flaw stability. Therefore, the qualitative assessment does consider the flaw has progressed beyond the point of leakage and into the ferritic base material.

<u>References</u>

1. WCAP-15973-P-A, Rev. 0, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs" (ML050700433) (non-proprietary version available at ML050700431)

2. Areva Calculation 32-9156231-000, "CCNPP-1 PZR Heater Sleeve As-Left J-Groove Weld Flaw Evaluation for IDTB Repair - Non-Proprietary," (ML11132A183)

3. Westinghouse Calculation Note, CN-SGDA-08-55, Rev. 2, "Evaluation of Pressurizer for EPU at Turkey Point Units 3 and 4 (NSSS Power 2652 MWt)," December 7, 2011. (Westinghouse Proprietary Class 2)

4. Westinghouse Report, 72-1E7-FCAST-R1, "Fracture Toughness and Crack Growth Rate Properties for A216 WCC Grade Cast Steel," April 7, 1972. (Westinghouse Proprietary Class 2)