UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING PROJECTED VALUES OF MATERIAL PROPERTIES

FOR FRACTURE TOUGHNESS REQUIREMENTS

FOR PROTECTION AGAINST PRESSURIZED THERMAL SHOCK EVENTS

FLORIDA POWER AND LIGHT COMPANY

TURKEY POINT PLANT, UNITS 3 AND 4

I. Introduction

As required by 10 CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock" (PTS Rule) which was published in the Federal Register on July 23, 1985, the licensee for each operating pressurized water reactor "shall submit projected values of RT_{PTS} (at the inner vessel surface) of reactor vessel beltline materials by giving values from the time of submittal to the expiration date of the operating license. The assessment must specify the bases for the projection including the assumptions regarding core loading patterns. This assessment must be submitted by January 23, 1986, and must be updated whenever changes in core loadings, surveillance measurements or other information indicate a significant change in projected values."

By letters dated January 23, 1986, and supplemented on June 5 and July 7, 1986, the Florida Power and Light Company submitted information on the material properties and the fast neutron fluence (E > 1.0 MeV) on the inside surface of the reactor pressure vessel, in compliance with the requirements of 10 CFR 50.61 for the Turkey Point Plant, Units 3 and 4. The RT_{PTS} and fluence values were projected to April 27, 2007, which is the expiration date of both licensees.

II. Evaluation of The Material Aspects

The controlling beltline material from the standpoint of PTS susceptibility was identified to be intermediate-to-lower girth weld SA-1101 (weld wire heat number 71249) for both unit 3 and unit 4.

The material properties of the controlling material and the associated margin and chemistry factor were reported to be:

	Utility Submittal	Staff Evaluation
Cu (copper content, %)	0.26	0.26
Ni (nickel content, %)	0.60	0.60
I (Initial RT_{NDT}, °F)	+10	+10

	Utility Submittal	Staff Evaluation
M (Margin, °F)	--	48
CF (Chemistry Factor, °F)	--	166.8

The controlling material has been properly identified. The justifications for the copper and nickel contents and the initial RT_{NDT} are given by reference to a submittal dated February 10, 1984, which was accepted by the staff on April 26, 1984 (S.A. Varga to J.W. Williams of FPL). The justifications meet our criteria for PTS submittals. The margin has been derived from consideration of the bases for these values, following the PTS Rule, Section 50.61 of 10 CFR Part 50. Assuming that the reported values of fluence are correct, Equation 1 of the PTS rule governs, and the chemistry factor is as shown above.

III. Evaluation of the Fluence Aspects

Early studies of the PTS issue for the Turkey Point plants indicated that (a) the controlling beltline material is the intermediate-to-lower circumferential weld SA-1101 and (b) a flux reduction factor of about 4.5 should be effected for both plants to prevent them from reaching the 10 CFR 50.61 screening criteria before April 2007 (i.e., the expiration of their operating licenses). To this end the licensee implemented a flux reduction scheme based on the use of part-length absorber rods located on the assemblies on the core flats. The purpose of this review was to evaluate the effectiveness of the flux reduction measures and to evaluate the projected estimate of the peak azimuthal fluence at the end of the current license on the lower circumferential welds.

The licensee's determination of the fast flux at the lower circumferential weld is based on the DOT 4.3 discrete ordinates transport code in (r,θ) geometry. The calculations employ a nuclear data library based on the 47-neutron group BUGLE-80 (ENDF/B-IV) library, and an S_8-P_3 angular decomposition. The neutron source is obtained from PDQ-7 generated pin-wise, cycle-specific power distributions. The presence of plutonium is accounted for by a mixed U+Pu core neutron source normalization factor. The fast ($E > 1.0$ MeV) flux at the lower circumferential weld is then given by:

$$\phi\ \text{weld} = \phi\text{DOT}(r=\text{PV inner surface}, \theta)\ P\ (z=\text{weld elevation})$$

i.e., the DOT 4.3 (r,θ) result is multiplied by the relative axial power at the elevation of the weld (from a NODE-P calculation) to provide an estimate of the three-dimensional fast flux at that location.

The basic elements of the Brookhaven National Laboratory (BNL), our contractor's, approach for determining the fast flux at the peak wall location on the lower circumferential pressure vessel welds are summarized below:

1. Forward and/or adjoint fixed source calculations are performed with DOT-4.3 in (r,θ) and (r,z) geometries in order to determine the contributions of selected assemblies and axial zones to the $E > 1.0$ MeV flux at the lower circumferential welds, near the core major axis (the peak azimuthal location).

2. The DOT calculations employ a 16-neutron group library derived from the ENDF/B-IV based on 100-neutron group EPR library and an S_8-P_3 angular decomposition.

3. Cycle-specific source data provided by the licensee are used in conjunction with the DOT-4.3 results to synthesize the three-dimensional flux. Only assembly averaged sources are considered, and the neglected pin-wise power distributions are accounted for via a generic adjustment factor determined from an earlier study.

4. An exposure correction is applied on an assembly basis and includes the effect of plutonium on both the source normalization and the energy-dependent source spectrum.

Results for the present and projected end of license fast fluences, and resulting values of RT_{PTS} at the inner surface of the lower circumferential weld near the core major axis are given in Tables 1 and 2 for Turkey Point Units 3 and 4, respectively. The four BNL results quantify the effects of exposure (Cases 1 vs. 2 and 3 vs. 4), and the licensee vs. the BNL approaches for estimating the three-dimensional flux at the limiting location.

For Unit 3: (1) the exposure effect is worth 3.5% and 7% at present and EOL conditions, respectively; (2) the axial treatment underestimates the present fluence by ~2% and the EOL fluence by ~10%; and (3) the difference between the licensee and BNL Case 1 results is <~3%.

For Unit 4, the exposure dependent results show a similar trend relative to the cases with no exposure correction, and the different axial treatments have a smaller effect (<4%). However, comparison of the licensee results and those from Case 1 show an ~12% discrepancy (vs. <~3% for Unit 3).

It is significant that, even though the BNL results for the fluence (Case 4) are higher than those obtained by the licensee, the resultant values for RT_{PTS} are still well below the NRC screening criterion of 300°F for circumferential welds, with end of license values of 271°F and 276°F for Units 3 and 4, respectively. Therefore, we conclude that the proposed flux reduction results in a RT_{PTS} which meets the 10 CFR 50.61 criterion and is acceptable.

IV. Conclusion

Both the licensee's and our confirmatory calculations are well below the screening criteria for the limiting material at the expiration date of the licenses. The licensee has calculated a RT_{PTS} of 236°F and 233°F for Units 3 and 4, respectively. As stated in the evaluation portion of this Safety Evaluation, the staff's confirmatory calculations are higher with a RT_{PTS} of 271°F and 276°F for Units 3 and 4, respectively, for the limiting circumferential weld material to April 27, 2007, which is the expiration date of both licenses.

We therefore conclude that the Turkey Point Units 3 and 4 pressure vessels meet the toughness requirements of 10 CFR 50.61 for operation to the end of their current licenses provided that future fuel loadings continue to use the special assemblies for the reduction of the fast neutron fluence to the lower circumferential welds.

In order for the staff to confirm the licensee's projected estimated RT_{PTS} throughout the life of the Turkey Point Plant, Units 3 and 4 operating licenses, the licensee is required to submit a re-evaluation of the RT_{PTS} and comparison to the predicted value with future Pressure-Temperature submittals which are required by 10 CFR 50, Appendix G.

Date:

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TABLE 1

Present and Projected EOL Fluence (>1.0 MeV) and RT_{PTS} for Turkey Point Unit-3

Case	Present Fluence(1)	RT_{PTS}(2)	End-of-License Fluence(1)	End-of-License RT_{PTS}(2)
BNL-FP&L Axial Treatment				
1. Zero Exposure	1.31	237	2.10	262
2. Exposure Corrected	1.35	239	2.25	266
BNL 3-D Synthesis				
3. Zero Exposure	1.33	238	2.31	267
4. Exposure Corrected	1.37	240	2.47	271
FP&L	1.27	236	2.15	263

(1) Fluence (>1.0 MeV) x 10^{-19} n/cm^2

(2) RT_{PTS} from Eqn. 1 of 10CFR 50.61

TABLE 2

Present and Projected EOL Fluence (>1.0 MeV) and RT_{PTS} for Turkey Point Unit-4

Case	Present Fluence(1)	RT_{PTS}(2)	End-of-License Fluence(1)	End-of-License RT_{PTS}(2)
BNL-FP&L Axial Treatment				
1. Zero Exposure	1.33	238	2.40	269
2. Exposure Corrected	1.39	240	2.60	274
BNL-3-D Synthesis				
3. Zero Exposure	1.32	238	2.48	271
4. Exposure Corrected	1.39	240	2.70	276
FP&L	1.19	233	2.16	263

(1) Fluence (>1.0 MeV) x 10^{-19} n/cm^2

(2) RT_{PTS} from Eqn. 1 of 10CFR 50.61