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

## UNION ELECTRIC COMPANY

## CALLAWAY PLANT

## DOCKET NO. 50-483

## 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 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 letter dated January 21, 1986, the Union Electric Company, licensee for the Callaway plant, submitted information on the material properties and the fast neutron fluence (E > 1.0 MeV) of the reactor pressure vessel in compliance with the requirements of 10 CFR 50.61 (Reference 1). The NRC Staff reviewed the pressure vessel material properties and found them acceptable (Reference 2). The following evaluation concerns the estimation of the fluence to the pressure vessel to the end of the current license and the corresponding value of the $RT_{PTS}$.

## EVALUATION OF THE MATERIAL ASPECTS

The controlling beltline material from the standpoint of PTS susceptibility was identified to be the lower shell plate R2708-1.

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, %) | 0.08 | 0.08 |
| Ni (nickel content, %) | 0.60 | 0.60 |
| I (Initial $RT_{NDT}$, °F) | 50 | 50 |
| M (Margin, °F) | -- | 48 |
| CF (Chemistry Factor, °F) | -- | 44.4 |

The controlling material has been properly identified. The justifications given for the copper and nickel contents and the initial $RT_{NDT}$ are acceptable. 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.

The methodolgy of the fluence calculation was based on the discrete ordinates code DOT with an ENDF/B-IV based cross section set. The scattering is treated with a $P_1$ approximation. However, a conservative 20% allowance was made for the flux estimate compared to a $P_3$ estimate. An additional 20% was added for uncertainties and another 20% for future core design changes. The total increase amounts to a factor of 1.73 for a peak fast fluence (E > 1.0 MeV) of $3.63 \times 10^{19}$ n/cm$^2$. The methodology and the approximations used are acceptable.

The equation specified in 10 CFR 50.61, as applicable for the Callaway Plant is:

$$RT_{PTS} = I+M+(-10+470xCu+350xCuxNi)xf^{0.27}$$

where:
I = Initial $Rt_{NDT}$ = 50°F
M = Uncertianty Margin = 48°F
Cu = w/o Copper in lower shell plate R2708-1 = 0.08
Ni = w/o Nickel in lower shell plate R2708-1 = 0.60
f = Peak Azimuthal Fluence (E > 1.0 MeV) lower shell plate R2708-1 in units of $10^{19}$ n/cm$^2$ = 3.63

Therefore, to the end of 32 effective full power years:

$$RT_{PTS} = 50+48+(-10+470x0.08+350x0.08x0.60\_x3.63^{0.27}$$
$$= 98+44.4x1.416 = 160.9°F$$

which is lower than 270°F, the applicable PTS rule screening criterion and is acceptable. It should be noted that the above fluence represents less than 2.5% of the fluence required to meet the 10 CFR 50.61 screening criteria.

In view of:

(a) the Pressure-Temperature updateing requirements for the fracture toughness of the beltline material in 10 CFR 50 Appendix G, and

(b) the fact that the $RT_{PTS}$ value is readily available from the calculation of the Pressure Temperature limits, and

(c) the staff desire to be informed on the current value of the $RT_{PTS}$ for all PWRs,

we request that the licensee submit a re-evaluation of the $RT_{PTS}$ and a comparison to the prediction of Reference 1 along with the future Pressure-Temperature operating limits which are required by 10 CFR 50 Appendix G.* It should be noted that this re-evaluation is a requirement by 10 CFR 50.61, whenever core loadings, surveillance measurements, or other information indicate a significant change in projected values.

* This request for information is covered under OMB clearance No. 3150-0011.

Docket No.: 50-483

15 DEC 1986

Mr. D. F. Schnell
Vice President - Nuclear
Union Electric Company
Post Office Box 149
St. Louis, Missouri 63166

Dear Mr. Schnell:

Subject: Projected Values of Material Properties for Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events

We have reviewed your letter dated January 21, 1986 which was submitted in response to the Pressurized Thermal Shock (PTS) Rule, 10 CFR 50.61, for the Callaway Plant. We have found the material properties of reactor vessel beltline materials, the projected fluence at the inner surface of the reactor vessel for the end of life of the plant, and the calculated $RT_{PTS}$ for the end of life of the plant to be acceptable. The calculated $RT_{PTS}$ is below the screening criteria of 270°F at 32 EFPY which is beyond the expiration date of the license and, therefore, meets the requirements of the PTS Rule.

The PTS Rule requires that the projected assessment of the $RT_{PTS}$ must be updated whenever changes in core loadings, surveillance measurements or other information (including changes in capacity factor) indicate a significant change in the projected values. This ensures that the licensees will track the accumulated fluence for the limiting beltline materials throughout the life of the plant to verify that their assumptions remain valid. In this regard we request that you submit a re-evaluation of the $RT_{PTS}$ and comparison with the predicted value in any future Pressure-Temperature submittals which are submitted as required by 10 CFR 50, Appendix G.

Our associated Safety Evaluation is enclosed.

Sincerely,

Paul W. O'Connor, Project Manager
PWR Project Directorate #4
Division of PWR Licensing-A

Enclosure: As stated

cc w/enclosure: See next page

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Union Electric Company

Callaway Plant
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