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 NORTHERN STATES POWER COMPANY PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNIT NO. 1 DOCKET NO. 50-282

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 10, 1986, Northern States Power Company (the Licensee) submitted projected values of RT_{PTS} together with material properties and fast neutron fluence of reactor vessel beltline material for the Prairie Island Nuclear Generating Plant Unit No. 1. The RT_{PTS} and fluence values were projected to June 25, 2008, the expiration date of the current license.

By letter dated February 21, 1986, the licensee has applied for a license amendment which would extend the operating license to August 9, 2013. This evaluation deals only with the reactor vessel material properties and fluence to the expiration date of the current license, June 25, 2008.

EVALUATION OF THE MATERIALS ASPECTS

The controlling beltline material from the standpoint of PTS susceptibility was identified to be the circumferential weld joining the intermediate to the lower shell forging (weld W-3), Weld Wire heat number 1752. 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, %)	0.14	0.14
Ni (nickel content, %)	0.17	0.17
I (Initial RT_{PTS}, °F)	0.0	0.0

	Utility Submittal	Staff Evaluation
M (Margin, °F)		59
CF (Chemistry Factor, °F)		64

The controlling material has been properly identified. The justification 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. Equation 1 of the PTS Rule governs, and the chemistry factor is as shown above.

EVALUATION OF THE FLUENCE ASPECTS

The maximum azimuthal fluence at the limiting weld material, the Circumferential Weld, W-3 Weld Wire Heat No. 1752, was determined to be 4.3×10^{19} p/cm^2 at the end of the current license. The Prairie Island Unit No. 1 fluence was estimated using an accepted two dimension transport code. Details of the methodology are described in the licensee's submittal dated January 10, 1986. The methodology and results were found acceptable.

EVALUATION OF THE CALCULATED RT_{PTS}

According to the PTS Rule, 10 CFR 50.61, the applicable equation for calculating RT_{PTS} is:

$$RT_{PTS} = I+M+(-10+470xCu + 350xCuxNi)\ f^{.27}$$

Where:

I = initial RT_{NDT} = 0°F

M = uncertainty = 59°F

Cu = % copper in weld W-3 = 0.19

Ni = % nickel in weld W-3 = 0.13

f = peak fluence ($E \geq 1.0$ MeV) on weld W-3 $\times 10^{19}$ cm^2/n = 4.3

Then:

$$RT_{PTS} = 0+59+(-10+470x0.19+350x0.19x0.13)4.3^{0.27}$$

$$RT_{PTS} = 59+87.95x1.483=189.4°F$$

To quantify the margin in terms of the fluence required to reach the screening criterion the staff solved the following equation:

$$300 = 59+64.13xf^{27} \quad \text{or}$$

$$f^{.27} = \frac{241}{64.13} = 3.758$$

or f = 134.7 (where this fluence value is outside the limits of the available experimental data of Reg. Guide 1.99)

and in terms of the end of life peak weld W-3 fluence it is 134.7/4.3 = 31 i.e., the fluence to the end of 32 EFPYs is about 3% of that required to reach the screening criterion.

For circumferential weld material the governing of screening criteria at the expiration date of the license is 300°F. 189.4°F is less than 300°F by a very large margin (110.6°F). This meets the requirements of the PTS Rule and is acceptable.

CONCLUSIONS

Calculations show that RT_{PTS} is 189.4°F for the limiting circumferential weld material at the expiration at the expiration date of the license. This is less then 300°F by a considerable margin which is the screening criteria for the limiting material at the expiration date of the license. This is acceptable and thus meets the requirements of the PTS Rule.

In order for us to confirm the licensee's projected estimated RT_{PTS} throughout the life of the license we will request the licensee 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.

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