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Supplement 1

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LOCA ECCS LIMITING BREAK AND EXPOSURE SENSITIVITY ANALYSIS FOR ENC XN-1 AND XN-2 RELOADS AT PRAIRIE ISLAND UNIT 1 WITH FIVE PERCENT STEAM GENERATOR TUBES PLUGGED USING ENC'S WREM IIA PWR MODEL

Supplement 1

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1.0 SUMMARY

This document provides the results of LOCA-ECCS analysis for the Prairie Island Unit 1 reactor to support reactor operation with ENC fuel reloads XN-1 and XN-2 for extended burnup. The analysis assumed 5% steam generator tube plugging in Prairie Island Unit 1. Previous ENC analysis(1) had supported operating reloads XN-1 and XN-2 to a peak pellet exposure of 47 GWD/MTM. The current analysis extends the burnup dependent total peaking limit (F_Q^T) to peak pellet burnups of 50 GWD/MTM for reload XN-1 and 51 GWD/MTM for reload XN-2. The corresponding peak rod burnups used in the analyses are 45.5 GWD/MTM for reload XN-1, and 46.4 GWD/MTM for reload XN-2.

Figure 1 provides the allowable total peaking (F_Q^T) vs. peak pellet burnup determined by previous analysis, and extended by the current analysis. The allowable F_Q^T vs. exposure is constant at 2.21 (14.03 kw/ft total, 13.66 kw/ft heat release in the fuel) to a peak pellet burnup of 36.7 and 39 GWD/MTM for reloads XN-1 and XN-2 respectively. Table 1 provides differences in fuel design parameters for reloads XN-1 and XN-2. At higher exposures, the F_Q^T limit decreases linearly to 2.009 at 47 GWD/MTM peak pellet burnup for both reloads XN-1 and XN-2. Above 47 GWD/MTM peak pellet burnup F_Q^T decreases linearly to 1.94 at 50 GWD/MTM for reload XN-1 and 1.91 at 51 GWD/MTM for reload XN-2. A reduction in F_Q^T at high exposures is necessary to offset the adverse effects of fission gas release on predicted clad rupture and flow blockage in the postulated LOCA. The F_Q^T reduction occurs at sufficiently high burnup that it is not anticipated to be restrictive for the projected core operation. Operation of the Prairie Island Unit 1 to the F_Q^T limit detailed in Figure 1 will assure that the plant operates in conformance with 10 CFR 50.46 criteria(2).

Table 1 Prairie Island Unit 1 Fuel Design Parameters

	Reload XN-1	Reload XN-2
Pellet Diameter (in)	.3565	.3555
Diametric Gap (in)	.0075	.0075
Clad Inner Diameter (in)	.364	.364
Clad Outer Diameter (in)	.424	.426
Fuel Length (in)	144.	144.
Plenum Volume (in^3)	.575	.575
Prepressurization (psig)	290	305
Dish fraction	.01	.01

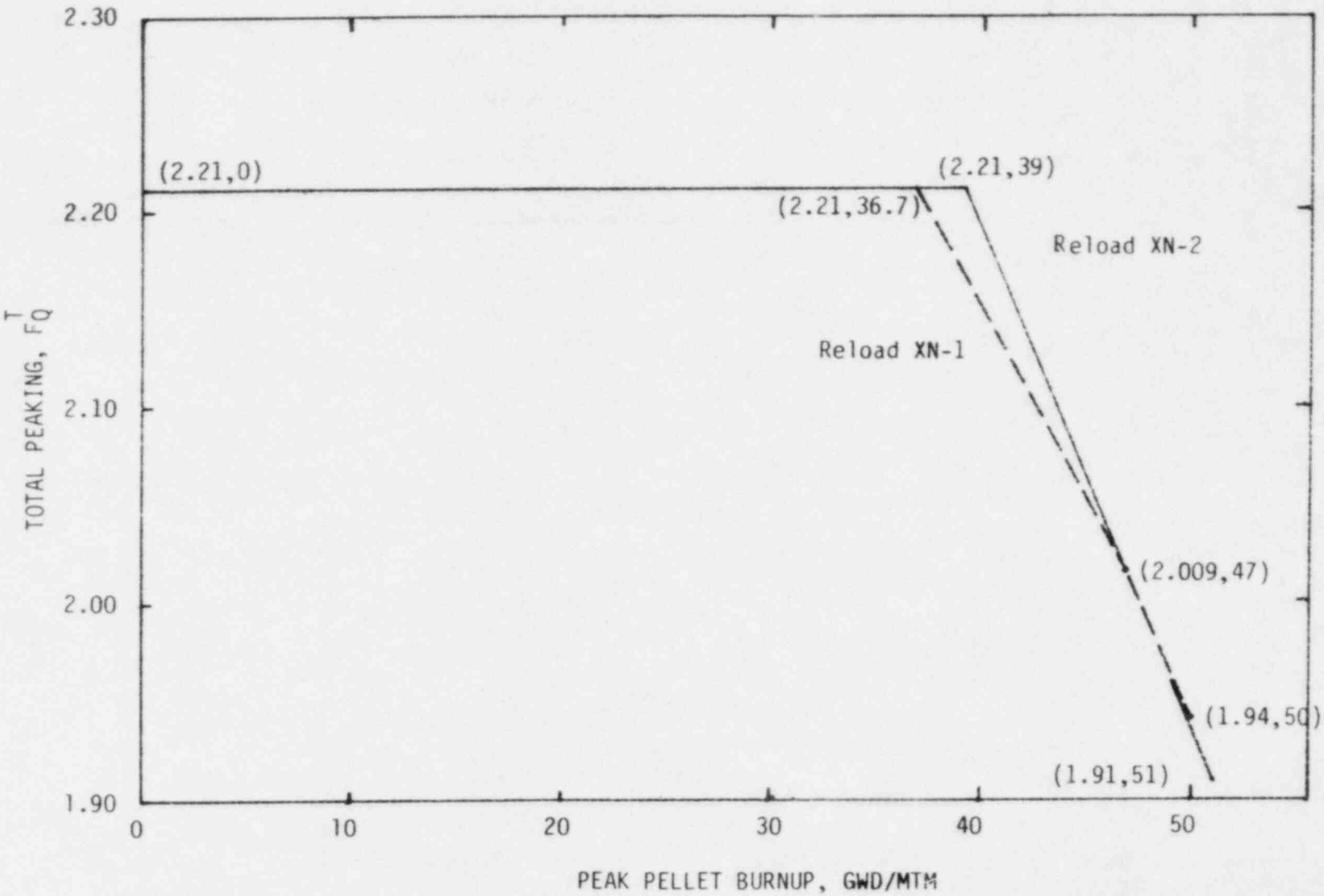

Figure 1 Prairie Island Unit 1 F_Q^T versus Peak Pellet Burnup for Reload Fuels XN-1 and XN-2

2.0 MODELS IN ASSUMPTIONS

The analysis used the ENC WREMII flow blockage methodology[3] and not the NRC flow blockage model as described in NUREG-0630[4]. The NUREG-0630 model as implemented by ENC[5] is currently under review by the NRC Staff, as well as PWR ECCS model updates[6]. The currently approved ENC flow blockage model, along with the WREM-IIA[7] ECCS models and the NRC enhanced fission gas release patch to GAPEX[8], give conservatively high peak cladding temperatures (PCTs) compared to the results with the models currently under NRC review. PCTs were also computed in accordance with the NRC interim upper plenum injection model[9].

The computer codes used in these analyses are listed in Table 2. These codes have been approved by the NRC for use in licensing analysis and are part of the ENC WREM-IIA model. The fission gas release predicted by GAPEX at the desired exposure is adjusted by the NRC enhancement formula for exposures greater than 20 GWD/MTM. The effect of uncertainties in internal rod pressure on rupture pressure have also been considered in the analysis.

Table 2 Prairie Island Unit 1 Computer Codes used in Current Analysis

Calculation	Computer Code
Blowdown Hot Channel Normalized Power Accumulator Injection	RELAP4/ENC28FB
Containment Pressure	CONTEMPT/LT22ENC
Reflood	REFLEX
Heatup	TOODEE2/UJAN82
Stored Energy Fission Gas Release	GAPEX
ΔPCT for UPI	NRC Model with Westinghouse modifications

3.0 ANALYSIS RESULTS

Calculations were made for the previously identified limiting break[10], 0.4 DECLG, with 5% of the steam generator tubes plugged. The results of the analysis are given in Table 3. Table 3 shows peak cladding temperatures less than 2200°F, the local maximum metal-water reaction less than 17% and core wide metal-water reaction less than the 1% limit. The results satisfied the 10 CFR 50.46 criteria at the F_Q^T limits listed. ECCS analysis parameters used to establish the F_Q^T limits of 2.21 are listed in Table 4. At high exposures, the radial peaking was reduced for the F_Q^T limits less than 2.21.

Table 3 Prairie Island Unit 1 ECCS Exposure Sensitivity Results for Reloads XN-1 and XN-2 at End-of-Life

	Reload XN-1	Reload XN-2
Peak Pellet Exposure (GWD/MTM)	50	51
Total Peaking, F_Q^T	1.94	1.91
Peak Cladding Temperature (PCT) (^{o}F)	1964	1891
Maximum Local Zr/H_2O Reaction (%)	2.2	1.6
at Time (Sec)	297	297
Core Wide Zr/H_2O Reaction (%)	1.0	1.0
Hot Rod Burst Time (sec)	171.9	160.4
Hot Rod Burst Location (ft)	8.88	8.63
Rupture Pressure (psia)	982	837
Subchannel Flow Blockage (%)	47	51
Time PCT (sec)	291.1	290.1
PCT Location (ft)	9.63	9.63
Maximum Zr/H_2O Reaction Location (ft)	9.63	9.63
ΔPCT for UPI (^{o}F)	1	1

Table 4 Prairie Island Unit 1 ECCS Analysis Parameters

Reactor Power (MWt)	1683.0 (102%)
Reactor Pressure, psia	2250.
Heat Release in Fuel	97.4%
Nominal Hot Assembly, Radial Peaking, F_r	1.4904
Nominal Hot Rod Locak Peaking, F_l	1.04
Nominal Engineering Factor, F_e	1.03
Nominal Axial Peaking, F_a	1.3843
Nominal Total Peaking $F_Q = F_r F_l F_e F_a$	2.21
Axial Power Peak Location, X/L	0.5

4.0 REFERENCES

1. Exxon Nuclear Company, LOCA ECCS Limiting Break and Exposure Sensitivity Analysis for ENC XN-1 and XN-2 Reloads at Prairie Island Unit 1 with Five Percent Steam Generator Tubes Plugged Using ENC WREM-IIA PWR Evaluation Model, XN-NF-81-06(P), February 1981.

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10. ECCS Large Break Spectrum Analysis for Prairie Island Unit 1 Using ENC WREM-IIA PWR Evaluation Model, XN-NF-78-46, November 1978.

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