NSP

Northern States Power Company

414 Nicollet Mall
Minneapolis, Minnesota 55401
Telephone (612) 330-5500

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Director
Office of Nuclear Reactor Regulation
US Nuclear Regulatory Commission
Washington DC 20555

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket Nos 50-282 License Nos DPR-42
50-306 DPR-60

Additional Information to Support the
License Amendment Request dated January 13, 1986

The attached information is being provided in response to NRC Staff questions concerning the January 13, 1986 License Amendment Request.

Please contact us if you have further questions concerning this submittal.

David Musolf

David Musolf
Manager - Nuclear Support Services

DMM/TMP/tp

Attachment

c: Regional Administrator-III, NRC
NRR Project Manager, NRC
Resident Inspector, NRC
MPCA
Attn: J W Ferman
G Charnoff

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Prairie Island Nuclear Generating Plant
Northern States Power Company

Additional Information to Support the License Amendment Request dated January 13, 1986

Applicability of this License Amendment Request

The changes proposed in this amendment are applicable to the operation of Unit 1 Cycle 11 and Unit 2 Cycle 10 and are a result of the changeover from Exxon fuel to Westinghouse fuel occurring on Cycle 11 of both units. Although Westinghouse OFA fuel is not being utilized in Unit 2 Cycle 10, the proposed changes are applicable to the operation of Unit 2 Cycle 10 as discussed in the Exhibit A. Unit 2 Cycle 11, and future cycles, will be evaluated per 10 CFR 50.59. If changes to the Technical Specifications are required, a license amendment will be submitted.

K(z) Curve Changes

This license amendment proposes the elimination of the third line segment of the K(z) curve, Figure TS.3.10-5. K(z) is a normalized factor used to limit the power in the upper half of the core. The existing curve consists of three segments. The first segment is flat and has a value of one. The second segment has a slight negative slope. The third line segment has a large negative slope. The third line segment is based on the small break LOCA analyses. In the past, it was felt that power must be restricted below the third line segment to ensure that 2200°F cladding temperature was not exceeded during a small break LOCA.

The analyses submitted in Exhibit F and G clearly demonstrate that operation with power distributions up to the less restrictive second line segment are not close to the 2200°F limit. The power shape used for the small break LOCA analyses is shown as the solid line in the attached Figure 1. The K(z) restrictions were also plotted on this curve. Since the K(z) factor is a normalized function, a value of F_Q must be used in order to plot this curve on a plot of power density versus core height. The K(z) restrictions assume an F_Q of 2.5. Currently, an F_Q of 2.3 is being requested. The analyses assumed a value of 2.5 since future submittals are planned to be made which will support an F_Q of 2.5. The power shape used in the analyses summarized in Exhibits F and G is conservative for the value of F_Q proposed in this amendment. It should be noted that no operating modes have been postulated which would produce power shapes as extreme as the one used for these small break LOCA analyses. Therefore, these analyses justify the deletion of the third line segment of the K(z) curve.

Large Break LOCA

The large break LOCA analysis was performed with the 81 Model approved by a Safety Evaluation Report attached to a letter transmitted 12/1/81 J R Miller (NRC) to E P Rahe (Manager of Nuclear Safety, Westinghouse). The LOCA analysis summarized in Exhibit E used a chopped cosine power shape. The chopped cosine power shape has been found generically to be limiting for power shapes bounded by the K(z) curve (See the attachment to the letter transmitting the above referenced SER page 12, Section 2.6.3 paragraph 1).

The chopped cosine power distribution has also been demonstrated to bound other power shapes for Prairie Island in the power shape sensitivity study performed with the 81 Model on Exxon fuel (See Letter dated 11/4/85, D M Musolf to the Director of NRR).

The LOCA analysis accounted for hydraulic mismatches between the Westinghouse and Exxon assemblies with a 10°F PCT penalty. The hydraulic mismatch between the two assembly types was small enough that only the crossflows due to rod size and grid designs needed to be evaluated. Differences in the grid design between the two assembly types can produce local flow maldistributions of up to 2.5% in the Westinghouse assemblies. Previous analyses produced sensitivities showing a 5% flow maldistribution could result in a 19°F peak cladding temperature rise. Therefore, the 2.5% flow maldistribution could cause a 9.5°F peak cladding temperature penalty. A 10°F peak cladding temperature penalty was added to the Westinghouse assemblies.

Offsite Doses from Analyzed Locked Rotor Events

Fuel failures projected in the Locked Rotor analyses (8%) will be bounded by the 100% fuel failures assumed in the LOCA Offsite Dose Analysis.

ENC (W-3) vs OFA DNB Values

For both nominal and transient conditions, the MDNBR has been calculated for both the ENC and the Westinghouse fuel explicitly. Rod bow penalties are then applied to the calculated MDNBR values for each particular fuel type before comparison to the design limit. With this method, the design MDNBR limits are a constant 1.30 and 1.17 for the W-3 and WRB-1 correlations respectively and the calculated values are reduced to account for the effect of rod bow.

Exhibit H (NSPNAD-8600) reported the MDNBR results for the ENC fuel using the W-3 correlation, since the ENC fuel was more limiting with respect to MDNBR than the Westinghouse fuel. This is true even after the rod bow penalties are accounted for (the rod bow penalty for Westinghouse fuel is 5% and less than 3% for ENC fuel). Table 1 shows a comparison of nominal MDNBR conditions for the two fuel types.

Fuel Mechanical Design Comparison

The fuel mechanical design comparison is shown in Table 2. The major differences are in fuel rod outside diameter and grid design. The compatibility of the two fuel types is discussed in Reference 5 of Exhibit H. A detailed discussion of the effect of fuel rod bowing is contained in Section 3.4 of Exhibit H.

Use of the W-3 CHF Correlation Below 1000 psia

The use of the W-3 CHF correlation was justified previously in the Prairie Island FSAR. The discussion is contained on pages 14.2-30.

RCS Flow Rates

The MDNBR methodology used in Exhibit H assumed a RCS total flow rate of 178,000 gpm, which is the minimum allowed by Prairie Island Tech. Spec. 3.10.J. When Prairie Island measures the RCS flow rate, instrument uncertainties (2.3%) are applied to the measurement before comparing it to the minimum allowable value. This method is used to ensure that the actual RCS flow rate is always above the Tech. Spec. (and thereby transient analysis) value.

ENC Grid Composition

The ENC grids do include spacer springs made of Inconel-718

Core Composition

There are 40 Westinghouse OFA design assemblies and 81 Exxon TOPROD design assemblies in the Prairie Island 1 Cycle 11 core. Unit 2 Cycle 11 will also add 40 Westinghouse OFA design assemblies.

The OFA design assemblies to be inserted in Cycle 11 of both units will have axial natural Uranium blankets and Gadolinia bearing fuel pins. This will be the first time Gadolinia will be used in Westinghouse designed fuel. However, these features have been used in the similar Exxon TOPROD fuel for the last 6 Prairie Island cycles (three on each unit). The similarity of Unit 1 Cycle 10 (with all ENC TOPROD fuel) and Unit 1, Cycle 11* is shown in Table 3. The parameter changing the most is the moderator coefficient. This is an effect of the smaller diameter Westinghouse fuel. Even though there will be less boron in the core at beginning of life for Cycle 11 (which by itself would tend to make the moderator coefficient less positive), the moderator coefficient is more positive due to additional coolant in the core with the smaller diameter Westinghouse fuel rods.

Average Flow Velocity in the Core

The average flow velocity in the core is as follows.

All ENC TOPROD Core	14.149 ft/sec
All Westinghouse OFA Core	13.267 ft/sec
Prairie Island 1 Cycle 11*	13.844 ft/sec

Moderator Temperatures at Full Power

T_{in}, nominal	530.5 °F
T_{ave}, nominal	560 °F

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* 40 OFA assemblies, 81 ENC TOPROD assemblies used in Exhibit H

Grid Height

	ENC TOPROD	Westinghouse OFA
Middle 5	2.25"	2.25"
Top & Bottom	2.25"	1.50"

The higher OFA loss coefficients are a result of using thicker pieces for the grid construction.

Effect of Guide Tube Diameter on RCCA Drop Times

The new OFA fuel has a reduced diameter guide tube. This will cause an increased resistance to RCCA insertion, thereby increasing the time it takes for the rods to fully insert following a SCRAM. However, the increase in rod drop time will not be large enough to necessitate a change in the Technical Specification limit of 1.8 sec.

Westinghouse Standard Fuel Assemblies

The currently operating Unit 2 cycle (Cycle 10) contains 4 Standard fuel assemblies. Originally, no Standard Westinghouse fuel was planned to be used in Unit 2 Cycle 10. During refueling several assemblies were damaged, and the Standard Westinghouse fuel was used as replacements. These assemblies are currently covered by a past Westinghouse analysis limiting them to an F_Q of 2.21. These assemblies are not covered by the LOCA analyses (allowing an F_Q of 2.30) submitted with this analysis. Therefore, we will limit these assemblies to the current Technical Specification F_Q limit of 2.21 and the existing K(z) curve until they are removed in October of this year. At this time thimble plugs will be removed, Westinghouse Optimized Fuel will be added and the new Upper internals will be installed in Unit 2.

Changes to Exhibit D

In Exhibit D, the response to Item 3 should read " . . . loop above 10% power" rather than " . . . loop below 10% power."

Add the following words to Item 7:

> The impact of the Westinghouse assemblies on the Exxon assemblies was also analyzed and found to be acceptable.

TABLE 1

Initial Conditions for MDNBR Analysis

	ENC	Westinghouse
Core Power (MW_{th})	1683	1683
Total RCS Flow (Mlbm/hr)	68.62	68.62
Active Core Flow (Mlbm/hr)	64.50	64.50
Coolant Inlet Temperature (^oF)	534.5	534.5
Pressure (psia)	2220	2220

Core Power = 102% rated

Total RCS Flow = Minimum Tech. Spec. Value (178,000 gpm)

Active Core Flow = 94% Total RCS Flow

Coolant Inlet Temperature = Nominal +4 ^oF

Pressure = Nominal -30 psia

Margin (5) = (1 - design limit/calculated value) * 100%

TABLE 2

	TOPROD	OFA
Fuel Assembly Length (in)	159.71	159.71
Fuel Rod Length (in)	152.00	151.85
Fuel Rod Pitch (in)	0.556	0.556
Fuel Rods/Assembly	179	179
Guide Tubes/Assembly	16	16
Instrument Tubes/Assembly	1	1
Clad Material	Zr-4	Zr-4
Clad O.D. (in)	0.417	0.400
Clad Thickness (in)	0.0295	0.0243
Fuel Pellet O.D. (in)	0.3505	0.3444
Guide Tube O.D. (in)	0.541	0.528
Number of Grids	7	7
Grid Material		
Middle 5 Grids	Zr-4	Zr-4
2 End Grids	Zr-4	Inc-718
Active Surface Area/Assembly (ft^2)	234.5	225.0
Flow Area/Assembly (in^2)	32.62	34.79
Average Heat Flux (MBtu/hr-ft^2)	0.1984	0.2068
Average Linear Power (Kw/ft)	6.35	6.35
FQ	2.30	2.30
Peak Linear Power (Kw/ft)	14.60	14.60

TABLE 3

		Cycle 10	Cycle 11
Rod Worth ARI		6625	6267
SDM	BOC (pcm)	1928	1946
	EOC (pcm)	344	252
Moderator Coef. (pcm/°F)	ARO, HZP, BOC	-3.0	-.8
Doppler Coef. (pcm/°F)		-1.7	-1.8
Boron Concentration	ARO, HZP, BOC	1447	1331
	ARO, HFP, 100 MWD/MTU	975	895
Boron Worth (pcm/ppm)	BOC, HZP 1200 ppm	-9.00	-9.18

	ENC	WOFA
Pressure drop across core used in analysis:	25.3 psi	24.0 psi

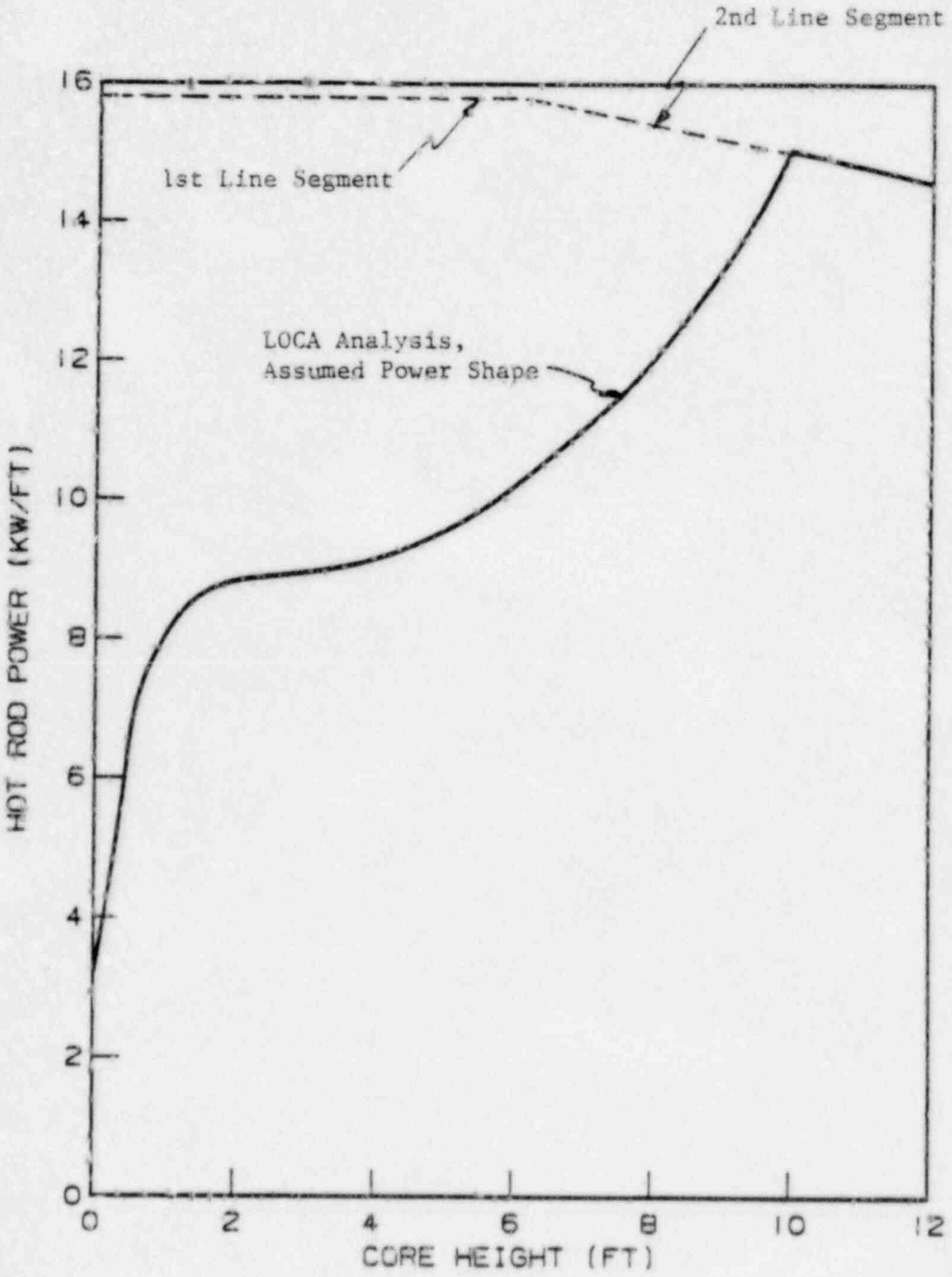

FIGURE 1 Small Break Power Distribution Assumed for Loca Analysis