7590-01

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of NORTHERN STATES POWER COMPANY (Prairie Island Nuclear Generating Plant, Units Nos. 1 and 2)	)	Dockets Nos. 50-282 and 50-306

EXEMPTION

I.

The Northern States Power Company (the licensee) is the holder of Facility Operating Licenses Nos. DPR-42 and DPR-60, which authorize operation of the Prairie Island Nuclear Generating Plant, Units Nos. 1 and 2, at a steady-state power level not in excess of 1633 megawatts thermal for each unit. The facilities are pressurized water reactors located at the licensee's site in Goodhue County, Minnesota. The licenses provide, among other things, that they are subject to all rules, regulations and orders of the Nuclear Regulatory Commission (the Commission) now or hereafter in effect.

II.

Appendix K of 10 CFR Part 50 specifies requirements and acceptable features of evaluation models for analyzing the heat removal from the reactor core during a loss of coolant accident (LOCA) by the emergency core cooling system (ECCS). Sections I.D.3 and I.D.5 are the subject of this exemption request. Specifically, Section I.D.3 is concerned with the calculation of the

reflood rate for pressurized water reactors. This section requires that the ratio of the total fluid flow at the core exit plane to the total liquid flow at the core inlet plane (carryover fraction) shall be used to determine the core exit flow and shall be determined in accordance with applicable experimental data. Section I.D.5 deals with heat transfer analysis during the refill and reflood phase of a LOCA. This section specifically requires that for reflood rates of one inch per second or higher, the reflood heat transfer coefficients shall be based on applicable experimental data for unblocked cores including FLECHT results ("PWR FLECHT (Full Length Emergency Cooling Heat Transfer), Final Report," Westinghouse Report WCAP-7665, April 1971).

III.

By letter dated July 28, 1988, the licensee requested exemption from the requirements of Sections I.D.3 and I.D.5 of Appendix K, as these requirements apply to a new evaluation model for the LOCA analyses dealing with the two-loop Westinghouse plants such as the Prairie Island Nuclear Generating Plant, Units Nos. 1 and 2. In the past, because of modeling difficulties, the evaluation model for the LOCA analyses for the Westinghouse two-loop plants such as Prairie Island assumed that treating the low pressure upper plenum injection water as injected into the lower plenum in the same manner as for the three and four-loop plants would provide reasonable results for a two-loop plant. However, the new model found acceptable (Reference 1) by the Commission's staff, assumes injection of the low pressure water directly into the upper plenum as would actually occur in the plant in the event of a LOCA. This more accurate representation, however, entails deviation from some modeling assumptions required by 10 CFR Part 50,

Appendix K. The acceptability of the exemption request is addressed below.

IV

Section I.D.3 of Appendix K of 10 CFR Part 50 assumes that a carryover fraction of the liquid entering the core inlet plane at the lower plenum as defined above would exit the reactor core and through the loop pipe. In an upper plenum injection plant, the liquid enters above the reactor core and exits through the lower plenum as well as through the loop piping. Therefore, the carryover fraction for the upper plenum injection plants provides no physical meaning nor can it be defined by the existing codes (i.e., WCOBRA/TRAC) used in the licensing calculations. In addition, the licensee's new evaluation model makes use of revised codes which have been demonstrated, via comparison to appropriate experimental data, as capable of calculating the core exit liquid flow without the use of the carryover fraction as defined in Section I.D.3. Thus, although the carryover fraction has not been calculated, the intent of the requirement is met by establishing the core exit flow during reflooding.

Section I.D.5 of Appendix K of 10 CFR Part 50 requires that for reflood rates of one inch per second or higher, the heat transfer coefficients shall be demonstrated to be more conservative than experimental data, including the FLECHT results. In cases where refill and reflood rates of less than one inch per second, the heat transfer coefficients shall be based on steam cooling taking into account any calculated flow blockage. These requirements were based on limited test data, at the time of rulemaking, simulating the liquid entering the core from the lower plenum. For a reactor with upper plenum injection, the entire flow pattern is different than that assumed at the time the requirement was developed. In the case of upper plenum injection, the reactor vessel is

filled with liquid falling or channeling through the core into the lower plenum, and the fuel assemblies are cooled by a combination of cocurrent downflow, cocurrent upflow, and counter current flow film boiling and radiation. In the case where liquid enters the lower plenum, the fuel assemblies are cooled by dispersed cocurrent upflow film boiling and radiation. During the refill phase in the reactor that has upper plenum injection, the water will fall into the core and contribute cooling, and therefore the assumption of only steam cooling discussed in Section I.D.5 is inappropriate. In addition, the one inch per second flooding rate threshold for steam cooling during reflood was based on lower plenum injection blockage heat transfer data that is not applicable for the upper plenum injection mode of cooling. Although the licensee's new evaluation model found acceptable by the Commission's staff (Reference 1) does not contain the limitations of I.D.3 and I.D.5, the new evaluation model contains heat transfer models that have been verified and validated with proper experimental data for the refill and reflood heat transfer coefficients for upper plenum injection. The experimental data include the upper head injection tests at the Westinghouse G-2 test facility and the large scale reflood upper plenum injection tests at the Japanese Cylindrical Core Test Facility (CCTF). The G-2 separate effect experiments provide information on a full length rod bundle film heat transfer in both cocurrent and counter-current flow with a pressure range between 20 and 100 psia which is typical range for upper plenum injection flooding situations. The integral CCTF experiments provide information on the core thermal hydraulic and system responses for upper plenum injection. Four CCTF reflood tests were analyzed which include a cold leg injection reference test and three combined injection tests with various upper plenum injection flow rates and injection configurations simulating symmetric

and skewed upper plenum injections. The comparisons with these data indicate that the new evaluation model provides a reasonably accurate description of the local phenomena and heat transfer calculation for the complex film boiling situation as well as the system response for an upper plenum injection plant. Although the new model deviates from Appendix K in these two particulars, it employs more accurate modeling assumptions for a two-loop plant, and the models have been validated by comparison with appropriate experimental data. Thus, the underlying intent of the rule -- to assure that ECCS evaluation models properly reflect applicable experimental data -- has been satisfied.

V.

Based on the above evaluation, the Commission's staff considers the licensee's alternative, due to the difference in the method of injecting liquid during LOCA conditions, to be equivalent to that achieved by conformance with Sections I.D.3 and I.D.5 of Appendix K to 10 CFR Part 50. Therefore, the licensee's request for exemption from Sections I.D.3 and I.D.5, as these requirements relate to injection of emergency cooling directly into the upper plenum of the reactor, may be granted.

Accordingly, the Commission has determined pursuant to 10 CFR 50.12(a), that the requested exemption is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Further, the Commission finds that special circumstances are present for this exemption in that application of the regulation in this particular circumstance is not necessary to achieve the underlying purposes of Sections I.D.3 and I.D.5 of Appendix K to 10 CFR Part 50, and that the

underlying purpose of these requirements is satisfied by the revised model. The licensee's alternative methods as discussed in IV above for performing the thermal/hydraulic analysis are capable of performing the same demonstration. Therefore, the Commission hereby grants the exemption request identified in Section III above.

Pursuant to 10 CFR 51.32, the Commission has determined that granting this exemption will have no significant impact on the environment (53 FR35940).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 16th day of September 1988.

FOR THE NUCLEAR REGULATORY COMMISSION

Gary M. Holahan

Gary M. Holahan, Acting Director
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IV, V and Special Projects
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REFERENCE I

Letter from Ashok C. Thadani (NRC) to W. J. Johnson (Westinghouse) "Acceptance for Referencing of Licensing Topical Report WCAP-10924, Westinghouse Large-Break LOCA Best Estimate Methodology, August 29, 1988.