Northern States Power Company
Prairie Island Nuclear Generating Plant
1717 Wakonade Dr. East
Welch, Minnesota 55089

December 20, 1996

10 CFR Part 50
Section 50.73

U S Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

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

Spent Fuel Storage Racks Outside Design Basis Due To Boraflex Degradation

The Licensee Event Report for this occurrence is attached. In the report, we made no new NRC commitments beyond those described in our December 6, 1996 response to Generic Letter 96-04.

This event was reported via the Emergency Notification System in accordance with 10 CFR Part 50, Section 50.72, on November 27, 1996. Please contact us if you require additional information related to this event.

Michael D Wadley
Plant Manager
Prairie Island Nuclear Generating Plant

c: Regional Administrator - Region III, NRC
NRR Project Manager, NRC
Senior Resident Inspector, NRC
Kris Sanda, State of Minnesota

Attachment

Ltr encl IE22 1/1
Add NRR/DRPW 1 1
DSC 1 1

300021

NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 04/30/98
ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Prairie Island Nuclear Generating Plant Unit 1	05000 282	1 OF 6

TITLE (4)
Spent Fuel Storage Racks Outside Design Basis Due To Boraflex Degradation

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
11	27	96	96	-- 19 --	00	12	20	96	Prairie Island Unit 2	05000 306
									FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	1
POWER LEVEL (10)	100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(i)	X	50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)		OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Gene Eckholt	612-388-1121

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
B	DB	RK	X999	N						

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

The Prairie Island spent fuel storage racks utilize Boraflex panels as a neutron absorber. Preliminary results from the Prairie Island specific version of the EPRI RACKLIFE computer program indicate that some of the Prairie Island spent fuel storage rack cells have experienced a significant loss of the boron carbide from the Boraflex panels. This information, in combination with information published in EPRI Interim Report TR-103300, indicates that some of the spent fuel storage rack cells are outside their design basis and do not meet the analysis assumptions detailed in Prairie Island Technical Specification 5.6 and the approved criticality analysis. A License Amendment Request, which requests approval of a criticality analysis for the Prairie Island spent fuel storage racks with no credit for Boraflex panels and instead utilizing credit for soluble boron was submitted on July 28, 1995. In the interim, administrative controls have been implemented to ensure that the spent fuel pool soluble boron concentration is maintained at a level adequate to ensure k_{eff} for the spent fuel storage racks will remain less than 0.95.

EVENT DESCRIPTION

The Prairie Island spent fuel storage racks, which utilize Boraflex as a neutron absorber, were put into use in late 1981 and were filled to near capacity by 1995. As a result, most of the individual spent fuel cells have a high accumulated gamma dose. A Boraflex coupon surveillance program was established when the racks were installed to monitor long term performance of the Boraflex material. At five year intervals, an irradiated Boraflex test coupon is removed from its location in the spent fuel pool and is sent for analysis of physical dimensions, hardness and Boron-10 areal density. The last coupon was analyzed in 1994 and was found to not be significantly degraded, with the Boron-10 areal density exceeding original specification.

In the mid-1980's, the nuclear industry began to recognize that there were material problems with Boraflex in spent fuel storage racks. The initial problem identified was shrinkage of the Boraflex panels. In situ inspections and laboratory results projected a maximum gap size of 4 inches. Even though the Prairie Island rack design was not believed to be susceptible to gap formation due to shrinkage, a 4 inch gap at the mid-plane of the Boraflex panel is assumed in the current approved criticality analysis for the Prairie Island spent fuel storage racks.

In 1991 it was noted that spent fuel pool silica levels at plants with Boraflex in their spent fuel storage racks were significantly higher than those without Boraflex. This indicated that the Boraflex may also be dissolving. These indications lead EPRI and the EPRI Boraflex Working Group to shift its focus from gap formation in Boraflex to the potential for Boraflex dissolution under long term exposure to spent fuel pool conditions. Because of the high level of silica in Prairie Island spent fuel pool relative to the rest of the industry, and because of a rack design which promoted a high exchange rate of water around the Boraflex panels, the Prairie Island racks were evaluated as part of the EPRI sponsored studies. The other plant studied utilized a rack design with a low water exchange rate around the Boraflex panels.

The EPRI sponsored studies have shown that the combination of gamma exposure and water ingress into the Boraflex panel cavity significantly degrades the silica polymer matrix. The Prairie Island rack design allowed for a large amount of water ingress to alleviate the potential for cell wall bulging as a result of the Boraflex material offgassing. The Prairie Island sample coupons were not designed to allow for significant water ingress and are therefore not believed to be accurate indicators of rack Boraflex degradation.

One of the objectives of the EPRI Boraflex degradation program was to provide utilities in the EPRI Boraflex Working Group with software to specifically model their spent fuel pool. The computer simulation that was developed, named RACKLIFE, utilizes spent fuel pool chemistry parameters (including silica levels) and cell-by-cell exposure histories to estimate each Boraflex panel's potential for degradation. RACKLIFE became available in the Spring of 1996 and the large database required to input into the simulation for Prairie Island was completed in September 1996. Once run with the Prairie Island data it was discovered that the published version of RACKLIFE was unable to match the release

rate of silica in the Prairie Island spent fuel pool. Additional modeling was necessary to simulate the Prairie Island spent fuel pool data using RACKLIFE. In our October 23, 1996 response to Generic Letter 96-04, we anticipated the RACKLIFE analysis to be completed in November of 1996. Due to continuing difficulties with the modeling of the Prairie Island specific conditions, the analysis was not completed in November of 1996. The assessment of the Prairie Island spent fuel racks using the EPRI RACKLIFE program is continuing.

However, even though the analysis has not been completed, preliminary information provided by the Prairie Island-specific RACKLIFE model, in combination with information published in EPRI Interim Report TR-103300, "Guidelines for Boraflex Use in Spent-Fuel Storage Racks" (December 1993), indicates that some of the spent fuel storage rack cells are outside their design basis and do not meet the analysis assumptions detailed in Prairie Island Technical Specification 5.6, Reference 2 (Criticality Analysis of the Prairie Island Units 1 & 2 Fresh and Spent Fuel Racks).

CAUSE OF THE EVENT

Early laboratory tests and computer simulations sponsored by EPRI showed that Boraflex degrades under spent fuel pool conditions as a function of gamma dose and water interaction. This information was published in EPRI Interim Report TR-103300, "Guidelines for Boraflex Use in Spent-Fuel Storage Racks" (December 1993). As the Boraflex is exposed to gamma radiation, crosslinking and scissioning begins to occur resulting in, among other things, gas evolution, a graying of the material and open porosity. The increase in graying and open porosity accelerates the dissolution of the Boraflex when it is in contact with the pool water.

Two scenarios for the degradation of Boraflex are discussed in the interim EPRI report based on separate rack designs, one modeled on a low flow design and one on a high flow design. The difference in the two models was the rate of exchange of water in the cavity surrounding the Boraflex panel which is a function of rack design and construction. The low flow design had a very small rate of exchange and the high flow, based on the Prairie Island racks, had a large water exchange rate. It was found that a quasi-chemical equilibrium was established both in the Boraflex panel cavity and in the entire spent fuel pool. The silica matrix that holds the boron carbide in place dissolves into ionic silica until the silica concentration reaches an equilibrium saturation level in the Boraflex cavity. However, in the high flow model the equilibrium condition is never reached because of the ready mixing with the bulk spent fuel pool water which has a lower silica concentration. It could be deduced that eventually the bulk pool water will also reach an equilibrium and thereby slow the reaction to the point where only makeup and dilution from refueling outages would drive more silica into solution. However, the readily measurable silica (reactive) also combines together to form colloids. This colloidal silica contributes to reducing both the local and bulk reactive silica levels thereby forcing more of the Boraflex to dissolve.

ANALYSIS OF THE EVENT

The Boraflex in the Prairie Island spent fuel storage racks was installed to maintain $k_{eff} \leq 0.95$ in combination with geometric factors inherent in the rack design. The spent fuel pool is required to have a criticality analysis that assumes unborated water and meets the 5% subcritical requirement. The increase in initial fuel enrichment and an earlier identified Boraflex shrinkage penalty reduced the margin to criticality in the current Prairie Island criticality analysis to 5.52%. The additional degradation of the Boraflex due to dissolution has further reduced the margin to criticality to the point that some spent fuel storage rack cells no longer meet the analysis assumptions detailed in Prairie Island Technical Specification 5.6, Reference 2 (Criticality Analysis of the Prairie Island Units 1 & 2 Fresh and Spent Fuel Racks).

To compensate for the Boraflex degradation, a Justification for Continued Operation (JCO) has been written to justify continued use of the spent fuel storage racks using the soluble boron in the spent fuel pool water as a suitable neutron poison to maintain required margin. Westinghouse has performed a criticality analysis which shows that maintaining the boron concentration greater than 1850 ppm will ensure $k_{eff} \leq 0.95$ under all conditions including postulated accident conditions assuming no Boraflex is present.

In conjunction with the criticality analysis, a dilution analysis and a probabilistic risk assessment (PRA) were performed to demonstrate the unlikelihood of a significant dilution event. The dilution analysis determined that no single source of water on the site was capable of diluting the spent fuel pool to the point that $k_{eff} \geq 1.0$ and the spent fuel pool dilution event frequency was less than the NRC Safety Goal Policy Statement target frequency risk level objective of 1.0E-6 per reactor year. With the spent fuel pool boron concentration currently above 3000 ppm, at no time has the margin to criticality been <5%. For these reasons there are not, and will not be, any adverse effects on the health and safety of the public.

Because some of the spent fuel storage rack cells were outside their design basis and outside the analysis assumptions detailed in Prairie Island Technical Specification 5.6.A.1.b, it was determined that the degradation of the spent fuel storage rack Boraflex was reportable pursuant to the following:

- 10 CFR 50.72(b)(1)(ii)(B) and 10 CFR 50.73(a)(2)(ii)(B): "In a condition that is outside the design basis of the plant", and

- 10 CFR 50.73(a)(2)(i)(B): "Any operation or condition prohibited by the plant's Technical Specifications"

CORRECTIVE ACTION

A safety evaluation addressing the use of soluble boron in the spent fuel pool to offset the degradation of the Boraflex in the racks was approved on November 27, 1996. That evaluation determined that the use of credit for soluble boron is an unreviewed safety question. A License Amendment Request, which requests approval of a criticality analysis for the Prairie Island spent fuel storage racks with no credit for Boraflex panels and instead utilizing credit for soluble boron, was submitted on July 28, 1995. This License Amendment Request specifically addresses the unreviewed safety question related to the use of credit for soluble boron in spent fuel pool criticality analyses.

As part of the developmental work for the July 28, 1995 License Amendment Request, spent fuel pool criticality analyses were performed that showed that 1850 ppm boron maintained $k_{eff} < 0.95$ under accident conditions with no credit for Boraflex or checkerboarding. Analyses crediting soluble boron using the existing checkerboarding requirements have not been performed, but that checkerboarding would provide additional margin. Until the NRC review of the July 28, 1995 License Amendment Request is completed, administrative controls have been implemented to ensure that the spent fuel pool soluble boron concentration is maintained at a level adequate to ensure K_{eff} for the spent fuel storage racks will remain less than 0.95. Those administrative controls conservatively require that the spent fuel pool boron concentration be maintained > 2000 ppm and that the spent fuel pool boron concentration be confirmed weekly.

To ensure that adequate soluble boron is maintained in the spent fuel pool under all conditions, the following actions have been taken.

- Procedures that provide for normal and emergency makeup to the spent fuel pool have been revised by temporary memo to require boron sampling following makeup to verify acceptable boron levels remain. The relevant requirements of the temporary memos will be permanently incorporated into the procedures once the July 28, 1995 License Amendment Request for soluble boron credit has been approved.

- Operator spent fuel pool checks have been increased in frequency from once per day to once per shift to potentially decrease the time an unplanned dilution can go undetected.

- Boric acid has been placed in the immediate vicinity of the spent fuel pool in the event manual addition is required.

- Spent fuel pool dilution sources have been tagged out to eliminate their use without adherence to the new administrative controls.

Finally, as part of the original Prairie Island response to Generic Letter 96-04, dated October 23, 1996, a fuel management strategy has been established to ensure that fresh and other high reactivity fuel

assemblies (based on a combination of burnup and initial enrichment) will only be placed in spent fuel storage rack cells that are projected to have little or no boron carbide loss. The determination of boron carbide loss will be based on the RACKLIFE simulations.

FAILED COMPONENT IDENTIFICATION

Spent fuel racks manufactured by PaR Systems with installed Boraflex manufactured by BISCO

PREVIOUS SIMILAR EVENTS

There have been no other similar events at Prairie Island.