UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY
PRAIRIE ISLAND INDEPENDENT SPENT FUEL STORAGE INSTALLATION
DOCKET No. 72-10

REQUEST FOR AMENDMENT TO MATERIALS LICENSE SNM-2506

License Amendment Request dated August 31, 1999
Storage of Fuel Inserts with
Spent Fuel Assemblies Stored in Dry Casks

Northern States Power Company, a Minnesota corporation, with this letter is submitting information to support a requested license amendment. This letter and its attachments contain no restricted or other defense information.

NORTHERN STATES POWER COMPANY

By *Joel P. Sorensen*
Joel P. Sorensen
Site General Manager
Prairie Island Nuclear Generating Plant

On this *1st* day of *September 1999* before me a notary public in and for said County, personally appeared, Joel P. Sorensen, Site General Manager, Prairie Island Nuclear Generating Plant, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company, that he knows the contents thereof, and that to the best of his knowledge, information, and belief the statements made in it are true and that it is not interposed for delay.

Marlys E. Davis

MARLYS E. DAVIS
NOTARY PUBLIC-MINNESOTA
My Commission Expires Jan. 31, 2000

EXHIBIT A

PRAIRIE ISLAND INDEPENDENT SPENT FUEL STORAGE INSTALLATION

License Amendment Request dated August 31, 1999

Evaluation of Proposed Changes to the
Technical Specifications, Appendix A and Conditions Nos. 6, 7 and 8 of
Materials License SNM-2506

Pursuant to 10 CFR Part 72, Section 72.56, the holders of Materials License SNM-2506 hereby propose the following changes to Appendix A, Technical Specifications and License Conditions Nos. 6, 7, and 8:

BACKGROUND

The initial evaluation of the storage of fuel inserts in TN-40 casks was contained within the safety evaluation for Prairie Island Plant Modification 88Y910, "Dry Cask Storage," which addressed the storage of the first TN-40 cask in the Prairie Island Independent Spent Fuel Storage Installation (ISFSI). The safety evaluation for Modification 88Y910 concluded that, while the storage of TN-40 casks at Prairie Island did constitute an unreviewed safety question, which had received prior NRC approval, the storage of fuel inserts[1] in TN-40 casks did not constitute an unreviewed safety question. This later conclusion was based upon a Transnuclear Incorporated (TN) evaluation documented in a November 9, 1994 letter to Northern States Power, which indicated that significant bounding design assumptions described in the Safety Analysis Report associated with the NRC license for the Prairie Island ISFSI were still satisfied.

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[1] The Safety Analysis Report submitted to the NRC did not specifically address the storage of fuel assembly inserts (burnable poison rod assembly (BPRA), control rod, source rod, and thimble plugging device TPD)) in the TN-40 casks. Because of the overall length of a fuel assembly with either a control rod or source assembly installed, they are not candidates for storage in a TN-40. BPRAs and thimble plugs do fit within the nominal dimension of a fuel assembly, and therefore are physically capable of being stored in a TN-40 cask.

The November 9, 1994, TN letter evaluated the safety of storing BPRA and TPD fuel assembly inserts in the TN-40 cask. The presence of a BPRA in a fuel assembly affects both the criticality and structural elements of the cask design, whereas a TPD only affects the structural aspects of the cask design because the TPD does not extend into the active fuel region of the fuel assembly. TN had communicated that the inserts will not have a significant effect on the other safety analyses of the cask (thermal, confinement, shielding, etc.).

The results of the Transnuclear criticality analyses show that loading an assembly with a 16 rod BPRA will slightly lower the assembly K_{eff} (0.8988 to 0.8958), while loading an assembly with an 8 rod BPRA will further lower the assembly K_{eff} to 0.8908.

Structural calculations are based on the maximum weight of an assembly, which is listed in Table 3.1-1 of the ISFSI SAR as 1,300 pounds. This value exceeds the actual heaviest assembly weight. Transnuclear has confirmed that as long as the total combined assembly/insert weight in a cask remains within 40x1,300=52,000 pounds the structural analysis contained in the SAR will remain valid.

An inspection finding at Virginia Power's Surrey facility documented in NRC Inspection Report 72-0002/98-201, September 16, 1998, the NRC determined that storage in the GNSI CASTOR V/21, the NAC I/28, the Westinghouse MC-10 and the Transnuclear TN-32 dry spent fuel casks of any fuel assembly containing any fuel insert requires prior NRC review and approval. The NRC Staff's current interpretation is that BPRA and TPD fuel inserts are not included in the 10CFR72.3 definition of "spent fuel" or "spent nuclear fuel", which is:

> fuel that has been withdrawn from a nuclear reactor . . .. Spent fuel includes the special nuclear material, byproduct material, and other radioactive materials associated with fuel assemblies.

Because the treatment of fuel assembly inserts in the Special Nuclear Material (SNM) license at Prairie Island for Transnuclear TN-40 spent fuel dry storage casks is very similar to the situation in the SNM license at Surrey for Transnuclear TN-32 spent fuel dry storage casks, the staff at Prairie Island initiated a Non-Conformance Report (NCR)(Condition Report 19982542) on October 13, 1998. This NCR addressed the operability of the TN-40 casks 01 through 07 that already contain 127 BPRA and TPD fuel inserts and identified that to prevent further violations no casks should be loaded with spent fuel assemblies containing BPRA or TPD fuel inserts until a license amendment has been approved by the NRC. (Casks 08 and 09 were loaded in February 1999 without any spent fuel assemblies containing BPRA or TPD fuel inserts.)

The operability of casks 01-07 loaded with spent fuel assemblies containing BPRA and TPD fuel inserts is demonstrated by the 72.48 evaluation performed as part of the original modification to install the ISFSI (Mod 88Y910). This safety evaluation evaluated criticality, weight loading, impact on seismic response, thermal loading and radiation shielding. In addition, several ISFSI Tech Spec related measurements are made for each cask prior to movement to the pad. These measurements confirm that the casks are performing as designed and are operable. The measurements include radiation levels, surface temperature and cask seal leakage rates. The 72.48 evaluation, in combination with the low safety significance of the issue (as described in the NRC inspection report), provides justification for not returning casks 01-07 to the plant for removal of inserts. Moving a cask and unloading the inserts would pose a small but unnecessary risk at this time.

In response to NRC Inspection 72-010/99-201, which affirmed the need for NRC review and approval of the storage in the TN-40 casks at Prairie Island of spent fuel assemblies containing BPRA and TPD fuel inserts, Prairie Island provided the NRC copies of the 88Y910 safety evaluation, the November 9, 1994, Transnuclear evaluation letter, and NCR 19982542. Also, in response to NRC Inspection Report 72-010/99-201, Prairie Island committed to submit by September 1, 1999, a License Amendment Request seeking NRC approval for the storage in TN-40 casks of spent fuel assemblies containing BPRA and TPD fuel inserts.

PROPOSED CHANGE AND REASONS FOR CHANGE

TS 3/4.1 Fuel To Be Stored At ISFSI

The Limiting Condition for Operation (LCO) 3.1.1 will specify that two types of fuel assembly inserts, burnable poison rod assembly (BPRA) and thimble plugging device (TPD), may be included in spent nuclear fuel assemblies to be loaded into TN-40 casks and stored at the Prairie Island ISFSI. Burnup and cooling time requirements for each type of fuel insert are identified.

Storing the BPRA and TPD fuel inserts inside the spent fuel assemblies that are loaded into the TN-40 casks is the most feasible storage concept available for these items. BPRA fuel inserts were used extensively in Cycle 1 for each reactor unit and were eliminated after Cycle 2 for each reactor unit. An analysis of core thermal limit performance allowed the use of TPD fuel inserts to be eliminated after Cycle 10 for each reactor unit. At the beginning of Cycle 11 for Unit 2 Prairie Island had 100 BPRA and 195 TPD fuel inserts stored within 295 of the nearly 880 STANDARD design spent fuel assemblies in the spent fuel pool. After Cycle 10 both reactor units started reloading with new fuel assembly designs such as Westinghouse OFA, which had thimble tubes that were not sized to accommodate the insertion of the older fuel inserts. This precludes moving the fuel inserts into more recently discharged fuel assemblies.

Currently, Prairie Island has 95 BPRA and 32 TPD fuel inserts loaded within the 280 spent fuel assemblies loaded in the first 7 TN-40 casks and consideration of several issues has identified that the preferred course of action is to leave these inserts in place:

1) Minimizing occupational exposure is a preferred course of action (ALARA) because of its widely accepted inherent conservatism.
2) Minimizing the handling of heavy loads is a preferred course of action because of its perceived inherent conservatism.

License Condition 6 Byproduct, source, and/or special nuclear material.

This License Condition will specify that byproduct material within two types of fuel assembly inserts, burnable poison rod assembly (BPRA) and thimble plugging device (TPD), may be included in spent nuclear fuel assemblies to be loaded into TN-40 casks and stored at the Prairie Island ISFSI.

This change is consistent with the requested change to T/S 3/4.1.

License Condition 7 Chemical and/or physical form.

This License Condition will specify the material utilized in the fabrication of the two types of fuel assembly inserts, burnable poison rod assembly (BPRA) and thimble plugging device (TPD), that has been made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

This change is consistent with the requested change to License Condition 6.

License Condition 8 **Maximum amount that licensee may possess at any one time under this license.**

This License Condition will permit one of either of the two types of fuel assembly inserts, burnable poison rod assembly (BPRA) and thimble plugging device (TPD), to be included in each spent nuclear fuel assembly to be loaded into TN-40 casks and stored at the Prairie Island ISFSI.

This change is consistent with the requested change to T/S 3/4.1.

SAFETY EVALUATION

BPRA and TPD Fuel Insert Descriptions

For the first 10 cycles of operation Prairie Island utilized thimble plugging devices manufactured by Westinghouse to restrict the reactor coolant flow through the thimble tubes in fuel assemblies that did not have either control rods, source rod assemblies, or burnable poison rod assemblies occupying these tubes. A TPD was constructed by attaching 16 short (~6") solid 304 stainless steel rods (rodlets) to a nozzle assembly composed of 304 stainless steel with Inconel 718 spring components.

Prairie Island utilized three variations of a single BPRA fuel insert design in the first two cycles of each units' operation. These were manufactured by Westinghouse. Either 8, 12 or 16 burnable neutron absorber rods, each consisting of a boron/Pyrex glass tube in the annulus between two different diameters 304 stainless steel tubes, that were plugged and seal welded on the ends. These absorber rods are then attached to a nozzle assembly identical to that used in a TPD. In cases where the number of absorber rods is less than 16 the positions without absorber rods are occupied by a substitute TPD rodlet.

Currently, Prairie Island does not use BPRA or TPD fuel inserts in reactor core designs, but has the following inventory of irradiated BPRA and TPD fuel inserts:

16 8-rod BPRA,
28 12-rod BPRA,
56 16-rod BPRA, and
195 TPD.

Cooling time and cask average burnup assumptions were applied in analysis calculations based on cycle average exposure histories and cycle shutdown dates. These calculation assumptions were not intended to be sufficiently bounding that these assumptions would be satisfied with a significant margin by all combinations of actual fuel insert conditions. These assumptions have been incorporated into the proposed Limiting Conditions of Operation in the Technical Specifications and plant procedures will be utilized to ensure compliance with these requirements:

BPRA	Assumption	burnup [2]	≤ 30,000 MWD/MTU
		cooling time	≥ 18 years
TPD	Assumption	burnup [3]	≤ 125,000 MWD/MTU
		cooling time	≥ 9 years

Internal Cask Cavity Pressurization

A BPRA will produce the most limiting effect on cask pressurization. It displaces the most cavity free volume and contains a gas inside its rods which if ruptured would add to the cavity pressure. A bounding case based on a cask full loading of 40 spent fuel assemblies each containing a 16-rod BPRA [4] has been evaluated assuming that all B^{10} in each BPRA rod has been transmuted to He and is available for release to the cask cavity in an accident. In this bounding case the cask internal pressure will increase to 89 psia versus the previously calculated value of 70 psia for a cask that contains spent fuel assemblies without any inserts. Both of these values are substantially below the maximum internal pressure design value of 100 psig (ISFSI SAR Table 3.4-1).

[2] TN-40 Dry Cask Average

[3] TN-40 Dry Cask Average

[4] This provides a very conservative estimate that exceeds bounding conditions established by cask loading weight limitations. During the time period that fuel inserts were being loaded with spent fuel assemblies into TN-40 casks, plant procedures were in place to ensure that the cask loading total weight was less than the design value of 52,000 lb (an average of 1,300 lb/assembly). This would not permit 40 16-pin BPRA inserts to be loaded in a single cask, since a 40 lb 16 pin BPRA together with a 1274 lb spent fuel assembly would weigh approximately 1314 lb. This would yield a cask loading total weight of 52,560 lb, which is 560 lb over the design limit.

Criticality Control

An evaluation was performed to quantify the change in fuel reactivity resulting from the displacement of borated water in the spent fuel assembly guide tubes by a BPRA during cask loading operations. This BPRA was conservatively assumed to be made of aluminum, which has a much lower neutron absorption cross section than the actual materials present in a BPRA. Results indicated that placing a BPRA in a spent fuel assembly would have an insignificant effect on assembly reactivity:

No BPRA K_{eff}	0.8988 ± 0.0033
16 rod BPRA K_{eff}	0.8958 ± 0.0030
8 rod BPRA K_{eff}	0.8908 ± 0.0033

Cask Surface Radiological Consequences

Co-60 from neutron activation of Co-59 in the stainless steel and Inconel is the only isotope that was considered to contribute to external dose since it is by far the major contributor to dose from activated hardware. Despite its smaller total mass a TPD fuel insert produces a larger increase in cask surface dose rate than a BPRA fuel insert, because it has a 17% larger Co-60 source term which is the result of a substantially larger exposure and a much shorter cooling time. For a cask fully loaded with spent fuel assemblies each containing a TPD the cask surface dose rate just above the cask side neutron shield will be approximately 133 mR/hr. While this is a significant increase from that point's surface dose rate of approximately 15 mR/hr for a fully loaded cask without any TPD fuel inserts, this dose rate is still within the 200 mR/hr limit set by Technical Specification LCO 3.6.1.

Comparison of the surveillance radiation measurements to calculated values for both casks with fuel inserts (01 through 07) and casks without fuel inserts (08 & 09) indicate that calculated dose exposures contain substantial conservatism.

Offsite Radiological Consequences

Due to the berm surrounding the ISFSI, the off-site dose to the nearest resident is exclusively from skyshine radiation, which is dominated by the neutron radiation . The skyshine from the casks is essentially from the radiation escaping from the top of the protective cover and also from the area above the radial neutron shield. The addition of TPD inserts only contributes to an increase in the gamma dose rate, which increases at the top of the protective by a factor of approximately 2.5 and on the side of the cask above the neutron shield by a factor of approximately 8.

The dose rate to the nearest resident is 1.14 mrem/yr, of which only 0.079 mrem/yr is from gamma. If one conservatively increases the gamma skyshine by a factor of 8 (since both top and sides contribute) for the 295 assemblies containing inserts, the calculated dose rate to the nearest resident would become approximately 1.22 mrem/yr, an insignificant increase of 0.08 mrem/yr. This total is a very small fraction of the 25 mrem/yr annual dose limit established in 10CFR72.104(a).

To date, 127 of the 295 total BPRAs and TPDs have been loaded and are stored at the ISFSI in casks 1-7. The table below compares the measured gamma dose rate to the SAR values. As can be seen, the measured gamma dose rates are a small fraction of the calculated values in the SAR. The offsite dose calculations are based on 1920 fuel assemblies, while Prairie Island only possesses 295 fuel inserts. This clearly demonstrates that that the existing offsite dose calculations are conservative for cask containing inserts. The remaining inserts are expected to have an even smaller impact on the total cask dose rates, due to the longer decay time before storage in future casks.

Gamma Dose Rates, Casks 1-7 (mrem/hr)

	SAR Value	Measured Values
Top	23	2.0 – 8.0
Sides	45	3.0 – 8.0

Weight Evaluation of Spent Fuel Assembly with BPRA or TPD Fuel Insert

Current plant procedures determine during the fuel assembly selection and identification process that the total weight of loaded fuel assemblies will be below 52,000 lb (ISFSI SAR Table 3.2-1). This total weight is consistent with the individual fuel assembly cask average maximum weight of 1300 lb identified in the ISFSI SAR Table 3.1-1.

The actual weights of the fuel assemblies is less than the 1300 lb/assembly assumed in the analyses, which leaves margin for inclusion of some BPRA and TPD fuel inserts with the fuel assemblies in the TN-40 casks. The plant 'spent fuel assembly selection' procedure currently assumes all assemblies weigh as much as a Westinghouse STANDARD design assembly although later fuel assembly designs each actually have a lower nominal design weight:

Westinghouse STANDARD	1274 lb/assembly,
Exxon STANDARD	1260 lb/assembly,
Exxon TOPROD	1213 lb/assembly,
Westinghouse OFA [5]	1135 lb/assembly,
Westinghouse VANTAGE+ [6]	1120 lb/assembly.

During the time period fuel inserts were being loaded into spent fuel assemblies for storage in the ISFSI TN-40 dry casks, the plant 'spent fuel assembly selection' procedure accounted for the weights of fuel inserts in determining that the cask loading design limit of 52,000 lb was not exceeded. The following fuel insert weights were taken from NSP drawing X-HIAW-1669 (Westinghouse 583F514):

TPD	10 lb,
8 pin BPRA	25.5 lb,
12 pin BPRA	32 lb, and
16 pin BPRA	40 lb.

The maximum possible weight that could be loaded into any TN-40 basket cell is the 1314 lb provided by a Westinghouse STANDARD fuel assembly containing a 16 pin BPRA. This condition is bounded by the 1,330 lb assumed in the structural analysis of the TN-40 basket for the weight of each fuel assembly.

<u>Additional Cask Thermal Loading from BPRA and TPD Fuel Inserts</u>

Calculations performed with the ORIGEN2 computer code have indicated that the total gamma and thermal energy radiated from each BPRA will be 0.9 watts and the total gamma and thermal energy radiated from each TPD will be 1.1 watts

The TN-40 cask is analyzed based on a heat load of 27 kW from 40 fuel assemblies (675 watts/assembly), which assumes a 10 year cooling time. The additional thermal load from a BPRA or TPD fuel insert is less than 0.2% of the design heat load. Appendix B of Regulatory Guide 3.54 Revision 1 indicates that expected

[5] Some of the spent fuel assemblies of this design will not currently be eligible for storage in the ISFSI because their initial enrichment exceeds 3.85 w/o U-235.
[6] All of the spent fuel assemblies of this design will not currently be eligible for storage in the ISFSI because their initial enrichment exceeds 3.85 w/o U-235.

differences of approximately 0.2% in the heat rate are not sufficient to require additional corrections. This suggests that the additional heat from a fuel insert is sufficiently small to be covered under the safety factors inherent in the decay heat generation calculational methodology made available in Regulatory Guide 3.54 Revision 0 and NUREG/CR-5625.

In addition the Thermal Analysis results presented in the ISFSI SAR Table 3.3-1 indicate that during long-term normal operating conditions the fuel cladding maximum temperature will be 602 °F. This is sufficiently below the maximum fuel cladding temperature limit of 644 °F, identified in the July 1993 SER for the Prairie Island ISFSI, to further indicate that a increase of less than 0.2% in the heat load from the contents of the storage cask is of negligible safety significance.

EXHIBIT B

PRAIRIE ISLAND INDEPENDENT SPENT FUEL STORAGE INSTALLATION

License Amendment Request dated August 31, 1999

Marked Up Pages
(shaded material to be added, strikethrough material to be removed)

Appendix A, Technical Specifications

3/4-1

3/4-2

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Special Nuclear Material License

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