SAFETY EVALUATION REPORT

INDEPENDENT SPENT FUEL STORAGE INSTALLATION
MATERIALS LICENSE NO. SNM-2506
AMENDMENT NO. 8

1.0 SUMMARY

The current operating license for the Prairie Island (PI) Independent Spent Fuel Storage Installation (ISFSI) states that the "amended license is effective as of the date of issuance, and shall expire at midnight October 31, 2013." Northern States Power Company (NSPM) submitted to the Nuclear Regulatory Commission (NRC) an application dated October 20, 2011, as supplemented February 29, 2012, for the renewal of its Special Nuclear Material (SNM) License No. 2506, under the provisions of 10 CFR Part 72. Due to ongoing NRC activities that affect the PI ISFSI license renewal application (LRA), the NRC did not issue a decision on the LRA prior to October 31, 2013. Therefore, in accordance with the timely renewal provisions of 10 CFR 72.42(c), PI ISFSI entered the period of timely renewal at midnight, October 31, 2013, and will therefore continue to operate under its current license as allowed by the NRC's regulations and the Administrative Procedure Act.

This safety evaluation report (SER) documents the review and evaluation of license amendment request (L-PI-13-050) to SNM License No. 2506 for the PI ISFSI. By letter dated July 17, 2013, as supplemented December 5, 2013, NSPM submitted a request to the NRC in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 72.56, to amend the Technical Specifications (TS) of Materials License No. SNM-2506 to lower the allowed thermal conductance values of basket components. NSPM proposed making the following changes to the TS:

1. The minimum total thermal conductance for the TN-40HT neutron absorber and aluminum 1100 plate combination is changed from 3.98 BTU/hr-^{o}F to 3.55 BTU/hr-°F in TS 4.3.2.b.

2. The nominal thickness of the aluminum 1100 plate at which the neutron absorber material need not be tested for thermal conductivity is changed from 0.359 inches or greater to 0.320 inches or greater in TS 4.3.2.b.

3. Conductivity and conductance values in TS Table 4.3-3 are revised based on the changes to TS Section 4.3.2.b.

NRC staff (staff) has reviewed the application including the justifications for the requested changes. As discussed in further detail below, based on the statements and representations in the application, as supplemented, the staff finds that the requested amendment to Materials License No. SNM-2506 for the PI ISFSI meets the regulatory requirements of 10 CFR Part 72.

2.0 REVIEW CRITERIA

Staff's evaluation of the requested changes is based on ensuring PI ISFSI continues to meet the applicable requirements of 10 CFR Part 72 for independent storage of spent fuel and of 10 CFR Part 20 for radiation protection. The staff followed the guidelines provided in NUREG-1567, “Standard Review Plan for Spent Fuel Dry Storage Facilities,” in conducting the evaluation. Staff’s evaluation focused only on changes to SNM-2506 requested in the application and did not reassess previously approved portions of the license, TS, the updated final safety analysis report (FSAR) or those areas of the FSAR modified by NSPM as allowed by 10 CFR 72.48. The objectives for the following review disciplines are as described below for the requested change.

3.0 THERMAL EVALUATION

3.1 Review of Requested Changes

The amendment reduced the basket’s total neutron absorber conductance value required in the TS from 3.98 to 3.55 Btu/hr-^{o}F. Changing the conductance allowed the applicant to construct the cask basket with neutron absorber and aluminum (Al 1100) plates of commercially available thicknesses. The amendment reduced the nominal aluminum thickness value at which the neutron absorber must be tested to ensure that the total conductance is at least 3.55 Btu/hr-^{o}F to 0.32 inches. The applicant proposed these changes because previous testing revealed that a neutron absorber thermal conductivity of 6.433 Btu/hr-in-^{o}F, in combination with an aluminum plate of 0.224 inches, resulted in a combined conductance that did not comply with the original TS conductance value of 3.98 Btu/hr-^{o}F. The applicant stated that the new conductance of 3.55 Btu/hr-^{o}F is satisfied for a 0.437 inches thick single neutron absorber plate with a thermal conductivity of 8.12 Btu/hr-in-^{o}F and for dual plates of aluminum and neutron absorber. Table 4.3-3 of the TS provided three examples of aluminum and neutron absorber dual plate combinations with different thicknesses and thermal conductivities.

In support of their amendment request, the applicant performed thermal analyses using a "lower conductivity" model. The applicant created a ¼ sector, full-length three-dimensional model of a TN-40HT cask using ANSYS, a finite element analysis program. The applicant’s ANSYS analyses of the storage cask were based on a dual plate neutron absorber constructed with an aluminum plate of 0.312 inches and a neutron absorber plate of 0.125 inches, for a combined thickness of 0.437 inches. The thermal conductivity assigned to the aluminum plate and the neutron-absorber plate was 11.09 and 0.68 Btu/hr-in-^{o}F, respectively. The calculated conductance of the dual basket plate was 3.55 Btu/hr-^{o}F, which satisfied the proposed TS. The parallel and serial effective conductivities of the combined aluminum and neutron absorber dual plates were input as orthotropic properties rather than explicitly modeling the individual aluminum and neutron absorber thermal conductivities; these orthotropic properties were applied equally to the individually modeled aluminum and neutron absorber plates. As discussed below, the model also incorporated changes to the basket design that were described in an earlier SAR (Revision 15). In the thermal analyses, the applicant assumed passive decay heat removal occurred by conduction and radiation inside the cask and by radiation and convection outside the cask. The boundary conditions for the exterior of the cask included convection heat transfer, environmental temperature, and solar insolation as specified in SAR Section A3.3.2.2.1.1.3. The applicant’s "lower thermal conductivity" model calculated the peak cladding temperature for normal/off-normal conditions to be 672 ^{o}F, which was below the allowable temperature of 752 ^{o}F. The applicant mentioned that using individual conductivities for the aluminum and neutron absorber, rather than applying the parallel and serial effective

conductivities, would have resulted in cladding temperatures approximately 7 ^{o}F higher because of the artificially reduced heat transfer area from the symmetric plane that is part of the ¼ sector model.

The applicant also performed thermal transient analyses with the "lower thermal conductivity" model for buried cask accident conditions, vacuum drying conditions, and fire accident conditions. Unlike previous analyses, the fire accident condition did not include a top cask sub-model evaluation because the applicant's calculations indicated that the amount of heat conducted to the top region of the cask remained bounded by previous amendments. Results from the buried cask accident, vacuum drying, and fire accident conditions indicated that peak cladding temperatures of 907 ^{o}F, 713 ^{o}F, and 692 ^{o}F, respectively, were lower than previous analyses because of more accurate models, as described below. The applicant's transient results also indicated that seal temperatures remained below the 536 ^{o}F allowable limit.

The applicant provided the "lower conductivity" model discussed above to show the acceptability of the reduced neutron absorber total conductance. However, within the SAR the applicant continued to refer to their "design basis" model conditions from earlier amendments because the "design basis" analyses bounded the "lower conductivity" analyses. The "design basis" analyses were bounding because it employed an overly conservative Stefan-Boltzmann constant, as described in Section A3.3.2.2.3.6.5, and because cross-sectional ANSYS models were utilized for the accident and vacuum drying conditions, rather than the full-length three-dimensional "lower conductivity" model. The "design basis" model included basket design changes described in an earlier SAR (Revision 15). These basket changes included adding a 1.0 inch gap at each end of the neutron absorber and aluminum plates for fabrication purposes and increasing the as-modeled axial cold gap between the stainless steel structural bars and neutron absorber and aluminum plates from 0.07 inches to 0.2 inches for thermal expansion purposes. The applicant's previously submitted "design basis" analyses showed that, by themselves, these changes resulted in peak cladding temperature increases of 14°F, 16 ^{o}F, and 6 ^{o}F for normal/off-normal storage, fire accident condition, and vacuum drying condition, respectively. Like the "lower conductivity" model, the "design basis" model results were based on a dual plate neutron absorber constructed with an aluminum plate of 0.312 inches and a neutron absorber plate of 0.125 inches, for a combined thickness of 0.437 inches. However, for the "design basis" model, the thermal conductivity of the neutron absorber varied with temperature with an approximate value of 4.17 Btu/hr-in-^{o}F and the aluminum plate thermal conductivity was 11.09 Btu/hr-in-^{o}F, resulting in a dual neutron poison plate total conductance of 3.98 Btu/hr-^{o}F.

3.2 Conclusions

Staff concluded the "lower conductivity" model, which was based on previously reviewed models from earlier amendments, reasonably describes the basket's revised neutron absorber and associated heat transfer mechanisms. Staff concluded that using effective thermal conductivities for the dual plates is acceptable because there is sufficient temperature margin with the allowable value. Staff performed an analysis using the applicant's submitted model because the SAR stated that Al 1100 thermal conductivity values were taken from ASME Code Section II Part D. Since the listed properties in the ASME Code have an associated uncertainty of ±10%, staff wanted to observe the effect on steady-state temperatures assuming the

aluminum thermal conductivity values were 10% lower than those presented in the TS. The staff's analysis showed that cladding temperatures would rise approximately 5 ^{o}F with the lower aluminum thermal conductivity. This relatively small increase is considered acceptable because there is a large temperature margin with the allowable value. The staff finds that reducing the total neutron absorber conductance value from 3.98 to 3.55 Btu/hr-^{o}F is acceptable with respect to thermal performance.

3.3 Evaluation Findings

F3.1 The staff finds that the thermal design of the system remains in compliance with 10 CFR 72.128(a)(4), and that the applicable design and acceptance criteria have been satisfied. The evaluation of the thermal design provides reasonable assurance that the system will continue to allow safe storage of spent fuel for a certified life of 20 years.

4.0 CRITICALITY EVALUATION

4.1 Review of Requested Changes

The staff reviewed the license amendment request (LAR) to determine if the proposed changes to the cask design features would negatively impact the ability of the TN-40HT dry cask system to adequately maintain criticality safety while in use at the PI ISFSI. As outlined in Table 4-1 of the FSAR, the criteria regarding criticality safety is not affected by the TN-40HT design modifications. During fabrication of the first three TN-40HT baskets, as specified in the LAR, the neutron absorber plates used were 0.185 inches thick which is larger than what had been assumed in regards to criticality safety. It was determined that the materials used in the fabrication of those baskets resulted in total thermal conductance values that would not meet the current TS limits. As a result, the applicant proposed to revise TS Design Features Section 4.3.2.b, Thermal Conductivity Testing of Neutron Absorbers, to revise the minimum total thermal conductance of the TN-40HT neutron absorber and aluminum 1100 plate from 3.98 Btu/hr-in-°F to 3.55 Btu/hr-in-°F. The applicant also proposed, as part of this amendment request, to revise Section A9.7.4.2 of the FSAR to change the nominal thickness of the aluminum 1100 plate at which the neutron absorber material need not be tested for thermal conductivity from 0.359 inches or greater to 0.32 inches or greater.

4.2 Conclusions

Staff determined, by review, that the proposed changes discussed above would not adversely impact the criticality safety function of the cask design system for the following reasons. First, the primary basis for criticality control in the TN-40HT was the areal boron-10 density listed in Table 4.3-1 of the TS (i.e., 45 mg/cm^2 for Boral and 37.5 mg/cm^2 for B-Al). This requirement was not revised as a result of this amendment request. Second, the neutron absorber plates for the three baskets which were fabricated in error were 0.185 inches thick. Since Section A.3.3.4.1.3.1 of the SAR for the original licensing basis (TN-40HT Cask Evaluation) identified that the absorber (poison) plates were modeled at a thickness of 0.125 inches for the design basis criticality evaluation, the neutron absorber plates for the three baskets fabricated in error are conservatively thick.

4.3 Evaluation Findings

Based on a review of the statements and representations in the application, the staff has reasonable assurance that changes to the nuclear criticality safety design have been adequately evaluated and meet the requirements as given in 10 CFR 72.124(a) and 10 CFR 72.124(b).

5.0 SHIELDING EVALUATION

5.1 Review of Requested Changes

The staff reviewed the proposed LAR to determine if the proposed changes would negatively impact the ability of the TN-40HT dry cask system to adequately minimize dose rates at the PI ISFSI. As outlined in Table 4-1 of the FSAR, the shielding criteria is not affected by the TN-40HT Design Modifications. During fabrication of the first three TN-40HT baskets, as specified in the LAR, the neutron absorber plates used were 0.185 inches thick, which is larger than what had been assumed in the design basis analyses. It was determined that the materials used in the fabrication of those baskets resulted in total thermal conductance values that would not meet the current TS limits. As a result, the applicant proposed to revise TS Design Features Section 4.3.2.b, Thermal Conductivity Testing of Neutron Absorbers, to revise the minimum total thermal conductance of the TN-40HT neutron absorber and aluminum 1100 plate from 3.98 Btu/hr-in-°F to 3.55 Btu/hr-in-°F.

5.2 Conclusions

Staff determined that the proposed design change, discussed above, does not adversely impact the shielding capability of the cask system. Section A7A.4.1 of the FSAR for the original licensing basis (TN-40HT Cask Evaluation) specifies that the absorber material (poison plate) is modeled as aluminum in the design basis shielding evaluation, with parameters shown in Table A7A.1-1 of the FSAR. Staff determined that this method conservatively bounds the proposed reduction in allowable thickness of the neutron plate as part of the revised thermal conductance values.

5.3 Evaluation Findings

F5.1 Based on a review of the statements and representations in the application, the staff has reasonable assurance that the changes to the cask design have been adequately evaluated and meet the requirements as given in 10 CFR 72.104 and 10 CFR 72.106.

6.0 CONFINEMENT EVALUATION

6.1 Review of Requested Changes

The applicant revised the minimum total thermal conductance of the TN-40HT neutron absorber and aluminum 1100 plate from 3.98 BTU/hr-F to 3.55 BTU/hr-F. Tables A.3.3-36 through A.3.3-39 submitted with the amendment request showed the cask component maximum temperatures remained below the temperature limits for off-normal, fire, buried cask, and

vacuum drying conditions. The lid seal and the vent and drain port seal temperatures for off-normal, fire, and buried cask conditions were bounded by those determined using the top cask sub-model described in SAR Section A3.3.2.2.1.1.2; therefore, these component temperatures were not re-evaluated by the applicant due to the revised minimum total thermal conductance of the TN-40HT neutron absorber and aluminum 1100 plate. Table A.3.3-39 showed that lid seal and the vent and drain port seal temperatures remained below the temperature limits for vacuum drying conditions. SAR Section A3.3.2.2.1.1.3 also showed that the temperature profiles for normal storage conditions were bounded by hot off-normal conditions.

6.2 Conclusions

Based upon a review of the applicant's submittal as described above, the staff concluded that the design of the TN-40HT confinement system was not adversely impacted by lowering the poison plate thermal conductance of the neutron absorber and aluminum 1100 plate combination. Staff also determined that the confinement function will be maintained for normal, off-normal, and accident conditions. The staff reached these findings based upon a review of the regulation itself, appropriate regulatory guides, applicable codes and standards, the applicant's analysis, and accepted engineering practices.

6.3 Evaluation Findings

F6.1 The staff finds the changes acceptable and that the storage system employed at the Prairie Island Nuclear Power Plant ISFSI will continue to meet the requirements of 10 CFR Part 72 for the confinement of radionuclides.

7.0 TECHNICAL SPECIFICATIONS

7.1 Review of Requested Change

The applicant proposed to lower the minimum required total thermal conductance for neutron absorber and aluminum plate combinations used to fabricate baskets for the TN-40HT storage cask specified in Section 4.3.2.b and Table 4.3.3 from 3.98 BTU/hr-^{o}F to 3.55 BTU/hr-^{o}F. The applicant also revised conductivity values in Table 4.3.3. This proposed change caused the aluminum plate thickness for which the neutron absorber thermal conductivity must be verified by testing to decrease.

The proposed changes were reviewed to ensure that they will not adversely impact the ability of the TN-40HT storage cask to safely store irradiated fuel while in use at the PI ISFSI. The technical and safety aspects of these changes were evaluated by the staff. As documented in Sections 3, 4, 5 and 6 of this SER, the staff concluded that the changes were acceptable.

7.2 Evaluation Findings

F7.1 The staff finds that the conditions for use remain in compliance with 10 CFR 72.44(c), and that the applicable design and acceptance criteria have been satisfied. The revised TS provide reasonable assurance that the PI ISFSI will continue to allow safe storage of spent fuel.

8.0 REQUIREMENTS FOR NOTICING PROPOSED ACTION

In accordance with 10 CFR 72.16, a Notice of Proposed Action and a Notice of Opportunity for Hearing was published in the *Federal Register* on September 16, 2013 (78 *FR* 56947). No requests for a hearing or leave to intervene were submitted. Accordingly, pursuant to 10 CFR 72.46(d), action can be taken on this license amendment request.

9.0 ENVIRONMENTAL REVIEW

The applicant stated that the amendment request met the categorical exclusion criteria in 10 CFR 51.22(c)(11). NRC staff determined the amendment request resulted in a change to process equipment. Per 10 CFR 51.22(c)(11), a categorical exclusion for such a change is allowed provided the following conditions are satisfied: (i) the amendment would not produce a significant change in either the type or amount of effluents released to the environment, (ii) would not produce a significant increase in occupational radiation exposure, (iii) would not have significant construction impacts, and (iv) would not produce a significant increase in the potential for or consequences from radiological accidents.

After evaluating the amendment request, staff made the following determinations: (i) the amendment would not produce a significant change in either the type or amount of effluents released to the environment because the amendment did not challenge the temperature limitations of confinement boundary components as documented in Sections 3 and 6, (ii) the amendment would not produce a significant increase in occupational radiation exposure because, as shown in Section 3, source term reconfiguration due to fuel cladding failure from elevated temperatures was not facilitated, and as shown in Section 5, components which performed a shielding function were not adversely impacted, (iii) the amendment would not have significant construction impacts because the change only impacted fabrication of cask basket components, and (iv) the amendment would not produce a significant increase in the potential for or consequences from radiological accidents because the change neither challenged confinement boundary components as documented in Sections 3 and 6, nor adversely impacted criticality control as shown in Section 4. Consequently, staff finds the amendment request meets the categorical exclusion criteria in 10 CFR 51.22(c)(11).

10.0 CONCLUSION

Based on its review of L-PI-13-050, as revised and supplemented, the staff determined there is reasonable assurance that: (i) the activities authorized by the amended license will be conducted without endangering the health and safety of the public, and (ii) these activities will be conducted in compliance with the applicable regulations. The staff further determined that the issuance of the amendment will not be inimical to the common defense and security. Therefore, the amendment should be approved.

Issued with Materials License No. SNM-2506.

Dated: March 10, 2014