November 7, 2005

MEMORANDUM TO: Marc L. Dapas, Director
Division of Nuclear Materials Safety
Region III

FROM: Edwin M. Hackett, Deputy Director /RA/
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: RESPONSE TO TASK INTERFACE AGREEMENT 2005-06, REGARDING LICENSING BASIS FOR, AND SEISMIC DESIGN OF, THE PALISADES INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) (TAC NO. MC6854)

Your memo of April 29, as supplemented May 12, 2005, submitted Task Interface Agreement (TIA) 2005-06 requesting assistance from the Office of Nuclear Reactor Regulation (NRR) in assessing the licensing basis, and seismic design, of the Palisades' ISFSI. Your TIA requested responses to the following questions:

1. During initial licensing of the Palisades Nuclear Power Plant, what did the [Nuclear Regulatory Commission] NRC accept for estimating the horizontal acceleration for seismic evaluations? The response should include a determination if, during initial licensing of the Palisades Nuclear Power Plant, the NRC accepted that the horizontal acceleration for seismic evaluations was "anchored" at

   a. the "ground surface" of the reactor building, elevation 590 [feet] and on top of the compacted glacial till, or;

   b. the "ground surface" of the general plant site, i.e., at any elevation and with any combination of soil structures intervening between the "ground surface" and the underlying bedrock.

2. During the initial licensing of the Palisades Nuclear Power Plant, did the NRC's safety evaluation of the applicant's design Safe-Shutdown Earthquake seismic horizontal acceleration include consideration of ground motion amplification from the bedrock surface to the "ground surface" due to the type and thickness of the intervening soil between the bedrock and the "ground surface?"

3. Does the NRC require, based upon the regulations in [Title 10 of the *Code of Federal Regulations* (10 CFR), Part 72] 10 CFR 72.212(b)(2)(i)(B) and 10 CFR 72.212(b)(3), a licensee to incorporate new information and technology into its assessment of the continued appropriateness and re-application of the previous reactor plant seismic siting and design criteria for the design and construction of an ISFSI pad?

A/3

4. Does the NRC require a licensee to demonstrate that the seismic design of its spent fuel canisters remains appropriate, using ISFSI pad-specific seismic data, if the calculated seismic horizontal acceleration level, using the reactor plant seismic data, is at the spent fuel canister seismic design limit and the pad-specific soil profile and elevation data would be expected to increase the calculated seismic horizontal acceleration?

NRR's Division of Engineering, Mechanical & Civil Engineering Branch, and the Office of Nuclear Materials Safety and Safeguards, Spent Fuel Project Office, Structural and Materials Section, assessed your request and provided the attached response.

Attachment: Response to TIA 2005-06

cc w/ attachment: B. Holian, RI
A. Blough, RI
V. McCree, RII
M. Satorius, RIII
C. Pederson, RIII
A. Howell, RIV
D. Chamberlain, RIV

4. Does the NRC require a licensee to demonstrate that the seismic design of its spent fuel canisters remains appropriate, using ISFSI pad-specific seismic data, if the calculated seismic horizontal acceleration level, using the reactor plant seismic data, is at the spent fuel canister seismic design limit and the pad-specific soil profile and elevation data would be expected to increase the calculated seismic horizontal acceleration?

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RESPONSE TO TASK INTERFACE AGREEMENT 2005-06,

REGARDING LICENSING BASIS FOR, AND SEISMIC DESIGN OF, THE PALISADES

INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI)

1. INTRODUCTION

U.S. Nuclear Regulatory Commission (NRC) Region III's memo of April 29, as supplemented May 12, 2005, submitted Task Interface Agreement (TIA) 2005-06 requesting assistance from the Office of Nuclear Reactor Regulation (NRR) and the Office of Nuclear Materials Safety and Safeguards (NMSS) in assessing the licensing basis, and seismic design, of the Palisades' ISFSI. On August 4, 2005, Region III completed an inspection of design and operational activities associated with the newly constructed Palisades ISFSI pad. The results of this inspection were documented in Region III's Division of Nuclear Materials Safety Inspection Report No. 07200007/2004-002. As a result, the inspectors identified two unresolved items (URIs). These items are associated with Nuclear Management Company's (NMC's) translation of the safe shutdown earthquake (SSE) from the reactor site to the ISFSI pad (URI 072007/2004-002-1), and its assessment of the sub-surface bearing stability beneath the ISFSI pad (URI 0720007/2004-002-2).

2. BACKGROUND

During an inspection of the 2004 ISFSI installation, the inspectors reviewed NMC's seismic calculations associated with the ISFSI pad and the spent fuel canisters. The inspectors determined that NMC performed the ISFSI pad SSE calculations assuming a seismic horizontal acceleration of 0.2g in the free-field and at the ISFSI pad ground surface elevation of 623 feet. NMC stated its understanding that the seismic horizontal acceleration value of 0.2g was approved by the NRC at the time of initial reactor plant licensing. NMC further stated its understanding that the 0.2g horizontal acceleration value was applicable for SSE seismic calculations associated with any location and at any elevation on the plant site. The inspectors noted that NMC performed a soil-structure interaction, seismic assessment for the ISFSI pad using the SSE seismic horizontal acceleration of 0.2g. The soil-structure interaction assessment results indicated that the spent fuel canisters would experience a 0.25g horizontal acceleration during an SSE. The spent fuel cannister seismic horizontal acceleration design limit is 0.25g.

While reviewing NMC's calculations, the inspectors noted significant differences between the elevation and subsurface soil composition of the reactor plant and the 2004 ISFSI pad. Specifically, the reactor containment building was constructed, following the removal of the soil/sands overburden, at a ground surface elevation of 590 feet on compacted glacial till. The 2004 ISFSI pad was constructed, without the removal of the soils/sands overburden, at a ground surface elevation of 625 feet on sands that NMC mechanically compacted. NMC estimated that the compacted glacial till soil layer, at the location of the 2004 ISFSI pad, was at an elevation of 560 to 570 feet.

ATTACHMENT

Based upon the subsurface soil composition and elevation differences between the reactor plant site and the 2004 ISFSI site, the inspectors concluded that NMC's application of the 0.2g horizontal acceleration value at the ISFSI site was non-conservative. Specifically, the inspectors noted that the calculated SSE seismic horizontal acceleration would likely be larger at the ISFSI compared to the reactor plant site due to the increased site elevation and the approximately 50 to 60 feet of mechanically compacted sands present on top of the compacted glacial till material at the ISFSI site. In addition, the inspectors concluded that the soil-structure interaction calculation results were non-conservative, which if revised to incorporate a larger horizontal acceleration value based on the increased ISFSI pad elevation and the soil profile differences, would likely result in a seismic horizontal acceleration value in excess of the spent fuel cannister design limit.

On June 28, 2005, NRR sent Region III a draft of the TIA response for review, and received comments from Region III on August 3, 2005. The discussion below responds to Region III's questions and comments:

Question 1

During initial licensing of the Palisades Nuclear Power Plant (Palisades), what did the Nuclear Regulatory Commission (NRC) accept for estimating the horizontal acceleration for seismic evaluations? The response should include a determination if, during initial licensing of Palisades, the NRC accepted that the horizontal acceleration for seismic evaluations was "anchored" at

a. the "ground surface" of the reactor building, elevation 590 feet and on top of the compacted glacial till, or;

b. the "ground surface" of the general plant site, i.e., at any elevation and with any combination of soil structures intervening between the "ground surface" and the underlying bedrock.

Region III's Comments on NRR's draft response to Question 1:

1. a Expand NRR's response to include a review of all (from pre-construction through initial operating license approval) documents used by the NRC in making the licensing decision. Region III requested NRR to consider the significant licensing questions, answers, and analysis that both the NRC and licensee made after the pre-construction period to develop and define the basis for the seismic design of the facility.

1. b Include an assessment of the "background " information provided in the TIA.

1. c Address the apparent technical inconsistencies between the draft response conclusion, that the NRC "accepted" maximum potential ground motion as being "anchored at the ground surface where the general plant site is," and the numerous NRC and licensee statements and evaluations that would appear to indicate otherwise. The relevant NRC and licensee statements and evaluations appear to document the following:

1. NMC's intention to remove the sand overburden prior to the construction of any safety-related buildings on the site.

2. NMC's commitment not to build any safety-related buildings on the sand overburden without undertaking "special compaction" efforts. This approach would appear to indicate both an understanding and intent by NMC and an understanding by the NRC that NMC planned to use the glacial till materials underlying the sand dunes as the primary interface for structural and seismic interactions. As such, it would appear logical that the NRC would expect NMC to apply the seismic ground acceleration at this defined interface.

3. The NRC's acceptance of NMC's approach to assessing the adequacy of the seismic design of safety-related structures which included NMC's analysis of the horizontal acceleration at the plant grade level of 590 feet not the general site elevation.

4. That NMC conducted, and the NRC reviewed, all of NMC's seismic calculations assuming the plant grade level for all safety-related buildings was at the 590 foot elevation, with the sand overburden removed, vice the general plant site elevation.

1. d Clarify and separate the discussions regarding the general site geology and the seismic design factors considered during plant licensing. As currently presented, the draft response relies upon information included in the general site geology description to draw conclusions regarding what the NRC may or may not have concluded regarding the proper application of seismic design criteria for the plant. While these two subjects are clearly related, the totality of the information included in the overall licensing documentation does not appear to indicate that either the licensee or the NRC accepted or intended to apply the seismic design criteria based upon the site descriptions included in the geology sections of NMC's documentation or the NRC safety evaluation of that information.

1. e Clarify our use and application of the information included in the NRC's "Safety Analysis in the Matter of Consumers Power Company Palisades Plant (SER)," by the Test and Power Reactor Safety Branch, Division of Reactor Licensing, Atomic Energy Commission, issued February 7, 1967. This clarification should address numerous apparent inconsistencies with the draft response and information either included in or referenced in the SER. For example, the draft TIA response references an "unambiguous" description that the plant site will be subject to 0.1 g seismic accelerations, considering the site as sand dunes, and further indicates that 0.2 g seismic accelerations should be applied due to "geological and other considerations in the area." The draft TIA response further references Revision 21 of the NMC's Safety Analysis Report to demonstrate that NMC developed the seismic acceleration values considering the ground surface at the site as the reference point. However, the draft response does not address NMC's and NRC consultant's clear statements that the dunes would be removed prior to any construction of safety-related buildings and that the safety-related buildings would utilize the compact glacial deposits. Further, referenced analyzes clearly indicate that NMC performed calculations, and the NRC accepted these calculations, with the

seismic horizontal accelerations applied at the plant grade level, i.e. 590 feet, for the safety-related structures. It would not seem logical for NMC to propose, nor for the NRC to accept, a seismic design criteria at a location and elevation different from what NMC intended to evaluate in its calculations or intended to site the safety-related structures. While the concept that the Modified Mercalli Intensity (MMI) scale is based upon observed effects in buildings from a "ground" level perspective, it does not seem logically to follow that NMC or the NRC would propose, or accept, the design of these buildings without consideration of the underlying soil. The draft response does not address this issue though it is discussed in the referenced documents.

Question 2

During the initial licensing of the Palisades Nuclear Power Plant, did the NRC's safety evaluation of the applicant's design [SSE] seismic horizontal acceleration include consideration of ground motion amplification from the bedrock surface to the "ground surface" due to the type and thickness of the intervening soil between the bedrock and the "ground surface?"

Region III's Comments on NRR's draft response to Question 2:

The draft response should be expanded to address apparent inconsistencies between the draft response and the referenced materials. Specifically, the draft response indicates that the NRC only "qualitatively" considered the affects of soil overburden above the underlying bedrock; however, available NRC documentation clearly indicates that the NRC quantitatively considered the amplification impacts of soil overburden when considering what would be an appropriate seismic ground acceleration value. Specifically, the NRC stated that the seismic acceleration should be considered to be 0.15 g at the bedrock with an amplification factor of 1.25, producing a ground acceleration of 0.2 g. It should be noted, that at the time this information was transmitted to the licensee, the NRC staff was aware of the licensee's intention to remove the sand overburden and to site the safety-related structures on the compacted glacial till. The NRC was also aware of the seismic velocities for the overburden, excluding the sands, between the bedrock and the assumed plant grade at 590 feet. Therefore, the development of an amplification factor that included a 50 to 100 foot layer of loose sands, that were scheduled to be removed, would not appear consistent. In addition, though the draft response references the licensee's discussion of the relative seismic velocity in the different soil overburden layers and the licensee's contention that the only minimal amplification would be expected due to the overburden, this was not the NRC's perspective at the time. As a matter of fact, though the licensee proposed to use a 0.05 g horizontal seismic acceleration in its design efforts, the NRC required the licensee to use a value of 0.2 g which is consistent with the previous consideration of the amplification affects of the overburden. Amendment No. 7 to the licensee's application for a construction permit also indicates that the licensee and the NRC [AEC] will review the results of dynamic tests to confirm the soil amplification factors applied to the seismic design.

Finally, the available documentation clearly indicates that both the NRC and the licensee were aware from the beginning, that the overburden of sand would be removed, that an

amplification factor between the bedrock and the "ground" surface would need to be evaluated in order to establish an appropriate seismic horizontal acceleration, and that the point at which the licensee planned to and applied the seismic horizontal acceleration was at the 590 foot elevation. Therefore, our proffering an argument that amplification was only qualitatively considered and that the general site elevation was the "anchoring" point for the seismic analysis, based primarily on the description of how the MMI scale is defined, may require significant additional support.

Question 3

Does the NRC require, based upon the regulations in [Title 10 of the *Code of Federal Regulations* (10 CFR), Part 72] 10 CFR 72.212(b)(2)(i)(B) and 10 CFR 72.212(b)(3), a licensee to incorporate new information and technology into its assessment of the continued appropriateness and re-application of the previous reactor plant seismic siting and design criteria for the design and construction of an ISFSI pad?

Question 4

Does the NRC require a licensee to demonstrate that the seismic design of its spent fuel canisters remains appropriate, using pad-specific seismic data, if the calculated seismic horizontal acceleration level, using the reactor plant seismic data, is at the spent fuel canister seismic design limit and the pad-specific soil profile and elevation data would be expected to increase the calculated seismic horizontal acceleration?

3. NRR AND NMSS STAFF EVALUATIONS

NRR Response to Question 1 and Comment 1.a

These items ask what the NRC accepted as the horizontal acceleration for seismic evaluation during initial licensing of Palisades, and which surface this ground motion referred to. The staff's interpretation is that the horizontal acceleration referred to the SSE motion anchored at the free ground surface. The SSE was called the maximum credible earthquake at the time the NRC issued the initial license to Palisades. NMC determined the SSE to be 0.2 g (Peak Ground Acceleration) as described in the NRC's SER. The Lawrence Livermore National Laboratory's "US Nuclear Power Plant Database System," released in 1994, shows the SSE as 0.2 g. This indicates that the decision made during the initial licensing phase remained valid, since no surprising findings were identified in terms of fault and seismic activities during the initial construction period or during subsequent licensee activities. The decision process during the initial licensing phase, as well as the period of plant operation, as stipulated in Section 2.4 of Palisades Final Safety Analysis Report, Revision 21, confirms that the SSE was not changed. The staff also points out that the above definition of the SSE is consistent with Appendix A to 10 CFR Part 100, which states "The SSE for the site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface."

NRR Response to Comment 1.b

NRR staff reviewed the background information provided with the TIA. The above response captures this.

NRR Response to Comment 1.c

The NRR staff's view is that the information cited in the telephone record mentioned under "Additional Information" in the TIA does not reflect the staff's position.

NRR Response to Comment 1.c.1

Determining the SSE at the free ground surface does not conflict with NMC's intention to remove the sand dune materials during the initial licensing period. An SSE only provides the response spectrum aspect of the site characteristics. However, the sand dune materials, which usually have a relatively low shear wave velocity, would have greater potential for liquefaction during a strong seismic event based on observations from earthquake experience. Therefore, the sand dune materials should have been removed prior to the construction.

NRR Response to Comment 1.c.2

Regardless of whether NMC had used the glacial tills beneath the sand dune, or the sand dune materials with special compaction, as the supporting materials of the safety-related structures, either application would have had no relevance to the fact that the SSE was anchored at the ground surface. Ground acceleration at other elevation levels can be derived from the SSE as long as the specific soil profiles are known.

NRR Response to Comment 1.c.3

Page II-20 of the Preliminary Description and Safety Analysis Report (SAR), Volume 1, Consumers Power Company, dated June 2, 1966, concluded that the anticipated maximum earthquake intensity at Palisades is between VI and VII MMI and, therefore, the recommended surface acceleration value is 0.05 g. However, the SER, which reflected the staff's positions, was more conservative in determining the Operating Basis Earthquake (OBE) as 0.1 g, and the SSE as 0.2 g. Below is an excerpt from the NRC's SER on this issue:

> Our consultants, the U.S. Coast and Geodetic Survey of the Department of Commerce's Environmental Science Services Administration, has evaluated the seismicity of the site and indicated that the plant may be subjected to a ground acceleration of 0.1 g during its life time, and that an acceleration of 0.2 g should be considered as the maximum potential earthquake.

The SER did not explain why it changed the applicant's ground motion value from 0.05 g to 0.1 g, and did not elaborate on how to convert the MMI into a ground-acceleration value. The SSE would be used as an input in calculating ground accelerations at different foundation levels. As such, ground accelerations at elevations other than the free ground surface do not represent the SSE. However, they are derived from the SSE.

NRR Response to Comment 1.c.4

The NRR staff cannot determine with any specificity the nature of the analyses NMC conducted, or the aspects of NMC's calculation the NRR had reviewed in the past during the original licensing phase. The records available to Region III should provide the answer to this question.

NRR Response to Comment 1.d

The SSE was determined using the geologic and seismic information specific to Palisades during the initial licensing period. The SSE is fundamentally based on the MMI at the site. If there were no additional discoveries during the construction period, it is reasonable to conclude that the SSE was used as an input to the structural analysis and design calculations.

NRR Response to Comment 1.e

The original description in the Appendix of the NRC's SER is cited below:

> The Survey's seismicity information, based on the seismic history, is that during the lifetime of the reactor facility, the area will be subjected to MM Intensity VI with an acceleration of 0.1 g considering the site geology as sand dunes of 575' - 600'. In addition, due to considerations of other geological conditions and other factors in the area, we believe that a MM Intensity VII, with accelerations fo 0.2 g (sand dunes), might occur and should be considered as the maximum potential earthquake.

The above statement included the conclusion reached after the NRC contractor reviewed the applicant's safety analysis report. Even if it is not clear what "other geological conditions and other factors" are, it is clear that the SSE was defined at the ground surface, and it is 0.2 g.

NRR Response to Question 2 and Comment

The NRC's SER of the applicant's SSE did not elaborate upon the ground motion amplification at the site. The additional request refers to a telephone record between R. Maccary and H. Wahl, dated Dec 12, 1966, to discuss the issue of the amplification. It is a one-page phone record. The relevant statements from the phone record are as follows:

> For E' 0.15 g acceleration at bedrock with an amplification factor of 1.25, producing 0.2 g ground acceleration, the structure damping is 5 [percent]. These values are tentative to some degree.

Based on this telephone record, it is not apparent whether the glacial till, the Cold Water Shale, or the hard rocks beneath the Cold Water Shale were intended to represent the bedrock. Bedrock is a relative term. In general, if a rock unit is supporting the overlying, relatively-soft rock, this rock can be called "bedrock." In addition, where did the "0.15 g" come from? No official documents, other than this one-page phone record, ever used the ground motion value of 0.15 g. Even the NRC's SER, which postdated the phone record, did not use 0.15 g. This calculation was not recorded in the SAR or the NRC's SER. The NRR staff does not feel it is appropriate to use the telephone record to question the validity of information that is formally

documented in SAR or the NRC's SER. Besides, the calculation was not accurate as well, since 0.15 times 1.25 is not equal to 0.2, but 0.1875.

NMSS Response to Question 3

No, the regulations in 10 CFR 72.212(b)(2)(i)(B) and 10 CFR 72.212(b)(3) require a general licensee to perform written evaluations of the cask storage pads to establish that the cask seismic design parameters limits, as specified in the Certificate of Compliance (CoC), are met. These evaluations are based upon using the nuclear power plant's seismic siting and design criteria. The general licensee under Part 72 does not need to incorporate new seismological information and technology, such as probabilistic seismic hazard analysis or sensitivity analyses, into its assessment of the already existing nuclear power plant seismic siting and design criteria.

Specifically, 10 CFR 72.102(f)(1) states the following:

> For sites that have been evaluated under the criteria of Appendix A of 10 CFR Part 100, the [design earthquake] DE must be equivalent to the safe shutdown earthquake (SSE) for a nuclear power plant.

Similarly, 10 CFR 72.103(a)(2) states, in part, the following:

> For a site with a co-located nuclear power plant (NPP), the existing geological and seismological design criteria for the NPP may be used.

Thus, the regulations permit the general licensee flexibility to use the nuclear power plant's existing seismic siting and design criteria SSE for a co-located ISFSI where the NPP site has been evaluated under the criteria of Appendix A of 10 CFR Part 100.

NMSS Response to Question 4

Yes, 10 CFR 71.212(b)(2(i)(B) requires a general licensee to consider potential amplification of the free-field earthquake magnitudes through soil-structure interaction, in determining the response at the top of the cask pad for comparison with the limiting cask seismic design parameters in the CoC. This requires NMC to use the pad-specific soil profile and elevation data to determine the seismic horizontal acceleration at the top of the pad.

The Final Rule published in the *Federal Register* (V68, N179, 54147, Sept.16, 2003) changing 10 CFR 71.212(b)(2(i)(B) states the following:

> The revision will also require consideration of potential amplification of earthquakes through soil-structure interaction, and soil liquefaction potential or other soil instability due to vibratory ground motions. Depending on the properties of soil and structures, the free-field earthquake acceleration input loads may be amplified at the top of the storage pad. These amplified acceleration values must be bound by the design basis seismic acceleration values for the cask, specified in the [CoC].

The design earthquake to be used for this soil-structure interaction analysis, as discussed in response to Question 3, is the SSE specified in the NPP's seismic siting and design criteria.

4. CONCLUSION

Based on the SSE definition and the NRC's SER description on how to determine the SSE at the site, the staff concludes that the SSE at Palisades was anchored to the free ground surface. The removal of the sand dune materials does not conflict with the fact that the SSE is defined at the ground surface. The SSE of 0.2 g was determined at the initial licensing phase before any construction started, and it has not changed since there were no additional fault and seismic activities identified during the construction period or during the plant operation phase.

The general licensee under Part 72 does not need to incorporate new seismological information and technology, such as, probabilistic seismic hazard analysis or sensitivity analyses, into its assessment of the already existing NPP seismic siting and design criteria.

Title 10 of the *Code of Federal Regulations* (10 CFR) 71.212(b)(2(i)(B) requires a general licensee to consider potential amplification of the free-field earthquake magnitudes through soil-structure interaction, in determining the response at the top of the cask pad for comparison with the limiting cask seismic design parameters in the CoC.

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