November 29, 2005

Mr. Paul A. Harden
Site Vice President
Nuclear Management Company, LLC
Palisades Nuclear Plant
27780 Blue Star Memorial Highway
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SUBJECT: PALISADES NUCLEAR PLANT — REQUEST FOR AUTHORIZATION TO EXTEND THE THIRD INSERVICE INSPECTION INTERVAL FOR REACTOR VESSEL WELD EXAMINATION (TAC NO. MC6547)

Dear Mr. Harden:

Nuclear Management Company, LLC's (NMC's) letter of March 31, as supplemented October 11, 2005, submitted a request for authorization to extend the third 10-year inservice inspection (ISI) interval for reactor vessel weld examinations. Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(i), NMC requested approval to use an alternative to the requirements of the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code*, Section XI, Paragraph IWB-2412, "Inspection Program B," for the Palisades Nuclear Plant.

The staff has completed its review of NMC's request, and concludes that the proposed alternative is justified on the basis that it would provide an acceptable level of quality and safety. Therefore, the staff authorizes the proposed alternative pursuant to 10 CFR 50.55a(a)(3)(i) for the third 10-year ISI interval at Palisades. The proposed alternative is authorized until the end of the fall 2007 refueling outage. Enclosed is our safety evaluation.

Sincerely,

/RA/

L. Raghavan, Chief
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-255

Enclosure: Safety Evaluation

cc w/encl: See next page

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Palisades Plant

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR AUTHORIZATION TO EXTEND THE THIRD

AMERICAN SOCIETY OF MECHANICAL ENGINEERS CODE, SECTION XI

10-YEAR INTERVAL FOR REACTOR VESSEL WELD EXAMINATION

NUCLEAR MANAGEMENT COMPANY, LLC

PALISADES NUCLEAR PLANT

DOCKET NO. 50-255

1.0 INTRODUCTION

The Nuclear Management Company, LLC's (NMC's), letter of March 31, as supplemented October 11, 2005, submitted a request for authorization to extend the inspection interval for performing reactor vessel (RV) weld examinations beyond the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code) allowable timeframe. The RV weld inservice inspection (ISI) consists of ultrasonic examinations intended to discover flaws or other discontinuities. Periodic examination is performed to determine whether flaws have initiated, whether pre-existing flaws have extended, or whether pre-existing flaws that may have been missed using older nondestructive examination technology are discernable using more advanced technology. The examinations must be performed at least once during every ISI program interval, as defined in Section XI of the ASME Code.

2.0 REGULATORY EVALUATION

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50.55a, requires licensees to perform periodic inspections of components. Section 10 CFR 50.55a(g) requires licensees to perform surveillance testing in accordance with ASME Code, Section XI, requirements. The code of record for Palisades for the third 10-year ISI interval, which began on May 12, 1995, is the 1989 Edition. Subsection IWA-2430(a) of this edition of the ASME Code states "The inservice examinations and system pressure tests required by IWB, IWC, IWD, and IWE shall be completed during each of the inspection intervals for the service lifetime of the power unit. The inspections shall be performed in accordance with the schedules of Inspection Program A of IWA-2431, or optionally Inspection Program B of IWA-2432." Palisades is using Inspection Program B.

IWA-2430(d) states, "For components inspected under Program B, each of the inspection intervals may be extended or decreased by as much as 1 year. Adjustments shall not cause successive intervals to be altered by more than 1 year from the original pattern of the intervals." NMC has taken advantage of this paragraph for an extension of 1 year. IWA-2430 (e) states " . . . for power units that are out of service continuously for 6 months or more, the inspection interval during which the outage occurred may be extended for a period equivalent to the

outage and the original pattern of intervals extended accordingly for successive intervals." NMC has taken advantage of this paragraph for a 215-day extension due to an extended maintenance outage in 2001. As a result of these ASME Code-allowed extensions, the third inspection interval currently ends on December 12, 2006.

Section 10 CFR 50.55a(a)(3)(i) states, in part, that the Director of the Office of Nuclear Reactor Regulation (NRR) may authorize alternatives to the requirements of paragraph 10 CFR 50.55a(g). In order for the Director of NRR to authorize an alternative in accordance with 10 CFR 50.55(a)(3)(i), the licensee must demonstrate that the proposed alternative provides an acceptable level of quality and safety.

NMC proposes to extend the third ISI interval for Palisades' RV weld examinations for one refueling cycle beyond the 11 years, 215 days permitted by the ASME Code and not perform the examinations during Palisades' spring 2006 refueling outage. Palisades' refueling cycles last approximately 18 months, but outage scheduling is such that the authorization is requested through the end of the fall 2007 refueling outage. This request does not affect the inspection requirements of the Palisades fourth 10-year ISI interval which begins on December 13, 2005.

3.0 TECHNICAL EVALUATION

3.1 Systems/Components for Which Relief Is Requested

The affected component is the Palisades Nuclear Plant RV. The ASME Code, Section XI, examination categories, and item numbers shown in the table below, pertain to the RV.

Examination Category	Item Number	Description
B-A	B1.11	Circumferential Shell Weld
B-A	B1.12	Longitudinal Shell Welds
B-A	B1.21	Circumferential Head Weld
B-A	B1.22	Meridional Head Weld
B-A	B1.30	Shell-to-Flange Weld
B-D	B3.90	Nozzle-to-Vessel Welds
B-J	B9.11	Circumferential Welds in Piping [only for the RV inlet and outlet nozzle to piping welds]

These examination categories and item numbers are from IWB-2500 and Table IWB-2500-1 of the ASME Code, Section XI, and were provided by NMC as part of its submittal. The B-J category welds are currently included in the risk-informed ISI program as defense-in-depth exams under the augmented inspection program. For the B-J category welds, proposed alternatives can be authorized only for the RV inlet and outlet nozzle-to-pipe welds.

3.2 Basis for Relief

NMC provided a qualitative assessment of the risk of RV failure. The assessment included the following:

- Description of previous, plant-specific RV ISI history.
- Description of fleet-wide RV ISI history.
- Discussion of degradation mechanisms that are known or expected to apply to the locations that are the subject of the proposed alternative.
- Discussion regarding the material condition of the welds (including a discussion about neutron embrittlement).
- Review of events that could challenge hypothetical flaws or discontinuities in the welds.

NMC said it examined the Category B-A, B-D and B-J welds twice previously. Those examinations achieved acceptable coverage, and no indications were found. NMC concluded that examinations were of sufficient quality to detect any significant flaws that would challenge RV integrity.

NMC described results of ISI examinations at 14 plants representing 301 total years of service, including plants fabricated by various vendors. No reportable indications were discovered at that group of plants. NMC noted in its March 31, 2005, submittal that studies by Pacific Northwest National Laboratory (PNNL) indicate that surface-breaking flaws are unlikely to extend through multiple layers of cladding. The Palisades RV is constructed with multi-pass welding and, therefore, has a low probability of containing through-cladding, surface-breaking flaws. Finally, NMC noted that all pressurized-water reactor (PWR) plants, except one, have performed at least one ISI, including the subject examinations, and that no surface-breaking, or near-surface flaws, of any significance have been found.

NMC identified fatigue as the only operable degradation mechanism for these welds, indicated the fatigue usage factor is very low, and identified the cooldown transient as the most challenging loading sequence. Since approximately only one additional cooldown transient is anticipated during the extension period, NMC concluded that any hypothetical fatigue crack growth would be inherently small.

NMC noted that the Palisades RV weld material is below, and will remain below, the pressurized thermal shock (PTS) screening criteria (according to 10 CFR 50.61) during the extension period. NMC indicated that its operating procedures, low-leakage cores, and heating of the safety injection water provide additional margin with respect to PTS beyond the margin assumed in the analyses used to develop 10 CFR 50.61.

NMC indicated that from a loading perspective, the most severe operational challenge to RV integrity is due to PTS events. Combining the low probability of a PTS event with the low probability of a flaw existing in the RV, NMC concluded that the probability of RV failure due to PTS is very small. NMC also noted that no Alloy 600, 82 or 182 materials are present in any of

these welds, or adjacent base materials, addressed by the subject request for an alternative.

3.3 Staff Evaluation

ISI of RV welds helps to ensure structural integrity by identifying flaw growth before flaws become large enough to represent challenges to pressure-boundary integrity. NMC summarized prior examinations performed on the RV welds. All of the subject welds have been examined, and no indications have been found. Although ultrasonic examination technology has improved over the past decades, the geometry and materials involved in RV weld examinations are such that these exams have not been particularly challenging from an inspection-technology perspective. Therefore, the staff agrees with NMC's qualitative assessment that the prior examinations were of sufficient quality to identify any significant flaws that would challenge RV integrity.

NMC discussed the population of all PWRs, and indicated that no surface-breaking flaws have been discovered and, for a population of 14 plants that were reviewed in detail, no reportable indications were identified in any of the RV welds. NMC also noted that NUREG/CR-6471, "Characterization of Flaws in U.S. Reactor Pressure Vessels," provides an estimate of the most likely flaw distribution for RV welds, and large flaws are not generally expected. The staff concludes that the fleet ISI experience, and the ISI experience specific to Palisades, are consistent with the PNNL evaluations in that no significant flaws are expected. Furthermore, the staff agrees the two-layer cladding process used during fabrication of the Palisades RV, results in a low probability that a surface-breaking flaw could extend through the cladding to either the manganese-molybdenum RV plate or weld material.

NMC indicated that fatigue is the only operative mechanism that could have caused flaws to either initiate or grow in the welds during the period since the previous inspection. The staff concludes that corrosion, stress corrosion cracking, and other forms of degradation due to the materials interaction with its chemical environment are not active degradation mechanisms for the RV welds. This is because the RV plates and welds are separated from the reactor coolant by a layer of corrosion resistant cladding. Even if the cladding was breached (for example due to an original fabrication flaw), the coolant water chemistry is controlled such that oxygen and other aggressive contaminants are maintained at very low levels so that the coolant is not aggressive to the ferritic material. Furthermore, the welds have not been subjected to a history of abnormal-operation loading events, so mechanical overload has not been an active flaw-initiation or propagation mechanism. Therefore, the staff agrees with the conclusion that fatigue is the only likely operative mechanism that could have created or propagated flaws since the date the previous ISI examinations were performed.

NMC said that the usage factor for these welds will be much lower than 1.0 after 40 projected years of operation, and that the most severe fatigue transient would be the cooldown. The staff agrees that any flaw growth due to normal operational transients during the period since the last ISI examination would be likely to be very minimal.

NMC provided the unirradiated nil-ductility transition reference temperature ($RT_{NDT(u)}$) values for each of the RV beltline materials, and provided the PTS reference temperature (RT_{PTS}) values to permit assessment of the effects of neutron irradiation. NMC noted that the RT_{PTS} value for each RV material will remain below the screening criteria of 10 CFR 50.61 (270 degrees F) for the remaining period of its original license. The NRC staff had previously reviewed and

approved these calculations as part of its review of Palisades' response to Generic Letter 92-01, “Reactor Vessel Structural Integrity.” Since the materials will remain below the screening criteria, the probability of brittle fracture is acceptably low. The analyses that supported the development of 10 CFR 50.61 included assumptions about the size, number, and distribution of hypothetical flaws that bound the sizes, number, and distribution identified by Palisades during their previous ISI examinations of the RV welds (no reportable flaws). Therefore, the staff concludes that complying with 10 CFR 50.61 is sufficient to demonstrate that the probability of RV failure due to PTS is adequately low.

The PTS risk associated with operation during any time interval is the product of the likelihood that a significant flaw exists and the likelihood that a PTS event occurs during the interval which would challenge the flaw. An increased risk associated with the requested extension arises from the potential existence of a significant flaw that would have been detected and repaired during the inspection at the end of the original interval. With an extended interval, this flaw would continue to be vulnerable to a severe PTS event during the period the inspection interval is extended. Instead of attempting to estimate this increased risk, NMC argues that the likelihood of a severe PTS event during the next operating cycle, which could challenge the integrity of the RPV if a significant flaw exists, is very low.

NMC characterized Palisades’ response to three scenarios (developed by the NRC staff during its PTS risk reevaluation work) that are believed to be the most likely scenarios that could cause a PTS event that would challenge significant flaws in the RV welds. The three scenarios are initiated by the following infrequent events:

- excessive loss of main steam caused by an unisolable failure of the main steam boundary
- simultaneous failure of two, or more, pressurizer safety-relief valves to properly operate
- a relatively-large failure of the pressure-retaining reactor coolant system (RCS) boundary in some specific locations

NMC discussed the operating procedures at Palisades that the operators would use to identify and mitigate the severity of a PTS event following either of the first two initiating events. However, the third initiating event, RCS boundary rupture, provides no opportunity for operator intervention following the initiating event. NMC discussed an operating procedure that gives guidance on the preferred water temperature of the source of safety injection water. This procedure minimizes the likelihood that cold safety-injection water would be injected into the RCS following a pressure boundary rupture. Injection of relatively warm water will mitigate the severity of the PTS event. The staff concurs that the likelihood of any of these initiating events occurring during the extension period is low. Furthermore, existing plant procedures can mitigate the severity of the PTS event that would be caused by these initiating events.

In summary, the staff has reviewed NMC’s evaluation and makes the following conclusions:

- Previous RV ISI results were of sufficient quality to provide useful results.
- Previous ISI examinations did not identify any reportable indications, or any indications requiring monitoring.

- The RV welds are not subjected to stresses or corrosive conditions that would create new flaws, or cause old flaws to grow.

- Industry experience with ISI examinations of similar welds has yielded similar results — there are no known significant RV flaws.

- The most severe degradation mode that is expected to be operative is fatigue, and the most severe operational event with respect to fatigue is cooldown, which is an infrequent evolution. Therefore, growth of flaws due to fatigue would be minimal during the period since the previous ISI examination and would be very small during the proposed extension period.

- The RV material has sufficient toughness to be acceptable with respect to PTS, as determined by NMC's compliance with the requirements of 10 CFR 50.61.

- The likelihood of a severe PTS event occurring during the proposed extension period is low.

Accordingly, the staff concurs with NMC's qualitative assessment that the Palisades' RV welds have a low likelihood of having significant flaws, and that there is a low likelihood of experiencing a severe PTS event during the proposed extension period. The staff finds that the risk associated with the one-cycle extension of the examination interval is sufficiently small that it need not be quantified to support the conclusion that this alternative continues to provide an acceptable level of quality and safety. Operation of the RV for an additional cycle, without performing the ISI examination of the subject welds, would not significantly increase the risk of flaw growth due to fatigue or to RV failure due to PTS.

4.0 CONCLUSION

Based on the above evaluation, the NRC staff concludes that NMC's proposed alternative provides reasonable assurance of an adequate level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the NRC staff authorizes the extension of the third 10-year ISI interval until the end of the fall 2007 refueling outage to complete the Palisades RV examinations. All other requirements of the ASME Code for which relief has not been specifically requested remain applicable including third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributors: R Hardies, S. Dinsmore

Date: November 29, 2005