July 24, 2002

Mr. Jeffrey S. Forbes
Site Vice President
Monticello Nuclear Generating Plant
Nuclear Management Company, LLC
2807 West County Road 75
Monticello, MN 55362-9637

SUBJECT: MONTICELLO NUCLEAR GENERATING PLANT - RISK-INFORMED INSERVICE INSPECTION PROGRAM (TAC NO. MB3819)

Dear Mr. Forbes:

By letter dated December 18, 2001, Nuclear Management Company, LLC (NMC), the licensee for the Monticello Nuclear Generating Plant, requested approval of an alternative risk-informed inservice inspection (RI-ISI) program for Monticello Inservice Inspection (ISI) Program for certain American Society of Mechanical Engineers (ASME) Code Class 1 and 2 piping welds.

The Monticello RI-ISI program was developed in accordance with Electric Power Research Institute (EPRI) Topical Report TR-112657, Revision B-A, using the Nuclear Energy Institute's template methodology. The results of the Nuclear Regulatory Commission (NRC) staff's review indicate that NMC's proposed RI-ISI program is an acceptable alternative to the ISI requirements of the ASME Code, Section XI, and therefore, NMC's request for relief is authorized pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that the alternative provides an acceptable level of quality and safety.

The enclosed safety evaluation authorizes application of the proposed RI-ISI program during the fourth 10-year ISI interval for Monticello.

Sincerely,

/RA/

Samuel Miranda, Project Manager, Section 1
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-263

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RISK-INFORMED INSERVICE INSPECTION PROGRAM

NUCLEAR MANAGEMENT COMPANY, LLC

MONTICELLO NUCLEAR GENERATING PLANT

DOCKET NO. 50-263

1.0 INTRODUCTION

By letter dated December 18, 2001 (Reference 1), the Nuclear Management Company, LLC (the licensee), proposed a risk-informed inservice inspection (RI-ISI) program as an alternative to a portion of their current Inservice Inspection (ISI) Program for the Monticello Nuclear Generating Plant. The scope of the RI-ISI program is limited to the American Society of Mechanical Engineers (ASME) Code Class 1 and 2 piping (Categories B-F, B-J, C-F-1, and C-F-2 welds) only.

The licensee's RI-ISI program was developed in accordance with the methodology contained in the Electric Power Research Institute's (EPRI's) report EPRI TR-112657, Rev. B-A (Reference 2), which was previously reviewed and approved by the Nuclear Regulatory Commission (NRC) staff. The RI-ISI program proposed by the licensee is an alternative pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(i). The licensee is requesting the alternative for the fourth 10-year ISI interval at Monticello.

2.0 BACKGROUND

2.1 Applicable Requirements

The Commission's regulation at 10 CFR 50.55a(g) requires that ISI of the ASME Code Class 1, 2, and 3 components be performed in accordance with Section XI of the ASME *Boiler and Pressure Vessel Code*, "Rules for Inservice Inspection of Nuclear Power Plant Components" (hereinafter called Code), and applicable addenda, except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). The regulation at 10 CFR 50.55a(a)(3) states, in part, that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee demonstrates that the proposed alternatives would provide an acceptable level of quality and safety, or if the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements set forth in the Code, to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that ISI of components conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of the Code, incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. Monticello starts its fourth 10-year ISI interval on June 1, 2002. The applicable edition of the ASME Code, Section XI, for the fourth 10-year ISI interval at Monticello is the 1995 edition through the 1996 addenda.

2.2 Summary of Proposed Approach

The licensee has proposed to use an RI-ISI program for ASME Code Class 1 and 2 piping (Examination Categories B-F, B-J, C-F-1, and C-F-2 welds), as an alternative to the ASME Code, Section XI, requirements. The Code requires in part that for each successive 10-year ISI interval, 100 percent of Category B-F welds and 25 percent of Category B-J welds for the Code Class 1 non-exempt piping be selected for volumetric and/or surface examination based on existing stress analyses and cumulative usage factors. For Category C-F welds, 7.5 percent of non-exempt welds are selected for volumetric and/or surface examination. The licensee's proposed alternative follows the NRC-approved RI-ISI process and methodology delineated in EPRI TR-112657, Rev. B-A. By assessing piping failure potential and piping failure consequences, and performing probabilistic risk assessment (PRA) and safety significance ranking of piping segments, the number of inspection locations is significantly reduced. However, the program retains the fundamental requirements of the Code, such as inspection methods, acceptance guidelines, pressure testing, corrective measures, documentation requirements, and quality control requirements. Thus, ISI program requirements of other non-related portions of the ASME Code, Section XI, are unaffected.

The licensee stated that the augmented ISI program for flow accelerated corrosion (FAC) implemented in response to NRC Bulletin 89-08, "Erosion/Corrosion - Induced Pipe Wall Thinning," is not changed by the RI-ISI program. Other remaining augmented ISI programs are either unaffected or modified in accordance with the guidance of the EPRI report.

It is most desirable that the implementation of an RI-ISI program for piping be initiated at the start of a plant's 10-year ISI interval consistent with the requirements of the ASME Code and addenda committed to by the licensee in accordance with 10 CFR 50.55a. However, the implementation may begin at any point in an existing interval as long as the examinations are scheduled and distributed consistent with the ASME Code requirements (e.g., the minimum examinations completed at the end of the three inspection periods under ASME Code, Section XI, Inspection Program B should be 16 percent, 50 percent, and 100 percent, respectively, and the maximum examinations credited at the end of the respective periods should be 34 percent, 67 percent, and 100 percent).

It is also the NRC staff's view that the inspections for the RI-ISI program and for the balance of the ISI program should be on the same interval start and end dates. This can be accomplished by either implementing the RI-ISI program at the beginning of the interval or merging the RI-ISI program into the ISI program for the balance of the inspections if the RI-ISI program is to begin during an existing ISI interval. One reason for this view is that it eliminates the problem of having different Codes of record for the RI-ISI program and for the balance of the ISI program.

A potential problem with using two different interval start dates and hence two different Codes of record would be having two sets of repair/replacement rules depending upon which program identified the need for repair (e.g., a weld inspection versus a pressure test).

The licensee has planned for complete implementation of the RI-ISI program concurrent with the start of the fourth ISI interval, which will begin on June 1, 2002.

3.0 EVALUATION

Pursuant to 10 CFR 50.55a(a)(3), the NRC staff has reviewed and evaluated the licensee's proposed RI-ISI program, including those portions related to the applicable methodology and processes contained in Reference 2, based on guidance and acceptance criteria provided in Regulatory Guides (RGs) 1.174 (Reference 3) and 1.178 (Reference 4) and in Standard Review Plan (SRP) Chapter 3.9.8 (Reference 5).

3.1 Proposed Changes to the ISI Program

The scope of the licensee's proposed RI-ISI program is limited to ASME Code Class 1 and Class 2 piping welds for the following Examination Categories: B-F for pressure retaining dissimilar metal welds in vessel nozzles, B-J for pressure-retaining welds in piping, C-F-1 for pressure-retaining welds in austenitic stainless steel or high alloy piping, and C-F-2 for pressure-retaining welds in carbon or low alloy steel piping. The RI-ISI program is proposed as an alternative to the existing ISI requirements of the ASME Code, Section XI. A general description of the proposed changes to the ISI program is provided in Sections 3 and 5 of the licensee's submittal.

During the course of its review, the NRC staff determined that the proposed RI-ISI program is consistent with the guidelines contained in EPRI TR-112657, which state that industry and plant-specific piping failure information, if any, is to be utilized to identify piping degradation mechanisms and failure modes, and consequence evaluations are to be performed using probabilistic risk assessments to establish piping segment safety ranking for determining new inspection locations. Thus, the NRC staff concludes that the licensee's application of the EPRI TR-112657 approach is an acceptable alternative to the current Monticello piping ISI requirements with regard to the number, locations, and methods of inspections, and provides an acceptable level of quality and safety pursuant to 10 CFR 50.55a(a)(3).

System pressure tests and visual examination of piping structural elements will continue to be performed on all Class 1, 2, and 3 systems in accordance with the ASME Code, Section XI, program. The RI-ISI program applies the same performance measurement strategies as existing ASME Code requirements and, in addition, increases the inspection volumes at weld locations that are exposed to thermal fatigue.

3.2 Engineering Analysis

In accordance with the guidance provided in RGs 1.174 and 1.178, an engineering analysis of the proposed changes is required using a combination of traditional engineering analyses and supporting insights from the PRA. The licensee elaborated as to how the engineering analyses conducted for the Monticello RI-ISI program ensure that the proposed changes are consistent with the principles of defense-in-depth and that adequate safety margins will be maintained.

This is accomplished by evaluating a location's susceptibility to a particular degradation mechanism and then performing an independent assessment of the consequence of a failure at that location.

The licensee's RI-ISI program at Monticello is limited to ASME Code Class 1 and 2 piping welds. The licensee stated in its submittal that other non-related portions of the ASME Code will be unaffected by this program. Piping systems defined by the scope of the RI-ISI program were divided into piping segments. Pipe segments are defined as lengths of pipe whose failure leads to similar consequences and are exposed to the same degradation mechanisms. That is, some lengths of pipe whose failure would lead to the same consequences may be split into two or more segments when two or more regions are exposed to different degradation mechanisms.

The submittal states that failure potential categories were generated utilizing industry failure history, plant-specific failure history, and other relevant information using the guidance provided in EPRI TR-112657. The degradation mechanisms identified in the submittal include thermal fatigue including thermal stratification, cycling and striping (TASCS) and thermal transients (TT), intergranular stress corrosion cracking (IGSCC), and flow accelerated corrosion (FAC). The licensee stated in Section 2.2 of its submittal that the augmented inspection program for FAC is relied upon to manage this mechanism and is not changed by the RI-ISI program.

Section 3 of the submittal (Ref. 1) describes a deviation to the EPRI RI-ISI methodology for assessing the potential for TASCS that was implemented by the licensee for Monticello. The methodology for assessing TASCS in the Monticello RI-ISI submittal is the same as the Materials Reliability Project (MRP) methodology in EPRI TR-1000701, "Interim Thermal Fatigue Management Guideline (MRP-24)," January 2001. The staff reviewed the licensee's methodology and screening criteria. The licensee has provided additional considerations for determining the potential for TASCS. These considerations include piping configuration and potential turbulence, low flow conditions, valve leakage, and heat transfer due to convection. The staff finds these considerations to be appropriate for determining the potential for TASCS. The licensee further stated that it will update the RI-ISI program based on the final EPRI MRP guidance as warranted.

3.3 Probabilistic Risk Assessment

The Monticello Individual Plant Examination (IPE) was submitted in February 1992. The IPE identified a core damage frequency (CDF) of 2.6E-5/year. The staff evaluation report (SER) of the IPE, dated May 26, 1994, concluded that the Monticello IPE satisfied the intent of Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities." Additionally, the NRC staff's SER did not report any significant weaknesses in the review of the Monticello IPE. The licensee updated the PRA in 1994, 1995, and 1999. A Boiling Water Owners Group PSA Peer Certification Review was performed on the 1995 Monticello PRA model and found that the PRA can be effectively used to support applications involving relative risk significance. The 1999 update incorporated the effects of power uprate conditions. As stated in its submittal, the licensee used the January 1999 update of the Level 1 and Level 2 PRA to evaluate the consequences of pipe rupture for the RI-ISI assessment. The CDF based on the January 1999 Monticello PRA is 1.5E-5/year and the large early release frequency (LERF) is 5.5E-7/year.

The NRC staff did not review the IPE analysis to assess the accuracy of the quantitative estimates. The NRC staff recognizes that the quantitative results of the IPE are used as order-of-magnitude estimates for several risk and reliability parameters used to support the assignment of segments into three broad consequence categories. Inaccuracies in the models or in assumptions large enough to invalidate the broad categorizations developed to support the RI-ISI should have been identified during the NRC staff's review of the IPE and by the licensee's model update control program. Minor errors or inappropriate assumptions will affect only the consequence categorization of a few segments and will not invalidate the general results or conclusions. The NRC staff finds the quality of the licensee's PRA sufficient to support the proposed RI-ISI program.

The degradation category and the consequence category were combined according to the approved methodology described in EPRI TR-112657 to categorize the risk significance of each segment. The risk significance of each segment is used to determine the number of weld inspections required in each segment.

As required by Section 3.7 of EPRI TR-112657, the licensee evaluated the change in risk expected from replacing the current ISI program with the RI-ISI program. The calculations estimated the change in risk due to removing locations and adding locations to the inspection program. The expected change in risk was quantitatively evaluated using the "Simplified Risk Quantification Method" described in Section 3.7 of EPRI TR-112657. For high consequence category segments, the licensee used the conditional core damage probability (CCDP) and conditional large early release probability (CLERP) based on the highest estimated CCDP and CLERP. For medium consequence category segments, bounding estimates of CCDP and CLERP were used. The licensee estimated the change in risk using bounding pipe failure rates from the EPRI methodology.

The licensee performed their bounding analysis with and without taking credit for an increased probability of detection (POD). In its submittal, the licensee estimated the aggregate change in CDF to be about 1.36E-8/yr and estimated the aggregate change in LERF to be about 1.36E-8/yr, excluding credit for any increased probability of detection (POD) due to the use of improved inspection techniques. Including the expected increased POD results in an aggregate estimated change in CDF of -7.4E-9/yr and aggregate estimated change in LERF of -7.3E-9/yr. The CDF and LERF values are essentially the same because the highest maximum CCDP and CLERP are the same value (9E-3) and the change in risk is dominated by the high consequence segments. CLERP requires failure or bypass of the containment in addition to a core damage event and is normally smaller than CCDP.

The NRC staff finds the licensee's process to evaluate and bound the potential change in risk reasonable because it accounts for the change in the number and location of elements inspected, recognizes the difference in degradation mechanism related to failure likelihood, and considers the effects of enhanced inspection. System level and aggregate estimates of the changes in CDF and LERF are less than the corresponding guideline values in EPRI TR-112657. The NRC staff finds that redistributing the welds to be inspected with consideration of the safety-significance of the segments provides assurance that segments whose failure could have a significant impact on plant risk receive an acceptable and often improved level of inspection. Therefore, the NRC staff concludes that the implementation of the RI-ISI program as described in the licensee's submittal will have a small impact on risk consistent with the guidelines of RG 1.174.

3.4 Integrated Decisionmaking

As described in the licensee's submittal, an integrated approach is utilized in defining the proposed RI-ISI program by considering in concert the traditional engineering analysis, risk evaluation, and the implementation and performance monitoring of piping under the program. This is consistent with the guidelines of RG 1.178.

The selection of pipe segments to be inspected using the results of the risk category rankings and other operational considerations is described in Section 3.5 of the licensee's submittal. Table 3.5 of the submittal provides the number of locations and inspections by risk category for the various Monticello systems. Table 5-2 provides a comparison of the number of inspections required under the existing ASME Code, Section XI, ISI program with the alternative RI-ISI program for Monticello. The risk impact analysis results for each system are provided in Table 3.6-1. The licensee used the methodology described in EPRI TR-112657 to guide the selection of examination elements within high- and medium-risk-ranked piping segments. The methodology described in EPRI TR-112657 requires that existing augmented programs, other than thermal fatigue and IGSCC Category A piping welds which the RI-ISI program subsumes, be maintained. The EPRI report describes targeted examination volumes (typically associated with welds) and methods of examination based on the type(s) of degradation expected. The NRC staff has reviewed these guidelines and has determined that, if implemented as described, the RI-ISI examinations should result in improved detection of service-related degradations over those currently required by ASME Code, Section XI.

The NRC staff finds that the location selection process is acceptable since it is consistent with the process approved for EPRI TR-112657, takes into account defense-in-depth, and includes coverage of systems subjected to degradation mechanisms in addition to those covered by augmented inspection programs.

The objective of the ISIs required by ASME Code, Section XI, is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary that may impact plant safety. Therefore, the RI-ISI program should meet this objective if found to be acceptable for use. Further, since the risk-informed program is based on inspection for cause, element selection should target specific degradation mechanisms. Chapter 4 of EPRI TR-112657 provides guidelines for the areas and/or volumes to be inspected, as well as the examination method, acceptance standard, and evaluation standard for each degradation mechanism. Based on review of the cited portion of the EPRI report, the NRC staff concludes that the examination methods for the proposed RI-ISI program are appropriate since they are selected based on specific degradation mechanisms, pipe sizes, and materials of concern.

3.5 Implementation and Monitoring

Implementation and performance monitoring strategies require careful consideration by the licensee and are addressed in Element 3 of RG 1.178 and SRP 3.9.8. The objective of Element 3 is to assess the performance of the affected piping systems under the proposed RI-ISI program by implementing monitoring strategies that confirm the assumptions and analyses used in the development of the RI-ISI program. To approve an alternative pursuant to 10 CFR 50.55a(a)(3)(i), implementation of the RI-ISI program, including inspection scope, examination methods, and methods of evaluation of examination results, must provide an adequate level of quality and safety.

The licensee stated that upon approval of the RI-ISI program, procedures that comply with the EPRI TR-112657 guidelines will be prepared to implement and monitor the RI-ISI program. The licensee confirmed that the applicable portions of the ASME Code, such as inspection methods, acceptance guidelines, pressure testing, corrective measures, documentation requirements, and quality control requirements would be retained.

The licensee stated in Section 4 of its submittal that the RI-ISI program is a living program and its implementation will require feedback of new relevant information to ensure the appropriate identification of safety significant piping locations. The submittal also states that, as a minimum, risk ranking of piping segments will be reviewed and adjusted on an ASME period basis and that significant changes may require more frequent adjustment as directed by NRC bulletin or generic letter requirements, or by industry and plant-specific feedback.

The licensee’s submittal presented the criteria for engineering evaluations and additional examinations if unacceptable flaws or relevant conditions are found during examinations. The submittal stated that the evaluation will include whether other elements in the segment or segments are subject to the same root cause conditions. Furthermore, additional examinations will be performed on these elements up to a number equivalent to the number of elements required to be inspected on the segment or segments scheduled for the current outage. The licensee also stated that elements selected for additional examinations will be selected based on the root cause or damage mechanism and will include high risk significant as well as medium risk significant elements (if needed) to reach the required number of additional elements.

The proposed periodic reporting requirements meet existing ASME Code requirements and applicable regulations and, therefore, are considered acceptable. The NRC staff finds that the proposed process for the RI-ISI program updates meets the guidelines of RG 1.174 which provide that risk-informed applications should include performance monitoring and feedback provisions; therefore, the licensee’s proposed process for program updates is acceptable.

4.0 CONCLUSION

In accordance with 10 CFR 50.55a(a)(3)(i), proposed alternatives to regulatory requirements may be used when authorized by the NRC when the applicant demonstrates that the alternative provides an acceptable level of quality and safety. In this case, the licensee's proposed alternative is to use the risk-informed process described in the NRC-approved EPRI TR-112657. As discussed in Section 3.0 of this safety evaluation, the NRC staff concludes that the licensee’s proposed RI-ISI program, as described in its submittal, will provide an acceptable level of quality and safety pursuant to 10 CFR 50.55a with regard to the number of inspections, locations of inspections, and methods of inspections.

The NRC staff finds that the results of the different elements of the engineering analysis are considered in an integrated decisionmaking process. The impact of the proposed change in the ISI program is founded on the adequacy of the engineering analysis and acceptable change in plant risk in accordance with RG 1.174 and 1.178 guidelines.

The Monticello methodology also considers implementation and performance monitoring strategies. Inspection strategies ensure that failure mechanisms of concern have been addressed and there is adequate assurance of detecting damage before structural integrity is affected. The risk significance of piping segments is taken into account in defining the inspection scope for the RI-ISI program.

The Monticello methodology provides for conducting an engineering analysis of the proposed changes using a combination of engineering analysis with supporting insights from a PRA. Defense-in-depth and quality are not degraded in that the methodology provides reasonable confidence that any reduction in existing inspections will not lead to degraded piping performance when compared to existing performance levels. Inspections are focused on locations with active degradation mechanisms as well as selected locations that monitor the performance of system piping. As discussed in Section 3.2 above, the staff reviewed the screening criteria for assessing the susceptibility of piping to TASCS. The NRC staff finds these criteria consistent with the interim thermal fatigue management guidelines described in EPRI Report 1000701. The licensee stated it will update the RI-ISI program based on the final EPRI MRP guidance as warranted.

Based on its review of the licensee's proposed RI-ISI program, the NRC staff concludes that the program is an acceptable alternative to the current ISI program, which is based on ASME Code, Section XI, requirements for Class 1 and Class 2 welds. Therefore, the licensee's request for relief is authorized pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that the request provides an acceptable level of quality and safety. This safety evaluation authorizes application of the proposed RI-ISI program for the fourth 10-year ISI interval for Monticello.

5.0 REFERENCES

1. Letter from Jeffrey S. Forbes, NMC, to NRC (containing *Risk-Informed Inservice Inspection Program Plan Monticello Nuclear Generating Plant*), dated December 18, 2001.

2. EPRI TR-112657, Revision B-A, *Revised Risk-Informed Inservice Inspection Evaluation Procedure*, January 2000.

3. NRC Regulatory Guide 1.174, *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*, July 1998.

4. NRC Regulatory Guide 1.178, *An Approach for Plant-Specific Risk-Informed Decision Making: Inservice Inspection of Piping*, September 1998.

5. NRC NUREG-0800, Chapter 3.9.8, *Standard Review Plan for Trial Use for the Review of Risk-Informed Inservice Inspection of Piping*, September 1998.

6. EPRI Report 1000701, *Interim Thermal Fatigue Management Guideline (MRP-24)* (attached to letter from A. Marion, NEI, to J. Strosnider, Jr.), dated March 16, 2001.

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Date: July 24, 2002