September 12, 2000

Mr. James Knubel
Chief Nuclear Officer
Power Authority of the State of
New York
123 Main Street
White Plains, NY 10601

SUBJECT: JAMES A. FITZPATRICK NUCLEAR POWER PLANT, AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE (ASME CODE) - RELIEF FOR RISK-INFORMED INSERVICE INSPECTION OF PIPING (TAC NO. MA6926)

Dear Mr. Knubel:

By letter dated October 13, 1999, you requested approval of an alternate risk-informed inservice inspection (RI-ISI) program for James A. FitzPatrick Nuclear Power Plant (JAF). This request was identified as a Cost Beneficial Licensing Action. Additional clarifying information was provided in your letters dated May 8, 2000, and May 24, 2000. Additional clarifying information was provided at a meeting on March 16, 2000, with a meeting summary dated April 28, 2000.

JAF RI-ISI program was developed in accordance with Electric Power Research Institute Topical Report TR-112657, Revision B-A, using the Nuclear Energy Institute template methodology. The results of our review indicate that your proposed RI-ISI program is an acceptable alternative to the requirements of the ASME Code Section XI, and that implementation of the RI-ISI program will result in a reduction in piping weld examinations, with an associated reduction in occupational radiation exposure, with little or no change in risk to the public due to piping failures. Therefore, your 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.

If you have questions regarding this matter, please contact Guy Vissing at 301-415-1441.

Sincerely,

/RA/ by A. Dromerick for

Marsha Gamberoni, Chief, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-333

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

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

POWER AUTHORITY OF THE STATE OF NEW YORK

DOCKET NO. 50-333

1.0 INTRODUCTION

Current inservice inspection (ISI) requirements for James A. FitzPatrick Nuclear Power Plant (JAF) are contained in the 1989 Edition of Section XI, Division 1 of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), entitled *Rules for Inservice Inspection of Nuclear Power Plant Components* (hereinafter called Code). In a submittal dated October 13, 1999, the licensee, Power Authority of the State of New York (PASNY), proposed a new inservice inspection (ISI) program entitled "*FitzPatrick Nuclear Power Plant Risk-Informed Inservice Inspection (RI-ISI) Program* (Ref. 1)." The RI-ISI program is limited to ASME Class 1 and Class 2 piping, Categories B-F, B-J, C-F-1, and C-F-2. The program was developed in accordance with the Electric Power Research Institute (EPRI) methodology contained in the Nuclear Regulatory Commission (NRC)-approved EPRI report EPRI-TR 112657, Revision B-A (EPRI-TR) (Ref. 2). Additional clarifying information was provided in a meeting held on March 16, 2000, and PASNY's letters dated May 8, 2000 (Ref. 3) and May 24, 2000 (Ref. 4).

In the proposed risk-informed ISI (RI-ISI) program, piping failure potential estimates were determined using the EPRI-TR guidance which utilizes industry piping failure history, plant specific piping failure history, and other relevant information. Using the failure potential and supporting insights on piping failure consequences from the licensee's probabilistic risk assessment (PRA), safety ranking of piping segments was established for determination of new inspection locations. The proposed program maintains the fundamental requirements of ASME Code Section XI, such as the examination technology, examination frequency and acceptance criteria. However, the proposed program reduces the required examination locations significantly and is able to demonstrate that an acceptable level of quality and safety is maintained. Thus, the proposed alternative approach is based on the conclusion that it provides an acceptable level of quality and safety and, therefore, is in conformance with Title 10, Code of Federal Regulations (10 CFR), Section 50.55a(a)(3)(i).

The NRC staff reviewed the licensee's proposed alternative of the ISI program for JAF, and applicable portions of the EPRI risk-informed Topical Report EPRI-TR 112657, based on guidance stated in NRC documents (Ref. 5, 6, and 7). The staff evaluation is provided below.

2.0 SUMMARY OF PROPOSED APPROACH

The licensee is required to perform ISI of ASME Code Category B-F, B-J and C-F piping welds during successive 10-year intervals. Currently, all B-F welds and 25% of all Category B-J piping welds greater than 1-inch nominal diameter are selected for volumetric and/or surface examination based on existing stress analyses and cumulative usage factors. For Category C-F piping welds, 7.5% of non-exempt welds are selected for surface and/or volumetric examination.

The licensee submitted the application as an RI-ISI "template" application. Template applications are short overview submittals intended to expedite preparation and review of RI-ISI submittals that comply with a pre-approved methodology. The licensee proposed to implement the staff approved RI-ISI methodology delineated in EPRI-TR 112657.

The licensee requested approval of this alternative for implementation during the inspection period current at the time of program approval. According to the information provided in Ref. 8, JAF is currently in the third 10-year interval that started on September 28, 1997 and ends on September 27, 2006. The current period (first period of the interval) started on September 28, 1997 and ends on March 28, 2001.

The implementation of an RI-ISI program for piping should be initiated at the start of a plant's 10-year ISI interval consistent with the requirements of the ASME Code Section XI, Edition and Addenda committed to by the Owner 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 to be consistent with ASME XI requirements, e.g., the minimum examinations completed at the end of the three inspections intervals under ASME Code, Section XI, Program B should be 16%, 50%, and 100%, respectively, and the maximum examinations credited at the end of the respective periods should be 34%, 67%, and 100%. In Ref. 8, the licensee stated that the ASME Code minimum and maximum inspections requirements will be met.

It is also the staff's view that the programs for the RI-ISI inspections (RI-ISIs) and for the balance of the inspections should be on the same interval start and end dates. This can be accomplished by either implementing the RI-ISI at the beginning of the interval or merging RI-ISIs into the program for the balance of the inspections if the RI-ISIs are 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-ISIs and for the balance of the inspections. 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). In Ref. 8, the licensee stated that the RI-ISI inspections and the balance of the inspections will be on the same interval start and end dates.

Ref. 8 stated that JAF would continue to submit its 10-year interval ISI program including the RI-ISI program. Ref. 8 also stated that JAF would submit the revised RI-ISI program prior to the end of the interval if relief requests are required from certain aspects or if there are program changes that require NRC approval similar to the practice under the current ASME XI program.

The staff finds that the JAF RI-ISI program meets the ASME XI and 10 CFR 50.55a requirements for minimum and maximum inspections during inspection periods and intervals and program submittal to the NRC.

3.0 EVALUATION

The licensee's submittal was reviewed with respect to the methodology and criteria contained in EPRI Report EPRI-TR 112657, Revision B-A. Further guidance in defining acceptable methods for implementing a risk-informed ISI program is also provided in Regulatory Guide (RG) 1.174, RG 1.178, and Standard Review Plan (SRP) Chapter 3.9.8.

3.1 Proposed Changes to ISI Program

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee has proposed to implement an RI-ISI program in accordance with the EPRI methodology contained in EPRI-TR 112657, Revision B-A, as an alternative to the ASME Code Section XI examination requirements for ASME Class 1 and 2 piping for the JAF. A general description of the proposed changes to the ISI program was provided in Section 3 of the licensee's submittal.

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 analysis and supporting insights from the probabilistic risk assessment (PRA). The licensee elaborated as to how the engineering analyses conducted for the JAF RI-ISI program ensures 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.

JAF's RI-ISI program is limited to ASME Class 1 and Class 2 piping. The licensee stated in its submittal that other non-related portions of the ASME Section XI 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 lead to the same consequence and which are exposed to the same degradation mechanism. 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 staff finds this appropriate, and necessary, because the methodology combines separate consequence categories with degradation mechanism categories to determine risk categories and therefore the two characteristics should not be mixed within a segment. The licensee has met SRP 3.9.8 guideline to confirm that a systematic process was used to identify and group pipe systems into segments with common failure consequences and susceptibility to common degradation mechanisms.

JAF 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 flow accelerated corrosion (FAC), microbe induced corrosion (MIC), and intergrannular stress corrosion cracking (IGSCC). The impact of these degradation mechanisms is monitored

through the augmented inspection programs developed in response to Generic Letters (GLs) 89-08, 88-01, and 89-13, respectively. The submittal stated that these three programs will be credited in the RI-ISI program development but will not be modified. All three programs are credited by assuming that the degradation mechanism is fully controlled by the program and thus need not be identified as a contributor to the failure potential category. In some cases, an augmented program inspection location may by credited as one of the inspection locations required by the RI-ISI program. The staff finds this acceptable because all three augmented programs provide for monitoring of the impact of the specific degradation mechanism, and the risk arising from any other degradation mechanism that might be present will be monitored in accordance with the RI-ISI methodology found acceptable during the EPRI-TR review.

The licensee stated that the consequences of pressure boundary failure were evaluated and ranked based on their impact on core damage and containment performance (isolation, bypass and large early release). The impact due to both direct and indirect effects was considered using guidance provided in EPRI-TR approved by the staff. The licensee reported no deviations from the consequence characterization methodology approved by the staff in EPRI-TR and their analyses are therefore acceptable.

3.3 Probabilistic Risk Assessment

JAF used JAF individual plant examination (IPE), Revision 1, dated April 1998, to support the RI-ISI submittal. The current estimates of core damage frequency (CDF) and large early release frequency (LERF) are 2E-6/yr and 7E-7/yr, respectively. The JAF IPE was submitted in September 1991. The more extensive of the two levels of NRC IPE reviews was applied to the FitzPatrick IPE. The review included a site visit for discussions with the plant personnel and a walk through of the plant areas important from a PRA perspective. The staff evaluation report dated May 9, 1994, identified three weaknesses in the analyses but concluded that JFNP's IPE satisfied the intent of GL 88-20. The RI-ISI submittal included an appendix discussing the weaknesses identified in the May 9, 1994, staff evaluation report. JAF has implemented the recommendations suggested in the 1994 staff evaluation report to remove the three weaknesses. Revision 1 of the IPE has also undergone the Boiling Water Reactor Owner's Group (BWROG) PRA certification process. The results of the peer review indicated that the IPE can be used to support applications involving relative risk significance and RI-ISI is a relative risk significant application. The approved EPRI TR-112657 report requires that functions relied upon to mitigate external events and transients during operation modes outside the scope of the IPE be systematically included in the categorization and JAF did not report a deviation in this area. The use of only an internal event IPE is therefore acceptable.

The staff did not review the IPE analysis to assess the accuracy of the quantitative estimates. The 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 assumptions large enough to invalidate the broad categorizations developed to support RI-ISI should have been identified in the licensee or the staff reviews. Minor errors or inappropriate assumptions will only affect the consequence categorization of a few segments and will not invalidate the general results or conclusions. The staff finds that the quality of the FitzPatrick PRA is sufficient to support this submittal, but notes that the industry PRA certification process is not being approved generically.

The degradation category and the consequence category were combined according to the approved methodology described in the EPRI topical report 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 discussed in Section 3.2 of this Safety Evaluation, the risk significant category is determined by the degradation mechanism category excluding any degradation mechanism currently being inspected in the augmented programs. Monitoring and control of the augmented programs' degradation mechanisms is considered sufficient, and the RI-ISI program is targeted to monitoring and control of any remaining degradation mechanisms based on the risk associated with those remaining degradation mechanisms. As required by Section 3.7 of the EPRI-TR, JAF evaluated the change in risk expected from replacing the current ISI program with the RI-ISI program. The analysis estimates the net change in risk due to the positive and negative influence of adding and removing locations from the inspection program. For 8 of the 14 systems included in the submittal, the expected change in risk was shown to be negative (i.e., a reduction in risk) using the qualitative analysis methodology. The expected change in risk in the remaining six systems was quantitatively evaluated using the "Simplified Risk Quantification Method" described in Section 3.7.2 of EPRI-TR. Some of these systems had an estimated risk increase while others had an estimated risk reduction. The greatest increase in CDF for any system was estimated to be 4E-10/yr. Neglecting the reduction in risk from the eight systems evaluated qualitatively, JAF estimated the aggregate change in CDF to be about -1E-9/yr including credit for the new locations selected but 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 -8.4E-9/yr.

The licensee stated that the implementation of the RI-ISI program is consistent with the EPRI-TR LERF guidelines but did not estimate the change in LERF. Using the methods and parameters used by the licensee to estimate the change in CDF, and the details of the changes in the number of locations inspected provided in the tables in the submittal, it is possible to bound the expected change in LERF. The bounding evaluation includes the expected increase in risk from welds that will no longer be inspected in all of the 14 systems, but does not include the expected reduction in risk due to the new locations selected for inspection. The staff estimated that the greatest bounding CDF increase in any one of the 14 systems is about 2E-9/yr. The bounding estimate for LERF can be developed from the bounding estimate for CDF by assuming that all the core damage scenarios lead to a large early release. Therefore, the greatest increase in LERF for any system is expected to be less than 2E-9/yr. A similar bounding estimate on the aggregate increase from the reduction of inspection locations in all 14 systems yields a maximum expected increase in LERF of 3E-9/yr.

The 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. All system level and aggregate estimates of the changes in CDF and LERF are less than the corresponding guideline values in the EPRI-TR. The staff finds that the improved inspection techniques will substantially increase the fraction of potential weld ruptures which would be identified by the inspection before the flaw develops into an actual rupture. The staff also finds that redistributing the welds to be inspected with consideration of the safety-significance of the segments provides assurance that segments whose failures have a significant impact on plant risk receive an acceptable and often improved level of inspection. Therefore, the staff concludes that the implementation of the RI-ISI

program as described in the application should be essentially risk neutral, and thus will not cause the NRC Safety Goals to be exceeded.

3.4 Integrated Decision Making

As described in the JAF 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 in compliance with the guidelines of RG 1.178.

The selection of pipe segments to be inspected is described in Section 3.5 of the submittal using the results of the risk category rankings and other operational considerations. Table 3.5-1 of the submittal provides the number of locations and inspections by risk category for the various JAF systems. Table 5-1 of the submittal provides a summary table comparing the number of inspections required under the existing ASME Section XI inservice inspection program with the alternative risk-informed inservice inspection program. Tables 3.8-1 identifies on a per system basis each applicable risk category and Table 3.8-2 provides the number of inspections added or deleted for each system. The licensee used the methodology described in the EPRI topical report to guide the selection of examination elements within high and medium ranked piping segments. This requires that existing FAC programs be maintained, and where other degradation mechanisms are identified, a minimum 25% of all elements within high safety-significant (Categories 1, 2 and 3) segments, and 10% of all elements with a medium safety-significant (Categories 4 and 5) ranking, be examined during each interval. The EPRI report describes targeted examination volumes (typically associated with welds) and methods of examination based on the type(s) of degradation expected. The 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 discontinuities over that currently required by ASME Section XI.

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

The objective of ISI required by ASME 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 must meet this objective to be found 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 staff concludes that the examination methods 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 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.

In the October 13, 1999, submittal, 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 the 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 HSS 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 proposed periodic reporting requirements meet existing ASME Code requirements and applicable regulations and, therefore, are considered acceptable. The proposed process for RI-ISI program updates meets the guidelines of RG 1.174 that provide that risk-informed applications must include performance monitoring and feedback provisions; therefore, the process for program updates is considered acceptable.

4.0 CONCLUSIONS

In accordance with 10 CFR 50.55a(a)(3)(i), proposed alternatives to piping inservice inspection 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 risk-informed process described in the NRC-approved EPRI Report EPRI-TR 112657, Revision B-A. The staff concludes that the PASNY's proposed RI-ISI program as described in EPRI-TR 112657, Revision B-A will provide an acceptable level of quality and safety pursuant to 10 CFR 50.55a for the proposed alternative to the piping ISI requirements with regard to the number of inspections, locations of inspections, and methods of inspection.

The staff finds that the results of the different elements of the engineering analysis are considered in an integrated decision-making 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 JAF 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.

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.

JAF 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 piping systems.

Changes made to the FAC, MIC, or IGSCC augmented inspection programs can be made within the framework of the respective industry initiatives. However, changes to these programs might result in removal of inspection locations so that the total number of inspections within a segment may be fewer than the risk category of the segment requires. Additional locations would need to be added, or original locations retained, to maintain the correspondence with the approved EPRI methodology.

The licensee has stated that the ASME XI Code minimum and maximum inspection requirements for Program B will be met and that the RI-ISI inspections and the balance of the inspections will be on the same interval start and end dates. The licensee has also stated that JAF would continue to submit its 10-year interval ISI program including the RI-ISI program every 10 years. The licensee has also stated in Ref. 8 that JAF would submit the revised RI-ISI program prior to the end of the interval if relief requests are required from certain aspects or if there are program changes that require NRC-approval similar to the practice under the current ASME XI program. The staff finds that the JAF RI-ISI program meets the ASME XI requirements for minimum and maximum inspections during inspection periods and intervals. The staff also finds that the JAF RI-ISI program meets the 10 CFR 50.55a requirements for program submittal to the NRC.

5.0 REFERENCES

1. Letter, dated October 13, 1999, J. Knubel (JAF Senior Vice President and Chief Nuclear Officer), to U.S. Nuclear Regulatory Commission, containing *James A. FitzPatrick Nuclear Power Plant Risk-Informed Inservice Inspection (RI-ISI) Program*.

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

3. Letter, dated May 8, 2000, J. Knubel (JAF Senior Vice President and Chief Nuclear Officer), to U.S. Nuclear Regulatory Commission, containing *Revised Risk-Informed Inservice Inspection (RI-ISI) Program*.

4. Letter, dated May 24, 2000, J. Knubel (JAF Senior Vice President and Chief Nuclear Officer), to U.S. Nuclear Regulatory Commission, containing Re-transmittal of Complete *Revised Risk-Informed Inservice Inspection (RI-ISI) Program*.

5. U.S. Nuclear Regulatory Commission, ”An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” Regulatory Guide 1.174, July 1998.

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

7. Standard Review Plan (SRP) Chapter 3.9.8, *Standard Review Plan for Trail Use for the Review of Risk-Informed Inservice Inspection of Piping*, NUREG-0800, May 1998.

8. Memorandum from Guy Vissing to Marsha Gamberoni, dated August 2, 2000, documenting PASNY Responses to Staff Questions dated July 18, 2000.

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