UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF FROM REQUIREMENTS FOR

ADDITIONAL INSPECTION OF CONTROL ROD DRIVE BOLTING

POWER AUTHORITY OF THE STATE OF NEW YORK

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

DOCKET NUMBER 50-333

1.0 INTRODUCTION

The Technical Specifications (TSs) for James A. FitzPatrick (FitzPatrick) Nuclear Power Plant state that the inservice inspection of the American Society of Mechanical Engineers (ASME) Code Class 1, 2, and 3 components shall be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel (B&PV) Code and applicable addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(6)(g)(i). 10 CFR 50.55a(a)(3) states that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified requirements 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) shall meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first ten-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME 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. The applicable edition of Section XI of the ASME Code for the FitzPatrick third ten-year inservice inspection (ISI) interval is the 1989 Edition.

By letter dated May 8, 1998, the Power Authority of the State of New York (the licensee, also known as the New York Power Authority) submitted its Third Ten-Year Interval Inservice Inspection Program Plan Request for Relief No. RR-14 for FitzPatrick. In addition, the licensee submitted additional information in its letter dated September 11, 1998, in response to an NRC request dated August 31, 1998.

2.0 EVALUATION

The NRC staff, with technical assistance from its contractor, the Idaho National Engineering and Environmental Laboratory (INEEL), has evaluated the information provided by the licensee in support of its Third Ten-Year Interval Inservice Inspection Program Request for Relief No. RR-14.

Based on the results of the review, the staff adopts the contractor's conclusions and recommendations presented in the attached Technical Letter Report (TLR).

Request for Relief No. RR-14, Paragraph IWB-2430, Additional Examinations for Bolting in Control Rod Drive (CRD) Housings: ASME Code, Section XI, examination Category B-G-2, Item B7.80 requires a VT-1 visual examination of bolting in CRD housings when the housing is disassembled. IWB-2430, *Additional Examinations*, requires additional examinations when CRD bolting is found to have flaws or relevant conditions that exceed the acceptance criteria of IWB-3517.

In accordance with 10 CFR 50.55a(a)(3)(ii), the licensee proposed to replace CRD bolting of the old design with bolting of a new design during routine CRD mechanism maintenance in lieu of performing the additional examinations required by IWB-2430 when cracking is detected in the CRD bolt head-to-shank fillet area. The licensee stated:

> During disassembly, a VT-1 examination will be completed on all removed CRD bolting. A surface examination will be done on all bolts that have relevant indications or suspect areas. If analysis disclose new conditions that have not been evaluated, then additional examinations will be performed. In lieu, of the expansion requirements of IWB-2430, all old design CRD bolts removed during scheduled CRD mechanism maintenance will be replaced with the new design bolt. This is justified by analysis as described above. The new design bolts may be re-used after a VT-1 and augmented surface examination determines that there are no relevant indications.

The Code requires a VT-1 visual examination for bolting in CRD housings when the housing is disassembled. When conditions exceeding acceptance criteria are identified, additional visual examinations are required in accordance with IWB-2430. In lieu of performing additional examinations, the licensee has proposed to replace all existing CRD housing bolts with bolts of a new design when the CRDs receive scheduled maintenance. All of the CRD bolting is scheduled to be replaced by the end of the third 10-year ISI interval. When CRDs with new-design bolting are disassembled for maintenance, the bolting will receive a VT-1 visual examination as required by the Code, and an augmented surface examination if indications that exceed the acceptance standards of IWB-3517 are found during the VT-1 examination.

The additional examinations required by IWB-2430 provide an indication of the extent of the degradation. If the degradation is determined to be more than an isolated case, the condition is analyzed and corrective actions are performed if warranted. The licensee found 6 out of 306 CRD bolts with unacceptable linear indications during refueling outage 12 in 1996. The corrective actions taken include replacement of all the bolting with bolting of a new design that is more resistant to the cracking mechanism found in existing bolts. However, replacing all of the remaining CRD mechanism bolting during the next refueling outage would result in additional personnel exposure of approximately 18 person-rem above the exposure accrued during routine CRD maintenance.

Engineering and metallurgical analyses by General Electric and Structural Integrity Associates, Inc. on CRD bolting with crack-like indications determined that only three of eight uniformly distributed bolts are needed to maintain the structural integrity of the CRD mechanism. Analysis also showed that uniform circumferential cracking of up to 0.15 inches in depth of all 8 CRD bolts at a CRD flange connection does not seriously affect the joint's structural integrity. The

metallurgical evaluation of the cracked bolting at FitzPatrick showed that the deepest crack was only 0.036 inches in depth. The licensee's evaluation provides reasonable assurance of the structural integrity of the CRD housing bolted connections and, considering the replacement schedule described above, requiring the licensee to extend additional examinations when flawed conditions are observed would result in hardship without a compensating increase in quality and safety. The staff concluded that the licensee's proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii).

3.0 CONCLUSION

The staff concluded that the licensee's metallurgical and engineering analyses provide reasonable assurance of the continued inservice structural integrity of the CRD bolting at the FitzPatrick Nuclear Power Plant. Replacing all CRD bolting at one time, during the Code-required additional examinations, would result in hardship without a compensating increase in the level of quality and safety. Therefore, the staff concluded that the licensee's proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii).

Attachment: Technical Letter Report

Principal Contributor: T. McLellan

Date: November 3, 1998

TECHNICAL LETTER REPORT
ON THIRD 10-YEAR INTERVAL INSERVICE INSPECTION
REQUEST FOR RELIEF NO. RR-14
FOR
NEW YORK POWER AUTHORITY
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
DOCKET NUMBER: 50-333

1. INTRODUCTION

By letter dated May 8, 1998, the licensee, New York Power Authority, submitted Request for Relief No. RR-14 seeking relief from the requirements of the ASME Code, Section XI, for the James A. FitzPatrick Nuclear Power Plant. This relief request is for the third 10-year inservice inspection (ISI) interval. By letter dated September 11, 1998, the licensee responded to the NRC request for additional information regarding Request for Relief No. RR-14. The Idaho National Engineering and Environmental Laboratory (INEEL) staff's evaluation of the subject request for relief is in the following section.

2. EVALUATION

The information provided by New York Power Authority in support of the request for relief from Code requirements has been evaluated and the basis for disposition is documented below. The Code of record for the FitzPatrick Nuclear Power Plant, third 10-year ISI interval, is the 1989 Edition of Section XI of the ASME Boiler and Pressure Vessel Code.

Request for Relief No. RR-14, Paragraph IWB-2430, Additional Examinations for Bolting in Control Rod Drive (CRD) Housings

Code Requirement—Examination Category B-G-2, Item B7.80 requires a VT-1 visual examination of bolting in CRD housings when the housing is disassembled. IWB-2430, *Additional Examinations*, requires additional examinations when CRD bolting is found to have flaws or relevant conditions that exceed the acceptance criteria of IWB-3517.

Licensee's Proposed Alternative—In accordance with 10 CFR 50.55a(a)(3)(ii), the licensee proposed to replace CRD bolting of the old design with bolting of a new design during routine CRD mechanism maintenance in lieu of performing the additional examinations

required by IWB-2430 when cracking is detected in the CRD bolt head-to-shank fillet area.

The licensee stated:

"During disassembly, a VT-1 examination will be completed on all removed CRD bolting. A surface examination will be done on all bolts that have relevant indications or suspect areas. If analysis disclose new conditions that have not been evaluated, then additional examinations will be performed. In lieu, of the expansion requirements of IWB-2430, all old design CRD bolts removed during scheduled CRD mechanism maintenance will be replaced with the new design bolt. This is justified by analysis as described above. The new design bolts may be re-used after a VT-1 and augmented surface examination determines that there are no relevant indications."

Licensee's Basis for Proposed Alternative (as stated)---

"During routine CRD mechanism maintenance, at several BWRs, visual examinations of the CRD bolting per ASME Section XI detected circumferential cracking around the shank on the head-to-shank fillet area of the bolt. Detailed metallurgical analysis of the defects determined the cracking mechanism to be stress corrosion blunted by general corrosion. Engineering and metallurgical analysis has concluded that the cracking does not compromise plant safety or CRD bolting integrity.

"During RFO-12(Fall 1996) the James A. FitzPatrick plant identified six bolts, out of 306, as having indications in excess of the ASME Section XI criteria. Two of the bolts, with the worst case indications, were subsequently sent out for metallurgical examination to characterize the flaws. The observed cracks were wide with blunted tips, which is similar to the cracking observed in all other plants. The maximum observed crack depth was 0.036 inches (Reference 2).

Table IWB-3515-1 of ASME Section XI provides the acceptance standards for indications that may be detected during volumetric examinations of bolting greater than 2 inch nominal size and is listed as 0.075 inches. The Code does not provide any guidance for volumetric flaw evaluation for bolting less than 2 inches in diameter. For the CRD cap screw, which has an inch nominal diameter, a linear-elastic fracture mechanics (LEFM) analysis was conducted (Reference 3) and an equivalent allowable depth of 0.071 inches, for a 360-degree circumferential crack, was determined. The analysis supports an allowed crack depth of up to 0.15 inches depending on the crack length and geometry.

"GE SIL 483 Rev 2, engineering analysis of the CRD bolted joint determined that only 3 uniformly distributed CRD cap screws out of 8 were needed to meet ASME Code margins (Reference 4). Analysis also showed (Reference 2) that uniform circumferential cracking up to 0.15 inches in depth of all 8 CRD cap screw bolts at a CRD flange connection is acceptable while still maintaining the ASME Code required structural integrity. Thus adequate safety margins exist even in the event a bolted joint contains potentially cracked bolts.

"The Authority has been replacing the CRD cap screws, with a new design bolt resistant to this cracking mechanism, as the cap screws are removed during normal maintenance of CRD mechanism. Presently, 64 of the 147 drives have the new design bolts. In addition, during an examination of the R012 CRD bolts, only 6 of the 306 inspected CRD bolts had

indications that exceeded the linear indication acceptance criteria of 1/4 inch for non-axial (circumferential) indications (Reference 5). Examinations included a VT-1 and Surface examination (PT). All indications were circumferential. No indications exceeded 7/8 inch in length.

"It is expected, however, further visual indications that exceed the acceptance criteria will be detected in the original bolting, and additional examinations will continue to be required during the third inservice inspection interval. Performance of the additional examinations whenever unacceptable visual indications are detected poses unreasonable plant hardship with no return in increased plant safety. It has been estimated that inspection and replacement of the old design CRD bolts for the remaining 73 CRD mechanisms would require 18 person REM (Reference 6). Also, the fracture mechanics and Code area requirements calculations showed that there is a significant structural margin with respect to any likely depth of cracking that may be present. Further, it appears that the intent of the Code in requiring the sample expansion is to assure that the extent and nature of the cracking that exceeds the acceptance criteria is not found elsewhere or is not more severe in remaining components of the same category. Engineering and metallurgical analysis results of cracked CRD cap screws from 9 plants show that this type of cracking is shallow, well understood, and does not compromise structural integrity.

"The above results provide a strong technical justification for eliminating the need for sample expansion. In addition, as the bolting is replaced with new design bolts, the condition of the original bolting will be monitored via ongoing Code VT-1 visual examination and augmented surface examinations for areas with relevant indications."

Evaluation—The Code requires a VT-1 visual examination for bolting in CRD housings when the housing is disassembled. When conditions exceeding acceptance criteria are identified, additional visual examinations are required in accordance with IWB-2430. In lieu of performing additional examinations, the licensee has proposed to replace all existing CRD housing bolts with bolts of a new design when the CRDs receive scheduled maintenance. All of the CRD bolting is scheduled to be replaced by the end of the third 10-year ISI interval. When CRDs with new-design bolting are disassembled for maintenance, the bolting will receive a VT-1 visual examination as required by the Code, and an augmented surface examination if indications that exceed the acceptance standards of IWB-3517 are found during the VT-1 examination.

The additional examinations required by IWB-2430 provide an indication of the extent of the degradation. If the degradation is determined to be more than an isolated case, the condition is analyzed and corrective actions are performed if warranted. The licensee found 6 out of 306 CRD bolts with unacceptable linear indications during refueling outage 12 in 1996. The corrective actions taken include replacement of all the bolting with bolting of a new design that is more resistant to the cracking mechanism found in existing bolts.

However, replacing all of the remaining CRD mechanism bolting during the next refueling outage would result in additional personnel exposure of approximately 18 person-rem above the exposure accrued during routine CRD maintenance.

Engineering and metallurgical analyses by General Electric and Structural Integrity Associates, Inc. on CRD bolting with crack-like indications determined that only three of eight uniformly distributed bolts are needed to maintain the structural integrity of the CRD mechanism. Analysis also showed that uniform circumferential cracking of up to 0.15 inches in depth of all 8 CRD bolts at a CRD flange connection does not seriously affect the joint's structural integrity. The metallurgical evaluation of the cracked bolting at FitzPatrick showed that the deepest crack was only 0.036 inches in depth. The licensee's evaluation provides reasonable assurance of the structural integrity of the CRD housing bolted connections and, considering the replacement schedule described above, requiring the licensee to extend additional examinations when flawed conditions are observed would result in significant hardship without a compensating increase in quality and safety. Therefore, it is recommended that the licensee's proposed alternative be authorized pursuant to 10 CFR 50.55a(a)(3)(ii).

3. CONCLUSION

The INEEL staff evaluated the licensee's submittals and concluded that the licensee's metallurgical and engineering analyses provide reasonable assurance of the continued inservice structural integrity of the CRD bolting at the FitzPatrick Nuclear Power Plant. Replacing all CRD bolting at one time, during the Code-required additional examinations, would result in hardship without a compensating increase in the level of quality and safety. Therefore, it is recommended that the licensee's proposed alternative be authorized pursuant to 10 CFR 50.55a(a)(3)(ii).