January 27, 2006

MEMORANDUM TO: A. Randolph Blough, Director
Division of Reactor Safety
Region I

FROM: Cornelius F. Holden, Deputy Director ***/RA/***
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: FINAL RESPONSE TO TASK INTERFACE AGREEMENT 2005-10 RELATED TO OPERABILITY DETERMINATION ON THROUGH-WALL CRACKING OF A TORUS (TAC NO. MC8580)

By memorandum dated October 7, 2005, NRC Region I submitted a task interface agreement to the Office of Nuclear Reactor Regulation (NRR) to obtain clarification on methodologies used to determine operability for a through-wall crack in a primary containment system.

In order to carefully evaluate the licensee's response to the through-wall crack in the torus at the James A. FitzPatrick Nuclear Power Plant, Region I requested NRR's assistance to address the following:

> What is the regulatory basis, if any, for determining the operability of a primary containment system, including a BWR [boiling-water reactor] Mark I torus, when a crack is discovered that clearly has penetrated the pressure boundary as evidenced, for example, by leakage of suppression pool water?
>
> In the circumstance when a licensee has physically observed a crack in a BWR Mark I torus, from which suppression pool water is observed leaking, is it permissible or appropriate for a licensee to apply ASME [American Society of Mechanical Engineers] Section XI, Paragraph IWE-3122.2, "Acceptance by Engineering Evaluation," for the purpose of determining the ability of a BWR Mark I torus to perform its safety function, when there is evidence that the crack is completely through the pressure retaining boundary?

The draft TIA was issued for Region I comments on December 6, 2005. Region I comments were received in an email from Harold Gray dated January 3, 2006. The date that the licensee recognized that the high-pressure-coolant-injection turbine exhausted to that area of the torus was revised to June 29, 2005. The final TIA response is enclosed.

Docket No. 50-333

Enclosure: As stated

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FOR TASK INTERFACE AGREEMENT 2005-10

RELATED TO OPERABILITY DETERMINATION ON THROUGH-WALL

CRACKING OF A TORUS

AT JAMES A. FITZPATRICK NUCLEAR POWER PLANT

DOCKET NO. 50-333

1.0 INTRODUCTION

At 9:51 a.m. on June 27, 2005, the licensee for the James A. FitzPatrick Power Nuclear Power Plant (JAFNPP) discovered water leaking through the torus vessel wall. The torus is part of the primary containment for the reactor vessel and reactor coolant system piping. Subsequent nondestructive evaluation characterized the leakage as a through-wall crack of approximately 4.6 inches in length. The torus is classified as an American Society of Mechanical Engineers (ASME) Section III Class MC Containment Vessel. The torus is a steel pressure vessel designed, fabricated and tested to the requirements for Class B vessels in the 1968 Edition of Section III of the ASME Boiler and Pressure Vessel Code (ASME Code). The torus vessel wall plate conforms to ASME SA-516, Grade 70 requirements for steel with high fracture toughness.

JAFNPP Technical Specification (TS) 3.6.1.1, Primary Containment, specifies the Limiting Condition for Operation, as, "Primary Containment shall be OPERABLE." When inoperable, the TS requires restoration of primary containment to OPERABLE status within 1 hour, or be in MODE 3 in 12 hours and MODE 4 in 36 hours. Operable/Operability is defined, for purposes of TS compliance, as a system or component being capable of performing its specified safety function.

Later in the day on June 27, 2005, the licensee provided to the Nuclear Regulatory Commission (NRC) staff a "Determination of Operability of FitzPatrick Torus Based on Flaw Tolerance Evaluation." This operability determination was performed by the licensee using guidance contained in NRC Generic Letter 91-18. The evaluation concluded there was "reasonable assurance of operability," because the torus could continue to perform its safety function, with a maximum flaw length up to 16.8 inches, until the next refueling outage. This conclusion was based on using stress intensity factors that, at that time, did not consider the affect of the high-pressure coolant injection (HPCI) turbine steam exhaust located near the flaw.

On June 29, 2005, the licensee recognized the presence of the HPCI exhaust in the affected torus bay, and determined the stress intensity would be considerably more then originally used in the initial operability determination during the period of time HPCI is in operation. The licensee concluded that a basis for continued operabilty of the torus, in such circumstance,

could no longer be reasonably supported. On June 30, 2005, at 7:29 p.m., in conformance with the JAFNPP TS requirements, the licensee initiated actions to shut down the plant. The plant entered MODE 4 at approximately 5:15 p.m. on July 1, 2005. MODE 4 was achieved more than 80 hours after the initial discovery of the through-wall crack.

The NRC's Region I Special Inspection Team was given a task to evaluate the conditions surrounding the discovery and remediation of the crack. As part of its charter, the team is required to evaluate Entergy's interpretation of the ASME Code and application of existing regulatory guidance in their initial evaluation of the torus shell through-wall defect and development of an operability determination for primary containment integrity.

2.0 TECHNICAL EVALUATION

What is the regulatory basis, if any, for determining the operability of a primary containment system, including a BWR [boiling-water reactor] Mark I torus, when a crack is discovered that clearly has penetrated the pressure boundary as evidenced, for example, by leakage of suppression pool water?

During the teleconference of June 30, 2005, the NRR staff had commented that the inservice inspection requirements (includes examination requirements, acceptance criteria when flaws or degradation are detected, and reporting requirements) of Subsection IWE of Section XI of the ASME Code are applicable to the pressure retaining Class MC components, and metallic liners and penetrations of Class CC components. As the subsection is incorporated by reference in 10 CFR 50.55a, the provisions for serviceability in Subsection IWE are the primary means for determining the operability of a primary containment system. The limitations and modifications associated with the use of the specific Edition and Addenda of Subsection IWE are provided in 10 CFR 50.55a(b)(2)(ix).

In the circumstance when a licensee has physically observed a crack in a BWR Mark I torus, from which suppression pool water is observed leaking, is it permissible or appropriate for a licensee to apply ASME Section XI, Paragraph IWE-3122.2, "Acceptance by Engineering Evaluation," for the purpose of determining the ability of a BWR Mark I torus to perform its safety function, when there is evidence that the crack is completely through the pressure retaining boundary?

IWE-3122 provides three methods for establishing acceptability of identified degradation in a component: (1) Acceptance by Examination, (2) Acceptance by Corrective Measures or Repair/Replacement Activity, or (3) Acceptance by Engineering Evaluation. Thus, pursuant to IWE-3122-3, acceptance of a component by an engineering evaluation is acceptable. IWE-3122.3 requires:

> A component whose examination detects flaws or areas of degradation that do not meet the acceptance standards of IWE-3500 is acceptable for continued service without a repair/replacement activity if an engineering evaluation indicates that the flaw or area of degradation is nonstructural in nature or has no unacceptable effect on the structural integrity of the containment. If either the thickness of the base metal in local areas is reduced by no more that 10% of the nominal plate thickness or the reduced thickness can be shown by analysis to

satisfy the requirements of the Design Specifications, the component is acceptable by engineering evaluation.

In the case of the JAFNPP torus, the design specification is indicated in Section 16.7 of the plant's Updated Final Safety Analysis Report (UFSAR). Table 16.7-2 of the UFSAR identifies the ASME Code allowable value of 17.5 ksi at 309 EF. The UFSAR does not indicate any fatigue stress limit. However, in its report SIR-05-234, "Failure and Operability Determination of the Torus Cracking at JAFNPP," the licensee calculated the stress intensity of 10.3 ksi in the vicinity of the cracking due to the applied cyclic load associated with HPCI discharge loads, without the associated stress concentration factors. From the extrapolated ASME Code fatigue curves for the calculated cycles of 1.25E7, the licensee identified the crack initiation stress as 22 ksi, and the corresponding stress concentration factor as 2.1. The actual strain concentration factor could be considerably higher than 2.1, depending upon strain levels developed due to (1) weld discontinuity and (2) the restraint imposed by the column support on the deformation of the torus shell. In any case, the torus in its through-wall cracked condition did not meet the criteria of the Design Specification. Thus, in accordance with the provisions of IWE-3122, the torus, in its through-wall cracked condition, was not acceptable for continued service.

3.0 CONCLUSION

The NRR staff has evaluated the Region I questions relating to the operability of the FitzPatrick torus with the through-wall crack. The NRR staff concludes that, in accordance with the provisions of IWE-3122, the torus, in its through-wall cracked condition, was not acceptable for continued service.

Principal Contributor: H. Ashar

Date: January 27, 2006