September 26, 2011

MEMORANDUM TO: Michael A. Norato, Chief
Component Integrity, Performance, and Testing Branch 2
Division of Engineering
Office of New Reactors

FROM: Gregory L. Makar, Materials Engineer ***/RA/***
Component Integrity, Performance, and Testing Branch 1
Division of Engineering
Office of New Reactors

SUBJECT: SUMMARY OF THE AUDIT CONDUCTED ON THE MATERIAL SPECIFICATION FOR THE FERMI UNIT 3 TURBINE ROTOR, AUGUST 3, 2011.

The U.S. Nuclear Regulatory Commission conducted an audit on August 3, 2011 of the General Electric Company (GE) material specification that will be used for the Fermi Unit 3 turbine rotor. The audit was held at the Nuclear Power Oversight Committee office in Rockville, Maryland. The audit team reviewed the specification document and discussed it in a web conference with GE. Specifically, the audit team reviewed the specified material composition and properties with respect to the Economic Simplified Boiling-Water Reactor Design Control Document Section 10.2.3, the Fermi Unit 3 bounding turbine missile probability analysis, and Standard Review Plan Section 10.2.3.

An audit report is enclosed. The audit report includes the audit scope, a description of the audit activity, and a summary of the audit results. As a result of the audit, the staff identified one potential request for additional information, related to how the specified mechanical properties were used in the bounding turbine missile probability analysis. This was subsequently issued as part of Question 10.02.03-17 on September 2, 2011.

Docket: 52-033

Enclosure: As stated

CONTACT: Gregory Makar, DE/CIB1
301-415-4034

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| DATE | 9/22/2011 | 9/26/2011 |

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**AUDIT REPORT**

**Turbine Rotor Material Specification**

**Fermi Unit 3 Combined License Application, FSAR Section 10.2**

Background

The Fermi Unit 3 combined license application (COLA) references the General Electric Company (GE) report GE ST-56834/P, Revision 2, submitted by GE Hitachi Nuclear Energy (GEH) Letter No. MGN 09-484, Supplement 1, dated September 30, 2010, as its applicable turbine missile probability analysis. This report (GE ST-56834/P, Revision 2) identified the rotor material specification as B50A373B8 (B8) or a more restrictive equivalent. In a letter dated April 28, 2010, the staff requested the applicant to provide the GE material specification B50A373B8 for review. The applicant's response, dated October 5, 2010, stated that the GE material specification would be available for Nuclear Regulatory Commission review. In addition, in a letter dated April 27, 2011, in response to RAI Number 5608, Question 10.02.03-1, the applicant stated that GE will change the material specification for nuclear low-pressure monoblock rotors to B50A373B12. Revision 3 of the turbine missile probability analysis, GE ST-56834/P, submitted by the Fermi Unit 3 applicant (DTE Energy) in a letter dated July 29, 2011, identified the material specification as B50A373B12. The staff determined it was necessary to review these material specifications (B8 and B12) in order to complete its review of Section 10.2 (Turbine Generator) of the COLA Final Safety Analysis Report. On August 1, 2011, the staff issued an audit plan for evaluating the specified material composition and properties with respect to the Economic Simplified Boiling-Water Reactor (ESBWR) Design Control Document (DCD) Tier 2 Section 10.2.3, GE ST-56834/P, and Standard Review Plan Section (SRP)10.2.3.

Regulatory Basis

The regulatory bases for this audit were General Design Criterion 4, "Environmental and dynamic effects design bases," and the turbine rotor materials selection and property criteria in SRP 10.2.3, "Turbine Rotor Integrity."

Audit Location and Date

The staff conducted the audit at the Nuclear Power Oversight Committee's office in Rockville, Maryland, on August 3, 2011. Mark Burnett of GE participated through a web conferencing session to present the material specification and respond to questions. Patricia Campbell of GEH also participated in the audit.

Audit Team

The audit was conducted by team leaders, John Honcharik (NRO/CIB1), Gregory Makar (NRO/CIB1), and Michael Eudy (NRO/NGE1and2).

Audited Documents

The staff reviewed the GE specification for nickel-chromium-molybenum-vanadium (NiCrMoV) steel rotor forgings, B50A373, dated July 2011. The applicant provided a hardcopy of the document at the audit site.

Enclosure

Audit Activities

In order to supplement the hardcopy of the specification, GE provided an overview of B50A373 using web conferencing. Mr. Burnett (GE) explained that B8 and B12 are two of the material classes in the B50A373 specification, and he displayed the pages comparing the requirements for the two classes. The staff then used the hardcopy to review in more detail the chemistry, processing, and mechanical properties of the B12 material and compare it to B8 with respect to ESBWR DCD Section 10.2.3 (Turbine Integrity), GE ST-56834/P, and the materials selection guidance in SRP 10.2.3.

Summary

The audit provided clarity that the B12 material is a new material class added to the existing specification for monoblock turbine rotor forgings (B50A373). GE introduced this material class specifically for turbine rotors at nuclear plants and stated that it places tighter control on the nickel content. The B8 material class has been used for monoblock forgings since the 1980s for both nuclear and fossil plants. The staff confirmed that the only difference between the two material classes is the tighter control on nickel content in B12. The remaining chemistry limits, processing steps, and mechanical properties are identical for the two classes.

The staff also determined from the audit that the B12 material meets the staff's SRP Section 10.2.3 guidance with respect to the following criteria: the material is a NiCrMoV steel with vacuum processing, chemical analysis of each forging is performed, deleterious elements such as sulfur and phosphorus are controlled to low levels, and the fracture appearance transition temperature (FATT) and Charpy V-notch ($C_v$) energy are determined in accordance with ASTM Standard A370. With respect to material property details not included in the DCD, such as strength, ductility, and the complete chemistry requirements, the staff determined that the B50A373B12 closely resembles materials in ASTM Standard A470, "Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts." The staff also confirmed that material properties that are not consistent with the guidelines in SRP 10.2.3, such as the FATT value of 30°F, have been approved in the DCD review.

As a result of the audit, the staff identified one potential request for additional information (RAI) concerning how the mechanical properties in the B50A373B12 specification were used in the bounding turbine missile analysis (GE ST-56834/P).

In conclusion, the audit confirmed that the material specification, GE specification B50A373B12, currently referenced in Revision 3 of the GE ST 56834/P report for the Fermi 3 low-pressure turbine rotor conforms to the guidance of SRP 10.2.3 (with exceptions approved in the staff's review of the DCD). The staff identified one potential RAI.