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Subject: **Response to Portion of NRC Request for Additional Information
Letter No. 98 – Steam and Power Conversion Systems– RAI Numbers
10.2-20, 10.2-21, and 10.2-22 and Design of Structures, Components,
Equipment, and Systems – RAI Number 3.5-17**

Enclosure 1 contains GEH's response to the subject DCD Chapter 10 NRC RAIs transmitted via the Reference 1 letter. Enclosure 2 contains GEH's response to the subject DCD Chapter 3 NRC RAI transmitted via the Reference 1 letter.

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,



James C. Kinsey
Project Manager, ESBWR Licensing

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NRO

Reference:

1. MFN 07-317, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 98 Related to the ESBWR Design Certification Application*, May 29, 2007.

Enclosure:

1. MFN 07-400 – Response to Portion of NRC Request for Additional Information Letter No. 98 – RAI Numbers 10.2-20, 10.2-21, and 10.2-22
2. MFN 07-400 – Response to Portion of NRC Request for Additional Information Letter No. 98 – RAI Number 3.5-17

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Enclosure 1

MFN 07-400

**Response to Portion of NRC Request for
Additional Information Letter No. 98
Related to ESBWR Design Certification**

Steam and Power Conversion Systems

RAI Numbers 10.2-20, 10.2-21, 10.2-22

NRC RAI 10.2-20:

DCD Tier 2, Rev. 2, Section 10.2.5 stated that the details of the turbine inservice test and inspection program (as requested in SRP 10.2.3) will be provided in a COL FSAR update, after the turbine has been purchased. However, the COL Holder Item was removed in DCD Revision 3. Provide a justification for its removal.

GEH Response:

The COL item in DCD Subsection 10.2.5.3 described above was deleted in DCD Revision 3. The requirement to provide details of the turbine inservice test and inspection program was relocated to Tier 1, Subsection 2.11.4 as ITAAC 4.b:

“The turbine and turbine valve inservice test and inspection program includes scope, frequency, methods, acceptance criteria, disposition of reportable indications, corrective actions, and technical basis for inspection frequency. In-service test, inspection and operating procedures are in accordance with industry practice and meet OEM requirements for turbine missile probability.”

Since the requirement is incorporated in the referenced Tier 1 ITAAC, COL item in DCD Subsection 10.2.5.3 was deleted from Tier 2 in Revision 3. See also the response to RAI 10.2-22.

DCD Impact:

No DCD changes will be made in response to this RAI.

NRC RAI 10.2-21:

DCD Tier 2, Rev. 3, Section 10.2.5.1 states that the COL Holder will provide an evaluation of the probability of turbine missile generation using criteria in accordance with NRC requirements. The probability of turbine missile generation should be completed prior to license issuance so that the staff can verify whether the probability of turbine missile generation is within NRC requirements. This means that the COL Applicant should provide the information, not the COL Holder. Justify the use of "the COL Holder" in lieu of "the COL Applicant" in subsection 10.2.5.1.

GEH Response:

The Turbine Missile Probability Analysis will not be available until after the as-built turbine material properties and final as-built rotor design details are available. It is expected that this information will not be available until after the issuance of the COL and is therefore specified as a COL holder item. Tier 1, subsection 2.11.4 discusses external turbine missile probability and requires it to be less than 1×10^{-4} per turbine year. Also reference Tier 1 Table 2.11.4-1, ITAAC 5:

“An analysis exists that documents that the probability of turbine material and overspeed related failures, resulting in external turbine missiles, is $< 1 \times 10^{-4}$ per turbine year.”

Based on proposed turbine rotor designs that utilize integral forgings, the probability of turbine missile generation is less than 1×10^{-5} for the ESBWR as stated in the Tier 2, Subsection 10.2.1. This probability is lower than that required by SRP Section 3.5.1.3, Table 3.5.1.3-1, for loading the turbine and bringing the plant (system) on line. This probability is to be confirmed by calculation and/or analysis and provided in the Turbine Missile Probability Analysis. Thus, the probability of turbine missile generation is available to the NRC staff in the DCD and is within NRC requirements. See also the response to RAI 10.2-22.

DCD Impact:

No DCD changes will be made in response to this RAI.

NRC RAI 10.2-22:

In DCD Tier 2, Revision 0, several COL action items were specified. Specifically, Subsection 10.2.5.1 specifies that the COL Applicant will provide turbine material property data and assure sufficient turbine warmup time. Subsection 10.2.5.2 specifies that the COL Applicant will provide the basis for the turbine overspeed. Subsection 10.2.5.3 specifies that the COL Applicant will provide the turbine inservice test and inspection requirements. However, none of these three subsections is shown in Section 10.2.5 of Revision 3.

The Staff noticed that the overspeed basis report and the inservice test and inspection report are incorporated in Section 10.2.3.4 (page 10.2-11). However, it is not clear in Section 10.2.3.4 who provides these reports and when. Also, the submission of turbine material property data and warmup time is not specified in Section 10.2.3. Therefore, GE needs to either reinstate all three COL Action Items, or state in Subsection 10.2.3.4 that the COL Applicant will submit the relevant documents.

GEH Response:

The referenced COL items were relocated as follows in DCD revision 3:

10.2.5.1 Low Pressure Turbine Disk Fracture Toughness

Turbine material property data and warm-up time, including stress calculations of turbine components, as discussed in Subsection 10.2.3.2, will be provided in a COL FSAR update after the turbine has been purchased and the turbine-specific data are known.

This item is included in Tier 1, Subsection 2.11.4, as ITAAC 4.a:

“An analysis exists that includes turbine material property data, rotor and blade design analyses (including loading combinations, assumptions and warm-up time) demonstrating sufficient safety margin to withstand loadings from overspeed events, and pre-service testing and inspection information (including scope, methods and acceptance criteria).”

10.2.5.2 Turbine Design Overspeed

The turbine overspeed protection design features (including overspeed trip setpoints) will be provided in a COL FSAR update, after the turbine has been purchased.

This item is included in Subsection 10.2.3.4:

“On a unit-specific basis, a report will provide the overspeed basis (including setpoints) applicable to the site and discuss how the turbine assembly is designed to withstand the normal conditions, anticipated operational occurrences, and accidents resulting in a turbine trip.”

10.2.5.3 *Turbine In-service Test and Inspection*

As applicable to an ESBWR, the details of the turbine in service test and inspection program (as requested in SRP 10.2.3) will be provided in a COL FSAR update, after the turbine has been purchased.

This item is included in Tier 1, Subsection 2.11.4 as ITAAC 4.b:

“The turbine and turbine valve in-service test and inspection program includes scope, frequency, methods, acceptance criteria, disposition of reportable indications, corrective actions, and technical basis for inspection frequency. In-service test, inspection and operating procedures are in accordance with industry practice and meet OEM requirements for turbine missile probability.”

In order to clarify the scope of the Turbine Missile Probability Analysis and satisfy the requirements of Regulatory Guide 1.206, new Subsection 10.2.3.8 is to be added to Chapter 10 per the attached proposed markup. New Subsection 10.2.3.8 requires the Turbine Missile Probability Analysis to include the aspects described in COL items 10.2.5.1, 10.2.5.2, and 10.2.5.3 that appeared in Revision 2 of DCD Chapter 10. COL item 10.2.5.1 for the Turbine Missile Probability Analysis is also to be revised to reference new Subsection 10.2.3.8.

DCD Impact:

DCD Tier 2, Subsections 10.2.3.8 and 10.2.5.1 are to be revised as noted in the attached markup pages.

Enclosure 2

MFN 07-400

**Response to Portion of NRC Request for
Additional Information Letter No. 98
Related to ESBWR Design Certification**

**Design of Structures, Components,
Equipment, and Systems**

RAI Number 3.5-17

NRC RAI 3.5-17:

Summary:

Justify changes to Revision 3 of the DCD Tier 2, Section 3.5.1.1.1.2 regarding turbine missile generation.

Full Text:

In Revision 3 of the DCD Tier 2, Section 3.5.1.1.1.2 (page 3.5-4) states that "The COL holder will provide an evaluation of the probability of turbine missile generation which concludes that the probability of turbine missile generation, $P1$, is less than 1×10^{-5} per Subsection 10.2.5.

- (a) The staff believes that the probability of turbine missile generation should be completed prior to license issuance so that the staff can verify that the probability of turbine missile generation is within NRC requirements and licensing basis. This means that the COL applicant should provide the information, not the COL holder. If the probability calculation is not approved by the NRC prior to license issuance, the plant owner needs to perform certain nondestructive examinations per SRP 3.5.1.3. Justify the use of "the COL holder" in lieu of "the COL applicant" in subsection 3.5.1.1.1.2.*
- (b) The staff believes that a turbine system maintenance program should be submitted prior to fuel load in addition to the probability calculation of turbine missile generation. The submission of the turbine maintenance program was specified in Section 3.5.4.4 of Revision 0 but was deleted in Revision 3. Please justify this deletion.*

GEH Response:

(a) The Turbine Missile Probability Analysis will not be available until after the as-built turbine material properties and final as-built rotor design details are available. It is expected that this information will not be available until after the issuance of the COL and is therefore specified as a COL holder item. Tier 1, subsection 2.11.4 discusses external turbine missile probability and requires it to be less than 1×10^{-4} per turbine year. Also reference Tier 1 Table 2.11.4-1, ITAAC 5:

"An analysis exists that documents that the probability of turbine material and overspeed related failures, resulting in external turbine missiles, is $< 1 \times 10^{-4}$ per turbine year."

Based on proposed turbine rotor designs that utilize integral forgings, the probability of turbine missile generation is less than 1×10^{-5} for the ESBWR as stated in the Tier 2, Subsection 10.2.1. This probability is lower than that required by SRP Section 3.5.1.3, Table 3.5.1.3-1, for loading the turbine and bringing the plant (system) on line. This probability will be confirmed by calculation and/or analysis and provided in the Turbine Missile Probability Analysis. Thus, the probability of turbine missile generation is available to the NRC staff in the DCD and is within NRC requirements. See also the response to RAI 10.2-21.

- (b) The calculated probability of turbine missile generation is dependent on the scope and conduct of maintenance activities as well as inspection and maintenance intervals. The probability of turbine missile generation will require assumptions to calculate. These assumptions remain valid only by performing a combination of preservice and inservice maintenance and inspections. Thus, the turbine missile probability evaluation will provide a list of maintenance activities and inspections, and the required frequency for each activity, that are required to maintain the calculated probability of turbine missile generation. Both the COL item in DCD Tier 2 Subsection 10.2.5.1 and the ITAAC stated in part (a) above require that this analysis report be provided. Accordingly, the COL item originally included in DCD Revision 0, Subsection 3.5.4.4, is no longer required.

Further, ITAAC 4.b in DCD Tier 1, Table 2.11.4-1, states:

“The turbine and turbine valve in-service test and inspection program includes scope, frequency, methods, acceptance criteria, disposition of reportable indications, corrective actions, and technical basis for inspection frequency. In-service test, inspection and operating procedures are in accordance with industry practice and meet OEM requirements for turbine missile probability.”

Based on the above, the final maintenance and inspection program will be included in the turbine missile probability evaluation. Chapter 10 in Tier 2 of the DCD is to be revised to provide details of what is included in the turbine missile probability evaluation. This revision includes a description of the maintenance plan details to be provided.

DCD Impact:

DCD Tier 2, Section 10.2.3 is to be revised as noted in the attached proposed markup in DCD Revision 4.

10.2.3.8 Turbine Missile Probability Analysis

An analysis is prepared containing an evaluation of the probability of turbine missile generation ~~will be prepared and provided or, in the case of proprietary information, made available for review~~. The report ~~will~~ provides a calculation of the probability of turbine missile generation using approved methods and industry guidance applicable to the fabrication technology employed. The analysis ~~will be prepared~~ is as a comprehensive report containing a description of turbine fabrication methods, material quality and properties, and required maintenance and inspections.

The following information ~~will be~~ is contained in the above analysis report or made available for review:

- The calculated probability of turbine missile generation from material and overspeed related failures based on as-built rotor and blade designs and as-built material properties (as determined in certified testing and NDE),
- Maximum anticipated speed resulting from a loss of load, assuming normal control system function without trip,
- Overspeed basis and overspeed protection trip setpoints,
- Description of the inservice inspection and testing program for valves essential to overspeed protection,
- Discussion of the design and structural integrity of turbine rotors (See subsection 10.2.3.4),
- List of material properties, including the method of obtaining those properties, that includes yield strength, stress-rupture properties, and minimum operating temperature of the HP rotor,
- Additional description of pre-service test and inspection procedures and acceptance criteria required to support calculated turbine missile probability,
- Actual maximum tangential and radial stresses and their locations in the LP rotor (see subsection 10.2.3.4),
- Rotor and blade design analyses (including loading combinations, assumptions and warm-up time) that demonstrate sufficient safety margin to withstand loadings from postulated overspeed events up to 120% of rated speed, and
- A description of inservice tests, inspections, and maintenance activities for the turbine and valve assemblies that are required to support the calculated missile probability, including inspection and test frequencies with technical bases, type of inspection, techniques, areas to be inspected, acceptance criteria, disposition of reportable indications, and corrective actions.

The above analysis/report ~~will be~~ is prepared using criteria in accordance with NRC requirements such as in Reference 10.2-3 and NUREG-0933 item A37.

10.2.5.1 Turbine Missile Probability Analysis

The COL Holder ~~will~~ provides an evaluation of the probability of turbine missile generation using the criteria in accordance with NRC requirements. See Subsection 10.2.3.8 for details of the analysis report.