GE Energy

David H. Hinds
Manager, ESBWR

PO Box 780 M/C L60
Wilmington, NC 28402-0780
USA

T 910 675 6363
F 910 362 6363
david.hinds@ge.com

MFN 06-154

Docket No. 52-010

June 12, 2006

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to NRC Request for Additional Information Letter No. 23 Related to ESBWR Design Certification Application – Steam and Power Conversion System – RAI Numbers 10.2-1 through 10.2-19 and 10.4-2 through 10.4-9**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter. This completes GE's response to RAI Letter No. 23.

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-140, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 23 Related to ESBWR Design Certification Application,* May 3, 2006

Enclosure:

1. MFN 06-154 – Response to NRC Request for Additional Information Letter No. 23 Related to ESBWR Design Certification Application – Steam and Power Conversion System – RAI Numbers 10.2-1 through 10.2-19 and 10.4-2 through 10.4-9

cc: WD Beckner USNRC (w/o enclosures)
AE Cubbage USNRC (with enclosures)
LA Dudes USNRC (w/o enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0000-0054-2601

ENCLOSURE 1

MFN 06-154

Response to NRC Request for Additional Information Letter No. 23 for the ESBWR Design Certification Application

Steam and Power Conversion System

RAI Numbers 10.2-1 through 10.2-19 and 10.4-2 through 10.4-9

NRC RAI 10.2-1

(A) Provide a general description of the overall turbine rotor (disk) design, including number of stages, bucket (blade) design, how the buckets are attached to the rotor, and whether the turbine rotor is forged. Provide diagrams and figures of the design.

(B) Discuss whether DCD Section 10.2.3 is also applicable to the structural integrity and inspection of the high-pressure rotor.

GE Response

(A) A complete description of the turbine rotor (disk) design will be provided as part of the COL Unit Specific Information, Subsection 10.2.2.5. See attached DCD/Tier 2, Rev 2 (DRAFT), page 10.2-14.

(B) Yes, DCD Section 10.2.3 is also applicable to the structural integrity and inspection of the high pressure rotor. See Subsection 10.2.5.3, attached DCD/Tier 2, Rev 2 (DRAFT), page 10.2-4, for the COL Unit Specific Information to be provided.

NRC RAI 10.2-2

DCD Section 10.2.3.1 states that tramp elements in turbine rotors are controlled during fabrication to the lowest practical concentrations to ensure adequate fracture toughness. SRP Section 10.2.3.II.1.a recommends that sulfur and phosphorus be controlled to low levels because they have a deleterious effect on toughness of the rotor. Provide the percentage of sulfur and phosphorus in the turbine rotor and discuss whether their chemical contents are considered low level.

GE Response

DCD Subsection 10.2.3.1 has been revised (see attached Rev 2 DRAFT page 10.2-10) to reflect the SRP Subsections 10.2.3.II.a, b. & c. The chemical analysis, per the DCD, will provide the sulfur and phosphorus content as part of the COL per Subsection 10.2.5.1 of the attached DRAFT Rev 2 of the DCD.

NRC RAI 10.2-3

DCD Section 10.2.3.1 states that the processing of the turbine materials is controlled to maintain the fracture appearance transition temperature (FATT) below-1 degrees C (30 F), which is inconsistent with SRP Section 10.2.3.II.b. SRP Section 10.2.3.II.1.b recommends that the 50% FATT, as obtained from Charpy tests performed in accordance with specification ASTM A-370, be no higher than 0 F for low-pressure turbine disks.

(A) Discuss the discrepancy.

(B) Discuss which industry codes were used to obtain the FATT and Charpy energy of the low-pressure turbine rotor.

GE Response

The DCD Draft Rev 2 Subsection 10.2.3.1 (same as for RAI 10.2-2) has been revised to reflect the SRP Subsection 10.2 3.II.1.b at Subsection 10.2.3.1 and 10.2.5.1, Low Pressure Turbine Disk Fracture Toughness.

(A) The discrepancy was a clerical inconsistency between the DCD and the SRP and has been revised, as shown on the attached Rev 2 DRAFT on pages 10.2-10 and 10.2-13.

(B) The DCD DRAFT Rev 2 is revised to add ASTM A370 and ASTM E-208 as required to reflect the intent of the SRP as shown on page 10.2-10.

NRC RAI 10.2-4

DCD Section 10.2.3.1 states that the room temperature Charpy energy above 45 ft-lbs in all areas of the rotor is maintained, which is not consistant with the minimum 60 ft-lb recommended in SRP Section 10.2.3II.1.c. SRP Section 10.2.3.II.1.c recommends that Charpy V-notch energy at the minimum operating temperature of each low-pressure disk in the tangential direction be at least 60 ft-lbs. Discuss the discrepancy.

GE Response

The DCD Rev 2 DRAFT is corrected at Subsection 10.2.3.1 to reflect SRP Subsection 10.2.3.II.1.c as agreed to and also shown in the attached page 10.2-10. This complete DCD Subsection 10.2.3.1 was rewritten as part of the Rev 2 DRAFT.

NRC RAI 10.2-5

DCD Section 10.2.3.2 states that the ratio of material fracture toughness, Kic, to the maxium tangential stress at speeds from normal to 115% of rated speed is at least 10 mm1/2.

(A) Clarify whether this ratio is obtained at the minimum operating temperature as recommended in SRP Section 10.2.3.II.2.

(B) Discuss how the fracture toughness properties were obtained and by which methods (Reference: SRP Section 10.2.3.II.2).

GE Response

(A) Yes, the ratio of material toughness is obtained at minimum operating temperature as revised in DCD Rev 2 DRAFT and shown in the attached page 10.2-10.

(B) Yes, the fracture toughness properties and method for obtaining are now discussed in the DCD Rev 2 DRAFT in Subsections 10.2.3.1 and 10.2.3.2 and is answered by both RAI's 10.2-5 and 10.2-3 as shown on page 10.2-10.

NRC RAI 10.2-6

DCD Section 10.2.3.2 states that stress calculations include components due to centrifugal loads, interference fit, and thermal gradients where applicable. Describe briefly the stress calculations, including analyzed components, applied loadings, the acceptance criteria, and the safety margins of the components.

If the stress calculations are unavailable at present, DCD Section 10.2.5.1 must include the following commitment to: "The COL applicant will provide turbine material property data and assure sufficient warmup time as required by Subsection 10.2.3.2. The COL applicant will provide stress calculations as discussed in Section 10.2.3.2 of DCD Tier 2."

GE Response

The COL Unit Specific Information Subsection 10.2.5.1 of the DCD Tier 2 has been revised per Rev 2 DRAFT to assure that the material property data, warm-up time, and stress calculations of turbine components are provided as a COL FSAR update when this data is known. See attached page 10.2-13, Rev 2 Draft.

NRC RAI 10.2-7

DCD Section 10.2.3.3 states that operating temperature of the high pressure rotors are below the stress rupture range; therefore, creep rupture is not a significant failure mechanism.

(A) *Identify the operating temperatures and the maximum possible temperature (temperature at anticipated transients or accident conditions) of the high pressure rotors.*
(B) *Identify the temperature at the stress rupture range and discuss how this temperature was obtained.*

GE Response

The DCD Tier 2 Heat Balance, Figure 10.1-2, shows the turbine main steam temperature to be ~540.6 F. Long term creep rupture begins to occur at ~ 800-900 F and increases with increase in the temperature. Therefore stress rupture is not a plausible failure mode since the maximum temperature the turbine should see will be ~ 555 F which equates to the high pressure reactor scram setpoint of 1055 psig.

NRC RAI 10.2-8

DCD Section 10.2.3 (actually 10.2.3.2) states that the multitude of natural critical frequencies of the turbine shaft assemblies existing between zero speed and 20% overspeed are controlled in the design and operation so as to cause no distress to the unit during operation. DCD Section 10.2.3 also mentions various speed such as "115% of the rated speed" and "8% higher than normal overspeed."

(A) *Elaborate on the various turbine speeds and define the associated terminology, such as "rated speed", normal overspeed" and "overspeed". Provide the actual revolutions per minute for each speed.*
(B) *Identify the design overspeed (the speed for which the turbine rotor is design), the minimum speed that would cause the turbine components to fail, the normal operating speed, and the speed at which the turbine is set to trip.*
(C) *Revise the expression, "normal overspeed", because an overspeed event cannot be normal.*

GE Response

(A) GE corrected/deleted the word "normal", in Subsection 10.2.3.4 (4), DRAFT Rev 2, when referring to overspeed of a turbine. Actual turbine speeds will be discussed in new DRAFT COL Item 10.2.5.2. See attached pages 10.2-11 and 10.2-14.
(B) This information will also be provided as part of COLA item Subsection 10.2.5.2 (attached page 10.2-14).
(C) The expression "normal" has been deleted when discussing overspeed as discussed in (A) above and shown in attached pages referenced.

NRC RAI 10.2-9

In 1991, a turbine overspeed event occurred at Salem Unit 2 which resulted in a failure of some turbine blades. The fragments of blades punctured the turbine casing and traveled some distance from the turbine. The event was caused by the failure of the turbine overspeed protection system (Reference NRC Letter dated January 7, 1992, from Charles W. Hehl of NRC to Steven E. Miltenberger of Public Service Electric and Gas Company, Subject: NRC Region I Augmented Inspection Team (AIT) Review of the November 9, 1991 Salem Unit 2 Turbine-Generator Overspeed and Fire Event).

(A) Describe how turbine speed is monitored such that a turbine overspeed event is minimized.
(B) Identify the margin between the turbine trip setpoint sped and design overspeed to demonstrate that the turbine can be tripped either manually or automatically before it reaches the design overspeed to assure turbine components' integrity.

GE Response

(A) Subsection 10.2.2.4, Paragraphs 3, 4, and 5 describe the triple and redundant turbine Primary Electrical overspeed system and the Emergency electrical trip modules.
(B) The margin of safety between the turbine overspeed primary and emergency setpoints and the "design overspeed" will be provided as part of Subsection 10.2.5.2, DCD Tier 2, DRAFT Rev 2. (page 10.2-14, attached).

NRC RAI 10.2-10

In NRC Information Notice 94-01, "Turbine Blade failures Caused By Torsional Excitation From Electrical System Disturbance," the staff discussed turbine blade failures of low-pressure turbines which were attributed to torsional excitation of the turbine generator shaft as a result of an electrical system disturbance. Discuss whether this phenomena was considered in the turbine design and whether the design includes mechanisms to preclude such event. As part of your response, discuss how the natural critical frequencies of the turbine shaft are controlled in the design and operation so as not to cause distress to the unit, including how the harmonic excitation of the turbine unit is managed at various shaft speed.

GE Response

Although the DCD is not required to address Notices or Curriculums (I.E. Bulletins and Generic Letters are addressed), GE has addressed this RAI. Subsection 10.2.3.4 (2) Turbine Design, has referenced to COL Subsection 10.2.5.5 to ensure that torsional vibration analysis is provided (see DCD DRAFT pages 10.2-14 and 10.2-11).

NRC RAI 10.2-11

SRP Section 10.2.3II.4 recommends that the turbine assembly be designed to withstand normal conditions, anticipated transients, and accidents resulting in a turbine trip. In DCD Section 10.2.3.3, "accidents" was not explicitly mentioned. Clarify whether loading from accident/faulted conditions have been considered in the turbine design calculations.

GE Response

GE has added the word "accidents" and other phrases from the SRP Section 10.2.3.II.4 to the DCD Tier 2 DRAFT Subsection 10.2.3.4, first sentence and (1) to reflect the SRP as agreed during our phone call (see attached pages 10.2-10 and 10.2-11).

NRC RAI 10.2-12

DCD Section 10.2.3.4. (2) states that, for pre-service inspection, the established acceptance criteria for volumetric (ultrasonic) and surface visual examinations of the finished machined rotor are more restrictive than those specified for ASME Class I components in ASME Code, Sections III and V. DCD Section 10.2.3.4. (2) also states that the acceptance criteria include the requirement that subsurface sonic indications are either removed or evaluated to ensure that they do not grow to a size which would compromise the turbine integrity.

- *(A) Discuss how the established acceptance criteria are more restrictive than the ASME Code, Sections III and V.*
- *(B) Discuss why radiography testing is not part of the volumetric examination.*
- *(C) Clarify whether 'surface visual examination' is meant as two separate examinations, i.e., 'surface examination' and 'visual examination'.*
- *(D) Discuss how the rotor is repaired after surface or subsurface indications are removed from a rotor.*
- *(E) Provide acceptance criteria for surface and subsurface indications in the rotor that require repair/removal.*

GE Response

- (A) The reference to ASME Boiler and Pressure Code, Sections III and V have been removed as they are not an applicable construction code required for the turbine design and manufacturing (see attached DCD Tier 2 DRAFT Rev 2, Subsection 10.2.3.5 (2) on page 10.2-11).
- (B) Radiographs are not normally performed on solid castings or forgings.
- (C) The words 'and surface' have been removed from Subsection 10.2.3.6 (2) as these are all visual items for 10.2.3.6 (1), (2), and (3), (see page 10.2-12 of Rev-2 DRAFT, attached).

(D) A surface indication is blended. A subsurface indication is cut out and plug welded. The procedure for surface inspection will be supplied to the owner as a turbine owners maintenance manual with receipt of the turbine. All subsurface indications are addressed prior to the rotor being accepted and shipped to the owner.

(E) The acceptance criteria for blending will be included in the above manual. The repair method and acceptance criteria for subsurface indications is a GE proprietary procedure, not released to the public, and can be reviewed at the GEST manufacturing facility.

NRC RAI 10.2-13

DCD Section 10.2.3.5 discusses visual and/or surface examination of turbine rotors, buckets, and couplings. It is stated that turbine in-service inspections, as required by the ASME Code, are performed in sections during the refueling outages so that a total inspection is completed at least once within the time period recommended by the manufacturer. DCD Section 10.2.3.5(1) states that all accessible surfaces of rotors are examined visually.

(A) Discuss whether visual examinations are equivalent to VT-1, VT-2, or VT-3 as defined in ASME Section XI, IWA-2210.

(B) Discuss why the in-service inspection of rotors, buckets, couplings, and coupling bolts does not include volumetric examinations, which can detect subsurface flaws whereas the visual or surface examination is incapable of detecting subsurface flaws.

(C) Discuss whether the buckets are removed from the rotor when performing visual examinations of the rotor and buckets. If the buckets are not removed from the rotor, describe how the potential flaw(s) would be detected in the areas/regions where the buckets are attached to the rotor, i.e., the areas which are accessible to visual examinations.

(D) Identify the in-service inspection frequency and inspection techniques for each turbine component that requires inspection.

(E) Provide acceptance criteria for indications detected in rotors, buckets, and couplings during in-service inspection that require repair/removal.

If the information is unavailable at present, DCD Section 10.2.5.3 should include the following commitment: "The COL applicant will provide the in-service test and inspection requirements for turbine overspeed protection as noted in Subsections 10.2.3.5(2) & (4). The COL applicant will provide the in-service inspection program for turbine assembly components as noted in Subsection 10.2.3.5."

GE Response

(A) As discussed during the RAI teleconference, it was agreed that the first paragraph of Subsection 10.2.3.6 (old Subsection 10.2.3.5) was misread. The turbine inspections are "concurrent" or 'coinciding' with the reactor in-service inspections and are "NOT" Section XI inspections. This is a scheduling issue only.
(B) Subsurface inspections and repairs deemed necessary were addressed during the manufacturing cycle of the turbine. Repeated subsurface inspections are not required after manufacturing. Surface inspections will detect possible propagation of surface indications (pitting, cracks, erosion, and corrosion).
(C) Buckets are not removed from the rotor when performing visual examinations of the rotor and buckets. Surface examination at the rotor/bucket interface (root) is acceptable to detect new flaws as they propagate from the outside toward the inside and can be visually detected.
(D) The turbine in-service inspection program is discussed in the COL Unit Specific Information Subsection 10.2.5.3.
(E) The inspection results of the turbine components are compared to the pre-service inspection criteria. Any indications are evaluated and dispositioned as repair or replacement, as required.

NRC RAI 10.2-14

DCD Section 10.2.3.5(4) states that inspection of all valves of one type will be conducted if any unusual condition is discovered.

(A) Discuss the type of examination (e.g., volumetric, surface, or visual) that will be conducted and identify the valve components that will be examined.
(B) Clarify what is meant by "all valves of one type" because DCD Section 10.2.3.5(4) specifically states that all main stop valves, main control valves, and combined intermediate valves CIVs) will be inspected during the first three refueling outages or extended maintenance shutdowns.
(C) Include 'valve leakage' and 'cracks' as part of the inspection listed in DCD Section 10.2.3.5(4).
(D) Clarify whether the subject valves will be disassembled when performing the inspection.
(E) *It is stated that the subsequent inspections will be scheduled by the COL licensee in accordance with the BWROG turbine surveillance test program. Discuss whether this program is consistent with the inspection and testing of valves in the Operation and Maintenance Code of the ASME Code.*

GE Response

(A) The DCD Tier 2 DRAFT Rev 2, page 10.2-12, (new numbering) Subsection 10.2.3.7(4) has had the word "visually" included as an editorial clarification as agreed to by teleconference of 4-21-06.
(B) The last sentence of Subsection 10.2.3.7 has been editorial enhanced to specify, "one functional type" of valve (like "stop", "control", "intercept") to clarify that if one control valve is inspected and found to have an indication, all of the four (4) control valves will be inspected, not all of the turbine valves.
(C) Valve leakage is part of the "tightness tests" of Subsection 10.2.3.7(3). The word "cracks" has been added to Subsection 10.2.3.7(4) (see attached Rev 2 DCD page 10.2-12).
(D) The valves described in Subsection 10.2.3.7(4) will be disassembled to perform the inspections. These inspections will be described in Subsection 10.2.5.3.
(E) The BWROG turbine surveillance test program does NOT fall under the requirements of the ASME OM Code-2004, Code for Operation and Maintenance of Nuclear Power Plants, in accordance with Subsection ISTC: In-service testing of valves in Light-Water Reactor Plants. The O&M code of the ASME Code pertains only to safety-related valves required to shut down a reactor to safe shutdown condition and interfaces with the 1st/IST Section XI program, not the BWROG turbine surveillance test program.

NRC RAI 10.2-15

DCD Section 10.2.5.3 states that the COL applicant will provide the turbine in-service test and inspection requirements as noted in Subsection 10.2.3.5(2) and (4). There are two Subsections 10.2.3.5(2). One is related to visual and surface examination of all low-pressure buckets as shown on page 10.2-11 and one is related to the inspection of turbine overspeed valves as shown on page 10.2-12. Please clarify the numbering of these subsections.

GE Response

The numbering has been clarified/corrected to form new Subsection 10.2.3.7 "In-Service Inspection of Valves". The title of Subsection 10.2.3.6 is also changed to, "In-Service Inspection of Turbine", as an editorial clarification.

NRC RAI 10.2-16

Rotors and buckets may encounter the following degradation mechanisms: pitting, stress corrosion cracking, corrosion fatigue, low-cycle fatigue, erosion, and erosion-corrosion. Discuss how the environmental conditions, the operational parameters, design features, fabrication, material properties, and maintenance are managed and considered to mitigate degradation in the turbine rotor and buckets.

GE Response

Section 10.2.3, Turbine Integrity, and attached subsections for 10.2.3 give the design guidelines that will be followed during the initial turbine design, installation, pre-service inspection, in-service inspection, and testing program. These guidelines, together with the following of recommended operational and maintenance parameters will mitigate degradation in the turbine rotor and buckets. Section 10.2.4 (Evaluation) further describes that the turbine is designed, constructed and inspected to minimize the possibility of any major (turbine) component failure.

NRC RAI 10.2-17

DCD Section 10.2.1.3 states that the valve arrangements and valve closure times are such that a failure of any single valve to operate does not result in excessive overspeed in the event of a TG trip signal.
Provide a more detailed time of closure time requirements to ensure turbine stability following a TG trip with a single valve failure to close. Demonstrate how the ESBWR design minimizes the occurrence of such event.

GE Response

Refer to Subsection 10.2.2.4, third paragraph, for a description of the primary and emergency overspeed trip system and paragraph 8 for a description of the redundancy of the Stop and Control valves, which ensures stability after a trip, even if one valve in the series fails to close. Also refer to Subsection 10.2.2.5 for further turbine protection system items.

NRC RAI 10.2-18

DCD Section 10.2.2.4 describes the functionality and protection provided by the primary and emergency trip systems, including provisions for redundancy and reliability.

(A) Describe how the overspeed protection system provides diversity (e.g. mechanical trip device) as recommended in SRP Section 10.2.

(B) Provide a detailed description of the emergency trip fluid system and discuss its reliability, to ensure adequate performance, when either the primary or the emergency trip system actuates, thus closing all stop, control and combined intermediate valves.

(C) Discuss design provisions for single failure and common cause failure that could prevent the emergency trip fluid from performing its intended function.

(D) *Provide approximate percentage of rated speeds for systems actuation as described in SRP 10.2, Rev 2 (July 1981), Subsection III, Paragraphs 2(b), 2(c) and 2(d).*

GE Response

(A) A triple and redundant system, as described in Subsection 10.2.2.4, paragraphs 3, 4, and 5 replace the mechanical trip device. The diversity is provided through the Primary and Emergency systems. Redundancy is further provided for by using three (3) separate speed signals for the Primary Trip and speed control systems, and three (3) additional speed signals for the Emergency trip system.

(B) The 8th paragraph, 10th paragraph, and 11th paragraph of Subsection 10.2.2.4 provides a detailed description of the fail safe closure provisions that ensure closure of all steam valves required to protect the turbine from overspeed, even with failure of both the systems due to loss of all power to the hydraulic systems.

(C) The design provisions that prevent single cause and common cause failure from preventing closure of the steam valves is discussed in detail in paragraph 11 of Subsection 10.2.2.4.

(D) The COL Unit Specific Information, Subsection 10.2.5.2, Turbine Design Overspeed, will provide the approximate percentage of rated speeds for systems actuation as described in SRP 10.2, Rev 2 (July 1981), Subsection III, Paragraphs 2(b), 2(c), and 2(d).

NRC RAI 10.2-19

DCD Section 10.2.2.7 states that main steam stop valves and turbine control valves are exercised at least once a month by closing each valve and observing the remote valve position indicator for fully OPEN and fully CLOSED position status.
Explain the discrepancy with SRP 10.2, Rev 2 (July 1981), Subsection II, Paragraph 5, which recommends such valves be exercised at least once a week by observing the position indicator and once a month by direct observation. Also, provide justification for not including reheat stop and intercept valves.

GE Response

The Rev 2 DRAFT of the DCD tier 2, Subsection 10.2.2.7, Paragraph 3 has been revised to reflect that the "main steam stop and turbine control valves are exercised at least once within each calendar quarter by closing each valve and observing the remote valve position indicator for fully OPEN and fully CLOSED position status." The valves are tested only once each quarter since weekly operation could be a PRA concern for human error, also the weekly testing was derived from fossil plants that experience carry-over of silica at pressures greater than 1000 psig. Nuclear plants operate at or below 1000 psig (turbine throttle pressure) and will not have the valve blockage that is experienced at higher operating pressures with poor chemistry control. BWR nuclear power plants can't have direct observation due to ALARA program (N16 radiation), therefore remote valve indication is monitored in the Main Control Room.

Subsection 10.2.2.7 states that provisions for testing while the unit is operating are included; note (2) for CIVs. These valves are not tested in full OPEN or CLOSE as are main stop and control valves. The Reheat stop and intercept valves are tested using their control pack to move them from 3% to 5% which then indicates a functional valve at the valve position indication in the MCR.

NRC RAI 10.4-2

Section 10.4-1 of the SRP, Revision 2, July 1981, states that measures should be provided to prevent loss of vacuum, corrosion and/or erosion of MC tubes and components. Provide detailed description of measures to prevent loss of condenser vacuum.

GE Response

The design measures to prevent loss of condenser start with the treatment of circulating water that then prevents algae or other growth from fouling the condenser tubes. DCD Subsection 10.4.1.3, Paragraph 4, further mentions the tube metal selected will be of a stainless or titanium that resists erosion, corrosion, and galvanic action. The tube sheet will be selected to complement the tube material and resist corrosion and galvanic action. Coating of the water box material will provide further protection to the circulating water system from corrosion and galvanic action resulting from dissimilar metal of the tubes and tube sheet to the water box plate material. Subsection 10.4.5.4, Circulating Water, further addresses the selection of corrosion and erosion resistant tube material.
Further measures to prevent loss of condenser vacuum are described within the Condenser Air Removal System, Subsection 10.4.2.1(1) & (2), which establish and maintain a vacuum in the condenser using vacuum pumps for startup and steam jet air ejectors during operation to maintain the condenser vacuum. The Turbine gland Seal System, Subsection 10.4.3, describes how gland seal steam prevents air-in leakage from the turbine gland seals from entering the system and the condenser at the sub-atmosphere glands of the low-pressure turbines. The turbine and condenser expansion joint provides a seal between the turbine and the condenser to prevent loss of vacuum at the joint.

NRC RAI 10.4-3

DCD Tier 2, Section 10.4.1.5.4 states that leakage of circulating water into the condenser shell is monitored by the online instrumentation and the process sampling system described in Section 9.3.2.
Conductivity of the condensate is continuously monitored at selected locations in the condenser. Conductivity and sodium are continuously monitored at the discharge of the condensate pumps. High condensate conductivity and sodium content, which indicate a condenser tube leak, are individually alarmed in the main control room.

Provide a detailed description of controlling and correcting methods including alarm setpoints, operator intervention and plant response as described in Section 10.4.1 of the SRP, Revision 2, July 1981.

GE Response

The COL Unit Specific Subsection 10.4.10.5 (DCD DRAFT Rev-2 attached) will provide threshold values and recommended operator actions for chemistry excursions in the condensate system.

NRC RAI 10.4-4

DCD Tier 2, Section 10.4.4.2.3 states that the turbine bypass control system can malfunction in either the open or closed mode, but requires multiple failures to do so.

Describe the ESBWR design provisions to preclude component or tube failure due to steam blowdown from the turbine bypass system when the system fails in the open position, as described in Section 10.4.1 of the SRP, Revision 2, July 1981.

GE Response

The plant will be designed and analyzed for the bypass system to pass 110% of the rated main steam flow. The bypass system is designed with pressure reducers prior to the condenser. The condenser will be designed with inlet baffles and impingement plates to preclude component or tube failures. Turbine low-pressure diaphragms are also installed in the condenser to protect the condenser and turbine from over-pressure damage.

NRC RAI 10.4-5

DCD Tier 2, Section 10.4.2.3 states that steam supply to the second-stage ejector is maintained at a minimum specified flow to ensure adequate dilution of hydrogen and prevent the off-gas from reaching the flammability limit of hydrogen. In addition, maximum power limits are placed on operation of the mechanical vacuum pumps to ensure the flammability limit of hydrogen is not reached.

Provide minimum steam flow, maximum power limit on the operation of the vacuum pump and design steam content volume percentage, in accordance with Section 10.4.2 of the SRP, Revision 2, July 1981, to ensure hydrogen flammability levels are not reached.

GE Response

The staff agreed that this RAI is applicable only if the ESBWR design includes a Hydrogen Water Chemistry System (HWC). RAI's 9.3-1 and 10.4-1 have already answered that the HWC is an option of the owner as a later plant modification and "is not offered in the ESBWR standard plant design [Per Subsection 9.3.9.1 and Reference 9.3-1, provisions (space and shielding in the turbine building) have been made to install the HWC system as a COL option.]".

NRC RAI 10.4-6

Provide ITAAC in the DCD Tier 1 for the TGSS or the rational for not providing.

GE Response:

Tier 2 Subsection 14.3.2 states "the Tier 1 entry for many systems with no safety significance (i.e., are not important to safety) is limited to the system name only and does not include any design description or ITAAC material." The ESBWR Turbine Gland Seal System neither performs or supports a safety-related function, and thus, is not safety-related (see Tier 2 Table 3.2-1(N33) and Subsection 10.4.3.1). Nor does it qualify as important to safety, as defined in Tier 1 Subsection 1.2.1. A TGSS failure would not result in an accident. A TGSS failure could result in air inleakage through sub-atmosphere turbine glands. If significant in-leakage were to occur, condenser vacuum could decrease to the point where a plant shutdown would initiate. This scenario constitutes a non-limiting anticipated operational occurrence (AOO), which does not result in the MCPR safety limit being exceeded, and thus, there would be no fuel damage. (The limiting loss of condenser vacuum scenario is an analyzed event in Tier 2 Subsection 15.2.2.8.) A TGSS failure also could result is some steam leakage into the Turbine Building. This event would be detected by radiation monitoring, before any 10 CFR 20 dose limit would be exceeded, and could require a plant shutdown. TGSS failures more represent operational concerns and not any significant safety concern. As described in Subsection 10.4.3.1, the TGSS does not qualify as part of the ESBWR "design bases," as defined in 10 CFR 50.2. Including a system description with an ITAAC for the TGSS would not provide any additional "reasonable assurance that the facility can be operated without undue risk to the health and safety of the public," as specified in 10 CFR 50, Appendix A. Therefore, a Tier 1 system description with an ITAAC for the TGSS is not required.

NRC RAI 10.4-7

DCD Tier 2, Section 10.4.4.2 states that the TBS, in combination with the other reactor systems, provides the capability to shed 100% of the TG rated load without the operation of the SRVs.

Section 2.12.5 of the ITAAC 9DCD Tier 1) states that the TBS capability is 110% of the TG rated load.

Provide clarification of the actual percentage of turbine load shedding capability.

GE Response

The TBS is designed to accept 110% of the rated main steam flow, as analyzed. The TBS will, therefore be capable of accepting a 100% TG rejection and act as the heat removal sink during reactor ramp down prior to reactor trip.

The ITAAC for the TBS Tier 1 will have an editorial clarification to reflect that the TBS capacity is 110% of the rated Main Steam flow.

NRC RAI 10.4-8

SRP Section 10.4.7, Revision 3, April 1984, stipulates that the condensate and feedwater system or other plant systems provide the capability to detect and control leakage from the system.

Describe systems and components that provide capability to detect and control leakage as stated in Section 10.4.7 of the SRP.

GE Response

DCD Section 3.4.1.4.3 contains the turbine building flood plan.

The turbine building sump indication in the condenser space will sense high level that would be indicative of a circulating water line break at the condenser and trip the CIRC Pumps and shut the isolation valves.

If the flood from a condenser is not isolated, breakaway panels will open at the ground level to prevent the total turbine building from being flooded.

Also, Auxiliary Operator rounds will detect any other minor leakage in normally accessed non-radiation zones.

NRC RAI 10.4-9

Rev 01 of DCD Tier 2, Section 10.4.5.6 states that the flooding of the Turbine Building due to CIRC failures would not affect the limited safety-related equipment in that building, because such equipment located inside the Turbine Building and all plant safety-related facilities are protected against site surface water intrusion and plant safety-related facility flooding through Turbine Building interconnecting tunnels is avoided.

Provide detailed elevation drawings to support these statements.

GE Response

The TB ground elevation drawing is found in Figure 1.2-13 of the DCD Tier 2. Subsection 3.4.1.4.3 also provides a description in the second paragraph of this subsection that explains the details of why TB flooding will not affect any safety-related buildings.

10.2.2.3 Normal Operation

During normal operation, the main stop valves and CIVs are wide open. Operation of the TG is under the control of the Turbine Control System (TCS). The Steam Bypass and Pressure Control System (SB&PC) controls the turbine control valves through the TCS to regulate reactor pressure. The normal function of the TCS is to generate the position signals for the four main stop valves, four main control valves, and six CIVs.

10.2.2.4 Turbine Overspeed Protection System

1 The turbine control and overspeed protection system controls turbine action under all normal or abnormal operating conditions, and ensures that a full load rejection does not cause the turbine to overspeed beyond acceptable limits. Under these conditions, the control and protection system permits an orderly power reduction using the turbine bypass system and the Select Control Rod Run-In (SCRRI) function. The overspeed protection system meets the single failure criterion and is testable when the turbine is in operation.

2 In addition to the normal speed control function provided by the turbine control system, a separate turbine overspeed protection system is included. The turbine overspeed protection system is a highly reliable and redundant system, which is classified as nonsafety-related.

3 Protection against turbine overspeed is provided by the Primary Electrical overspeed system and the Emergency overspeed trip system. Redundancy is achieved by using three (3) separate speed signals for the Primary Trip and speed control systems, and three (3) additional speed signals for the Emergency trip system.

4 The overspeed sensing devices, tooth wheel and speed pickup probes, are located in the Turbine front standard and, therefore, are protected from the effects of missiles or pipe break. The hydraulic lines are fail-safe; that is, if one were to be broken, loss of hydraulic pressure would result in a turbine trip. The electric trip signals are redundant. One circuit could be disabled by damage to the wiring, but the other system is fail-safe (i.e., loss of signal results in a turbine trip). These features provide inherent protection against failure of the overspeed system caused by missiles or pipe whipping.

5 The Primary and Emergency electrical trip overspeed modules each consist of three (3) independent circuits. Each circuit monitors a separate speed signal and activates trip logic at various speed levels. The output of these circuits is used in tripping and monitoring of the turbine, as well as speed control within the Primary trip module. The turbine trip is initiated upon failure of two of the three channels. Either trip module can de-energize the electro-hydraulic 2-out-of-3 Emergency Trip Device (ETD), thereby dumping the emergency trip fluid to all steam valve actuators, resulting in a turbine trip. The ETD is configured with 2-out-of-3 trip logic, and includes three (3) electrical trip solenoid valves, all de-energized to trip. Any two (2) trip solenoid valves shifting to the trip position will cause the emergency trip fluid to be de-pressurized. The ETD is testable on-line, such that each individual trip solenoid valve can be tested one at a time.

6 Two air relay dump valves are provided which actuate on turbine trip. The valves control air to the extraction non-return valves, which limit contributions to turbine overspeed from steam and water in the extraction lines and feedwater heaters. The closing time of the extraction non-return valves is less than 2 seconds.

Upon loss of generator load from any initial load conditions, the TCS acts to prevent rotor speed from exceeding the overspeed trip, and controls the speed of the turbine to run the house load. Failure of any single component does not result in rotor speed exceeding design overspeed. The following component redundancies are employed to guard against overspeed:

(1) Main stop valves/Control valves;

(2) Intermediate stop valves/Intercept valves;

(3) Primary Speed Control/Power-load Unbalance Circuits/Emergency Trip Device solenoid valves;

(4) Fast acting solenoid valves/Emergency trip fluid system; and

(5) Speed Control/Primary Overspeed trip/Emergency Overspeed trip.

The main stop valves and control valves provide full redundancy in that these valves are in series and have completely independent operating controls and operating mechanisms. Closure of either all four stop valves or all four control valves shuts off all main steam flow to the HP turbine. The combined intermediate stop and intercept valves are also in series and have completely independent operating controls and operating mechanisms. Closure of either valve or both valves in each of the six sets of combined intermediate stop and intercept valves shuts off all MSR outlet steam flow to the three LP turbines.

The speed control unit utilizes at least three speed signals, configured in a 2-out-of-3 control scheme. An increase in turbine speed tends to close the control valves. Loss of two speed signals initiates a turbine trip via the Emergency Trip System (ETS).

Fast acting valves initiate fast closure of control and intercept valves under load rejection conditions that might otherwise lead to rapid rotor acceleration. At loads exceeding 40%, the Power-Load Unbalance (PLU) circuits are armed to provide these signals to the fast-acting valves on the control and intercept valve actuators. A rapid dump of the ETS fluid system due to de-energization of the ETS trip solenoid valves initiates fast closure of these steam valves whether the fast-acting solenoid valves work or not.

If speed control should fail, the overspeed trip devices must close the steam admission valves to prevent turbine overspeed. Component redundancy and fail-safe design of the ETS hydraulic system and trip circuitry provide turbine overspeed protection. Three speed signals independent of the speed control unit provide input to the backup, overspeed trip. For reliability, two-out-of-three logic is employed in both Primary and Emergency overspeed trip circuitry. Single component failure does not compromise trip protection. Loss of power trips the turbine through fail-safe circuitry.

10.2.2.5 Turbine Protection System

In addition to the overspeed trip signals discussed, the ETS closes the main stop and control valves and the CIVs to shut down the turbine on the following signals.

(1) Emergency trip pushbutton in control room

(2) Moisture separator high level

(3) High condenser pressure

(4) Low lube oil pressure

(5) LP turbine exhaust hood high temperature

(6) High reactor water level

(7) Thrust bearing wear

(8) Overspeed (Primary and Emergency trip systems)

(9) Manual Push-button on front standard

(10) Loss of stator coolant

(11) Low hydraulic fluid pressure

(12) Any generator trip

(13) Loss of TCS electrical power

(14) Excessive turbine shaft vibration

(15) Loss of two speed signals – either Primary or Emergency

(16) Loss of two pressure control channels

All of the above trip signals except generator trips, loss of power, vibration and manual trips use 2/3 coincident trip logic.

When the ETS is activated, it overrides all operating signals and trips the main stop and control valves, and combined intermediate valves by way of their disk/dump valves.

10.2.2.6 Turbine-Generator Supervisory Instruments

Although the turbine is not readily accessible during operation, the turbine supervisory instrumentation is sufficient to detect most malfunctions. The turbine supervisory instrumentation includes monitoring of the following:

(1) Vibration and eccentricity

(2) Thrust bearing wear

(3) Exhaust hood temperature and spray pressure

(4) Oil system pressures, levels and temperatures

(5) Bearing metal and oil drain temperatures

(6) Shell temperature

(7) Valve positions

(8) Shell and rotor differential expansion

(9) Shaft speed, electrical load, and control valve inlet pressure indication

(10) Hydrogen temperature, pressure and purity

(11) Stator coolant temperature and conductivity

(12) Stator-winding temperature

(13) Exciter air temperatures

(14) Turbine gland sealing pressure

(15) Gland steam condenser vacuum

(16) Steam chest pressure

(17) Seal oil pressure

10.2.2.7 Testing

The Primary and Emergency overspeed trip circuits and devices can be tested remotely at rated speed, under load, by means of controls on the TCS operator interface panel. Operation of the overspeed protection devices under controlled, overspeed condition is checked at startup and after each refueling or major maintenance outage.

During refueling or maintenance shutdowns coinciding with the in-service inspection schedule required by Section XI of the ASME Code for reactor components, at least one main steam stop valve, one turbine control valve, one reheat stop valve, and one reheat intermediate valve are dismantled to conduct visual and surface examinations of valve seats, disks and stems. If unacceptable flaws or excessive corrosion is found in a valve, all other valves of that type would be dismantled and inspected. Valve bushings will be inspected and cleaned, and bore diameters should be checked for proper clearance.

Main steam stop valves and turbine control valves are exercised at least once within each acalendar ~~month~~ quarter by closing each valve and observing the remote valve position indicator for fully OPEN and fully CLOSED position status. 10.2-18 1st PARA

Unlimited access to required areas (outside radiation shielded areas) around the turbine under operating conditions is provided. ~~Radiation shielding is provided as necessary to permit access.~~

Provisions for testing each of the following devices while the unit is operating are included: 10.2-18 2nd para

(1) Main steam stop valves and turbine control valves

(2) Low pressure turbine combined intermediate valves (CIVs)

(3) Emergency trip devices

(4) Turbine extraction non-return valves

(5) Remote trip solenoids

(6) Lubricating oil pumps

(7) Control fluid pumps

(8) Primary and Emergency trip device

(9) Power-load Unbalance circuits

10.2.3 Turbine Integrity

10.2.3.1 Materials Selection

Turbine rotors and parts are made from vacuum melted or vacuum degassed Ni-Cr-Mo-V alloy steel by processes, which minimize flaw occurrence and provide adequate fracture toughness. ~~Tramp e~~Elements such as sulfur and phosphorus are controlled to ~~the lowest practical concentrations consistent with good scrap selection and melting practice, and consistent with obtaining adequate initial and long life fracture toughness for the environment in which the parts operate~~low levels. Chemical analysis should be made for each forging. The ~~turbine materials have the lowest~~ fracture appearance transition temperatures (50%FATT) ~~and highest~~as obtained from Charpy ~~V-notch energies obtainable, on a consistent basis, from water-quenched Ni-Cr-Mo-V material at the sizes and strength levels used~~tests performed in accordance with the specification ASTM A-370 should be no higher then 0°F for low pressure turbine disks. Nil-ductility transition (NDT) temperature obtained in accordance with specification ASTM E-208 may be used in lieu of FATT. NDT temperatures should be no higher than –30°F. The processing is controlled to maintain the FATT below -1°C (30°F) and to maintain the room temperature Charpy V-notch (Cv) energy ~~above 61J (~~at the minimum operating temperature of each low-pressure disk in the tangential direction should be at least.~~45~~60 ft-~~lbf~~lbs~~) in all areas of the rotor~~. A minimum of three Cv specimens should be tested in accordance with specification ASTM A-370.

10.2.3.2 Fracture Toughness

Suitable material toughness is obtained through the use of selected materials as described in Subsection 10.2.3.1, to produce a balance of material strength and toughness to ensure safety while simultaneously providing high reliability, availability and efficiency during operation.

Stress calculations include components due to centrifugal loads, interference fit and thermal gradients where applicable. The ratio of material fracture toughness, K_{IC} (as derived from material tests on each major part or rotor), to the maximum tangential stress at speeds from normal to ~~115% of rated~~design overspeed, is at least ~~$10\ mm^{1/2}$~~two SQRT-in at minimum operating temperature. Adequate material fracture toughness needed to maintain this ratio is assured by a large historical database of tests.

Turbine operating procedures are employed to preclude brittle fracture at startup by ensuring that metal temperatures are (a) adequately above the FATT, and (b) as defined above, sufficient to maintain the fracture toughness to tangential stress ratio at or above $10\ mm^{1/2}$. Sufficient warm-up time is specified in the turbine operating instruction to ensure that toughness is adequate to prevent brittle fracture during startup. (See COL information, Subsection 10.2.5.1.)

10.2.3.3 High Temperature Properties

The operating temperatures of the high-pressure rotors are below the stress rupture range. Therefore, creep-rupture is not a significant failure mechanism.

10.2.3.4 Turbine Design

The turbine assembly is designed to withstand normal conditions~~, and~~ anticipated transients (anticipated operational occurrences), and accidents~~including those~~ resulting in turbine trip, without loss of structural integrity. The design of the turbine assembly meets the following criteria:

(1) Turbine shaft bearings are designed to retain their structural integrity under normal operating loads~~-and~~, anticipated transients, ~~including those leading to~~and accidents resulting in turbine trips.

(2) The multitude of natural critical frequencies, of the turbine shaft assemblies existing between zero speed and 20% overspeed, are controlled in the design and operation so as to cause no distress to the unit during operation. (See Subsection 10.2.5.5)

(3) The maximum turbine ~~disk~~-rotor tangential stress resulting from centrifugal forces, interference fit, and thermal gradients does not exceed 0.75 of the yield strength of the materials at 115% of rated speed.

(4) Turbine components are designed for an overspeed far above the 8% ~~higher than normal overspeed~~ resulting from a loss of load. The basis for the assumed overspeed ~~will be submitted to the NRC staff for review. (See~~are described in Subsection 10.2.~~5.2 for COL information.)~~3.5 (4) (see Subsection 10.2.5.2).

(5) The turbine ~~disk~~-rotor design facilitates in-service inspection of all high stress regions, including bores and keyways.

~~10.2.3.4~~ 10.2.3.5 Pre-service Inspection

The pre-service procedures and acceptance criteria are as follows:

(1) Forgings are rough machined with minimum stock allowance prior to heat treatment.

(2) Each finished machined rotor is subjected to 100% volumetric (ultrasonic), and surface visual examinations, using established acceptance criteria~~. These criteria are more restrictive than those specified for Class 1 components in the ASME Boiler and Pressure Vessel Code, Sections III and V, and include the~~ and requirement that subsurface sonic indications are either removed or evaluated to ensure that they do not grow to a size which would compromise the integrity of the unit during its service life.

(3) All finished machined surfaces are subjected to a magnetic particle test with no flaw indications permissible.

(4) Each fully bucketed turbine rotor assembly is spin tested at the highest anticipated speed resulting from a loss of load.

Additional pre-service inspections include air leakage tests performed to determine that the hydrogen cooling system is leak-tight before hydrogen is introduced into the generator casing. The hydrogen purity is tested in the generator after hydrogen has been introduced. The generator windings and all motors are megger tested. Vibration tests are performed on all motor-driven equipment. Hydrostatic tests are performed on all coolers. All piping is pressure tested for leaks. Motor-operated valves are factory leak tested and in-place tested once installed.

~~10.2.3.5~~ 10.2.3.6 In-service Inspection of Turbine

The in-service inspection program for the turbine assembly includes the complete inspection of all normally inaccessible parts, such as couplings, coupling bolts, turbine shafts, low-pressure turbine buckets, low-pressure and high-pressure rotors. During plant shutdown (coinciding with the in-service inspection schedule for ASME Section III components, as required by the ASME Boiler and Pressure Vessel Code Section XI,) turbine inspection is performed in sections during the refueling outages so that a total inspection has been completed at least once within the time period recommended by the manufacturer.

This inspection consists of visual and surface examinations as indicated below:

(1) Visual examination of all accessible surfaces of rotors.

(2) Visual ~~and surface~~ examination of all low-pressure buckets.

(3) 100% visual examination of couplings and coupling bolts.

10.2.3.7 ~~The i~~In-~~service~~Service ~~inspection~~ Inspection of Turbine ~~v~~Valves ~~important to overspeed protection includes the following:~~

(1) All main stop valves, control valves, extraction non-return valves, and CIVs will be tested under load. Test controls installed on the main control room (MCR) turbine panel permit full stroking of the stop valve, control valves, and CIVs. Valve position indication is provided on the ~~main control room~~MCR panel. Some load reduction ~~is~~ may be necessary before testing main stop and control valves, and CIVs. Extraction non-return valves are tested, by equalizing ~~air~~ pressure across the ~~air~~ cylinder. ~~Movement of the valve arm is observed upon action of the spring closure mechanism.~~

(2) Main stop valves, control valves, extraction non-return valves, and CIVs will be tested ~~by the COL licensee~~ in accordance with the BWROG turbine surveillance test program(see Subsection 10.2.5.3), by closing each valve and observing by the MCR valve position indication that the valve moves smoothly to a fully closed position. Closure of each main stop valve, control valve and CIV during test will be verified by observation of the ~~valve motion~~MCR valve position indication.

(3) Tightness tests of the main stop and control valves are performed at least once per maintenance cycle by checking the coast down characteristics of the turbine from no load with each set of four valves closed alternately.

(4) All main stop valves, main control valves, and CIVs will be visually inspected once during the first three refueling or extended maintenance shutdowns. Subsequent inspections will be, scheduled ~~by the COL licensee,~~ in accordance with the BWROG turbine surveillance test program (see Subsection 10.2.5.3). The inspections will be conducted for:

   a. Wear of linkages and valve stem packing;

   b. Erosion of valve seats and stems;

   c. Deposits on stems and other valve parts, which could interfere with valve operation; and

   d. Distortions, misalignment, or cracks.

Inspection of all valves of one functional type (like stop, control, intercept) will be conducted if any unusual condition is discovered during the inspection of any single valve.

10.2.4 Evaluation

The turbine-generator is nonsafety-related, and is not needed to effect or support a safe shutdown of the reactor.

The turbine is designed, constructed, and inspected to minimize the possibility of any major component failure.

The turbine has a redundant, testable overspeed trip system to minimize the possibility of a turbine overspeed event.

Unrestrained stored energy in the extraction steam system has been reduced to an acceptable minimum by the addition of non-return valves in selected extraction lines.

The TG equipment shielding requirements and the methods of access control for all areas of the Turbine Building ensure that the dose criteria specified in 10 CFR 20 for operating personnel are not exceeded.

All areas in proximity to TG equipment are zoned according to expected occupancy times and radiation levels anticipated under normal operating conditions.

Specification of the various radiation zones in accordance with expected occupancy is listed in Chapter 12.

If deemed necessary during unusual occurrences, the occupancy times for certain areas will be reduced by administrative controls enacted by health physics personnel.

The design basis operating concentrations of N^{16} in the turbine cycle are indicated in Section 12.2.

The connection between the low-pressure turbine exhaust hood and the condenser is made by means of a rubber or stainless steel expansion joint.

Because there is no safety-related mechanical equipment in the turbine area, and because the condenser is at sub-atmospheric pressure during all modes of turbine operation, failure of the joint would have no adverse effects on safety-related equipment.

The TG trip logic and control schemes respectively use coincident logic and redundant controllers and input signals to assure that the plant availability goals are achieved and spurious trips are avoided.

10.2.5 COL Unit Specific Information

10.2.5.1 Low Pressure Turbine Disk Fracture Toughness

~~The COL applicant will provide turbine material property data and assure sufficient turbine warm-up time as required by Subsection 10.2.3.2.~~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.

RAI 10.2-6
10.2-2

10.2.5.2 Turbine Design Overspeed

The ~~COL applicant will provide the basis for the~~ turbine overspeed ~~as required by Subsections 10.2.3.3(4) and 10.2.3.4(4)~~protection design features (including overspeed trip setpoints) will be provided in a COL FSAR update, after the turbine has been purchased.

10.2.5.3 Turbine In-service Test and Inspection

~~The COL applicant will provide the turbine in-service test and inspection requirements as noted in Subsection 10.2.3.5(2) and (4)~~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.

10.2.5.4 Extraction Non-return Values

~~The extraction lines where the non-return valves are used will be defined in the COL phase~~Where needed to prevent over speeding or water entrainment, the steam extraction lines will be provided with non-return valves.

10.2.5.5 Turbine General Design Description

The COL applicant will provide a general description of the overall turbine rotor (disk) design, including number of stages, bucket (blade) design, how the buckets are attached to the rotor, and whether the turbine rotor is forged. (Provide diagrams and figures of the design.) Torsional vibration analysis is provided with the turbine general design to show that the turbine generator rotor resonance is outside of the normal operating frequency and its harmonics.

10.2.6 References

10.2-1 J. A. Begley and W.A. Logsdon, Westinghouse Scientific Paper 71-1E7 MSLRF-P1.

10.2-2 ~~EPRI NP-5283-SR-A~~Electric Power Research Institute, "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations – 1987,"EPRI NP-5283-SR-A, September 1987~~Revision"~~.

10.4.10.4 Circulating Water System

A compatable design description (Subsection 10.4.5.2) shall be provided in the COL phase (See Subsection 10.4.5.7.2).

An evaluation (Subsection 10.4.5.3) shall be provided in the COL phase (See Subsection 10.4.5.7.2).

Tests and Inspections (Subsection 10.4.5.4) shall be provided in the COL phase (See subsection 10.4.5.7.2).

A permanent flow meter installation shall be analyzed in the COL phase (See Subsection 10.4.5.5) as well as Instrument Application provided for in the COL phase (See Subsection 10.4.5.7.2).

Flood Protection (Subsection 10.4.5.6) shall be provided in the COL phase (See Subsection 10.4.5.7.2).

10.4.10.5 Leakage (of Circulating Water into the Condenser)

The COL will provide threshold values and recommended operator actions for chemistry excursions in the condensate system. RAI 10.4-3