

APR1400 Design Certification

Resolution of Turbine Issues Section 10.2.3



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Purposes

- Discuss draft resolution of MCB issues relating to Turbine Design Section 10.2.3
- Receive NRC feedback

Background (1/1)

Approach Determined by Not Specifying Particular Turbine

- Detailed turbine design characteristics not known yet
- Specifically how protection against turbine missiles is assured will depend on unit selected by COL applicant
 - Limit turbine missile probability to less than value in section 3.5.1.3
 - Rotor design (monoblock vs. welded vs. shrunk on disk)
 - Material properties, including fracture toughness
 - Vendor specific turbine missile probability analysis methodology
 - Probability results depend on preceding items
 - Inspection frequency and methods depend on missile probability analysis
- Applicable regulations and guidance considered in preparing APR1400 DCD

Regulatory Requirements/Guidance

SRP & RG 1.206: 10.2.3

- Demonstrate rotor integrity, specifically:
 - Materials Selection. Forged or welded rotor made from material and by process to minimize flaw occurrence and maximize fracture toughness properties; material should be examined and tested
 - Fracture Toughness. LP disk forged or welded rotor fracture toughness properties acceptable if specified criteria are met.
 - Pre-service Inspection. Acceptable if meets specified criteria.
 - Turbine Rotor Design. Designed to withstand normal conditions, anticipated transients, and accidents resulting in a turbine trip without loss of structural integrity and meets specified criteria.
 - Inservice Inspection. Acceptable if meets specified criteria.
- SRP 3.5.1.3 discusses turbine missile probability analysis

NRC Comments

Issue #1

- Delete incomplete sentence that reads “In-service test, inspection and frequency.” in Tier 1 of the APR1400 FSAR, Table 2.7.1.1-1, ITAAC Number 7 since it is an editorial error.

Response: Suggested changes will be made

NRC Comments

Issue #2

- NRC notes there are 3 turbine design options
 1. Integral/monoblock
 2. Welded
 3. Shrunk on disk
- Staff understands DCD allows for 1 or 2, but not 3
- If correct, revise Section 10.2.3.1 to say large integral forgings or welded rotors using multiple forgings will have a 50 percent FATT, as obtained from Charpy tests performed in accordance with ASTM A-370 that is no higher than -18°C (0°F) for low-pressure turbine forgings.

Resolutions

Issue #2 Response

- The staff is correct regarding there being three design options
- APR1400 DCD allows COL applicant to use any of the three
- The NRC has previously and recently accepted any of the three for new or backfit rotors, provided appropriate requirements are met
- SRP 10.2.3 was last issued as Revision 1 in 1981
 - Predates growth in use of monoblock designs which have material properties which vary with depth in forging due to rate of cooling.
 - Includes material properties applicable to only shrunk on disk designs.
 - Feb 2015 ACRS letter on **STP3&4 COL** review noted that SRP 10.2.3: “acceptance criteria regarding Charpy V-notch energy and fracture appearance transition temperature need to be updated to address differences between turbine rotors fabricated with shrunk-on discs versus monoblock rotors.”
 - The ACRS indicates that the staff agreed with this assessment.

Resolutions

Issue #2 Response continued

- APR1400 DCD had allowed for material property differences by including statement “If used, the larger size of integral rotors limits the achievable properties at the rotor body center bore. The 50 percent FATT, as obtained from Charpy tests performed in accordance with ASTM A-370, is no higher than -1.1°C (30°F) and the Charpy V-notch energy at the minimum operating temperature is at least 6.22 kg-m (45 ft-lbf).”
- This was consistent with staff acceptance of ESBWR in SER.
- Based on Feb 2015 ACRS letter, DCD will be revised to eliminate premature identification of material properties that could conflict with ACRS requested revision of SRP and cause the COL applicant to require a departure.
- Not including the value is consistent with requiring COL applicant to perform turbine missile probability analysis at time rotor design and properties are known.
- Will revise DCD to clarify this.

NRC Comments

Issue #3

- APR1400 FSAR, Section 10.2.3.5 states “Non-return check valves are inspected by an inspection program in accordance with vendor recommendations.” Revise to state, “Non-return check valves are inspected by an inspection program in accordance with vendor recommendations as supported by the turbine missile probability analysis.”
- **Response: suggested changes will be made**

NRC Comments

Issue #4

- NRC notes
 - COL Item 10.2(3) requires the COL applicant is to provide a description of how the turbine missile probability analysis conforms with DCD Subsection 10.2.3.6 to ensure that the requirements for protection against turbine missiles will be met.
 - NUREG-0800, “Standard Review Plan,” Section 10.2.3, “Turbine Rotor Integrity,” and Regulatory Guide (RG) 1.115, Revision 2, “Protection Against Turbine Missiles,” state a turbine missile probability analysis is to be submitted to the NRC for review and approval. Therefore, this COL Item 10.2(3) should be revised accordingly as follows: “The COL applicant is to submit a turbine missile probability analysis which conforms with Subsection 10.2.3.6 to demonstrate that the requirements for protection against turbine missiles ...will be met.”

Resolutions

● Issue #4 Response

- New plant turbine missile probability analysis is ensured by ITAAC.
- APR1400, ITAAC 8a in Tier 1 Table 7.1.1-1 requires existence of a turbine missile probability report.
- Other ITAAC address other attributes of missile protection (e.g. inspection).
- Requiring COL Applicant to submit report for approval is not needed
 - inconsistent with ITAAC approach
 - our understanding is that it is not required by regulation
 - more than done by other DC applicants.
- COL items direct COL applicant on information to be included in the COL, which itself is reviewed and approved by the NRC.

Conclusions

- **APR1400 DCD contains sufficient ITAAC and COL information items to ensure COL applicant:**
 - Obtains appropriate rotors
 - Ensures all required documentation available for NRC review as part of COL or ITAAC Closure Notice Packages
- **We request issues 1, 3 and 4 be clarification items and issue 2 be an RAI.**