REQUEST FOR ADDITIONAL INFORMATION 598-4754 REVISION 2

6/15/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 10.02 - Turbine Generator
Application Section: 10.2

QUESTIONS for Balance of Plant Branch 1 (AP1000/EPR Projects) (SBPA)

10.02-3

RAI 10.02-5

SRP Section 10.2 specifies that turbine overspeed protection systems should include both redundancy and diversity. Additionally, operating experience insights need to be addressed in accordance with 10 CFR 52.47(a)(22) requirements. Diversity is important to minimize common-cause and common-mode failure vulnerabilities. Turbine overspeed protection for the US-APWR satisfies the SRP guidance in that both electric and mechanical turbine overspeed protection systems are provided. However, the description provided in Tier 2 Section 10.2 is insufficient for the staff to determine if common-cause and common-mode failures have been adequately considered and addressed by the design. Therefore, the following additional information is needed:

1) The description of the turbine overspeed protection systems should clearly indicate what parts are shared. For example, shared air and hydraulic dump lines and components such as trip blocks, dump valves and reservoirs should be described in the DCD. For clarity, the response should include schematic diagrams that show these flow paths, applicable components, and valves being actuated (i.e., turbine stop, control, reheat stop, intercept, and extraction non-return valves).

2) Common mode and common cause failure vulnerabilities that could prevent the turbine overspeed trip systems from functioning properly and are pertinent to the design should be addressed. While Tier 2 Section 10.2 indicates that the problems identified in NUREG-1275, “Operating Experience Feedback Report – Turbine-Generator Overspeed Protection Systems,” have been addressed by the design, there is no discussion of design considerations that are important in this regard. A summary discussion is needed to explain how common-cause and common-mode failure vulnerabilities that are pertinent to the design have been addressed. For example, solenoid valves, steam isolation valves, hydraulic systems, air systems, and binding of mechanical trip devices have historically been problematic in this regard. Also, the potential for flow restrictions to occur in hydraulic or air system dump lines is of concern and should be addressed (especially in those cases where small diameter flow paths are used such as could be the case in trip blocks, or where redundant flow paths are not provided). Design and programmatic measures that provide assurance that these common-mode and common-cause failures are not likely to occur should be described and

means to ensure proper implementation by COL applicants should be established as appropriate.

- The use of certain materials that are not subject to corrosion, conditioning equipment, desiccants, filters and design standards are examples of design considerations that may be pertinent for addressing some common-mode and common-cause failures.

- Implementation of periodic surveillance and inspections (including diagnostic routines that assess the status of turbine generator control and overspeed protection functions), maintenance, testing, and corrective actions are examples of programmatic controls that may be applicable for assuring that common-mode and common-cause failures are prevented from occurring. For example, measures that ensure the reliable performance of components and the quality of hydraulic and air systems are pertinent in this regard.

10.02-4

RAI 10.2-6

SRP Section 10.2, Subsection III, specifies review considerations that pertain to the turbine-generator system. Sufficient information is needed for the reviewer to evaluate the turbine-generator systems, including subsystems and components, that are considered essential for the safe integrated operation of the facility. Additionally, operating experience insights need to be addressed in accordance with 10 CFR 52.47(a)(22) requirements. The responses that were provided to RAIs 10.2-1 through 10.2-4 and related DCD markups provided additional information and clarification concerning design features associated with the turbine-generator system. However, the information in the DCD continues to be incomplete and confusing in some respects. Consequently, additional information is needed and the description in the DCD should be revised accordingly to address the following considerations:

1) Typically, extraction steam non-return isolation valves (NRVs) must be credited to prevent the turbine from exceeding the design overspeed limit of 120 percent of rated speed following a loss of load event (given a single failure and no credit for normal speed control). However, the description does not address this consideration and identify those NRVs that must be credited in this regard, including locations where they are needed (also locations where two valves are necessary to address single failure considerations) and valve types that are used; how they interface with the turbine overspeed protection systems; and how these valves will be inspected, maintained, and tested to ensure adequate performance over the life of the plant. This information should be included in the DCD.

2) Tier 2 Section 10.2.1.2 indicates that the turbine control system is designed to trip the turbine generator upon failure of the turbine control system. However, failures that can occur and associated consequences with respect to turbine

overspeed protection are not very well explained in Tier 2 Section 10.2.2.3 and additional information should be provided in this regard and the DCD should be revised as appropriate.

3) The main turbine stop and control valves are described in Tier 2 Section 10.2.2.2.1. The description indicates that a plug-type valve is used for the control valves, but the description is incomplete in that the type of valve used for the stop valves is not provided. Also, the failure mode of the turbine stop, control, reheat stop, intercept, and extraction non-return valves upon a loss of power and impact on turbine overspeed protection should be described.

4) Tier 2 Table 10.2-2 and Tier 2 Section 10.1.2 indicate that the mechanical and electrical overspeed trip systems each close the main turbine stop and reheat stop valves. This is not entirely consistent with the description provided in Tier 2 Section 10.2.2.3 which indicates that the electrical overspeed trip system also closes the turbine control and intercept valves. Also, in order to satisfy the acceptance criteria listed in SRP Section 10.2, the mechanical overspeed trip device must also close the turbine control and intercept valves (or provide equivalent protection). However, the description of the mechanical trip function and the consequences of draining the mechanical overspeed and manual trip header are not clearly explained in this regard. Consequently, additional information is needed and the DCD should be revised accordingly to address this apparent inconsistency and to explain how the mechanical trip device satisfies the SRP acceptance criteria with respect to turbine valve closure considerations.

5) While the closure times are provided for the turbine steam admission valves and extraction NRVs in Tier 2 Table 10.2-4, the bases for these times with respect to turbine overspeed protection should be explained. The DCD also should explain how valve closure times and seat leakage will be confirmed and maintained over time and the DCD should be revised as appropriate to include this information.

6) Tier 2 Section 10.2.2.3.1 should identify the major components of the turbine control system and a simplified schematic is needed to facilitate the staff's understanding and review of this system. While the description indicates that the turbine control system is capable of preventing a turbine trip following a load rejection by closing the turbine control and intercept valves, there is not clear to what extent the turbine control system interacts with the turbine steam bypass system (described in Tier 2 Section 10.4.4) to mitigate this transient and additional information is needed in this regard. Also, Tier 2 Sections 10.2.2.3.1.4 and 10.2.2.3.1.5 refer to "OPC solenoid valves" and this acronym should be defined.

7) Tier 2 Section 10.2.2.3.1.3 refers to a DEH overspeed protection control emergency trip header for the control and intercept dump valves, and indicates that an emergency trip header is used for the stop and reheat dump valves. Further, Tier 2 Section 10.2.2.3.2.3 refers to a mechanical overspeed and manual trip header. A summary description of the arrangement, design and function of these different headers is needed to facilitate the staff's understanding and review of turbine overspeed protection features and the DCD should be revised as appropriate to include this information.

8) Tier 2 Section 10.2.2.3.1.3 indicates that the emergency trip system devices are independent of the digital electro-hydraulic control system. However, Tier 2 Section 10.2.2.3.2.2 indicates that the emergency trip header interfaces with the overspeed protection control header via a check valve. Additional information is needed to address this apparent inconsistency and the DCD should be revised as appropriate.

9) Tier 2 Section 10.2.2.3.2 indicates that turbine protective trips will cause the main stop, control, intercept, and reheat stop valves to trip. However, tripping of the extraction NRVs also should be included (relates to Item 1, above).

10) Tier 2 Section 10.2.2.3.2.1 describes the emergency trip system. To facilitate the staff's understanding and review of this system, a simplified schematic should be provided for both the backup electric and mechanical overspeed trip systems (relates to RAI 10.2-05).

11) Tier 2 Section 10.2.2.3.2.6 indicates that the emergency trip system can trip the turbine in response to a signal from the plant control system or plant safety and monitoring system (i.e., remote trip). Additional information is needed to explain where and how these remote trips are initiated, as well as how the remote trips interface with the turbine backup emergency trip system and to what extent they interface with signal conditioning and processing software as opposed to use of direct hard-wired circuits. The DCD should be revised as appropriate to include this information.

12) Tier 2 Section 3.5.1.3 indicates that the turbine control system (includes control and emergency trip functions) is fail-safe. However, the description in Tier 2 Section 10.2 does not specifically describe why the turbine control system is considered to be fail-safe and additional information should be provided in this regard and the DCD should be revised as appropriate to include this information.

13) The response to RAI 10.2-2 indicates that a software common-cause failure (CCF) can cause signal processing of the emergency back-up electrical overspeed trip system to be disabled. While the response refers to the diverse actuation system (DAS) for mitigating this situation, it does not specifically identify what actions are initiated by DAS in response to the problem. Additional information is needed to fully explain the function of DAS in this regard and the DCD should be revised as appropriate to include this information.

14) The response to RAI 10.2-3 indicates that because the turbine generator control system is not safety-related, the single failure criterion of Class 1E does not apply. Nonetheless, single failure vulnerabilities that could prevent satisfactory performance of the turbine overspeed protection function need to be identified and addressed. Consequently, additional information is needed to address any single failure vulnerabilities that exist in this regard and the DCD should be revised as appropriate to include this information.

15) The orientation of the turbine with respect to safety-related SSCs is discussed in Tier 2 Section 3.5.1.3. However, the description in the DCD is incomplete in that it does not address the orientation of the turbine with respect to those SSCs that are listed in the appendix to Regulatory Guide 1.117, consistent with the

guidance provided in SRP Section 3.5.1.3 and Regulatory Guide 1.115. Therefore, additional information should be provided in this regard and the DCD should be revised as appropriate to include this information.

16) Tier 2 Section 3.5.1.3.2 and Tier 2 Section 10.2.2.1 indicate that the USAPWR acceptance limit for turbine failure probability is 1×10^{-5} per year. As shown in Table 3.5.1.3-1 of SRP Section 3.5.1.3, a turbine failure probability of 1×10^{-5} per year is specified as the acceptable limit for an unfavorably oriented turbine. However, Tier 2 Sections 3.5.1.3 and 10.2.2 both indicate that the turbine is favorably oriented which (per SRP Section 3.5.1.3) corresponds to a minimum allowable turbine failure probability of 1×10^{-4} per year. This apparent inconsistency should be explained and the DCD should be revised as appropriate.

17) Tier 2 Section 10.2.2.3.3 describes turbine generator supervisory instrumentation (TSI) and other monitors that are included in the design. Asterisks are provided to identify those monitors that are included in the TSI system, but the significance and role of TSI monitors and annunciation have not been explained. Also, while most monitors are self explanatory, the conditions that actuate the TSI failure alarm should be explained, including what the consequences of TSI failure are. The DCD should be revised as appropriate to include this information.

18) Tier 2 Section 10.2.2.3.5 indicates that the turbine trip circuitry is tested prior to unit startup, and that the load on the turbine is reduced to facilitate control valve testing. The staff finds that the description does not adequately describe (either explicitly or by making reference to other sections of the DCD) periodic inspections and tests that will be performed to ensure that the turbine is adequately protected from exceeding 120 percent of its rated speed.

    · The DCD should provide a more complete description of inspections and tests that will be performed to ensure that turbine control and overspeed protection (including electrical and mechanical remote trip functions) are adequately maintained, including (for example) a summary description of inspections and tests that will be completed while shutdown and during plant operation; inspection and test frequencies; the status of turbine overspeed protection when testing is being performed during plant operation; the status of turbine overspeed protection when abnormalities exist and/or are identified during plant operation; and diagnostic routines that will be performed to assess the status of the turbine generator control and overspeed protection systems, such as the status of speed inputs and microprocessors (note that inspections and tests relate to programmatic controls for addressing common-cause and common-mode failure considerations as discussed in RAI 10.2-5).

· Tier 2 Section 3.5.1.3 indicates that inservice inspection programs will be maintained as outlined under Item 4 of the Acceptance Criteria provided in SRP Section 3.5.1.3, Paragraph II. However, the description is incomplete in that it also should include inservice testing programs in accordance with the SRP guidance. Consequently, the DCD should be revised to address this consideration.