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

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10210

Subject: MHI's Responses to US-APWR DCD RAI 598-4754 Revision 2

Reference: 1) "REQUEST FOR ADDITIONAL INFORMATION 598-4754 REVISION 2, SRP Section: 10.02 – Turbine Generator, Application Section: 10.2, dated June 15, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Responses to Request for Additional Information 598-4754 Revision 2."

Enclosed are the responses to 2 RAIs contained within Reference 1.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosure:

1. Responses to Request for Additional Information 598-4754 Revision 2

CC: J. A. Ciocco
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NRO

Docket No. 52-021
MHI Ref: UAP-HF-10210

Enclosure 1

UAP-HF-10210
Docket No. 52-021

Responses to Request for Additional Information No. 598-4754
Revision 2

July 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/20/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 598-4754 REVISION 2**

SRP SECTION: **10.02 TURBINE GENERATOR**

APPLICATION SECTION: **10.2**

DATE OF RAI ISSUE: **6/15/2010**

QUESTION NO.: 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 nonreturn 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.

ANSWER:

Response to Question 1)

A schematic diagram which shows common parts of the turbine overspeed protection systems is provided on Fig.1. The electrical overspeed trip (EOST) detects rotation speed of the turbine shaft. In the event of reaching the setting point of the turbine speed, four (4) trip solenoid valves open to drain the emergency trip header fluid pressure and subsequently the main turbine stop, reheat stop, and extraction nonreturn valves are closed and then the turbine control and intercept valves are closed before turbine trip.
On the other hand, the mechanical overspeed trip (MOST) uses the interface piston valve for turbine trip. The interface piston valve is the key valve that connects the lubrication oil system and control oil system. It maintains the control oil pressure within the emergency trip header of the lubrication oil system during normal operation.
In the event that the speed of the turbine shaft goes up to the setting point of the MOST, the weight overcomes the spring force, actuate the MOST, and drain the autostop fluid of the manual trip header, which opens the interface piston valve to lead the control fluid within the emergency trip header to drain. After that the main turbine stop, reheat stop, extraction nonreturn valves are closed before control and intercept valves are closed, and subsequently leads to turbine trip.

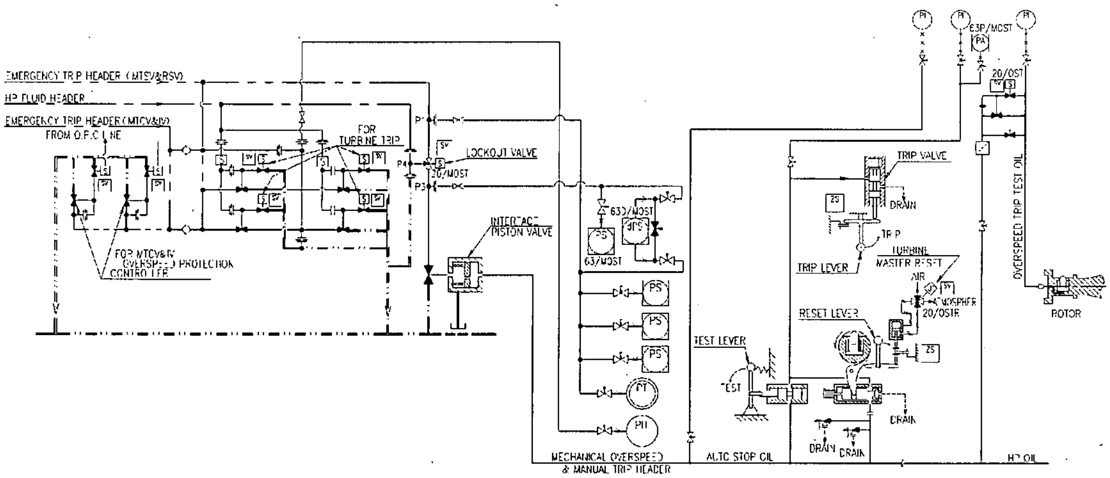

Fig.1 OVERSPEED TRIP DEVICE

Response to Question 2)

The overspeed protection system closes the main turbine stop and control valves. It consists of two completely isolated systems of the mechanical and the electrical overspeed protections. The mechanical overspeed trip system is capable of checking the overspeed protection function with maintaining the function during turbine operation at rated speed. It is recommended that testing be carried out once a month from the central control room and once a month manually at local to ensure soundness of the mechanical overspeed trip system. While, the electrical overspeed protection system consists of triple redundant speed sensors and quadruple redundant microprocessors. It can check that there is not any difference in values of speed signals from each other (reasonable check) and also it has self diagnosis function in order to ensure the soundness of the system. The final actuators of the electrical overspeed protection system are turbine trip solenoid valves, which are able to be tested during the turbine operation as described in 10.2.2.3.2.2.

Impact on DCD

There is no impact on DCD.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

7/20/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 598-4754 REVISION 2**

SRP SECTION: **10.02 TURBINE GENERATOR**

APPLICATION SECTION: **10.2**

DATE OF RAI ISSUE: **6/15/2010**

QUESTION NO.: 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.

ANSWER:

Response to Question 1)

Section 10.2 in DCD regarding extraction nonreturn valve will be revised to add more explanation. Nonreturn valves are served on extraction steam piping to protect from water induction by checking reverse flow into turbine. In view of turbine overspeed protection, the piping volume between the nonreturn valve and the turbine extraction connection must be minimized as practical, in order to reduce stored energy in extraction piping entering into the turbine during transient condition.
The nonreturn valve is swing type and is equipped power assisting actuator as backup for prompt and certain valve movement when fluid flow is zero. This actuator is initiated by turbine trip. The valve disc is free to swing, and closes if flow is zero or reverse direction. Because of fluid flow force, it does not fully close when the flow direction is normal. Therefore the closure time refers to actuator closing time which is described in Table 10.2-4 in DCD rev.2.
The actuator closure time is tested prior to commercial operation (i.e. demonstration test by manufacturer). Valve test is conducted prior to each startup to confirm proper movement. During plant normal operation, the valve test is conducted periodically by direct observation of valve arm movement (partial close) as described in Section 10.2.3.5 in DCD rev.2. Valve seat is confirmed by seat surface check.

Response to Question 2)

The overspeed protection system has to cut off steam automatically and rapidly to stop it from entering the turbine in order to prevent overspeed during operation and any damage due to other abnormal factors from occurring.
Operation timing regarding overspeed shall be 1.11x and less of rated speed. For the activation of the overspeed protection system, please refer to the Response to Question 4).

Response to Question 3)

A plug-type valve is used for the stop valves and it will be indicated in the description of Tier 2 Section 10.2.2.2.1. At a loss of power, a trip solenoid valve opens to drain control fluid of the trip header. At a loss of the pressure in the trip header fluid, the main stop, reheat stop, and extraction non-return valves close. A check valve which interfaces with the overspeed protection control header opens to reduce the pressure in the overspeed control header and closes the control and intercept valves, which is a fail-safe function which leads to a turbine trip.

Response to Question 4)

The mechanical and electrical overspeed trip systems also close the turbine control and intercept valves as well. Tier 2 Table 10.2-2 and Tier 2 Section 10.1.2 will be revised.
The mechanical overspeed trip system trips the unit via the interface piston valve. The interface piston valve is normally closed by the autostop oil pressure in the manual trip header of the lubricating oil system. A spring-loaded overspeed trip weight is provided on the turbine shaft. It defeats the spring force in the event that the speed of turbine shaft reaches to the setting speed of the overspeed trip and actuates the mechanical overspeed trip system to release autostop fluid of the manual trip header to drain. When the autostop fluid pressure decreases down to a certain level or less, the interface piston valve opens to lead the control fluid to drain. At a loss of the trip header pressure, the main stop and reheat stop valves close. A check valve which interfaces with the overspeed protection control header opens to reduce the pressure of the overspeed control header and closes the control and intercept valves to lead a turbine trip.

Response to Question 5)

As for nonreturn valve, see the above Response to question 1).

Response to Question 6)

Tier 2 Section 10.2.2.3.1 describe the turbine control system as DEH control system. The non-safety digital MELTAC platform is applied to DEH control system same as other plant control and monitoring systems (PCMS).
Also Tier 2 Section 10.2.2.3.1 describe that the DEH system employs three electric speed inputs whose signals are processed in redundant microprocessors and that the steam valves are positioned by DEH control system.
As for the other mechanical component related to the turbine control system, please refer to Response to question 1) of RAI 10.02-5. OPC stands for Overspeed Protection Controller and it has been included in DCD chapter 10 ACRONYMS.
As for the turbine bypass control, the function is described in DCD section 7.7.1.1.11. The function of turbine bypass control is included in the reactor control system and not interacted by the turbine control system.

Response to Question 7)

DCD Section 10.2.2.3.2.3 "Overspeed Trip Functions and Mechanisms" will be revised to facilitate the understanding and review of turbine overspeed protection features.

Response to Question 8)

DCD Section 10.2.2.3.1.4 "Valve Control" will be revised to describe that the emergency trip system devices are independent of the DEH control system.

Response to Question 9)

See the above response to the Response to question 1).

Response to Question 10)

Please refer to Response to the Response to question 1) of RAI 10.02-05. A simplified schematic for the backup electric and mechanical overspeed trip systems is shown in Fig.1.

Response to Question 11)

As described in DCD 7.3.1.11 and Figure 7.3-4, the turbine trip solenoid valves are actuated by SLS (Safety Logic System). As described in DCD Table 7.3-2 and Figure 7.3-3, SLS receive the turbine trip signal by hardwired line from the turbine protection system. SLS de-energize the turbine trip solenoid valve and trip the turbine in case of reactor trip or high-high SG water level and also when SLS receive the turbine trip signal from the turbine protection system. The turbine trip signal from the turbine protection system includes the signal of the emergency backup electrical overspeed trip which is described in DCD 10.2.2.3.2.3.

Response to Question 12)

As described in DCD 10.2.2.3.1.1, the turbine is tripped automatically by the turbine protection system in the event that both of redundant microprocessor of DEH system fail to perform their function. As shown in DCD 10.2.2.3.2.2, the turbine trip solenoid valves are energized when closed. Therefore, loss of power for the turbine trip solenoid valves will open the valves and the turbine will trip. Above description is the base for Tier 2 Section 3.5.1.3.

Response to Question 13)

As explained in the response to RAI 10.2-2, a software common-cause failure (CCF) can cause signal processing of the emergency back-up electrical overspeed trip system to be disabled. The diverse actuation system (DAS) provides monitoring, control and actuation of safety and non-safety systems required to cope with abnormal plant conditions concurrent with a CCF that disables all functions of the PSMS and PCMS. The DAS includes an automatic actuation function, human system interface (HSI) functions located at the diverse HSI panel (DHP), and interfaces with the PSMS and PCMS. The manual actuation for turbine trip is also provided in the DHP. Refer to DCD in the first place 7.8 for more detail. Therefore, the operator can trip the turbine manually in case of CCF by means of the manual actuation in the DHP. In addition, it is clear that the mechanical overspeed trip system is valid in case of CCF.

Response to Question 14)

As described in DCD 10.2.2.3.1, DEH system employs three electric speed inputs whose signals are processed in redundant microprocessors. As described in DCD 10.2.2.3.2.3, the emergency overspeed trips consist of a mechanical and an electrical trip. Also, the electrical overspeed trip system has separate, redundant speed sensors. Therefore, there is no singe failure vulnerability in the turbine overspeed protection function.

Response to Question 15)

Safety-related SSCs are addressed as stated in DCD Subsection 3.5.1.3.1. Per MHI's amended response to RAI 323-2071, Revision 1, (UAP-HF-10143, dated May 24, 2010) question 3.5.1.3-3, Subsection 3.5.1.3.1 has been revised to clarify the strike zone with respect to the turbine generator orientation to safety-related SSCs. In addition, Subsection 3.5.1.3.2 has been revised to state the estimated probability of damage from a turbine failure in a favorable orientation is shown to be more conservative than RG 1.115 criteria. The markups for Subsections 3.5.1.3.1 and 3.5.1.3.2 will be updated as shown below to address the orientation of the turbine generator with respect to SSCs listed in the appendix of RG 1.117 consistent with the guidance in RG 1.115. As such, Subsection 3.5.5 will be revised to add reference to RG 1.117.

Response to Question 16)

US-APWR maintains the conservatively lower probability of turbine missile generation of 1.0E-5 per year. This missile generation probability supports an unfavorably oriented layout by maintaining an acceptably low probability of missile damage (1.0E-7) to safety-related SSCs located within the missile strike zone, and is conservative for a COLA that includes a favorably oriented layout. MHI's amended response to RAI 323-2071 dated May 24, 2010 (UAP-HF-10143, ML101470208) reflects this approach to provide flexibility for turbine orientation with respect to site-specific safety-related SSCs.

Response to Question 17)

TSI is the turbine supervisory instrument which is identified as the special system, and other monitoring items are implemented by ordinary instrumentation. Therefore, the role and significance of TSI is same as other monitoring system. Since TSI is the independent system, the failure alarm of TSI is provided in order to give the operator the caution and it is described in DCD 10.2.2.3.3.

Response to Question 18)

DCD Section 10.2.2.3.2.3 "Overspeed Trip Functions and Mechanisms", DCD Section 10.2.2.3.2.4 "Test Blocks", DCD Section 10.2.2.3.5 "Inspection and Testing Requirements" will be revised to describe the information of testing of the protective device.

Impact on DCD

See attachments for the mark-up of DCD Tier 2 changes to be incorporated.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

flywheel is sufficiently higher than the maximum rotating speed of the motor postulated at the plant, and the soundness of the flywheel is maintained. Therefore, the probability of missile occurrence from high-speed rotating equipment inside containment, P_1, is less than 10^{-7}.

3.5.1.2.3 Gas or Pressurized Cylinder Explosion

Conclusions relating to statistical significance of postulated missiles due to gas or pressurized cylinder explosion also apply inside containment. By an analysis similar to that in Subsection 3.5.1.1.3, it is concluded that no items have the capability of generating potential missiles related to a gas or pressurized cylinder explosion inside the containment. Therefore, the product of the probability of occurrence, P_1, and the probability of impacting a significant target, P_2, is less than 10^{-7}.

3.5.1.2.4 Gravitational Missiles

Subsection 3.5.1.1.4 discusses gravitational missiles, including crane drop of heavy loads, falling objects resulting from non-seismic SSCs during seismic event, and secondary missiles caused by a falling object striking a high-energy system. Conclusions relating to statistical significance of these postulated missiles also apply to similar potential gravitational missiles inside containment. Therefore, the probability of missile occurrence, P_1, or the product of P_1 and the probability of impacting a significant target, P_2, is less than 10^{-7}.

3.5.1.3 Turbine Missiles

The two broad categories of turbine failures are referred to as design over-speed and destructive over-speed failures. Missiles resulting from design over-speed failures are the result of brittle fracture of turbine blade wheels or portions of the turbine rotor itself. Failures of this type can occur during startup or normal operation. Missiles resulting from destructive over-speed failures would be generated if the over-speed protection system malfunctions and the turbine speed increases to a point at which the low-pressure wheels or rotor undergo ductile failure.

3.5.1.3.1 Geometry

As defined by "Protection Against Low-Trajectory Turbine Missiles", RG 1.115, Rev. 1 (Reference 3.5-6), current evidence suggests low trajectory turbine missile strikes are concentrated within an area bounded by lines inclined at 25 degrees to the turbine wheel planes and passing through the end wheels of the low pressure stages.

The T/G is located south of the nuclear island with its shaft oriented along the north-south axis. In this orientation, ~~the potential for low trajectory turbine missiles to impact safety-related SSCs within the same unit is minimized since safety-related SSCs are located outside the high-velocity, low-trajectory missile strike zone~~ the R/B, PCCV, PS/B, and SSCs defined by the guidance and examples in RG 1.117 (Reference 3.5-19) within the same unit are located outside the high velocity and low trajectory missile strike zone as defined by RG 1.115 (Reference 3.5-6). The T/G and associated equipment with respect to essential safety-related SSCs are shown in figures found in Section 1.2.

The COL Applicant is responsible to assess the orientation of the T/G of this and other unit(s) at multi-unit site for the probability of missile generation using the evaluation of Subsection 3.5.1.3.2.

3.5.1.3.2 Evaluation

Protection against damage from turbine missiles to safety-related SSCs is provided by the orientation of the T/G, by the robust turbine rotors, and by the redundant and fail-safe turbine design control system as described in Section 10.2. The rotor design, material selection, preservice and inservice programs and redundant control system support a very low probability of turbine missile generation. The turbine rotor design is discussed in Subsection 10.2.3, in which material selection, fracture toughness/fracture analysis is discussed. Description of the inservice inspection and testing program that will be used to maintain an acceptably low probability of missile generation is also given in Subsection 10.2.3.

The probability of unacceptable damage resulting from turbine missiles, P_4, is expressed as the product of (a) the probability of turbine failure resulting in the ejection of turbine rotor (or internal structure) fragments through the turbine casing, P_1; (b) the probability of ejected missiles perforating intervening barriers and striking safety-related SSCs, P_2; and (c) the probability of struck SSCs failing to perform their safety function, P_3.

Mathematically, $P_4 = P_1 \times P_2 \times P_3$ where RG 1.115 (Reference 3.5-6) considers an acceptable risk rate for P_4 as less than 10^{-7} per year. For ~~favorably oriented T/Gs as outlined in~~ the geometry of ~~Section~~ Subsection 3.5.1.3, ~~the product of P_2 and P_3 is conservatively estimated as 10^{-3} per year~~ the product of P_2 and P_3 is estimated as 10^{-2} per year, which is a more conservative estimate than for a favorably oriented single unit and in conformance with the guidance in SRP Section 3.5.1.3. This conservative estimation provides the flexibility for the orientation of site-specific SSCs of concern based on the guidance of RG 1.117 (Reference 3.5-19) and RG 1.115 (Reference 3.5-6). The determination of P_1 (probability of turbine failure resulting in the ejection of turbine rotor (or internal structure) fragments through the turbine casing) is strongly influenced by the program for periodic inservice testing and inspection. Criteria as described in NUREG-0800 Standard Review Plan 3.5.1.3, Table 3.5.1.3-1 (Reference 3.5-7) correlates P_1 to operating cases necessary to obtain P_4 in an acceptable risk rate of 10^{-7} per year, where P_1 is less than $P_4 / (P_2 \times P_3)$ or 10^{-4}. The P_1 applicable to the US-APWR is described in Subsection 10.2.2. The COL Applicant is to commit to actions to maintain P_1 within this acceptable limit as outlined in RG 1.115, "Protection Against Low-Trajectory Turbine Missiles" (Reference 3.5-6) and SRP Section 3.5.1.3, "Turbine Missiles" (Reference 3.5-7). Reports MUAP-07028-NP, "Probability of Missile Generation From Low Pressure Turbines" (Reference 3.5–17) and MUAP-07029-NP, "Probabilistic Evaluation of Turbine Valve Test Frequency" (Reference 3.5-18) are to be used to establish programs and criteria for preservice inspection, inservice inspection interval and turbine valve test frequency in order to maintain the turbine missile generation probability, P_1, equal or less than the acceptable limit of 1×10^{-5} per year. Inservice inspection programs are to be maintained as outlined in SRP 3.5.1.3, Section II, Acceptance Criteria, Section 4 (Reference 3.5-7).

3.5-9 A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects, R. P. Kennedy, Nuclear Engineering and Design, Volume 37, Number 2, pp 183-202, 1976.

3.5-10 Barrier Design Procedures, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, Standard Review Plan, Section 3.5.3, Rev. 3, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3.5-11 U.S. Reactor Containment Technology, W.B. Cottrell and A.W. Savolainen, NSIC-5, Oak Ridge National Laboratories, Volume 1, Chapter 6, 1965.

3.5-12 Reactor Safeguards, C. R. Russell, MacMillan Publishers, New York, 1962.

3.5-13 Ballistic Perforation Dynamics, R. F. Recht and T. W. Ipson, ASME Journal of Applied Mechanics, Volume 30, Series E, Number 3, September 1963.

3.5-14 Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments), Regulatory Guide 1.142, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, DC, November 2001.

3.5-15 Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities, including Supplement 2 (2004), ANSI/AISC N690-1994, American National Standards Institute/American Institute of Steel Construction, 1994 & 2004.

3.5-16 Code Requirements for Nuclear Safety-Related Concrete Structures, American Concrete Institute (ACI) 349, 1997.

3.5-17 Probability of Missile Generation From Low Pressure Turbines, MUAP-07028-P Rev. 0 (Proprietary) and MUAP-07028-NP Rev. 0 (Non-Proprietary), Mitsubishi Heavy Industries, Ltd., Tokyo, Japan, December 2007.

3.5-18 Probabilistic Evaluation of Turbine Valve Test Frequency, MUAP-07029-P Rev. 0 (Proprietary) and MUAP-07029-NP Rev. 0 (Non-Proprietary), Mitsubishi Heavy Industries, Ltd., Tokyo, Japan, December 2007.

3.5-19 Tornado Design Classification, Regulatory Guide 1.117, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, April 1978.

control fails or upon a load rejection. Additional protection is provided by an emergency trip system which continuously monitors critical turbine parameters on a multi-channel basis, trips the turbine in the event that speeds in excess of overspeed protection control trip set points are reached. Emergency overspeed trip consists of a mechanical and an electrical trip. Mechanical overspeed trip device drains emergency trip oil and closes the main turbine stop, the main turbine control, the intercept and the reheat valves if turbine speed exceeds 110 percent of rated speed. The electric overspeed trip system closes the main stop and reheat stop valves (2-out-of-3 trip logic) if the turbine speed exceeds 111 percent of rated speed. This system is described in Subsection 10.2.2.3.

Turbine Missile Protection

Turbine rotor integrity minimizes the probability of generating turbine missiles and is discussed in Subsection 10.2.3. Turbine missiles are addressed in Subsection 3.5.1.3. The favorable orientation of the turbine-generator directs potential missiles away from safety-related equipment and structures.

Radioactivity Protection

Under normal operating conditions, there are no radioactive contaminants of operational concern present in the steam and power conversion system. However, it is possible for the system to become contaminated through steam generator tube leakage. In this event, radiological monitoring of the main condenser air removal system, the gland seal system, the steam generator blowdown system, and the main steam lines will detect contamination and alarm high radioactivity concentrations. A discussion of the radiological aspects of primary-to-secondary system leakage and limiting conditions for operation is contained in Chapter 11. The steam generator blowdown system described in Subsection 10.4.8 serves to limit the radioactivity level in the secondary cycle, below the operational limits.

Flow Accelerated Corrosion Protection

Flow accelerated corrosion (FAC) resistant materials are used in steam and power conversion systems for components exposed to two-phase flow where significant erosion can occur. Factors considered in the evaluation of FAC include system piping and component configuration and geometry, water chemistry, piping and component material, fluid temperature, and fluid velocity.

In addition to material selection, pipe size and layout may also be used to minimize the potential for FAC in systems with two-phase flow condition. To maintain a noncorrosive environment, the secondary side water chemistry (see Subsection 10.3.5) uses an all volatile chemistry for pH adjustment and corrosion prevention chemicals. Steam and power conversion systems are designed to facilitate inspection and FAC monitoring programs.

10.1.3 Combined License Information

No additional information is required to be provided by a COL applicant in connection with this section.

10.2 Turbine-Generator (T/G)

10.2.1 Design Bases

10.2.1.1 Safety Design Bases

The T/G does not serve a safety-related function and therefore has no nuclear safety design basis. Classification of the equipment and components of the T/G in regard to the seismic and quality group is provided in Section 3.2.

The T/G could be potential source of high-energy turbine missiles, which could cause damage to safety-related equipment or systems. The turbine is designed to minimize the possibility of turbine missile generation as discussed in Subsection 10.2.3. The turbine control system and main valves arrangement is designed to minimize the possibility of turbine missile generation and is discussed in Subsection 10.2.2 in detail.

10.2.1.2 Non-Safety Power Generation Design Bases

The following is a list of the major design features of the T/G:

- The T/G is designed for base load operation and for load follow operation.
- The T/G is designed for electric power production consistent with the capability of the reactor and the reactor coolant system.
- The gross generator output at the rated thermal power of the reactor and at VWO condition is shown in the heat balance diagrams in Figure 10.1-2 and Figure 10.1-3 respectively.
- The T/G is designed to trip automatically under abnormal conditions such as overspeed greater than 110% of the rated speed. The turbine control system is designed to control the rotating speed within the range which does not activate the emergency trip system, and is also designed to trip the T/G at the failure of the control system. The redundant emergency trip system is designed to prevent rotating speed from exceeding design overspeed.
- The T/G is designed to allow periodic on-line testing on the main valves (main turbine stop valve (MTSV), main turbine control valves (MTCV), reheat stop valve (RSV) and Intercept valve (IV)), emergency trip system and other protection devices.
- The system and component arrangement is designed so that any single component failure will not cause exceeding design overspeed.
- The system is designed to provide proper drainage of related piping and components to prevent water induction into the main turbine.
- Nonreturn valves are served on extraction steam piping to prevent water induction by checking reverse flow into turbine. Each valve is swing type and is equipped actuator as backup to assist closure action. In view of turbine overspeed protection, the piping

volume between the nonreturn valve and the turbine extraction connection must be minimized as practical.

- The moisture separator/reheaters (MS/Rs), MS/R drain tanks, generator stator cooling water demineralizer, stator cooling water tank, seal oil drain regulator, lubricant oil cooler and accumulator are designed to ASME Code Section VIII requirements (Reference 10.2-1). The other parts are designed to the T/G manufacturer's standards.

10.2.2 Description

10.2.2.1 General Description

The T/G is an 1800rpm tandem compound six exhaust flow unit consisting of one double-flow high-pressure turbine (HPT x 1), three double-flow low-pressure turbines (LPT x 3), a generator, two sets of external moisture separator/reheaters (MS/Rs), exciter, controls, and auxiliary subsystems (see Figure 10.2-1). The major design parameters of the T/G and auxiliaries are presented in Table 10.2-1. The flow diagram Figure 10.3-4 shows the stop, control, intercept, and reheat stop valves.

The T/G and associated piping, valves, and controls are located completely within the turbine building. There are no safety-related systems or components located within the turbine building. The probability of a destructive overspeed condition and missile generation, assuming the recommended inspection and test frequencies, is less than 1 x 10^{-5} per year in accordance with NUREG-800 SRP Subsection 3.5.1.3, turbine missiles (Reference 10.2-2). In addition, the orientation of the T/G is such that a high-energy missile to be directed at an approximately 90 degree angle away from safety-related structures, systems, and components. The layout drawings that show the general arrangement of the T/G and associated equipment in relation to essential safety-related SSC are shown in Section 1.2, Figure 1.2. Failure of the T/G equipment does not preclude safe shutdown of the reactor. The T/G components and instrumentation associated with protecting the T/G from an overspeed condition are accessible under operating conditions.

The T/G foundation is a reinforced concrete structure. The T/G foundation and equipment anchorage are designed to the same seismic design requirement as the turbine building. See Section 3.7 for additional information on seismic design requirements.

10.2.2.2 Component Description

The T/G train consists of one double-flow high-pressure turbine, three double-flow low-pressure turbines and one generator. Two external MS/Rs with two stages of reheating are located on each side of the T/G centerline. The single direct-driven generator is water-cooled and rated at 1,900 MVA at 0.9 PF. Other related system components include a complete T/G bearing lubrication oil system, a Digital electro-hydraulic (DEH) control system with supervisory instrumentation, a turbine gland seal system (see Subsection 10.4.3), overspeed protective devices, turning gear, a stator coil cooling water system, H_2 & CO_2 gas control system and seal oil system, a rectifier section, and a voltage regulator.

10.2.2.2.1 Main Turbine Stop Valve and Main Turbine Control Valves (MTSV & MTCV)

The function of the MTSV is to quickly shut off the main steam flow to the turbine when the MTSVs receives a trip signal. The main function of the MTCV is to regulate the main steam flow to the turbine through the control system.

Main steam from the steam generators (SGs) enters the high-pressure turbine through four horizontally-mounted plug-type MTSVs and four plug-type MTCVs. Main steam flow through one MTSV is combined with main steam flow from the other MTSVs in the steam chamber. Two MTCVs, located in the steam chamber, direct the main steam flow to the high-pressure turbine inlet stage. There are two sets of steam chambers that are located on both sides of high-pressure turbine casing.

MTSVs are operated in on-off mode by a signal from the emergency trip system or solenoid valve for testing.

The MTSV incorporates a pilot valve. When the turbine is started, the MTCVs are fully open and the pilot valve of the MTSV is operated with full arc admission so that the turbine parts can be uniformly heated during the start-up process.

Steam strainers are located at the inlet of each MTSVs.

10.2.2.2.2 High-Pressure Turbine (HPT)

The main steam enters the HPT through the four MTCVs and the lead pipes and expands across several stationary and rotating blades axially in both the governing and generator side directions. The HPT has two extraction connections. One extraction connection supplies heating steam to both the No. 7 (final) high-pressure feedwater heaters and first stage reheater while the other extraction connection supplies heating steam to the No. 6 high-pressure feedwater heaters. Steam is exhausted to the external MS/Rs through exhaust connection taps and cross-under pipes. Part of the HPT exhaust steam is supplied to deaerating feedwater heater.

The HPT rotor is machined from an alloy steel forging (mono block design). A separate extension shaft, which is bolted to the governor end of the rotor, carries the main oil pump and overspeed trip weight.

After assembly of the HPT rotor, the high speed balance test and overspeed test up to 120% is carried out to confirm the integrity of the HPT rotor.

10.2.2.2.3 External Moisture Separator/Reheaters (MS/R)

MS/Rs employ a two-stage reheater. The first stage reheater uses the extraction steam from the high-pressure turbine and the second stage reheater uses a portion of the main steam supply to reheat the steam to a superheated condition. The reheated steam flows

The MTSVs, MTCVs, RSVs and IVs have dump valves connected to the hydraulic portion of their respective valve actuators. Opening a dump valve causes the connected control or stop valve to rapidly close. The dump valve actuators are connected to trip headers and open in response to loss of pressure in the connected emergency trip header. The control and intercept dump valves are connected to the DEH overspeed protection control emergency trip header and the stop and reheat stop dump valves are connected to the emergency trip header. In the event of OPC actuation, only the control fluid pressure of DEH overspeed protection control header is decreased via a check valve. Therefore, the emergency trip system is independent of the DEH overspeed protection system.

10.2.2.3.1.4 Power/Load Unbalance

A power/load unbalance circuit initiates fast closing of the MTCVs and the IVs under load rejection conditions that might lead to rapid rotor acceleration and consequent overspeed.

Valve action occurs when the power/load unbalance exceeds the load by 30 percent or more. LPT inlet steam pressure is used as a measure of turbine power. Generator current is used as a measure of generator load to provide discrimination between a loss of load incident and an electric system fault.

When a power/load unbalance condition is detected, the OPC solenoid valves are quickly energized to close the MTCVs and the IVs. When the condition clear, the power/load unbalance circuitry resets automatically, and the OPC solenoid valves are reset.

10.2.2.3.1.5 Overspeed Protection

The DEH system has two modes of operation to protect the turbine against overspeed. The first mode is the speed control which maintains the desired speed as discussed in Subsection 10.2.2.3.1.1. The second mode is the overspeed protection control which operates if the normal speed control should fail or upon a loss of load. An overspeed protection demand is sent to the OPC solenoid valve for MTCVs and IVs. The solenoid valve is energized and a drain path for the hydraulic fluid opens in the overspeed protection control header, if the turbine speed exceeds 103 percent of the rated speed. The loss of fluid pressure in the header causes the MTCVs and the IVs to close. If the speed falls below rated speed following an overspeed protection controller action, the header pressure is reestablished, the MTCVs and the IVs are reopened, and the unit resumes speed control. Refer to Table 10.2-2 for a description of the sequence of events following a full loss of load and the nominal trip setpoints. An emergency trip system is also provided to trip the turbine in the event that speed in exceeds of the overspeed protection trip points. The emergency trip system is discussed in Subsection 10.2.2.3.2.1.

Redundancy is built into the overspeed protection control in the DEH system. The failure of a single OPC solenoid valve will not disable the trip functions. Loss of hydraulic pressure in the emergency trip system causes the turbine to trip. Therefore, damage to the overspeed protection components, results in the closure of the valves and the interruption of steam-flow to the turbine.

mechanical overspeed and manual trip header. The mechanical overspeed and manual trip header can be tripped manually via a trip handle mounted on the governor pedestal. The mechanical overspeed and manual trip are installed equipment for hydraulic test which can test without overspeed of the turbine shaft. If it is tested on site, trip weight will fall out after opening manual test valve with pulling a lever and mechanical overspeed trip equipment will be operated. After operating, trip operation can be confirmed because hydraulic pressure which detect mechanical overspeed trip is decreased rapidly. The mechanical overspeed and manual trip is tested remotely from the center online. If the test solenoid valve for the overspeed trip is excited after making the mechanical overspeed trip system a test mode with the lockout solenoid valve, trip weight will be operated. After operating, trip operation can be confirmed because automatic stop oil and hydraulic pressure which detect mechanical overspeed trip is decreased.

The electrical overspeed trip system has separate, redundant speed sensors and provides backup overspeed protection utilizing the trip solenoid valves in the emergency trip control block to drain the emergency trip header. The hydraulic fluid in the trip and overspeed protection control headers is independent of the bearing lubrication system to minimize the potential for contamination of the fluid.

The emergency trip header of the control fluid system and the manual trip header of the lubricating oil system are interconnected via the interface piston valve. The interface piston valve is normally closed under the autostop fluid header pressure of the manual trip header of the lubricating oil system, which establishes the control fluid pressure in the emergency trip header of the control fluid system.

The speed control and overspeed protection function of the DEH combined with the emergency trip system and electrical and mechanical overspeed trips provide a level of redundancy and diversity at least equivalent to the recommendations for turbine overspeed protection found in III.2 of the Standard Review Plan (NUREG-0800) Section 10.2 (Reference 10.2-3). Additionally, the issues and problems with overspeed protection systems identified in NUREG-1275 have been addressed (Reference 10.2-4).

10.2.2.3.2.4 Test Blocks

Low bearing oil pressure, Low main oil pump discharge pressure and Low condenser vacuum are each sensed by separate test block instrumentation. Each test block assembly consists of a steel test block, two pressure indications, two manual valves, two solenoid valves, and four pressure switches. Each assembly is arranged into two channels. The assemblies, mounted on the governor pedestal, are connected to pressure sensors mounted in a nearby terminal box. The assemblies have an orifice on the system supply side and are connected to a drain or vent on the other side. An orifice is provided in each channel so that the measured parameter is not affected during testing. An isolation valve on the supply side allows the test block assembly to be serviced.

If the medium (pressure or vacuum) reaches a trip setpoint, then the pressure sensors cause the emergency trip header mechanism to operate. When functionally testing an individual trip device, the medium is reduced to the trip setpoint in one channel either locally through the hand test valves or remotely from the trip test panel via the test solenoid valves.

- Rupture diaphragms located on each of the low-pressure turbine cylinder covers
- Turbine water induction protection systems on the extraction ~~steam~~ lines. The extraction line isolation valves and nonreturn valves close, and drain valves open, following a turbine trip signal.

10.2.2.3.3 Turbine Generator Supervisory Instrumentation

The turbine-generator is provided with turbine supervisory instrumentation including monitors for the following:

- Speed*
- MTSV position
- MTCV position
- RSV and IV positions
- Temperatures as required for controlled starting, including:
  - Steam chest inner surface
  - Steam chest outer surface
  - First-stage inlet lower inner surface
  - Cross-over pipe downstream of RSV No. 1
  - Cross-over pipe downstream of RSV No. 2
  - Cross-over pipe downstream of RSV No. 3
  - Cross-over pipe downstream of RSV No. 4
  - Cross-over pipe downstream of RSV No. 5
  - Cross-over pipe downstream of RSV No. 6
- Casing and shaft differential expansion*
- Vibration of each bearing*
- Shaft eccentricity*
- Bearing metal temperature
- Bearing oil temperature

- Extraction steam pressure, each extraction point
- Low-pressure turbine exhaust hood pressure
- Exhaust hood temperature for each exhaust

Generator supervisory instruments are provided, with sensors and/or transmitters mounted on the associated equipment. These indicate or record the following:

- Stator winding temperature (three detectors per phase)
- Stator coil cooling water temperature (one detectors per coil)
- Hydrogen cooler inlet and outlet gas temperature (two detectors at each point)
- Hydrogen gas pressure
- Hydrogen gas purity
- Generator ampere, voltage, and power

Additional generator protective devices are listed in Table 10.2-3.

10.2.2.3.4 Plant Loading and Load Following

The T/G control system has the same loading and load following characteristics as the control system described in Section 7.7.

10.2.2.3.5 Inspection and Testing Requirements

Major system components are readily accessible for inspection and are available for testing during normal plant operation. Turbine trip circuitry is tested prior to unit startup. To test control valves with minimal disturbance, the load is reduced to that capable of being carried with one control valve closed.

The information of testing of the protective device is described in the following sections:

Emergency trip test	Section 10.2.2.3.2.2
EOST test	Included in Section 10.2.2.3.2.2
MOST test	Section 10.2.2.3.2.3
Low Bearing oil Trip Test	Section 10.2.2.3.2.6
Low Vacuum Trip Test	Section 10.2.2.3.2.6
Low MOP Discharge oil Trip Test	Section 10.2.2.3.2.6

Table 10.2-2 Turbine Overspeed Protection

Percent of rated Speed (Approximate)	Event (see note)
100	Turbine initially is at valves wide open. Full load is lost. Speed begins to rise. When the breaker opens, the load drop anticipator immediately closes the control and the intercept valves if the load at the time of separation is greater than 30 percent.
101	Control and intercept valves begin to close.
103	The overspeed protection controller closes the control and the intercept valves until the speed drops below 103 percent.
110	The mechanical overspeed trip device drains emergency trip oil and closes the main turbine stop, the main turbine control, the intercept and the reheat valves.
111	The electrical overspeed trip system closes the main stop, the main turbine control, the intercept and the reheat stop valves based on a two-out-of-three trip logic system.

Note:

Following the above sequence of events, the turbine will approach but not exceed the design overspeed (120 percent of the rated speed).

Table 10.2-4 Turbine-Generator Valve Closure Times

Valve	Closing time (seconds)
MTSVs	0.3
MTCVs	0.3
IVs	0.3
RSVs	0.3
Extraction nonreturn valves	<1.0

(note) Closure time of extraction nonreturn valves refers to actuator operation time.