U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

10.2 TURBINE GENERATOR

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - None

I. AREAS OF REVIEW

Nuclear reactor plants include a turbine generator system (TGS) to convert the energy in steam from the nuclear steam supply system into electrical energy. The TGS consists essentially of the turbine unit and the automatic devices, alarms, and trips which control and regulate turbine action, and the generator unit and its controls. The turbine control system and the steam inlet stop and control valves, the low pressure turbine steam intercept and inlet control valves, and the extraction steam control valves control the speed of the turbine under normal and abnormal conditions, and are thus related to the overall safe operation of the plant.

The turbine generator system installed in a nuclear plant is typically equipped with redundant overspeed protection instrumentation and controls and the main steam and reheat steam control and stop valving arrangements typically provide redundancy in the valves essential for overspeed protection. The intent of the review under this SRP section is to verify that such redundancy, in conjunction with inservice inspection and testing of the essential valves, makes a turbine overspeed condition above the design overspeed very unlikely and to assure conformance with General Design Criterion 4. Assessment of the risk to essential plant systems and structures from potential turbine missiles is reviewed under SRP Section 3.5.1.3.

1. The PSB reviews the turbine generator system and the components and subsystems normally provided with this equipment with respect to the following considerations:

   a. The general arrangement of the turbine and associated equipment with respect to safety-related structures and systems and balance of plant.

   b. The types and locations of main steam stop and control valves, reheat stop and intercept valves, and associated piping arrangements.

USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

c. The capability of the turbine generator control and overspeed protection systems to detect a turbine overspeed condition and to actuate appropriate system valves or other protective devices to preclude an overspeed condition above the design overspeed.

d. The overspeed protection instrumentation and controls with respect to redundancy, testability, and reliability.

2. The PSB reviews the inservice inspection and operability assurance program for valves essential for overspeed protection.

3. Consideration of turbine orientation as related to turbine missiles is reviewed by Auxiliary Systems Branch as part of its primary review responsibility for SRP Section 3.5.1.3.

In the review of the turbine generator, the PSB will coordinate with other branches for their evaluations that interface with the overall review of the system as follows: The Mechanical Engineering Branch (MEB) determines the acceptability of the seismic and quality group classifications for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2. The MEB determines that the components, piping, and structures are designed in accordance with applicable codes and standards as part of its primary review responsibility for SRP Sections 3.9.1 through 3.9.3. The Auxiliary Systems Branch (ASB) determines that the TGS is in accordance with Branch Technical Positions ASB 3-1 and MEB 3-1 as related to pipe cracks or breaks in high- and moderate-energy piping systems outside of containment as part of its primary review responsibility for SRP Section 3.6.1. The Materials Engineering Branch (MTEB) verifies, upon request of PSB, the compatibility of the materials of construction with service conditions. The Radiological Assessment Branch (RAB) determines if any radiation shielding is necessary to assure safe access to turbine equipment as part of its primary review responsibility for SRP Section 12.0. The Procedures and Test Review Branch determines the acceptability of the preoperational and startup tests as part of its primary review responsibility for SRP Section 14.0.

The reviews for fire protection, technical specifications, and quality assurance are coordinated and performed by the Chemical Engineering Branch, Licensing Guidance Branch, and Quality Assurance Branch as part of their primary review responsibility for SRP Sections 9.5.1, 16.0, and 17.0, respectively.

For those areas of review identified above as being part of the primary review responsibility of the other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branches.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the turbine generator system, as described in the applicant's Safety Analysis Report (SAR), is based on the General Design Criteria and the other specific criteria listed below, and on the similarity of the design to that of plants previously reviewed and found acceptable.

The design of the turbine generator system is acceptable if the integrated design of the system meets the requirement of General Design Criterion 4 as related to the protection of structures, systems, and components important to safety from the effects of turbine missiles by providing a turbine overspeed

protection system (with suitable redundancy) to minimize the probability of generation of turbine missiles. Specific criteria necessary to meet the requirements of GDC 4 are as follows:

1. A turbine control and overspeed protection system should be provided to control turbine action under all normal or abnormal operating conditions, and to assure that a full load turbine trip will not cause the turbine to overspeed beyond acceptable limits. Under these conditions, the control and protection system should permit an orderly reactor shutdown either by use of the turbine bypass system and main steam relief system or other engineered safety systems. The overspeed protection system should meet the single failure criterion and should be testable when the turbine is in operation.

2. Turbine main steam stop and control valves and reheat steam stop and intercept valves should be provided to protect the turbine from exceeding set speeds and to protect the reactor system from abnormal surges. The reheat stop and intercept valves should be capable of closure concurrent with the main steam stop valves, or of sequential closure within an appropriate time limit, to assure that turbine overspeed is controlled within acceptable limits. The valve arrangements and valve closure times should be such that a failure of any single valve to close will not result in excessive turbine overspeed in the event of a TGS trip signal.

3. The extraction steam check valves provided at extraction connections shall be capable of closing within an appropriate time limit to maintain stable turbine speeds in the event of a TGS trip signal.

4. The TGS should be provided with the capability to permit periodic testing of components important to safety while the unit is operating at rated load.

5. An inservice inspection program for main steam and reheat valves should be provided and it should include the following provisions:

   a. At approximately 3-1/3-year intervals, during refueling or maintenance shutdowns coinciding with the inservice inspection schedule required by Section XI of the ASME Code for reactor components, at least one main steam stop valve, one main steam control valve, one reheat stop valve, and one reheat intercept valve should be dismantled and visual and surface examinations conducted of valve seats, disks, and stems. If unacceptable flaws or excessive corrosion are found in a valve, all other valves of that type should be dismantled and inspected. Valve bushings should be inspected and cleaned, and bore diameters should be checked for proper clearance.

   b. Main steam stop and control valves and reheat stop and intercept valves should be exercised at least once a week by closing each valve and observing by the valve position indicator that it moves smoothly to a fully closed position. At least once a month, this examination should be made by direct observation of the valve motion.

6. Unlimited access to all levels of the turbine area under all operating conditions should be provided. Radiation shielding should be provided as necessary to permit access.

7. Connection joints between the low pressure turbine exhaust and the main condenser should be arranged to prevent adverse effects on any safety-related equipment in the turbine room in the event of rupture (it is preferable not to locate safety-related equipment in the turbine room).

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and preliminary design as set forth in the Preliminary Safety Analysis Report meet the acceptance criteria given in subsection II. For review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the Final Safety Analysis Report.

The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

The review procedures given are for a typical turbine generator system. Any variance of the review, to take account of a proposed unique design, will be such as to assure that the system meets the criteria of subsection II. The reviewer evaluates the TGS, subsystems, and components of the unit that are considered essential for the safe integrated operation of the reactor facility. The reviewer will select and emphasize material from this review plan, as may be appropriate for a particular case.

The primary reviewer will coordinate this review with other branches for their particular areas of responsibility as stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. The SAR is reviewed to determine that the system description and piping and instrumentation diagrams (P&IDs) show the turbine generator system. The general arrangement of the TGS and associated equipment with respect to safety-related structures, systems, and components is noted.

2. The reviewer verifies the adequacy of the control and overspeed protection system and determines that:

   a. Support systems, subsystems, control systems, and alarms and trips will function for all abnormal conditions, including a single failure of any component or subsystem, and will preclude an unsafe turbine overspeed. The indepth defense that is provided by the turbine generator protection system to preclude excessive overspeeds should be designed with diverse protection means.

   b. For normal speed-load control, the speed governor action of the electro-hydraulic control system fully cuts off steam at approximately 103 percent of rated turbine speed by closing the control, and intercept valves.

   c. A mechanical overspeed trip device is provided that will actuate the control, stop, and intercept valves at approximately 111 percent of rated speed.

d. An independent and redundant backup electrical overspeed trip circuit is provided that senses the turbine speed by magnetic pickup and closes all valves associated with speed control at approximately 112 percent of rated speed. This backup electrical overspeed trip system may utilize the same sensing techniques as the electro-hydraulic control system. However, the circuitry is reviewed to determine that the control signals from the two systems are isolated from and independent of one another.

3. The main steam stop, control, reheat stop, and intercept valving arrangements and valve closure times are reviewed to ensure that no single valve failure can disable the overspeed control function.

4. The extraction steam valving arrangements and valve closure times are reviewed to see that stable turbine operation will result after a TGS trip.

5. The capability for testing of essential components during TGS operation is reviewed.

6. The proposed inservice inspection program for essential speed control valves is reviewed to verify that it includes the provisions of item 5 of subsection II of this SRP section.

7. The RAB reviews the expected radiation levels around the TGS and the degree of access to TGS components during operation and the MEB reviews the quality and seismic classification as indicated in subsection I of this SRP section.

8. If there are safety-related systems or portions of systems located close to the TGS, the physical layout of the system is reviewed to assure that protection has been provided from the effects of high and moderate energy TGS piping failures or failure of the connections from the low pressure turbine section of the main condenser. The means of providing such protection will be given in Section 3.6 of the SAR, and the procedures for reviewing this information are given in the corresponding SRP Sections.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and his review supports conclusions of the following type, to be included in the staff's Safety Evaluation Report:

> The turbine generator system (TGS) includes all components and equipment normally provided including turbine main steam stop and control valves and reheat steam stop and intercept valves. The scope of review of the turbine generator system for the _____ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and for control and supporting systems that are essential to its operation.
>
> The basis for acceptance of the turbine generator system in our review was conformance of the designs, design criteria, and design bases to the Commission's regulations as set forth in General Design Criteria (GDC) of Appendix A to 10 CFR Part 50. The staff concludes

that the plant design is acceptable and meets the requirements of GDC 4 with respect to the protection of structures, systems, and components important to safety from the effects of turbine missiles. The applicant has met this requirement by providing a turbine overspeed protection system to control the turbine action under all operating conditions and which assures that a full-load turbine trip will not cause the turbine to overspeed beyond acceptable limits and will not result in turbine missiles.

The staff concludes that the design of the turbine generator system conforms to all applicable GDC, staff positions, industry standards, and it can perform its designed safety functions and is therefore acceptable.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

2. Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Reactor Power Plants."

3. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1.

4. Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.