U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

10.4.4 TURBINE BYPASS SYSTEM

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of the turbine bypass system as related to the balance of plant.

Secondary - None

I. AREAS OF REVIEW

The turbine bypass system (TBS) provides operational flexibility so that the plant may accept certain load changes without disturbing the nuclear steam supply system. The TBS is designed to discharge a stated percentage of rated main steam flow directly to the main condensers, bypassing the turbine. This steam bypass enables the plant to take step load reductions up to the TBS capacity without the reactor or turbine tripping. The system is also used during startup and shutdown to control reactor pressure for a boiling water reactor (BWR) and steam generator pressure for a pressurized water reactor (PWR). The TBS is not required for safe shutdown, as the relief and safety valves are operated under emergency conditions. The system is not required to function as a heat sink for the prevention or mitigation of postulated accidents. Failure of the TBS during a load reduction or turbine trip would result in the actuation of the relief valves and possibly the safety valves.

For a BWR without a main steam isolation valve leakage control system (MSIVLCS), the TBS potentially serves an accident mitigation function. A TBS, along with the main steam system and condenser, can mitigate the effects of MSIV leakage during a LOCA by the holdup and plateout of fission products. A TBS in such a BWR must be capable of maintaining its integrity after a safe shutdown earthquake (SSE).

The specific areas of review are as follows:

1. Review of the system from the branch connection at the main steam system to the main condensers.

2. Review of the TBS to determine that a failure of the system or system components will not have an adverse effect on essential equipment.

3. Review of the TBS functional requirements for both normal and abnormal operating conditions, and with respect to the following: (a) capability to isolate those portions of the system that could leak or malfunction; (b) capability to perform adequate operational testing and inservice inspection; (c) to ensure there are no adverse effects of postulated system piping failures on safety-related equipment; and (d) to reduce the possibility of reactor transients due to inadvertent operation of the TBS from faults in the TBS instrumentation and control.

4. Inspection, Test, Analysis, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the applicant's proposed information on the ITAAC associated with the systems, structures, and components (SSCs) related to this SRP section is reviewed in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria - Design Certification." The staff recognizes that the review of ITAAC is performed after review of the rest of this portion of the application against acceptance criteria contained in this SRP section. Furthermore, the ITAAC are reviewed to assure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

5. COL Action Items and Certification Requirements and Restrictions. COL action items may be identified in the NRC staff's final safety evaluation report (FSER) for each certified design to identify information that COL applicants must address in the application. Additionally, DCs contain requirements and restrictions (e.g., interface requirements) that COL applicants must address in the application. For COL applications referencing a DC, the review performed under this SRP section includes information provided in response to COL action items and certification requirements and restrictions pertaining to this SRP section, as identified in the FSER for the referenced certified design.

Review Interfaces

The listed SRP sections interface with this section as follows:

1. Review to ensure conformance to Branch Technical Position SPLB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," concerning cracks and breaks in high- and moderate-energy piping outside containment is performed under SRP Section 3.6.1.

2. Review of the fire protection program is performed under SRP Section 9.5.1.

3. Review of the seismic and quality group classifications is performed under SRP Sections 3.2.1 and 3.2.2.

4. Review to ensure conformance to Branch Technical Position EMEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," concerning cracks and breaks in high- and moderate-energy piping outside containment is performed under SRP Section 3.6.2.

5. Review to ensure the steam bypass capacity is consistent with reactor transient analysis is performed under SRP Section 4.4.

6. Acceptability of the preoperational and startup tests is performed under SRP Section 14.2.

7. Review of technical specifications is performed under SRP Section 16.0.

8. Review of quality assurance programs is performed under SRP Sections 17.1 and 17.2.

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

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. General Design Criterion 4 (GDC 4), "Environmental and Dynamic Effects Design Basis," in that failure of the TBS due to a pipe break or malfunction of the TBS should not adversely affect essential systems or components (i.e., those necessary for safe shutdown or accident prevention or mitigation).

2. General Design Criterion 34 (GDC 34), "Residual Heat Removal," as related to the ability to use the system for shutting down the plant during normal operations. The operation of the TBS eliminates the need to rely solely on safety systems, which are required to meet the redundancy and power source requirements of this criterion.

3. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;

4. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for review described in Subsection I of this SRP

section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

1. Piping Failures

The requirements of GDC 4 related to the ability of structures, systems and components important to safety to meet environmental conditions associated with normal operation, maintenance, testing, and postulated accident conditions is met by demonstrating that failure of the TBS due to a pipe break or malfunction of the TBS will not adversely affect essential systems or components (i.e., those necessary for safe shutdown or accident prevention or mitigation).

2. Residual Heat Removal

The requirements of GDC 34 related to providing a reliable system that removes residual heat during normal plant shutdown is met by demonstrating the ability to use the turbine bypass system for shutting down the plant during normal operations. The operation of the TBS eliminates the need to rely solely on safety systems, which are required to meet the redundancy and power source requirements of this criterion.

3. MSIV alternate leakage path (ALT)

For BWR plants that do not incorporate an MSIVLCS and for which TBS holdup and plateout of fission products is credited in the analysis of design basis accident radiological consequences, guidance from SECY 93-087 (Reference 5) is applicable. Specifically, the turbine bypass lines from the first valve up to the condenser inlet do not need to be classified as seismic category I if the following criteria are met:

a. They have been analyzed using a dynamic seismic analysis method to demonstrate their structural integrity under SSE loading conditions.
b. All pertinent QA requirements of Appendix B to 10 CFR Part 50 are applied.
c. For lines utilized as an MSIV leakage path to the condenser, reliable power sources must be available for control and isolation valves so that a control operator can establish the flow path assuming a single active failure.

In addition, the TBS lines and other components utilized as an MSIV leakage path to the condenser are assigned a quality group classification in accordance with the criteria of SRP Section 3.2.2, Appendix A.

Technical Rationale

The technical rationale for application of these requirements to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. GDC 4 requires that structures, systems, and components important to safety be designed to meet environmental conditions associated with normal operation, maintenance, testing, and postulated accident. However, dynamic effects associated with postulated pipe ruptures in nuclear power plants may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of a rupture in the fluid system piping is extremely low under conditions consistent with the design basis for the piping.

Although the turbine bypass system is not classified as a system important to safety, GDC 4 applies to this SRP section because a failure of the TBS or one of its components could have an adverse impact on a structure, system, or component important to safety.

Meeting the requirements of this criterion provides a level of assurance that structures, systems, and components important to safety will not be adversely affected by a failure of the turbine bypass system.

2. GDC 34 requires that the applicant provide a system to remove residual heat, and it establishes specific requirements related to performance, redundancy, and reliability.

Although the TBS is not the residual heat removal system specified in GDC 34, it can perform that function. GDC 34 applies to this SRP section because using the TBS during normal plant shutdown reduces demands on systems important to safety.

Meeting the requirements of this criterion provides a level of assurance that the residual heat removal system will remain operable and that safety systems will have the capability to transfer residual heat from the reactor core at a rate that does not exceed specified fuel design limits or the design conditions of the reactor pressure boundary.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from the procedures described below, as may be appropriate for a particular case.

For each area of review specified in subsection I of this SRP section, the review procedure is identified below. These review procedures are based on the identified SRP acceptance criteria. For deviations from these specific acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives to the SRP criteria provide an acceptable method of complying with the relevant NRC requirements identified in subsection II.

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II of this SRP section. For review of operating license (OL) and combined operating license applications, the procedures are used 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 (FSAR).

The procedures for REVIEW OF OL and COL 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 technical specifications review, as indicated in subsection I of this SRP section.

The primary reviewer will coordinate this review with the other branches' areas of review as stated in subsection I of this SRP section. The primary reviewer obtains and uses such input as required to ensure that this review procedure is complete.

The reviewer selects and emphasizes material from this SRP section as may be appropriate for a particular case.

1. The SAR is reviewed to determine that the system description and piping and instrumentation diagrams (P&IDs) delineate the system and components.

2. The SAR is reviewed to verify that the system design bases and an evaluation of the system capacity are provided, including the relation between the TBS capacity and relief valve capacity in terms of percentage of rated main steam flow, the maximum reactor power step change the system is designed to accommodate without a reactor or turbine trip, and the maximum electric load step change the reactor is designed to accommodate without reactor control rod motion or steam bypassing.

3. TBS lines and other TBS components in BWR plants that do not incorporate an MSIVLCS and that take credit for fission product holdup and plateout in the TBS are reviewed for compliance with the applicable SRP acceptance criteria of Subsection II of this SRP.

4. The reviewer uses engineering judgment and the results of failure modes and effects analyses to determine that:

   a. Failure of the TBS to operate will not preclude operation of any essential systems. Statements in the SAR that confirm the above are acceptable.

   b. Failure of the TBS high energy piping will not have adverse effects on any safety-related systems or components that may be located close to the system.

5. For reviews of DC and COL applications under 10 CFR Part 52, the reviewer should follow the above procedures to verify that the design set forth in the safety analysis report, and if applicable, site interface requirements meet the acceptance criteria. For DC applications, the reviewer should identify necessary COL action items. With respect to COL applications, the scope of the review is dependent on whether the COL applicant references a DC, an ESP or other NRC-approved material, applications, and/or reports.

   After this review, SRP Section 14.3 should be followed for the review of Tier I information for the design, including the postulated site parameters, interface criteria, and ITAAC.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The turbine bypass system (TBS) includes all components and piping from the branch connection at the main steam system to the main condensers. The scope of review of the turbine bypass system included layout drawings, piping and instrumentation diagrams, and descriptive information for the TBS and auxiliary supporting systems that are essential to its operation.

The basis for acceptance of the TBS 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) 4 and 34 of Appendix A to 10 CFR Part 50.

1. The applicant has met the requirements of GDC 4, "Environmental and Dynamic Effects Design Bases," with respect to the system being

designed such that a safe shutdown will not be precluded as a result of the TBS failure.

2. The applicant has met the requirements of GDC 34, "Residual Heat Removal," with respect to the ability to use the turbine bypass system for shutting down the plant during normal operations. The turbine bypass system is designed such that sufficient steam can be bypassed to the main condenser so that the plant can be shutdown during normal operations without using the turbine generator.

3. If the TBS lines and other TBS components in BWR plants that do not incorporate an MSIVLCS are credited for fission product holdup and plateout, the applicant has met the guidance of SECY 93-087.

The staff concludes that the design of the turbine bypass system conforms to all applicable GDCs, staff positions and industry standards and is therefore acceptable.

For DC and COL reviews, the findings will also summarize (to the extent that the review is not discussed in other SER sections) the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable, and interface requirements and combined license action items relevant to this SRP section.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section, unless superceded by a later revision.

1. Plants with an operating license issued prior to April 1984 and/or operating license applications docketed prior to April 1984 need not comply with the provisions of this revision.

2. COL and OL applicants will be required to comply with the provisions of this revision.

3. It should be noted that steam generators in plants with an operating license issued prior to April 1984 and plants where an operating license SER had been issued prior to April 1984, now comply with the revised BTP ASB 10-2.

VI. REFERENCES

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

2. 10 CFR Part 50, Appendix A, General Design Criterion 34, "Residual Heat Removal."

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

4. Branch Technical Position EMEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2, "Determination of Rupture Locations and Dynamic Effects associated with the Postulated Rupture of Piping."

5. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," April 2, 1993, paragraph II.E, "Classification of Main Steamlines in Boiling Water Reactors (BWR)," and a related Commission memorandum from S. J. Chilk to J. M. Taylor (dated July 21, 1993) approving the staff position.

6. 10 CFR 52.47, “Contents of applications.” U.S. Nuclear Regulatory Commission.

7. 10 CFR 52.80(A), “Issuance of combined licenses.” U.S. Nuclear Regulatory Commission.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

SRP Section 10.4.4
Description of Changes

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in (Draft) Revision 3, dated April 1996 of this SRP. See ADAMS accession number ML052070595.

In addition this SRP section was administratively updated in accordance with NRR Office Instruction, LIC-200, Revision 1, "Standard Review Plan (SRP) Process." The revision also adds standard paragraphs to extend application of the updated SRP section to prospective submittals by applicants pursuant to 10 CFR Part 52.

The technical changes are incorporated in Revision 3, dated [Month] 2007:

Review Responsibilities - Editorial revision to identify office branches by functional description (in lieu of specific branch codes, which are subject to change). This change is reflected throughout the SRP section.

I. AREAS OF REVIEW

1. A standard paragraph and references for ITAAC were added to the Areas of Review.

2. The Review Interfaces subsection was reorganized and updated to provide a consistent format between all SRP Sections. Also, branch acronyms were removed as part of the standard format revision.

3. Language was added to include the potential accident mitigation function of the turbine bypass system to holdup and plateout fission products from MSIV leakage during a LOCA.

II. ACCEPTANCE CRITERIA

1. Acceptance criteria were added for ITAAC as part of the common SRP format update.

2. Applicable NRC requirements and specific SRP acceptance criteria that the staff has determined to meet the applicable requirements was added.

3. A Technical Rationale subsection was added to explain the basis for including each General Design Criterion.

4. Added Acceptance Criteria from SECY 93-087 applicable to TBSs credited for fission product holdup and plateout.

III. REVIEW PROCEDURES

1. A standard paragraph was added to address COL applications under 10 CFR Part 52.

2. Added a Review Procedure applicable to TBSs credited for fission product holdup and plateout.

IV. EVALUATION FINDINGS

1. A standard paragraph was added to address COL applications under 10 CFR Part 52.

2. Added an Evaluation Finding to address TBSs credited for fission product holdup and plateout.

V. IMPLEMENTATION

1. Standard language was added to address applications under 10 CFR Part 52.

VI. REFERENCES

1. References were updated to include the relevant ITAAC requirements.

2. Added SECY-93-087 to the list of references to provide guidance for reviewing the post-accident function of the TBS for those plants to which it is applicable.

3. Added a Review Procedure applicable to TBSs credited for fission product holdup and plateout.