



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

10.4.4 TURBINE BYPASS SYSTEM

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of power conversion systems

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).

Revision 3 - March 2007

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan 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 an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRN_SRP@nrc.gov.

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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. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure 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. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

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

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 Chapter 17.

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

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 the review described in 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 (ALP). 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 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 Branch Technical Position 3-1.

Technical Rationale

The technical rationale for application of these acceptance criteria 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 material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives 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). These procedures are used during a DC or COL review.

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 staff 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.

For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

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 the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

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 submitted six months or more after the date of issuance of this SRP section, unless superseded 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 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 Position 3-1, "Classification of Main Steam Components Other than the Reactor Coolant Pressure Boundary for BWR Plants."
4. Branch Technical Positions 3-3, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."

5. Branch Technical Position 3-4, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment."
6. Branch Technical Position 10-2, "Design Guidelines for Avoiding Water Hammers in Steam Generators."
7. 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.
8. 10 CFR 52.47, "Contents of applications." .
9. 10 CFR 52.80(A), "Issuance of combined licenses."

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.

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