U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

10.4.4 TURBINE BYPASS SYSTEM

REVIEW RESPONSIBILITIES

Primary - ~~Power Systems Branch (PSB)~~Plant Systems Branch (SPLB)[1]

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).[2]

The ~~PSB~~SPLB[3] reviews the system from the branch connection at the main steam system to the main condensers.

1. The ~~PSB~~SPLB[4] reviews the TBS to determine that a failure of the system or system components will not have an adverse effect on essential equipment.

2. The ~~PSB~~SPLB[5] reviews 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 ~~assure~~ ensure[6] 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.

Review Interfaces[7]

1. The SPLB performs the following reviews as part of its primary review responsibility under the Standard Review Plan (SRP) sections indicated:[8]

   The ~~Auxiliary Systems Branch (ASB)~~SPLB[9] determines that the TBS conforms to Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," concerning cracks and breaks in high- and moderate-energy piping outside containment as part of its primary review responsibility for SRP Section 3.6.1.[10]

   b. The SPLB evaluates the fire protection program as part of its primary review responsibility for SRP Section 9.5.1.[11]

2. In the review of the turbine bypass system, the ~~PSB~~SPLB[12] will coordinate other branches' evaluations that interface with the overall review of the system as follows:

   a. The Mechanical Engineering Branch ~~(MEB)~~(EMEB)[13] determines that the appropriate seismic and quality group classifications have been established for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2.

   b. The EMEB determines that the TBS conforms to Branch Technical Position MEB 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 as part of its primary review responsibility for SRP Section 3.6.2.[14]

   ~~The Auxiliary Systems Branch (ASB) determines that TBS is in accordance with Branch Technical Positions ASB 3-1 and MEB 3-1 as related to cracks and breaks in high- and moderate-energy piping outside of containment as part of its primary review responsibility for SRP Section 3.6.1.~~[15]

c. The Reactor Systems Branch ~~(RSB)~~(SRXB)[16] determines that the steam bypass capacity is consistent with reactor transient analysis as part of its primary review responsibility for SRP Section 4.4.

d. The ~~Procedures and Test Review Branch~~Quality Assurance and Maintenance Branch (HQMB)[17] determines the acceptability of the preoperational and startup tests as part of its primary review responsibility for SRP Section 14.~~0~~2.[18]

e. The review~~s for fire protection,~~ of technical specifications~~, and quality assurance are coordinated and~~is performed by the ~~Chemical Engineering Branch, Licensing Guidance Branch~~Technical Specifications Branch (TSB)~~, and Quality Assurance Branch~~ as part of ~~their~~its primary review responsibility for SRP Section~~s 9.5.1,~~ 16.0.~~ and 17.0, respectively.~~[19]

f. The review of quality assurance programs is performed by the Quality Assurance and Maintenance Branch (HQMB) as part of its primary review responsibility for SRP Sections 17.1 and 17.2.[20]

For those areas of review identified above as ~~being~~ 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[21] branches.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the turbine bypass system, as described in the applicant's safety analysis report (SAR), is based on the specific General Design Criteria, industry standards, and other criteria listed below and on the similarity of the design to that of plants previously reviewed and found acceptable.

The design of the turbine bypass system is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 4 (GDC 4), "Environmental and Dynamic Effects Design Basis,"[22] 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,"[23] 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.

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 6) is applicable as follows:

A. The turbine bypass lines from the first valve up to the condenser inlet need not be classified as seismic category I if the following criteria are met:

   1. They have been analyzed using a dynamic seismic analysis method to demonstrate their structural integrity under SSE loading conditions.

   2. All pertinent QA requirements of Appendix B to 10 CFR Part 50 are applied.

   3. 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.

B. 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.[24]

Technical Rationale:

The technical rationale for application of these acceptance criteria to the TBS is discussed in the following paragraphs:[25]

A. 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 conditions. 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.[26]

B. 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.[27]

III. REVIEW PROCEDURES

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) 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.

The 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 ~~LGB~~TSB[28] 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 ~~assure~~ 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 criteria of II.A and B.[29]

~~3~~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 standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.[30]

IV. EVALUATION FINDINGS

The reviewer determines that sufficient information has been provided and that the review supports conclusions of the following type, to be included in the staff's safety evaluation report:

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 ~~for the _____ plant~~[31] 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 ~~Missile~~Dynamic Effects[32] 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.[33]

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 design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff’s evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC),

site interface requirements, and combined license action items that are relevant to this SRP section.[34]

V. IMPLEMENTATION

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

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.[35] 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.

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.[36]

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and ~~Missile~~Dynamic Effects[37] Design Bases."

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

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

4. Branch Technical Positions ASB 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."[38]

5. Branch Technical Position MEB 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."[39]

6. 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.[40]

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SRP Draft Section 10.4.4
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB name and abbreviation	Changed PRB to Plant Systems Branch (SPLB).
2.	**Integrated Impact No. 1375**	Added the potential accident mitigation function of the turbine bypass system to holdup and plateout fission products from MSIV leakage during a LOCA.
3.	Current PRB name and abbreviation	Changed PRB to SPLB.
4.	Current PRB designation	Changed PRB to SPLB.
5.	Current PRB designation	Changed PRB to SPLB.
6.	Editorial correction	Changed "assure" to "ensure" (global for this section).
7.	SRP-UDP format item	Added subsection titled "Review Interfaces."
8.	SRP-UDP format item	Added introduction to PRB reviews.
9.	Current PRB designation	Changed PRB to SPLB.
10.	SRP-UDP format item	This review interface was moved here from a later paragraph because SPLB has primary responsibility for review against Branch Technical Position ASB 3-1.
11.	SRP-UDP format item	Review of the fire protection branch is now the responsibility of the primary review branch (SPLB). The statement of this responsibility was relocated to this subsection from a later paragraph.
12.	Current PRB designation	Changed PRB to SPLB.
13.	Current interfacing review branch designation	Changed review interface to EMEB.
14.	SRP-UDP format item	Made a separate paragraph to show that review against Branch Technical Position MEB 3-1 is the responsibility of EMEB. SPLB now reviews against ASB 3-1. This SPLB review was moved forward in the SRP under the primary review responsibilities of SPLB. Added title of the branch technical position as an aid to the reviewer. Also corrected text to show the location of BTP MEB 3-1 as SRP Section 3.6.2.
15.	SRP-UDP format item	Reformatted this paragraph as two separate paragraphs. Branch Technical Position ASB 3-1 is implemented by the primary review branch (SPLB). Branch Technical Position MEB 3-1 is implemented by EMEB.
16.	Current interfacing review branch designation	Changed review interface to SRXB.

Item	Source	Description
17.	Current interfacing review branch name and designation	Changed review interface to HQMB.
18.	Editorial correction	The review is guided by SRP Section 14.2, not 14.0.
19.	SRP-UDP format item	The original paragraph has been broken into three paragraphs. The current review branch names and abbreviations have been provided. The review of the fire protection program is now the responsibility of the primary review branch (SPLB). Therefore, this statement of responsibility was moved up with the set of primary responsibility review interfaces.
20.	SRP-UDP format item	This statement was separated from the above paragraph to stand alone. The quality assurance program review is now the responsibility of the Quality Assurance and Maintenance Branch (HQMB). Reference to governing SRP section(s) was changed to SRP Sections 17.1 and 17.2. (SRP Section 17.0 does not exist.) This plan covers both CP and OL reviews.
21.	Editorial modification	Removed superfluous "being" from the first line of the sentence. Added "review" in the final line for clarity.
22.	Editorial modification	Added initialism for and title of GDC 4 to aid reviewers.
23.	Editorial modification	Added initialism for and title of GDC 34 to aid reviewers.
24.	**Integrated Impact No. 1375**	Added Acceptance Criteria from SECY 93-087 applicable to TBSs credited for fission product holdup and plateout.
25.	SRP-UDP format item	Added "Technical Rationale" and introductory paragraph to ACCEPTANCE CRITERIA.
26.	SRP-UDP format item	Added technical rationale for GDC 4.
27.	SRP-UDP format item	Added technical rationale for GDC 34.
28.	Current interfacing review branch designation	Changed review interface to TSB.
29.	**Integrated Impact No. 1375**	Added a Review Procedure applicable to TBSs credited for fission product holdup and plateout.
30.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
31.	Editorial modification	Deleted unnecessary wording.
32.	Integrated Impact No. 551	Updated the title of the General Design Criterion. The title was changed in 1987 as a result of rulemaking activities.

Item	Source	Description
33.	**Integrated Impact No.1375**	Added an Evaluation Finding to address TBSs credited for fission product holdup and plateout.
34.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.
35.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
36.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
37.	Integrated Impact No. 551	Updated the title of the General Design Criterion. The title was changed in 1987 as a result of rulemaking activities.
38.	Editorial modification	Added the title of SRP Section 3.6.1 for specificity and completeness.
39.	Editorial modification	Added the title of SRP Section 3.6.2 for specificity and completeness.
40.	Integrated Impact No. 1375	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.

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Integrated Impact No.	Issue	SRP Subsections Affected
551	Update the title of GDC 4, "Environmental and Dynamic Effects Design Bases," to reflect a change made during rulemaking in 1987.	II.1, IV.1, and VI.1
1375	In recognition of the staff position in SECY-93-087, Item II.E, add review of the TBS post-accident function for those BWRs relying on the main steam line and condenser to hold up and plate out fission product instead of using a main steam isolation valve leakage control system.	I, II, III.3, IV.3, and VI.6