



## U.S. NUCLEAR REGULATORY COMMISSION

# STANDARD REVIEW PLAN

### 3.5.1.3 TURBINE MISSILES

#### REVIEW RESPONSIBILITIES

**Primary** - Organization for Component Integrity

**Secondary** - None

#### I. AREAS OF REVIEW

General Design Criterion 4 (GDC 4), "Environmental and Missile Dynamic Effects Design Bases," of Appendix A to 10 CFR Part 50 requires that structures, systems, and components (SSCs) important to safety shall be designed to accommodate the effects of and to be compatible with environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These SSCs shall be appropriately protected against dynamic effects including, among others, the effects of missiles.

When reviewing the following topics, the reviewer should consider the following:

1. The large steam turbines have rotors with large masses and rotate at relatively high speeds during normal reactor operation. The failure of a rotor may result in the generation of high energy missiles that could affect safety-related SSCs. Plant designs are reviewed to determine whether safety-related plant SSCs have adequate protection against the effects of potential turbine missiles. The primary review area is the evaluation of the turbine missile generation probability.

Rev. 3 - [Month] 2007

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### 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 the Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of the standard format have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) will be based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," until the SRP itself is updated.

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 [NRR\\_SRP@nrc.gov](mailto:NRR_SRP@nrc.gov).

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2. 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.
3. 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. The organization responsible for civil engineering reviews the turbine missile impact effects on steel and concrete barriers (e.g., penetration depth, scabbing, and structural response) as part of its primary review responsibility for SRP Section 3.5.3.
2. The organization responsible for component integrity reviews the turbine rotor failure analysis, fracture toughness properties, turbine startup procedures, and inservice inspection as part of its primary review responsibility for SRP Section 10.2.3.
3. The organization responsible for main steam and feedwater system reviews the turbine overspeed protection, including overspeed sensing and tripping, and turbine startup procedures as part of its primary review responsibility for SRP Section 10.2. This organization also reviews SSCs to be protected from turbine missiles as part of its primary review responsibility for SRP Section 3.5.2.
4. The organization responsible for component performance and testing reviews the adequacy of the inservice testing program of pumps and valves as part of its primary review responsibility for SRP Section 3.9.6.

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

## II. ACCEPTANCE CRITERIA

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

1. The NRC acceptance criteria is based on meeting the relevant requirements of General Design Criteria (GDC) 4, as it relates to SSCs important to safety being appropriately protected against environmental and dynamic effects, including the effects of missiles, that may result from equipment failure. Failure of large steam turbines in the main turbine generator has the potential to eject high-energy missiles that can produce such damage. The staff's overall safety objective is to ensure that SSCs important to safety are adequately protected from the effects of turbine missiles. Accordingly, consideration should be given to safety-related systems (i.e., those SSCs necessary to perform required safety functions). The specific criteria necessary to meet the relevant requirements of GDC 4 to reduce the probability of turbine missile generation are as follows:
  - (a) The integrity of the reactor coolant pressure boundary;
  - (b) The capability to shut down and maintain the reactor in a safe condition; and
  - (c) The capability to prevent accidents that could result in potential offsite exposures, which represent a significant fraction of the guideline exposures specified in 10 CFR Part 100, "Reactor Site Criteria."

Examples of safety-related systems that should be protected are described in the Appendix to Regulatory Guide (RG) 1.117, "Tornado Design Classification."

2. 10 CFR 52.47(a)(1)(vi), as it relates to ITAAC (for design certification) sufficient to assure that the SSCs in this area of review will operate in accordance with the certification.
3. 10 CFR 52.97(b)(1), as it relates to ITAAC (for combined licenses) sufficient to assure that the SSCs in this area of review have been constructed and will be operated in conformity with the license and the Commission'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. 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 structures, systems, or components,  $P_2$ ; and (c) the probability of struck structures, systems, or components failing to perform their safety function,  $P_3$ . Stated in mathematical terms,  $P_4 = P_1 \times P_2 \times P_3$ .

In accordance with the guidance provided in SRP Section 2.2.3 and RG 1.115, the probability of unacceptable damage from turbine missiles should be less than or equal to 1 in 10 million per year for an individual plant (i.e.,  $P_4$  should be  $\leq 10^{-7}$  per year per plant).

Although the calculation of strike probability,  $P_2$ , is not difficult in principle (i.e., a straightforward ballistics analysis), in practice it requires numerous modeling approximations and simplifying assumptions to define the properties of missiles, interactions of missiles with barriers and obstacles, trajectories of missiles as they interact with and perforate (or are deflected by) barriers, and identification and location of safety-related targets. Specific approximations and assumptions tend to have a significant effect on the resulting value of  $P_2$ . Similarly, a reasonably accurate specification of the damage probability,  $P_3$ , is complicated by difficulties associated with defining the missile impact energy required to render safety-related systems unavailable to perform their safety functions and with postulating sequences of events that would follow a missile-producing turbine failure.

Because of the uncertainties associated with calculating  $P_2$  and  $P_3$ , the staff concludes that such analyses are "order of magnitude" calculations only. On the basis of simple estimates for a variety of plant layouts, the strike and damage probability product can be reasonably assumed to fall in a range that depends on the gross features of turbine generator orientation.

- (a) For favorably oriented turbine generators, the product of  $P_2$  and  $P_3$  tends to be in the range of  $10^{-4}$  to  $10^{-3}$  per year per plant.
- (b) For unfavorably oriented turbine generators, the product of  $P_2$  and  $P_3$  tends to be in the range of  $10^{-3}$  to  $10^{-2}$  per year per plant.

Favorably oriented turbine generators are located such that the containment and all, or almost all, safety-related SSCs outside containment are excluded from the low-trajectory hazard zone described in RG 1.115.

Because of assumptions and modeling difficulties in the probabilistic calculations as described above, the staff does not encourage applicants to calculate  $P_2$ ,  $P_3$ , or their product. Instead, the staff accepts a product of strike and damage probabilities of  $10^{-3}$  per year per plant for a favorably oriented turbine and  $10^{-2}$  per year per plant for an unfavorably oriented turbine. The suggested values represent the staff's best estimate of the product of  $P_2$  and  $P_3$ , based on the results of calculations performed at the NRC and elsewhere (Refs. 5 and 14).

2. Operating experience indicates that turbine rotor crack (Refs. 6, 11, and 12), turbine stop and control valve failures (Refs. 7, 10, and 12), blade failures (Ref. 12), and rotor ruptures can result in the generation of high-energy missiles (Refs. 9 and 12). Analyses (Refs. 7 and 8) indicate that missile generation can be modeled and the probability of missile generation can be strongly influenced by a suitable program of periodic inservice testing and inspection.

In general, two modes of turbine rotor failure can result in turbine missile generation: (a) rotor material failure at approximately the rated operating speed and (b) failure of the

overspeed protection system. Failure of turbine rotors at or below the design speed (nominally, 120% of normal operating speed) can be caused by small flaws or cracks that grow to critical size during operation. Failure of the turbine rotors at destructive overspeed (about 180% to 190% of normal operating speed) can result from failure of the overspeed protection system. The material properties of the turbine casing are of interest because secondary missiles could be generated if the casing fails or, alternatively, the casing could serve to arrest and contain missiles.

The missile generation probability at the design speed should be related to rotor design parameters, material properties, and the intervals of inservice examinations of disks. The missile generation probability at the destructive overspeed should be related to the speed sensing and tripping characteristics of the turbine governor and overspeed protection system, the design and arrangement of main steam control and stop valves, the reheat steam intercept, reheat stop valves, and the inservice testing and inspection intervals for system components and valves. In addition, the turbine casing material in its operational environment should be evaluated for fracture toughness properties. SRP Section 10.2 provides additional guidance regarding inspection and testing of turbine generator components. Further information regarding turbine missile generation mechanisms and probabilities can be found in References 5, 12, and 13.

3. The staff believes that maintaining an acceptably low missile generation probability,  $P_1$ , by means of a suitable program of periodic testing and inspection is a reliable method for ensuring that the objective of precluding generation of turbine missiles (and hence the possibility of damage to safety-related structures, systems, and components by those missiles) can be met. The NRC safety objective for turbine missiles (i.e.,  $P_4$  should be  $\leq 10^{-7}$  per year per plant) is best expressed in terms of either of two sets of criteria applied to missile generation probability,  $P_1$ . All applicants are expected to commit to operating criteria (see Table 3.5.1.3-1 below) appropriate to the applicable turbine orientation. One set of criteria should be applied to favorably oriented turbines; the other should be applied to unfavorably oriented turbines.

This approach places responsibility on the applicant for initially demonstrating, and thereafter maintaining, an NRC-specified turbine reliability. Accordingly, the applicant should commit to conduct appropriate inservice inspection and testing throughout the life of the plant. Accordingly, the applicant should demonstrate the capability to perform visual, surface, and volumetric (ultrasonic) examinations suitable for inservice inspection of turbine rotors and shafts and provide reports, as required, describing the applicant's methods for determining turbine missile generation probabilities (Refs. 5, 13, and 14) for NRC review and approval.

4. Applicants obtaining turbines from manufacturers that have prepared NRC-approved reports to describe their methods and procedures for calculating turbine missile generation probabilities are expected to meet criteria appropriate to the orientation of the turbine (see Table 3.5.1.3-1). Turbine manufacturers should provide applicants with tables of missile generation probabilities versus time (inservice visual, surface, and volumetric rotor inspection interval for design speed failure and inservice valve testing interval for destructive overspeed failure) for each turbine. These probabilities should be used to establish inspection and test schedules that meet NRC safety objectives.

**TABLE 3.5.1.3-1**  
**PROBABILITY OF TURBINE FAILURE RESULTING IN THE EJECTION OF**  
**TURBINE ROTOR (OR INTERNAL STRUCTURE) FRAGMENTS THROUGH THE TURBINE**  
**CASING ( $P_1$ ) AND RECOMMENDED LICENSEE ACTIONS**

Case	PROBABILITY PER YEAR FOR A FAVORABLY ORIENTED TURBINE	PROBABILITY PER YEAR FOR AN UNFAVORABLY ORIENTED TURBINE	RECOMMENDED LICENSEE ACTION
A	$P_1 < 10^{-4}$	$P_1 < 10^{-5}$	This condition represents the general, minimum reliability requirement for loading the turbine and bringing the system on line.
B	$10^{-4} < P_1 < 10^{-3}$	$10^{-5} < P_1 < 10^{-4}$	If this condition is reached during operation, the turbine may be kept in service until the next scheduled outage, at which time the licensee must take action to reduce $P_1$ to meet the appropriate Case A criterion before returning the turbine to service.
C	$10^{-3} < P_1 < 10^{-2}$	$10^{-4} < P_1 < 10^{-3}$	If this condition is reached during operation, the turbine must be isolated from the steam supply within 60 days, at which time the licensee must take action to reduce $P_1$ to meet the appropriate Case A criterion before returning the turbine to service.
D	$10^{-2} < P_1$	$10^{-3} < P_1$	If this condition is reached during operation, the turbine must be isolated from the steam supply within 6 days, at which time the licensee must take action to reduce $P_1$ to meet the appropriate Case A criterion before returning the turbine to service.

5. Applicants are expected to commit to the following program if turbines are obtained from manufacturers that have not submitted, or received NRC approval for, reports describing their methods and procedures for calculating turbine missile generation probabilities:

- (a) An inservice inspection program should be used to detect rotor or disk flaws that could lead to brittle failure at or below design speed in the steam turbine rotor assembly. The turbine rotor design should facilitate inservice inspection of all high-stress regions, including disk bores and keyways, without removal of the disks from the shaft. The volumetric inservice inspection interval for the steam turbine rotor assembly should be established according to the following guidelines:

- (1) The initial inspection of a new rotor or disk should be performed before any postulated crack is calculated to grow to more than one-half the critical crack depth. If the calculated inspection interval is less than the scheduled first fuel cycle, the licensee should seek the manufacturer's guidance on delaying the inspection until the first refueling outage. If the calculated inspection interval is longer than the first fuel cycle, the licensee should seek the manufacturer's guidance for scheduling the first inspection during a later refueling outage.
  - (2) Disks that have been inspected and found free of cracks or that have been repaired to eliminate all indications of cracks should be reinspected using the criterion described in (1) above. Crack growth should be calculated from the time of the last inspection.
  - (3) Disks operating with known and measured cracks should be reinspected before the elapse of one-half the time calculated for any crack to grow to one-half the critical depth. The guidance described in (1) above should be used to set the inspection date on the basis of the calculated inspection interval.
  - (4) Under no circumstances should the volumetric inservice inspection interval for low-pressure (LP) disks exceed 3 years or two fuel cycles, whichever is longer.
- (b) In accordance with the manufacturer's procedures, the turbine inservice inspection program should use visual, surface, and volumetric examinations to inspect turbine components such as couplings, coupling bolts, LP turbine shafts, blades and disks, and high-pressure (HP) rotors. Shafts and disks with crack(s) having depths at or near one-half the critical crack depth should be repaired or replaced. All cracked couplings and coupling bolts should be replaced.
- (c) The inservice inspection and test program should be used for the governor and overspeed protection system to provide further assurance that flaws or component failures will be detected in the overspeed sensing and tripping subsystems, main steam control and stop valves, reheat steam intercept and stop valves, or extraction steam non-return valves — any of which could lead to an overspeed condition above that specified by the design overspeed. The inservice inspection program for operability of the governor and overspeed protection system should include, at a minimum, the following provisions:
- (1) For typical turbine governor and overspeed protection systems, at intervals of approximately 3 years during refueling or maintenance shutdowns, at least one main steam control valve, one main steam stop valve, one reheat intercept valve, one reheat stop valve, and one of each type of steam extraction valve should be dismantled for examination. Visual and surface examinations of valve seats, disks, and stems should be conducted. Valve bushings should be inspected and cleaned, and

bore diameters should be checked for proper clearance. If any valve is shown to have flaws or excessive corrosion or improper clearances, the valve should be repaired or replaced. All other valves of that type should also be dismantled and inspected.

- (2) At least once a week during normal operation, main steam control and stop valves, reheat intercept and stop valves, and steam extraction non-return valves should be exercised by closing each valve and observing directly the valve motion as it moves smoothly to a fully closed position.
- (3) At least once a month during normal operation, each component of the electro-hydraulic governor system (which modulates control and intercept valves), as well as the primary and backup overspeed trip devices (both of which trip the main steam control and stop valves and the reheat intercept and stop valves), should be tested.

The online test failure of any one of these subsystems mandates repair or replacement of failed components within 72 hours. Otherwise, the turbine should be isolated from the steam supply until repairs are completed. Refer to SRP Section 10.2 for additional information regarding inspection and testing of turbine generator components.

- (d) The design, inspection, and operating conditions should provide assurance that the probability of turbine missile generation will not exceed those described in Table 3.5.1.3-1.
6. An applicant may propose to install barriers or to take credit for existing structures or features as barriers. Such a decision could be based on the applicant's deterministic judgment that a SSCs is particularly vulnerable to destruction or unacceptable damage in the event of a turbine failure. The applicant should include specific details in the safety analysis report (SAR) supporting the need for such protection. If an applicant proposes to design or evaluate barriers to reduce or eliminate turbine missile hazards to equipment, the barriers should meet the acceptance criteria described in SRP Section 3.5.3. Additional design guidance is provided in Reference 4.

#### Technical Rationale

The technical rationale for application of these requirements to reviewing this SRP section is discussed in the following paragraphs:

1. Compliance with GDC 4 requires that components important to safety be designed to accommodate the effects of, and be compatible with, environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. Components are to be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failure and from events and conditions outside the nuclear power unit.



2. The protection of safety-related SSCs from the effects of turbine missiles is discussed in this SRP section. The staff recommends that the calculated probability of damage to such equipment be less than 1 in 10 million per plant per year. Specific guidance regarding the arrangement, design, and inspection of turbine generators is provided to ensure that the probability of turbine missile damage will not exceed the limit value during the life of the plant.
3. Meeting the requirements of GDC 4 provides assurance that SSCs important to safety will be protected from the effects of turbine missiles and will be capable of performing their intended safety function.

### 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 organizations responsible for various sections of the review interface will provide input for the areas of review stated in subsection I of this SRP section. The primary reviewer organization obtains and uses such input as required to ensure that this review procedure is complete.

The review procedure involves the following:

1. Review the plant layout to determine the relative placement of the containment and other safety-related SSCs with respect to the turbine-generator unit(s). Determine whether the orientation of the turbine is favorable or unfavorable according to the acceptance criteria in subsection II. Compare the strike and damage probability with the acceptance criteria as described in subsection II.
2. Compare the applicant's turbine missile generation probability based on the applicant's input with the acceptance criteria described in subsection II. Review the applicant's methods and analyses to determine that the probability of turbine missile generation is acceptable. Compare the staff's acceptance criteria of inspection programs for defining turbine missile generation probability with the applicant's program. Review the applicant's inspection program to determine whether the applicant's level of commitment is acceptable.
3. Review the reasons for providing barriers and their placement against turbine missiles, if the applicant proposes to install barriers or use existing structures or features as barriers. The organization responsible for civil engineering and structures reviews, the structural capability of these barriers to withstand turbine missiles in accordance with the procedures specified in SRP Section 3.5.3.

4. 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.

1. This applicant having sufficiently demonstrated to the staff that the probability of turbine missile damage to safety-related SSCs is acceptably low, the staff concludes that the turbine missile risk for the proposed plant design is acceptable and meets the requirements of GDC 4.
2. For design certification reviews, the findings will summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's ITAAC evaluation, including site interface requirements, and COL action items that are relevant to this SRP section.
3. 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 COL action items relevant to this SRP section.

#### V. IMPLEMENTATION

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

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 superseded by a later revision.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

## VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Dynamic Effects Design Bases."
2. Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles."
3. Regulatory Guide 1.117, "Tornado Design Classification."
4. "Fundamentals of Protective Design," TM-5-855-1, Department of the Army, July 1965.
5. NUREG-1048, Supplement 6, "Safety Evaluation Report Related to the Operation of Hope Creek Generating Station," July 1986 (includes Appendix U, "Probability of Missile Generation in General Electric Nuclear Turbines").
6. NUREG/CR-1884, "Observations and Comments on the Turbine Failure at Yankee Atomic Electric Company, Rowe, Massachusetts," March 1981.
7. J. J. Burns, Jr., "Reliability of Nuclear Power Plant Steam Turbine Overspeed Control Systems," ASME 1977 Failure Prevention and Reliability Conference, Chicago, Illinois, September 1977, page 27.
8. W. G. Clark, Jr., B. B. Seth, and D. H. Shaffer, "Procedures for Estimating the Probability of Steam Turbine Disc Rupture From Stress Corrosion Cracking," ASME/IEEE Power Generation Conference, October 4-8, 1981, St. Louis, Missouri.
9. D. Kalderon, "Steam Turbine Failure at Hinkley Point A," Proceedings of the Institute of Mechanical Engineers, 186, 31/72, 1972, page 341.
10. License Event Report No. 82-132, Docket No. 50-361, "Failure of Turbine Stop Valve 2UV-2200E to Close Fully," San Onofre Nuclear Generating Station, Unit 2, November 19, 1982.
11. Preliminary Notification of Event or Unusual Occurrence, PNO-111-81-104, "Circle in the Hub of the Eleventh Stage Wheel in the Main Turbine," Monticello Nuclear Power Station, November 24, 1981.
12. NRC Memorandum from E. Jordan to W. Russell (with enclosed report, AEOD/S94-02 by H. Ornstein), "AEOD Special Study -- Turbine-Generator Overspeed Protection Systems at U.S. Light-Water Reactors," September 30, 1994.
13. Letter from C. Rossi (NRC) to J. Martin (Westinghouse Electric Corporation), "Approval for Referencing of Licensing Topical Reports WSTG-1-P, May 1981, 'Procedures for Estimating the Probability of Steam Turbine Disc Rupture From Stress Corrosion Cracking,' March 1974, 'Analysis of the Probability of the Generation and Strike of Missiles from a Nuclear Turbine,' WSTG-2-P, May 1981, 'Missile Energy Analysis Methods for Nuclear Steam Turbines,' and WSTG-3-P, July 1984, 'Analysis of the Probability of a Nuclear Turbine Reaching Destructive Overspeed,'" February 2, 1987.

14. NUREG-0887, Supplement No. 3, "Safety Evaluation Report Related to the Operation of Perry Nuclear Power Plant, Units 1 and 2," April 1983.
15. NRC Inspection Manual Chapter IMC-2504, "Construction Inspection Program - Non-ITAAC Inspections," issued April 25, 2006.

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**PAPERWORK REDUCTION ACT STATEMENT**

The information collections contained in the draft 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.

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### SRP Section 3.5.1.3 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 ML052070373.

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 200X:

1. Removed most acceptance criteria and review procedures in the 1981 edition of SRP 3.5.1.3 because the NRC has changed its evaluation of turbine missiles. The original SRP provided guidance on the evaluation of the turbine missile strike zones and trajectories and missile interaction with barriers. Since the 1980s, the NRC has focused its evaluation on preventing and minimizing the turbine missile generation by specifying a set of minimum acceptable probabilities of turbine failure resulting from ejection of turbine disk or internal structure fragments through the turbine casing.
2. Added technical rationale for the acceptance criteria and 10 CFR Part 52 reviews.

Review Responsibilities - Reflects changes in review branches resulting from reorganization and branch consolidation. Change is reflected throughout the SRP.

#### I. AREA OF REVIEW

Revised the area of review to focus on the probability of turbine missile generation. The review will also include plant designs to determine whether potential turbine missiles may affect safety-related structures, systems, and components. References to interfacing branches were relocated to the Review Interfaces section.

#### II. ACCEPTANCE CRITERIA

Revised the original acceptance criteria to be consistent with the approach the staff has taken when reviewing turbine missile issues in licensing applications or amendments since the 1980s. The revised acceptance criteria are based on limiting the probability of turbine failure resulting in the ejection of turbine disk (or internal structure) fragments through the turbine casing. The probabilities are also based on the orientation of the turbine with respect to the reactor building.

#### III. REVIEW PROCEDURES

Revised the original review procedures to be consistent with the revised acceptance criteria. The revised review procedures include the review of orientation of the turbine which dictates the allowable turbine failure probability. Added guidance pertaining to standard design certification reviews under 10 CFR Part 52, such as procedures in SRP Section 14.3.

IV. EVALUATION FINDINGS

Removed unnecessary guidance for the case when the turbine missile risk is high, which would not comply with GDC 4. Added guidance pertaining to design certification review under 10 CFR Part 52.

V. IMPLEMENTATION

Added 10 CFR Part 52 to the implementation guidance. Added the timeline with regard to the use of the final version of this SRP.

VI. REFERENCES

Added ten references which provide technical bases for revised acceptance criteria and review procedures.