UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

August 23, 2007

NRC REGULATORY ISSUE SUMMARY 2007-20 IMPLEMENTATION OF PRIMARY-TO-SECONDARY LEAKAGE PERFORMANCE CRITERIA

ADDRESSEES

All holders of operating licenses for pressurized-water reactors (PWRs), except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

INTENT

The U.S. Nuclear Regulatory Commission (NRC) is issuing this Regulatory Issue Summary (RIS) to notify licensees of its regulatory position regarding implementation of the primary-to-secondary leakage performance criteria described in Technical Specification Task Force (TSTF), "Steam Generator Tube Integrity." NRC expects addressees to review this RIS for applicability to their facilities and consider actions as appropriate. This RIS requires no action or written response from addressees.

BACKGROUND INFORMATION

The NRC staff, with external stakeholder involvement, developed modified generic Technical Specifications (TS) for addressing steam generator (SG) tube integrity. The generic changes to the Standard Technical Specifications were submitted by the TSTF and are designated TSTF-449. On May 6, 2005 (70 FR 24126), the NRC approved Revision 4 to TSTF-449 and applied the consolidated line item improvement process to provide an example application for adoption of TSTF-449 into a licensee's TSs. The NRC staff's model safety evaluation on TSTF-449 was published in the *Federal Register* on March 2, 2005 (70 FR 10298).

The revised generic TSs are performance-based because they focus on ensuring the tubes satisfy performance criteria that are commensurate with assurance of adequate tube integrity. There are three SG performance criteria: structural integrity, accident-induced leakage, and operational leakage. SG tube integrity is maintained when all three of these criteria are met.

All PWR plants have submitted applications to adopt SG TSs similar to those in TSTF-449. In reviewing these applications, there have been numerous interactions between the NRC staff and licensees concerning the accident-induced leakage performance criteria including its relationship to the operational leakage performance criterion. During these interactions, it

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appeared that uncertainties existed regarding how to implement the operational and accident-induced primary-to-secondary leakage criteria. The purpose of this RIS is to clarify the NRC staff's position related to implementation of the leakage performance criteria in TSTF-449 and committed to by licensees.

The operational leakage performance criterion in TSTF-449 is 150 gallons per day (gpd) through any one SG. This limit is based on operating experience with SG tube degradation mechanisms that result in primary-to-secondary leakage. This criterion, in conjunction with the implementation of the SG program described in TSTF-449, which ensures SG tube integrity is maintained between inspections, is an effective measure for limiting the frequency of SG tube ruptures.

The accident-induced primary-to-secondary leakage performance criteria consists of two criteria. The first criterion involves limiting the primary-to-secondary leakage rate for all design basis accidents, other than a SG tube rupture, to a value less than that assumed in the accident analyses in terms of total leakage rate for all SGs and leakage rate for an individual SG. Since this criterion was established as part of the plant licensing basis, applicants for PWR licenses are required to analyze the consequences of postulated design basis accidents. Typical accidents analyzed include a locked rotor, control rod ejection, and a main steamline break. These analyses consider the potential for primary-to-secondary leakage to exist and the analyses must show that the offsite radiological doses associated with this leakage does not exceed the regulatory requirements which include Title 10 of the *Code of Federal Regulations* (10 CFR) Part 100, "Reactor Site Criteria," limits (or some fraction thereof), 10 CFR 50.67, "Accident Source Term," and General Design Criterion (GDC) 19, "Control Room," of 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants." The second criterion of the accident-induced leakage performance criteria involves limiting the primary-to-secondary leak rate to 1 gallon per minute (gpm) per SG, unless the NRC staff has approved higher limits for specific types of degradation at specific locations. This second criterion is intended to ensure that the potential for induced leakage during severe accidents will be maintained at a level that will not increase risk.

SUMMARY OF ISSUE

The purpose of this RIS is to clarify the NRC staff's position related to the implementation of the leakage performance criteria in TSTF-449 and committed to by licensees.

Issue 1: Potential primary-to-secondary leakage for all design basis accidents should not exceed the value assumed in the accident analyses.

Primary-to-secondary leakage is assumed to occur in several design basis accidents (e.g., locked rotor or steam line break). The radiological dose consequences associated with this assumed leakage are evaluated to ensure they remain within regulatory limits (e.g., 10 CFR Part 100, GDC 19). The accident-induced leakage performance criteria is intended to ensure the primary-to-secondary leak rate during an accident remains less than or equal to the primary-to-secondary leak rate assumed in the accident analyses.

Implementing the accident-induced leakage performance criteria requires an analysis of the condition of the SG tubing during a SG inspection to calculate the magnitude of the

primary-to-secondary leak rate which could potentially occur for each of the design basis accidents. These calculated leak rates for each design basis accident should not exceed the value assumed in the corresponding accident analyses. This applies to all such accidents except for a SG tube rupture (which is specifically exempted in the performance criteria). For some accidents, this may involve calculating the total primary-to-secondary leak rate associated with all of the flaws in a SG for a specific accident and comparing this leak rate to the leak rate assumed in the accident analyses (i.e., the accident-induced leak rate limit for this accident); for other accidents it may simply involve comparing the leakage rate observed during normal operation to the leakage rate assumed in the accident analyses. This latter case would only be applicable in the event that the loading conditions (e.g., differential pressure or temperature) on the tubes during the accident are no more severe (from a leakage integrity standpoint) than the loading conditions on the tubes during normal operation. That is, the normal operating leakage would bound the leakage expected during the accident.

Issue 2: Accident-induced leakage includes leakage existing prior to the accident.

Accident-induced leakage includes the leakage existing prior to the accident in addition to the incremental increase in primary-to-secondary leakage induced during the accident. The accident-induced leak rate is the primary-to-secondary leak rate that would be observed during an accident. The accident-induced leak rate is not limited to just the increase (or decrease) in the leak rate as a result of the different loading conditions imposed on the SG tubes during the postulated accident.

Issue 3: The temperature at which the volumetric primary-to-secondary flow rate (i.e., leak rate) is evaluated should be consistent with the temperature assumed in the accident analyses.

The primary-to-secondary leak rate measured during normal operation and assumed in the accident analyses are in terms of volumetric flow rates (i.e., gpd or gpm). The volume that a specific amount of water (primary-to-secondary leakage) occupies depends on its temperature. The normal operating primary-to-secondary leakage rate is normally calculated at room temperature conditions in accordance with industry guidelines. However, the primary-to-secondary leakage rate assumed in the accident analyses may have been assumed to occur for a different temperature. In addition, at some plants, the primary-to-secondary leakage rate for a specific accident may have been evaluated at one temperature for assessing the offsite radiological dose consequences and at another temperature for assessing the control room radiological dose consequences. In comparing the accident-induced primary-to-secondary leak rates to their limits, the volumetric flow rate should be determined for the specific temperature(s) used in the accident analyses. In addition, if the accident analyses were performed assuming that accident-induced leakage is equal to the normal operating leakage rate limit for a specific temperature, the measured normal operating primary-to-secondary leak rate should be adjusted to that temperature for comparison with the normal operating primary-to-secondary leak rate limit.

This issue is also addressed in NRC Information Notice 97-79, “Potential Inconsistency in the Assessment of the Radiological Consequences of a Main Steam Line Break Associated with the Implementation of Steam Generator Tube Voltage-Based Repair Criteria.”

Issue 4: The assumptions regarding the pre- and post-accident leakage rate must be satisfied.

The analyses for a design basis accident may assume a pre-accident primary-to-secondary leak rate. The pre-accident primary-to-secondary leak rate is assumed to establish the secondary coolant activity. The accident analyses may assume a post-accident leak rate different from that assumed prior to the accident. To satisfy the accident-induced leakage performance criteria, the pre- and post-accident primary-to-secondary leak rate must be less than the corresponding value(s) assumed in the accident analyses for the appropriate temperature conditions.

Issue 5: The normal operating primary-to-secondary leak rate may need to be kept well below the normal operating primary-to-secondary leak rate limit to ensure the accident-induced leakage performance criteria are not exceeded.

The loading conditions on the tubes during an accident may be different than the loading conditions on the tubes during normal operation. As a result, the primary-to-secondary leak rate observed during normal operation may change under accident conditions. In some cases, the primary-to-secondary leak rate may increase as a result of the accident, while in other cases it may decrease. If the loading conditions during an accident result in an increase in the primary-to-secondary leak rate (when compared to the normal operating leak rate), it may be necessary to restrict the normal operating leak rate to less than the normal operating leakage rate limit. This applies not only to units that assume the primary-to-secondary leak rate observed during the accident is the same as the normal operating primary-to-secondary leak rate limit, an assumption that is permitted by the NRC's Standard Review Plan; but also to other units since the increase in primary-to-secondary leak rate going from normal operating conditions to accident conditions can result in significant increases in the leak rate (depending on the accident). The actual amount that the leak rate may increase is a function of several factors including the type of flaw that is leaking. For example, the leak rate from a crack may increase significantly (e.g., by an order of magnitude depending on through-wall crack length) under accident conditions.

Issue 6: The term "most limiting accident" should be clearly defined when it is used.

The term "most limiting accident" can have various meanings. In some cases, this term is used to describe the accident that results in the largest primary-to-secondary leak rate (given a specific set of flaws or conditions (e.g., leak limiting sleeves) in the SG). In other cases, the term is used to describe the accident that results in the most significant radiological dose consequences relative to the applicable regulatory limits (e.g., largest dose or closest to the radiological dose limit). Because the term "most limiting accident" does not have a single meaning, the staff and licensees should clearly define what is meant by "most limiting accident" whenever the term is used.

Issue 7: In the event that a primary-to-secondary leak rate is not assumed for each SG, appropriate controls should be in place to ensure the assumed accident-induced primary-to-secondary leak rate for all SGs is not exceeded.

In some cases, an accident analyses will be performed using a total primary-to-secondary leak rate without discerning the leak rate associated with each of the SGs. In this case, there should be appropriate controls in place to ensure that the total primary-to-secondary leak rate from all SGs is kept below the primary-to-secondary leak rate assumed in the accident analyses. These controls should account for any primary-to-secondary leak rate that may be observed during normal operation and the possible changes in the normal operating leak rate as a result of accident loading conditions.

For example, at one plant a total primary-to-secondary leak rate of 1 gpm is assumed in the radiological dose analyses for a steam line break accident. This plant has two SGs and there are no assumptions regarding the amount of leakage from each of the SGs. If the projected accident-induced leak rate from the faulted SG was calculated to be 1 gpm (based on the flaws in the SG), this would be acceptable provided the normal operating primary-to-secondary leak rate in the other SG was zero. This example illustrates that if the projected accident-induced primary-to-secondary leak rate for the faulted SG is allowed to approach the leak rate assumed in the accident analyses, the operational leak rate for the other SG may need to be kept below the normal operating primary-to-secondary leak rate limit. This would not be a concern if the accident analyses (or plant procedures) were to assume the non-faulted SG was leaking at the normal operating leak rate limit (or if the sum of the projected accident-induced leak rate for the faulted SG and the normal operating leak rate limit for the non-faulted SG was kept below the 1 gpm accident-induced leak rate limit).

Issue 8: Exclusions to the risk-informed 1 gpm limit on accident-induced leakage are evaluated on a case-by-case basis.

In adopting TSTF-449, the NRC staff recognized that for certain severe accident sequences involving high primary side pressure and a depressurized secondary system (“high-dry” condition), primary-to-secondary leakage may lead to more heating of the leaking tube than would be the case if the tube were not leaking, thus increasing the potential for failure of that tube and a consequent large early release. The 1 gpm accident-induced leakage limit on the total leak rate from each SG during design basis accidents (other than a SG tube rupture) ensures that the potential for induced leakage during severe accidents will be maintained at a level that will not increase risk.

Under certain circumstances, the staff has approved exceptions to the 1 gpm accident-induced leakage limit. These exceptions have been limited to the leakage associated with a specific degradation mechanism at a specific location; under all circumstances, the calculated total leak rate (from all sources) must be kept below the primary-to-secondary leak rate assumed in the accident analyses. The staff evaluates the exceptions to the 1 gpm limit on a case-by-case basis by considering the risk implications associated with the increased limit. Approval of the exceptions to the 1 gpm limit are not limited to degradation mechanisms to which an alternate repair criteria (NRC approved tube repair criteria that may be implemented as an alternative to

the standard depth based repair criteria of 40-percent through-wall), nor does approval of an alternate tube repair criteria automatically justify an exception to the 1 gpm limit.

BACKFIT DISCUSSION

This RIS requires no action or written response and is, therefore, not a backfit under 10 CFR 50.109. Consequently, the NRC staff did not perform a backfit analysis.

FEDERAL REGISTER NOTIFICATION

A notice of opportunity for public comment on this RIS was not published in the *Federal Register* because this RIS is informational and pertains to a staff position that does not represent a departure from current regulatory requirements and practice.

CONGRESSIONAL REVIEW ACT

The NRC has determined that this action is not subject to the Congressional Review Act.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in this RIS are covered by the requirements of 10 CFR Parts 50 and 100, which were approved by the Office of Management and Budget (OMB), approval numbers 3150-0011 and 3150-0093.

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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Please direct any questions about this matter to either of the technical contacts listed below.

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ML070570297

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