Project No. 694

WCAP-14572, Revision 1-NP-A, Supplement 2

October 2, 2006

OG-06-320

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U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: PWR Owners Group
Transmittal of NRC-Approved Topical Report WCAP-14572 Revision 1-NP-A, Supplement 2 Revision 1-NP-A "Pressurized Water Reactor Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications", September 2006 (TAC NO. MC3979), PA-MSC-0076, Revision 2

Reference: 1. Letter, R. Peralta (NRC) to G. Bischoff (PWROG), "Corrections to the Final Safety Evaluation for Pressurized Water Reactor (PWR) Owners Group Topical Report WCAP-14572 Revision 1-NP-A, Supplement 2 "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications", (TAC NO. MC3979), dated June 22, 2006.

The purpose of this letter is to transmit four (4) non-proprietary copies of WCAP-14572 Revision 1-NP-A, Supplement 2 Revision 1-NP-A for NRC files. WCAP-14572 Revision 1-NP-A, Supplement 2 Revision 1-NP-A contains the staff's Safety Evaluation and RAI responses. This transmittal completes action on topical report WCAP-14572 Revision 1-NP-A, Supplement 2 Revision 1-NP-A; thus, the PWROG requests that TAC No. MC3979 be closed.

If you require further information, please contact Mr. James Molkenthin in the PWR Owners Group Program Management Office at 860-731-6727.

Sincerely,

P Molkenthin for

Frederick P. "Ted" Schiffley, II, Chairman
PWR Owners Group

FPS:JPM:las

Enclosures (4)

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Westinghouse Non-Proprietary Class 3

WCAP-14572 Revision 1-NP-A
Supplement 2 Revision 1-NP-A

September 2006

Pressurized Water Reactor Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications

Westinghouse

WCAP-14572 Revision 1-NP-A
Supplement 2 Revision 1-NP-A

Pressurized Water Reactor Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications

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September 2006

Work performed for the Pressurized Water Reactor Owners Group under PA-MSC-0076.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
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June 22, 2006

RECEIVED
JUN 30 2006
OG PROJECT OFFICE

Mr. Gordon Bischoff, Manager
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SUBJECT: CORRECTIONS TO THE FINAL SAFETY EVALUATION FOR PRESSURIZED WATER REACTOR (PWR) OWNERS GROUP TOPICAL REPORT WCAP-14572, REVISION 1-NP-A, SUPPLEMENT 2, "WESTINGHOUSE OWNERS GROUP APPLICATION OF RISK-INFORMED METHODS TO PIPING INSERVICE INSPECTION TOPICAL REPORT CLARIFICATIONS" (TAC NO. MC3979)

Dear Mr. Bischoff:

By letter dated August 10, 2004, and its supplement dated June 22, 2005, the Westinghouse Owners Group (WOG), now known as the Pressurized Water Reactor Owners Group (PWR Owners Group), submitted Topical Report (TR) WCAP-14572, Revision 1-NP-A, Supplement 2, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications," (WCAP-14572, Sup. 2) to the U.S. Nuclear Regulatory Commission (NRC) staff for review and approval. By letter dated February 6, 2006, an NRC draft safety evaluation (SE) regarding our approval of WCAP-14572, Sup. 2, was provided to the PWR Owners Group for review and comments. The PWR Owners Group commented on the draft SE in a teleconference between the PWR Owners Group and the NRC staff on February 23, 2006, and submitted the comments by letter dated March 3, 2006. The NRC staff agreed with the PWR Owners Group comments and modifications as discussed with the PWR Owners Group and issued the final SE on May 1, 2006.

Subsequently, the PWR Owners Group informed the NRC staff via an e-mail dated May 24, 2006, that they had incorrectly marked-up the draft SE when they submitted their comments in the letter dated March 3, 2006. In that e-mail, the PWR Owners Group provided the corrected

G. Bischoff - 2 -

mark-up of their comments on the draft SE. Accordingly, the final SE has been corrected and is enclosed with this letter. The NRC staff's disposition of PWR Owners Group's corrected comments are also discussed in the attachment to the corrected final SE.

If you have any questions, please contact Mr. Girija Shukla at 301-415-8439.

Sincerely,

Juan D. Peralta, Acting Chief
Special Projects Branch
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Office of Nuclear Reactor Regulation

Project No. 694

Enclosure: Corrected Final Safety Evaluation

cc w/encl:
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UNITED STATES
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CORRECTED FINAL SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT WCAP-14572, REVISION 1-NP-A, SUPPLEMENT 2, "WESTINGHOUSE OWNERS GROUP APPLICATION OF RISK-INFORMED METHODS TO PIPING INSERVICE INSPECTION TOPICAL REPORT CLARIFICATIONS"

PRESSURIZED WATER REACTOR (PWR) OWNERS GROUP

PROJECT NO. 694

1.0 INTRODUCTION AND BACKGROUND

By letter dated August 10, 2004, the Westinghouse Owners Group (WOG) now known as the Pressurized Water Reactor Owners Group (PWR Owners Group) submitted Topical Report (TR) WCAP-14572, Revision 1-NP-A, Supplement 2, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications," (WCAP-14572, Sup. 2) to the U.S. Nuclear Regulatory Commission (NRC) staff for review and approval (Reference 1). Further clarifying information and revised pages to WCAP-14572, Sup. 2, were provided in a supplemental letter dated June 22, 2005 (Reference 2).

WCAP-14572, Sup. 2, was submitted as a supplement to Topical Report WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection," (Reference 3), which was reviewed and approved by the NRC staff on December 15, 1998. WCAP-14572, Revision 1-NP-A (original, or approved WCAP-14572) provides guidance on selecting and categorizing piping components as high safety significant (HSS) or low safety significant (LSS) groups in order to develop a risk-informed inservice inspection (RI-ISI) program as an alternative to the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (Code) Section XI, inservice inspection (ISI) requirements for piping. RI-ISI programs focus inspections of piping at HSS locations and locations where failure mechanisms (i.e., degradation mechanisms) are likely to be present. The goal of the RI-ISI program is to provide an ongoing substantive assessment of piping conditions.

The WOG submitted WCAP-14572, Sup. 2, to propose a modified method to calculate the failure probability of some pipe segments and to further clarify two topics described in the approved WCAP-14572. WCAP-14572, Sup. 2, addresses the following three topics:

- A methodology for evaluating a segment that includes piping with different diameters (i.e., a multiple pipe diameter (MPD) segment) as an alternative to the previously approved methodology presented in the approved WCAP-14572.

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- The expert panel decision process for moving a segment that, based on the quantitative results, would normally be HSS into the LSS segment category.

- The requirements for examination based on the postulated failure modes and configuration of each piping structural element revised to the requirements presented in the WOG supplemental letter dated June 22, 2005.

2.0 REGULATORY EVALUATION

Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g) specifies that ISI of nuclear power plant components shall be performed in accordance with the requirements of the ASME Code, Section XI, except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). The regulation 10 CFR 50.55a(a)(3) states, in part, that proposed alternatives to the requirements of paragraph (g) may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant shall demonstrate that: (i) The proposed alternatives would provide an acceptable level of quality and safety, or (ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

In its December 15, 1998, safety evaluation (SE), the NRC staff concluded that the RI-ISI program described in the original WCAP-14572 provides an acceptable level of quality and safety pursuant to 10 CFR 50.55a for the proposed alternative to the piping ISI requirements with regard to the number of inspections, locations of inspections, and methods of inspections.

The NRC staff reviewed WCAP-14572, Sup. 2, with respect to the guidance contained in Regulatory Guide (RG) 1.178, "An Approach for Plant-Specific Risk-Informed Decision Making: Inservice Inspection of Piping" (Reference 4) and Standard Review Plan (SRP) Chapter 3.9.8, "Standard Review Plan for the Review of Risk-Informed Inservice Inspection of Piping" (Reference 5). These documents describe an acceptable methodology, acceptance guidelines, and a review process for proposed plant-specific, risk-informed changes to ISI of piping programs. Further guidance is provided in RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (Reference 6) and in SRP Chapter 19, Rev. 1, "Use of Probabilistic Risk Assessment in Plant-Specific, Risk-Informed Decisionmaking: General Guidance" (Reference 7), which contains general guidance for using probabilistic risk assessments (PRAs) in risk-informed decisionmaking. WCAP-14572, Sup. 2, was also evaluated for its contribution to the goal of the approved WCAP-14572, to provide a substantive ongoing assessment of the piping condition by focusing inspections of piping at HSS locations and locations where failure mechanisms are likely to be present.

3.0 TECHNICAL EVALUATION

WCAP-14572, Sup. 2, proposes a new method of evaluating MPD segments as an alternative to the previously approved methodology presented in the approved WCAP-14572. The approved WCAP-14572, permits MPD segments, but does not provide any guidance specific to evaluating these types of segments. In the proposed method, a failure probability is estimated for each part of the segment with a different diameter, and the highest failure probability is used

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to represent the segment. WCAP-14572, Sup. 2, recognizes that use of the new method could result in fewer inspections compared to using the approved method.

WCAP-14572, Sup. 2, also proposes guidelines that the expert panel may use for moving a segment, that the quantitative results indicate should be in the HSS category, into the LSS category. The approved WCAP-14572 states that piping segments that have been determined by quantitative methods to be HSS should not be classified as LSS by the expert panel without sufficient justification that is documented as part of the program. WCAP-14572, Sup. 2, proposes guidance on what justification and documentation is necessary for the expert panel to change the classification of piping segments from HSS to LSS.

Additionally, WCAP-14572, Sup. 2, revises Table 4.1-1 in the approved WCAP-14572. Table 4.1-1 provides the requirements for the examination of piping structural elements selected for inspection. The purpose for the revision to Table 4.1-1 is to incorporate acquired knowledge and to reflect changes in the examination methods used in the industry since the issuance of the approved WCAP-14572.

3.1 Evaluating Multiple Pipe Diameter Segments

The approved WCAP-14572 methodology is based on dividing the piping systems up into piping segments. Piping segments are primarily defined as lengths of piping where the consequence of failure is the same for a pressure boundary failure anywhere within the segment. One of the three other criteria that may be used to define a segment is pipe size, but the methodology does not prohibit including piping with different diameters within one segment. WCAP-14572, Sup. 2, proposes a specific method to evaluate these MPD segments that differs from the method approved in the original WCAP-14572, for all pipe segments.

3.1.1 Approved Method

The approved WCAP-14572 describes a method for evaluating piping segments by defining piping segments, calculating the failure probability of each segment, and selecting which welds to inspect. The approved methodology assigns all significant degradation mechanisms present in the segment to a single weld, imposes the most severe operating characteristics and environment on that weld, and estimates the failure probability of that weld. This estimate is used to characterize the failure probability of the entire segment. For some configurations of piping and degradation mechanisms, the estimated failure probability may be excessively conservative when the worst-case properties are combined at a single weld. Consequently, if the resulting failure probability is excessively conservative, the segment should be subdivided until a reasonable failure probability can be obtained. Excessively conservative estimates may occur in any piping segment, but are expected to occur more frequently in MPD segments because pipe size is a major factor contributing to the failure probability.

The number and location of inspections in the final RI-ISI program are strongly dependent on the failure probability estimates. A high failure probability results in the segment being designated as HSS unless the consequences of the segment rupture are benign compared to other segments. Segments that are not classified as HSS are classified as LSS and no inspections are required in LSS segments. Once the population of HSS segments has been identified, an element selection process and a change-in-risk evaluation determine which, and how many, elements to inspect.

The approved WCAP-14572 describes a structural element selection process. Each segment is placed in the Structural Element Selection Matrix. HSS segments with a high failure importance are placed in Region 1 of the matrix and HSS segments with a low failure importance are placed in Region 2 of the matrix. Segments placed in Region 1 are further divided into Regions 1A and 1B. Region 1A contains the welds in an HSS segment that are affected by an active degradation mechanism. Region 1B contains the remaining welds in the HSS segment (i.e., those that are affected by no, or by only postulated, degradation mechanisms).

All welds in Region 1A are selected for inspection. A minimum of one weld is selected for inspection in the remaining welds in Region 1B. A minimum of one weld is also selected for inspection from each segment placed in Region 2. For the butt welds in Region 1B and Region 2, a statistical analysis is used to determine if more than one inspection is needed. Experience from RI-ISI submittals indicates that, almost always, no additional inspections are required to satisfy the statistical analysis guidelines.

In the final step in the development of an RI-ISI program, the change-in-risk associated with replacing the existing ASME program with the RI-ISI program is estimated. The change-in-risk calculation uses the failure probabilities without ISI to represent segments that do not have any inspections and uses the failure probabilities with ISI to represent segments that have one or more inspections. In the change-in-risk evaluation, the number of inspections in each segment does not have an impact on the failure probability used to represent a segment. Segments that included one or more ASME inspections, but will not include any RI-ISI inspections, will contribute an increase in risk to the total change. Segments that included ASME inspections and will include RI-ISI inspections are risk neutral. Segments that did not include ASME inspection exams, but will include one or more RI-ISI inspections, will contribute a reduction in risk to the total change. The approved WCAP-14572 guidelines state that if properly implemented, the RI-ISI program should always result in a risk-neutral to risk-reduction situation compared to the ASME program. If this guideline is not satisfied, inspections should be added.

3.1.2 Proposed Method

In WCAP-14572, Sup. 2, the WOG proposes an alternate method for estimating the failure probability of MPD segments and proposes an additional guideline for the element selection criteria. The change-in-risk calculation and risk-neutral guidelines are not changed.

The proposed method for estimating the failure probability involves temporarily separating a MPD segment into sub-segments based on the different pipe diameters. All the degradation mechanisms and operating characteristics in each sub-segment are applied to one weld of that sub-segment and the failure probability estimated for each sub-segment. The highest failure probability from all the temporary sub-segments is used as the failure probability for the MPD segment. Otherwise, the MPD segment is maintained as a single segment during the remaining evaluations.

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In WCAP-14572, Sup. 2, the WOG also proposes an additional element selection criterion. The proposed guidance requires that one or more inspections be conducted that addresses each postulated degradation mechanism in each HSS segment.

3.1.3 Evaluation

The proposed method will retain some MPD segments that would otherwise require subdivision using the approved method. Therefore, the proposed methodology results in the same, or fewer segments than using the approved method. Thus, there could be fewer but larger HSS segments and fewer but larger LSS segments. The difference in the number of segments is only important insofar as it affects the number and location of inspections in the final RI-ISI program. Fewer HSS segments could result in selecting fewer locations for inspection because the element selection process is not influenced by the size of the segment. Fewer LSS segments could result in selecting fewer locations because the change-in-risk estimate is based on the number of segments and not by the number of welds in each segment.

WCAP-14572, Sup. 2, describes eight different piping configurations that were evaluated to investigate the potential differences in the number of RI-ISI program inspections based on the element selection process that is applied to HSS segments. A piping configuration is characterized by type of weld (socket or butt welds), distribution of degradation mechanisms between the different pipe sizes and weld types, and whether the degradation mechanisms are active or postulated. One configuration was identified that could result in the proposed methodology requiring fewer inspections than the approved methodology. This configuration is characterized by the presence of different postulated degradation mechanisms in different pipe sizes of a segment that has at least some butt welds in more than one pipe size.

The approved methodology would require that all the postulated degradation mechanisms be combined in the smallest pipe size and this might result in an overly conservative failure probability requiring that the segment be subdivided. If the results were overly conservative and the segment must be subdivided, two or more of the new segments would contain postulated degradation mechanisms. The sub-segment with the highest failure probability (and therefore the failure probability selected for the entire MPD segment) would become a new HSS segment because its failure probability and consequence would remain the same. The classification of the remaining new segments (previously sub-segments) will depend on their individual failure probabilities and one or more of the new segments could be HSS. Each of these new HSS segments would require a minimum of one inspection for a total of at least two inspections as compared to the one inspection required for the entire MPD segment with the proposed methodology.

The difference in the number of HSS segments between application of the approved versus the proposed method is highly dependent on the configuration and further generic investigation of this difference would be inconclusive. In Reference 2, the WOG proposed including an additional element selection guideline as part of the proposed methodology. This guideline directs the licensee to conduct one or more examinations that address each postulated degradation mechanism when an HSS segment is modeled with multiple postulated degradation mechanisms. The configuration identified in WCAP-14572, Sup. 2, as the most likely to result in fewer inspections using the proposed method includes, by definition, different postulated degradation mechanisms. Application of the new guideline will reduce the likelihood that the proposed method will result in fewer locations being selected in these MPD segments. The new guideline also improves the element selection process compared to the approved method by ensuring that, in general, inspections are targeted toward the full population of degradation mechanisms.

After completing the element selection process on the HSS segments, the approved WCAP-14572 compares the RI-ISI program and the ASME Section XI program by calculating the change-in-risk from implementation of the RI-ISI program. The change-in-risk calculations depend on the number of segments, not the number of inspections. WCAP-14572, Sup. 2, demonstrates that there may be a smaller estimated increase in risk when the proposed methodology is used instead of the approved method. The approved WCAP-14572 guidelines suggest inspections be added until at least a risk-neutral change is estimated. A smaller estimated risk increase would more often meet the change-in-risk guidelines without adding locations and, therefore, the final RI-ISI program would have the same or fewer inspections when using the proposed method instead of the approved method.

Table 2.2-4 of Reference 2 describes 11 basic configurations that were evaluated to investigate the potential differences in the number of RI-ISI inspections based on the change-in-risk calculation. The configurations are characterized by the presence or absence of ASME inspections in different sized piping and the presence or absence of RI-ISI inspections in the same piping after replacing the ASME program with the RI-ISI program. Reference 2 identified 2 of the 11 configurations for which subdividing an MPD segment into 2 or more new segments would increase the change-in-risk estimate. Both configurations result in additional LSS segments if the MPD segment needs to be subdivided using the approved method. Increasing the number of LSS segments will likely increase the estimated change-in-risk because there are more segments in which inspections could be discontinued and, therefore, contribute to the estimated increase in risk.

WCAP-14572, Sup. 2, stated that the impact of these two possible configurations is minimal for three reasons. First, MPD segments usually do not contain ASME Section XI exams on more than one size. Therefore, splitting up MPD segments will create few new LSS segments that contribute to the change-in-risk. Second, LSS segments have a low risk-significance and, therefore, those few new segments that were inspected under ASME and contribute to the risk increase will have a minimal impact on the change-in-risk estimate. Third, there is conservatism built into the change-in-risk calculation. In an MPD segment with an ASME Section XI inspection, it is possible that the ASME Section XI inspection is not at the location with the highest failure probability although the highest failure probability is used in the change-in-risk estimate. Thus, the ASME Section XI inspection may not address the majority of the risk associated with the segment, whereas the RI-ISI program focuses inspections on locations where failure mechanisms are likely to be present. The NRC staff accepts that few of the new segments would be expected to have had ASME inspections and the risk contribution from the few segments that had ASME inspections will be minimal. Therefore, the NRC staff finds that the impact of applying the proposed, instead of the approved, method on the change-in-risk will not be significant.

As described in the SE approving the original WCAP-14572, the goal of the RI-ISI program is to maintain an ongoing assessment of the piping condition. A major improvement in the RI-ISI program compared to the ASME program is that the RI-ISI inspections are targeted toward

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elements where the condition of the piping is believed most at risk of degradation (i.e., locations where degradation mechanisms are, or are potentially, present). The proposed method includes the new guideline that, in any given HSS segment, one or more inspections are performed that address each of the different postulated degradation mechanisms.
This guideline further improves the RI-ISI program's coverage of degradation mechanisms and, thereby, improves the assurance that the piping conditions are appropriately assessed. The NRC staff believes that this improved assurance will result in a more comprehensive RI-ISI program, even though there might be a slight reduction in the number of locations inspected.

3.2 Expert Panel Categorization of Segments as LSS that are Quantitatively HSS

The approved WCAP-14572 permits the expert panel to classify piping segments as LSS that have been determined by quantitative methods to be HSS, but requires sufficient justification that is documented as part of the program. WCAP-14572, Sup. 2, provides guidance clarifying "sufficient justification" for crediting operator actions, which is the most common reason used by the expert panels to reclassify the safety significance of segments.

The approved WCAP-14572 recommends that pipe segments with risk reduction worth (RRW) greater than 1.005 should be categorized as HSS while the segments with RRW values between 1.001 and 1.004 should be identified for additional consideration by the expert panel. The consequences of some segments' failure can be mitigated by an operator action. Operator action refers to those actions taken to isolate or mitigate the consequences of piping failure. Each such segment has two RRW values calculated, one "with operator action" and one "without operator action." The highest RRW value is nominally assigned to the segment for classification.

The most common scenario where the expert panel reclassifies an HSS segment as LSS is one where the expert panel finds that the "without operator action" results represent an overly conservative or unrealistic scenario. In some cases, the core damage frequency (CDF) and large early release frequency (LERF) RRW "without operator action" results are greater than 1.005 while the CDF and LERF RRW "with operator action" are less than 1.005 or even less than 1.001. The approved WCAP-14572 would initially classify the segment as HSS based on the quantitative results.

WCAP-14572, Sup. 2, provides the following guidance clarifying the conditions that should exist before an expert panel has an opportunity to judge that the likelihood of the operators failing to take the appropriate mitigating actions is unrealistic.

- The operator actions are proceduralized.
- Indications are available to alert the operators to take the appropriate action.
- There is time available for the operator to diagnose and take the action that results in a success path (i.e., isolating or mitigating the piping failure) prior to the action becoming ineffective to mitigate the piping failure consequences.
- The equipment associated with taking the action must be available.

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If the expert panel determines that the above conditions exist, and decides it is appropriate to categorize a segment as LSS that is quantitatively HSS, WCAP-14572, Sup. 2, further states that the following elements of the justification will be documented:

- identification of the procedure that the operators are using,
- identification of the instrumentation that would alert the operators to take the appropriate actions,
- the estimated time that the operators have to respond to the event, and
- if the operator action is modeled in the plant PRA, the results of the importance analysis for a pipe segment after applying human error probabilities (HEPs) developed for operator actions in the internal events PRA for actions that can be used as surrogates for the RI-ISI operator action.

Determining whether the above conditions are satisfied requires the same information as that required by the *ASME Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications*, ASME RA-S-2002, to support fully defining an operator response that will be used in a PRA analysis (Index No. HR-F2). As discussed in RG 1.200, the NRC staff has determined that PRA analyses that comply with the ASME standard are considered adequate to support risk-informed regulatory application (with some exceptions though there are no exceptions to HR-F2). The approved WCAP-14572 guidance for RI-ISI program development permits the licensee to directly judge whether the likelihood of the operators failing to perform the action is unrealistic and does not require using a human reliability analysis methodology to estimate a HEP. The option to use applicable, previously quantified HEPs relies on a more rigorous analysis and, therefore, is also acceptable. The NRC staff finds that the additional guidance provided in WCAP-14572, Sup. 2, is acceptable because the clarification is consistent with acceptable information requirements for evaluating HEPs, and the use of this information to directly judge whether the likelihood of the operators failing to perform the action is consistent with RI-ISI program development as applied in the approved WCAP-14572.

3.3 Examination Requirements by Degradation Mechanism for Elements Selected for Inspection for the Risk-Informed Inservice Inspection Program

WCAP-14572, Sup. 2, proposes to replace Table 4.1-1 in the approved WCAP-14572, with the revised table included in Section 4 of WCAP-14572, Sup. 2. The purpose of the revision to the table is to incorporate acquired knowledge and reflect more appropriate inspections for specific degradation mechanisms. A summary of the changes to Table 4.1-1 is discussed below.

Column Examination Requirements/Fig. No. removes the references to figures in IWC of the Code. This change maintains a consistent requirement for all risk-informed inspections regardless of pipe class.

A change to Item No. R1.12 removes the figure references to branch nozzles and to piping 4-inch nominal pipe size and larger. This change reflects the experience of observing high cycle fatigue damage in small bore piping (both socket and butt welds).

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Item No. R1.13 modifies the term for the degradation mechanism from "Elements Subject to Corrosive, Erosive, or Cavitation Wastage" to "Elements Subject to Erosion Cavitation."

For Item No. R1.15, "Elements Subject to Primary Water Stress Corrosion Cracking (PWSCC)," WCAP-14572, Sup. 2, proposes to change the examination method from a VT-2 visual examination to a volumetric examination. The corresponding acceptance standard is also proposed to change to the acceptance standards in IWB-3514.

In Item No. R1.17, "or Pitting" has been added to include that microbiologically-influenced corrosion may form pitting. The pitting locations may become sites for crack initiation. In addition, the examination requirement column for this item added Figure Nos. IWB-2500-8(a) and IWB-2500-8(b) to include inspections for small bore piping applications.

WCAP-14572, Sup. 2, proposes to add two new item numbers to the table. The first is Item No. R1.19, "Elements Subject to External Chloride Stress Corrosion Cracking (ECSCC)." Item No. R1.19 proposes a surface examination using the acceptance criteria in IWB-3514. The second new item number is R1.20, "Elements not Subject to a Degradation Mechanisms." These elements will receive a volumetric examination using the acceptance criteria in IWB-3514. These items are not expected to have any degradation. Therefore, these inspections will account for uncertainty and unknown conditions in the subject segment.

These changes represent new insights and reflect the inspection method most likely to detect the expected degradation mechanism. In cases where there is no expected degradation mechanism, the elements will be inspected using a volumetric examination. Should any unexpected degradation be occurring in the HSS elements selected for inspection, a volumetric examination should be capable of detecting any patterns of degradation. Therefore, the NRC staff finds that the proposed replacement of Table 4.1-1 in the previously approved WCAP-14572, with Table 4.1.1 in WCAP-14572, Supplement 2, is acceptable.

4.0 CONCLUSIONS AND CONDITIONS

The NRC staff concludes that the proposed RI-ISI program as described in the approved WCAP-14572, and WCAP-14572, Sup. 2, as clarified and revised by the June 22, 2005, supplemental letter, will provide an acceptable level of quality and safety with regard to the number of inspections, locations of inspections, and methods of inspections. WCAP-14572, Sup. 2, clarifies and describes proposed modifications to the previously approved WCAP-14572. Based on its evaluation of WCAP-14572, Sup. 2, the NRC staff has reached the following conclusions:

The NRC staff finds that the methodology proposed in WCAP-14572, Sup. 2, to calculate the failure probability of MPD segments and to select elements for inspection is an acceptable alternative to the method approved in the original WCAP-14572. The alternative method to calculate the failure probability may result in slightly fewer inspections than the original method, but the expanded element selection process will increase the number of inspections targeted toward all the different postulated degradation mechanisms in segments with relatively high consequences. WCAP-14572, Sup. 2, applies the new selection criteria to all segments, not only MPD segments. Increasing the number of inspections targeted toward all the postulated degradation mechanisms supports the NRC staff's expectations that the RI-ISI program provides reasonable assurance that the program will provide a substantive ongoing assessment of the piping condition.

Most of the decisions that the expert panel makes about reclassifying an HSS segment to an LSS segment are based on the expert panel's conclusion that the likelihood that the operators fail to perform a task is very low. The NRC staff finds that the guidelines presented in WCAP-14572, Sup. 2, on the information that an expert panel needs (and must document) to support the judgement that an HEP is very low are consistent with the acceptable guidelines for evaluating HEPs and, therefore, are acceptable.

Table 4.1-1 in WCAP-14572, Sup. 2, provides the requirements for inspection of HSS piping structural elements. The table updates the requirements in Table 4.1-1 in WCAP-14572, by incorporating acquired knowledge since the approval of the TR and reflects the examination method most likely to detect the expected degradation mechanism. The NRC staff finds that the replacement of Table 4.1-1 in the previously approved WCAP-14572, with Table 4.1-1 in WCAP-14572, Sup. 2, is acceptable.

According to the methodology in the approved WCAP-14572, licensees will identify those aspects of plant licensing bases that may be affected by the proposed change, including the final safety analysis report, technical specifications, and licensing conditions. In addition, licensees will identify all changes to commitments that may be affected, as well as the particular piping systems, segments, and welds that are affected by the changes in the augmented programs. Specific revisions to the inspection scope, schedules, locations, and techniques will also be identified, as will plant systems that rely on the affected piping.

Licensees who have not implemented the approved methodology described in the original WCAP-14572, need to submit relief requests to implement the approved methodology described in WCAP-14572, and as modified by WCAP-14572, Sup. 2. Licensees who have already implemented RI-ISI programs based on the original WCAP-14572, may not need to submit relief requests to incorporate the modifications in WCAP-14572, Sup. 2, and may make changes to their ISI programs in accordance with the provisions of 10 CFR 50.59, if its evaluation criteria are met. As applied to methodologies in the FSAR, prior NRC approval is not required if the change involves the use of a method approved by the NRC for the intended application. However, deviations from the NRC's approved methodology described in the original WCAP-14572, or as modified by WCAP-14572, Sup. 2, need to be identified and submitted to the NRC staff for prior review and approval.

5.0 REFERENCES

1. Letter from F. P. Schiffley, II (Chairman, Westinghouse Owners Group) to Chief Financial Officer, U.S. Nuclear Regulatory Commission, Transmittal of Supplement 2 to WCAP-14572, Revision 1-NP-A, (Non-Proprietary) "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications." (PA-MSC-0076), August 10, 2004.

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2. Letter from D. F. Pilmer (Vice-Chairman, Westinghouse Owners Group) to U.S. Nuclear Regulatory Commission, Responses to the NRC Request for Additional Information Regarding the Review of WCAP-14572, Revision 1-NP-A Supplement 2, (Non-Proprietary), "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications" (PA-MSC-0076), June 22, 2005.

3. WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," February 1999.

4. NRC Regulatory Guide 1.178, "An Approach for Plant-Specific Risk-Informed Decision Making for Inservice Inspection of Piping," September 1998.

5. Standard Review Plan Chapter 3.9.8, "Standard Review Plan for the Review of Risk-Informed Inservice Inspection of Piping," NUREG-0800, September 2003.

6. NRC Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," July 1998.

7. Standard Review Plan Chapter 19, Rev. 1, "Use of Probabilistic Risk Assessment in Plant-Specific, Risk-Informed Decisionmaking: General Guidance," NUREG-0800, November 2002.

Attachment: Resolution of Comments

Principal Contributors: Stephen Dinsmore
Andrea Keim

Date: June 22, 2006

RESOLUTION OF PRESSURIZED WATER REACTOR OWNERS GROUP COMMENTS ON FINAL SAFETY EVALUATION FOR TOPICAL REPORT WCAP-14572, REVISION 1-NP-A, SUPPLEMENT 2, "WESTINGHOUSE OWNERS GROUP APPLICATION OF RISK-INFORMED METHODS TO PIPING INSERVICE INSPECTION TOPICAL REPORT CLARIFICATIONS"

By letter dated March 3, 2006, the Pressurized Water Reactor (PWR) Owners Group commented on the draft SE. These comments were discussed in a teleconference between the PWR Owners Group and the NRC staff on February 23, 2006. The NRC staff agreed with the PWR Owners Group comments and modifications as discussed with the PWR Owners Group and issued the final SE on May 1, 2006.

Subsequently, the PWR Owners Group informed the NRC staff via an e-mail dated May 24, 2006, that they incorrectly marked-up the draft SE when they submitted their comments in the letter dated March 3, 2006. In that e-mail, the PWR Owners Group also provided the corrected mark-up of their comments on the draft SE. The NRC staff's disposition of PWR Owners Group's corrected comments is discussed below:

No.	Final SE Reference	Corrected Mark-up of Final SE Text	Corrected Final SE Text	NRC Staff Resolution
1.	Page No. 7	~~If the operator action is modeled in the plant PRA,~~ The equipment associated with taking the action must be available.	The equipment associated with taking the action must be available.	Adopted
2.	Page No. 7	large early release frequency (LERF) RRW "without operator action" results **are** ~~is~~ greater than	large early release frequency (LERF) RRW "without operator action" results are greater than	Adopted
2.	Page No. 8	**if the operator action is modeled in the plant PRA**, the results of the importance analysis for a pipe segment after applying human error probabilities (HEPs) developed for operator actions in the internal events PRA for actions that can be used as surrogates for the RI-ISI operator action.	if the operator action is modeled in the plant PRA, the results of the importance analysis for a pipe segment after applying human error probabilities (HEPs) developed for operator actions in the internal events PRA for actions that can be used as surrogates for the RI-ISI operator action.	Adopted

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 1, 2006

RECEIVED
MAY 08 2006
WOG PROJECT OFFICE

Mr. Gordon Bischoff, Manager
PWR Owners Group Program Management Office
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: FINAL SAFETY EVALUATION FOR PRESSURIZED WATER REACTOR (PWR) OWNERS GROUP TOPICAL REPORT WCAP-14572, REVISION 1-NP-A, SUPPLEMENT 2, "WESTINGHOUSE OWNERS GROUP APPLICATION OF RISK-INFORMED METHODS TO PIPING INSERVICE INSPECTION TOPICAL REPORT CLARIFICATIONS" (TAC NO. MC3979)

Dear Mr. Bischoff:

By letter dated August 10, 2004, and its supplement dated June 22, 2005, the Westinghouse Owners Group (WOG), now known as the Pressurized Water Reactor Owners Group (PWR Owners Group), submitted Topical Report (TR) WCAP-14572, Revision 1-NP-A, Supplement 2, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications," (WCAP-14572, Sup. 2) to the U.S. Nuclear Regulatory Commission (NRC) staff for review and approval. By letter dated February 6, 2006, an NRC draft safety evaluation (SE) regarding our approval of WCAP-14572, Sup. 2, was provided to the PWR Owners Group for review and comments. The PWR Owners Group commented on the draft SE in a teleconference between the PWR Owners Group and the NRC staff on February 23, 2006, and submitted the comments by letter dated March 3, 2006. The NRC staff agrees with the PWR Owners Group comments and the modifications as discussed with the PWR Owners Group in the teleconference have been made to the enclosed final SE. The NRC staff's disposition of PWR Owners Group's comments are also discussed in the attachment to the final SE enclosed with this letter.

The NRC staff has found that WCAP-14572, Sup. 2, is acceptable for referencing in licensing applications to the extent specified and under the limitations delineated in the TR and in the enclosed final SE. The final SE defines the basis for our acceptance of the TR.

Our acceptance applies only to material provided in the subject TR. We do not intend to repeat our review of the acceptable material described in the TR. When the TR appears as a reference in license applications, our review will ensure that the material presented applies to the specific plant involved. License amendment requests that deviate from this TR will be subject to a plant-specific review in accordance with applicable review standards.

In accordance with the guidance provided on the NRC website, we request that the PWR Owners Group publish accepted proprietary and non-proprietary versions of this TR within three months of receipt of this letter. The accepted versions shall incorporate this letter and the enclosed final SE after the title page. Also, they must contain historical review information, including NRC requests for additional information and your responses. The accepted versions shall include an "-A" (designating accepted) following the TR identification symbol.

G. Bischoff - 2 -

If future changes to the NRC's regulatory requirements affect the acceptability of this TR, the PWR Owners Group and/or licensees referencing it will be expected to revise the TR appropriately, or justify its continued applicability for subsequent referencing.

Sincerely,

Ho K. Nieh, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 694

Enclosure: Final Safety Evaluation

cc w/encl:
Mr. James A. Gresham, Manager
Regulatory Compliance and Plant Licensing
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

FINAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT WCAP-14572, REVISION 1-NP-A, SUPPLEMENT 2, "WESTINGHOUSE OWNERS GROUP APPLICATION OF RISK-INFORMED METHODS TO PIPING INSERVICE INSPECTION TOPICAL REPORT CLARIFICATIONS"

PRESSURIZED WATER REACTOR (PWR) OWNERS GROUP

PROJECT NO. 694

1.0 INTRODUCTION AND BACKGROUND

By letter dated August 10, 2004, the Westinghouse Owners Group (WOG) now know as the Pressurized Water Reactor Owners Group (PWR Owners Group) submitted Topical Report (TR) WCAP-14572, Revision 1-NP-A, Supplement 2, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications," (WCAP-14572, Sup. 2) to the U.S. Nuclear Regulatory Commission (NRC) staff for review and approval (Reference 1). Further clarifying information and revised pages to WCAP-14572, Sup. 2, were provided in a supplemental dated June 22, 2005 (Reference 2).

WCAP-14572, Sup. 2, was submitted as a supplement to Topical Report WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection," (Reference 3), which was reviewed and approved by the NRC staff on December 15, 1998. WCAP-14572, Revision 1-NP-A (original, or approved WCAP-14572) provides guidance on selecting and categorizing piping components as high safety significant (HSS) or low safety significant (LSS) groups in order to develop a risk-informed inservice inspection (RI-ISI) program as an alternative to the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (Code) Section XI, inservice inspection (ISI) requirements for piping. RI-ISI programs focus inspections of piping at HSS locations and locations where failure mechanisms (i.e., degradation mechanisms) are likely to be present. The goal of the RI-ISI program is to provide an ongoing substantive assessment of piping conditions.

The WOG submitted WCAP-14572, Sup. 2, to propose a modified method to calculate the failure probability of some pipe segments and to further clarify two topics described in the approved WCAP-14572. WCAP-14572, Sup. 2, addresses the following three topics:

- A methodology for evaluating a segment that includes piping with different diameters (i.e., a multiple pipe diameter (MPD) segment) as an alternative to the previously approved methodology presented in the approved WCAP-14572.

- The expert panel decision process for moving a segment that, based on the quantitative results, would normally be HSS into the LSS segment category.
- The requirements for examination based on the postulated failure modes and configuration of each piping structural element revised to the requirements presented in the WOG supplemental letter dated June 22, 2005.

2.0 REGULATORY EVALUATION

Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g) specifies that ISI of nuclear power plant components shall be performed in accordance with the requirements of the ASME Code, Section XI, except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). The regulation 10 CFR 50.55a(a)(3) states, in part, that proposed alternatives to the requirements of paragraph (g) may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant shall demonstrate that: (i) The proposed alternatives would provide an acceptable level of quality and safety, or (ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

In its December 15, 1998, safety evaluation (SE), the NRC staff concluded that the RI-ISI program described in the original WCAP-14572 provides an acceptable level of quality and safety pursuant to 10 CFR 50.55a for the proposed alternative to the piping ISI requirements with regard to the number of inspections, locations of inspections, and methods of inspections.

The NRC staff reviewed WCAP-14572, Sup. 2, with respect to the guidance contained in Regulatory Guide (RG) 1.178, "An Approach for Plant-Specific Risk-Informed Decision Making: Inservice Inspection of Piping" (Reference 4) and Standard Review Plan (SRP) Chapter 3.9.8, "Standard Review Plan for the Review of Risk-Informed Inservice Inspection of Piping" (Reference 5). These documents describe an acceptable methodology, acceptance guidelines, and a review process for proposed plant-specific, risk-informed changes to ISI of piping programs. Further guidance is provided in RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (Reference 6) and in SRP Chapter 19, Rev. 1, "Use of Probabilistic Risk Assessment in Plant-Specific, Risk-Informed Decisionmaking: General Guidance" (Reference 7), which contains general guidance for using probabilistic risk assessments (PRAs) in risk-informed decisionmaking. WCAP-14572, Sup. 2, was also evaluated for its contribution to the goal of the approved WCAP-14572, to provide a substantive ongoing assessment of the piping condition by focusing inspections of piping at HSS locations and locations where failure mechanisms are likely to be present.

3.0 TECHNICAL EVALUATION

WCAP-14572, Sup. 2, proposes a new method of evaluating MPD segments as an alternative to the previously approved methodology presented in the approved WCAP-14572. The approved WCAP-14572, permits MPD segments, but does not provide any guidance specific to evaluating these types of segments. In the proposed method, a failure probability is estimated for each part of the segment with a different diameter, and the highest failure probability is used

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to represent the segment. WCAP-14572, Sup. 2, recognizes that use of the new method could result in fewer inspections compared to using the approved method.

WCAP-14572, Sup. 2, also proposes guidelines that the expert panel may use for moving a segment, that the quantitative results indicate should be in the HSS category, into the LSS category. The approved WCAP-14572 states that piping segments that have been determined by quantitative methods to be HSS should not be classified as LSS by the expert panel without sufficient justification that is documented as part of the program. WCAP-14572, Sup. 2, proposes guidance on what justification and documentation is necessary for the expert panel to change the classification of piping segments from HSS to LSS.

Additionally, WCAP-14572, Sup. 2, revises Table 4.1-1 in the approved WCAP-14572. Table 4.1-1 provides the requirements for the examination of piping structural elements selected for inspection. The purpose for the revision to Table 4.1-1 is to incorporate acquired knowledge and to reflect changes in the examination methods used in the industry since the issuance of the approved WCAP-14572.

3.1 Evaluating Multiple Pipe Diameter Segments

The approved WCAP-14572 methodology is based on dividing the piping systems up into piping segments. Piping segments are primarily defined as lengths of piping where the consequence of failure is the same for a pressure boundary failure anywhere within the segment. One of the three other criteria that may be used to define a segment is pipe size, but the methodology does not prohibit including piping with different diameters within one segment. WCAP-14572, Sup. 2, proposes a specific method to evaluate these MPD segments that differs from the method approved in the original WCAP-14572, for all pipe segments.

3.1.1 Approved Method

The approved WCAP-14572 describes a method for evaluating piping segments by defining piping segments, calculating the failure probability of each segment, and selecting which welds to inspect. The approved methodology assigns all significant degradation mechanisms present in the segment to a single weld, imposes the most severe operating characteristics and environment on that weld, and estimates the failure probability of that weld. This estimate is used to characterize the failure probability of the entire segment. For some configurations of piping and degradation mechanisms, the estimated failure probability may be excessively conservative when the worst-case properties are combined at a single weld. Consequently, if the resulting failure probability is excessively conservative, the segment should be subdivided until a reasonable failure probability can be obtained. Excessively conservative estimates may occur in any piping segment, but are expected to occur more frequently in MPD segments because pipe size is a major factor contributing to the failure probability.

The number and location of inspections in the final RI-ISI program are strongly dependent on the failure probability estimates. A high failure probability results in the segment being designated as HSS unless the consequences of the segment rupture are benign compared to other segments. Segments that are not classified as HSS are classified as LSS and no inspections are required in LSS segments. Once the population of HSS segments has been identified, an element selection process and a change-in-risk evaluation determine which, and how many, elements to inspect.

The approved WCAP-14572 describes a structural element selection process. Each segment is placed in the Structural Element Selection Matrix. HSS segments with a high failure importance are placed in Region 1 of the matrix and HSS segments with a low failure importance are placed in Region 2 of the matrix. Segments placed in Region 1 are further divided into Regions 1A and 1B. Region 1A contains the welds in an HSS segment that are affected by an active degradation mechanism. Region 1B contains the remaining welds in the HSS segment (i.e., those that are affected by no, or by only postulated, degradation mechanisms).

All welds in Region 1A are selected for inspection. A minimum of one weld is selected for inspection in the remaining welds in Region 1B. A minimum of one weld is also selected for inspection from each segment placed in Region 2. For the butt welds in Region 1B and Region 2, a statistical analysis is used to determine if more than one inspection is needed. Experience from RI-ISI submittals indicates that, almost always, no additional inspections are required to satisfy the statistical analysis guidelines.

In the final step in the development of an RI-ISI program, the change-in-risk associated with replacing the existing ASME program with the RI-ISI program is estimated. The change-in-risk calculation uses the failure probabilities without ISI to represent segments that do not have any inspections and uses the failure probabilities with ISI to represent segments that have one or more inspections. In the change-in-risk evaluation, the number of inspections in each segment does not have an impact on the failure probability used to represent a segment. Segments that included one or more ASME inspections, but will not include any RI-ISI inspections, will contribute an increase in risk to the total change. Segments that included ASME inspections and will include RI-ISI inspections are risk neutral. Segments that did not include ASME inspection exams, but will include one or more RI-ISI inspections, will contribute a reduction in risk to the total change. The approved WCAP-14572 guidelines state that if properly implemented, the RI-ISI program should always result in a risk-neutral to risk-reduction situation compared to the ASME program. If this guideline is not satisfied, inspections should be added.

3.1.2 Proposed Method

In WCAP-14572, Sup. 2, the WOG proposes an alternate method for estimating the failure probability of MPD segments and proposes an additional guideline for the element selection criteria. The change-in-risk calculation and risk-neutral guidelines are not changed.

The proposed method for estimating the failure probability involves temporarily separating a MPD segment into sub-segments based on the different pipe diameters. All the degradation mechanisms and operating characteristics in each sub-segment are applied to one weld of that sub-segment and the failure probability estimated for each sub-segment. The highest failure probability from all the temporary sub-segments is used as the failure probability for the MPD segment. Otherwise, the MPD segment is maintained as a single segment during the remaining evaluations.

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In WCAP-14572, Sup. 2, the WOG also proposes an additional element selection criterion. The proposed guidance requires that one or more inspections be conducted that addresses each postulated degradation mechanism in each HSS segment.

3.1.3 Evaluation

The proposed method will retain some MPD segments that would otherwise require subdivision using the approved method. Therefore, the proposed methodology results in the same, or fewer segments than using the approved method. Thus, there could be fewer but larger HSS segments and fewer but larger LSS segments. The difference in the number of segments is only important insofar as it affects the number and location of inspections in the final RI-ISI program. Fewer HSS segments could result in selecting fewer locations for inspection because the element selection process is not influenced by the size of the segment. Fewer LSS segments could result in selecting fewer locations because the change-in-risk estimate is based on the number of segments and not by the number of welds in each segment.

WCAP-14572, Sup. 2, describes eight different piping configurations that were evaluated to investigate the potential differences in the number of RI-ISI program inspections based on the element selection process that is applied to HSS segments. A piping configuration is characterized by type of weld (socket or butt welds), distribution of degradation mechanisms between the different pipe sizes and weld types, and whether the degradation mechanisms are active or postulated. One configuration was identified that could result in the proposed methodology requiring fewer inspections than the approved methodology. This configuration is characterized by the presence of different postulated degradation mechanisms in different pipe sizes of a segment that has at least some butt welds in more than one pipe size.

The approved methodology would require that all the postulated degradation mechanisms be combined in the smallest pipe size and this might result in an overly conservative failure probability requiring that the segment be subdivided. If the results were overly conservative and the segment must be subdivided, two or more of the new segments would contain postulated degradation mechanisms. The sub-segment with the highest failure probability (and therefore the failure probability selected for the entire MPD segment) would become a new HSS segment because its failure probability and consequence would remain the same. The classification of the remaining new segments (previously sub-segments) will depend on their individual failure probabilities and one or more of the new segments could be HSS. Each of these new HSS segments would require a minimum of one inspection for a total of at least two inspections as compared to the one inspection required for the entire MPD segment with the proposed methodology.

The difference in the number of HSS segments between application of the approved versus the proposed method is highly dependent on the configuration and further generic investigation of this difference would be inconclusive. In Reference 2, the WOG proposed including an additional element selection guideline as part of the proposed methodology. This guideline directs the licensee to conduct one or more examinations that address each postulated degradation mechanism when an HSS segment is modeled with multiple postulated degradation mechanisms. The configuration identified in WCAP-14572, Sup. 2, as the most likely to result in fewer inspections using the proposed method includes, by definition, different postulated degradation mechanisms. Application of the new guideline will reduce the likelihood

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that the proposed method will result in fewer locations being selected in these MPD segments. The new guideline also improves the element selection process compared to the approved method by ensuring that, in general, inspections are targeted toward the full population of degradation mechanisms.

After completing the element selection process on the HSS segments, the approved WCAP-14572 compares the RI-ISI program and the ASME Section XI program by calculating the change-in-risk from implementation of the RI-ISI program. The change-in-risk calculations depend on the number of segments, not the number of inspections. WCAP-14572, Sup. 2, demonstrates that there may be a smaller estimated increase in risk when the proposed methodology is used instead of the approved method. The approved WCAP-14572 guidelines suggest inspections be added until at least a risk-neutral change is estimated. A smaller estimated risk increase would more often meet the change-in-risk guidelines without adding locations and, therefore, the final RI-ISI program would have the same or fewer inspections when using the proposed method instead of the approved method.

Table 2.2-4 of Reference 2 describes 11 basic configurations that were evaluated to investigate the potential differences in the number of RI-ISI inspections based on the change-in-risk calculation. The configurations are characterized by the presence or absence of ASME inspections in different sized piping and the presence or absence of RI-ISI inspections in the same piping after replacing the ASME program with the RI-ISI program. Reference 2 identified 2 of the 11 configurations for which subdividing an MPD segment into 2 or more new segments would increase the change-in-risk estimate. Both configurations result in additional LSS segments if the MPD segment needs to be subdivided using the approved method. Increasing the number of LSS segments will likely increase the estimated change-in-risk because there are more segments in which inspections could be discontinued and, therefore, contribute to the estimated increase in risk.

WCAP-14572, Sup. 2, stated that the impact of these two possible configurations is minimal for three reasons. First, MPD segments usually do not contain ASME Section XI exams on more than one size. Therefore, splitting up MPD segments will create few new LSS segments that contribute to the change-in-risk. Second, LSS segments have a low risk-significance and, therefore, those few new segments that were inspected under ASME and contribute to the risk increase will have a minimal impact on the change-in-risk estimate. Third, there is conservatism built into the change-in-risk calculation. In an MPD segment with an ASME Section XI inspection, it is possible that the ASME Section XI inspection is not at the location with the highest failure probability although the highest failure probability is used in the change-in-risk estimate. Thus, the ASME Section XI inspection may not address the majority of the risk associated with the segment, whereas the RI-ISI program focuses inspections on locations where failure mechanisms are likely to be present. The NRC staff accepts that few of the new segments would be expected to have had ASME inspections and the risk contribution from the few segments that had ASME inspections will be minimal. Therefore, the NRC staff finds that the impact of applying the proposed, instead of the approved, method on the change-in-risk will not be significant.

As described in the SE approving the original WCAP-14572, the goal of the RI-ISI program is to maintain an ongoing assessment of the piping condition. A major improvement in the RI-ISI program compared to the ASME program is that the RI-ISI inspections are targeted toward

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elements where the condition of the piping is believed most at risk of degradation (i.e., locations where degradation mechanisms are, or are potentially, present). The proposed method includes the new guideline that, in any given HSS segment, one or more inspections are performed that address each of the different postulated degradation mechanisms.
This guideline further improves the RI-ISI program's coverage of degradation mechanisms and, thereby, improves the assurance that the piping conditions are appropriately assessed. The NRC staff believes that this improved assurance will result in a more comprehensive RI-ISI program, even though there might be a slight reduction in the number of locations inspected.

3.2 Expert Panel Categorization of Segments as LSS that are Quantitatively HSS

The approved WCAP-14572 permits the expert panel to classify piping segments as LSS that have been determined by quantitative methods to be HSS, but requires sufficient justification that is documented as part of the program. WCAP-14572, Sup. 2, provides guidance clarifying "sufficient justification" for crediting operator actions, which is the most common reason used by the expert panels to reclassify the safety significance of segments.

The approved WCAP-14572 recommends that pipe segments with risk reduction worth (RRW) greater than 1.005 should be categorized as HSS while the segments with RRW values between 1.001 and 1.004 should be identified for additional consideration by the expert panel. The consequences of some segments' failure can be mitigated by an operator action. Operator action refers to those actions taken to isolate or mitigate the consequences of piping failure. Each such segment has two RRW values calculated, one "with operator action" and one "without operator action." The highest RRW value is nominally assigned to the segment for classification.

The most common scenario where the expert panel reclassifies an HSS segment as LSS is one where the expert panel finds that the "without operator action" results represent an overly conservative or unrealistic scenario. In some cases, the core damage frequency (CDF) and large early release frequency (LERF) RRW "without operator action" results is greater than 1.005 while the CDF and LERF RRW "with operator action" are less than 1.005 or even less than 1.001. The approved WCAP-14572 would initially classify the segment as HSS based on the quantitative results.

WCAP-14572, Sup. 2, provides the following guidance clarifying the conditions that should exist before an expert panel has an opportunity to judge that the likelihood of the operators failing to take the appropriate mitigating actions is unrealistic.

- The operator actions are proceduralized.
- Indications are available to alert the operators to take the appropriate action.
- There is time available for the operator to diagnose and take the action that results in a success path (i.e., isolating or mitigating the piping failure) prior to the action becoming ineffective to mitigate the piping failure consequences.
- If the operator action is modeled in the plant PRA, the equipment associated with taking the action must be available.

If the expert panel determines that the above conditions exist, and decides it is appropriate to categorize a segment as LSS that is quantitatively HSS, WCAP-14572, Sup. 2, further states that the following elements of the justification will be documented:

- identification of the procedure that the operators are using,
- identification of the instrumentation that would alert the operators to take the appropriate actions,
- the estimated time that the operators have to respond to the event, and
- the results of the importance analysis for a pipe segment after applying human error probabilities (HEPs) developed for operator actions in the internal events PRA for actions that can be used as surrogates for the RI-ISI operator action.

Determining whether the above conditions are satisfied requires the same information as that required by the *ASME Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications*, ASME RA-S-2002, to support fully defining an operator response that will be used in a PRA analysis (Index No. HR-F2). As discussed in RG 1.200, the NRC staff has determined that PRA analyses that comply with the ASME standard are considered adequate to support risk-informed regulatory application (with some exceptions though there are no exceptions to HR-F2). The approved WCAP-14572 guidance for RI-ISI program development permits the licensee to directly judge whether the likelihood of the operators failing to perform the action is unrealistic and does not require using a human reliability analysis methodology to estimate a HEP. The option to use applicable, previously quantified HEPs relies on a more rigorous analysis and, therefore, is also acceptable. The NRC staff finds that the additional guidance provided in WCAP-14572, Sup. 2, is acceptable because the clarification is consistent with acceptable information requirements for evaluating HEPs, and the use of this information to directly judge whether the likelihood of the operators failing to perform the action is consistent with RI-ISI program development as applied in the approved WCAP-14572.

3.3 Examination Requirements by Degradation Mechanism for Elements Selected for Inspection for the Risk-Informed Inservice Inspection Program

WCAP-14572, Sup. 2, proposes to replace Table 4.1-1 in the approved WCAP-14572, with the revised table included in Section 4 of WCAP-14572, Sup. 2. The purpose of the revision to the table is to incorporate acquired knowledge and reflect more appropriate inspections for specific degradation mechanisms. A summary of the changes to Table 4.1-1 is discussed below.

Column Examination Requirements/Fig. No. removes the references to figures in IWC of the Code. This change maintains a consistent requirement for all risk-informed inspections regardless of pipe class.

A change to Item No. R1.12 removes the figure references to branch nozzles and to piping 4-inch nominal pipe size and larger. This change reflects the experience of observing high cycle fatigue damage in small bore piping (both socket and butt welds).

Item No. R1.13 modifies the term for the degradation mechanism from "Elements Subject to Corrosive, Erosive, or Cavitation Wastage" to "Elements Subject to Erosion Cavitation."

For Item No. R1.15, "Elements Subject to Primary Water Stress Corrosion Cracking (PWSCC)," WCAP-14572, Sup. 2, proposes to change the examination method from a VT-2 visual examination to a volumetric examination. The corresponding acceptance standard is also proposed to change to the acceptance standards in IWB-3514.

In Item No. R1.17, "or Pitting" has been added to include that microbiologically-influenced corrosion may form pitting. The pitting locations may become sites for crack initiation. In addition, the examination requirement column for this item added Figure Nos. IWB-2500-8(a) and IWB-2500-8(b) to include inspections for small bore piping applications.

WCAP-14572, Sup. 2, proposes to add two new item numbers to the table. The first is Item No. R1.19, "Elements Subject to External Chloride Stress Corrosion Cracking (ECSCC)." Item No. R1.19 proposes a surface examination using the acceptance criteria in IWB-3514. The second new item number is R1.20, "Elements not Subject to a Degradation Mechanisms." These elements will receive a volumetric examination using the acceptance criteria in IWB-3514. These items are not expected to have any degradation. Therefore, these inspections will account for uncertainty and unknown conditions in the subject segment.

These changes represent new insights and reflect the inspection method most likely to detect the expected degradation mechanism. In cases where there is no expected degradation mechanism, the elements will be inspected using a volumetric examination. Should any unexpected degradation be occurring in the HSS elements selected for inspection, a volumetric examination should be capable of detecting any patterns of degradation. Therefore, the NRC staff finds that the proposed replacement of Table 4.1-1 in the previously approved WCAP-14572, with Table 4.1.1 in WCAP-14572, Supplement 2, is acceptable.

4.0 CONCLUSIONS AND CONDITIONS

The NRC staff concludes that the proposed RI-ISI program as described in the approved WCAP-14572, and WCAP-14572, Sup. 2, as clarified and revised by the June 22, 2005, supplemental letter, will provide an acceptable level of quality and safety with regard to the number of inspections, locations of inspections, and methods of inspections. WCAP-14572, Sup. 2, clarifies and describes proposed modifications to the previously approved WCAP-14572. Based on its evaluation of WCAP-14572, Sup. 2, the NRC staff has reached the following conclusions:

The NRC staff finds that the methodology proposed in WCAP-14572, Sup. 2, to calculate the failure probability of MPD segments and to select elements for inspection is an acceptable alternative to the method approved in the original WCAP-14572. The alternative method to calculate the failure probability may result in slightly fewer inspections than the original method, but the expanded element selection process will increase the number of inspections targeted toward all the different postulated degradation mechanisms in segments with relatively high consequences. WCAP-14572, Sup. 2, applies the new selection criteria to all segments, not only MPD segments. Increasing the number of inspections targeted toward all the postulated degradation mechanisms supports the NRC staff's expectations that the RI-ISI program provides reasonable assurance that the program will provide a substantive ongoing assessment of the piping condition.

Most of the decisions that the expert panel makes about reclassifying an HSS segment to an LSS segment are based on the expert panel's conclusion that the likelihood that the operators fail to perform a task is very low. The NRC staff finds that the guidelines presented in WCAP-14572, Sup. 2, on the information that an expert panel needs (and must document) to support the judgement that an HEP is very low are consistent with the acceptable guidelines for evaluating HEPs and, therefore, are acceptable.

Table 4.1-1 in WCAP-14572, Sup. 2, provides the requirements for inspection of HSS piping structural elements. The table updates the requirements in Table 4.1-1 in WCAP-14572, by incorporating acquired knowledge since the approval of the TR and reflects the examination method most likely to detect the expected degradation mechanism. The NRC staff finds that the replacement of Table 4.1-1 in the previously approved WCAP-14572, with Table 4.1-1 in WCAP-14572, Sup. 2, is acceptable.

According to the methodology in the approved WCAP-14572, licensees will identify those aspects of plant licensing bases that may be affected by the proposed change, including the final safety analysis report, technical specifications, and licensing conditions. In addition, licensees will identify all changes to commitments that may be affected, as well as the particular piping systems, segments, and welds that are affected by the changes in the augmented programs. Specific revisions to the inspection scope, schedules, locations, and techniques will also be identified, as will plant systems that rely on the affected piping.

Licensees who have not implemented the approved methodology described in the original WCAP-14572, need to submit relief requests to implement the approved methodology described in WCAP-14572, and as modified by WCAP-14572, Sup. 2. Licensees who have already implemented RI-ISI programs based on the original WCAP-14572, may not need to submit relief requests to incorporate the modifications in WCAP-14572, Sup. 2, and may make changes to their ISI programs in accordance with the provisions of 10 CFR 50.59, if its evaluation criteria are met. As applied to methodologies in the FSAR, prior NRC approval is not required if the change involves the use of a method approved by the NRC for the intended application. However, deviations from the NRC's approved methodology described in the original WCAP-14572, or as modified by WCAP-14572, Sup. 2, need to be identified and submitted to the NRC staff for prior review and approval.

5.0 REFERENCES

1. Letter from F. P. Schiffley, II (Chairman, Westinghouse Owners Group) to Chief Financial Officer, U.S. Nuclear Regulatory Commission, Transmittal of Supplement 2 to WCAP-14572, Revision 1-NP-A, (Non-Proprietary) "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications." (PA-MSC-0076), August 10, 2004.

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2. Letter from D. F. Pilmer (Vice-Chairman, Westinghouse Owners Group) to U.S. Nuclear Regulatory Commission, Responses to the NRC Request for Additional Information Regarding the Review of WCAP-14572, Revision 1-NP-A Supplement 2, (Non-Proprietary), "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications" (PA-MSC-0076), June 22, 2005.

3. WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," February 1999.

4. NRC Regulatory Guide 1.178, "An Approach for Plant-Specific Risk-Informed Decision Making for Inservice Inspection of Piping," September 1998.

5. Standard Review Plan Chapter 3.9.8, "Standard Review Plan for the Review of Risk-Informed Inservice Inspection of Piping," NUREG-0800, September 2003.

6. NRC Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," July 1998.

7. Standard Review Plan Chapter 19, Rev. 1, "Use of Probabilistic Risk Assessment in Plant-Specific, Risk-Informed Decisionmaking: General Guidance," NUREG-0800, November 2002.

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Date: May 1, 2006

Attachment: Resolution of Comments

RESOLUTION OF PRESSURIZED WATER REACTOR OWNERS GROUP COMMENTS ON DRAFT SAFETY EVALUATION FOR TOPICAL REPORT WCAP-14572, REVISION 1-NP-A, SUPPLEMENT 2, "WESTINGHOUSE OWNERS GROUP APPLICATION OF RISK-INFORMED METHODS TO PIPING INSERVICE INSPECTION TOPICAL REPORT CLARIFICATIONS"

By letter dated March 3, 2006, the Pressurized Water Reactor (PWR) Owners Group commented on the draft SE. These comments were discussed in a teleconference between the PWR Owners Group and the NRC staff on February 23, 2006. The NRC staff agrees with the PWR Owners Group's specific technical comments and the modifications as discussed with the PWR Owners Group in the teleconference have been made to the final SE, as described below. Editorial comments suggested by the PWR Owners Group have also been adopted in the final SE, but not discussed below.

No.	Draft SE Reference	PWR Owners Group Comments	NRC Staff Resolution
1.	Page No. 6, Line No. 42-44	It is stated, "The proposed method includes the new guideline that, in any given HSS (page 6, lines 42-44) segment, at least one inspection is performed for each of the different degradation mechanisms." As noted in Section 3.1.2, third paragraph (page 4, lines 40-41), the proposed guidance requires that one or more examinations be conducted that addresses each postulated degradation mechanism in each HSS segment. While these statements are very similar, our concern is that, in the future, the statement in Section 3.1.3 could be misinterpreted to mean that a separate examination must be conducted for each postulated degradation mechanism in a HSS segment instead of stating that each postulated degradation mechanism must be addressed by an examination. It is possible that a single examination can be used to address more than one postulated degradation mechanism on a HSS segment. To avoid this potential misinterpretation, replace the statement in Section 3.1.3 (quoted above) with the following, "The proposed method includes the new guideline that, in any given HSS segment, one or more inspections are performed that address each of the different postulated degradation mechanisms."	Adopted

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No.	Draft SE Reference	PWR Owners Group Comments	NRC Staff Resolution
2.	Page No. 7, Line No. 35-37 and Page No. 8, Line No. 5-22	The last bullet in Section 3.2 states "the results of the importance analysis for a pipe last bullet and last segment after applying human error probabilities (HEPs) developed for operator paragraph actions in the internal events PRA for actions that can be used as surrogates for the RI- (page 7, lines 35-37 and ISI operator action." In paragraph preceding this bullet it states, "If the expert panel page 8, lines 5-22) determines that the above conditions exist, and decides it is appropriate to categorize a segment as LSS that is quantitatively HSS, WCAP-14572, Sup. 2, further states that the following elements of the justification will be documented." Section 3.3 of WCAP-14572, Supplement 2 states, In some instances, the operator action to isolate or mitigate a piping failure may be included in the plant PRA model that already has a human factors analysis conducted on the operator action. In these instances, the surrogate PRA runs could be made using the human error probabilities in the PRA model for the operator action, instead of assuming that the operator takes no action or always takes the correct action to isolate or mitigate the piping failure. The more realistic piping CDF, LERF and other risk metrics that are obtained can be used as additional justification for the segment being categorized to the lower classification. If human error probabilities are used, document that the risk metrics both with and with operator action for the segment are based on the results that include the human error probabilities modeled in the plant PRA model for the operator actions to isolate or mitigate the piping failure.	Adopted

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No.	Draft SE Reference	PWR Owners Group Comments	NRC Staff Resolution
		Not all operator actions to isolate or mitigate a piping failure are modeled in a plant PRA model. However, when an operator action modeled in the plant PRA is used to justify categorizing a segment as LSS, then the documentation should include the analysis results and notation that both the without and with operator action risk metrics are based on the modeled operator action. In those instances where the operator action to isolate or mitigate piping failure are not modeled in the plant PRA model, the first three bullets in lines 1-4 on page 8 of the draft SE are documented. As noted in the draft SE, the last paragraph of Section 3.2 (line 17), using quantified operator actions is an option. To avoid misinterpretations in the future, add the following to the beginning of the last bullet in Section 3.2 of the draft SE, "if the operator action is modeled in the plant PRA,..	

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PWR OWNERS GROUP MEMBER PARTICIPATION* FOR PROJECT/TASK PA-MSC-0076			
		Participant	
Utility Member	Plant Site(s)	Yes	No
AmerenUE	Callaway (W)		X
American Electric Power	D.C. Cook 1&2 (W)		X
Arizona Public Service	Palo Verde Unit 1, 2, & 3 (CE)		X
Constellation Energy Group	Calvert Cliffs 1 & 2 (CE)		X
Constellation Energy Group	Ginna (W)		X
Dominion Connecticut	Millstone 2 (CE)		X
Dominion Connecticut	Millstone 3 (W)		X
Dominion Kewaunee	Kewaunee (W)		X
Dominion VA	North Anna 1 & 2, Surry 1 & 2 (W)		X
Duke Energy	Catawba 1 & 2, McGuire 1 & 2 (W), Oconee 1, 2, 3 (B&W)	X	
Entergy Nuclear Northeast	Indian Point 2 & 3 (W)		X
Entergy Operations South	Arkansas 2, Waterford 3 (CE), Arkansas 1 (B&W)		X
Exelon Generation Co. LLC	Braidwood 1 & 2, Byron 1 & 2 (W), TMI 1 (B&W)		X
FirstEnergy Nuclear Operating Co	Beaver Valley 1 & 2 (W), Davis-Besse (B&W)	X	
Florida Power & Light Group	St. Lucie 1 & 2 (CE)		X
Florida Power & Light Group	Turkey Point 3 & 4, Seabrook (W)		X
Nuclear Management Company	Prairie Island 1&2, Pt. Beach 1&2 (W)		X
Nuclear Management Company	Palisades (CE)	X	
Omaha Public Power District	Fort Calhoun (CE)		X
Pacific Gas & Electric	Diablo Canyon 1 & 2 (W)		X
Progress Energy	Robinson 2, Shearon Harris (W), Crystal River 3 (B&W)		X
PSEG-Nuclear	Salem 1 & 2 (W)		X
Southern California Edison	SONGS 2 & 3 (CE)		X
South Carolina Electric & Gas	V.C. Summer (W)		X

PWR OWNERS GROUP MEMBER PARTICIPATION* FOR PROJECT/TASK PA-MSC-0076 (cont.)			
		Participant	
Utility Member	Plant Site(s)	Yes	No
So. Texas Project Nuclear Operating Co.	South Texas Project 1 & 2 (W)		X
Southern Nuclear Operating Co.	Farley 1 & 2, Vogtle 1 & 2 (W)	X	
Tennessee Valley Authority	Sequoyah 1 & 2, Watts Bar (W)	X	
TXU Power	Comanche Peak 1 & 2 (W)		X
Wolf Creek Nuclear Operating Co.	Wolf Creek (W)		X

* Project participants as of the date the final deliverable was completed. On occasion, additional members will join a project. Please contact the PWR Owners Group Program Management Office to verify participation before sending this document to participants not listed above.

PWR OWNERS GROUP INTERNATIONAL MEMBER PARTICIPATION* FOR PROJECT/TASK PA-MSC-0076			
		Participant	
Utility Member	Plant Site(s)	Yes	No
British Energy	Sizewell B		X
Electrabel (Belgian Utilities)	Doel 1, 2 & 4, Tihange 1 & 3		X
Kansai Electric Co., LTD	Mihama 1, Ohi 1 & 2, Takahama 1 (W)		X
Korea Hydro & Nuclear Power Corp.	Kori 1, 2, 3 & 4 Yonggwang 1 & 2 (W)		X
Korea Hydro & Nuclear Power Corp.	Yonggwang 3, 4, 5 & 6 Ulchin 3, 4 , 5 & 6(CE)		X
Nuklearna Electrarna KRSKO	Krsko (W)		X
Nordostschweizerische Kraftwerke AG (NOK)	Beznau 1 & 2 (W)		X
Ringhals AB	Ringhals 2, 3 & 4 (W)	X	
Spanish Utilities	Asco 1 & 2, Vandellos 2, Almaraz 1 & 2 (W)		X
Taiwan Power Co.	Maanshan 1 & 2 (W)		X
Electricite de France	54 Units		X

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- Alex McNeill (Dominion Generation)
- Mark Pyne (Duke Energy Company)

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LIST OF ACRONYMS AND ABBREVIATIONS

ASME	American Society of Mechanical Engineers
CDF	Core damage frequency
ECSCC	External chloride stress corrosion cracking
FAC	Flow accelerated corrosion
HAZ	Heat affected zone
HSS	High safety significant
IGSCC	Intergranular stress corrosion cracking
ISI	Inservice inspection
LERF	Large early release frequency
LSS	Low safety significant
MIC	Microbiologically influenced corrosion
NDE	Non-destructive examination
NPS	Nominal pipe size
PRA	Probabilistic risk assessment
PWROG	Pressurized Water Reactor Owners Group
PWSCC	Primary water stress corrosion cracking
RRW	Risk reduction worth
SRRA	Structural reliability and risk assessment
TGSCC	Transgranular stress corrosion cracking
USNRC	United States Nuclear Regulatory Commission

EXECUTIVE SUMMARY

This Supplement to WCAP-14572 Revision 1-NP-A provides clarifications of the methodology described in WCAP-14572 Revision 1-NP-A. Specifically, this Supplement addresses:

- How failure probabilities are estimated for multiple pipe size segments,
- The expert panel decision process for categorizing a segment as low safety significant (LSS) that is quantitatively high safety significant (HSS), and
- The requirements for examination based on the postulated failure modes and configuration of each piping structural element.

The Supplement provides methods for estimating the failure probability for multiple pipe size segments that result in the same number of examinations or a negligibly small difference in the number of examinations that has an insignificant impact using either method. The Supplement also provides additional guidance to an expert panel to categorize a segment as LSS that is quantitatively HSS.

Additionally, this Supplement updates Table 4.1-1 from WCAP-14572 Revision 1-NP-A to incorporate acquired knowledge and to reflect the examination methods that are actually being conducted by the industry since the issuance of the approved version of the WCAP. Table 4.1-1 in WCAP-14572 Revision 1-NP-A identifies the requirements for examinations based on the postulated failure modes and the configuration of each piping structural element.

1 INTRODUCTION

This Supplement to WCAP-14572 Revision 1-NP-A provides clarification for the methodology described in WCAP-14572 Revision 1-NP-A. Specifically, the Supplement addresses:

- How failure probabilities are estimated for multiple pipe size segments,
- The expert panel decision process for categorizing a segment as LSS that is quantitatively HSS, and
- The requirements for examination based on the postulated failure modes and configuration of each piping structural element.

Section 2 provides methods for estimating the failure probability for multiple pipe size segments that result in the same number of examinations or a negligibly small difference in the number of examinations that has an insignificant impact using either method. Section 3 provides additional guidance to an expert panel to categorize a segment as LSS that is quantitatively HSS. Section 4 presents the revised requirements for examination based on the postulated failure modes and configuration of each piping structural element to incorporate acquired knowledge and to reflect the examination methods that are actually being conducted by the industry since the issuance of WCAP-14572 Revision 1-NP-A.

2 CALCULATING FAILURE PROBABILITIES FOR MULTIPLE PIPE SIZE SEGMENTS

2.1 BACKGROUND

Section 3.5 of WCAP-14572 Revision 1-NP-A and Supplement 1 to the WCAP discuss how to estimate the structural reliability and risk assessment (SRRA) failure probabilities for segments. Based on the information presented, there are two methods that can be used for calculating the SRRA failure probability for a multiple pipe size segment.

The first method is:

- A failure probability is calculated for every pipe size in the segment since some of the input parameters (e.g. nominal pipe size and thickness-to-outer diameter ratio) used by the SRRA code vary based on the pipe dimensions. In some, but not all cases, other input parameters vary for these "sub-segments" based upon the conditions for that particular sub-segment. The highest failure probability associated with the segment is then used to represent the segment.

The second method is:

- All of the degradation mechanisms in the segment being evaluated are included on a single weld (i.e., the limiting degradation mechanisms are combined or added and included on the limiting weld in the segment).

- If the results are not overly conservative the calculated failure probability is used.

- If the results are overly conservative, the segment is split and a failure probability is recalculated for each of these new segments. If the results are not overly conservative, these calculated failure probabilities are used. If the results are overly conservative, the segment is split until reasonable results are obtained.

This Supplement presents generic discussions and plant-specific examples that confirm that both methods are acceptable by demonstrating that there is essentially no difference in the number of examinations between the two methods or that any difference in the number of examinations would result in an insignificant impact. Therefore, the use of the first method as discussed above is acceptable.

Section 2.2 provides additional discussion on the comparison of the methods and a summary of the plant-specific examples, and Section 2.3 provides additional guidance on estimating failure probabilities for multiple pipe size segments. Details of the plant-specific examples are presented in Appendix A.

2.2 DISCUSSION

Section 2.2 and its associated subsections are provided for informational purposes only. The analyses described in this Section do not represent additional requirements for conducting a risk-informed ISI program.

This Section demonstrates that there is no net difference in the number of examinations between the two methods or that any difference in the number of examinations results in an insignificant impact. To support this conclusion, both a qualitative discussion and a quantitative plant-specific, full assessment comparison are conducted.

Assessing the difference of the two methods involves evaluating the number of examinations identified by each method. The examinations to be conducted in a risk-informed inservice inspection (ISI) program are identified by one of the following means:

- Segments that are categorized by the expert panel as HSS are selected for inspection.
- The structural element selection process determines the number of examinations that are conducted on HSS segments.
- Segments may be selected for inspection to meet the change-in-risk criteria.
- Segments may be selected for inspection for defense-in-depth.

Each of the above areas is discussed in the following paragraphs to demonstrate that there is no difference in the number of examinations between the two methods or that any difference in the number of examinations results in an insignificant impact.

2.2.1 Evaluating Potential Differences Based on Categorization of Segments by the Expert Panel

The expert panel categorizes every segment as HSS or LSS. If the most limiting SRRA inputs from all sizes are used on a single weld (the second method), the segment failure probability may be higher than if a failure probability is calculated for every pipe size in the segment and the highest failure probability is used to represent the segment (the first method). If the failure probability for a LSS multiple pipe size segment is changed from the first method to the second method, there is a possibility that the failure probability could increase and that the expert panel could change the categorization of the segment to HSS. However, if the multiple pipe size segment is split into separate segments based on pipe size, the new segments would also be categorized as LSS for the following reasons:

- The multiple pipe size segment that is based on the most limiting failure probability from any of the pipe sizes in the segment is categorized LSS by the expert panel.
- The risk metrics for the new segments would be the same or lower than the multiple pipe size segment since the most limiting failure probability from all the pipe sizes is used to represent the multiple pipe size segment.
- Given the same or lower risk metrics and the same deterministic insights, the expert panel would be expected to categorize the split segments as LSS.

Given the above, there is no difference in the number of examinations for LSS multiple pipe size segments based on the expert panel categorization of segments.

For a HSS segment, there is no impact to the HSS segment, with respect to its categorization as HSS by the expert panel. If the failure probability increases, the risk metrics for the segment would also increase. However, the segment is already categorized as HSS. Therefore, there is no impact on the categorization by the expert panel. Note, due to the relative ranking process that is used, a higher failure probability could potentially impact other segments by decreasing their importance. This is one of the reasons for calculating a failure probability for each pipe size in a multiple pipe size segment.

Another way to minimize this impact is to split the HSS multiple pipe size segment into separate segments based on size. There is a potential that the number of examinations could be impacted based on the categorization of the segments and structural element selection process. Before this potential difference can be examined further, a general understanding of the structural element selection process is necessary. This potential difference based on splitting a HSS multiple pipe size segment into separate segments based on pipe size is discussed in greater detail in the following sections.

2.2.2 Evaluating Potential Differences Based on the Structural Element Selection Process

In the structural element selection process as discussed in Section 3.7 of WCAP-14572 Revision 1-NP-A, each segment is placed in a region based on its safety significance and its failure importance. Segments that are HSS are placed in Region 1 or 2. HSS segments with a high failure importance are placed in Region 1, and HSS segments with a low failure importance are placed in Region 2. Segments placed in Region 1 are further divided into the portions that are affected by an active degradation mechanism, Region 1A, and portions that are not affected by an active degradation mechanism, Region 1B.

All structural elements in Region 1A are selected for examination. How the failure probability for a multiple pipe size segment is calculated has no impact on which structural elements are selected for inspection in Region 1A. For the structural elements in Region 1B and 2, the Perdue Model statistical analysis is used to determine the minimum number of examinations. Page 174 of WCAP-14572 Revision 1-NP-A discusses dividing a segment into lots, thus determining the number of structural elements on a multiple pipe size segment where a failure probability is calculated for each pipe size is already approved. Thus, for the structural element selection process itself, there is no difference in the number of examinations.

2.2.3 Evaluating Potential Differences Based on Splitting a HSS Multiple Pipe Size Segment

In the second method, if the failure probability for a HSS multiple pipe size segment failure probability is overly conservative, the segment should be split into separate segments and the failure probabilities for these new segments recalculated. Splitting a HSS multiple pipe size segment into separate segments based on pipe size may increase the number of examinations. Per page 174 of WCAP-14572 Revision 1-NP-A, a minimum of one examination is conducted on each HSS segment. If a HSS multiple pipe size segment is split into separate segments based on pipe size and more than one pipe size is categorized as HSS, the minimum number of examinations may increase from one to the number of segment pipe sizes that are categorized as HSS. In this situation, the potential impact does not involve areas with an active degradation mechanism but instead potentially impacts areas where inspection sampling is used to address unexpected degradation.

Although there is a potential for a difference in the absolute number of examinations, any differences are expected to result in an insignificant impact. There are several reasons why a multiple pipe size segment would not need to be split or why there would be no difference in the number of examinations. The following paragraphs explain on a qualitative basis the instances where there would be no difference in the number of examinations.

The Only Difference in SRRA Inputs Are the Nominal Pipe Size or Thickness-to-Outside Diameter Ratio

Per Section 3.3 of WCAP-14572 Revision 1-NP-A, multiple pipe size segments are permitted. By definition, a multiple pipe size segment will have either different nominal pipe sizes or thickness-to-outside diameter ratios. Since the nominal pipe size and the thickness-to-outside diameter ratios are inputs to the SRRA code and since multiple pipe size segments are acceptable, it can be concluded that differences in the nominal pipe size and the thickness-to-outside diameter ratios are acceptable. Therefore, if the only differences in the SRRA inputs for a HSS multiple pipe size segment are the physical pipe dimensions (i.e., nominal pipe size and/or the thickness-to-outside diameter ratio) there is no need to split the segment, and there is no difference in the number of examinations.

Segments Comprised of Socket Welded Piping

If a HSS segment is comprised of socket welded piping and does not have an externally generated degradation, the entire segment is examined via a VT-2 examination. This applies to both single and multiple pipe size segments. If a multiple pipe size segment is split based on pipe size, each of the new segments would be examined via a VT-2 examination. Therefore, for HSS socket welded multiple pipe size segments where there is no externally generated degradation; there is no difference in the number of examinations.

Segments Comprised of Butt and Socket Welded Piping Where the Only Differences in SRRA Inputs are Between the Butt and Socket Welded Portions

If a HSS segment contains both socket welded piping and butt welded piping and there is no externally generated degradation mechanism on the socket welded piping, the socket welded piping is examined via a VT-2 visual examination. The number of examinations on the butt welded piping would be based upon any active degradation mechanisms and the Perdue Model statistical analysis as previously mentioned in Section 2.2.2. The Perdue Model analysis would be based on the data from the butt welded portion of the segment. If the only differences in the SRRA inputs are between the butt welded piping and the socket welded piping and the segment is split between the socket welded portion and the butt welded portion, the socket welded segment (or socket welded portion of the original segment) would be examined via a VT-2. The number of examinations on the butt welded segment (or butt welded portion of the original segment) would be based upon any active degradation mechanisms and the Perdue Model analysis. The Perdue Model analysis for the butt welded segment would be based on data from the butt welded portion of the piping, resulting in no change in the way the examinations are determined for the combined segment. Therefore, for HSS multiple pipe size segments containing butt welded piping and socket welded piping where there is no external degradation mechanism on the socket welded piping and the only difference in the SRRA inputs are between the socket welded and the butt welded portions of the segment, there is no difference in the number of examinations. Thus, there is no need to combine degradation mechanisms between the butt and socket welded portions of piping because the same number of examinations are identified for the butt and socket welded portions of piping; independent of whether the degradation mechanisms are combined or not.

No Difference in the Failure Probability Used to Represent the Segment

In some instances, calculating the failure probability for a multiple pipe size segment that is generated by calculating a failure probability for each pipe size and using the highest failure probability to represent the segment versus calculating the failure probability using the most limiting inputs from any pipe size will result in approximately the same failure probability. In these instances, the results are not overly conservative, and there is no need to split the HSS multiple pipe size segments. Therefore, for HSS multiple pipe size segments where the failure probability from the combined limiting degradation mechanisms from the various pipe sizes in a multiple pipe size segment are approximately the same as the failure probabilities from the various pipe sizes, there is no difference in the number of examinations.

There are occasions where the SRRA inputs on one pipe size in a HSS multiple pipe size segment are more conservative than the inputs for the other size(s). When the more conservative inputs are used on the other size(s), the failure probabilities for the other sizes may increase; however, they may be approximately the same as or less than the failure probability for the size where the more limiting inputs were originally used. Since the failure probability representing the segment remains the same, there is no difference in the number of examinations.

Only One Size Remains HSS When Splitting a HSS Multiple Pipe Size Segment

When a HSS multiple pipe size segment is split into separate segments based on pipe size, it is possible that all of the new segments except one will be categorized as LSS by the expert panel due to lower failure probabilities for all but one of the new segments. Regarding whether an active degradation mechanism is present, there are three basic scenarios:

- No active degradation mechanism on the multiple pipe size segment.
- An active degradation mechanism on the split segment that is HSS and no active degradation mechanism on the split segment that is LSS.
- An active degradation mechanism on both the HSS and LSS segments split by size.

In the following discussion of all three scenarios, only one of the segments split by size is HSS. If the multiple pipe size segment has no active degradation mechanism, there is no difference in the minimum number of examinations. If the multiple pipe size segment has an active degradation mechanism and only the segment split by size that is HSS has an active degradation mechanism, there is no difference in the minimum number of examinations. All structural elements affected by the active degradation mechanism will be examined, and a minimum of one examination will be conducted from the statistical analysis. If the multiple pipe size segment has an active degradation mechanism on both the HSS and LSS segments split by size, there is a potential reduction in the number of examinations required by the risk-informed ISI program. The new segment that is LSS and affected by an active degradation mechanism would be considered for an owner defined program but would not be required to be examined per the risk-informed ISI program. Thus, if only one pipe size remains HSS when splitting a HSS multiple pipe size segment there is no difference in the number of examinations or a reduction in the number of examinations, which makes the first method more conservative in this circumstance.

Section 3.5 of WCAP-14572 Revision 1-NP-A requires the use of engineering experience in estimating the failure probability of piping segments. There are instances where it may be more appropriate to divide a multiple pipe size segment into separate segments in order that the categorization will be properly determined e.g., for different consequences between the sizes. In those cases, the segments need to be split. The potential to divide a multiple pipe size segment is not considered just once, but several times by the engineering team developing the SRRA failure probabilities, the engineers conducting the risk evaluation, and the expert panel.

Increases in the Segment Failure Probability That Are Not Overly Conservative

If the failure probability in a multiple pipe size segment is determined by using SRRA inputs specific to each pipe size, then, in some cases, using the most limiting SRRA inputs from all the pipe sizes will result in an increase in the failure probability for the segment that is not overly conservative. Generally any increase that is less than an order of magnitude is considered not to be overly conservative. A more conservative criterion for evaluating if a failure probability is overly conservative is to add the failure probabilities from the individual pipe sizes in the HSS multiple pipe size segment and compare that to the failure probability based on the most limiting SRRA inputs from all the pipe sizes in the segment. If the sum of the failure probabilities from the individual pipe sizes are approximately the same or higher than the failure probability based on the most limiting SRRA inputs from all the pipe sizes, then the effect on other segments is negligible or conservative. Thus, there is no need to split the segment and there is no difference in the number of examinations.

The impact that one segment has on another segment's risk metric of risk reduction worth (RRW) is through the first segment's impact on the overall piping core damage frequency (CDF) or large early release frequency (LERF). The RRW measures how much the core damage frequency will decrease if the unavailability of the component of interest is set to 0 (that is, the component is always available/perfectly reliable). The equation used to calculate RRW is:

$$RRW = CDF_{base} / CDF_0 \tag{2-1}$$

where:

CDF_{base} = Base Core Damage Frequency

CDF_0 = Core Damage Frequency when the component failure probability is set to 0

$$CDF_0 = CDF_{base} - CDFsegment \tag{2-2}$$

where:

$CDF_{segment}$ = Core Damage Frequency of the segment

Substituting equation (2-2) into equation (2-1) results in:

$$RRW = CDF_{base} / (CDF_{base} - CDFsegment) \quad (2\text{-}3)$$

If a segment is overly conservative, the base core damage frequency will increase. This in turn will decrease the RRW for the other segments. Segments with an RRW greater than 1.005 are considered quantitatively HSS. Segments with RRWs between 1.001 and 1.004 are given additional consideration. For example, the change in a segment's RRW from 1.005 to 1.004 is used to identify the relative sensitivity that one segment has on another segment's RRW. A RRW of 1.005 is entered into equation (2-3) to represent the RRW equation where the RRW is equal to 1.005.

$$1.005 = CDF_{base} / (CDF_{base} - CDFsegment) \quad (2\text{-}4)$$

A variable "x" is used to represent the change in the base core damage frequency that results in a decrease in the RRW from 1.005 to 1.004. The appropriate values are entered into equation (2-3) to represent the RRW equation for an RRW of 1.004

$$1.004 = xCDF_{base} / (xCDF_{base} - CDFsegment) \quad (2\text{-}5)$$

Solving equation (2-5) for CDFsegment:

$$CDFsegment = (0.004 / 1.004) * xCDF_{base} \quad (2\text{-}6)$$

Substituting equation (2-6) into equation 2-4 for CDFsegment and solving for x, results in:

$$x = (1.004 * 0.005) / (1.005 * 0.004) = 1.249$$

To get a decrease in a segment's RRW from 1.005 to 1.004, the base CDF must increase by approximately 25 percent. To obtain decreases in a segment's RRW from 1.005 to lower than 1.004, the base CDF must increase significantly more. Based on the above, unless the segment is a very dominant segment, a small increase in the failure probability is unlikely to affect the other segments. Thus, a small change in the failure probability is not overly conservative and the segment does not need to be split into separate segments. Therefore, there is no difference in the number of examinations for small increases in the failure probability used to represent the segment.

Increases in the Segment Failure Probability That Are Potentially Overly Conservative

In some instances, using the most limiting SRRA inputs from all the pipe sizes in a segment will result in an overly conservative failure probability. If none of the above instances apply to the segment and the HSS multiple pipe size segment is split based on pipe size, there would be a difference in the absolute number of examinations due to the requirement of a minimum of one examination per HSS segment. However, this difference would be insignificant for the following reasons:

- All structural elements that are affected by an active degradation mechanism or that are modeled as being highly susceptible to an active degradation mechanism are examined whether the segment is split or not. Thus, there is no difference in the number of structural elements that are affected by an active degradation mechanism or that are modeled as being highly susceptible to an active degradation mechanism.

- The potential difference in the number of examinations is associated with segments where there is no expected degradation mechanism.

- For those elements where there is no expected degradation mechanism, the number of examinations is determined by the Perdue Model analysis. A sufficient number of examinations must be conducted to have a 95% confidence level that the current target leak rates will not be exceeded. In accordance with WCAP-14572 Revision 1-NP-A page 174, a minimum of one examination will be conducted even if the Perdue Model analysis shows a 100% confidence level with no risk-informed ISI. This minimum requirement may result in a difference in the number of examinations; however, it still meets the acceptance criteria in Section 3.7.2 of the WCAP.

- In the cases where one pipe size has a more limiting SRRA input than the other sizes, using the more limiting SRRA input for the other sizes is most likely to result in no difference in the failure probability used to represent the segment or an increase in the segment failure probability that is not overly conservative.

- The most likely occurrence for increases in the segment failure probability that are potentially overly conservative is associated with situations where different sizes have different more limiting SRRA inputs or degradation mechanisms. As discussed above, if these degradation mechanisms are active or the segment is modeled as being highly susceptible to an active degradation mechanism, there is no difference in the number of examinations. However, if a HSS segment is modeled with multiple postulated degradation mechanisms, conduct one or more examinations that address each postulated degradation mechanism.

Although there could be a difference in the absolute number of required examinations determined using the first method versus the second method for calculating the SRRA failure probabilities of multiple pipe size segments, the number of examinations must meet the acceptance criteria in Section 3.7.2 of the WCAP. The WCAP-14572 Revision 1-NP-A methodology is based on the more global intent and purpose of a risk-informed ISI program rather than the absolute number of examinations. The purpose of risk-informed ISI programs is to properly address areas of degradation with moderate to high safety consequences (areas of degradation with low safety consequence are evaluated as part of the risk-informed ISI program for consideration in a licensee defined program). The first method properly identifies those piping segments with active degradation and moderate to high safety consequences. The calculation of failure probabilities for segments with multiple sizes does not impact the areas involving active degradation mechanisms, but instead impacts areas where inspection sampling is used to address unexpected degradation.

This Supplement contains quantitative evaluations of the potential differences from five risk-informed ISI programs. For each of the risk-informed ISI programs evaluated, the following process is used to identify any potential differences in the number of examinations.

1. The HSS multiple pipe size segments are identified.

2. Each HSS multiple pipe size segment is evaluated against the criteria identified above to determine if there are any potential differences in the number of examinations.

Summaries of the results regarding the potential differences with respect to the HSS segments are provided on the following pages. More details of the quantitative evaluations are provided in Appendix A.

Unit A Risk-Informed ISI Program

The unit A risk-informed ISI program is a full scope program that has 45 HSS multiple pipe size segments. A summary of the evaluation of the unit A HSS multiple pipe size segments is provided in Table 2.2-1.

Table 2.2-1 Summary of Evaluation of Unit A HSS Multiple Pipe Size Segments

Number of HSS Multiple Pipe Size Segments	Potential Difference in Number of Examinations	Basis
22	0	Only Differences in SRRA Inputs Are the Nominal Pipe Size or Thickness-to-Outside Diameter Ratio
2	0	Segments Comprised of Socket Welded Piping
10	0	Segments Comprised of Butt and Socket Welded Piping Where the Only Difference in SRRA Inputs is Between the Butt and Socket Welded Portions
10	0	No Difference in the Failure Probability Used to Represent the Segment
0	0	Only One Size Remains HSS When Splitting a HSS Multiple Pipe Size Segment
1	0	Increases in the Segment Failure Probability That Are Not Overly Conservative
0	0	Increases in the Segment Failure Probability That Are Potentially Overly Conservative

Based on the evaluation of the unit A HSS multiple pipe size segments, there is no difference in the number of examinations.

Unit B Risk-Informed ISI Program

The unit B risk-informed ISI program is a Class 1 and Class 2 program that has 29 HSS multiple pipe size segments. A summary of the evaluation of the unit B HSS multiple pipe size segments is provided in Table 2.2-2.

Table 2.2-2 Summary of Evaluation of Unit B HSS Multiple Pipe Size Segments

Number of HSS Multiple Pipe Size Segments	Potential Difference in Number of Examinations	Basis
16	0	Only Differences in SRRA Inputs Are the Nominal Pipe Size or Thickness-to-Outside Diameter Ratio
1	0	Segments Comprised of Socket Welded Piping
0	0	Segments Comprised of Butt and Socket Welded Piping Where the Only Difference in SRRA Inputs is Between the Butt and Socket Welded Portions
11	0	No Difference in the Failure Probability Used to Represent the Segment
0	0	Only One Size Remains HSS When Splitting a HSS Multiple Pipe Size Segment
1	0	Increases in the Segment Failure Probability That Are Not Overly Conservative
0	0	Increases in the Segment Failure Probability That Are Potentially Overly Conservative

The original evaluation of the unit B HSS multiple pipe size segments identified a potential difference of one examination. Additional evaluation has identified that the increase in the failure probability for one segment is not overly conservative. Thus, there is no difference in the number of examinations.

Unit C Risk-Informed ISI Program

The unit C risk-informed ISI program is a Class 1 and Class 2 program that has 32 HSS multiple pipe size segments. A summary of the evaluation of the unit C HSS multiple pipe size segments is provided in Table 2.2-3.

Table 2.2-3 Summary of Evaluation of Unit C HSS Multiple Pipe Size Segments

Number of HSS Multiple Pipe Size Segments	Potential Difference in Number of Examinations	Basis
23	0	Only Differences in SRRA Inputs Are the Nominal Pipe Size or Thickness-to-Outside Diameter Ratio
0	0	Segments Comprised of Socket Welded Piping
5	0	Segments Comprised of Butt and Socket Welded Piping Where the Only Difference in SRRA Inputs is Between the Butt and Socket Welded Portions
4	0	No Difference in the Failure Probability Used to Represent the Segment
0	0	Only One Size Remains HSS When Splitting a HSS Multiple Pipe Size Segment
0	0	Increases in the Segment Failure Probability That Are Not Overly Conservative
0	0	Increases in the Segment Failure Probability That Are Potentially Overly Conservative

Based on the evaluation of the unit C HSS multiple pipe size segments, there is no difference in the number of examinations.

Unit D and Unit E Risk-Informed ISI Programs

The unit D and unit E risk-informed ISI programs are Class 1 and Class 2 programs. Similar to the other risk-informed ISI programs that are evaluated for any potential difference in the number of examinations, it is determined that there are no differences in the number of examinations. However, a unique situation occurred on one segment at both unit D and unit E that had not occurred at the other units that are evaluated. This situation is discussed in the following paragraphs.

The pressurizer surge lines at unit D and unit E are multiple pipe size segments consisting of two pipe sizes. When the limiting SRRA inputs from all pipe sizes are used to calculate the failure probability, the controlling failure probabilities for the segments are approximately the same. Thus, there is no difference in the number of examinations.

The pressurizer surge lines are modeled with the potential for two postulated degradation mechanisms that are not active and the surge lines are not considered highly susceptible to these degradation mechanisms. Thus, the segments are placed in Region 2 of the structural element selection matrix. The Perdue Model analysis of the surge line indicated that a minimum of one examination is required to maintain a 95 percent confidence that the current target leak rates would not be exceeded. The expert panel elected to assign two examinations to each of these segments to address each of the potential degradation mechanisms. Had the segment been split by pipe size, it is reasonable to assume that each of the split segments would have been categorized as HSS. With a minimum of one examination per HSS segment, it is reasonable to assume that two examinations would have been conducted on each of the pressurizer surge lines. Since the SRRA failure probabilities calculated by both methods are approximately the same, there is no need to split the segments, and there is no difference in the number of examinations. However, additional guidance has been added to Section 2.3 of this Supplement to WCAP-14572 Revision 1-NP-A to address this situation where a segment has more than one postulated degradation mechanism that is neither active nor modeled as highly susceptible to an active degradation mechanism. The guidance requires that one or more examinations be conducted that address each postulated degradation mechanism on the HSS segment. In some cases, this may result in doing more examinations than is required by the statistical analysis.

2.2.4 Evaluating Potential Differences Based on the Change-in-Risk Evaluation

For the change-in-risk evaluation, a comparison of the risk-informed ISI program and the current American Society of Mechanical Engineers (ASME) Section XI ISI program is conducted using the risk evaluation that is developed as part of the risk-informed ISI program. On a simplified basis, the failure probabilities without ISI are used to represent segments that have no examination and the failure probabilities with ISI are used to represent segments that have an examination. As discussed in Section 4.4.2 of WCAP-14572 Revision 1-NP-A, the number of examinations (excluding the combination with some augmented examinations) has no impact on the failure probability that is used to represent a segment for either program.

As previously discussed, WCAP-14572 Revision 1-NP-A allows the use of multiple pipe size segments. However, if a multiple pipe size segment is split, there is a potential effect on meeting the change-in-risk criteria. The splitting of multiple pipe size segments is used in some of the previous discussions to demonstrate that there is no difference in the number of examinations; therefore, the potential effects of splitting a multiple pipe size segment on the change-in-risk evaluation are evaluated in the following paragraphs.

There are 11 basic scenarios for the change-in-risk evaluation that can occur if multiple pipe size segments are split by pipe size. Additional scenarios are possible if a multiple pipe size segment has more than two pipe sizes; however, these additional scenarios can be broken down into combinations of these basic 11 scenarios. For each of these scenarios, the ability to meet the change-in-risk criteria is affected by the failure probabilities used to represent the split segments which is dependent upon whether the split segments would or would not be examined for each respective program. The failure probabilities with ISI are generally lower than failure probabilities without ISI. Each basic scenario is evaluated in Table 2.2-4 by comparing the potential difference between the RI-ISI program and the ASME Section XI program for the multiple pipe size segment against the combined potential difference between the two programs for the split segments. Augmented examinations are not addressed in Table 2.2-4 since the augmented examinations are conducted as part of both the risk-informed ISI and the ASME Section XI programs and are treated the same for each program in the change-in-risk calculation.

Table 2.2-4 Scenarios for Splitting Multiple Pipe Size Segments and Their Effects on the Change-in-Risk Evaluation

Scenario	Multiple Pipe Size Segment		Split Segment 1			Split Segment 2			Ability to Meet Change-in-Risk Criteria After Split
	Safety Significance	# ASME Section XI Exams	Safety Significance	RI-ISI Exam	ASME Section XI Exam	Safety Significance	RI-ISI Exam	ASME Section XI Exam	
1	LSS	2	LSS	N	Y	LSS	N	Y	Less[1]
2	LSS	1	LSS	N	Y	LSS	N	N	Neutral[2]
3	LSS	0	LSS	N	N	LSS	N	N	Neutral[3]
4	HSS	2	HSS	Y	Y	HSS	Y	Y	Neutral[4]
5	HSS	1	HSS	Y	Y	HSS	Y	N	Greater[5]
6	HSS	0	HSS	Y	N	HSS	Y	N	Greater[6]
7	HSS	2	HSS	Y	Y	LSS	N	Y	Less[7]
8	HSS	1	HSS	Y	Y	LSS	N	N	Neutral[8]
9	HSS	1	HSS	Y	N	LSS	N	Y	Greater[9]
10	HSS	0	HSS	Y	N	HSS	Y	N	Greater[10]
11	HSS	0	HSS	Y	N	LSS	N	N	Neutral[11]

NOTES:

1. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the ASME Section XI program. However, the combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the ASME Section XI program would be less than that for the risk-informed ISI program for this scenario, the ability to meet the change-in-risk criteria would be reduced.
2. The difference in risk between the two programs for the multiple pipe size segment and split segment 1 would be the same. There would be no difference in risk between the programs for split segment 2. The combined difference in risk between the two programs for the split segments would be the same as the difference in risk between the programs for the multiple pipe size segment and the ability to meet the change-in-risk criteria would not be affected.
3. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.
4. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.

Table 2.2-4 Scenarios for Splitting Multiple Pipe Size Segments and Their Effects on the Change-in-Risk Evaluation (cont.)

NOTES: (cont.)

5. There would be no difference in risk between the two programs for the multiple pipe size segment and split segment 1. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the risk-informed ISI program would be lower. The combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program is less than the ASME Section XI program, the ability to meet the change-in-risk criteria is greater.
6. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the risk-informed ISI program. However, the combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program would be less than that for the ASME Section XI program for this scenario, the ability to meet the change-in-risk criteria would be greater.
7. There would be no difference in risk between the two programs for the multiple pipe size segment and split segment 1. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the ASME Section XI program would be lower. The combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the ASME Section XI program is less than the risk-informed ISI program, the ability to meet the change-in-risk criteria is reduced.
8. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.
9. There would be no difference in risk between the two programs for the multiple pipe size segment. The difference in risk between the two programs for split segment 1 would be different. The risk associated with the risk-informed ISI program would be lower. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the ASME Section XI program would be lower. Split segment 1 would be HSS, and split segment 2 would be LSS. Therefore the effects from split segment 1 would dominate. The combined differences in risk between the two programs for the split segments would be greater than the difference between the two programs for the multiple pipe size segment. Since split segment 1 would dominate the effect and the risk would be lower with the risk-informed ISI program for split segment 1, the ability to meet the change-in-risk criteria would be greater.
10. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the risk-informed ISI program. However, the combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program would be less than that for the ASME Section XI program for this scenario, the ability to meet the change-in-risk criteria would be greater.
11. The difference in risk between the two programs for the multiple pipe size segment and split segment 1 would be the same. There would be no difference in risk between the programs for split segment 2. The combined difference in risk between the two programs for the split segments would be the same as the difference in risk between the programs for the multiple pipe size segment and the ability to meet the change-in-risk criteria would not be affected.

The evaluations of these basic scenarios demonstrate that, in all but two cases, splitting a multiple pipe size segment will either have a neutral effect on the change-in-risk evaluation or increase the ability of the RI-ISI program to meet the change-in-risk criteria. For the two cases in which meeting the change-in-risk criteria may be more difficult, the potential impact, if any, is expected to be minimal for the following reasons:

- Based on the experience to date, multiple pipe size segments typically do not contain an ASME Section XI examination on more than one size.

- These multiple pipe size segments are LSS. Segments that are defined as LSS have a lower piping CDF and LERF and are unlikely to have a significant impact on the change-in-risk calculations and in meeting the criteria.

- There is inherent conservatism built into the change-in-risk calculation. It is conservatively assumed that the ASME Section XI examinations address the risk associated with the segment, although in reality they may not. In a multiple pipe size segment with an ASME Section XI examination, it is possible that the ASME Section XI examination is not on the pipe size with the highest failure probability. Furthermore, it is possible that on a single size segment, the ASME Section XI examination may not occur at the element with the controlling postulated degradation mechanism. In these cases, it is possible that the ASME Section XI examination does not address the majority of the risk associated with the segment. Thus, crediting the ASME Section XI examinations for addressing the risk in a segment results in a conservative evaluation relative to meeting the change-in-risk acceptance criteria.

To support the above qualitative arguments, the change-in-risk is reevaluated for five units. For one unit, there are no LSS multiple pipe size segments with an ASME Section XI examination on more than one pipe size. Note that for some of these evaluations, it is conservatively assumed that any LSS multiple pipe size segment containing an ASME Section XI examination contains an ASME Section XI examination on every pipe size in the segment. For all five units, the change-in-risk criteria are met without adding additional inspections when the LSS multiple pipe size segments that contain an ASME Section XI examination on more than one size are split into separate segments based on pipe size.

2.2.5 Evaluating Potential Difference Based on Defense-in-Depth

As part of the process, the risk-informed ISI program is evaluated to ensure that the defense-in-depth philosophy is maintained. Regulatory Guide 1.178 identifies that an important element of defense-in-depth for risk-informed ISI is maintaining the reliability of independent barriers to fission product release. The consideration of examining a segment for defense-in-depth reasons is not affected by how the failure probability for a multiple pipe size segment is estimated. Thus, there is no difference in the number of examinations based on maintaining defense-in-depth.

2.2.6 Conclusions

This Supplement presents generic discussions and plant-specific quantitative examples for estimating a multiple pipe size segment failure probability. The discussion of plant-specific examples demonstrates that the two methods for calculating SRRA failure probabilities for multiple pipe size segments result in either no difference in the number of examinations or an insignificant impact on the number of examinations for the following reasons:

- Any difference in the number of examinations would not impact the areas involving active degradation mechanisms, but would impact areas where inspection sampling is used to address potential degradation mechanisms.

- Although the input parameters for different cases of the same segment may vary, the parameters that are chosen for each case are the most limiting for that section (or size) of the segment. The failure probability estimates associated with each pipe size for each segment are based on the realistic, limiting inputs associated with that section of piping.

- The WCAP-14572 Revision 1-NP-A methodology uses a relative ranking process in the risk evaluation. The use of overly conservative data could result in other segments being quantitatively LSS, when they could have been quantitatively HSS. Generating the failure probability for each sub-segment ensures that overly conservative SRRA failure probabilities are not calculated. Choosing the highest sub-segment failure probability for the segment ensures that the risk associated with any portion or sub-segment within the segment is reasonable. Additionally, no portion or sub-segment within the segment would be quantitatively LSS, when it could have been quantitatively HSS.

- The WCAP-14572 Revision 1-NP-A methodology requires the use of engineering experience in estimating the failure probability of segments. There may be instances where it may be more appropriate to divide a multiple pipe size segment into separate segments so that the risk categorization can be properly determined. Therefore, in these instances, the segments will have to be split. The potential to divide a multiple pipe size segment is not considered just once, but several times; by the engineering team performing the segment definition, by the engineering team estimating the SRRA failure probabilities, by the engineering team conducting the risk evaluation, and by the expert panel associated with the risk-informed ISI.

- Additional guidance on selecting examination locations in segments with multiple degradation mechanisms is provided in Section 2.3 of this Supplement.

Based on the quantitative evaluation of risk-informed ISI programs from five units, there is no difference in the number of examinations between the two methods. The intent of a risk-informed ISI program is not to identify a specific number of examinations to be included in the program, but rather for the program to address the areas of highest risk. Both methods described in this Supplement for estimating a failure probability of a multiple pipe size segment address this risk and meet the acceptance criteria in WCAP-14572, Revision 1-NP-A Sections 3.7.2 and 4.4.2.

2.3 ADDITIONAL SPECIFIC GUIDANCE ON CALCULATING FAILURE PROBABILITIES FOR MULTIPLE PIPE SIZE SEGMENTS

Based on the discussion provided in Section 2.2, there are two general methods by which the segment failure probability can be estimated for multiple pipe size segments. Both methods will provide valid results for use in the Pressurized Water Reactor Owners Group (PWROG) risk-informed ISI methodology. Both methods also involve some additional considerations that must be taken into account when estimating the failure probability of a multiple pipe size segment.

The first method estimates a failure probability for every pipe size in the segment. In estimating the failure probability for a given pipe size, all the degradation mechanisms for that pipe size are combined onto a single weld (i.e., the most limiting SRRA inputs applicable to that pipe size in the segment should be applied to the SRRA run for that pipe size). Some SRRA input parameters such as nominal pipe size and thickness-to-outer diameter ratio will vary between pipe sizes and in some, but not all cases, other input parameters may vary based upon the conditions for that particular pipe size in the segment. The highest failure probability from the various pipe sizes in the segment is then used to represent the segment failure probability.

The second method places all of the degradation mechanisms for any size in the segment onto a single weld. When calculating the SRRA failure probability, the most limiting SRRA inputs from all the pipe sizes are entered into the SRRA run or runs for that particular segment. The results should be carefully reviewed to ensure that the failure probabilities for multiple pipe size segments are not overly conservative.

- If the results are not overly conservative, the calculated failure probability is used.
- If the results are overly conservative, either the first method is used to estimate the failure probability or the segment is split and a failure probability is estimated for each of these new segments. The process of estimating a failure probability and evaluating the results is repeated until reasonable results are obtained.

If a multiple pipe size segment has two or more degradation mechanisms that occur on different pipe sizes of the segment, combining the degradation mechanisms into a single failure probability can lead to an unrealistic and overly conservative result. One way to determine this is to conduct sensitivity runs where only the degradation mechanism(s) (i.e., SRRA inputs parameters) applicable to a given pipe size are used for that pipe size. If the results for the combined degradation mechanisms at one location are more than an order of magnitude higher that either of the uncombined results, consideration should be given to splitting the segment or using the first method to estimate the failure probability.

Note that regardless of which method is used to determine the failure probability, if a multiple pipe size segment is categorized as HSS, all locations in the segment identified by the engineering subpanel as being affected by or highly susceptible to an active degradation mechanism must be examined. If a segment contains two or more active degradation mechanisms, the structural elements subjected to any one of the active degradation mechanisms must be examined.

There is no need to combine degradation mechanisms between the butt and socket welded portions of piping because the same number of examinations are identified for the butt and socket welded portions of piping; independent of whether the degradation mechanisms are combined or not.

In some cases, a segment, including a multiple pipe size segment, may not be analyzed as being highly susceptible to an active degradation mechanism, but the engineering subpanel may still postulate some potential for an active degradation mechanism. Since the segment does not have an active degradation mechanism, the Perdue Model can be used to determine the number of examination locations. In this situation, the examination location or locations should be based on where the postulated degradation mechanism might occur. If more than one degradation mechanism is postulated on a HSS segment, conduct one or more examinations that would address each of the postulated degradation mechanisms. Note that in some cases, this may result in more examinations relative to what is required by the Perdue Model statistical analysis.

3 EXPERT PANEL CATEGORIZATION OF SEGMENTS AS LOW SAFETY SIGNIFICANT THAT ARE QUANTITATIVELY HIGH SAFETY SIGNIFICANT

3.1 BACKGROUND

This section presents an example of when an expert panel may decide to categorize a segment as LSS that is determined by quantitative methods to be HSS. This example is used to clarify what is considered to be sufficient justification for an expert panel to make such a decision. Both quantitative and deterministic insights are used by the expert panel in determining the safety significance of each segment. In general, if either the quantitative or deterministic insights merit the segment being categorized as HSS, the expert panel should categorize the segment as HSS. The risk metrics of RRW for the CDF and LERF without and with operator action cases are the primary quantitative measures for identifying HSS segments. The operator actions in these cases refer only to those actions to isolate or mitigate piping failures. A segment is considered to be quantitatively HSS if any of the RRWs calculated for the four cases are greater than 1.005.

Expert panels may categorize segments that have been determined by quantitative methods to be HSS as LSS in accordance with Section 3.6.3 of WCAP-14572. However, the expert panel should not categorize segments as low safety significant that have been determined by quantitative methods to be high safety significant without sufficient justification that is documented as part of the risk-informed ISI program. This supplement provides additional guidance on what is considered to be sufficient justification and the documentation for categorization of segments as LSS that are quantitatively HSS.

3.2 DISCUSSION

There are scenarios where some of the RRWs for a segment may be greater than 1.005 while the other RRWs for the segment are lower (i.e., less than 1.005 or even less than 1.001). In some of these instances, the expert panel may conclude that RRWs greater than 1.005 are overly conservative or represent an unrealistic scenario. Where possible, the conservative modeling should be revised and more realistic results should be obtained. Due to probabilistic risk assessment (PRA) model limitations, not all instances can be recalculated with more realistic results. Therefore, with sufficient justification, the expert panel can categorize these segments as LSS. The justification must be adequately documented in a manner such that an independent expert panel would come to the same conclusion.

An example of when the expert panel may consider categorizing a segment as LSS that is quantitatively HSS is associated with the consideration of operator actions. The expert panel may conclude that it is unrealistic that the operators would not take some corrective action to isolate or mitigate the piping failure. For these cases, the expert panel can base the safety significance on the with operator action results. However, in doing so, the expert panel is assuming that the operators will always take the appropriate action to isolate or mitigate the piping failure. The expert panel must consider what actions the operators would take, the indications that would be available to alert the operator to take the appropriate action, and the time available for diagnosis and for the operators to take the actions. The equipment associated with taking the action must be available.

3.3 ADDITIONAL SPECIFIC GUIDANCE ON EXPERT PANEL CATEGORIZATION

The expert panel evaluates the risk-informed results and makes a final decision by identifying the safety significance of each piping segment. As discussed in WCAP-14572 Revision 1-NP-A Section 3.6.3, segments that have been determined by quantitative methods to be HSS (i.e., segments with any RRW > 1.005) typically should be categorized as HSS by the expert panel. The primary focus of the expert panel is to add segments to the higher classification. As part of the process, the expert panel may feedback comments to the appropriate engineering personnel which may result in an adjustment of the numerical results. Adjusted numerical results should be reviewed by the expert panel.

The segments that have been determined by quantitative methods to be HSS should not be classified lower by the expert panel without sufficient justification that is documented as part of the risk-informed ISI program. In these instances, the justification must be documented in a manner such that an independent expert panel would come to the same conclusion. An example of when an expert panel may consider categorizing a segment as LSS that is quantitatively HSS is associated with operator actions where the expert panel concludes that the without operator action results represent an overly conservative or unrealistic scenario. In this situation, the CDF and/or LERF RRWs without operator action are greater than 1.005 while the CDF and LERF RRWs with operator action are less than 1.005 or even less than 1.001.

By categorizing these segments as LSS, the expert panel is basing the safety significance of the segment primarily on the with operator action results, which means that the expert panel is assuming that the operators will always take the appropriate mitigating actions. In doing so, the expert panel must consider the following items:

- The operator actions are proceduralized.
- Indications are available to alert the operators to take the appropriate action.
- There is time available for the operator to diagnose and take the action that results in a success path (i.e., isolating or mitigating the piping failure) prior to the action becoming ineffective to mitigate the piping failure consequences. The equipment associated with taking the action must be available.

To ensure that the justification would reasonably lead an independent expert panel to the same conclusions, the key elements of the justification are documented. This key documentation should include:

- Identification of the procedure that the operators are using.
- Identification of the instrumentation that would alert the operators to take the appropriate actions.
- The estimated time that the operators have to respond to the event.
- If the operator action is modeled in the plant PRA, the results of the importance analysis for a pipe segment after applying human error probabilities (HEPs) developed for operator actions in the internal events PRA for actions that can be used as surrogates for the RI-ISI operator action.

The PWROG risk-informed ISI methodology evaluates four cases for quantitative results - CDF without operator action, CDF with operator action, LERF without operator action and LERF with operator action. In these cases, operator action refers only to those actions taken to isolate or mitigate the consequences of the piping failure. It does not include those actions that are modeled as part of the PRA in response to one of the modeled initiating events. The case without operator action assumes that the operators take no action to isolate or mitigate the piping failure, while the case with operator action assumes that the operators always carry out the correct actions to isolate or mitigate the piping failure. One reason for looking at the extremes of assuming no operator action versus the operator always taking the correct action is to bound the possible impact of operator actions. In some instances, the operator action to isolate or mitigate a piping failure may be included in the plant PRA model that already has a human factors analysis conducted on the operator action. In these instances, the surrogate PRA runs could be made using the human error probabilities in the PRA model for the operator action, instead of assuming that the operator takes no action or always takes the correct action to isolate or mitigate the piping failure. The more realistic piping CDF, LERF and other risk metrics that are obtained can be used as additional justification for the segment being categorized to the lower classification. If human error probabilities are used, document that the risk metrics both without and with operator action for the segment are based on results that include the human error probabilities modeled in the plant PRA model for the operator actions to isolate or mitigate the piping failure.

In all other instances where the expert panel has determined that overly conservative results are obtained, the inputs or assumptions that result in the overly conservative results should be reexamined. If possible, more realistic inputs or assumptions should be developed and the appropriate risk metrics recalculated to determine the segment's quantitative safety significance. If the more realistic results are still HSS, the segment should be categorized as HSS by the expert panel. If the more realistic results are not quantitatively HSS, the expert panel can determine the segment's safety significance in accordance with the normal process. In general, if more realistic results cannot be developed, the segment should be categorized HSS by the expert panel.

This supplement provides additional guidance on an example of when an expert panel may categorize a segment as LSS that is quantitatively HSS. Other scenarios may exist where there may be sufficient justification for an expert panel to categorize a segment as LSS that is quantitatively HSS. Even after considering the above guidance, the expert panel may decide it is appropriate to categorize a segment as LSS that is quantitatively HSS. In these instances, the expert panel should not categorize the segment as LSS without sufficient justification that is documented as part of the process in a manner that would lead an independent expert panel to the same conclusion.

4 EXAMINATION REQUIREMENTS BY DEGRADATION MECHANISM FOR ELEMENTS SELECTED FOR INSPECTION FOR THE RISK-INFORMED ISI PROGRAM

4.1 BACKGROUND

Table 4.1-1 in WCAP-14572 Revision 1-NP-A identifies the requirements for the examination of the HSS piping structural elements selected for inspection. The purpose of this section is to revise Table 4.1-1 to incorporate acquired knowledge and to reflect the examination methods that are actually being conducted by the industry since the issuance of the approved version of the WCAP. Once this supplement is approved, Table 4.1-1 in this Supplement replaces Table 4.1-1 in WCAP-14572 Revision 1-NP-A.

4.2 DISCUSSION

Table 4.1-1 in this supplement replaces the Table 4.1-1 in WCAP-14572 Revision 1-NP-A. There are several changes for Table 4.1-1 that have occurred since it first appeared in WCAP-14572 Rev. 1-NP-A. Experience in the implementation and use of risk-informed ISI has been incorporated in the table contained in this supplement. The changes in the table are consistent with those currently being proposed in a Nonmandatory Appendix to ASME Section XI that contains this table. A summary of the changes to Table 4.1-1 is discussed below.

In the column "Examination Requirement/Fig No.," the references to figures in section IWC of the Code have been removed for both item number R1.11 and R1.12. This change maintains a consistent requirement for all risk-informed inspections regardless of pipe class.

The change to the table for item number R1.12 removes the figure references to branch nozzles and to piping 4" nominal pipe size (NPS) or larger. This change reflects the experience of observing high cycle fatigue damage in small bore piping (both socket and butt welded).

Item number R1.13 eliminates the specific term "wastage" in the Parts Examined column and simplifies the examination method to read Volumetric with reference to Note 7 which is itself a modified Note 9 from the original version. This item used to address internal and external wastage by recommending a volumetric examination for internal wastage and a surface examination for external wastage.

The next change in the table concerns the cracking associated with primary water stress corrosion cracking (PWSCC) observed in recent years. This mechanism is now examined with requirements similar to thermal fatigue. The examination method has changed from a visual to a volumetric examination (socket welds and their associated branch connection welds require only a VT-2 examination). Because the examination is volumetric, the acceptance standard listed in the table also changes from IWB-3142 to IWB-3514 to be consistent with the examination method. The revised table removes a footnote associated with the "Parts Examined" column. The removed note stated "Applies to mill annealed Alloy 600 nozzle welds and heat affected zone (HAZ) without stress relief".

In item number R1.17, the "or Pitting" has been added in the new table to emphasize that microbiologically influenced corrosion (MIC) may also include pitting. The pitting locations may become sites for crack initiation. The Examination Requirement column for this item added Figure numbers IWB-2500-8(a) and -8(b) to include examinations for small bore piping applications.

Two new item numbers are added to the table in this revision. The first is "Elements Subject to External Chloride Stress Corrosion Cracking (ECSCC)". This degradation mechanism has been identified as one of the few that can cause crack initiation on the outside surface of piping. The associated figure numbers that define the examination requirements include the piping welds and the piping branch connection welds common to the other item numbers in the table. Since this is a mechanism that can affect large and small bore lines equally, the surface examination is required for both small and large bore lines.

The second new entry in the table addresses the situation where there are elements that are not subject to a degradation mechanism. This case is looked at the same way that a thermal fatigue case is addressed. These examinations will account for uncertainty and unknown conditions in the segment. The expectation is that no flaws will be found as a result of these examinations, but if something is happening in the segment that is causing a potential issue, then this type of examination will help to identify it.

4.3 ADDITIONAL SPECIFIC GUIDANCE ON EXAMINATION REQUIREMENTS

The HSS piping structural elements selected for inspection should be examined in accordance with the requirements of Table 4.1-1 for the areas and/or volumes of concern. Table 4.1-1 in this supplement replaces Table 4.1-1 in WCAP-14572 Revision 1-NP-A.

Table 4.1-1 Examination Category R-A, Risk-Informed Piping Examinations

					Extent and Frequency [Note (3)]		
Item No.	Parts Examined	Examination Requirement/ Fig. No. [Note (2)]	Examination Method	Acceptance Standard	1st Interval	Successive Intervals	Defer to End of Interval
R1.10	High Safety Significant Piping Structural Elements						
R1.11	Elements Subject to Thermal Fatigue	IWB-2500-8(c) [Note (1)] IWB-2500-9, 10, 11	Volumetric [Notes (8), (9)]	IWB-3514	Element [Notes (2), (4)]	Same as 1st	Not Permissible
R1.12	Elements Subject to High Cycle Mechanical Fatigue	IWB-2500-8(a) and (b)	Visual, VT-2 [Notes (8), (9)]	IWB-3142	Each Refueling	Same as 1st	Not Permissible
R1.13	Elements Subject to Erosion Cavitation	[Note (6)]	Volumetric [Note (7)]	IWB-3514 [Note (6)]	Element [Note (2)]	Same as 1st	Not Permissible
R1.14	Elements Subject to Crevice Corrosion Cracking	[Note (5)]	Volumetric [Notes (8), (9)]	IWB-3514	Element [Note (2)]	Same as 1st	Not Permissible
R1.15	Elements Subject to Primary Water Stress Corrosion Cracking (PWSCC)	IWB-2500-8(c) [Note (1)] IWB-2500-9, 10, 11	Volumetric [Notes (8), (9)]	IWB-3514	Element [Note (2), (4)]	Same as 1st	Not Permissible
R1.16	Elements Subject to Intergranular or Transgranular Stress Corrosion Cracking (IGSCC or TGSCC)	IWB-2500-8(c) [Note (1)] IWB-2500-9, 10, 11	Volumetric [Notes (7), (8), (9)]	IWB-3514	Element [Note (2), (4)]	Same as 1st	Not Permissible
R1.17	Elements Subject to localized Microbiologically Influenced Corrosion (MIC) or Pitting	IWB-2500-8(a), IWB-2500-8(b), IWB-2500-8(c), IWB-2500-9, 10, 11	Visual, VT-3 Internal Surfaces or Volumetric [Note (6) or (7)]	[Note (6)]	Element [Note (2)]	Same as 1st	Not Permissible
R1.18	Elements Subject to Flow Accelerated Corrosion (FAC)	[Note (7)]	[Note (7)]	[Note (7)]	[Note (7)]	[Note (7)]	[Note (7)]
R1.19	Elements Subject to External Chloride Stress Corrosion Cracking (ECSCC)	IWB-2500-8(a), IWB-2500-8(b), IWB-2500-8(c), IWB-2500-9, 10, 11	Surface	IWB-3514	Element [Note (2)]	Same as 1st	Not Permissible

Table 4.1-1 Examination Category R-A, Risk-Informed Piping Examinations (cont.)

Item No.	Parts Examined	Examination Requirement/ Fig. No. [Note (2)]	Examination Method	Acceptance Standard	Extent and Frequency [Note (3)] 1st Interval	Successive Intervals	Defer to End of Interval
R1.20	Elements not Subject to a Degradation Mechanism	IWB-2500-8(c) [Note (1)] IWB-2500-9, 10, 11	Volumetric [Notes (8), (9)]	IWB-3514	Element [Notes (2), (4)]	Same as 1st	Not Permissible

NOTES:

1. The length of the examination volume shown in Figure IWB-2500-8(c) shall be increased by enough distance [approximately ½ in. (13mm)] to include each side of the base metal thickness transition or counterbore.
2. Includes examination locations and Class 1 weld examination requirement figures that typically apply to Class 1, 2, 3, or Non-Class welds identified in accordance with the risk-informed selection process described in WCAP-14572, Revision 1-NP-A.
3. Includes 100% of the examination location. When the required examination volume or area cannot be examined, due to interference by another component or part geometry, limited examinations shall be evaluated for acceptability. Acceptance of limited examinations or volumes shall not invalidate the results of the risk-informed evaluation. Areas with acceptable limited examinations, and their bases, shall be documented.
4. The examination shall include any longitudinal welds at the location selected for examination in [Note 2]. The longitudinal weld examination requirements shall be met for both transverse and parallel flaws within the examination volume defined in [Note 2] for the intersecting circumferential welds.
5. The examination volume shall include the volume surrounding the weld, weld HAZ, and base metal, as applicable, in the crevice region. Examination should focus on detection of cracks initiating and propagating from the inner surface.
6. The examination volume shall include base metal, welds, and weld HAZ in the affected regions of carbon and low alloy steel, and the welds and weld HAZ of austenitic steel. Examinations shall verify the minimum wall thickness required. Acceptance criteria for localized thinning are in course of preparation. The examination method and examination region shall be sufficient to characterize the extent of the element degradation.
7. In accordance with the Owner's existing programs such as IGSCC, MIC, or FAC programs as applicable.
8. Socket welds of any size and branch pipe connection welds NPS 2 (DN 50) and smaller, require only VT-2 visual examination.
9. VT-2 visual examinations shall be conducted during a system pressure test or a pressure test specific to that element or segment, in accordance with IWA-5000, IWB-5000, IWC-5000, or IWD-5000, as applicable, and shall be performed during each refueling outage or at a frequency consistent with the time (e.g., 18 to 24 months) between refueling outages.

5 SUMMARY AND CONCLUSIONS

This Supplement to WCAP-14572 Revision 1-NP-A provides clarifications of the methodology described in WCAP-14572 Revision 1-NP-A. Specifically, the Supplement addresses:

- How failure probabilities are estimated for multiple pipe size segments,
- The expert panel decision process for categorizing a segment as LSS that is quantitatively HSS, and
- The requirements for examination based on the postulated failure modes and configuration of each piping structural element.

The Supplement provides methods for estimating the failure probability for multiple pipe size segments that result in the same number of examinations or a negligibly small difference in the number of examinations that has an insignificant impact using either method. The Supplement also provides additional guidance to an expert panel to categorize a segment as LSS that is quantitatively HSS.

Additionally, this Supplement updates Table 4.1-1 from WCAP-14572 Revision 1-NP-A to incorporate acquired knowledge and to reflect the examination methods that are actually being conducted by the industry since the issuance of the approved version of the WCAP.

6 REFERENCES

1. Westinghouse Electric Company, WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," February 1999.

2. Westinghouse Electric Company, WCAP-14572, Revision 1-NP-A, Supplement 1, "Westinghouse Structural Reliability and Risk Assessment (SRRA) Model for Piping Risk-Informed Inservice Inspection," February 1999.

3. United States Nuclear Regulatory Commission, Letter from Thomas H. Essig, USNRC to Lou Liberatori, Chairman, Westinghouse Owners Group, "Safety Evaluation of Topical Report WCAP-14572, Revision 1, 'Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report,'" December 15, 1998.

4. Letter WOG-03-218 from Robert Bryan, Jr., Chairman, Westinghouse Owners Group to Samuel J. Collins, Director, Office of Nuclear Reactor Regulation, USNRC, NRC Requests for Additional Information (RAIs) Associated with Plant Specific Applications of the Methodology in WCAP-14572-NP-A, Rev. 1, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report, " dated April 21, 2003.

5. United States Nuclear Regulatory Commission, Regulatory Guide 1.178, "An Approach for Plant-Specific, Risk-Informed Decision Making for Inservice Inspection of Piping," Revision 1, September 2003.

6. United States Nuclear Regulatory Commission, Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Revision 1, November 2002.

APPENDIX A
PLANT-SPECIFIC EXAMPLES FOR CALCULATION OF FAILURE PROBABILITIES FOR MULTIPLE PIPE SIZE SEGMENTS

Appendix A is provided for informational purposes only. The analyses described in this Appendix do not represent additional requirements for conducting a risk-informed ISI program.

As discussed in Section 2, there is a potential for a difference in the absolute number of examinations between the two methods for calculating SRRA failure probabilities for multiple pipe size segments. The two methods are (1) calculating a failure probability for each pipe size by using the most limiting SRRA inputs from that pipe size and then using the highest failure probability to represent the multiple pipe size segment and (2) calculating a failure probability using the most limiting SRRA inputs from all the sizes in a multiple pipe size segment. To demonstrate that there is no difference in the number of examinations or that any difference in the number of examinations would be insignificant, several risk-informed ISI programs are evaluated for potential differences. The evaluation of the licensee's risk-informed ISI programs focused on the two areas where a potential difference using the two different methods might occur:

- If the segment is categorized as HSS, there may be more examinations if the segment is split since a minimum of one examination is conducted for each HSS segment.
- If the segment is categorized as LSS and each pipe size contained an ASME Section XI examination, the change-in-risk criteria in WCAP-14572 Revision 1-NP-A may not be met. If this situation occurred, additional change-in-risk examinations may be needed to meet the change-in-risk criteria.

Below is a summary of the process that is used to evaluate a licensee's risk-informed ISI program to identify if there would be any potential difference in the number of examinations.

- All multiple pipe size segments are identified.
- The categorization as HSS or LSS of each multiple pipe size segment is identified.
- All the SRRA runs for the HSS multiple pipe size segments are reviewed to determine their applicability. SRRA runs for input to the Perdue Model and use in sensitivity runs are excluded from further review, since these SRRA runs intentionally include variations in the SRRA inputs that have no effect on the categorization of segments as HSS or LSS or any effect on the change-in-risk evaluation.
- Each applicable SRRA run for a HSS multiple pipe size segment is reviewed and the SRRA inputs compared to determine what, if any, differences exist.
- A "process of elimination" is applied based on the following questions to eliminate a HSS multiple pipe size segment from further review by identifying a condition for the segment that would result in no difference in the number of examinations.

- Are the only differences in the SRRA inputs associated with the physical pipe dimensions (i.e., the nominal pipe size and / or the thickness-to-outside diameter ratio)?

- Is the segment comprised of only socket welded piping?

- Is the segment comprised of butt and socket welded piping, and the only difference in the SRRA inputs is between the butt and socket welded portions of the multiple pipe size segment?

- If the HSS multiple pipe size segment is split into multiple segments and the failure probabilities from each pipe size are used to represent their respective pipe size segments, is only one of the segments split by pipe size categorized as HSS?

If the answer to any of the above is "yes," the segment can be eliminated from further consideration. For each HSS multiple pipe size segment that is not eliminated based on the above questions, new SRRA failure probabilities are calculated using the most limiting SRRA inputs from all of the pipe sizes in the segment. The process of elimination is then continued based on the following questions.

- Would the SRRA failure probability used to represent the multiple pipe size segment be the same when comparing the new SRRA failure probabilities against the original failure probabilities used to represent the segment?

- If there is an increase in the failure probability that would be used to represent the multiple pipe size segment, is the new failure probability used to represent the segment not overly conservative? If the sum of the failure probabilities that would be used for the individual pipe sizes is approximately the same as the failure probability for the segment using the most limiting SRRA inputs from all of the pipe sizes in the segment, the failure probability is considered to be not overly conservative.

If the answer to either of the above is "yes," the segment can be eliminated from further consideration.

- If a HSS multiple pipe size segment is not "eliminated" from further evaluation (i.e., shown to have no difference in the number of examinations) based on the above questions, the segment is assumed to be split and the number of examinations on the segments split by size is estimated to identify the potential difference in the number of examinations.

- All LSS multiple pipe size segments that contain an ASME Section XI examination on more than one pipe size are identified.

- If none of the LSS multiple pipe size segments contain more than one ASME Section XI examination, then there would be no change to the change-in-risk evaluation. The change-in-risk criteria would still be met, and there would be no difference in the number of examinations based on the LSS piping.

- If more than one size on a LSS multiple pipe size segment contains an ASME Section XI examination, the LSS multiple pipe size segment is assumed to be split based on the number of pipe sizes which contain an ASME Section XI examination. Splitting LSS multiple pipe size segments is conservatively performed by multiplying the segment CDF and LERF by the number of pipe sizes that contain an ASME Section XI examination.

- The change-in-risk results are then reevaluated against the change-in-risk criteria. If the change-in-risk criteria are met, there is no difference in the number of examinations based on the LSS multiple pipe size segments.

- If the change-in-risk criteria are not met, some of the conservatisms are removed. LSS multiple pipe size segments that contain an ASME Section XI examination on more than one pipe size, where the only differences in the SRRA inputs are due to the physical pipe dimensions, are not split into separate segments. Additionally, for those segments that are split, more accurate piping CDF and LERF values are calculated for each pipe size by using the failure probability for each pipe size, rather than using the values from the most limiting pipe size to represent all pipe sizes in the segment.

- The change-in-risk results are then reevaluated against the change-in-risk criteria. If the change-in-risk criteria are met, there is no difference in the number of examinations based on the LSS multiple pipe size segments.

- If the change-in-risk criteria are not met, additional examinations are identified until the change-in-risk criteria are met. Any additional examinations would represent a difference in the number of examinations.

Five risk-informed ISI programs are evaluated to demonstrate that using either method to calculate the failure probability for multiple pipe size segments results in no difference in the number of examinations or a negligibly small difference in the number of examinations that has an insignificant impact. These units represent one full scope and four Class 1 and Class 2 applications. The following sections in this Appendix provide more details on the evaluations performed on these risk-informed ISI programs.

Of these five units evaluated, there is no difference in the number of examinations based on the two methods.

A.1 UNIT A

Unit A risk-informed ISI program is a full scope program. Unit A has 263 multiple pipe size segments. Forty five of these multiple pipe size segments are HSS and the remaining 218 multiple pipe size segments are LSS. An evaluation of the HSS multiple pipe size segments showed no difference in the number of examinations. Table A.1-1 presents, on a segment basis, the differences in the SRRA inputs, the potential difference in the number of examinations, and the basis for the evaluation of the HSS multiple pipe size segments.

There are five LSS multiple pipe size segments at unit A that contain an ASME Section XI examination on the segment. It is conservatively assumed that each of these segments contains an ASME Section XI examination of each of the pipe sizes. The change-in-risk is reevaluated and the change-in-risk criteria are still met for all four cases of CDF and LERF without and with operator action. Thus, there is no difference in the number of examinations for the LSS multiple pipe size segments.

Overall there is no difference in the number of examinations at unit A for both the HSS and LSS multiple pipe size segments.

Table A.1-1 Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations			
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
AFW-010	– Normal operating pressure (1.2 versus 1.22 [ksi]) – Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – DW & thermal stress (0.05 versus 0.11) – Design limiting stress 0.1 versus 0.26)	0	The differences in the SRRA inputs for initial flaw condition, DW & thermal stress and design limiting stress are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences. The original controlling failure probabilities without ISI for the 3" portion of the segment with a 1.2 ksi normal operating pressure for the small leak, large leak and full break are: • 4.82E-05, 6.36E-06, and 5.81E-06. The revised controlling failure probabilities without ISI for the 3" portion of the segment assuming a 1.22 ksi normal operation pressure for the small leak, large leak and full break are: • 4.82E-05, 6.40E-06, and 5.81E-06. The original and revised failure probabilities for the 3" portion of the segment are approximately the same. Thus there is no difference in the number of examinations.
AFW-012	– Temperature at pipe weld (100 versus 120 [°F]) – Normal operating pressure (0.85 versus 1.2 versus 1.22 [ksi]) – Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – DW & thermal stress (0.05 versus 0.11) – Vibratory Stress Range (0.001 versus 0.75 [ksi]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs for initial flaw condition, DW & thermal stress and design limiting stress are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences. The original failure probabilities for various combinations of 0.85, 1.20 and 1.22 ksi normal operating pressures, 100 and 120°F temperatures at pipe weld and 0.001 and 0.75 vibratory stress ranges without ISI for the small leak, large leak and full break are: • 4" portion - 2.54E-04, 8.89E-07, 1.88E-07 • 6" portion - 2.57E-05, 2.25E-06, 6.78E-07 The revised failure probabilities assuming a 1.22 ksi normal operating pressure, a 120 °F temperature at pipe weld and a 0.75 vibratory stress range without ISI for the small leak, large leak and full break are: • 4" portion - 2.42E-04, 1.35E-05, 2.44E-05 • 6" portion - 2.57E-05, 2.25E-06, 6.78E-07

Table A.1-1 (cont.) Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations

Segment	Different SRRA Inputs Between the Pipe Sizes (1), (2)	Potential Difference in Examinations	Basis
			The failure probabilities for the 6" portion of piping remained the same. The failure probabilities for the small leak on the 4" portion also remained approximately the same. Although the large leak and full break failure probabilities for the 4" portion did increase, they remained below the controlling failure probabilities for the segment, which are based on the socket welded piping. Thus there is no difference in the number of examinations.
AFW-016	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – DW & thermal stress (0.11 versus 0.17) – Material wastage potential (0.001 versus 1) – Design limiting stress (0.1 versus 0.26)	0	Water hammer has been modeled for each of the pipe sizes in this segment. The design limiting stress was changed to reflect the water hammer. The same design limiting stress was used for water hammer for each pipe size thus there is no difference in the design limiting stress between the pipe sizes in this segment for the water hammer cases. The other differences in the SRRA inputs initial flaw condition, DW & thermal stress, material wastage potential and design limiting stress for the base cases (no water hammer) are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
AFW-018	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – DW & thermal stress (0.11 versus 0.17) – Material wastage potential (0.001 versus 1) – Design limiting stress (0.1 versus 0.26)	0	Water hammer has been modeled for each of the pipe sizes in this segment. The design limiting stress was changed to reflect the water hammer. The same design limiting stress was used for water hammer for each pipe size thus there is no difference in the design limiting stress between the pipe sizes in this segment for the water hammer cases. The other differences in the SRRA inputs initial flaw condition, DW & thermal stress, material wastage potential and design limiting stress for the base cases (no water hammer) are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
BLD-003	– DW & thermal stress (0.11 versus 0.17) – Material wastage potential (0.001 versus 0.05) – Vibratory stress range (0.05 versus 0.1 [ksi]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.

Table A.1-1 (cont.) Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations

Segment	Different SRRA Inputs Between the Pipe Sizes (1), (2)	Potential Difference in Examinations	Basis
BLD-004	– Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
BLD-005A		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
BLD-006A		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CDS-013	– Material wastage potential (0.05 versus 0.1)	0	Water hammer has been modeled for each of the pipe sizes in this segment. The design limiting stress was changed to reflect the water hammer. The same design limiting stress was used for water hammer for each pipe size thus there is no difference in the design limiting stress between the pipe sizes in this segment. The original controlling failure probabilities without ISI for the small leak, large leak and full break are: • 8" portion with a 0.05 material wastage potential - 2.22E-03, 2.32E-03, 2.32E-03 • 12" portion with a 0.1 material wastage potential - 4.40E-03, 4.40E-03, 4.40E-03 The revised failure probabilities without ISI for the 8" portion assuming a 0.1 material wastage potential for the small leak, large leak and full break are: • 7.10E-03, 7.10E-03, 7.1E-03 Although the controlling failure probabilities for the segment increased from 4.4E-03 to 7.1E-03, the 7.1E-03 failure probability is not overly conservative. The impact on other segment RRWs would be insignificant. Note that the only difference in the SRRA inputs is the material wastage potential, which is an active degradation mechanism covered by an augmented program. Since 100% of the elements subjected to an active degradation mechanism are examined and the only difference in the SRRA inputs is associated with an active degradation mechanism, there is no difference in the number of examinations.

Table A.1-1 (cont.) Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations			
Segment	Different SRRA Inputs Between the Pipe Sizes (1), (2)	Potential Difference in Examinations	Basis
CSW-004		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CSW-005A	– Temperature at pipe weld (80 versus 103 [°F])	0	The original controlling failure probabilities without ISI for the JB-1 24" portion of the segment with a 80°F temperature at pipe weld for the small leak and large leak are: • 9.29E-04 and 1.30E-04. The revised controlling failure probabilities without ISI for the JB-1 24" portion of the segment assuming a 103°F temperature at pipe weld for the small leak and large leak are: • 9.29E-04 and 1.30E-04. The original and revised failure probabilities for the JB-1 24" portion of the segment are the same. Thus there is no difference in the number of examinations.
CSW-006A	– Temperature at pipe weld (80 versus 103 [°F])	0	The original controlling failure probabilities without ISI for the JB-1 24" portion of the segment with a 80°F temperature at pipe weld for the small leak and large leak are: • 9.29E-04 and 1.30E-04. The revised controlling failure probabilities without ISI for the JB-1 24" portion of the segment assuming a 103°F temperature at pipe weld for the small leak and large leak are: • 9.29E-04 and 1.30E-04. The original and revised failure probabilities for the JB-1 24" portion of the segment are the same. Thus there is no difference in the number of examinations.
CSW-007		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CSW-008		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.

Table A.1-1 (cont.) Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations

Segment	Different SRRA Inputs Between the Pipe Sizes (1), (2)	Potential Difference in Examinations	Basis
CSW-016		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CSW-017		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
FPS-021		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
HED-003		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
HED-005	– Crack inspection accuracy (0.24 versus 0.32) – Temperature at pipe weld (445 versus 455 [°F])	0	The difference in crack inspection accuracy only affects the with ISI failure probabilities. Since there is no augmented program on this segment, the without ISI failure probabilities are used for the risk evaluation. Therefore there is no impact on the number of examinations from a difference in the crack inspection accuracy. The original controlling failure probabilities without ISI for the 8" portion of the segment with a 445°F temperature at pipe weld for the large leak and full break leak are: • 1.06E-01 and 1.06E-01. The revised controlling failure probabilities without ISI for the 8" portion of the segment assuming a 455°F temperature at pipe weld for the large leak and full break are: • 1.06E-01 and 1.06E-01. The original and revised failure probabilities for the 8" portion of the segment are the same. Thus there is no difference in the number of examinations.
MSS-027		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.

Table A.1-1 (cont.)	Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
MSS-036		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
MSS-041		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
MSS-072		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
MSS-073		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
MSS-075		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
NSW-001		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
NSW-004		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
NSW-005	– Temperature at pipe weld (80 versus 90 [°F]) – Normal operating pressure (0.04 versus 0.09 versus 0.125 [ksi]) – DW & thermal stress (0.05 versus 0.11) – Design limiting stress (0.1 versus 0.26)	0	The differences in the DW & thermal stress and design limiting stress are associated with butt welded piping versus socket welded piping. The original controlling failure probabilities without ISI for the large leak are: • 3" portion with a 80°F temperature at pipe weld and a 0.125 ksi normal operating pressure – 3.76E-03 • 3" portion with a 90°F temperature at pipe weld and a 0.09 ksi normal operating pressure – 3.76E-03 • 4" portion with a 80°F temperature at pipe weld and a 0.125 ksi normal operating pressure – 3.40E-03 • 4" portion with a 90°F temperature at pipe weld and a 0.04 ksi normal operating pressure – 3.40E-03

Table A.1-1 (cont.) Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations

Segment	Different SRRA Inputs Between the Pipe Sizes [(1), (2)]	Potential Difference in Examinations	Basis
			• 6" portion with a 80°F temperature at pipe weld and a 0.125 ksi normal operating pressure – 1.22E-03 • 6" portion with a 90°F temperature at pipe weld and a 0.04 ksi normal operating pressure – 1.22E-03 • 6" portion with a 90°F temperature at pipe weld and a 0.09 ksi normal operating pressure - 1.22E-03 The revised controlling failure probabilities without ISI for the 3", 4" and 6" portions of the segment assuming a 90°F temperature at pipe weld and a 0.125 ksi normal operating pressure for the large leak are: • 3.76E-03, 3.40E-03, and 1.22E-03. The original and revised failure probabilities for the 3", 4" and 6" portions of the segment are the same. Thus there is no difference in the number of examinations.
NSW-010A		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
NSW-010C	– Temperature at pipe weld (103 versus 108 [°F])	0	The original controlling failure probability without ISI for the 6" portion of the segment with a 103°F temperature at pipe weld for the large leak is • 1.20E-03. The revised controlling failure probability without ISI for the 6" portion of the segment assuming a 108°F temperature at pipe weld for the large leak is • 1.20E-03. The original and revised failure probabilities for the 6" portion of the segment are the same. Thus there is no difference in the number of examinations.
PCS-022B		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.

Table A.1-1 (cont.) Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations

Segment	Different SRRA Inputs Between the Pipe Sizes (1), (2)	Potential Difference in Examinations	Basis
PCS-023	– Fatigue stress range (0.3 versus 0.5) – Low cycle fatigue frequency (5 versus 10 [cycles/year])	0	This segment is comprised of socket welded piping. Therefore there is no impact on the number of examinations.
PZR-014A	– Type of material (304 versus 316 stainless) – Temperature at pipe weld (549 versus 589 [°F]) – Normal operating pressure (2.060 versus 2.085 [ksi])	0	This segment is comprised of socket welded piping. Therefore there is no impact on the number of examinations.
SDC-002B2		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
SDC-005	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The original failure probabilities without ISI for the small leak and large leak are: • 2.5" portion with a 0.26 design limiting stress and no X-Ray - 5.13E-03 and 2.11E-03 • 3" portion with a 0.26 design limiting stress and no X-Ray - 4.51E-03 and 2.24E-03 • 8" portion with a 0.1 design limiting stress and with X-Ray - 2.08E-05 and 1.89E-05 • 10" portion with a 0.1 design limiting stress and with X-Ray - 2.15E-04 and 1.87E-05 The revised failure probabilities without ISI assuming a 0.26 design limiting stress and no X-Ray for small leak and large leak are: • 8" portion - 1.90E-04 and 2.38E-04 • 10" portion - 1.40E-03 and 2.84E-04 Although the failure probabilities for the 8" and 10" portions of the segment increased for those portions of the segment, the small leak failure probabilities remained less than the 2.5" and 3" portions and the large leak failure probabilities

Table A.1-1 (cont.)	Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes [(1), (2)]**	**Potential Difference in Examinations**	**Basis**
			increased to be the approximately the same as the 2.5" and 3" portions. Thus there is no difference in the number of examinations.
SDC-006	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The original failure probabilities without ISI for the small leak and large leak are: • 2.5" portion with a 0.26 design limiting stress and no X-Ray - 5.13E-03 and 2.11E-03 • 3" portion with a 0.26 design limiting stress and no X-Ray - 4.51E-03 and 2.24E-03 • 8" portion with a 0.1 design limiting stress and with X-Ray - 2.08E-05 and 1.89E-05 • 10" portion with a 0.1 design limiting stress and with X-Ray - 2.15E-04 and 1.87E-05 The revised failure probabilities without ISI assuming a 0.26 design limiting stress and no X-Ray for small leak and large leak are: • 8" portion - 1.90E-04 and 2.38E-04 • 10" portion - 1.40E-03 and 2.84E-04 Although the failure probabilities for the 8" and 10" portions of the segment increased for those portions of the segment, the small leak failure probabilities remained less than the 2.5" and 3" portions and the large leak failure probabilities increased to be the approximately the same as the 2.5" and 3" portions. Thus there is no difference in the number of examinations.
SDC-007A2	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.

Table A.1-1 (cont.) Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations

Segment	Different SRRA Inputs Between the Pipe Sizes (1), (2)	Potential Difference in Examinations	Basis
SDC-009	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
SDC-011A1		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
SDC-011A2	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
SDC-011A3	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
SDC-012A2	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
SDC-012A3	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.

Table A.1-1 (cont.)	Evaluation of Unit A HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
SSS-007	– Normal operating pressure (0.047 versus 0.125 [ksi]) – Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE]) – Design limiting stress (0.1 versus 0.26)	0	The differences in the design limiting stress are associated with butt welded piping versus socket welded piping. The original failure probabilities without ISI for large leak are: • 3" portion with a 0.047 ksi normal operation pressure and no X-Ray - 3.30E-07 • 4" portion with a 0.047 ksi normal operating pressure and no X-Ray - 4.22E-07 • 6" portion with a 0.125 ksi normal operating pressure and with X-Ray - 6.68E-08 The revised failure probabilities without ISI assuming a 0.125 ksi normal operating pressure and no X-Ray for large leak are: • 3" portion – 3.30E-07 • 4" portion – 4.3E-07 • 6" portion – 6.05E-07 The failure probabilities for the 3" and 4" portions of the segment remained approximately the same. Although the failure probability for the 6" portion of the segment increased, the failure probability remained less than the controlling failure probability for the segment which is based on the socket welded piping. Thus there is no difference in the number of examinations.
SSS-009		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.

Notes:

1. Nominal pipe size and thickness-to-outside diameter ratio differences are not listed in Table A.1-1.
2. If no units are identified the value is dimensionless.

A.2 UNIT B

Unit B risk-informed ISI program is a Class 1 and Class 2 program. Unit B has a 156 multiple pipe size segments. Twenty nine of these multiple pipe size segments are HSS and the remaining 127 multiple pipe size segments are LSS. The original evaluation of the HSS multiple pipe size segments showed a potential difference of one examination. Further evaluation of the HSS multiple pipe size segments showed no difference in the number of examinations. Table A.2-1 presents, on a segment basis, the differences in the SRRA inputs, the potential difference in the number of examinations and the basis for the evaluation of the HSS multiple pipe size segments.

At unit B, there are no multiple pipe size segments that contain an ASME Section XI examination on more than one pipe size; therefore, there is no difference in the number of examinations for the LSS multiple pipe size segments.

Overall there is no difference in the number of examinations at unit B for both HSS and LSS multiple pipe size segments.

Table A.2-1	Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes [(1), (2)]**	**Potential Difference in Examinations**	**Basis**
CH-004		0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations.
CH-016 CH-017 CH-018		0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations.
CH-026		0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations.
CH-050A	– Vibratory stress range (0.001 versus 1.0 [ksi])	0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. This segment is comprised of socket welded piping. Therefore there is no impact on the number of examinations.

Table A.2-1 (cont.)	Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
CH-095 CH-096 CH-097		0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations.
CH-102 CH-103 CH-104		0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations.
MS-026	– Design limiting stress (0.1 versus 0.18 for base cases)	0	Design limiting stress is not normally a significant factor in determining the failure probability unless full break is controlling. MS-026 is included in an augmented program; therefore, the failure probabilities with ISI are used for this segment in the risk evaluation. The original failure probabilities with ISI for disabling leak rates of 2gpm and 0gpm (full break) are: • 3" portion with a 0.1 design limiting stress - 2.92E-08 and 2.19E-08 • 4" portion with a 0.18 design limiting stress - 2.43E-08 and 1.65E-08 Note that these controlling failure probabilities are not based on the base cases but instead are based on the snubber not locking cases, which used the same design limiting stress for the 3" and 4" portions of the segment.

Table A.2-1 (cont.) Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations			
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
			The revised failure probabilities with ISI on the 3" portion of the segment with a design limiting stress value of 0.18 for the base cases for disabling leak rates of 2gpm and 0gpm (full break) are: • 1.17E-08 and 9.88E-09. Note that although these new base case failure probabilities for the 3" portion of the piping increased from the original 3" base case failure probabilities of 4.46E-09 and 6.60E-11, the controlling failure probabilities for this segment remains the same. Thus there is no effect on the number of examinations.
RC-004 RC-005 RC-006		0	The fatigue stress range contains two different values (0.3 and 0.5). All cases (SRRA runs) between the sizes contain the same fatigue stress range. Thus there is no difference in the fatigue stress range. The design limiting stress contains two different values (0.26 and 0.42). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations.
RC-067	– Stress corrosion potential (0.001 versus 0.003)	0	The fatigue stress range contains two different values (0.3 and 0.7). All cases (SRRA runs) between the sizes contain the same fatigue stress range. Thus there is no difference in the fatigue stress range. The design limiting stress contains two different values (0.15 and 0.42). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak.

Table A.2-1 (cont.)	Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
			The original controlling failure probabilities without ISI for disabling leak rates of 2gpm, 100gpm, 1500gpm and 0gpm (full break) are: • 3" portion with a 0.001 stress corrosion potential - 1.22E-06, 9.69E-07, 7.72E-07, and 7.72E-07 • 6" portion with a 0.003 stress corrosion potential – 6.32E-07, 5.21E-07, 4.97E-07, and 4.86E-07 The revised controlling failure probabilities without ISI for the 3" portion of the segment assuming a 0.003 stress corrosion potential for disabling leak rates of 2gpm, 100gpm, 1500gpm and 0gpm (full break) are: • 1.23E-06, 9.38E-07, 7.59E-07, and 7.59E-07. The revised controlling failure probabilities are approximately the same as the revised failure probabilities. Thus there is no difference in the number of examinations.
RH-004		0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations.
RH-005 RH-006	– Vibratory stress range (1.0 versus 1.5 [ksi])	0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The original controlling failure probabilities without ISI for disabling leak rates of 2gpm, 28gpm, and 0gpm (full break) are:

Table A.2-1 (cont.)	Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
			• 8" portion with a 1.5 vibratory stress range - 1.27E-05, 9.07E-06, and 9.45E-06 • 10" portion with a 1.0 vibratory stress range – 9.27E-06, 5.73E-06, and 4.60E-06 The revised controlling probabilities without ISI on the 10" portion assuming a 1.5 vibratory stress range for disabling leak rates of 2gpm, 28gpm, and 0gpm (full break) are: • 9.29E-06, 5.78E-06, and 4.66E-06. The revised controlling failure probabilities for the 10" portion of the segment are approximately the same. In addition, the 8" failure probabilities are still the controlling failure probabilities for the segment. Therefore there is no difference in the number of examinations.
RH-028		0	The fatigue stress range contains two different values (0.3 and 0.7). All cases (SRRA runs) between the sizes contain the same fatigue stress range. Thus there is no difference in the fatigue stress range. The design limiting stress contains two different values (0.1 and 0.42). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations.
RS-009 RS-030 RS-031	– Temperature at pipe weld (210 versus 215 [°F]) – Normal operating pressure (0.065 versus 0.120 [ksi])	0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak.

Table A.2-1 (cont.) Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations

Segment	Different SRRA Inputs Between the Pipe Sizes (1), (2)	Potential Difference in Examinations	Basis
			The original controlling failure probabilities without ISI for disabling leak rates of 2gpm and 193gpm are: • 8" portion with a 215°F temperature at pipe weld and a 0.065 ksi normal operating pressure –1.21E-05 and 5.05E-06 • 12" portion with a 210°F temperature at pipe weld and a 0.120 ksi normal operating pressure – 2.10E-05 and 1.52E-05 The revised controlling failure probabilities without ISI assuming a 215°F temperature at pipe weld and 0.120 ksi normal operating pressure for disabling leak rates of 2gpm and 193gpm are: • 8" portion – 1.38E-05 and 9.31E-06 • 12" portion – 2.05E-05 and 1.46E-05 Although there is an increase in the failure probabilities without ISI in the 8" portion of the segment for a disabling leak rate of 193gpm, the remaining controlling failure probabilities are approximately the same. Additionally the overall controlling failure probabilities for the segment are associated with the 12" portion and are approximately the same. Therefore there is no difference in the number of examinations.
RS-010	– Temperature at pipe weld (210 versus 215 [°F]) – Normal operating pressure (0.065 versus 0.120 [ksi]) – Fatigue stress range (0.3 versus 0.7 for snubber locking cases) – Design limiting stress (0.26 with a probability of 0.001 [in any one year] versus 0.42 with a probability of 0.0000025 [in any one year] for	0	The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The original controlling failure probabilities without ISI for disabling leak rates of 2gpm and 193gpm are: • 8" portion with a 215°F temperature at pipe weld, a 0.065 ksi normal operating pressure, and a 0.26 design limiting stress with a probability of 0.001 in any one year for snubber not locking cases (note no snubber locking cases were run) – 1.21E-05 and 5.05E-06 • 12" portion with a 210°F temperature at pipe weld, a 0.120 ksi normal operating pressure, a 0.7 fatigue stress range for snubber locking cases and a 0.42 design limiting stress with a probability of 0.0000025 in any one year for snubber not locking cases - 8.34E-05 and 6.82E-05

Table A.2-1 (cont.)	Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes [1], [2]**	**Potential Difference in Examinations**	**Basis**
	snubber not locking cases)		The revised controlling failure probabilities without ISI assuming a 215°F temperature at pipe weld, a 0.120 ksi normal operating pressure, a 0.7 fatigue stress range for snubber locking cases, a 0.26 design limiting stress with a probability of 0.001 in any one year for the first set of snubber not locking cases and a 0.42 design limiting stress with a probability of 0.0000025 in any one year for the second set of snubber not locking cases for disabling leak rates of 2gpm and 193gpm are: • 8" portion – 3.61E-05 and 4.45E-05 • 12" portion – 8.07E-05 and 7.00E-05 Although the controlling failure probabilities for the 8" portion did increase, the overall controlling failure probabilities for the segment are associated with the 12" portion, which remained approximately the same. Therefore there is no difference in the number of examinations.
RS-032 RS-033	– Fatigue stress range (0.3 versus 0.7) – Design limiting stress (.26 with a probability of 0.0001 [in any one year] versus 0.42 with a probability of 0.0000025 [in any one year] for snubber not locking)	0	The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The original controlling failure probabilities without ISI for disabling leak rates of 2gpm and 193gpm are: • 4" portion with a 0.26 design limiting stress with a probability of 0.0001 in any one year for snubber not locking cases (note no snubber locking cases were run) – 1.78E-05 and 1.78E-05 • 10" portion with a 0.7 fatigue stress range for snubber locking cases and a 0.42 design limiting stress with a probability of 0.0000025 in any one year for snubber not locking cases - 1.12E-05 and 8.03E-06 The revised controlling failure probabilities without ISI assuming a 0.7 fatigue stress range for snubber locking cases, a 0.26 design limiting stress with a probability of 0.0001 in any one year for the first set of snubber locking cases and a 0.42 design limiting stress with a probability of 0.0000025 in any one year for the second set of snubber not locking cases for disabling leak rates of 2gpm and 193gpm are:

Table A.2-1 (cont.) Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations			
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
			• 4" portion – 1.78E-05 and 1.78E-05 • 10" portion – 1.12E-05 and 8.03E-06 The revised controlling failure probabilities are approximately the same. Therefore there is no difference in the number of examinations.
SI-042A	– Residual stress level (10 versus 20 [ksi])	0	The fatigue stress range contains two different values (0.3 and 0.5). All cases (SRRA runs) between the sizes contain the same fatigue stress range. Thus there is no difference in the fatigue stress range. The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. This segment has three schedules 10S, 40S and 160. The SRRA inputs for two of the three schedules (10S and 40S) are the same except the thickness-to-outside diameter ratio. The failure probabilities without ISI for disabling leak rate 193gpm are: • 10S schedule with a 10 ksi residual stress level – 7.58E-06 • 40S schedule with a 10 ksi residual stress level – 1.52E-06 • 160 schedule with a 20 ksi residual stress level – 4.57E-06 The revised controlling failure probabilities without ISI assuming a 20 ksi residual stress level are: • 10S schedule – 1.26E-05 • 40S schedule – 7.28E-06 Although the controlling failure probabilities for the segment increased from 7.58E-06 to 1.26E-05, the 1.26E-05 failure probability is not overly conservative. If the segment is split, it would be split into two segments – one segment with a schedule of 160 and the other with schedules of 10S and 40S. The sum of the failure probabilities for these two segments is: • 7.58E-06 + 4.57E-06 = 1.22E-05

Table A.2-1 (cont.)	Evaluation of Unit B HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes [(1), (2)]**	**Potential Difference in Examinations**	**Basis**
			Since the sum of the failure probabilities of the split segments are approximately the same as the failure probability using the most limiting SRRA inputs, the impact on other segment RRWs would be insignificant. Therefore, there is no need to split the segment and there is no difference in the number of examinations.
SI-043A	– Residual stress level (10 versus 20 [ksi])	0	The design limiting stress contains two different values (0.1 and 0.26). All cases (SRRA runs) between the sizes contain the same design limiting stress. Thus there is no difference in the design limiting stress. The original controlling failure probabilities without ISI are: • 6" portion with a 10 residual stress level – 1.92E-07 • 10" portion with a 20 residual stress level – 2.65E-07 The revised controlling failure probability without ISI is: • 6" portion with a 20 residual stress level – 1.93E-07 The revised failure probability for the 6" portion is nearly the same as the original failure probability for the 6" portion. Additionally the controlling failure probability for the segment remains the 10" portion of the segment. Therefore there is no difference in the number of examinations.

Notes:

1. Nominal pipe size and thickness-to-outside diameter ratio differences are not listed in Table A.2-1.
2. If no units are identified the value is dimensionless.

A.3 UNIT C

Unit C risk-informed ISI program is a Class 1 and Class 2 program. Unit C has 179 multiple pipe size segments. Thirty two of these multiple pipe size segments are HSS and the remaining 147 multiple pipe size segments are LSS. An evaluation of the HSS multiple pipe size segments showed no difference in the number of examinations. Table A.3-1 presents, on a segment basis, the differences in the SRRA inputs, the potential difference in the number of examinations, and the basis for the evaluation of the HSS multiple pipe size segments.

There are three LSS multiple pipe size segments at unit C that contain an ASME Section XI examination on more than one pipe size in the segment. Each of these segments contains ASME Section XI examinations on two pipe sizes. The change-in-risk evaluation is conducted assuming that these LSS multiple pipe size segments are split into two segments each. The change-in-risk criteria are still met for all four cases of CDF and LERF without and with operator action. Thus, there is no difference in the number of examinations for the LSS multiple pipe size segments.

Overall there is no difference in the number of examinations at unit C for both the HSS and LSS multiple pipe size segments.

Table A.3-1 Evaluation of Unit C HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations			
Segment	**Different SRRA Inputs Between the Pipe Sizes [(1), (2)]**	**Potential Difference in Examinations**	**Basis**
CHS-005		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CHS-006 CHS-007		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CHS-019A CHS-020A CHS-021A		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CHS-026A		0	The fatigue stress range contains two different values (0.15 and 0.5). All cases (SRRA runs) between the sizes contain the same fatigue stress ranges. Thus there is no difference in the fatigue stress range. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CHS-026C CHS-026G		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CHS-028C		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
CHS-050A		0	The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.

Table A.3-1 (cont.) Evaluation of Unit C HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations

Segment	Different SRRA Inputs Between the Pipe Sizes (1), (2)	Potential Difference in Examinations	Basis
MSS-004 MSS-005 MSS-006		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
MSS-026		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
QSS-003 QSS-004	– Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE])	0	The only difference in the SRRA inputs for this segment is that the 12" piping had a radiographic examination after the last weld pass and the 10" piping did not. The snubber not locking case is the controlling failure probability for the 10" and 12" portions of the segment. The original failure probabilities without ISI are: • 10" portion with no X-Ray – 7.99E-09 • 12" portion with X-Ray – 1.22E-09 The revised failure probability without ISI assuming no radiographic examination on the 12" portion is: • 7.99E-09. Although changing the initial flaw condition from 12.8 to 1 has an effect on the failure probability for that portion of the segment, the failure probability assuming no X-Ray on the 12" portion of the segment is the same as the 10" portion of the segment. Thus there is no difference in the number of examinations.
QSS-005 QSS-006		0	The fatigue stress range contains two different values (0.1 and 0.3). All cases (SRRA runs) between the sizes contain the same fatigue stress ranges. Thus there is no difference in the fatigue stress range. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.

Table A.3-1 (cont.)	Evaluation of Unit C HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
QSS-026 QSS-027	– Residual stress level (5 versus 10 [ksi]) – Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE])	0	The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The differences in the SRRA inputs for residual stress level and initial flaw condition are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
QSS-035		0	The fatigue stress range contains two different values (0.1 and 0.3). All cases (SRRA runs) between the sizes contain the same fatigue stress ranges. Thus there is no difference in the fatigue stress range. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
RCS-058	– Stress corrosion potential (0.001 versus 0.003) – Design limiting stress (0.26 versus 0.42 for snubber not locking cases)	0	The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The snubber not locking case is not the controlling failure probability for the 4" and 6" portions of the segment. The base cases are the controlling failure probability. The snubber not locking cases increased by approximately 1.5 orders of magnitude but still are not the controlling failure probabilities. The original controlling failure probabilities without ISI for disabling leak rates of 2gpm, 100gpm, 1500gpm, and 0gpm (full break) are: • 4" portion with a 0.001 stress corrosion potential – 2.16E-07, 1.64E-07, 1.38E-07, and 1.26E-07 • 6" portion with a 0.003 stress corrosion potential – 1.30E-07, 9.43E-08, 8.84E-08, and 8.51E-08 The revised controlling failure probabilities without ISI on the 4" portion of the segment assuming a stress corrosion potential of 0.003 and a design limiting stress of 0.42 for the snubber not locking cases for disabling leak rates of 2gpm, 100gpm, 1500gpm, and 0gpm (full break) are:

Table A.3-1 (cont.) Evaluation of Unit C HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations			
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
			• 2.36E-07, 1.50E-07, 1.38E-07, and 1.38E-07. The revised controlling failure probabilities are approximately the same as the original failure probabilities. Thus there is no difference in the number of examinations.
RCS-067	– Stress corrosion potential (0.001 versus 0.003)	0	The fatigue stress range contains two different values (0.3 and 0.5). All cases (SRRA runs) between the sizes contain the same fatigue stress ranges. Thus there is no difference in the fatigue stress range. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The original controlling failure probabilities without ISI for disabling leak rates of 2gpm, 100gpm, 1500gpm, and 0gpm (full break) are: • 3" portion with a 0.001 stress corrosion potential – 1.68E-07, 1.18E-07, 8.41E-08, and 8.41E-08 • 6" portion with a 0.003 stress corrosion potential – 7.72E-08, 6.70E-08, 6.55E-08, and 6.15E-08 The revised controlling probabilities without ISI on the 3" portion of the segment assuming a stress corrosion potential of 0.003 for disabling leak rates of 2gpm, 100gpm, 1500gpm, and 0gpm (full break) are: • 1.78E-07, 1.04E-07, 6.79E-08, and 6.79E-08 The revised controlling failure probabilities are approximately the same as the original failure probabilities. Thus there is no difference in the number of examinations.
SIS-022A		0	The fatigue stress range contains two different values (0.3 and 0.5). All cases (SRRA runs) between the sizes contain the same fatigue stress ranges. Thus there is no difference in the fatigue stress range. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.

Table A.3-1 (cont.)	Evaluation of Unit C HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations		
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
SIS-043A		0	The fatigue stress range contains two different values (0.3 and 0.5). All cases (SRRA runs) between the sizes contain the same fatigue stress ranges. Thus there is no difference in the fatigue stress range. The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
SIS-056A SIS-057B	– Crack inspection accuracy (0.24 versus 0.32) – Temperature at pipe weld (70 versus 120 [°F]) – Residual stress level (5 versus 10 [ksi]) – Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE])	0	The minimum detectable leak contains two different values (0.001 and 1 gpm). All cases (SRRA runs) between the sizes contain the same minimum detectable leak. Thus there is no difference in the minimum detectable leak. The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.
SIS-061B		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
SIS-062B		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.
SIS-064A	– Crack inspection accuracy (0.24 versus 0.32) – Residual stress level (5 versus 10 [ksi]) – Initial flaw condition (12.8 [No X-Ray] versus 1 [X-Ray NDE])	0	The differences in the SRRA inputs are associated with butt welded piping versus socket welded piping. Therefore there is no impact on the number of examinations from these differences.

Table A.3-1 (cont.) Evaluation of Unit C HSS Multiple Pipe Size Segments for Potential Difference in the Number of Examinations			
Segment	**Different SRRA Inputs Between the Pipe Sizes (1), (2)**	**Potential Difference in Examinations**	**Basis**
SIS-065A		0	The only differences in the SRRA inputs are associated with the physical pipe dimensions. Therefore there is no impact on the number of examinations from these differences.

Notes:

1. Nominal pipe size and thickness-to-outside diameter ratio differences are not listed in Table A.3-1.
2. If no units are identified the value is dimensionless.

A.4 UNIT D AND UNIT E

Unit D and unit E risk-informed ISI programs are Class 1 and Class 2 programs. Similar to the other risk-informed ISI programs that are evaluated, there is no difference in the number of examinations. However, a unique situation occurred on one segment at both unit D and unit E that did not occur at the other units that are evaluated. This situation is discussed in the following paragraphs.

The pressurizer surge lines at unit D and unit E are multiple pipe size segments consisting of two pipe sizes – 14 inch and 16 inch. The differences in the SRRA inputs, other than the nominal pipe size and thickness-to-outside diameter ratio for the two pipe sizes, are a stress corrosion potential of 0.001 versus 0.003 and a fatigue stress range of 0.5 versus 0.3.

The 16 inch portion of the segments is conservatively postulated to have some potential for thermal stratification based on an evaluation that the highest potential for thermal stratification existed in this portion of the surge line. Postulating some thermal stratification is conservative, since thermal stratification has been previously determined to have a limited impact on the integrity of the pressurizer surge line. The 16 inch portion of the segments is not modeled with stress corrosion cracking since it does not contain an Inconel weld. The 14 inch portion of the segments is modeled with a potential for stress corrosion cracking due to an Inconel weld. Thermal stratification is not modeled on the 14 inch portion based on a prior evaluation. Although the segments are not quantitatively HSS, the risk results placed the surge lines in the region for additional consideration by the expert panel, who categorized the surge lines as HSS due to the postulated thermal stratification.

The original controlling failure probabilities without ISI for the large leak with disabling leak rates of 2 gpm, 100 gpm, 1500 gpm, and 500 gpm are respectively:

- 14" portion – 1.96E-08, 4.19E-09, 4.18E-09, 4.18E-09
- 16" portion - 3.08E-07, 2.81E-07, 2.80E-07, 2.75E-07

The revised failure probabilities assuming a stress corrosion potential of 0.003 and a fatigue stress range of 0.5 for the large leak with disabling leak rates of 2 gpm, 100 gpm, 1500 gpm, and 5000 gpm are respectively:

- 14" portion – 2.69E-07, 2.19E-07, 1.93E-07, 1.92E-07
- 16" portion – 3.08E-07, 2.83E-07, 2.81E-07, 2.80E-07

Although the failure probabilities for the 14 inch portion did increase, they remain below the controlling failure probabilities for the 16 inch portion segment. The controlling failure probabilities for the 16 inch portion of the segments remain approximately the same. Thus, there is no difference in the number of examinations.

In this example, the stress corrosion cracking and thermal stratification are judged not to be active and the surge lines are not modeled as being highly susceptible to an active degradation mechanism. Thus, the segments are placed in Region 2 of the structural element selection matrix. The Perdue Model analysis of the surge line indicated that a minimum of one examination is required to maintain a 95 percent confidence that the current target leak rates would not be exceeded. The expert panel assigned two examinations to each of these segments to address the potential for thermal stratification and the potential for stress corrosion cracking on the Inconel weld. Had the segment been split, it is reasonable to assume that each of the split segments would have been categorized as HSS. With a minimum of one examination per HSS segment, it is reasonable to assume that two examinations would have been conducted on each of the pressurizer surge lines. Since the SRRA failure probabilities calculated by both methods are approximately the same, there is no need to split the segments, and there is no difference in the number of examinations. However, additional guidance has been added to Section 2.3 of this Supplement to WCAP-14572 to address this situation where a segment has more than one postulated degradation mechanism that is neither active nor modeled as highly susceptible to an active degradation mechanism. The guidance is that consideration be given to conducting an examination on the segment that addresses each postulated degradation mechanism. In some cases, this may result in doing more examinations than is required by the Perdue Model statistical analysis.

APPENDIX B
RESPONSES TO THE NRC REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING THE REVIEW OF WCAP-14572, REV. 1-NP-A SUPPLEMENT 2

June 22, 2005
WOG-05-296

WCAP-14572 Rev. 1-NP-A
Supplement 2
Project Number 694

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Westinghouse Owners Group
<u>Responses to the NRC Request for Additional Information (RAI) Regarding the Review of WCAP-14572, Rev. 1-NP-A Supplement 2, (Non-Proprietary), "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications" (PA-MSC-0076)</u>

Reference 1: Letter from Girija Shukla (NRC) to Mr. Gordon Bischoff (Westinghouse Owners Group), Dated November 24, 2004, Acceptance of Topical Report WCAP-14572-NP, Rev. 1, "WOG Application of Risk-Informed Methods to Piping ISI Topical Report Clarifications" for Review (TAC No. MC3979)

Attachment 1 to this letter provides the responses to the NRC Request for Additional Information (RAI) from the review of WCAP-14572, Rev. 1-NP-A Supplement 2, (Non-Proprietary), "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report Clarifications". The draft responses to the RAIs have been revised as agreed to in the telecon between Westinghouse, the Westinghouse Owners Group and the NRC held on April 26, 2005. These RAI responses do not contain any proprietary information. These RAI responses are being provided to support issuance of the draft Safety Evaluation by August 15, 2005 in accordance with your acceptance review letter (Reference 1).

Attachment 2 contains the mark-up revisions to the WCAP-14572, Rev. 1-NP-A Supplement 2 on the actual pages from Supplement 2.

US NRC Document Control Desk
WOG-05-296

June 22, 2005
Page 2 of 2

If you have any questions regarding this information, please feel free to call Mr. Steven DiTommaso of the Westinghouse Owners Group Program Management Office at 412-374-5217.

Very truly yours,

Steven M. DiTommaso for

D. F. Pilmer
Vice-Chairman, Westinghouse Owners Group

mjl

Attachments

cc: WOG Steering Committee
WOG Licensing Subcommittee
WOG Materials Subcommittee
G. Shukla, USNRC (via Federal Express)
S. Dinsmore, USNRC (via Federal Express)
WOG Project Management Office
P. Stevenson, Westinghouse

Attachment 1 to WOG-05-296

REQUEST FOR ADDITIONAL INFORMATION (RAI)
WESTINGHOUSE OWNERS GROUP
APPLICATION OF RISK INFORMED METHODS TO PIPING INSERVICE INSPECTION
TOPICAL REPORT CLARIFICATIONS
(TOPICAL REPORT WCAP-14572, REVISION 1-NP-A, SUPPLEMENT 2)
REQUEST FOR ADDITIONAL INFORMATION (RAI)

WCAP-14572, Revision 1-NP-A, Supplement 2 addresses two methods of calculating failure probabilities for multiple pipe size segments. In the first method, a failure probability is calculated for every pipe size in the multiple pipe size segment, and the highest failure probability associated with the segment is used to represent the segment. In the second method, all of the degradation mechanisms present in the segment are combined on the limiting weld in the segment. If the resulting failure probability is not overly conservative, the calculated failure probability is used. If it is overly conservative, the segment is split by size and a new failure probability is recalculated for each of the new segments. Supplement 2 argues that the first method is an acceptable alternative to the second method, in which all of the degradation mechanisms present in the segment are combined on the limiting weld in the segment, as outlined in WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report."

In arguing that the first method is acceptable, Supplement 2 attempts to demonstrate that there is no difference or an insignificant difference in the number of examinations yielded by using the first method as opposed to using the second method. In order to compare the two methods, Supplement 2 discusses the range of possible scenarios among multiple pipe size segments that could occur in Risk-Informed Inservice Inspection (RI-ISI) programs using the first method. In reviewing Supplement 2, the staff believes that there are ten different scenarios presented to evaluate the potential differences in the number of exams based on the categorization of segments into High Safety Significant (HSS) or Low Safety Significant (LSS) categories. Additionally, the staff believes that there are four different scenarios presented to evaluate potential differences in the number of exams based on the change-in-risk evaluation. Appendix A of Supplement 2 describes a review/screening process that examines each of the scenarios to identify if there would be any potential difference in the number of examinations when using the first method as opposed to using the second method. This process was followed to evaluate five RI-ISI programs that used the first method to calculate failure probabilities for multiple pipe size segments.

NRC RAI 1. *Does Westinghouse concur that there are ten different scenarios based on the categorization and four different scenarios based on the change in risk evaluations that are described in Supplement 2? If not, how many scenarios does Westinghouse believe are addressed in Supplement 2? Briefly list each scenario described in the review/screening process described in Appendix A.*

Response to NRC RAI 1

There are eight basic scenarios based on categorization. They are identified in Table RAI 1-1. For all the scenarios except number 1, the multiple pipe size segment is categorized high safety significant (HSS). The progression from one scenario to the next is important in understanding how Section 2 of Supplement 2 evaluates each scenario and covers the possible cases.

Table RAI 1-1 WCAP-14572 Supplement 2 Scenarios Based on Categorization		
Number	**Scenario**	**Is the Scenario Used in Supplement 2 Appendix A?**
1	The multiple pipe size segment is low safety significant (Section 2.2.1).	Due to a prior agreement between the NRC and WOG (May 14, 2003 meeting at the NRC) that this scenario does not result in a difference in the number of examinations, this scenario was not specifically identified or called out in Appendix A.
2	*The Only Difference in SRRA Inputs Are the Nominal Pipe Size or Thickness-to-Outside Diameter Ratio* (Section 2.2.3). Note that this scenario is the second method described in the first bullet for the second method in Section 2.1.	Yes
3	*Segments Comprised of Socket Welded Piping* (Section 2.2.3). The segment is comprised of socket welded piping and does not have an externally generated degradation mechanism.	Yes
4	*Segments Comprised of Butt and Socket Welded Piping Where the Only Differences in SRRA Inputs are Between the Butt and Socket Welded Portions* (Section 2.2.3). The segment is comprised of butt and socket welded piping where the only differences in SRRA inputs are between the butt and socket welded portions and there is no externally generated degradation mechanism on the socket welded piping.	Yes
5	*No Difference in the Failure Probability Used to Represent the Segment* (Section 2.2.3). In some cases the failure probabilities do not significantly differ using the two methods.	Yes
6	*Only One Size Remains HSS When Splitting a HSS Multiple Pipe Size Segment* (Section 2.2.3). When a HSS multiple pipe size segment is split into separate segments based on pipe size, it is possible that one split segment will be categorized as HSS and the rest will be categorized as LSS by the expert panel due to lower failure probabilities for all but the HSS split segment.	No
7	*Increases in the Segment Failure Probability That Are Not Overly Conservative* (Section 2.2.3). If the failure probability in a multiple pipe size segment is determined by using SRRA inputs specific to each pipe size, then it is possible that using the most limiting SRRA inputs from all the pipe sizes may result in an increase in the failure probability for the segment that is not overly conservative.	Yes
8	*Increases in the Segment Failure Probability That Are Potentially Overly Conservative* (Section 2.2.4) It is possible that using the most limiting SRRA inputs from all the pipe sizes in a segment will result in an overly conservative failure probability.	No

Note that there is a potential for combinations of scenarios to be used to demonstrate that there is no difference in the number of examinations. For example, a multiple pipe size segment may be comprised of 2 or more butt welded sizes and 2 or more socket welded sizes. The only difference in the butt welded portions may be the nominal pipe size. Thus, using scenario 2 there is no difference in the number of examinations for the butt welded portion. Scenario 3 may be used to demonstrate that there is no difference for the socket welded portion due to multiple sizes. And finally scenario 4 is used to demonstrate that there is no difference in the number of examinations due to butt and socket welded piping in the same segment. Numerous combinations are possible and may have been encountered and used as part of this analysis.

There are 11 basic scenarios for the change-in-risk evaluation that can occur if multiple pipe size segments are split by pipe size. Additional scenarios are possible if a multiple pipe size segment has more than two pipe sizes; however, these additional scenarios can be broken down into combinations of these basic 11 scenarios. These 11 basic scenarios are presented in Table RAI 1-2.

RAI 1-2 Basic Scenarios Associated with the Change-in-Risk Evaluation

Scenario	Multiple Pipe Size Segment		Split Segment 1		Split Segment 2		Is the Scenario Used in Supplement 2 Appendix A? (1)
	Safety Significance	# ASME Section XI Exams	Safety Significance	ASME Section XI Exam	Safety Significance	ASME Section XI Exam	
1	LSS	2	LSS	Y	LSS	Y	Yes (2)
2	LSS	1	LSS	Y	LSS	N	Yes (3)
3	LSS	0	LSS	N	LSS	N	Yes (3)
4	HSS	2	HSS	Y	HSS	Y	No
5	HSS	1	HSS	Y	HSS	N	No
6	HSS	0	HSS	N	HSS	N	No
7	HSS	2	HSS	Y	LSS	Y	No
8	HSS	1	HSS	Y	LSS	N	No
9	HSS	1	HSS	N	LSS	Y	No
10	HSS	0	HSS	N	HSS	N	No
11	HSS	0	HSS	N	LSS	N	No

Notes: (1) None of the HSS segments used in this study would have resulted in a LSS split segment. Since meeting the change-in-risk criteria would not have been adversely affected, the HSS multiple pipe size segments were not checked to determine if there was an ASME Section XI exam on more than one size.

(2) For one plant, all LSS multiple pipe size segments were conservatively assumed to have an ASME Section XI examination on each pipe size.

(3) For this analysis no distinction was made between the LSS multiple pipe size segments with ASME Section XI exams on one pipe size and the LSS multiple pipe size segments with no ASME Section XI exams.

Refer to the response to RAI 7 for revised text for part of Section 2.2.4 to reflect this additional information on the scenarios associated with the change-in-risk evaluation.

NRC RAI 2. *Is the review/screening process described in Appendix A of Supplement 2 to be applied as part of the development of every RI-ISI program that utilizes the first method to calculate failure probabilities for multiple pipe size segments? Is the process intended to be applied to licensees that already have an approved RI-ISI program? If either of the above is true, where does Supplement 2 state this?*

Responses to NRC RAI 2

2.a *Is the review/screening process described in Appendix A of Supplement 2 to be applied as part of the development of every RI-ISI program that utilizes the first method to calculate failure probabilities for multiple pipe size segments?*

Response to 2.a:
No. The review process is included to demonstrate that there are no differences or insignificant differences between the two methods of calculating failure probabilities.

2.b *Is the process intended to be applied to licensees that already have an approved RI-ISI program?*

Response to 2.b:
No. The review process is included to demonstrate that there are no differences or insignificant differences between the two methods of calculating failure probabilities.

2.c *If either of the above is true, where does Supplement 2 state this?*

Response to 2.c:
The Supplement does not state this. The one-time comparison is presented in Supplement 2 in detail as a generic basis for supporting failure probabilities that were calculated in accordance with first method described in Section 2.1.

To clearly identify the informational only portions of Supplement 2, the following text will be added:

New first paragraph under Section 2.2:
Section 2.2 and its associated subsections are provided for informational purposes only. The analyses described in this Section do not represent additional requirements for conducting a risk-informed ISI program.

New first paragraph under Appendix A:
Appendix A is provided for informational purposes only. The analyses described in this appendix do not represent additional requirements for conducting a risk-informed ISI program.

NRC RAI 3. *Page 2-4 of Supplement 2 presents the following scenario:*

1. *An HSS multiple pipe size segment.*
2. *The only differences in the structural reliability and risk assessment (SRRA) computer code inputs for each size in the segment are nominal pipe size and/or thickness-to-outside diameter ratio.*

Is every weld in these segments exposed to the same conditions? Must the segment have either no degradation mechanisms in all of the multiple pipe size segment, only postulated degradation mechanisms, or only active degradation mechanisms to be included in this scenario? Please explain why this scenario would never result in overly conservative pipe failure frequencies for all combinations of degradation mechanisms and pipe sizes. Does use of the smallest pipe size for the SRRA input always yield the highest failure probabilities, regardless of any degradation mechanism or must the calculation be done for each pipe size to identify the highest failure frequency? Please provide the maximum range *of pipe sizes (i.e., the smallest and the largest pipe size) in these types of multi-pipe size segments. Please provide the maximum number of different pipe sizes in these types of segments.*

Responses to NRC RAI 3

3.a *Is every weld in these segments exposed to the same conditions?*

Response to 3.a:
Not necessarily. Every weld may not be exposed to the same conditions, however, for this scenario the SRRA inputs other than nominal pipe size and/or thickness-to-outside diameter ratio have been set to the same values.

3.b *Must the segment have either no degradation mechanisms in all of the multiple pipe size segment, only postulated degradation mechanisms, or only active degradation mechanisms to be included in this scenario?*

Response to 3.b:

No – any combination. In this case, the limiting conditions from all of the pipe sizes are used on all sizes.

3.c *Please explain why this scenario would never result in overly conservative pipe failure frequencies for all combinations of degradation mechanisms and pipe sizes.*

Response to 3.c:
This scenario could potentially result in overly conservative failure frequencies if degradation mechanisms that apply to only one of the segment's pipe sizes are combined with mechanisms applicable only to the segment's other pipe sizes. The potential for calculating overly conservative results also exits for a single pipe size segment for which overly conservative SRRA inputs have been used or a segment that has different degradations mechanisms on different locations of the pipe. Regardless of whether the segment has multiple pipe sizes, there are checkpoints in the methodology for identifying overly conservative failure frequencies. First, the SRRA results are reviewed for reasonableness by the engineering team responsible for their generation. Next, the SRRA results are reviewed at a higher level during the review of the risk evaluation results. Finally, the expert panel is presented with the failure information for each segment. If, at any point in this process, it is determined that the failure frequencies are overly conservative, the responsible engineering team will review the inputs and assumptions and remove any excess conservatism. In doing this, the team may decide it is appropriate to split the segment.

3.d *Does use of the smallest pipe size for the SRRA input always yield the highest failure probabilities, regardless of any degradation mechanism or must the calculation be done for each pipe size to identify the highest failure frequency?*

Response to 3.d:
In most cases, if all inputs are the same except pipe size, then the smaller pipe size will have a higher failure probability.

3.e *Please provide the maximum range of pipe sizes (i.e., the smallest and the largest pipe size) in these types of multi-pipe size segments.*

Response to 3.e:
There is no formal limit on the maximum range of pipe sizes allowed for a segment. For the units used as examples in Appendix A, Units A, B, and C calculated failure probabilities using the first method described in Section 2.1. Units D and E followed the second method described in Section 2.1 except for one segment per unit as described in Appendix A. Therefore, the ranges requested are from Units A, B,

and C. For this scenario, the maximum range of the nominal pipe diameters in one multiple pipe size segment is 3 inches to 24 inches.

3.f *Please provide the maximum number of different pipe sizes in these types of segments.*

Response to 3.f:
There is no formal limit on the maximum number of pipe sizes allowed for a segment. For this scenari for Units A, B, and C in Appendix A, the maximum number of pipe sizes in one multiple pipe size segment is 5.

NRC RAI 4. *Page 2-4 of Supplement 2 presents the following scenario:*

1. *An HSS multiple pipe size segment that contains both socket welded piping and butt welded piping.*
2. *There is no external degradation mechanism on the socket welded piping.*
3. *The only difference in the SRRA inputs is between the socket and butt welded portions of the segment.*

Must all the socket and butt welds be exposed to the same degradation mechanisms? Does the segment have either no degradation mechanisms in the multiple pipe size segment, only postulated degradation mechanisms, or only active degradation mechanisms? Can there be different postulated or active degradation mechanisms between the socketed and the butt welded portions of the segment? Please explain why this scenario would never result in overly conservative pipe failure frequencies for all combinations of degradation mechanisms and pipe sizes.

Supplement 2 argues that, in this scenario, there is no difference in the number of exams when using th first method as opposed to using the second method. However, as stated in Section 2.2.3, page 2-3, of Supplement 2, "If a HSS multiple pipe size segment is split into separate segments based on pipe size a more than one pipe size is categorized as HSS, the minimum number of examinations may increase fro one to the number of segment pipe sizes that are categorized as HSS." Within each of these segments, socket welds without external degradation will be inspected using VT-2, and all of the butt welds with active degradation mechanisms will be inspected. However, the butt welds without active degradation mechanisms will use the Perdue model analysis to determine the number of welds to inspect within eac segment. WCAP-14572 (p. 178, 3.7.2) states that, when using the Perdue model, a minimum of one ex is chosen for each HSS segment. Therefore, each HSS segment created when the segment is split based on size, with a butt weld would require a minimum of one exam. So, there appears to be a potential for the number of exams to increase when an HSS multiple pipe size segment containing both socket welds and butt welds is split into separate segments based on size. Please justify your conclusion that, in this case, there is no difference in the number of examinations.

Responses to NRC RAI 4

4.a *Must all the socket and butt welds be exposed to the same degradation mechanisms?*

Response to 4.a:
No. In this scenario, the socket and butt welds are subject to different degradation mechanisms or the same degradation mechanism but with different severities or a combination of different degradation mechanisms and different severities.

4.b *Does the segment have either no degradation mechanisms in the multiple pipe size segment, only postulated degradation mechanisms, or only active degradation mechanisms?*

Response to 4.b:
Any combination is possible.

4.c *Can there be different postulated or active degradation mechanisms between the socketed and the butt welded portions of the segment?*

Response to 4.c:

Yes, by the definition of this scenario, the socket and butt welds are subject to different degradation mechanisms or the same degradation mechanism but with different severities or a combination of different degradation mechanisms and different severities.

4.d *Please explain why this scenario would never result in overly conservative pipe failure frequencies for all combinations of degradation mechanisms and pipe sizes.*

Response to 4.d:
As discussed in the response to RAI 3, overly conservative failure frequencies can be calculated for any segment. However, the means by which the failure frequencies are calculated for this scenario using the first method does not introduce any additional potential for overly conservative results. The degradation mechanisms applicable to the socket welds are only applied to the socket welds and are not applied to the butt welds, and the degradation mechanisms applicable to the butt welds are only applied to the butt welds and are not applied to the socket welds. Thus, the failure frequencies are calculated in a best estimate manner.

4.e *Please justify your conclusion that, in this case, there is no difference in the number of examinations.*

Response to 4.e:
In this scenario, the only difference in degradation mechanisms is between the butt and socket welded portions of piping. If the segment was split, the only split considered would be between the butt and socket welded piping. If there are multiple butt welded pipe sizes, the only differences are associated with the physical dimensions and are addressed in Supplement 2 under the subsection titled "*The Only Difference in SRRA Inputs Are the Nominal Pipe Size or Thickness-to-Outside Diameter Ratio.*" Thus, the butt welded portion of the segment is modeled such that all degradation mechanisms in the butt welded portion are included in the limiting weld (i.e., the limiting degradation mechanisms from the butt welded portion are combined or added and included in the limiting butt weld). If there are multiple socket welded sizes, they would be addressed in Supplement 2 under the subsection titled "*Segments Comprised of Socket Welded Piping.*" Therefore, there is no difference in the number of welds inspected for this scenario.

The following text will be added to the bottom of page 2-4:

> Thus, there is no need to combine degradation mechanisms between the butt and socket welded portions of piping because the same number of examinations are identified for the butt and socket welded portions of piping; independent of whether the degradation mechanisms are combined or not.

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The following text will be added before the last paragraph in Section 2.3:

> There is no need to combine degradation mechanisms between the butt and socket welded portions of piping because the same number of examinations are identified for the butt and socket welded portions of piping; independent of whether the degradation mechanisms are combined or not.

NRC RAI 5. *On page 2-6 and 2-7 of Supplement 2, the following scenario is addressed:*

1. *An HSS multiple pipe size segment is not eliminated by another scenario and a new failure probability is calculated using the most limiting inputs for all the pipe sizes.*
2. *The HSS multiple pipe size segment's failure probability, calculated by using the most limiting SRRA inputs from all pipe sizes, results in an increase in the failure probability of the segment that is not overly conservative.*

Supplement two states two methods to determine if the failure probability is overly conservative: (1) any increase that is less than an order of magnitude; or (2) if the sum of the failure probabilities from the individual pipe sizes is approximately the same or higher than the failure probability based on the most limiting SRRA inputs, the failure probability is considered not to be overly conservative. Which of these methods is used in the review/screening process described in Appendix A?

Response to NRC RAI 5

Only the sum of the failure probabilities was used in this analysis. The text of the second item under the first paragraph on page A-2 of Supplement 2 will be revised as shown below:

> - If there is an increase in the failure probability that would be used to represent the multiple pipe size segment, is the new failure probability used to represent the segment not overly conservative? ~~Generally, if the increase in the failure probability is less than an order of magnitude or~~ If the sum of the failure probabilities that would be used for the individual pipe sizes is approximately the same as the failure probability for the segment using the most limiting SRRA inputs from all of the pipe sizes in the segment, the failure probability is considered to be not overly conservative.

NRC RAI 6. *On page 2-8 of Supplement 2, the following scenario is addressed:*

1. *An HSS multiple pipe size segment is not eliminated by another scenario and a new failure probability is calculated using the most limiting inputs for all the pipe sizes.*
2. *The HSS multiple pipe size segment's failure probability, calculated by using the most limiting SRRA inputs from all pipe sizes, results in an increase in the failure probability of the segment that is overly conservative. Thus, the segment is split by pipe size.*
3. *If this segment has multiple postulated degradation mechanisms, the minimum requirement of one examination will result in a difference in the number of exams between using each of the methods to calculate the failure probability for a multiple pipe size segment.*

The impact of this scenario on the ability of the RI-ISI program to provide an ongoing assessment of piping conditions by targeting locations with degradation mechanisms depends on the number of postulated mechanisms in the RI-ISI program. Appendix A of Supplement 2 provides an evaluation of five risk-informed ISI programs which used the first method to calculate the failure probability of multiple pipe size segments. In each of these programs, how many segments had only postulated degradation mechanisms, only active degradation mechanisms, and both active and postulated degradation mechanisms? If the review/screening process described in Appendix A identifies the above scenario, does the process require that more exams be added to the RI-ISI program?

Responses to NRC RAI 6

6.a *In each of these programs, how many segments had only postulated degradation mechanisms, only active degradation mechanisms, and both active and postulated degradation mechanisms?*

Response to 6.a:
As stated in the response to RAI 3.e, Units D and E estimated failure probabilities following the second method described in Section 2.1, except for one segment per unit as described in Appendix A. Therefore, the information requested is from Units A, B, and C. Table RAI-6 shows the number of HSS segments for each unit and whether they include active or postulated degradation mechanisms. For these three units, examinations are performed for the active mechanisms (Structural Element Selection Matrix Region 1A) and an additional examination is always performed for a postulated mechanism (Structural Element Selection Matrix Region 1B). For this reason, there are no segments that are considered to have only an active degradation mechanism. The potential for multiple degradation mechanisms has occurred in Units A, B, and C.

Table RAI 6 Number of Segments with Active and/or Postulated Degradation Mechanisms

Unit	Number of HSS Segments	Number of Segments with Active and Postulated Degradation Mechanisms	Number of Segments with Only Postulated Degradation Mechanisms
A	45	32	13
B	29	2	27
C	32	6	26

6.b *If the review/screening process described in Appendix A identifies the above scenario, does the process require that more exams be added to the RI-ISI program?*

Response to 6.b:
Scenario 8, described in the response to RAI 1, did not occur for the plants presented in Appendix A. Supplement 2, Section 2.3, includes a requirement that if more than one degradation mechanism is postulated on a HSS segment conduct one or more examinations that would address each of the postulated degradation mechanisms. This requirement may result in an increased number of examinations.

The second to last sentence in the last paragraph of Section 2.3 will be revised to:

> If more than one degradation mechanism is postulated on a HSS segment, ~~it is recommended that consideration be given to conducting~~ conduct one or more examinations that would address each of the postulated degradation mechanisms.

The second to last sentence in the last paragraph of Section 2.2.3 will be revised to:

> The guidance **requires** ~~recommends~~ that one or more ~~consideration be given to conducting an~~ examinations **be conducted** ~~on the segment~~ that address~~es~~ each postulated degradation mechanism **on the HSS segment.**

The last sentence in the fourth bullet on page 2-8 will be revised to:

> However, if a HSS segment is modeled with multiple postulated degradation mechanisms, ~~it is recommended that consideration be given to conducting~~ **conduct** one or more examinations that address each postulated degradation mechanism.

NRC RAI 7. *Page 2-13 of Supplement 2 describes a scenario to evaluate potential differences in the number of exams based on the change-in-risk evaluation. The scenario involves an HSS multiple pipe size segment that is divided by pipe size. Supplement 2 concludes that there is no difference or a conservative difference in the number of examinations due to splitting an HSS multiple pipe size segment. However, if at least one inspection was performed in every size under ASME Section XI and the HSS multiple pipe size segment is split by pipe size resulting in HSS segments and LSS segments, only the HSS segment would be inspected under RI-ISI. The LSS segments would no longer be inspected, thus a possible increase in change-in-risk occurs. This results in a potential for adding more exams. Please justify the conclusion that, in this scenario, there is no difference in the number of examinations when a multiple pipe size HSS segment is split by size.*

Response to NRC RAI 7

This particular scenario could make it less likely to meet the change-in-risk criteria and there is the potential that additional examinations may be needed to meet the change-in-risk criteria. However, the potential impact, if any, is expected to be minimal as discussed below.

The text on pages 2-13 and 2-14 of Supplement 2, beginning with "From a change-in-risk perspective"... and ending with "Thus, crediting the ASME Section XI examinations for addressing the risk in a segment results in a conservative evaluation relative to meeting the change-in-risk acceptance criteria." will be replaced the revised text below. This revised text is based on the additional information provided in the response to RAI 1 and this RAI.

There are 11 basic scenarios for the change-in-risk evaluation that can occur if multiple pipe size segments are split by pipe size. Additional scenarios are possible if a multiple pipe size segment has more than two pipe sizes; however, these additional scenarios can be broken down into combinations of these basic 11 scenarios. For each of these scenarios, the ability to meet the change-in-risk criteria is affected by the failure probabilities used to represent the split segments which is dependent upon whether the split segments would or would not be examined for each respective program. The failure probabilities with ISI are generally lower than failure probabilities without ISI. Each basic scenario is evaluated in Table 2.2-4 by comparing the potential difference between the RI-ISI program and the ASME Section XI program for the multiple pipe size segment against the combined potential difference between the two programs for the split segments. Augmented examinations are not addressed in Table 2.2-4 since the augmented examinations are conducted as part of both the risk-informed ISI and the ASME Section XI programs and are treated the same for each program in the change-in-risk calculation.

Table 2.2-4 Scenarios for Splitting Multiple Pipe Size Segments and Their Effects on the Change-in-Risk Evaluation									
Scenario	**Multiple Pipe Size Segment**		**Split Segment 1**			**Split Segment 2**			**Ability to Meet Change-in-Risk Criteria After Split**
	Safety Significance	# ASME Section XI Exams	Safety Significance	RI-ISI Exam	ASME Section XI Exam	Safety Significance	RI-ISI Exam	ASME Section XI Exam	
1	LSS	2	LSS	N	Y	LSS	N	Y	Less[1]
2	LSS	1	LSS	N	Y	LSS	N	N	Neutral[2]
3	LSS	0	LSS	N	N	LSS	N	N	Neutral[3]
4	HSS	2	HSS	Y	Y	HSS	Y	Y	Neutral[4]
5	HSS	1	HSS	Y	Y	HSS	Y	N	Greater[5]
6	HSS	0	HSS	Y	N	HSS	Y	N	Greater[6]
7	HSS	2	HSS	Y	Y	LSS	N	Y	Less[7]
8	HSS	1	HSS	Y	Y	LSS	N	N	Neutral[8]
9	HSS	1	HSS	Y	N	LSS	N	Y	Greater[9]
10	HSS	0	HSS	Y	N	HSS	Y	N	Greater[10]
11	HSS	0	HSS	Y	N	LSS	N	N	Neutral[11]

Notes:

1. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the ASME Section XI program. However, the combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the ASME Section XI program would be less than that for the risk-informed ISI program for this scenario, the ability to meet the change-in-risk criteria would be reduced.
2. The difference in risk between the two programs for the multiple pipe size segment and split segment 1 would be the same. There would be no difference in risk between the programs for split segment 2. The combined difference in risk between the two programs for the split segments would be the same as the difference in risk between the programs for the multiple pipe size segment and the ability to meet the change-in-risk criteria would not be affected.
3. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.
4. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.
5. There would be no difference in risk between the two programs for the multiple pipe size segment and split segment 1. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the risk-informed ISI program would be lower. The combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program is less than the ASME Section XI program, the ability to meet the change-in-risk criteria is greater.

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6. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the risk-informed ISI program. However the combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program would be less than that for the ASME Section XI program for this scenario, the ability to meet the change-in-risk criteria would be greater.
7. There would be no difference in risk between the two programs for the multiple pipe size segment and split segment 1. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the ASME Section XI program would be lower. The combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the ASME Section XI program is less than the risk-informed ISI program, the ability to meet the change-in-risk criteria is reduced.
8. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.
9. There would be no difference in risk between the two programs for the multiple pipe size segment. The difference in risk between the two programs for split segment 1 would be different. The risk associated with the risk-informed ISI program would be lower. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the ASME Section XI program would be lower. Split segment 1 would be HSS, and split segment 2 would be LSS. Therefore the effects from split segment 1 would dominate. The combined difference in risk between the two programs for the split segments would be greater than the difference between the two programs for the multiple pipe size segment. Since split segment 1 would dominate the effect and the risk would be lower with the risk-informed ISI program for split segment 1, the ability to meet the change-in-risk criteria would be greater.
10. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the risk-informed ISI program. However, the combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program would be less than that for the ASME Section XI program for this scenario, the ability to meet the change-in-risk criteria would be greater.
11. The difference in risk between the two programs for the multiple pipe size segment and split segment 1 would be the same. There would be no difference in risk between the programs for split segment 2. The combined difference in risk between the two programs for the split segments would be the same as the difference in risk between the programs for the multiple pipe size segment and the ability to meet the change-in-risk criteria would not be affected.

The evaluations of these basic scenarios demonstrate that, in all but two cases, splitting a multiple pipe size segment will either have a neutral effect on the change-in-risk evaluation or increase the ability of the RI-ISI program to meet the change-in-risk criteria. For the two cases in which meeting the change-in-risk criteria may be more difficult, the potential impact, if any, is expected to be minimal for the following reasons:

- Based on the experience to date, multiple pipe size segments typically do not contain an ASME Section XI examination on more than one size.

- These multiple pipe size segments are LSS. Segments that are defined as LSS have a lower piping CDF and LERF and are unlikely to have a significant impact on the change-in-risk calculations and in meeting the criteria.

- There is inherent conservatism built into the change-in-risk calculation. It is conservatively assumed that the ASME Section XI examinations address the risk associated with the segment, although in reality they may not. In a multiple pipe size segment with an ASME Section XI examination, it is possible that the ASME Section XI examination is not on the pipe size with the highest failure probability. Furthermore, it is possible that on a single size segment, the ASME Section XI examination may not occur at the element with the controlling postulated degradation mechanism. In these cases, it is possible that the ASME Section XI examination does not address the majority of the risk associated with the segment. Thus, crediting the ASME Section XI examinations for addressing the risk in a segment results in a conservative evaluation relative to meeting the change-in-risk acceptance criteria.

NRC RAI 8. *The review/screening process discussed in Appendix A appears to have two scenarios under which examinations would be added to the RI-ISI program. One of these scenarios is addressed in question 6. The other scenario occurs when:*

> *An LSS multiple pipe size segment contains an ASME Section XI exam on more than one size. This segment is split based on size and the change-in-risk criteria is not met, even with conservatisms removed.*

Does the process recommend an increased number of examinations? If so, where in Supplement 2 is this stated?

Response to NRC RAI 8

In Supplement 2, there is no recommendation to increase the number of inspections to meet the change-in-risk criteria. The units analyzed in Appendix A met the change-in-risk criteria with no additional examinations. Units D and E encountered a scenario other than 1 and 2 above where their expert panel increased the number of examinations above what was required by the Perdue Model. This scenario is addressed in the revised last paragraph in Section 2.3 of Supplement 2 which requires that one or more examinations be conducted to address each of the postulated degradation mechanisms on a HSS segment with more than one postulated degradation mechanism. This may result in an increased number of examinations.

Appendix A of Supplement 2, provides an evaluation of five risk-informed ISI programs which used the first method to calculate the failure probability of multiple pipe size segments. For these programs, how many different sizes did the multiple pipe size segments contain? What were the ranges of these sizes?

Response to NRC RAI 9

As discussed in the response to RAI 3, the requested data is provided for Units A, B, and C in Appendix A. For Unit A, the segment that had the maximum number of pipe sizes had 6 different sizes whose nominal pipe diameters ranged from ½" to 6". The Unit A segment that had the maximum range of sizes included nominal pipe diameters from 3" to 24". For Unit B, the segment that had the maximum number of pipe sizes had 3 different sizes whose nominal pipe diameters ranged from 6" to 12". The same Unit B segment also had the maximum range of sizes. For Unit C, the segment that had the maximum number of pipe sizes had 4 different sizes whose nominal pipe diameters ranged from 3/4" to 3". The Unit C segment that had the maximum range of sizes included nominal pipe diameters from 8" to 14".

Section 3 of Supplement 2 describes the basis for which the expert panel can classify segments that have been determined, by quantitative methods, to be HSS as LSS. However, the basis does not appear to include consideration of the time necessary for operators to diagnose the failed functions or the availability of equipment needed to recover from or mitigate the failures. Please state if Supplement 2 states these considerations as part of the basis for the expert panel to reclassify segments from HSS to LSS.

Response to NRC RAI 10

The wording in Supplement 2 was intended to imply that the time to diagnose the failed function is to be included in the time considered. The following sentences will be revised to explicitly state this:

In Section 3.2, the last sentence of the second paragraph will be revised to:

The expert panel must ~~carefully~~ consider what actions the operators would take, the indications that would be available to alert the operator to take the appropriate action, and the time available ~~to the operators to take the actions~~ **for diagnosis and for the operators to take the actions. The equipment associated with taking the action must be available.**

In Section 3.3, the third bullet of the third paragraph will be revised to:

There is time available for the operator to **diagnose and** take the action that results in a success path (i.e., isolating or mitigating the piping failure) prior to the action becoming ineffective to mitigate the piping failure consequences. **The equipment associated with taking the action must be available.**

Response to Clarification 1

Although not associated with the response to any RAI, Note 2 of Table 4.1-1 will be revised to:

> Includes examination locations and Class 1 weld examination requirement figures that typically apply to Class 1, 2, 3, or Non-Class welds identified in accordance with the risk-informed selection process described in ~~Supplement 1 or 2~~ **WCAP-14572, Revision 1-NP-A.**

Attachment 2

2 CALCULATING FAILURE PROBABILITIES FOR MULTIPLE PIPE SIZE SEGMENTS

2.1 BACKGROUND

Section 3.5 of WCAP-14572 Revision 1-NP-A and Supplement 1 to the WCAP discuss how to estimate the structural reliability and risk assessment (SRRA) failure probabilities for segments. Based on the information presented, there are two methods that can be used for calculating the SRRA failure probability for a multiple pipe size segment.

The first method is:

- A failure probability is calculated for every pipe size in the segment since some of the input parameters (e.g. nominal pipe size and thickness-to-outer diameter ratio) used by the SRRA code vary based on the pipe dimensions. In some, but not all cases, other input parameters vary for these "sub-segments" based upon the conditions for that particular sub-segment. The highest failure probability associated with the segment is then used to represent the segment.

The second method is:

- All of the degradation mechanisms in the segment being evaluated are included on a single weld (i.e., the limiting degradation mechanisms are combined or added and included on the limiting weld in the segment).
- If the results are not overly conservative the calculated failure probability is used.
- If the results are overly conservative, the segment is split and a failure probability is recalculated for each of these new segments. If the results are not overly conservative, these calculated failure probabilities are used. If the results are overly conservative, the segment is split until reasonable results are obtained.

This Supplement presents generic discussions and plant-specific examples that confirm that both methods are acceptable by demonstrating that there is essentially no difference in the number of examinations between the two methods or that any difference in the number of examinations would result in an insignificant impact. Therefore, the use of the first method as discussed above is acceptable.

Section 2.2 provides additional discussion on the comparison of the methods and a summary of the plant-specific examples, and Section 2.3 provides additional guidance on estimating failure probabilities for multiple pipe size segments. Details of the plant-specific examples are presented in Appendix A.

2.2 DISCUSSION

Section 2.2 and its associated subsections are provided for informational purposes only. The analyses described in this section do not represent additional requirements for conducting a risk-informed ISI program.

This Section demonstrates that there is no net difference in the number of examinations between the two methods or that any difference in the number of examinations results in an insignificant impact. To

Although there is a potential for a difference in the absolute number of examinations, any differences are expected to result in an insignificant impact. There are several reasons why a multiple pipe size segment would not need to be split or why there would be no difference in the number of examinations. The following paragraphs explain on a qualitative basis the instances where there would be no difference in the number of examinations.

The Only Difference in SRRA Inputs Are the Nominal Pipe Size or Thickness-to-Outside Diameter Ratio

Per Section 3.3 of WCAP-14572 Revision 1-NP-A, multiple pipe size segments are permitted. By definition, a multiple pipe size segment will have either different nominal pipe sizes or thickness-to-outside diameter ratios. Since the nominal pipe size and the thickness-to-outside diameter ratios are inputs to the SRRA code and since multiple pipe size segments are acceptable, it can be concluded that differences in the nominal pipe size and the thickness-to-outside diameter ratios are acceptable. Therefore, if the only differences in the SRRA inputs for a HSS multiple pipe size segment are the physical pipe dimensions (i.e., nominal pipe size and/or the thickness-to-outside diameter ratio) there is no need to split the segment, and there is no difference in the number of examinations.

Segments Comprised of Socket Welded Piping

If a HSS segment is comprised of socket welded piping and does not have an externally generated degradation, the entire segment is examined via a VT-2 examination. This applies to both single and multiple pipe size segments. If a multiple pipe size segment is split based on pipe size, each of the new segments would be examined via a VT-2 examination. Therefore, for HSS socket welded multiple pipe size segments where there is no externally generated degradation; there is no difference in the number of examinations.

Segments Comprised of Butt and Socket Welded Piping Where the Only Differences in SRRA Inputs are Between the Butt and Socket Welded Portions

If a HSS segment contains both socket welded piping and butt welded piping and there is no externally generated degradation mechanism on the socket welded piping, the socket welded piping is examined via a VT-2 visual examination. The number of examinations on the butt welded piping would be based upon any active degradation mechanisms and the Perdue Model statistical analysis as previously mentioned in Section 2.2.2. The Perdue Model analysis would be based on the data from the butt welded portion of the segment. If the only differences in the SRRA inputs are between the butt welded piping and the socket welded piping and the segment is split between the socket welded portion and the butt welded portion, the socket welded segment (or socket welded portion of the original segment) would be examined via a VT-2. The number of examinations on the butt welded segment (or butt welded portion of the original segment) would be based upon any active degradation mechanisms and the Perdue Model analysis. The Perdue Model analysis for the butt welded segment would be based on data from the butt welded portion of the piping, resulting in no change in the way the examinations are determined for the combined segment. Therefore, for HSS multiple pipe size segments containing butt welded piping and socket welded piping where there is no external degradation mechanism on the socket welded piping and the only difference in the SRRA inputs are between the socket welded and the butt welded portions of the segment, there is no difference in the number of examinations. Thus, there is no need to combine degradation mechanisms between the butt and socket welded portions of piping because the same number of examinations are identified for the butt and socket welded portions of piping; independent of whether the degradation mechanisms are combined or not.

- The potential difference in the number of examinations is associated with segments where there is no expected degradation mechanism.

- For those elements where there is no expected degradation mechanism, the number of examinations is determined by the Perdue Model analysis. A sufficient number of examinations must be conducted to have a 95% confidence level that the current target leak rates will not be exceeded. In accordance with WCAP-14572 Revision 1-NP-A page 174, a minimum of one examination will be conducted even if the Perdue Model analysis shows a 100% confidence level with no risk-informed ISI. This minimum requirement may result in a difference in the number of examinations; however, it still meets the acceptance criteria in Section 3.7.2 of the WCAP.

- In the cases where one pipe size has a more limiting SRRA input than the other sizes, using the more limiting SRRA input for the other sizes is most likely to result in no difference in the failure probability used to represent the segment or an increase in the segment failure probability that is not overly conservative.

- The most likely occurrence for increases in the segment failure probability that are potentially overly conservative is associated with situations where different sizes have different more limiting SRRA inputs or degradation mechanisms. As discussed above, if these degradation mechanisms are active or the segment is modeled as being highly susceptible to an active degradation mechanism, there is no difference in the number of examinations. However, if a HSS segment is modeled with multiple postulated degradation mechanisms, ~~it is recommended that consideration be given to conducting~~ conduct one or more examinations that address each postulated degradation mechanism.

Although there could be a difference in the absolute number of required examinations determined using the first method versus the second method for calculating the SRRA failure probabilities of multiple pipe size segments, the number of examinations must meet the acceptance criteria in Section 3.7.2 of the WCAP. The WCAP-14572 Revision 1-NP-A methodology is based on the more global intent and purpose of a risk-informed ISI program rather than the absolute number of examinations. The purpose of risk-informed ISI programs is to properly address areas of degradation with moderate to high safety consequences (areas of degradation with low safety consequence are evaluated as part of the risk-informed ISI program for consideration in a licensee defined program). The first method properly identifies those piping segments with active degradation and moderate to high safety consequences. The calculation of failure probabilities for segments with multiple sizes does not impact the areas involving active degradation mechanisms, but instead impacts areas where inspection sampling is used to address unexpected degradation.

This Supplement contains quantitative evaluations of the potential differences from five risk-informed ISI programs. For each of the risk-informed ISI programs evaluated, the following process is used to identify any potential differences in the number of examinations.

1. The HSS multiple pipe size segments are identified.

2. Each HSS multiple pipe size segment is evaluated against the criteria identified above to determine if there are any potential differences in the number of examinations.

Unit D and Unit E Risk-Informed ISI Programs

The unit D and unit E risk-informed ISI programs are Class 1 and Class 2 programs. Similar to the other risk-informed ISI programs that are evaluated for any potential difference in the number of examinations, it is determined that there are no differences in the number of examinations. However, a unique situation occurred on one segment at both unit D and unit E that had not occurred at the other units that are evaluated. This situation is discussed in the following paragraphs.

The pressurizer surge lines at unit D and unit E are multiple pipe size segments consisting of two pipe sizes. When the limiting SRRA inputs from all pipe sizes are used to calculate the failure probability, the controlling failure probabilities for the segments are approximately the same. Thus, there is no difference in the number of examinations.

The pressurizer surge lines are modeled with the potential for two postulated degradation mechanisms that are not active and the surge lines are not considered highly susceptible to these degradation mechanisms. Thus, the segments are placed in Region 2 of the structural element selection matrix. The Perdue Model analysis of the surge line indicated that a minimum of one examination is required to maintain a 95 percent confidence that the current target leak rates would not be exceeded. The expert panel elected to assign two examinations to each of these segments to address each of the potential degradation mechanisms. Had the segment been split by pipe size, it is reasonable to assume that each of the split segments would have been categorized as HSS. With a minimum of one examination per HSS segment, it is reasonable to assume that two examinations would have been conducted on each of the pressurizer surge lines. Since the SRRA failure probabilities calculated by both methods are approximately the same, there is no need to split the segments, and there is no difference in the number of examinations. However, additional guidance has been added to Section 2.3 of this Supplement to WCAP-14572 Revision 1-NP-A to address this situation where a segment has more than one postulated degradation mechanism that is neither active nor modeled as highly susceptible to an active degradation mechanism. The guidance requires ~~recommends~~ that one or more ~~consideration be given to conducting an~~ examinations ~~on the segment~~ be conducted that addresse~~s~~ each postulated degradation mechanism on the HSS segment. In some cases, this may result in doing more examinations than is required by the statistical analysis.

2.2.4 Evaluating Potential Differences Based on the Change-in-Risk Evaluation

For the change-in-risk evaluation, a comparison of the risk-informed ISI program and the current American Society of Mechanical Engineers (ASME) Section XI ISI program is conducted using the risk evaluation that is developed as part of the risk-informed ISI program. On a simplified basis, the failure probabilities without ISI are used to represent segments that have no examination and the failure probabilities with ISI are used to represent segments that have an examination. As discussed in Section 4.4.2 of WCAP-14572 Revision 1-NP-A, the number of examinations (excluding the combination with some augmented examinations) has no impact on the failure probability that is used to represent a segment for either program.

As previously discussed, WCAP-14572 Revision 1-NP-A allows the use of multiple pipe size segments. However, if a multiple pipe size segment is split, there is a potential effect on meeting the change-in-risk criteria. The splitting of multiple pipe size segments is used in some of the previous discussions to demonstrate that there is no difference in the number of examinations; therefore, the potential effects of splitting a multiple pipe size segment on the change-in-risk evaluation are evaluated in the following paragraphs.

From a change-in-risk perspective, splitting a HSS multiple pipe size segment by pipe size does not result in additional examinations. HSS segments are inspected in the risk-informed ISI program. If all the various sizes in a segment are inspected in accordance with ASME Section XI, the same failure probability would be used for both programs for each of the segments split by size. Thus, there would be no effect on meeting the change-in-risk criteria. Since most multiple pipe size segments do not contain an ASME Section XI examination on more than one pipe size, the failure probability of the split HSS segment representing the ASME Section XI program would be without ISI whereas the failure probability of the split HSS segment representing the risk-informed ISI program would be with ISI. The net effect increases the ability to meet the change-in-risk criteria and possibly reduces the number of additional examinations required to meet the change-in-risk criteria. Thus, there is no difference or a conservative difference in the number of examinations due to splitting a HSS multiple pipe size segment.

If a LSS multiple pipe size segment is split and none of the pipe sizes contains an ASME Section XI examination, there is no effect on meeting the change-in-risk criteria. The failure probability without ISI would be used for all the pipe sizes in both the risk-informed and the ASME Section XI programs and there would be no difference in the CDF and LERF between the risk-informed and the ASME Section XI programs for these segments. Similarly, if a LSS multiple pipe size segment is split and only one pipe size contains an ASME Section XI examination, there is no effect on meeting the change-in-risk criteria. In both cases, before the segment is split and after it is split, the failure probability with ISI is used once for the ASME Section XI program, while all other failure probabilities are without ISI. Thus, there is no difference in the number of examinations due to splitting a LSS multiple pipe size segment, where none of the pipes sizes or only one pipe size contains an ASME Section XI examination.

If a LSS multiple pipe size segment is split by pipe size and more than one pipe size contains an ASME Section XI examination, the failure probability with ISI would be used for the split segments to represent the ASME Section XI program. The failure probability without ISI would be used for the split segments to represent the risk-informed ISI program. For the split segments, the difference between the two programs is increased because there are multiple segments instead of one. This situation could make it less likely to meet the change-in-risk criteria and additional examinations may be needed to meet the change-in-risk criteria. The potential impact, if any, is expected to be minimal for the following reasons:

- Based on the experience to date, multiple pipe size segments typically do not contain an ASME Section XI examination on more than one size.
- These multiple pipe size segments are LSS. Segments that are defined as LSS have a lower piping CDF and LERF and are unlikely to have a significant impact on the change-in-risk calculations and in meeting the criteria.
- There is inherent conservatism built into the change-in-risk calculation. It is conservatively assumed that the ASME Section XI examinations address the risk associated with the segment, although in reality they may not. In a multiple pipe size segment with an ASME Section XI examination, it is possible that the ASME Section XI examination is not on the pipe size with the highest failure probability. Furthermore, it is possible that on a single size segment, the ASME

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There are 11 basic scenarios for the change-in-risk evaluation that can occur if multiple pipe size segments are split by pipe size. Additional scenarios are possible if a multiple pipe size segment has more than two pipe sizes; however, these additional scenarios can be broken down into combinations of these basic 11 scenarios. For each of these scenarios, the ability to meet the change-in-risk criteria is affected by the failure probabilities used to represent the split segments which is dependent upon whether the split segments would or would not be examined for each respective program. The failure probabilities with ISI are generally lower than failure probabilities without ISI. Each basic scenario is evaluated in Table 2.2-4 by comparing the potential difference between the RI-ISI program and the ASME Section XI program for the multiple pipe size segment against the combined potential difference between the two programs for the split segments. Augmented examinations are not addressed in Table 2.2-4 since the augmented examinations are conducted as part of both the risk-informed ISI and the ASME Section XI programs and are treated the same for each program in the change-in-risk calculation.

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Table 2.2-4 Scenarios for Splitting Multiple Pipe Size Segments and Their Effects on the Change-in-Risk Evaluation

Scenario	Multiple Pipe Size Segment		Split Segment 1			Split Segment 2			Ability to Meet Change-In-Risk Criteria After Split
	Safety Significance	# ASME Section XI Exams	Safety Significance	RI-ISI Exam	ASME Section XI Exam	Safety Significance	RI-ISI Exam	ASME Section XI Exam	
1	LSS	2	LSS	N	Y	LSS	N	Y	Less[1]
2	LSS	1	LSS	N	Y	LSS	N	N	Neutral[2]
3	LSS	0	LSS	N	N	LSS	N	N	Neutral[3]
4	HSS	2	HSS	Y	Y	HSS	Y	Y	Neutral[4]
5	HSS	1	HSS	Y	Y	HSS	Y	N	Greater[5]
6	HSS	0	HSS	Y	N	HSS	Y	N	Greater[6]
7	HSS	2	HSS	Y	Y	LSS	N	Y	Less[7]
8	HSS	1	HSS	Y	Y	LSS	N	N	Neutral[8]
9	HSS	1	HSS	Y	N	LSS	N	Y	Greater[9]
10	HSS	0	HSS	Y	N	HSS	Y	N	Greater[10]
11	HSS	0	HSS	Y	N	LSS	N	N	Neutral[11]

Notes:

1. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the ASME Section XI program. However, the combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the ASME Section XI program would be less than that for the risk-informed ISI program for this scenario, the ability to meet the change-in-risk criteria would be reduced.
2. The difference in risk between the two programs for the multiple pipe size segment and split segment 1 would be the same. There would be no difference in risk between the programs for split segment 2. The combined difference in risk between the two programs for the split segments would be the same as the difference in risk between the programs for the multiple pipe size segment and the ability to meet the change-in-risk criteria would not be affected.
3. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.
4. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.
5. There would be no difference in risk between the two programs for the multiple pipe size segment and split segment 1. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the risk-informed ISI program would be lower. The combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program is less than the ASME Section XI program, the ability to meet the change-in-risk criteria is greater.
6. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the risk-informed ISI program. However the combined difference in risk between the two programs for the split segments would be

greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program would be less than that for the ASME Section XI program for this scenario, the ability to meet the change-in-risk criteria would be greater.

7. There would be no difference in risk between the two programs for the multiple pipe size segment and split segment 1. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the ASME Section XI program would be lower. The combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the ASME Section XI program is less than the risk-informed ISI program, the ability to meet the change-in-risk criteria is reduced.
8. There would be no difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2. The ability to meet the change-in-risk criteria would not be affected.
9. There would be no difference in risk between the two programs for the multiple pipe size segment. The difference in risk between the two programs for split segment 1 would be different. The risk associated with the risk-informed ISI program would be lower. The difference in risk between the two programs for split segment 2 would be different. The risk associated with the ASME Section XI program would be lower. Split segment 1 would be HSS, and split segment 2 would be LSS. Therefore the effects from split segment 1 would dominate. The combined difference in risk between the two programs for the split segments would be greater than the difference between the two programs for the multiple pipe size segment. Since split segment 1 would dominate the effect and the risk would be lower with the risk-informed ISI program for split segment 1, the ability to meet the change-in-risk criteria would be greater.
10. The difference in risk between the two programs for the multiple pipe size segment, split segment 1 and split segment 2 would be the same which is lower risk for the risk-informed ISI program. However, the combined difference in risk between the two programs for the split segments would be greater than the difference in risk between the programs for the multiple pipe size segment. Since the risk for the risk-informed ISI program would be less than that for the ASME Section XI program for this scenario, the ability to meet the change-in-risk criteria would be greater.
11. The difference in risk between the two programs for the multiple pipe size segment and split segment 1 would be the same. There would be no difference in risk between the programs for split segment 2. The combined difference in risk between the two programs for the split segments would be the same as the difference in risk between the programs for the multiple pipe size segment and the ability to meet the change-in-risk criteria would not be affected.

The evaluations of these basic scenarios demonstrate that, in all but two cases, splitting a multiple pipe size segment will either have a neutral effect on the change-in-risk evaluation or increase the ability of the RI-ISI program to meet the change-in-risk criteria. For the two cases in which meeting the change-in-risk criteria may be more difficult, the potential impact, if any, is expected to be minimal for the following reasons:

- Based on the experience to date, multiple pipe size segments typically do not contain an ASME Section XI examination on more than one size.

- These multiple pipe size segments are LSS. Segments that are defined as LSS have a lower piping CDF and LERF and are unlikely to have a significant impact on the change-in-risk calculations and in meeting the criteria.

- There is inherent conservatism built into the change-in-risk calculation. It is conservatively assumed that the ASME Section XI examinations address the risk associated with the segment, although in reality they may not. In a multiple pipe size segment with an ASME Section XI examination, it is possible that the ASME Section XI examination is not on the pipe size with the highest failure probability. Furthermore, it is possible that on a single size segment, the ASME Section XI examination may not occur at the element with the controlling postulated degradation mechanism. In these cases, it is possible that the ASME Section XI examination does not address the majority of the risk associated with the segment. Thus, crediting the ASME Section XI examinations for addressing the risk in a segment results in a conservative evaluation relative to meeting the change-in-risk acceptance criteria.

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~~Section XI examination may not occur at the element with the controlling postulated degradation mechanism. In these cases, it is possible that the ASME Section XI examination does not address the majority of the risk associated with the segment. Thus, crediting the ASME Section XI examinations for addressing the risk in a segment results in a conservative evaluation relative to meeting the change-in-risk acceptance criteria.~~

To support the above qualitative arguments, the change-in-risk is reevaluated for five units. For one unit, there are no LSS multiple pipe size segments with an ASME Section XI examination on more than one pipe size. Note that for some of these evaluations, it is conservatively assumed that any LSS multiple pipe size segment containing an ASME Section XI examination contains an ASME Section XI examination on every pipe size in the segment. For all five units, the change-in-risk criteria are met without adding additional inspections when the LSS multiple pipe size segments that contain an ASME Section XI examination on more than one size are split into separate segments based on pipe size.

2.2.5 Evaluating Potential Difference Based on Defense-In-Depth

As part of the process, the risk-informed ISI program is evaluated to ensure that the defense-in-depth philosophy is maintained. Regulatory Guide 1.178 identifies that an important element of defense-in-depth for risk-informed ISI is maintaining the reliability of independent barriers to fission product release. The consideration of examining a segment for defense-in-depth reasons is not affected by how the failure probability for a multiple pipe size segment is estimated. Thus, there is no difference in the number of examinations based on maintaining defense-in-depth.

2.2.6 Conclusions

This Supplement presents generic discussions and plant-specific quantitative examples for estimating a multiple pipe size segment failure probability. The discussion of plant-specific examples demonstrates that the two methods for calculating SRRA failure probabilities for multiple pipe size segments result in either no difference in the number of examinations or an insignificant impact on the number of examinations for the following reasons:

- Any difference in the number of examinations would not impact the areas involving active degradation mechanisms, but would impact areas where inspection sampling is used to address potential degradation mechanisms.

- Although the input parameters for different cases of the same segment may vary, the parameters that are chosen for each case are the most limiting for that section (or size) of the segment. The failure probability estimates associated with each pipe size for each segment are based on the realistic, limiting inputs associated with that section of piping.

- The WCAP-14572 Revision 1-NP-A methodology uses a relative ranking process in the risk evaluation. The use of overly conservative data could result in other segments being quantitatively LSS, when they could have been quantitatively HSS. Generating the failure probability for each sub-segment ensures that overly conservative SRRA failure probabilities are not calculated. Choosing the highest sub-segment failure probability for the segment ensures that the risk associated with any portion or sub-segment within the segment is reasonable.

- If the results are not overly conservative, the calculated failure probability is used.

- If the results are overly conservative, either the first method is used to estimate the failure probability or the segment is split and a failure probability is estimated for each of these new segments. The process of estimating a failure probability and evaluating the results is repeated until reasonable results are obtained.

If a multiple pipe size segment has two or more degradation mechanisms that occur on different pipe sizes of the segment, combining the degradation mechanisms into a single failure probability can lead to an unrealistic and overly conservative result. One way to determine this is to conduct sensitivity runs where only the degradation mechanism(s) (i.e. SRRA inputs parameters) applicable to a given pipe size are used for that pipe size. If the results for the combined degradation mechanisms at one location are more than an order of magnitude higher that either of the uncombined results, consideration should be given to splitting the segment or using the first method to estimate the failure probability.

Note that regardless of which method is used to determine the failure probability, if a multiple pipe size segment is categorized as HSS, all locations in the segment identified by the engineering subpanel as being affected by or highly susceptible to an active degradation mechanism must be examined. If a segment contains two or more active degradation mechanisms, the structural elements subjected to any one of the active degradation mechanisms must be examined.

In some cases, a segment, including a multiple pipe size segment, may not be analyzed as being highly susceptible to an active degradation mechanism, but the engineering subpanel may still postulate some potential for an active degradation mechanism. Since the segment does not have an active degradation mechanism, the Perdue Model can be used to determine the number of examination locations. In this situation, the examination location or locations should be based on where the postulated degradation mechanism might occur. If more than one degradation mechanism is postulated on a segment, ~~it is recommended that consideration be given to~~ HHS conduct~~ing~~ one or more examinations that would address each of the postulated degradation mechanisms. Note that in some cases, this may result in more examinations relative to what is required by the Perdue Model statistical analysis.

There is no need to combine degradation mechanisms between the butt and socket welded portions of piping because the same number of examinations are identified for the butt and socket welded portions of piping; independent of whether the degradation mechanisms are combined or not.

3 EXPERT PANEL CATEGORIZATION OF SEGMENTS AS LOW SAFETY SIGNIFICANT THAT ARE QUANTITATIVELY HIGH SAFETY SIGNIFICANT

3.1 BACKGROUND

This section presents an example of when an expert panel may decide to categorize a segment as LSS that is determined by quantitative methods to be HSS. This example is used to clarify what is considered to be sufficient justification for an expert panel to make such a decision. Both quantitative and deterministic insights are used by the expert panel in determining the safety significance of each segment. In general, if either the quantitative or deterministic insights merit the segment being categorized as HSS, the expert panel should categorize the segment as HSS. The risk metrics of RRW for the CDF and LERF without and with operator action cases are the primary quantitative measures for identifying HSS segments. The operator actions in these cases refer only to those actions to isolate or mitigate piping failures. A segment is considered to be quantitatively HSS if any of the RRWs calculated for the four cases are greater than 1.005.

Expert panels may categorize segments that have been determined by quantitative methods to be HSS as LSS in accordance with Section 3.6.3 of WCAP-14572. However, the expert panel should not categorize segments as low safety significant that have been determined by quantitative methods to be high safety significant without sufficient justification that is documented as part of the risk-informed ISI program. This supplement provides additional guidance on what is considered to be sufficient justification and the documentation for categorization of segments as LSS that are quantitatively HSS.

3.2 DISCUSSION

There are scenarios where some of the RRWs for a segment may be greater than 1.005 while the other RRWs for the segment are lower (i.e., less than 1.005 or even less than 1.001). In some of these instances, the expert panel may conclude that RRWs greater than 1.005 are overly conservative or represent an unrealistic scenario. Where possible, the conservative modeling should be revised and more realistic results should be obtained. Due to probabilistic risk assessment (PRA) model limitations, not all instances can be recalculated with more realistic results. Therefore, with sufficient justification, the expert panel can categorize these segments as LSS. The justification must be adequately documented in a manner such that an independent expert panel would come to the same conclusion.

An example of when the expert panel may consider categorizing a segment as LSS that is quantitatively HSS is associated with the consideration of operator actions. The expert panel may conclude that it is unrealistic that the operators would not take some corrective action to isolate or mitigate the piping failure. For these cases, the expert panel can base the safety significance on the with operator action results. However, in doing so, the expert panel is assuming that the operators will always take the appropriate action to isolate or mitigate the piping failure. The expert panel must ~~carefully~~ consider what actions the operators would take, the indications that would be available to alert the operator to take the appropriate action, and the time availabl~~e to the operators to take the actions.~~ for diagnosis and for the the operators to take the actions. The equipment associated with taking the action must be available.

3.3 ADDITIONAL SPECIFIC GUIDANCE ON EXPERT PANEL CATEGORIZATION

The expert panel evaluates the risk-informed results and makes a final decision by identifying the safety significance of each piping segment. As discussed in WCAP-14572 Revision 1-NP-A Section 3.6.3, segments that have been determined by quantitative methods to be HSS (i.e., segments with any RRW > 1.005) typically should be categorized as HSS by the expert panel. The primary focus of the expert panel is to add segments to the higher classification. As part of the process, the expert panel may feedback comments to the appropriate engineering personnel which may result in an adjustment of the numerical results. Adjusted numerical results should be reviewed by the expert panel.

The segments that have been determined by quantitative methods to be HSS should not be classified lower by the expert panel without sufficient justification that is documented as part of the risk-informed ISI program. In these instances, the justification must be documented in a manner such that an independent expert panel would come to the same conclusion. An example of when an expert panel may consider categorizing a segment as LSS that is quantitatively HSS is associated with operator actions where the expert panel concludes that the without operator action results represent an overly conservative or unrealistic scenario. In this situation, the CDF and/or LERF RRWs without operator action are greater than 1.005 while the CDF and LERF RRWs with operator action are less than 1.005 or even less than 1.001.

By categorizing these segments as LSS, the expert panel is basing the safety significance of the segment primarily on the with operator action results, which means that the expert panel is assuming that the operators will always take the appropriate mitigating actions. In doing so, the expert panel must consider the following items:

- The operator actions are proceduralized.
- Indications are available to alert the operators to take the appropriate action.
- There is time available for the operator diagnose and ~~to~~ take the action that results in a success path (i.e., isolating or mitigating the piping failure) prior to the action becoming ineffective to mitigate the piping failure consequences. The equipment associated with taking action must be available

To ensure that the justification would reasonably lead an independent expert panel to the same conclusions, the key elements of the justification are documented. This key documentation should include:

- Identification of the procedure that the operators are using.
- Identification of the instrumentation that would alert the operators to take the appropriate actions.
- The estimated time that the operators have to respond to the event.

The WOG risk-informed ISI methodology evaluates four cases for quantitative results - CDF without operator action, CDF with operator action, LERF without operator action and LERF with operator action.

Table 4.1-1 Examination Category R-A, Risk-Informed Piping Examinations (cont.)

					Extent and Frequency [Note (3)]		
Item No.	Parts Examined	Examination Requirement/ Fig. No. [Note (2)]	Examination Method	Acceptance Standard	1st Interval	Successive Intervals	Defer to End of Interval
R1.20	Elements not Subject to a Degradation Mechanism	IWB-2500-8(c) [Note (1)] IWB-2500-9, 10, 11	Volumetric [Notes (8), (9)]	IWB-3514	Element [Notes (2), (4)]	Same as 1st	Not Permissible

NOTES:

1. The length of the examination volume shown in Figure IWB-2500-8(c) shall be increased by enough distance [approximately ½ in. (13mm)] to include each side of the base metal thickness transition or counterbore.
2. Includes examination locations and Class 1 weld examination requirement figures that typically apply to Class 1, 2, 3, or Non-Class welds identified in accordance with the risk-informed selection process described in ~~Supplement 1 or 2~~. WCAP-1472, Revision 1-NP-A.
3. Includes 100% of the examination location. When the required examination volume or area cannot be examined, due to interference by another component or part geometry, limited examinations shall be evaluated for acceptability. Acceptance of limited examinations or volumes shall not invalidate the results of the risk-informed evaluation. Areas with acceptable limited examinations, and their bases, shall be documented.
4. The examination shall include any longitudinal welds at the location selected for examination in [Note 2]. The longitudinal weld examination requirements shall be met for both transverse and parallel flaws within the examination volume defined in [Note 2] for the intersecting circumferential welds.
5. The examination volume shall include the volume surrounding the weld, weld HAZ, and base metal, as applicable, in the crevice region. Examination should focus on detection of cracks initiating and propagating from the inner surface.
6. The examination volume shall include base metal, welds, and weld HAZ in the affected regions of carbon and low alloy steel, and the welds and weld HAZ of austenitic steel. Examinations shall verify the minimum wall thickness required. Acceptance criteria for localized thinning are in course of preparation. The examination method and examination region shall be sufficient to characterize the extent of the element degradation.
7. In accordance with the Owner's existing programs such as IGSCC, MIC, or FAC programs as applicable.
8. Socket welds of any size and branch pipe connection welds NPS 2 (DN 50) and smaller, require only VT-2 visual examination.
9. VT-2 visual examinations shall be conducted during a system pressure test or a pressure test specific to that element or segment, in accordance with IWA-5000, IWB-5000, IWC-5000, or IWD-5000, as applicable, and shall be performed during each refueling outage or at a frequency consistent with the time (e.g., 18 to 24 months) between refueling outages.

APPENDIX A
PLANT-SPECIFIC EXAMPLES FOR CALCULATION OF FAILURE PROBABILITIES FOR MULTIPLE PIPE SIZE SEGMENTS

Appendix A is provided for informational purposes only. The analyses described in this appe do not represent additional requirements for conducting a risk-informed ISI program

As discussed in Section 2, there is a potential for a difference in the absolute number of examinations between the two methods for calculating SRRA failure probabilities for multiple pipe size segments. The two methods are (1) calculating a failure probability for each pipe size by using the most limiting SRRA inputs from that pipe size and then using the highest failure probability to represent the multiple pipe size segment and (2) calculating a failure probability using the most limiting SRRA inputs from all the sizes in a multiple pipe size segment. To demonstrate that there is no difference in the number of examinations or that any difference in the number of examinations would be insignificant, several risk-informed ISI programs are evaluated for potential differences. The evaluation of the licensee's risk-informed ISI programs focused on the two areas where a potential difference using the two different methods might occur:

- If the segment is categorized as HSS, there may be more examinations if the segment is split since a minimum of one examination is conducted for each HSS segment.
- If the segment is categorized as LSS and each pipe size contained an ASME Section XI examination, the change-in-risk criteria in WCAP-14572 Revision 1-NP-A may not be met. If this situation occurred, additional change-in-risk examinations may be needed to meet the change-in-risk criteria.

Below is a summary of the process that is used to evaluate a licensee's risk-informed ISI program to identify if there would be any potential difference in the number of examinations.

- All multiple pipe size segments are identified.
- The categorization as HSS or LSS of each multiple pipe size segment is identified.
- All the SRRA runs for the HSS multiple pipe size segments are reviewed to determine their applicability. SRRA runs for input to the Perdue Model and use in sensitivity runs are excluded from further review, since these SRRA runs intentionally include variations in the SRRA inputs that have no effect on the categorization of segments as HSS or LSS or any effect on the change-in-risk evaluation.
- Each applicable SRRA run for a HSS multiple pipe size segment is reviewed and the SRRA inputs compared to determine what, if any, differences exist.
- A "process of elimination" is applied based on the following questions to eliminate a HSS multiple pipe size segment from further review by identifying a condition for the segment that would result in no difference in the number of examinations.
  - Are the only differences in the SRRA inputs associated with the physical pipe dimensions (i.e., the nominal pipe size and / or the thickness-to-outside diameter ratio)?

- Is the segment comprised of only socket welded piping?

- Is the segment comprised of butt and socket welded piping, and the only difference in the SRRA inputs is between the butt and socket welded portions of the multiple pipe size segment?

- If the HSS multiple pipe size segment is split into multiple segments and the failure probabilities from each pipe size are used to represent their respective pipe size segments, is only one of the segments split by pipe size categorized as HSS?

If the answer to any of the above is "yes," the segment can be eliminated from further consideration. For each HSS multiple pipe size segment that is not eliminated based on the above questions, new SRRA failure probabilities are calculated using the most limiting SRRA inputs from all of the pipe sizes in the segment. The process of elimination is then continued based on the following questions.

- Would the SRRA failure probability used to represent the multiple pipe size segment be the same when comparing the new SRRA failure probabilities against the original failure probabilities used to represent the segment?

- If there is an increase in the failure probability that would be used to represent the multiple pipe size segment, is the new failure probability used to represent the segment not overly conservative? ~~Generally, if the increase in the failure probability is less than an order of magnitude or~~ If the sum of the failure probabilities that would be used for the individual pipe sizes is approximately the same as the failure probability for the segment using the most limiting SRRA inputs from all of the pipe sizes in the segment, the failure probability is considered to be not overly conservative.

If the answer to either of the above is "yes," the segment can be eliminated from further consideration.

- If a HSS multiple pipe size segment is not "eliminated" from further evaluation (i.e., shown to have no difference in the number of examinations) based on the above questions, the segment is assumed to be split and the number of examinations on the segments split by size is estimated to identify the potential difference in the number of examinations.

- All LSS multiple pipe size segments that contain an ASME Section XI examination on more than one pipe size are identified.

- If none of the LSS multiple pipe size segments contain more than one ASME Section XI examination, then there would be no change to the change-in-risk evaluation. The change-in-risk criteria would still be met, and there would be no difference in the number of examinations based on the LSS piping.

- If more than one size on a LSS multiple pipe size segment contains an ASME Section XI examination, the LSS multiple pipe size segment is assumed to be split based on the number of pipe sizes which contain an ASME Section XI examination. Splitting LSS multiple pipe size