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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
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)

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.

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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 scenario, 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 the 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 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." Within each of these segments, the 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 each segment. WCAP-14572 (p. 178, 3.7.2) states that, when using the Perdue model, a minimum of one exam 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.

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 addresses 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.

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 be conducted ~~on the segment~~ that addresses 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

Insert text on following 4 pages.

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.
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.

~~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~~ 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.

HHS

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 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 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 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? ~~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