OG-02-057
December 20, 2002

WCAP-14572 Revision 1-NP-A Addendum 1
Project Number 694

Domestic Members
AmerenUE
Callaway
American Electric Power Co.
D C Cook 1 & 2
Carolina Power & Light Co
H B Robinson 2
Shearon Harris
Dominion Nuclear Connecticut
Millstone 3
Dominion Virginia Power
North Anna 1 & 2
Surry 1 & 2
Duke Power Company
Catawba 1 & 2
McGuire 1 & 2
Entergy Nuclear Operations Inc.
Indian Point 2 & 3
Exelon Generation Company LLC
Braidwood 1 & 2
Byron 1 & 2
FirstEnergy Nuclear Operating Co
Beaver Valley 1 & 2
Florida Power & Light Co.
Turkey Point 3 & 4
Northeast Utilities
Seabrook
Nuclear Management Co.
Point Beach 1 & 2
Prairie Island 1 & 2
Kewaunee
Pacific Gas & Electric Co.
Diablo Canyon 1 & 2
PSEG - Nuclear
Salem 1 & 2
Rochester Gas & Electric Co
R E Ginna
South Carolina Electric & Gas Co.
V C Summer
STP Nuclear Operating Co.
South Texas Project 1 & 2
Southern Nuclear Operating Co
J M Farley 1 & 2
A.W Vogtle 1 & 2
Tennessee Valley Authority
Sequoyah 1 & 2
Watts Bar 1
TXU Electric
Commanche Peak 1 & 2
Wolf Creek Nuclear Operating Corp
Wolf Creek

International Members
Electrabel
Doel 1, 2, 4
Tihange 1, 3
Electricite de France
Kansai Electric Power Co.
Mihama 1
Takahama 1
Ohi 1 & 2
Korea Hydro & Nuclear Power Co
Kori 1 - 4
Yonggwang 1 & 2
British Energy plc
Sizewell B
Krsko
Krsko
Spanish Utilities
Asco 1 & 2
Vandellos 2
Almaraz 1 & 2
Ringhals AB
Ringhals 2 - 4
Taiwan Power Co.
Maanshan 1 & 2

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

Attention: Chief, Information Management Branch,
Division of Inspection and Support Programs

Subject: Westinghouse Owners Group
WOG Response to NRC Request for Additional Information to Support the Review of WCAP-14572 Revision 1-NP-A Addendum 1-Markup

References:

1. Westinghouse Owners Group Letter, Mr. Karl Jacobs to Mr. Stephen Bloom, U.S. Nuclear Regulatory Commission, "Transmittal of Revised Pages for WCAP-14572, Revision 1-NP-A Addendum 1, Addendum to Westinghouse Owners Group application of Risk-Informed Methods to Piping Inservice Inspection Topical Report to Address Changes to Augmented Inspection Requirements", June 2, 2000 OG-00-050.

2. U.S. Nuclear Regulatory Commission Letter, Mr. Stephen Dembeck to Mr. Robert H Bryan, "Addendum to Westinghouse Owners group application of Risk-Informed Methods To Piping Inservice Inspection Topical Report To Address Changes To Augmented Inspection Requirements" (TAC No. MA7995), March 8, 2001.

3. U.S. Nuclear Regulatory Commission Email from Mr. Girija Shukla to Mr. Dennis Weakland, Mr. Gordan Bischoff, et al, "Proposed WOG HELB Submittal Contents (WCAP-14572)", October 4, 2002.

4. U.S. Nuclear regulatory Commission Letter, Mr. Thomas Essig to Mr. Lou Liberatori, "Safety Evaluation of Topical Report WCAP-14572, Revision 1, Westinghouse Owners Group application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," December 15, 1998.

As a result of the September 25, 2002 meeting between the Nuclear Regulatory Commission (NRC), FirstEnergy Nuclear Operating Company (FENOC), and the Westinghouse Owners Group (WOG) additional information was requested (Reference 3). This information will support the NRC review of the subject topical report (Reference 1) and completes the Reference 2 request for a pilot plant application of the methodology. Beaver Valley Power Station Unit 2 is the

D048

pilot plant for the application. The additional information provided in Enclosures 1 and 2 consists of the following:

1. Standard RI-ISI Template submittal considering the Combined Base Class 1 and 2 and Break Exclusion Zone (BEZ) piping. BEZ specific piping results are identified where applicable throughout.

2. Quantitative input results for the PRA quantification, the failure probabilities for the ranking evaluation and the conditional CDF or LERF as appropriate for each of the 72 BEZ segments. The input values for the base scope (Class 1 and Class 2), combined scope (Class 1, Class 2, and BEZ) and the BEZ alone evaluation are provided.

Enclosures 3, 4, and 5 are provided to complete the package for your review and include the following:

3. Reference 3 NRC Email from Mr. Girija Shukla to Mr. Dennis Weakland, Mr. Gordon Bischoff, et al, "Proposed WOG HELB Submittal Contents (WCAP-14572)", October 4, 2002.

4. Hand mark-up of the additional changes to the version provided in Reference 1, including impacts of the pilot plant application.

5. Clean completed version of WCAP-14572, Revision 1-NP-A Addendum 1, "Addendum to Westinghouse Owners Group application of Risk-Informed Methods to Piping Inservice Inspection Topical Report to Address Changes to Augmented Inspection Requirements" with all proposed changes incorporated.

Note that there are no differences between the combined scope and BEZ alone sets of information except for the risk ranking RRW values. For common segments, the differences between the base scope and combined scope are solely due to consequences resulting from new breaks postulated in the BEZ. FENOC documents refer to Break Exclusion Region piping as the Break Exclusion Zone.

In response to discussions during the September 25 meeting, the WOG proposes the following:

1. Definition of the scope of applicable piping in the RI-ISI program is per the approved methodology (Reference 4).

2. The approved methodology would be applied without additional considerations where Break Exclusion Region piping constitutes the entire scope of the Risk-Informed application

3. Programs that consider piping classifications in addition to the piping designated as part of the Break Exclusion Region would perform additional screening for possible High Safety Significance classification. The screening would consist of the following for the segments that constitute the Break Exclusion Region:

   a Individual segment contribution to Core Damage Frequency is greater than or equal to 1E-8 per year.

   b. Individual segment contribution to Large Early Release Frequency is greater than or equal to 1E-9 per year.

   c. Break Exclusion Region inspections fall significantly below 10% of the total Break Exclusion Region scope.

The additional screening of the segments that constitute the Break Exclusion Region piping would result in additional inspections unless plant specific design features or analysis is specifically credited to mitigate any concerns and justify a low safety significance ranking.

The additional screening criteria apply only to the high energy piping segments in the original break exclusion region augmented program when addressed under Addendum 1 to WCAP-14572. The screening is not applicable to the segments outside of the break exclusion region piping. These criteria assure a minimum level of defense in the break exclusion region piping segments.

Please advise of the completion of the review of WCAP-14572, Revision 1-NP-A Addendum 1, "Addendum to Westinghouse Owners Group application of Risk-Informed Methods to Piping Inservice Inspection Topical Report to Address Changes to Augmented Inspection Requirements" as provided in this transmittal. The WOG kindly requests completion and issuance of the Safety Evaluation Report (SER) by March 31, 2003 to support Spring 2003 outages

If you require further information, feel free to contact Mr. Steve Lurie, Owners Group Project Office at 860-731-6241.

Very truly yours,

Robert H Bryan

Robert H. Bryan, Chairman
Westinghouse Owners Group

Enclosures

OG-02-057
December 19, 2002

cc: WOG Steering Committee
WOG Primary Representatives
WOG Materials Subcommittee Representatives
G. Shukla, USNRC OWFN 07 E1 (2L, 2A) (via Federal Express)
H. A. Sepp
G. C. Bischoff
J. D. Andrachek
K.R. Balkey
B.A. Bishop
C. L. Boggess
P.L. Strauch
S.R. Bemis
S.A. Binger
P.V. Pyle
K. J. Vavrek
J. Molkenthin
P.J. Hijeck
S.W. Lurie

ENCLOSURE 1

RI-ISI Template submittal considering the Combined Base Class 1 and 2 and Break Exclusion Zone (BEZ) piping

FirstEnergy Nuclear Operation Company
Beaver Valley Power Station Unit No. 2 Class 1 and 2 and Break Exclusion Zone
Risk-Informed Inservice Inspection Piping Program
Using the Westinghouse Owners Group (WOG) Methodology
(WCAP-14572, Revision 1-NP-A, February 1999)

Revision 0

November 2002

RISK-INFORMED INSERVICE INSPECTION PROGRAM PLAN

Table of Contents

1. INTRODUCTION/RELATION TO NRC REGULATORY GUIDE RG-1.174 3
1.1 Introduction 3
1.2 PRA Quality 3
2. PROPOSED ALTERNATIVE TO ISI PROGRAM 4
2.1 ASME Section XI 4
2.2 Augmented Programs 5
3. RISK-INFORMED ISI PROCESSES 5
3.1 Scope of Program 6
3.2 Segment Definitions 7
3.3 Consequence Evaluation 7
3.4 Failure Assessment 12
3.5 Risk Evaluation 16
3.6 Expert Panel Categorization 18
3.7 Identification of High Safety Significant Segments 20
3.8 Structural Element and NDE Selection 21
3.9 Program Relief Requests 22
3.10 Change in Risk 22
4. IMPLEMENTATION AND MONITORING PROGRAM 26
5. PROPOSED ISI PROGRAM PLAN CHANGE 27
6. SUMMARY OF RESULTS AND CONCLUSIONS 30
7. REFERENCES/DOCUMENTATION 30

1. INTRODUCTION/RELATION TO NRC REGULATORY GUIDE RG-1.174

1.1 Introduction

Inservice inspections (ISI) are currently performed on piping at Beaver Valley Power Station Unit 2 to the requirements of the ASME Boiler and Pressure Vessel Code Section XI, 1989 Edition as required by 10CFR50.55a. Furthermore, within the Break Exclusion Zone (BEZ), inservice inspections are performed to the requirements of MEB 3-1 of Standard Review Plan (SRP) 3.6.2 to comply with the requirements of General Design Criterion 4. FirstEnergy Nuclear Operating Company (FENOC) refers to Break Exclusion Region (BER) piping as the Break Exclusion Zone. The terms BEZ and BER may be used interchangeable in this document. Beaver Valley Power Station Unit 2 is currently in the second inspection period of the second inspection interval as defined by the Code for Program B.

The objective of this submittal is to request a change to the ISI program plan for piping through the use of a risk-informed ISI program. The risk-informed process used in this submittal is described in Westinghouse Owners Group WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," WCAP-14572, Revision 1-NP-A, Supplement 1, "Westinghouse Structural Reliability and Risk Assessment (SRRA) Model for Piping Risk-Informed Inservice Inspection," (referred to as "the WCAP" for the remainder of this document)," and WCAP-14572, Revision 1-NP-A, Addendum 1, "Augmented Piping Risk Informed ISI".

As a risk-informed application, this submittal meets the intent and principles of Nuclear Regulatory Commission (NRC) Regulatory Guide 1.174. Further information is provided in Section 3.10 relative to defense-in-depth.

1.2 PRA Quality

The Beaver Valley Power Station Unit 2 Level 1 and Level 2 probabilistic risk assessment (PRA) model, Version BV2REV2 dated October 31, 1997 was used to evaluate the consequences of pipe ruptures during operation of BVPS Unit 2 in Modes 1 and 2. The base core damage frequency (CDF) and base large, early release frequency (LERF) from this version of the PRA model are 7.14E-05/yr and 1.22E-06/yr, respectively.

The suggested schedule for PRA model updates are 3-year intervals. Each unit's PRA model update is also recommended to be staggered 18 months apart from the other unit, to avoid overlap in the update process between PRA models and impacted programs. The administrative guidance for this activity is contained in administrative procedures.

Based on past PRA model updates performed for the Beaver Valley Units (two on Unit 2), it was observed that most PRA model updates do not change significantly due to plant modifications and new failure data. To ensure that this remains valid, administrative procedures require that a PRA model be revised any time a plant modification increases the CDF by more than 20% above the baseline CDF value. The impacts of these plant modifications are documented and analyzed for any increases in the baseline CDF and LERF. To date no single modification has increased CDF by more than 3% and the accumulated change in CDF due to plant modifications since the last PRA model update at Unit 2 are about a .2% increase. Additionally, keeping within the established Maintenance Rule performance criteria for risk significant Systems, Structures, and Components (SSCs), helps to ensure that the impact on

CDF due to equipment unavailability and failures remains minimal. Therefore, the current Beaver Valley PRA models are meeting the intent of Regulatory Guide 1.174 in that they reflect the actual design, construction, operational practices and experiences as they relate to risk significant systems. In the past, the significant changes to the PRA models were typically due to removing conservatism of previous models (e.g., using best estimate analyses in place of design bases analyses) or by taking additional credit for backup components (e.g., using LHSI pumps in-place of HHSI pumps during small break LOCAs). Other significant changes involve improved state-of-the-art knowledge on PRA issues. Furthermore, an evaluation based on the Appendix B of the EPRI PSA Applications Guide, was performed to confirm that the PRA conforms to the industry state-of-the-art with respect to completeness of coverage of potential scenarios.

The PRA model has been extensively reviewed including internal multi-disciplined reviews during the IPE process, and internal and external PRA consultant reviews during the PRA model updates.

During the NRC's review of the Individual Plant Evaluation (IPE), concerns were identified regarding the limited consideration of pre-initiator human actions. The NRC noted that the Human Reliability Analysis could have been strengthened by the use of a reasonably rigorous process to identify potential pre-initiator human error contributions to system unavailability. System unavailability has been monitored as part of implementation of the Maintenance Rule, including any system unavailability due to human errors. The plant specific data collected for system unavailability was then used in the PRA model updates performed since the initial IPE submittal. To identify pre-initiator human error contributions to system unavailability, possible misalignments that could reasonably occur on standby systems were postulated and the impact on top event logic models and minimal cutsets was determined. The probability that the system/train is unavailable due to a misalignment event was calculated based on generic failure rates for errors of omission, the frequency of tests and maintenance on standby systems, and the duration of the misalignment. System unavailability resulting from human errors is therefore accounted for in the current models.

Several PRA model changes for the upcoming Unit 2 PRA model update were not incorporated into the PRA in time to support this submittal (i.e., RCP seal LOCA model updates). Preliminary results show that the majority of core damage frequency reduction will come from this refined modeling and applying state-of-the-art knowledge type activities. The RI-ISI Expert Panel was advised of these modifications and their impact on the piping systems. Therefore, these concerns were considered as part of the expert panel deliberations.

2. PROPOSED ALTERNATIVE TO ISI PROGRAM

2.1 ASME Section XI

ASME Section XI Categories B-F, B-J, C-F-1 and C-F-2 currently contain the requirements for examining via non-destructive examination (NDE) for Class 1 and 2 piping components. This current program is limited to ASME Class 1 and Class 2 piping, including piping currently exempt from NDE requirements. The alternative risk-informed inservice inspection (RI-ISI) program for piping is described in the WCAP. The RI-ISI program will be substituted for the current examination program on piping in accordance with 10 CFR 50.55(a)(3)(i) by implementing an alternative methodology that provides an acceptable level of quality and safety. Other examination categories will be unaffected. The WCAP, provides the

requirements defining the relationship between the risk-informed examination program and the remaining unaffected portions of ASME Section XI.

2.2 Augmented Programs

MEB 3-1 of SRP 3.6.2 contains the requirements for Break Exclusion Region areas in which breaks are not postulated. One of these requirements is the 100% volumetric inspection of all welds during each inspection interval per the Beaver Valley Power Station Unit No. 2 Updated Final Safety Analysis Report (UFSAR). The UFSAR defined the Break Exclusion Region as the Break Exclusion Zone that consists of High Energy piping in the Main Steam Valve Area. The Main Steam Valve Area is defined by the physical walls of the area. The alternative risk-informed inservice inspection (RI-ISI) program for Break Exclusion Zone piping is described in the Addendum to the WCAP. The RI-ISI program will be substituted for the current Break Exclusion Zone program on piping in accordance with 10 CFR 50.55(a)(3)(i) and 10CFR50.59, by implementing an alternative methodology that provides an acceptable level of quality and safety. Other augmented inspection programs will be unaffected.

3. RISK-INFORMED ISI PROCESSES

The processes used to develop the RI-ISI program are consistent with the methodology described in the WCAP.

The process that is being applied, involves the following steps:

- Scope Definition
- Segment Definition
- Consequence Evaluation
- Failure Assessment
- Risk Evaluation
- Expert Panel Categorization
- Element/NDE Selection
- Implement Program
- Feedback Loop

<u>Deviations</u>

As part of the risk evaluation described in Section 3.5, the uncertainty analysis as described on page 125 of the WCAP was performed and is now included as part of the base process.

<u>Structural Element/NDE Section; Change In Risk</u>

The change in risk methodology described in Section 3.10 deviated from the methodology for segments located inside containment and segments that interface with the Reactor Coolant System (RCS) such that radiation monitors and sump level will detect a leak. The RCS was defined to be the Class 1 primary loop pressure boundary piping. Beaver Valley Power Station Unit 2 capability to detect a leak within the RCS is defined to be 1 gpm per Tech Spec documentation. For these segments, the failure probability "with ISI" for those being inspected by NDE and "without ISI" for those not being inspected is used along with credit for leak detection.

3.1 Scope of Program

The scope of this program is ASME Class 1 and 2 and Break Exclusion Zone piping, including piping exempt from current requirements. The piping systems included in the risk-informed ISI program are provided in Table 3.1-1.

Table 3.1-1: System Selection and Segment Definition for Beaver Valley Power Station 2 Class 1 and 2 and BEZ Piping

System Description	PRA	Section XI	BEZ	Number of Segments	
				Combined Scope	BEZ Only
Steam Generator Blowdown System (BDG)	Yes	No	No	24	0
Chemical and Volume Control System (CHS)	Yes	Yes	No	160	0
Containment Isolation System (CI)	Yes	No	No	84	0
Reactor Plant Drains and Vents Systems (DAS)	Yes	Yes	No	7	0
Steam Generator Feedwater System (FWA)	Yes	Yes	Yes	57	12
Gaseous Nitrogen System (GNS)	Yes	No	No	6	0
Hydrogen Control System (HCS)	Yes	No	No	40	0
Main Steam System (MSS)	Yes	Yes	Yes	53	44
Quench Spray System (QSS)	Yes	Yes	No	38	0
Reactor Coolant System (RCS)	Yes	Yes	No	91	0
Residual Heat Removal System (RHS)	Yes	Yes	No	58	0
Recirculation Spray System (RSS)	Yes	Yes	No	68	0
Safety Injection System (SIS)	Yes	Yes	No	172[1]	0
Sampling System (SSR)	Yes	No	No	59	0
Break Exclusion Zone (BEZ)	Yes	No	Yes	16	16
Total				933	72

Note: 1. Three "Not Used" segments under the SIS identifier are included in the segment count.

3.2 Segment Definitions

Once the systems to be included in the program are determined, the piping for these systems is divided into segments.

The number of pipe segments defined for the Class 1 and 2 piping and BEZ (15 systems) is summarized in Table 3.1-1. The Valve Operating Number Diagrams and Piping Flow Diagrams were used to define the segments.

3.3 Consequence Evaluation

The consequences of pressure boundary failures are measured in terms of core damage and large early release. The impact on these measures due to both direct and indirect effects was considered. Table 3.3-1 summarizes the postulated consequences for each system.

Table 3.3-1
Summary of Postulated Consequences by System

System	Summary of Consequences
Steam Generator Blowdown System (BDG)	Direct effects: Reactor Trip (RT), Partial Loss of Main Feedwater (PLMFW), Steam Line Break Upstream of MSIV Initiating Events. Loss of Auxiliary Feedwater and Main Feedwater to Steam Generators. Loss of the containment pressure boundary. Indirect effects: None
Chemical and Volume Control System (CHS)	Direct effects: Reactor Trip (RT), Small or Medium LOCA Initiating Events. The following consequences would occur due to pipe failures in various locations with the CHS. • Loss of High Head and Low Head Safety Injection • Loss of recirculation • Loss of seal injection to one or more RCP seals • Loss of one or both charging trains • Loss of Letdown • Loss of normal and emergency boration • Loss of Refueling Water Storage Tank inventory outside of containment • Loss of Containment Sump Inventory outside of containment • Loss of the containment pressure boundary. Indirect effects: Indirect effects for spray were identified that disabled the system function of alternate trains of CHS and an SIS train.

Table 3.3-1 Summary of Postulated Consequences by System	
System	Summary of Consequences
Containment Isolation System (CI)	Direct effects: Loss of Primary Component Cooling Initiating Event. Loss of the containment pressure boundary and inability to isolate resulting in a containment by-pass and direct release path. Indirect effects: None
Reactor Plant Drains and Vents Systems (DAS)	Direct effects: Loss of the containment pressure boundary. Indirect effects: None
Steam Generator Feedwater System (FWA) Note: 12 segments in this system are part of the BEZ	Direct effects: Reactor Trip (RT), Partial Loss of Main Feedwater (PLMFW), Main Feedwater Line Break (MFWLB), and Total Loss of Main Feedwater (TLMFW) Initiating Events. Loss of main or auxiliary feedwater to one or more steam generators. Loss of the containment pressure boundary. Indirect effects: Potential impacts were included as part of the direct effects assessment.
Gaseous Nitrogen System (GNS)	Direct effects: Loss of accumulator injection. Loss of the containment pressure boundary. Indirect effects: None
Hydrogen Control System (HCS)	Direct effects: Loss of the containment pressure boundary. Indirect effects: None
Main Steam System (MSS) Note: 44 segments in this system are part of the BEZ	Direct effects: Steam Line Break Upstream of MSIV (SLBI), Steam Line Break Downstream of MSIV (SLBD), and Steam Line Break in Common RHR Valve Line (SLBC) Initiating Events. Loss of Main Feedwater to all steam generators due to MFW pump trip on SI signal. Failure of one or more of the steam supply paths to the Turbine Driven Auxiliary Feedwater Pump. Disable the atmospheric steam dump valves on the faulted steam generator. Loss of the containment pressure boundary. Indirect effects: Potential impacts were included as part of the direct effects assessment.

Table 3.3-1 Summary of Postulated Consequences by System	
System	Summary of Consequences
Quench Spray System (QSS)	Direct effects: Loss of RWST inventory outside containment. Loss of one or both trains of QSS, LHSI / HHSI injection and Recirculation. Loss of the containment pressure boundary. Indirect effects: Jet Impingement/Spray and Flooding fails Auxiliary Feedwater Pumps, Low Head SI Pump, Recirculation Spray or Quench Spray Pump.
Reactor Coolant System (RCS)	Direct effects: Depending upon location and size, segment failure will result in either a small, medium, or large break LOCA. In addition, failures of other functions such as hot or cold leg injection or recirculation, loss of RHR, loss of pressurizer spray, and loss of letdown or charging could occur. Loss of the containment pressure boundary. Indirect effects: A review of all of the impacts of RCS piping failures were evaluated and mitigated as part of design basis activities.
Residual Heat Removal System (RHS)	Direct effects: Small, medium, or large LOCA Initiating Events. Loss of the containment pressure boundary. Depending upon location, segment failure (without operator action) results in a loss of one or more of the following functions: • Loss of RHR • Loss of HHSI and LHSI Hot Leg Recirculation • Loss of accumulator injection Operator action, in most cases, would isolate the faulted RHS train. Loss of the containment pressure boundary. Indirect effects: A review of all of the impacts of RHS piping failures were evaluated and mitigated as part of design basis activities.

Table 3.3-1 Summary of Postulated Consequences by System	
System	Summary of Consequences
Recirculation Spray System (RSS)	Direct effects: Loss of containment sump inventory due to the failure outside containment. Failure will eventually lead to failure of all RSS and all HHSI/LHSI recirculation. Loss of containment and decay heat removal. Loss of the containment pressure boundary. Indirect effects: None
Safety Injection System (SIS)	Direct effects: Reactor Trip (RT); Small, Medium or Large LOCA Initiating Events. Depending upon location, segment failure can result in a loss of one or more of the following functions: • Loss of accumulator injection • High Pressure Injection • High Pressure Recirculation • Low Pressure Injection • Low Pressure Recirculation • Loss of RWST inventory outside containment, HHSI, LHSI, QSS, and RSS Pumps for Injection and Recirculation Loss of the containment pressure boundary. Indirect effects: None
Sampling System (SSR)	Direct effects: Reactor Trip (RT) and Partial Loss of Main Feedwater (PLMFW Initiating Events. Depending upon location segment failure can result in a loss of one of the following: • Loss of auxiliary feedwater to one steam generator • Loss of affected accumulator • Loss of one charging pump and boration flow to other operating pumps. Loss of the containment pressure boundary. Indirect effects: None

Table 3.3-1 Summary of Postulated Consequences by System	
System	Summary of Consequences
Break Exclusion Zone (BEZ) Note: all 16 segments in this system are part of the BEZ	Direct Effects: Reactor Trip (RT), Total Loss of Main Feedwater (TLMFW), Partial Loss of Main Feedwater (PLMFW), Main Feedwater Line Break (MFWLB), or Steam Line Break Downstream of MSIV (SLBD) Initiating Events. Loss of main feedwater to one or more steam generators. Failure of 1 of 3 steam supply paths to the Turbine Driven Auxiliary Feedwater Pump. Disable the atmospheric steam dump valves on the faulted steam generator. Indirect Effects: A jet impingement/spray will cause the loss of all contents in the Unit 2 Main Steam Valve Area and Containment Instrument Air room through the west door.

3.4 Failure Assessment

Failure estimates were generated utilizing industry failure history, plant specific failure history and other relevant information. An engineering team was established that has access to expertise from ISI, NDE, materials, stress analysis and system engineering. The team was trained in the failure probability assessment methodology and the Westinghouse structural reliability and risk assessment (SRRA) code, including identification of the capabilities and limitations as described in Supplement 1 to the WCAP. The WinSRRA code was used to calculate failure probabilities for the failure modes, materials, degradation mechanisms, input variables and uncertainties it was programmed to consider as discussed in Supplement 1 to the WCAP. All the piping configurations included in the RI-ISI program except for segments SSR-057, SSR-058, and SSR-059 could be adequately modeled using the code. WinSRRA was used to determine failure probabilities where appropriate in these segments but the segments contain pressure fit components. The industry history for failure of these fittings was determined to be controlling when compared to the values determined from WinSRRA. The controlling values were used in the risk assessments for these segments.

The engineering team assessed industry and plant experience, plant layout, materials, and operating conditions to identify the potential failure mechanisms and causes. Information was gathered from various sources by the Engineering team to provide input for the SRRA model. BV2 snubber failure history was reviewed to identify any potential effects that could increase piping failure probability.

Consideration is also given to whether a segment is addressed by either a plant stress corrosion cracking or erosion corrosion augmented program. This information is used to determine which failure probability is used in the risk-informed ISI process. The effects of ISI on existing augmented programs are included in the risk evaluation used to assist in categorizing the segments as described on page 105 of the WCAP. The failure probabilities used in the risk-informed process are documented and maintained in the plant records.

Table 3.4-1 summarizes the failure probability estimates for the dominant potential failure mechanisms by system. Table 3.4-1 also describes why the degradation mechanisms could occur at various locations within the system. Full break cases may be included but only when pipe whip is of concern. All instances where pipe whip was a concern were addressed as part of the original plant design for BV2 and supporting indirect effect calculation included in this program.

Failure probabilities for all of the segments that constitute the BEZ were determined using WinSRRA per Supplement 1 to the WCAP. Failure probabilities for the BEZ segments were all determined to be insignificant in regards to active degradation leading to piping failures. This supports the General Design Criteria 4 requirement for excluding consideration of pipe ruptures when the probability of fluid system pipe rupture is extremely low under conditions consistent with the design basis for the piping.

Table 3.4-1 Failure Probability Estimates (without ISI)				
System	Dominant Potential Degradation Mechanism(s)/Combinations(s)	Failure Probability Range at 40 Years with No ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)[1]	
BDG	Erosion/Corrosion, Thermal Fatigue	6.91E-08 – 4.91E-05	SYS 2.29E-10 - 1.67E-04	System is included in the current Flow Accelerated Corrosion Augmented Inspection program.
CHS	Thermal Fatigue	2.00E-07 – 6.93E-05	MLOCA 2.04E-10 - 1.73E-06 SLOCA 1.88E-10 - 2.07E-05 SYS 1.67E-10 - 1.89E-05	
	Thermal & Vibratory Fatigue	3.48E-05 – 7.21E-03	SLOCA 3.65E-09 - 5.22E-03 SYS 1.38E-09 - 5.22E-03	Vibration occurs near the orifices in various locations throughout the system. Downstream of the charging pumps and letdown heat exchanger are the critical orifice locations. Vibration occurs on small branch connections near pumps.
CI	Erosion/Corrosion, Thermal Fatigue	2.44E-05 – 2.44E-05	SYS 1.85E-10 - 1.06E-07	Microbiological mechanisms were identified in the river water portions of the piping lines.
	Thermal Fatigue	8.59E-08 – 3.16E-05	SYS 9.86E-11 - 3.37E-06	
DAS	Thermal Fatigue	6.46E-07 - 3.32E-05	SYS 1.33E-09 - 1.01E-07	
FWA[2]	Erosion/Corrosion, Thermal Fatigue	1.51E-08 – 5.21E-06	SYS 1.50E-12 - 1.20E-06	System is included in the current Flow Accelerated Corrosion Augmented Inspection program.
GNS	Thermal Fatigue	1.08E-05 – 6 04E-05	SYS 1.08E-05 – 6.04E-05	Gas segments where in all cases a small leak would disable the system function.
HCS	Thermal Fatigue	2.58E-06 – 1.05E-05	SYS 2.58E-06 – 1.05E-05	Gas segments where in all cases a small leak would disable the system function.

Table 3.4-1
Failure Probability Estimates (without ISI)

System	Dominant Potential Degradation Mechanism(s)/Combinations(s)	Failure Probability Range at 40 Years with No ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)[1]	
MSS[2]	Erosion/Corrosion, Thermal Fatigue	2.49E-07 – 8.71E-04	SYS 2.50E-10 - 6.58E-05	System is included in the current Flow Accelerated Corrosion Augmented Inspection program.
QSS	Thermal Fatigue	4.70E-07 - 3.84E-05	SYS 6.71E-14 - 8.79E-08	
	Vibrational Fatigue	2.45E-07 - 1.44E-05	SYS 4.75E-10 - 5.01E-06	Vibration occurs on small branch connections near pumps.
RCS	Stress Corrosion/Cracking, Thermal Fatigue	5.59E-10 – 2.07E-05	LLOCA 5.78E-11 - 1.50E-05 MLOCA 3.49E-12 - 1.50E-05 SLOCA 3.10E-12 - 1.50E-05 SYS 3.46E-12 - 1.51E-05	
	Stress Corrosion /Cracking, Thermal Fatigue, Vibrational Fatigue, Striping/Stratification	1.12E-05 – 3.03E-04	LLOCA 6.34E-10 - 7.01E-05 MLOCA 6.74E-10 - 7.12E-05 SLOCA 7.93E-10 - 7.20E-05 SYS 2.84E-09 - 1.89E-04	Industry history identifies thermal striping or stratification occurs in the pressurizer surge line. Temperature monitoring is on going but no evidence of fatigue or structural concerns have been noted.
	Thermal Fatigue	2.15E-08 – 1.84E-06	SLOCA 4.22E-11 - 1.41E-06 SYS 4.70E-11 - 1.98E-06	
RHS	Stress Corrosion /Cracking, Thermal Fatigue	9.11E-08 – 7.85E-07	LLOCA 3.46E-10 - 3.24E-07 MLOCA 4.45E-10 - 3.31E-07 SLOCA 5.20E-10 - 3.36E-07 SYS 3.96E-10 - 3.48E-07	
	Thermal Fatigue	9.11E-08 – 9.32E-05	SLOCA 6.02E-09 - 5.90E-08 SYS 1.50E-11 - 1.52E-05	
RSS	Thermal Fatigue	4.18E-07 - 4.71E-05	SYS 4.56E-14 - 1.07E-05	
SIS	Thermal Fatigue	1.58E-07 – 4.12E-04	LLOCA 3.31E-09 - 1.27E-04 MLOCA 3.12E-10 - 1.35E-04 SLOCA 2.50E-10 - 1.39E-04 SYS 1.03E-10 - 1.98E-04	

Table 3.4-1 Failure Probability Estimates (without ISI)				
System	Dominant Potential Degradation Mechanism(s)/Combinations(s)	Failure Probability Range at 40 Years with No ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)[1]	
SSR	Thermal Fatigue	9.11E-08 – 4.91E-05	SLOCA 3.52E-10 - 2.58E-07 SYS 8.76E-10 - 1.26E-05	
BEZ[2]	Erosion/Corrosion, Thermal Fatigue	2.57E-08 – 4.08E-04	SYS 1.24E-09 - 6.00E-05	

Notes:
1 - Disabling leak rate – LLOCA, MLOCA, SLOCA, and SYS (system disabling leak).
2 – contains BEZ segments

3.5 Risk Evaluation

Each piping segment within the scope of the program was evaluated to determine its core damage frequency (CDF) and large, early release frequency (LERF) due to the postulated piping failure. Calculations were also performed with and without operator action.

Once this evaluation is completed, the total pressure boundary core damage frequency and large early release frequency are calculated by summing across the segments for each system.

The uncertainty analysis as described on page 125 of the WCAP was performed and is now included as part of the base process. The results of these calculations are presented in Tables 3.5-1A for the Combined Scope and 3.5-1B for the BEZ only scope.

The Combined Scope results show the core damage frequency due to piping failure without operator action is 1.90E-06/year, and with operator action is 1.36E-06/year. Combined Scope large early release frequency due to piping failure without operator action is 2.33E-08/year, and with operator action is 2.15E-08/year.

The BEZ only results show the core damage frequency due to piping failure without operator action is 9.93E-11/year, and with operator action is 1.07E-10/year. BEZ only large early release frequency due to piping failure without operator action is 1.46E-12/year, and with operator action is 2.62E-12/year. The higher value for LERF with operator action is attributed to the conservative requirement that no manual actions by the operator are credited in the evaluation.

To assess safety significance, the risk reduction worth (RRW) and risk achievement worth (RAW) were calculated for each piping segment.

Table 3.5-1A: Combined Scope Number of Segments and Piping Risk Contribution by System (without ISI)					
System	# of Segments	CDF without Operator Action (/yr)	CDF with Operator Action (/yr)	LERF without Operator Action (/yr)	LERF with Operator Action (/yr)
BDG	24	1.16E-08	1.16E-08	1.30E-10	1.24E-10
CHS	160	2.34E-07	1.32E-08	1.25E-09	1.41E-10
CI	84	1.65E-09	1.65E-09	7.30E-12	7.30E-12
DAS	7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWA	57	6.17E-12	3.95E-12	3.46E-13	8.39E-14
GNS	6	3.47E-14	3.47E-14	0.00E+00	0.00E+00
HCS	40	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MSS	53	9.45E-11	1.03E-10	1.45E-12	2.60E-12
QSS	38	1.54E-09	9.88E-10	2.29E-11	1.96E-11
RCS	91	5.32E-07	5.32E-07	8.24E-09	8.23E-09
RHS	58	7.46E-10	7.46E-10	1.16E-11	1.16E-11
RSS	68	6.46E-11	4.16E-11	1.63E-12	1.45E-12
SIS	172	1.11E-06	8.04E-07	1.36E-08	1.29E-08
SSR	59	9.44E-10	4.28E-11	8.39E-12	1.45E-12
BEZ	16	1.02E-11	9.96E-12	2.01E-13	1.72E-13
Total	933	1.90E-06	1.36E-06	2.33E-08	2.15E-08

Table 3.5-1B: BEZ Only Number of Segments and Piping Risk Contribution by System (without ISI)					
System	# of Segments	CDF without Operator Action (/yr)	CDF with Operator Action (/yr)	LERF without Operator Action (/yr)	LERF with Operator Action (/yr)
FWA	12	2.99E-12	2.99E-12	3.61E-14	3.61E-14
MSS	44	8.62E-11	9.46E-11	1.23E-12	2.41E-12
BEZ	16	1.02E-11	9.96E-12	2.01E-13	1.72E-13
Total	72	9.93E-11	1.07E-10	1.46E-12	2.62E-12

3.6 Expert Panel Categorization

The final safety determination, (i.e., high and low safety significance), of each piping segment was made by the expert panel using both probabilistic and deterministic insights. The expert panel was comprised of personnel who have expertise in the following fields: probabilistic safety assessment, inservice examination, nondestructive examination, stress and material considerations, plant operations, plant and industry maintenance, repair and failure history, system design and operation, and SRRA methods including uncertainty. Members associated with the Maintenance Rule were used to ensure consistency with the other PRA applications.

The expert panel had the following positions represented by either the permanent or alternate member at all times during the expert panel meeting.

- Probabilistic Risk Assessment (PRA Supervisor)
- Operations (Nuclear Operations (ANSS)
- Inservice Inspection and Nondestructive Examination (NDE Inspection)
- Plant & Industry Maintenance (Maintenance Engineering/Maintenance Rule)
- Repair, and Failure History (System Engineer)
- System Design and Operation (System Engineer)
- Licensing and Safety Analysis (Licensing/Safety Engineer)
- Materials (Materials Engineering)
- Stress (Structural Engineering)

A simple majority of members or alternates filling the above positions constituted a quorum. The quorum however must have the following disciplines represented:

- Probabilistic Risk Assessment
- Plant Operations
- Plant Maintenance
- Plant Engineering
- Safety Analysis

This core team of panel members was supplemented by other experts, including an ISI Engineer and PRA Engineer, as required for the piping system under evaluation. FirstEnergy Nuclear Operating Company appointed the expert panel chairperson. The chairperson conducted and ruled on the proceedings of the meetings.

Members and alternates received training and indoctrination in the risk-informed inservice inspection selection process. They were indoctrinated in the application of risk analysis techniques for ISI. These techniques included risk importance measures, threshold values, failure probability models, failure mode assessments, PRA modeling limitations and the use of expert judgment. Training documentation is maintained with the expert panel's records.

Worksheets were provided to the panel on each system for each piping segment, containing information pertinent to the panel's selection process. This information, in conjunction with each panel member's own expertise and other documents as appropriate, were used to determine the safety significance of each piping segment.

A consensus process was used by the expert panel. Consensus was defined as unanimous for this initial application of the RI-ISI methodology. The chairperson permitted active discussion during the proceedings and appropriate time for deliberation.

Minutes of each meeting were generated. The minutes included the names of members and alternates in attendance and whether a quorum was present. The minutes contained relevant discussion summaries and the results of membership voting. These minutes are available as program records.

3.7 Identification of High Safety Significant Segments

The number of high safety significant segments for each system, as determined by the expert panel, is shown in Table 3.7-1A along with a summary of the risk evaluation identification of high safety significant segments (HSS). Table 3.7-1B summarizes the results from the risk evaluation assessment for the BEZ only segments based exclusively on the RRW numbers.

Table 3.7-1A: Combined Scope
Summary of Risk Evaluation and Expert Panel Categorization Results

System	Number of segments with any RRW ≥1.005	Number of segments with any RRW between <1.005 and ≥1.001	Number of segments with all RRW < 1.001	Number of segments with any RRW between 1.005 and 1.001 placed in HSS	Number of segments with all RRW < 1.001 selected for inspection	Total number of segments selected for inspection (High Safety Significant Segments)
BDG	2	4	18	0	18	24 (0)
CHS	2	20	138	14	18	33 (33)
CI	0	2	82	0	0	0 (0)
DAS	0	0	7	0	0	0 (0)
FWA	0	0	57	0	57	57 (0)
GNS	0	0	6	0	0	0 (0)
HCS	0	0	40	0	0	0 (0)
MSS	0	0	53	0	53	53 (8)
QSS	0	2	36	2	13	15 (15)
RCS	24	2	65	0	2	26 (26)
RHS	0	1	57	1	0	1 (1)
RSS	0	1	67	0	0	0 (0)
SIS	32	28	112	1	6	24 (24)
SSR	0	0	59	0	0	0 (0)
BEZ	0	0	16	0	0	0(0)
TOTAL	60	60	813	18	167	233 (107)

Table 3.7-1B: BEZ Only Summary of Risk Evaluation and Expert Panel Categorization Results						
System	Number of segments with any RRW ≥1.005	Number of segments with any RRW between <1.005 and ≥1.001	Number of segments with all RRW < 1.001	Number of segments with any RRW between 1.005 and 1.001 placed in HSS	Number of segments with all RRW < 1.001 selected for inspection	Total number of segments selected for inspection (High Safety Significant Segments)
FWA	9	0	3	(1)	(1)	(1)
MSS	28	3	13	(1)	(1)	(1)
BEZ	9	3	4	(1)	(1)	(1)
TOTAL	46	6	20	(1)	(1)	(1)

Notes: 1. Not evaluated by Expert Panel under scope of program.

3.8 Structural Element and NDE Selection

The structural elements in the high safety significant piping segments were selected for inspection and appropriate non-destructive examination (NDE) methods were defined.

The initial program being submitted addresses the high safety significant (HSS) piping components placed in regions 1 and 2 of Figure 3.7-1 in the WCAP. Segments considered as "high failure importance" (Region 1) were identified as all segments being affected by an active failure mechanism or analyzed to be highly susceptible to a failure mechanism (probability of large leak at 40 years generally exceeds 1E-04). Region 3 piping components, which are low safety significant, are to be considered in an Owner Defined Program and are not considered part of the program requiring approval. Region 1, 2, 3 and 4 piping components will continue to receive Code required pressure testing, as part of the current ASME Section XI program. For the 933 piping segments that were evaluated in the RI-ISI program, Region 1 contains 10 segments, Region 2 contains 97 segments, Region 3 contains 145 segments, and Region 4 contains 678 segments. Three segment identifiers in the SIS system sequence were not used to identify a piping segment but included in the segment counts. These segments were not included in the region counts.

The number of locations to be inspected in a HSS segment was determined using a Westinghouse statistical (Perdue) model as described in section 3.7 of the WCAP. All of the HSS piping segments in Region 1 and Region 2 were evaluated using the Perdue model.

Table 4.1-1 in the WCAP, was used as guidance in determining the examination requirements for the HSS piping segments. VT-2 visual examinations are scheduled in accordance with the station's pressure test program that remains unaffected by the risk-informed inspection program.

Additional Examinations

Since the risk-informed inspection program will require examinations on a large number of elements constructed to lesser pre-service inspection requirements, the program in all cases will determine through an engineering evaluation the root cause of any unacceptable flaw or relevant condition found during examination. The evaluation will include the applicable service conditions and degradation mechanisms to establish that the element(s) will still perform their intended safety function during subsequent operation. Elements not meeting this requirement will be repaired or replaced.

The evaluation will include whether other elements on the segment or segments are subject to the same root cause and degradation mechanism. Additional examinations will be performed on these elements up to a number equivalent to the number of elements initially required to be inspected on the segment or segments. If unacceptable flaws or relevant conditions are again found similar to the initial problem, the remaining elements identified as susceptible will be examined. No additional examinations will be performed if there are no additional elements identified as being susceptible to the same service related root cause conditions or degradation mechanism.

3.9 Program Relief Requests

An attempt has been made to provide a minimum of >90% coverage (per Code Case N-460) when performing the risk-informed examinations. However, not all limitations will be known until the examination is performed, since some locations will be examined for the first time by the specified techniques.

When the examination does not meet >90% coverage, the process outlined in Section 4.0 of the WCAP will be followed.

3.10 Change in Risk

The risk-informed ISI program has been done in accordance with Regulatory Guide 1.174, and the risk from implementation of this program is expected to slightly decrease when compared to that estimated from current requirements.

The change in risk calculations were performed according to all the guidelines provided on page 213 of the WCAP. A comparison between the proposed RI-ISI program and the current ASME Section XI ISI program was made to evaluate the change in risk. The approach evaluated the change in risk with the inclusion of the probability of detection as determined by the SRRA model. All four criteria for accepting the results discussed on page 214 and 215 in the WCAP were met (or adjustments were made to add segments until the criteria were met). This evaluation resulted in the identification of 2 RCS piping segments for which examinations are now required.

The change in risk methodology deviated from the methodology for segments located inside containment and that interface with the RCS such that radiation monitors and sump level will detect a leak. The Reactor Coolant System was defined to be the Class 1 primary loop pressure boundary piping. Beaver Valley Power Station Unit 2 capability to detect a leak within the RCS is defined to be 1 gpm per Tech Spec documentation. For these segments, the

failure probability "with ISI" for those being examined by NDE and "without ISI" for those not being examined is used along with credit for leak detection.

The results from the risk comparison are shown in Table 3.10-1. As seen from the table, the RI-ISI program reduces the risk associated with piping CDF/LERF slightly more than the current Section XI program while reducing the number of examinations. Table 3.10-1 also includes the systems that are the main contributors to the risk reduction in moving from the current program to the RI-ISI program. The primary basis for this risk reduction is that examinations are now being placed on piping segments that are high safety significant and which are not examined by NDE in the current ASME Section XI ISI program.

Defense-In-Depth

The reactor coolant piping will continue to receive a system pressure test and visual VT-2 examination as currently required by the ASME Section XI Code. Larger reactor coolant loop piping segments were retained in the program for "defense-in-depth" considerations. All reactor vessel dissimilar metal welds were selected for examination.

Segments that would result in the loss of more than one redundant safety train were ranked as HSS and included for examination regardless of RRW values. This included 8 exams in the MSS system, which are part of the BEZ piping at the containment boundary.

Table 3.10-1 COMPARISON OF CDF/LERF FOR CURRENT SECTION XI AND RISK-INFORMED ISI PROGRAMS		
Case	Current Section XI	Risk-Informed
CDF No Operator Action	8.24E-07	8.02E-07
• BDG	1.16E-08	1.16E-08
• CHS	2.45E-07	2.31E-07
• CI	1.65E-09	1.65E-09
• DAS	0.00E+00	0.00E+00
• FWA	6.17E-12	6.17E-12
• GNS	3.47E-14	3.47E-14
• HCS	0.00E+00	0.00E+00
• MSS	9.45E-11	9.45E-11
• QSS	1.50E-09	2.68E-10
• RCS	1.69E-07	1.69E-07
• RHS	3.79E-12	3.79E-12
• RSS	6.43E-11	6.46E-11
• SIS	3.94E-07	3.88E-07
• SSR	9.44E-10	9.44E-10
• BEZ	1.02E-11	1.02E-11
CDF with Operator Action	2.81E-07	2.73E-07
• BDG	1.16E-08	1.16E-08
• CHS	2.33E-09	1.11E-09
• CI	1.65E-09	1.65E-09
• DAS	0.00E+00	0.00E+00
• FWA	3.95E-12	3.95E-12
• GNS	3.47E-14	3.47E-14
• HCS	0.00E+00	0.00E+00
• MSS	1.03E-10	1.03E-10
• QSS	9.79E-10	1.71E-11
• RCS	1.69E-07	1.69E-07
• RHS	3.79E-12	3.79E-12
• RSS	4.16E-11	4.16E-11
• SIS	9.54E-08	8.92E-08
• SSR	4.28E-11	4.28E-11
• BEZ	9.96E-12	9.96E-12

Table 3.10-1 (continued) COMPARISON OF CDF/LERF FOR CURRENT SECTION XI AND RISK-INFORMED ISI PROGRAMS		
Case	Current Section XI	Risk-Informed
LERF No Operator Action	6.41E-09	6.32E-09
• BDG	1.30E-10	1.30E-10
• CHS	1.25E-09	1.18E-09
• CI	7.30E-12	7.30E-12
• DAS	0.00E+00	0.00E+00
• FWA	3.46E-13	3.46E-13
• GNS	0.00E+00	0.00E+00
• HCS	0.00E+00	0.00E+00
• MSS	1.45E-12	1.45E-12
• QSS	2.21E-11	1.96E-12
• RCS	2.62E-09	2.62E-09
• RHS	5.76E-14	5.76E-14
• RSS	1.63E-12	1.63E-12
• SIS	2.38E-09	2.37E-09
• SSR	8.39E-12	8.39E-12
• BEZ	2.01E-13	2.01E-13
LERF with Operator Action	4.52E-09	4.36E-09
• BDG	1.24E-10	1.24E-10
• CHS	1.46E-11	9.81E-12
• CI	7.30E-12	7.30E-12
• DAS	0.00E+00	0.00E+00
• FWA	8.39E-14	8.39E-14
• GNS	0.00E+00	0.00E+00
• HCS	0.00E+00	0.00E+00
• MSS	2.60E-12	2.60E-12
• QSS	1.89E-11	4.89E-13
• RCS	2.62E-09	2.62E-09
• RHS	5.76E-14	5.76E-14
• RSS	1.45E-12	1.45E-12
• SIS	1.73E-09	1.60E-09
• SSR	1.45E-12	1.45E-12
• BEZ	1.72E-13	1.72E-13

4. IMPLEMENTATION AND MONITORING PROGRAM

Upon approval of the RI-ISI program, procedures that comply with the guidelines described in the WCAP will be prepared to implement and monitor the program. The new program will be integrated into the existing ASME Section XI interval. Changes to the Updated Final Safety Analysis Report are necessary as a result of program implementation.

The applicable aspects of the Code not affected by this change would be retained, such as examination methods, acceptance guidelines, pressure testing, corrective measures, documentation requirements, and quality control requirements. Existing ASME Section XI program-implementing procedures would be retained and would be modified to address the RI-ISI process, as appropriate. Additionally the procedures will be modified to include the high safety significant locations in the program requirements regardless of their current ASME class.

The proposed monitoring and corrective action program will contain the following elements:

A. Identify
B. Characterize
C. (1) Evaluate, determine the cause and extent of the condition identified
   (2) Evaluate, develop a corrective action plan or plans
D. Decide
E. Implement
F. Monitor
G. Trend

The RI-ISI program is a living program requiring feedback of new relevant information to ensure the appropriate identification of high safety significant piping locations. As a minimum, risk ranking of piping segments will be reviewed and adjusted on an ASME Period basis. Significant changes may require more frequent adjustment as directed by NRC Bulletin or Generic Letter requirements, or by plant specific feedback.

5. PROPOSED ISI PROGRAM PLAN CHANGE

A comparison between the RI-ISI program and the current ASME Section XI program requirements for piping is given in Table 5-1. An identification of piping segments that are part of plant augmented programs is also included in Table 5-1.

As a result of the high safety significant classifications assigned by the Expert Panel the following screening was considered for the segments constituting the BEZ:

1. Individual segment contribution to Core Damage Frequency is greater than or equal to 1E-8.
2. Individual segment contribution to Large Early Release Frequency is greater than or equal to 1E-9.
3. Break Exclusion Region inspections fall significantly below 10% of the total Break Exclusion Region scope.

Items 1 and 2 were satisfied. Item 3 was not directly satisfied but plant specific design features and analysis was specifically credited to mitigate any concerns and justify a low safety significance ranking. Design features include mitigation of flooding concerns, isolation of BEZ in a localized area, and mitigation by non-BEZ piping in the event there would be a piping failure in the BEZ.

The plant will be performing examinations on elements not currently required by ASME Section XI. An example of these additional examinations is provided below.

- The ASME Section XI Code does not require examination of piping less than 3/8-inch wall thickness on Class 2 piping greater than 4-inch nominal pipe size (NPS). The welds are counted for percentage requirements, but not examined by NDE. The RI-ISI program will require examination in this population of welds. Examples where the risk informed process requires examination and the Code did not are the suction lines to the charging pumps.

The initial program will be started in the inspection period current at the time of program approval. For example, the second (of three) inspection periods of the current 10-year inspection interval for BV2 ends on April 29, 2005. If the program is approved such that a refueling outage remains in the second period, 66% of the required RI-ISI examinations will be performed by the end of the current inspection interval.

Table 5-1: STRUCTURAL ELEMENT SELECTION (SES) RESULTS
AND COMPARISON TO ASME SECTION XI 1989 EDITION REQUIREMENTS
AND BEZ PROGRAM REQUIREMENTS

System	High Safety Significant Segments (No. of HSS in Augmented Program / Total No. of Segments in Aug. Program)	Degradation Mechanism(s)	Safety Class	ASME Code Exam Category	Total Weld Count (Welds requiring Volumetric (Vol) and Surface (Sur)		ASME XI Program Examinations		UFSAR BEZ Program Examinations		RI-ISI[a]		
					Vol & Sur	Sur only	Vol & Sur	Sur only	Vol only	Sur only	SES Matrix Region	No. of Aug. Program Segments	Number of Exam Locations
BDG	0 (0/24)	FAC/TF	Class 2	N/A	0	0	0	0	0	0	3	24[c]	0
CHS	33 (0/0)	TF/VF, TF	Class 1	B-J	4	369	3	57	0	0	2, 3, 4	0	0
			Class 2	C-F-1	343	315	26	27	0	0		0	19 + 14[b]
CI	0 (0/0)	FAC/TF, TF	Class 2	N/A	0	0	0	0	0	0	4	0	0
DAS	0 (0/0)	TF	Class 1	B-J	0	36	0	24	0	0	4	0	0
FWA	0 (0/57)	FAC/TF	Class 2	C-F-2	56	0	9	0	12	0	3	57[c]	0
GNS	0 (0/0)	TF	Class 2	N/A	0	0	0	0	0	0	4	0	0
HCS	0 (0/0)	TF	Class 2	N/A	0	0	0	0	0	0	4	0	0
MSS	8 (8/53)	FAC/TF	Class 2	C-F-2	136	3	16	0	105	0	1B, 3	53[c]	8[e]
QSS	15 (0/0)	TF, VF	Class 2	C-F-1	200	0	16	0	0	0	1A, 1B, 2, 4	0	15 + 4[b]
RCS	26 (0/0)	SCC/TF, SCC/TF/VF/SS, TF	Class 1	B-F	18	0	18	0	0	0	2, 4	0	26 + 2[d]
			Class 1	B-J	217	350	57	136	0	0		0	
RHS	1 (0/0)	TF/SCC, TF	Class 1	B-J	22	6	7	2	0	0	2, 4	0	1
			Class 2	C-F-1	283	0	23	0	0	0		0	0
RSS	0 (0/0)	TF	Class 2	C-F-1	199	0	16	0	0	0	4	0	0
SIS	24 (0/0)	TF	Class 1	B-J	222	157	43	14	0	0	2, 4	0	0
			Class 2	C-F-1	934	200	71	17	0	0		0	19 + 5[b]
SSR	0 (0/0)	TF	Class 1	N/A	0	0	0	0	0	0	4	0	0
			Class 2	N/A	0	0	0	0	0	0		0	0
BEZ	0 (0/16)	E/C, TF	Note f	N/A	84[g]	228	0	0	84	32	3	16[c]	0

Table 5-1: STRUCTURAL ELEMENT SELECTION (SES) RESULTS
AND COMPARISON TO ASME SECTION XI 1989 EDITION REQUIREMENTS
AND BEZ PROGRAM REQUIREMENTS

System	High Safety Significant Segments (No. of HSS in Augmented Program / Total No. of Segments in Aug. Program)	Degradation Mechanism(s)	Safety Class	ASME Code Exam Category	Total Weld Count (Welds requiring Volumetric (Vol) and Surface (Sur)		ASME XI Program Examinations		UFSAR BEZ Program Examinations		RI-ISI[a]		
					Vol & Sur	Sur only	Vol & Sur	Sur only	Vol only	Sur only	SES Matrix Region	No. of Aug. Program Segments	Number of Exam Locations
TOTAL	107 (8 / 150)	FAC/TF, TF, SCC/TF, E/C, SCC/TF/VF TF/ VF, WH, VF	Class 1		483	918	128	233	0	0			27 NDE + 2 VIS
			Class 2		2151	518	177	44	117	0			61 NDE + 23 VIS
			Non-Q		18	129	0	0	84	32			0
			Total		2652	1565	306	277	201	32			88 NDE + 25 VIS

Summary: Current ASME Section XI selects a total of 586 welds while the proposed RI-ISI program selects a total of 88 welds (113 - 25 visual exams), which results in an 85% reduction. UFSAR BEZ selects a total of 233 welds while the proposed RI-ISI program selects a total of 8 welds, which results in a 96.5% reduction.

Degradation Mechanisms: VF – Vibratory Fatigue; TF – Thermal Fatigue; FAC – Flow-Assisted Corrosion, SCC – Stress Corrosion Cracking; Strip/Strat – Striping/Stratification; E/C – Erosion / Corrosion

Notes for Table 5-1

a. System pressure test requirements and VT-2 visual examinations shall continue in all ASME Code Class systems.
b. VT-2 examination at one location within segment.
c. Augmented programs for erosion-corrosion continue.
d. Examinations added for change in risk considerations (Total of two segments - RCS).
e. Included also in augment program for erosion-corrosion. Augmented program continues.
f. The BEZ counts include Non-Q welds designated by the UFSAR as part of the Break Exclusion Zone and those Class 2 welds located in the Main Steam Valve Room (MSVR) that are exempt from ASME XI examination requirements due to size (i.e., $\leq$ 4" NPS). The non-exempt Class 2 welds located in the MSVR are included in the FWA and MSS counts.
g. For Non-Q BEZ large bore welds the examination requirement is volumetric only.

6. SUMMARY OF RESULTS AND CONCLUSIONS

A partial scope (Class1 and Class 2 and BEZ) risk-informed ISI application has been completed for BV2. Upon review of the proposed risk-informed ISI examination program given in Table 5-1, an appropriate number of examinations are proposed for the high safety significant segments across the Class 1 and 2 and Break Exclusion Zone portions of the plant piping systems. Resources to perform examinations currently required by ASME Section XI in the Class 1 and 2 and UFSAR Break Exclusion Zone portions of the plant piping systems, though reduced, are distributed to address the greatest amount of risk within the scope. Thus, the change in risk principle of Regulatory Guide 1.174 is maintained. The examinations performed will address specific damage mechanisms postulated for the selected locations through appropriate examination selection. Additional examinations will be performed when evidence of degradation is discovered.

The plant is designed to ASME III for all Class 1 piping. There is an improved level of fatigue analysis and operating condition scrutiny for the ASME III NB-3600 design as compared to non-ASME III plants. This results in a much larger percentage of its Class 1 piping constructed with butt welds as opposed to socket welds and more detailed information is available for input to the estimation of the failure probability.

From a risk perspective, the PRA dominant accident sequences include station blackout, small LOCAs and steam generator tube rupture events with loss of core cooling from the secondary side.

For the RI-ISI program, appropriate sensitivity and uncertainty evaluations have been performed to address variations in piping failure probabilities and PRA consequence values along with consideration of deterministic insights to assure that all high safety significant piping segments have been identified.

As a risk-informed application, this submittal meets the intent and principles of Regulatory Guide 1.174.

7. REFERENCES/DOCUMENTATION

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

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

WCAP-14572 Revision 1-NP-A Addendum 1-Markup " Addendum to Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report to Address Changes to Augmented Inspection Requirements", as submitted by the WOG to the NRC via OG-00-050, dated 6/2/00.

U.S. Nuclear Regulatory Commission, "An Approach Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to Licensing Basis," Regulatory Guide 1.174, July 1998.

BVPS-2 Updated Final Safety Analysis Report (UFSAR)

Supporting Onsite Documentation

1. Segment Definition Calculations:
   1. 10080-DMC-0139, Revision 0, 4/17/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Quench Spray System".
   2. 10080-DMC-0140, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Recirculation Spray System, Revision 0, 4/17/02".
   3. 10080-DMC-0141, Revision 0, 4/17/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Reactor Plant Vents and Drains System".
   4. 10080-DMC-0142, Revision 1, 4/17/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Chemical and Volume Control System".
   5. 10080-DMC-0143, Revision 0, 4/17/02 "Beaver Valley Unit 2 RI-ISI Segment Definition for the Steam Generator Blowdown System".
   6. 10080-DMC-0144, Revision 0, 4/17/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Steam Generator Feedwater System".
   7. 10080-DMC-0145, Revision 0, 4/17/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Main Steam System".
   8. 10800-DMC-0146, Revision 0, 3/30/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Reactor Plant Sampling System".
   9. 10080-DMC-0147, Revision 0, 3/27/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Post DBA Hydrogen Control System"
   10. 10080-DMC-0148, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Gaseous Nitrogen System, Revision 0, 3/30/02"
   11. 10800-DMC-0149, Revision 1, 3/30/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Containment Isolation System".
   12. 10800-DMC-0150, Revision 0, 3/16/02, "Beaver Valley Unit 2 RI-ISI Segment definition for the Reactor Coolant System".
   13. 10800-DMC-0151, Revision 0, 3/25/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Residual Heat Removal System"
   14. 10800-DMC-0152, Revision 0, 3/20/02, "Beaver Valley Unit 2 RI-ISI Segment Definition for the Safety Injection System"
   15. 10080-DMC-0741, Revision 0, 4/19/02, "Beaver Valley Risk Informed In-Service Inspection (RI-ISI) Segment Definition For Unit 2 Break Exclusion Zone (BEZ)"
2. 10080-DMC-0724, Revision 0, 10/15/01, "Beaver Valley Unit 2 Risk-Informed ISI Indirect (Spatial) Consequence Evaluation".
3. 10080-DMC-0740, Revision 0, 4/23/02, "Beaver Valley Unit 2 BEZ Risk Informed In-Service Inspection (RI-ISI) Indirect (Spatial) Consequence Evaluation".
4. 10080-DMC-0730, Revision 1, 1/22/02, "Risk-Informed In-Service Inspection (RI-ISI) PRA Calculation For Unit 2 RI-ISI Systems".
5. 10080-DMC-0745, Revision 0, 4/19/02, "PRA Calculation for Unit 2 BEZ Risk Informed In-Service Inspection (RI-ISI) Direct and Indirect (Spatial) Evaluation".
6. SRRA Documentation:
   1. 10080-DMC-0153, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Reactor Plant Vents and Drains System".
   2. 10080-DMC-0154, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Containment Depressurization System (QSS)".
   3. 10080-DMC-0155, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Containment Depressurization System (RSS)".

4. 10080-DMC-0156, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Residual Heat Removal (RHS) System".
5. 10080-DMC-0157, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Steam Generator Blowdown (BDG) System".
6. 10080-DMC-0158, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for Reactor Coolant (RCS) System".
7. 10080-DMC-0159, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Steam Generator Feedwater (FWA) System".
8. 10080-DMC-0160, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Chemical and Volume Control (CHS) System".
9. 10080-DMC-0161, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Main Steam (MSS) System".
10. 10080-DMC-0162, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Post-DBA Hydrogen Control (HCS) System".
11. 10080-DMC-0163, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Safety Injection (SIS) System".
12. 10080-DMC-0164, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Containment Isolation System".
13. 10080-DMC-0165, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Reactor Plant Sampling System (SSR)".
14. 10080-DMC-0168, Revision 0, "Risk-Informed InService Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Gaseous Nitrogen System (GNS)".
15. 10080-DMC-0743, Revision 0, 4-23-02, "Risk-Informed In-Service Inspection (RI-ISI) Structural Reliability and Risk Assessment (SRRA) for the Break Exclusion Zone (BEZ)".

7. CN-RRA-02-52, Revision 0 "Beaver Valley Power Stations 2 Risk Evaluation for Class 1 and 2 and BEZ Piping", 8/23/02
8. CN-RRA-02-63, Revision 0, "Beaver Valley Power Station 2 BEZ Perdue Evaluation", 9/12/02.
9. CN-RRA-02-55, Revision 0, "Beaver Valley Power Station 2 Change In Risk Evaluation for Class 1 and 2 and BEZ Piping", 3/27/02
10. Expert Panel Data:
    - 10.1 FENOC-01-356, "Expert Panel Review Materials", 12/17/01
    - 10.2 ND1MLM:0184, "Risk Informed ISI Expert Panel", 1/2/02
    - 10.3 FENOC-02-45, "RI-ISI Expert Panel Action Item Resolutions", 1/28/02
    - 10.4 ND1MLM:0214, "Results of the Expert Panel Review of Comment Resolution", 3/11/02
    - 10.5 CN-RRA-02-12, Revision 0, "Beaver Valley Power Station 2 Expert Panel Database," 5/16/02.
    - 10.6 ND1MLM:0281, "Risk Informed ISI Expert Panel Results", 8/9/2002

ENCLOSURE 2

Quantitative input results for the PRA quantification, the failure probabilities for the ranking evaluation and the conditional CDF or LERF as appropriate for each of the 72 BEZ segments.

Base, Combined Base BEZ, and BEZ Comparizon CDF With Operator Action

BASE ONLY CDF With Operator Action						Combination Base & BEZ CDF With Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITH OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITH OPERATOR ACTION RRW	WITH OPERATOR ACTION RRW
FWA-001	IE	1.46E-05	8.68E-10	8.74E-15	1 000	FWA-001	IE	1 46E-05	8 68E-10	4 77E-13	1 000	1.009
							IE-JI/S	1.30E-04	1.01E-08			
	SYS	7 15E-05	8 68E-10				SYS	7.15E-05	8 68E-10			
							SYS-JI/S	1 27E-03	1.01E-08			
FWA-002	IE	1 46E-05	8 68E-10	8 74E-15	1 000	FWA-002	IE	1 46E-05	8 68E-10	4 77E-13	1 000	1 009
							IE-JI/S	1 30E-04	1.01E-08			
	SYS	7.15E-05	8 68E-10				SYS	7.15E-05	8 68E-10			
							SYS-JI/S	1 27E-03	1 01E-08			
FWA-003	IE	1 46E-05	8 68E-10	8.74E-15	1 000	FWA-003	IE	1 46E-05	8.68E-10	4.77E-13	1.000	1.009
							IE-JI/S	1.30E-04	1.01E-08			
	SYS	7.15E-05	8 68E-10				SYS	7.15E-05	8 68E-10			
							SYS-JI/S	1.27E-03	1.01E-08			
FWA-004	None	0.00E+00	0.00E+00	0 00E+00	1 000	FWA-004	None	0 00E+00	0.00E+00	0 00E+00	1.000	1 000
FWA-005	None	0 00E+00	0 00E+00	0 00E+00	1.000	FWA-005	None	0 00E+00	0 00E+00	0 00E+00	1.000	1.000
FWA-006	None	0 00E+00	0 00E+00	0 00E+00	1.000	FWA-006	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000
FWA-007	IE	1 73E-05	8 68E-10	1 04E-14	1 000	FWA-007	IE	1.73E-05	8.68E-10	4.79E-13	1.000	1.009
							IE-JI/S	1 30E-04	1 01E-08			
	SYS	7.37E-05	8 68E-10				SYS	7 37E-05	8 68E-10			
							SYS-JI/S	1.27E-03	1 01E-08			
FWA-008	IE	1.73E-05	8 68E-10	1 04E-14	1 000	FWA-008	IE	1 73E-05	8.68E-10	4 79E-13	1.000	1.009
							IE-JI/S	1.30E-04	1 01E-08			
	SYS	7.37E-05	8 68E-10				SYS	7.37E-05	8 68E-10			
							SYS-JI/S	1 27E-03	1 01E-08			
FWA-009	IE	1.73E-05	8 68E-10	1 04E-14	1 000	FWA-009	IE	1.73E-05	8 68E-10	4 79E-13	1 000	1 009
							IE-JI/S	1.30E-04	1 01E-08			
	SYS	7.37E-05	8 68E-10				SYS	7.37E-05	8 68E-10			
							SYS-JI/S	1 27E-03	1 01E-08			
FWA-010	IE	5 95E-06	9 85E-09	4 05E-14	1 000	FWA-010	IE	5.95E-06	9 85E-09	4 05E-14	1 000	1 001
	SYS	7.37E-05	9 85E-09				SYS	7 37E-05	9 85E-09			
FWA-011	IE	5 95E-06	9 85E-09	4 05E-14	1 000	FWA-011	IE	5 95E-06	9 85E-09	4 05E-14	1 000	1 001
	SYS	7 37E-05	9 85E-09				SYS	7 37E-05	9 85E-09			
FWA-012	IE	5 95E-06	9 85E-09	4 05E-14	1 000	FWA-012	IE	5 95E-06	9 85E-09	4 05E-14	1 000	1 002
	SYS	7.37E-05	9 85E-09				SYS	7 37E-05	9 85E-09			
MSS-004	IE	2 64E-05	3.74E-08	6 81E-13	1.000	MSS-004	IE	2 64E-05	3 74E-08	1 88E-12	1 000	1 036
							IE-JI/S	1 40E-04	2 40E-08			
	SYS	7.37E-05	3 74E-08				SYS	7 37E-05	3.74E-08			
							SYS-JI/S	1 27E-03	2 40E-08			
MSS-005	IE	2 64E-05	3 74E-08	6 81E-13	1 000	MSS-005	IE	2 64E-05	3 74E-08	1.88E-12	1.000	1.036
							IE-JI/S	1.40E-04	2 40E-08			
	SYS	7 37E-05	3 74E-08				SYS	7.37E-05	3 74E-08			
							SYS-JI/S	1 27E-03	2 40E-08			
MSS-006	IE	2 64E-05	3.74E-08	6.81E-13	1 000	MSS-006	IE	2 64E-05	3 74E-08	1 88E-12	1 000	1 035
							IE-JI/S	1.40E-04	2 40E-08			
	SYS	7.37E-05	3.74E-08				SYS	7 37E-05	3 74E-08			
							SYS-JI/S	1 27E-03	2 40E-08			
MSS-013	IE	2 64E-05	6.61E-07	1.20E-11	1 000	MSS-013	IE	2 64E-05	6 61E-07	1 20E-11	1 000	1 194
	SYS	7.37E-05	6 61E-07				SYS	7 37E-05	6.61E-07			
MSS-014	IE	2 64E-05	6 61E-07	1.20E-11	1 000	MSS-014	IE	2 64E-05	6 61E-07	1 20E-11	1 000	1.187
	SYS	7.37E-05	6 61E-07				SYS	7.37E-05	6 61E-07			
MSS-015	IE	2 64E-05	6 61E-07	1.20E-11	1 000	MSS-015	IE	2 64E-05	6 61E-07	1.20E-11	1.000	1.185
	SYS	7 37E-05	6 61E-07				SYS	7.37E-05	6 61E-07			
MSS-016	IE-FB	2.64E-05	3.82E-07	6 95E-12	1 000	MSS-016	IE-FB	2 64E-05	3 82E-07	6 95E-12	1 000	1 084

Base, Combined Base BEZ, and BEZ Comparizon CDF With Operator Action

BASE ONLY CDF With Operator Action						Combination Base & BEZ CDF With Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITH OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITH OPERATOR ACTION RRW	WITH OPERATOR ACTION RRW
	SYS-FB	7.37E-05	3 82E-07				SYS-FB	7.37E-05	3 82E-07			
MSS-017	IE-FB	2 64E-05	3 82E-07	6 95E-12	1.000	MSS-017	IE-FB	2 64E-05	3 82E-07	6 95E-12	1 000	1 094
	SYS-FB	7.37E-05	3.82E-07				SYS-FB	7.37E-05	3 82E-07			
MSS-018	IE-FB	2 64E-05	3 82E-07	6 95E-12	1 000	MSS-018	IE-FB	2 64E-05	3 82E-07	6 95E-12	1 001	1 105
	SYS-FB	7 37E-05	3 82E-07				SYS-FB	7.37E-05	3 82E-07			
MSS-019	SYS-FB	7.15E-05	3 82E-07	3 36E-15	1 000	MSS-019	SYS-FB	7.15E-05	3 82E-07	3 36E-15	1 000	1.014
MSS-020	SYS-FB	7.15E-05	3 82E-07	3 36E-15	1 000	MSS-020	SYS-FB	7 15E-05	3 82E-07	3.36E-15	1 000	1 014
MSS-021	SYS-FB	7.15E-05	3 82E-07	3.36E-15	1 000	MSS-021	SYS-FB	7 15E-05	3 82E-07	3 36E-15	1 000	1.014
MSS-022	IE	2 64E-05	1 74E-08	3 17E-13	1 000	MSS-022	IE	2.64E-05	1.74E-08	7.77E-13	1 000	1 028
							IE-JI/S	2 64E-05	7 90E-09			
							IE-PW	2 64E-05	1.74E-08			
	SYS	7 37E-05	1.74E-08				SYS	7.37E-05	1.74E-08			
							SYS-JI/S	7.37E-05	7 90E-09			
							SYS-PW	7 37E-05	1.74E-08			
MSS-023	IE	2 64E-05	1 74E-08	3 17E-13	1.000	MSS-023	IE	2 64E-05	1.74E-08	7.77E-13	1 000	1 020
							IE-JI/S	2 64E-05	7.90E-09			
							IE-PW	2 64E-05	1.74E-08			
	SYS	7.37E-05	1 74E-08				SYS	7.37E-05	1.74E-08			
							SYS-JI/S	7 37E-05	7 90E-09			
							SYS-PW	7 37E-05	1.74E-08			
MSS-024	IE	2 64E-05	1.74E-08	3.17E-13	1.000	MSS-024	IE	2 64E-05	1.74E-08	7 77E-13	1 000	1 021
							IE-JI/S	2 64E-05	7.90E-09			
							IE-PW	2 64E-05	1.74E-08			
	SYS	7 37E-05	1.74E-08				SYS	7 37E-05	1.74E-08			
							SYS-JI/S	7 37E-05	7.90E-09			
							SYS-PW	7 37E-05	1.74E-08			
MSS-025	None	0 00E+00	0 00E+00	0 00E+00	1 000	MSS-025	None	0.00E+00	0 00E+00	0 00E+00	1 000	1 000
MSS-026	IE	2 66E-05	2.19E-08	4.02E-13	1.000	MSS-026	IE	2 66E-05	2.19E-08	2 19E-12	1 000	1 078
							IE-JI/S	1 40E-04	1.38E-08			
							IE-PW	1.40E-04	2.19E-08			
	SYS	9 02E-05	2.19E-08				SYS	9 02E-05	2 19E-08			
							SYS-JI/S	1.27E-03	1.38E-08			
							SYS-PW	1 27E-03	2.19E-08			
MSS-027	IE-FB	2 64E-05	4 50E-07	8 19E-12	1 000	MSS-027	IE-FB	2 64E-05	4 50E-07	8 19E-12	1 000	1 134
	SYS-FB	7.37E-05	4.50E-07				SYS-FB	7 37E-05	4 50E-07			
MSS-028	IE-FB	2 64E-05	4.50E-07	8 19E-12	1 000	MSS-028	IE-FB	2 64E-05	4 50E-07	8.19E-12	1.000	1.110
	SYS-FB	7 37E-05	4 50E-07				SYS-FB	7.37E-05	4 50E-07			
MSS-029	IE-FB	2 64E-05	4.50E-07	8.19E-12	1 000	MSS-029	IE-FB	2 64E-05	4 50E-07	8 19E-12	1 000	1.098
	SYS-FB	7 37E-05	4 50E-07				SYS-FB	7.37E-05	4 50E-07			
MSS-030	None	0 00E+00	0.00E+00	0 00E+00	1 000	MSS-030	SYS-JI/S	7.16E-05	1 38E-08	3 70E-15	1 000	1.028
							SYS-PW	7.16E-05	2 19E-08			
MSS-031	None	0 00E+00	0 00E+00	0.00E+00	1.000	MSS-031	None	0 00E+00	0 00E+00	0 00E+00	1 000	1.000
MSS-032	None	0.00E+00	0 00E+00	0 00E+00	1 000	MSS-032	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000
MSS-033	None	0 00E+00	0 00E+00	0 00E+00	1 000	MSS-033	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000
MSS-034	None	0 00E+00	0 00E+00	0 00E+00	1 000	MSS-034	None	0 00E+00	0 00E+00	0.00E+00	1.000	1.000
MSS-035	None	0 00E+00	0 00E+00	0 00E+00	1.000	MSS-035	SYS-JI/S	7.15E-05	7 43E-07	4 24E-15	1 000	1 243
							SYS-PW	7.15E-05	2.17E-05			
MSS-036	None	0 00E+00	0 00E+00	0 00E+00	1 000	MSS-036	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000
MSS-037	None	0.00E+00	0 00E+00	0 00E+00	1 000	MSS-037	None	0 00E+00	0 00E+00	0 00E+00	1.000	1.000
MSS-038	None	0 00E+00	0 00E+00	0 00E+00	1.000	MSS-038	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000
MSS-039	None	0 00E+00	0.00E+00	0 00E+00	1.000	MSS-039	None	0 00E+00	0 00E+00	0 00E+00	1 000	1.000
MSS-040	None	0 00E+00	0 00E+00	0 00E+00	1 000	MSS-040	None	0 00E+00	0 00E+00	0 00E+00	1.000	1.000
MSS-041	IE	1 45E-06	1.19E-07	1.19E-13	1.000	MSS-041	IE	1 45E-06	1.19E-07	1 19E-13	1 000	1.003

Base, Combined Base BEZ, and BEZ Comparison CDF With Operator Action

BASE ONLY CDF With Operator Action						Combination Base & BEZ CDF With Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITH OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITH OPERATOR ACTION RRW	WITH OPERATOR ACTION RRW
	SYS	7.14E-05	1 19E-07				SYS	7.14E-05	1 19E-07			
MSS-042	IE	1.45E-06	1.19E-07	1.19E-13	1.000	MSS-042	IE	1 45E-06	1.19E-07	1 19E-13	1 000	1 003
	SYS	7.14E-05	1.19E-07				SYS	7.14E-05	1.19E-07			
MSS-043	IE	1.45E-06	1 19E-07	1 19E-13	1 000	MSS-043	IE	1.45E-06	1.19E-07	1 19E-13	1 000	1 003
	SYS	7 14E-05	1.19E-07				SYS	7.14E-05	1.19E-07			
MSS-044	SYS	7.14E-05	4 09E-07	0 00E+00	1 000	MSS-044	SYS	7.14E-05	4 09E-07	0 00E+00	1 000	1 000
MSS-045	SYS	7.14E-05	4 09E-07	0 00E+00	1 000	MSS-045	SYS	7.14E-05	4.09E-07	0 00E+00	1 000	1 000
MSS-046	SYS	7.14E-05	4 09E-07	0 00E+00	1 000	MSS-046	SYS	7.14E-05	4 09E-07	0 00E+00	1.000	1.000
MSS-047	IE	2.64E-05	1.74E-08	3.17E-13	1.000	MSS-047	IE	2 64E-05	1 74E-08	3 17E-13	1 000	1 008
	SYS	7 37E-05	1.74E-08				SYS	7 37E-05	1.74E-08			
MSS-048	IE	2 64E-05	1 74E-08	3 17E-13	1 000	MSS-048	IE	2 64E-05	1 74E-08	3 17E-13	1 000	1 008
	SYS	7.37E-05	1.74E-08				SYS	7.37E-05	1.74E-08			
MSS-049	IE	2 64E-05	1.74E-08	3 17E-13	1 000	MSS-049	IE	2 64E-05	1.74E-08	3 17E-13	1.000	1.008
	SYS	7.37E-05	1.74E-08				SYS	7.37E-05	1.74E-08			
MSS-050	IE	2 64E-05	2 19E-08	3 99E-13	1 000	MSS-050	IE	2 64E-05	2.19E-08	3 99E-13	1 000	1 007
	SYS	7 37E-05	2.19E-08				SYS	7.37E-05	2 19E-08			
MSS-051	IE	2 64E-05	2.19E-08	3.99E-13	1.000	MSS-051	IE	2.64E-05	2.19E-08	3 99E-13	1 000	1 009
	SYS	7 37E-05	2.19E-08				SYS	7 37E-05	2.19E-08			
MSS-052	IE	2 64E-05	2.19E-08	3.99E-13	1.000	MSS-052	IE	2.64E-05	2 19E-08	3 99E-13	1 000	1 007
	SYS	7.37E-05	2.19E-08				SYS	7.37E-05	2.19E-08			
MSS-053	IE	2 66E-05	1.74E-08	3 20E-13	1.000	MSS-053	IE	2 66E-05	1.74E-08	3 20E-13	1 000	1 011
	SYS	9 02E-05	1.74E-08				SYS	9 02E-05	1.74E-08			
						BEZ-001MSS	IE	2 38E-05	3.74E-08	1.81E-12	1.000	1 033
							IE-JI/S	1 40E-04	2 40E-08			
							SYS	3 75E-04	3 74E-08			
							SYS-JI/S	1.27E-03	2.40E-08			
						BEZ-002MSS	IE	2 38E-05	3 74E-08	1 81E-12	1 000	1 031
							IE-JI/S	1.40E-04	2.40E-08			
							SYS	3 75E-04	3.74E-08			
							SYS-JI/S	1 27E-03	2 40E-08			
						BEZ-003MSS	IE	2.38E-05	3.74E-08	1.81E-12	1.000	1 036
							IE-JI/S	1 40E-04	2 40E-08			
							SYS	3.75E-04	3.74E-08			
							SYS-JI/S	1 27E-03	2 40E-08			
						BEZ-004MSS	IE	2 38E-05	5 96E-08	9.78E-13	1.000	1.020
							SYS	3 75E-04	5 96E-08			
						BEZ-005MSS	IE	2 38E-05	5 96E-08	9.78E-13	1.000	1.025
							SYS	3 75E-04	5 96E-08			
						BEZ-006MSS	IE	2 38E-05	5 96E-08	9.78E-13	1.000	1 030
							SYS	3 75E-04	5 96E-08			
						BEZ-007SDS	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000
						BEZ-008SDS	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000
						BEZ-009SDS	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000
						BEZ-010FWS	IE	1 46E-05	2 20E-12	4 93E-13	1 000	1 009
							IE-JI/S	1.30E-04	1 06E-08			
							SYS	7.15E-05	2 20E-12			
							SYS-JI/S	1 27E-03	1 06E-08			
						BEZ-011FWS	IE	1 46E-05	2 20E-12	4 93E-13	1.000	1.009
							IE-JI/S	1 30E-04	1 06E-08			
							SYS	7.15E-05	2 20E-12			
							SYS-JI/S	1.27E-03	1.06E-08			
						BEZ-012FWS	IE	1.46E-05	2.20E-12	4 93E-13	1.000	1.009

Base, Combined Base BEZ, and BEZ Comparizon CDF With Operator Action

BASE ONLY CDF With Operator Action						Combination Base & BEZ CDF With Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITH OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITH OPERATOR ACTION RRW	WITH OPERATOR ACTION RRW
							IE-JI/S	1.30E-04	1.06E-08			
							SYS	7 15E-05	2 20E-12			
							SYS-JI/S	1 27E-03	1 06E-08			
						BEZ-013FWS	IE	3 33E-06	1.44E-08	3 31E-14	1 000	1 001
							SYS	7 15E-05	1 44E-08			
						BEZ-014FWS	IE	3 33E-06	1 44E-08	3 31E-14	1 000	1 001
							SYS	7 15E-05	1 44E-08			
						BEZ-015FWS	IE	3 33E-06	1.44E-08	3 31E-14	1 000	1 001
							SYS	7 15E-05	1.44E-08			
						BEZ-016FWS	None	0 00E+00	0 00E+00	0 00E+00	1 000	1 000

Base, Combined Base BEZ, and BEZ Comparizon CDF Without Operator Action

Base ONLY CDF Without Operator Actio						Combination Base & BEZ CDF Without Operator Actio						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITHOUT OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITHOUT OPERATOR ACTION RRW	WITHOUT OPERATOR ACTION RRW
FWA-001	IE	1.46E-05	8 68E-10	8.74E-15	1.000	FWA-001	IE	1.46E-05	8.68E-10	4.77E-13	1.000	1.011
							IE-JI/S	1.30E-04	1.01E-08			
	SYS	1.38E-04	8 68E-10				SYS	1.38E-04	8.68E-10			
							SYS-JI/S	1.27E-03	1 01E-08			
FWA-002	IE	1.46E-05	8.68E-10	8.74E-15	1.000	FWA-002	IE	1.46E-05	8.68E-10	4.77E-13	1.000	1.011
							IE-JI/S	1.30E-04	1.01E-08			
	SYS	1.38E-04	8.68E-10				SYS	1.38E-04	8 68E-10			
							SYS-JI/S	1.27E-03	1.01E-08			
FWA-003	IE	1.46E-05	8.68E-10	8.74E-15	1.000	FWA-003	IE	1.46E-05	8 68E-10	4.77E-13	1 000	1.011
							IE-JI/S	1.30E-04	1.01E-08			
	SYS	1.38E-04	8.68E-10				SYS	1.38E-04	8.68E-10			
							SYS-JI/S	1.27E-03	1.01E-08			
FWA-004	None	0.00E+00	0.00E+00	0 00E+00	1 000	FWA-004	None	0.00E+00	0.00E+00	0.00E+00	1.000	1.000
FWA-005	None	0.00E+00	0 00E+00	0.00E+00	1.000	FWA-005	None	0.00E+00	0.00E+00	0 00E+00	1.000	1.000
FWA-006	None	0 00E+00	0.00E+00	0 00E+00	1.000	FWA-006	None	0 00E+00	0 00E+00	0.00E+00	1.000	1 000
FWA-007	IE	1.73E-05	8 68E-10	1 04E-14	1.000	FWA-007	IE	1.73E-05	8.68E-10	4.79E-13	1 000	1 011
							IE-JI/S	1.30E-04	1.01E-08			
	SYS	1.45E-04	8.68E-10				SYS	1.45E-04	8.68E-10			
							SYS-JI/S	1.27E-03	1.01E-08			
FWA-008	IE	1.73E-05	8.68E-10	1 04E-14	1.000	FWA-008	IE	1.73E-05	8.68E-10	4.79E-13	1.000	1.011
							IE-JI/S	1.30E-04	1.01E-08			
	SYS	1.45E-04	8.68E-10				SYS	1.45E-04	8.68E-10			
							SYS-JI/S	1.27E-03	1 01E-08			
FWA-009	IE	1.73E-05	8 68E-10	1.04E-14	1.000	FWA-009	IE	1.73E-05	8 68E-10	4.79E-13	1.000	1.011
							IE-JI/S	1.30E-04	1 01E-08			
	SYS	1.45E-04	8.68E-10				SYS	1 45E-04	8.68E-10			
							SYS-JI/S	1.27E-03	1.01E-08			
FWA-010	IE	5.95E-06	9.85E-09	4.05E-14	1 000	FWA-010	IE	5.95E-06	9 85E-09	4.05E-14	1.000	1.001
	SYS	7.37E-05	9.85E-09				SYS	7.37E-05	9.85E-09			
FWA-011	IE	5 95E-06	9.85E-09	4.05E-14	1.000	FWA-011	IE	5.95E-06	9 85E-09	4.05E-14	1.000	1 001
	SYS	7.37E-05	9.85E-09				SYS	7.37E-05	9.85E-09			
FWA-012	IE	5.95E-06	9.85E-09	4.05E-14	1.000	FWA-012	IE	5.95E-06	9.85E-09	4.05E-14	1.000	1 001
	SYS	7.37E-05	9.85E-09				SYS	7.37E-05	9.85E-09			
MSS-004	IE	2 64E-05	3.74E-08	6.81E-13	1.000	MSS-004	IE	2.64E-05	3.74E-08	1.88E-12	1.000	1.042
							IE-JI/S	1.40E-04	2.40E-08			
	SYS	1.45E-04	3.74E-08				SYS	1.45E-04	3.74E-08			
							SYS-JI/S	1.27E-03	2.40E-08			
MSS-005	IE	2 64E-05	3.74E-08	6.81E-13	1.000	MSS-005	IE	2.64E-05	3.74E-08	1.88E-12	1.000	1.042
							IE-JI/S	1 40E-04	2.40E-08			
	SYS	1.45E-04	3.74E-08				SYS	1.45E-04	3.74E-08			
							SYS-JI/S	1.27E-03	2 40E-08			
MSS-006	IE	2.64E-05	3.74E-08	6.81E-13	1 000	MSS-006	IE	2 64E-05	3.74E-08	1.88E-12	1.000	1 046
							IE-JI/S	1.40E-04	2.40E-08			
	SYS	1.45E-04	3.74E-08				SYS	1.45E-04	3 74E-08			
							SYS-JI/S	1.27E-03	2.40E-08			
MSS-013	IE	2 38E-05	6.61E-07	1.08E-11	1 000	MSS-013	IE	2.38E-05	6 61E-07	1.08E-11	1 000	1.190
	SYS	7.14E-05	6.61E-07				SYS	7.14E-05	6.61E-07			

Base, Combined Base BEZ, and BEZ Comparizon CDF Without Operator Action

Base ONLY CDF Without Operator Actio						Combination Base & BEZ CDF Without Operator Actio						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITHOUT OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITHOUT OPERATOR ACTION RRW	WITHOUT OPERATOR ACTION RRW
MSS-014	IE	2.38E-05	6 61E-07	1.08E-11	1.000	MSS-014	IE	2.38E-05	6.61E-07	1.08E-11	1.000	1.219
.	SYS	7.14E-05	6.61E-07				SYS	7.14E-05	6 61E-07			
MSS-015	IE	2.38E-05	6.61E-07	1.08E-11	1 000	MSS-015	IE	2.38E-05	6 61E-07	1 08E-11	1.000	1 235
	SYS	7.14E-05	6.61E-07				SYS	7.14E-05	6.61E-07			
MSS-016	IE-FB	2.38E-05	3.82E-07	6.27E-12	1.000	MSS-016	IE-FB	2.38E-05	3.82E-07	6.27E-12	1.000	1 042
	SYS-FB	7.14E-05	3 82E-07				SYS-FB	7.14E-05	3.82E-07			
MSS-017	IE-FB	2.38E-05	3.82E-07	6.27E-12	1.000	MSS-017	IE-FB	2.38E-05	3 82E-07	6.27E-12	1.000	1.042
	SYS-FB	7.14E-05	3.82E-07				SYS-FB	7.14E-05	3.82E-07			
MSS-018	IE-FB	2.38E-05	3.82E-07	6.27E-12	1.000	MSS-018	IE-FB	2 38E-05	3 82E-07	6 27E-12	1 000	1.042
	SYS-FB	7.14E-05	3.82E-07				SYS-FB	7.14E-05	3.82E-07			
MSS-019	SYS-FB	7.15E-05	3.82E-07	3.36E-15	1.000	MSS-019	SYS-FB	7.15E-05	3 82E-07	3 36E-15	1 000	1.016
MSS-020	SYS-FB	7.15E-05	3.82E-07	3 36E-15	1.000	MSS-020	SYS-FB	7.15E-05	3.82E-07	3.36E-15	1.000	1 016
MSS-021	SYS-FB	7.15E-05	3.82E-07	3 36E-15	1 000	MSS-021	SYS-FB	7.15E-05	3.82E-07	3.36E-15	1.000	1.016
MSS-022	IE	2.38E-05	1.74E-08	2.86E-13	1.000	MSS-022	IE	2.38E-05	1.74E-08	7.01E-13	1 000	1.018
							IE-JI/S	2.38E-05	7.90E-09			
							IE-PW	2.38E-05	1.74E-08			
	SYS	7.14E-05	1.74E-08				SYS	7.14E-05	1.74E-08			
							SYS-JI/S	7.14E-05	7.90E-09			
							SYS-PW	7.14E-05	1.74E-08			
MSS-023	IE	2.38E-05	1.74E-08	2.86E-13	1.000	MSS-023	IE	2.38E-05	1.74E-08	7.01E-13	1.000	1.029
							IE-JI/S	2.38E-05	7.90E-09			
							IE-PW	2.38E-05	1.74E-08			
	SYS	7.14E-05	1.74E-08				SYS	7.14E-05	1.74E-08			
							SYS-JI/S	7.14E-05	7.90E-09			
							SYS-PW	7.14E-05	1.74E-08			
MSS-024	IE	2.38E-05	1.74E-08	2 86E-13	1.000	MSS-024	IE	2.38E-05	1.74E-08	7.46E-13	1 000	1 024
							IE-JI/S	2.64E-05	7.90E-09			
							IE-PW	2.64E-05	1.74E-08			
	SYS	7.14E-05	1.74E-08				SYS	7.14E-05	1.74E-08			
							SYS-JI/S	7.37E-05	7.90E-09			
							SYS-PW	7.37E-05	1.74E-08			
MSS-025	None	0 00E+00	0 00E+00	0 00E+00	1.000	MSS-025	None	0.00E+00	0.00E+00	0 00E+00	1 000	1.000
MSS-026	IE	2.66E-05	2.19E-08	4.02E-13	1 000	MSS-026	IE	2.66E-05	2.19E-08	2.19E-12	1 000	1 091
							IE-JI/S	1.40E-04	1.38E-08			
							IE-PW	1.40E-04	2.19E-08			
	SYS	9.02E-05	2.19E-08				SYS	9.02E-05	2.19E-08			
							SYS-JI/S	1.27E-03	1.38E-08			
							SYS-PW	1.27E-03	2.19E-08			
MSS-027	IE-FB	2.38E-05	4.50E-07	7.38E-12	1.000	MSS-027	IE-FB	2.38E-05	4.50E-07	7.38E-12	1.000	1.048
	SYS-FB	7.14E-05	4.50E-07				SYS-FB	7.14E-05	4.50E-07			
MSS-028	IE-FB	2.38E-05	4.50E-07	7.38E-12	1.000	MSS-028	IE-FB	2.38E-05	4.50E-07	7.38E-12	1 000	1.048
	SYS-FB	7.14E-05	4.50E-07				SYS-FB	7.14E-05	4.50E-07			
MSS-029	IE-FB	2.38E-05	4.50E-07	7.38E-12	1.000	MSS-029	IE-FB	2.38E-05	4.50E-07	7.38E-12	1.000	1 048
	SYS-FB	7.14E-05	4.50E-07				SYS-FB	7.14E-05	4.50E-07			
MSS-030	None	0 00E+00	0 00E+00	0 00E+00	1.000	MSS-030	SYS-JI/S	7.16E-05	1.38E-08	3.70E-15	1.000	1.028
							SYS-PW	7.16E-05	2.19E-08			
MSS-031	None	0.00E+00	0 00E+00	0 00E+00	1.000	MSS-031	None	0.00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-032	None	0.00E+00	0 00E+00	0 00E+00	1.000	MSS-032	None	0.00E+00	0.00E+00	0.00E+00	1 000	1 000

Base, Combined Base BEZ, and BEZ Comparison CDF Without Operator Action

Base ONLY CDF Without Operator Action					
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITHOUT OPERATOR ACTION RRW
MSS-033	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-034	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-035	None	0 00E+00	0 00E+00	0.00E+00	1.000
MSS-036	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-037	None	0.00E+00	0.00E+00	0.00E+00	1 000
MSS-038	None	0.00E+00	0 00E+00	0.00E+00	1.000
MSS-039	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-040	None	0 00E+00	0.00E+00	0.00E+00	1.000
MSS-041	IE	1.45E-06	1.19E-07	1.19E-13	1.000
	SYS	7.14E-05	1.19E-07		
MSS-042	IE	1.45E-06	1.19E-07	1.19E-13	1.000
	SYS	7.14E-05	1.19E-07		
MSS-043	IE	1.45E-06	1.19E-07	1.19E-13	1.000
	SYS	7.14E-05	1.19E-07		
MSS-044	SYS	7.14E-05	4 09E-07	0 00E+00	1.000
MSS-045	SYS	7.14E-05	4.09E-07	0.00E+00	1.000
MSS-046	SYS	7.14E-05	4 09E-07	0.00E+00	1.000
MSS-047	IE	2.64E-05	1.74E-08	3.17E-13	1.000
	SYS	1.45E-04	1.74E-08		
MSS-048	IE	2.64E-05	1.74E-08	3.17E-13	1.000
	SYS	1.45E-04	1.74E-08		
MSS-049	IE	2.64E-05	1.74E-08	3.17E-13	1.000
	SYS	1.45E-04	1.74E-08		
MSS-050	IE	2.38E-05	2.19E-08	3 59E-13	1.000
	SYS	7.14E-05	2.19E-08		
MSS-051	IE	2.38E-05	2.19E-08	3.59E-13	1.000
	SYS	7.14E-05	2.19E-08		
MSS-052	IE	2.38E-05	2.19E-08	3.59E-13	1 000
	SYS	7.14E-05	2.19E-08		
MSS-053	IE	2.66E-05	1.74E-08	3.20E-13	1.000
	SYS	9.02E-05	1.74E-08		

Combination Base & BEZ CDF Without Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITHOUT OPERATOR ACTION RRW	WITHOUT OPERATOR ACTION RRW
MSS-033	None	0.00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-034	None	0 00E+00	0.00E+00	0.00E+00	1.000	1 000
MSS-035	SYS-JI/S	7.15E-05	7.43E-07	4.24E-15	1.000	1.121
	SYS-PW	7.15E-05	2.17E-05			
MSS-036	None	0.00E+00	0.00E+00	0.00E+00	1 000	1.000
MSS-037	None	0 00E+00	0 00E+00	0.00E+00	1.000	1.000
MSS-038	None	0.00E+00	0.00E+00	0.00E+00	1.000	1 000
MSS-039	None	0 00E+00	0 00E+00	0 00E+00	1.000	1.000
MSS-040	None	0.00E+00	0.00E+00	0 00E+00	1.000	1 000
MSS-041	IE	1 45E-06	1.19E-07	1.19E-13	1.000	1.003
	SYS	7.14E-05	1.19E-07			
MSS-042	IE	1.45E-06	1.19E-07	1.19E-13	1 000	1 003
	SYS	7.14E-05	1.19E-07			
MSS-043	IE	1.45E-06	1.19E-07	1.19E-13	1.000	1 003
	SYS	7.14E-05	1.19E-07			
MSS-044	SYS	7.14E-05	4.09E-07	0.00E+00	1.000	1.000
MSS-045	SYS	7.14E-05	4 09E-07	0 00E+00	1.000	1.000
MSS-046	SYS	7.14E-05	4.09E-07	0.00E+00	1.000	1.000
MSS-047	IE	2.64E-05	1.74E-08	3.17E-13	1 000	1.010
	SYS	1.45E-04	1.74E-08			
MSS-048	IE	2.64E-05	1.74E-08	3.17E-13	1 000	1.012
	SYS	1.45E-04	1.74E-08			
MSS-049	IE	2.64E-05	1.74E-08	3.17E-13	1.000	1 009
	SYS	1 45E-04	1.74E-08			
MSS-050	IE	2.38E-05	2.19E-08	3 59E-13	1 000	1 008
	SYS	7.14E-05	2.19E-08			
MSS-051	IE	2.38E-05	2.19E-08	3.59E-13	1.000	1 009
	SYS	7.14E-05	2.19E-08			
MSS-052	IE	2.38E-05	2.19E-08	3 59E-13	1 000	1 008
	SYS	7.14E-05	2.19E-08			
MSS-053	IE	2.66E-05	1.74E-08	3.20E-13	1.000	1 015
	SYS	9 02E-05	1.74E-08			
BEZ-001MSS	IE	2.64E-05	3.74E-08	1.88E-12	1.000	1.050
	IE-JI/S	1.40E-04	2.40E-08			
	SYS	1.45E-04	3.74E-08			
	SYS-JI/S	1.27E-03	2 40E-08			
BEZ-002MSS	IE	2.64E-05	3.74E-08	1 88E-12	1.000	1 038
	IE-JI/S	1 40E-04	2.40E-08			
	SYS	1 45E-04	3.74E-08			
	SYS-JI/S	1.27E-03	2.40E-08			
BEZ-003MSS	IE	2.64E-05	3.74E-08	1.88E-12	1 000	1 042
	IE-JI/S	1.40E-04	2.40E-08			
	SYS	1.45E-04	3.74E-08			
	SYS-JI/S	1.27E-03	2.40E-08			
BEZ-004MSS	IE	2.38E-05	5.96E-08	9.78E-13	1 000	1 015
	SYS	7.15E-05	5 96E-08			
BEZ-005MSS	IE	2.38E-05	5.96E-08	9.78E-13	1.000	1.015

Base, Combined Base BEZ, and BEZ Comparison CDF Without Operator Action

Base ONLY CDF Without Operator Action						Combination Base & BEZ CDF Without Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITHOUT OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING CDF	WITHOUT OPERATOR ACTION RRW	WITHOUT OPERATOR ACTION RRW
							SYS	7.15E-05	5.96E-08			
						BEZ-006MSS	IE	2.38E-05	5.96E-08	9.78E-13	1.000	1 015
							SYS	7.15E-05	5.96E-08			
						BEZ-007SDS	None	0.00E+00	0 00E+00	0.00E+00	1.000	1.000
						BEZ-008SDS	None	0 00E+00	0.00E+00	0.00E+00	1.000	1 000
						BEZ-009SDS	None	0.00E+00	0.00E+00	0.00E+00	1 000	1.000
						BEZ-010FWS	IE	1.46E-05	2 20E-12	4.93E-13	1.000	1.010
							IE-JI/S	1.30E-04	1.06E-08			
							SYS	1.38E-04	2.20E-12			
							SYS-JI/S	1.27E-03	1 06E-08			
						BEZ-011FWS	IE	1.46E-05	2.20E-12	4.93E-13	1 000	1 010
							IE-JI/S	1.30E-04	1.06E-08			
							SYS	1 38E-04	2.20E-12			
							SYS-JI/S	1.27E-03	1.06E-08			
						BEZ-012FWS	IE	1 46E-05	2.20E-12	4.93E-13	1 000	1 010
							IE-JI/S	1.30E-04	1.06E-08			
							SYS	1.38E-04	2.2E-12			
							SYS-JI/S	1 27E-03	1 06E-08			
						BEZ-013FWS	IE	3.33E-06	1.44E-08	3.31E-14	1.000	1.001
							SYS	7.15E-05	1.44E-08			
						BEZ-014FWS	IE	3 33E-06	1.44E-08	3.31E-14	1.000	1 001
							SYS	7.15E-05	1.44E-08			
						BEZ-015FWS	IE	3 33E-06	1.44E-08	3.31E-14	1.000	1 001
							SYS	7.15E-05	1.44E-08			
						BEZ-016FWS	None	0.00E+00	0	0	1.000	1 000

Base, Combined Base BEZ, and BEZ Companzon LERF With Operator Action

Base ONLY LERF With Operator Action						Combination Base & BEZ LERF With Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITH OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITH OPERATOR ACTION RRW	WITH OPERATOR ACTION RRW
FWA-001	IE	2.19E-07	8 68E-10	1.31E-16	1.000	FWA-001	IE	2.19E-07	8.68E-10	4.04E-15	1.000	1.004
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	1.22E-06	8.68E-10				SYS	1.22E-06	8.68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-002	IE	2.19E-07	8 68E-10	1.31E-16	1.000	FWA-002	IE	2.19E-07	8 68E-10	4 04E-15	1.000	1.004
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	1.22E-06	8.68E-10				SYS	1.22E-06	8.68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-003	IE	2.19E-07	8 68E-10	1.31E-16	1.000	FWA-003	IE	2 19E-07	8.68E-10	4.04E-15	1.000	1.004
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	1.22E-06	8.68E-10				SYS	1.22E-06	8.68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-004	None	0 00E+00	0.00E+00	0.00E+00	1.000	FWA-004	None	0 00E+00	0.00E+00	0.00E+00	1.000	1.000
FWA-005	None	0.00E+00	0 00E+00	0 00E+00	1.000	FWA-005	None	0 00E+00	0 00E+00	0.00E+00	1.000	1.000
FWA-006	None	0.00E+00	0 00E+00	0 00E+00	1.000	FWA-006	None	0.00E+00	0.00E+00	0 00E+00	1.000	1.000
FWA-007	IE	1.06E-06	8.68E-10	6.41E-16	1 000	FWA-007	IE	1.06E-06	8.68E-10	4.55E-15	1.000	1 005
							IE-JI/S	5 38E-07	1.01E-08			
	SYS	5.27E-06	8.68E-10				SYS	5 27E-06	8 68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-008	IE	1.06E-06	8.68E-10	6.41E-16	1.000	FWA-008	IE	1 06E-06	8.68E-10	4.55E-15	1.000	1.005
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	5.27E-06	8 68E-10				SYS	5.27E-06	8 68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-009	IE	1 06E-06	8 68E-10	6.41E-16	1.000	FWA-009	IE	1 06E-06	8.68E-10	4.55E-15	1.000	1.005
							IE-JI/S	5.38E-07	1 01E-08			
	SYS	5.27E-06	8 68E-10				SYS	5.27E-06	8.68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-010	IE	5 06E-07	9 85E-09	3.44E-15	1.000	FWA-010	IE	5 06E-07	9 85E-09	3 44E-15	1.000	1.006
	SYS	1.48E-06	9 85E-09				SYS	1.48E-06	9 85E-09			
FWA-011	IE	5.06E-07	9.85E-09	3 44E-15	1.000	FWA-011	IE	5.06E-07	9.85E-09	3.44E-15	1.000	1.005
	SYS	1 48E-06	9 85E-09				SYS	1.48E-06	9.85E-09			
FWA-012	IE	5.06E-07	9 85E-09	3 44E-15	1 000	FWA-012	IE	5.06E-07	9.85E-09	3.44E-15	1 000	1 007
	SYS	1.48E-06	9.85E-09				SYS	1.48E-06	9.85E-09			
MSS-004	IE	1.63E-06	3 74E-08	4.23E-14	1.000	MSS-004	IE	1.63E-06	3.74E-08	7.50E-14	1.000	1.068
							IE-JI/S	1.95E-06	2.40E-08			
	SYS	5 27E-06	3.74E-08				SYS	5 27E-06	3.74E-08			
							SYS-JI/S	1.05E-05	2.40E-08			
MSS-005	IE	1.63E-06	3.74E-08	4 23E-14	1.000	MSS-005	IE	1.63E-06	3.74E-08	7.50E-14	1.000	1 068
							IE-JI/S	1.95E-06	2.40E-08			
	SYS	5.27E-06	3.74E-08				SYS	5 27E-06	3.74E-08			
							SYS-JI/S	1.05E-05	2 40E-08			
MSS-006	IE	1.63E-06	3 74E-08	4.23E-14	1.000	MSS-006	IE	1.63E-06	3.74E-08	7.50E-14	1.000	1.063
							IE-JI/S	1.95E-06	2.40E-08			
	SYS	5.27E-06	3.74E-08				SYS	5.27E-06	3.74E-08			
							SYS-JI/S	1 05E-05	2.40E-08			
MSS-013	IE	6 60E-07	6.61E-07	3.01E-13	1.000	MSS-013	IE	6 60E-07	6.61E-07	3.01E-13	1.000	1.224

Base, Combined Base BEZ, and BEZ Comparizon LERF With Operator Action

Base ONLY LERF With Operator Action						Combination Base & BEZ LERF With Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITH OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITH OPERATOR ACTION RRW	WITH OPERATOR ACTION RRW
	SYS	1.48E-06	6.61E-07				SYS	1.48E-06	6 61E-07			
MSS-014	IE	6 60E-07	6.61E-07	3 01E-13	1 000	MSS-014	IE	6 60E-07	6 61E-07	3 01E-13	1.000	1.299
	SYS	1.48E-06	6 61E-07				SYS	1.48E-06	6 61E-07			
MSS-015	IE	6.60E-07	6.61E-07	3.01E-13	1.000	MSS-015	IE	6.60E-07	6.61E-07	3.01E-13	1.000	1.190
	SYS	1.48E-06	6 61E-07				SYS	1 48E-06	6 61E-07			
MSS-016	IE-FB	6 60E-07	3.82E-07	1.74E-13	1 000	MSS-016	IE-FB	6 60E-07	3.82E-07	1.74E-13	1 000	1.114
	SYS-FB	1.48E-06	3.82E-07				SYS-FB	1.48E-06	3.82E-07			
MSS-017	IE-FB	6 60E-07	3 82E-07	1.74E-13	1.000	MSS-017	IE-FB	6 60E-07	3 82E-07	1.74E-13	1.000	1.133
	SYS-FB	1 48E-06	3 82E-07				SYS-FB	1.48E-06	3 82E-07			
MSS-018	IE-FB	6.60E-07	3.82E-07	1.74E-13	1.000	MSS-018	IE-FB	6.60E-07	3.82E-07	1.74E-13	1.000	1.116
	SYS-FB	1.48E-06	3.82E-07				SYS-FB	1.48E-06	3.82E-07			
MSS-019	SYS-FB	1.22E-06	3.82E-07	0.00E+00	1.000	MSS-019	SYS-FB	1.22E-06	3 82E-07	0 00E+00	1.000	1 000
MSS-020	SYS-FB	1.22E-06	3 82E-07	0 00E+00	1 000	MSS-020	SYS-FB	1.22E-06	3 82E-07	0.00E+00	1.000	1.000
MSS-021	SYS-FB	1.22E-06	3 82E-07	0.00E+00	1 000	MSS-021	SYS-FB	1.22E-06	3.82E-07	0.00E+00	1.000	1.000
MSS-022	IE	6.60E-07	1.74E-08	7.93E-15	1.000	MSS-022	IE	6.60E-07	1.74E-08	1.94E-14	1.000	1.027
							IE-JI/S	6.60E-07	7.90E-09			
							IE-PW	6 60E-07	1.74E-08			
	SYS	1.48E-06	1.74E-08				SYS	1.48E-06	1.74E-08			
							SYS-JI/S	1.48E-06	7.90E-09			
							SYS-PW	1.48E-06	1.74E-08			
MSS-023	IE	6 60E-07	1.74E-08	7.93E-15	1.000	MSS-023	IE	6 60E-07	1.74E-08	1.94E-14	1.000	1 028
							IE-JI/S	6 60E-07	7.90E-09			
							IE-PW	6.60E-07	1.74E-08			
	SYS	1.48E-06	1.74E-08				SYS	1.48E-06	1.74E-08			
							SYS-JI/S	1 48E-06	7.90E-09			
							SYS-PW	1.48E-06	1.74E-08			
MSS-024	IE	6 60E-07	1.74E-08	7.93E-15	1 000	MSS-024	IE	6.60E-07	1.74E-08	1.94E-14	1.000	1.028
							IE-JI/S	6.60E-07	7.90E-09			
							IE-PW	6 60E-07	1.74E-08			
	SYS	1.48E-06	1.74E-08				SYS	1.48E-06	1.74E-08			
							SYS-JI/S	1.48E-06	7.90E-09			
							SYS-PW	1.48E-06	1.74E-08			
MSS-025	None	0 00E+00	0 00E+00	0 00E+00	1.000	MSS-025	None	0.00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-026	IE	5.54E-07	2.19E-08	8.39E-15	1.000	MSS-026	IE	5.54E-07	2.19E-08	2.36E-14	1.000	1.042
							IE-JI/S	6.13E-07	1.38E-08			
							IE-PW	6.13E-07	2.19E-08			
	SYS	1.93E-06	2.19E-08				SYS	1.93E-06	2.19E-08			
							SYS-JI/S	3.36E-06	1.38E-08			
							SYS-PW	3.36E-06	2.19E-08			
MSS-027	IE-FB	6.60E-07	4.50E-07	2.05E-13	1 000	MSS-027	IE-FB	6.60E-07	4.50E-07	2 05E-13	1.000	1.139
	SYS-FB	1.48E-06	4.50E-07				SYS-FB	1.48E-06	4 50E-07			
MSS-028	IE-FB	6.60E-07	4.50E-07	2.05E-13	1.000	MSS-028	IE-FB	6.60E-07	4.50E-07	2.05E-13	1.000	1.162
	SYS-FB	1.48E-06	4.50E-07				SYS-FB	1.48E-06	4.50E-07			
MSS-029	IE-FB	6.60E-07	4.50E-07	2.05E-13	1.000	MSS-029	IE-FB	6.60E-07	4 50E-07	2.05E-13	1.000	1.143
	SYS-FB	1.48E-06	4.50E-07				SYS-FB	1.48E-06	4.50E-07			
MSS-030	None	0 00E+00	0 00E+00	0.00E+00	1.000	MSS-030	SYS-JI/S	1.22E-06	1.38E-08	0.00E+00	1.000	1.000
							SYS-PW	1.22E-06	2.19E-08			

Base, Combined Base BEZ, and BEZ Comparizon LERF With Operator Action

Base ONLY LERF With Operator Action					
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITH OPERATOR ACTION RRW
MSS-031	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-032	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-033	None	0 00E+00	0 00E+00	0 00E+00	1 000
MSS-034	None	0 00E+00	0 00E+00	0.00E+00	1.000
MSS-035	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-036	None	0 00E+00	0.00E+00	0 00E+00	1.000
MSS-037	None	0 00E+00	0.00E+00	0 00E+00	1 000
MSS-038	None	0 00E+00	0 00E+00	0 00E+00	1 000
MSS-039	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-040	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-041	IE	2.44E-08	1.19E-07	2.00E-15	1.000
	SYS	1.22E-06	1.19E-07		
MSS-042	IE	2.44E-08	1.19E-07	2.00E-15	1.000
	SYS	1.22E-06	1.19E-07		
MSS-043	IE	2.44E-08	1.19E-07	2 00E-15	1.000
	SYS	1.22E-06	1.19E-07		
MSS-044	SYS	1.22E-06	4.09E-07	0.00E+00	1.000
MSS-045	SYS	1.22E-06	4.09E-07	0.00E+00	1 000
MSS-046	SYS	1.22E-06	4.09E-07	0.00E+00	1 000
MSS-047	IE	6 60E-07	1.74E-08	7.93E-15	1 000
	SYS	1.48E-06	1.74E-08		
MSS-048	IE	6.60E-07	1.74E-08	7.93E-15	1.000
	SYS	1.48E-06	1.74E-08		
MSS-049	IE	6.60E-07	1.74E-08	7.93E-15	1.000
	SYS	1.48E-06	1.74E-08		
MSS-050	IE	6.60E-07	2.19E-08	9.98E-15	1.000
	SYS	1 48E-06	2.19E-08		
MSS-051	IE	6 60E-07	2.19E-08	9.98E-15	1.000
	SYS	1.48E-06	2.19E-08		
MSS-052	IE	6.60E-07	2.19E-08	9 98E-15	1.000
	SYS	1 48E-06	2.19E-08		
MSS-053	IE	5.54E-07	1.74E-08	6.67E-15	1.000
	SYS	1.93E-06	1.74E-08		

Combination Base & BEZ LERF With Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITH OPERATOR ACTION RRW	WITH OPERATOR ACTION RRW
MSS-031	None	0.00E+00	0.00E+00	0 00E+00	1 000	1 000
MSS-032	None	0 00E+00	0 00E+00	0 00E+00	1.000	1 000
MSS-033	None	0 00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-034	None	0.00E+00	0 00E+00	0.00E+00	1.000	1.000
MSS-035	SYS-JI/S	1.22E-06	7 43E-07	0 00E+00	1.000	1.000
	SYS-PW	1.22E-06	2.17E-05			
MSS-036	None	0 00E+00	0 00E+00	0.00E+00	1.000	1.000
MSS-037	None	0.00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-038	None	0 00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-039	None	0.00E+00	0.00E+00	0.00E+00	1.000	1 000
MSS-040	None	0.00E+00	0 00E+00	0 00E+00	1.000	1.000
MSS-041	IE	2.44E-08	1.19E-07	2.00E-15	1.000	1.002
	SYS	1.22E-06	1.19E-07			
MSS-042	IE	2.44E-08	1.19E-07	2.00E-15	1.000	1.002
	SYS	1 22E-06	1.19E-07			
MSS-043	IE	2 44E-08	1.19E-07	2.00E-15	1.000	1.002
	SYS	1.22E-06	1.19E-07			
MSS-044	SYS	1.22E-06	4.09E-07	0.00E+00	1 000	1.000
MSS-045	SYS	1.22E-06	4 09E-07	0 00E+00	1.000	1.000
MSS-046	SYS	1.22E-06	4.09E-07	0 00E+00	1.000	1.000
MSS-047	IE	6 60E-07	1.74E-08	7.93E-15	1.000	1.021
	SYS	1.48E-06	1.74E-08			
MSS-048	IE	6.60E-07	1.74E-08	7.93E-15	1.000	1.010
	SYS	1.48E-06	1.74E-08			
MSS-049	IE	6.60E-07	1.74E-08	7.93E-15	1.000	1 009
	SYS	1.48E-06	1.74E-08			
MSS-050	IE	6 60E-07	2.19E-08	9.98E-15	1.000	1.009
	SYS	1.48E-06	2.19E-08			
MSS-051	IE	6.60E-07	2.19E-08	9 98E-15	1.000	1 008
	SYS	1.48E-06	2.19E-08			
MSS-052	IE	6 60E-07	2.19E-08	9.98E-15	1.000	1.010
	SYS	1.48E-06	2.19E-08			
MSS-053	IE	5.54E-07	1.74E-08	6 67E-15	1.000	1.010
	SYS	1.93E-06	1.74E-08			
BEZ-001MSS	IE	2.87E-07	3.74E-08	4.01E-14	1.000	1.027
	IE-JI/S	1.95E-06	2.40E-08			
	SYS	6.41E-06	3.74E-08			
	SYS-JI/S	1.05E-05	2.40E-08			
BEZ-002MSS	IE	2 87E-07	3.74E-08	4 01E-14	1.000	1.028
	IE-JI/S	1.95E-06	2.40E-08			
	SYS	6.41E-06	3.74E-08			
	SYS-JI/S	1.05E-05	2.40E-08			
BEZ-003MSS	IE	2.87E-07	3.74E-08	4 01E-14	1.000	1 028
	IE-JI/S	1.95E-06	2.40E-08			
	SYS	6.41E-06	3.74E-08			
	SYS-JI/S	1.05E-05	2.40E-08			

Base, Combined Base BEZ, and BEZ Comparizon LERF With Operator Action

Base ONLY LERF With Operator Action					
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITH OPERATOR ACTION RRW

Combination Base & BEZ LERF With Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITH OPERATOR ACTION RRW	WITH OPERATOR ACTION RRW
BEZ-004MSS	IE	2.87E-07	5.96E-08	1.18E-14	1 000	1.017
	SYS	6 41E-06	5.96E-08			
BEZ-005MSS	IE	2.87E-07	5 96E-08	1.18E-14	1 000	1.017
	SYS	6.41E-06	5.96E-08			
BEZ-006MSS	IE	2.87E-07	5.96E-08	1.18E-14	1.000	1.016
	SYS	6.41E-06	5.96E-08			
BEZ-007SDS	None	0.00E+00	0 00E+00	0 00E+00	1.000	1 000
BEZ-008SDS	None	0 00E+00	0.00E+00	0 00E+00	1 000	1 000
BEZ-009SDS	None	0 00E+00	0 00E+00	0 00E+00	1 000	1.000
BEZ-010FWS	IE	2.19E-07	2.20E-12	4.12E-15	1.000	1.004
	IE-JI/S	5.38E-07	1.06E-08			
	SYS	1.22E-06	2 20E-12			
	SYS-JI/S	1 05E-05	1 06E-08			
BEZ-011FWS	IE	2.19E-07	2 20E-12	4.12E-15	1.000	1 004
	IE-JI/S	5.38E-07	1.06E-08			
	SYS	1 22E-06	2 20E-12			
	SYS-JI/S	1 05E-05	1 06E-08			
BEZ-012FWS	IE	2.19E-07	2 20E-12	4.12E-15	1 000	1.004
	IE-JI/S	5.38E-07	1.06E-08			
	SYS	1.22E-06	2.20E-12			
	SYS-JI/S	1.05E-05	1 06E-08			
BEZ-013FWS	IE	1.43E-07	1.44E-08	1.42E-15	1 000	1.002
	SYS	1.22E-06	1.44E-08			
BEZ-014FWS	IE	1.43E-07	1.44E-08	1.42E-15	1.000	1.002
	SYS	1.22E-06	1.44E-08			
BEZ-015FWS	IE	1 43E-07	1.44E-08	1.42E-15	1 000	1 002
	SYS	1.22E-06	1.44E-08			
BEZ-016FWS	None	0 00E+00	0	0	1 000	1 000

Base, Combined Base BEZ, and BEZ Comparizon LERF Without Operator Action

Base ONLY LERF Without Operator Action						Combination Base & BEZ LERF Without Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITHOUT OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITHOUT OPERATOR ACTION RRW	WITHOUT OPERATOR ACTION RRW
FWA-001	IE	2.19E-07	8 68E-10	1.33E-16	1 000	FWA-001	IE	2.19E-07	8 68E-10	4 04E-15	1 000	1 006
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	2 64E-06	8 68E-10				SYS	2.64E-06	8.68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-002	IE	2.19E-07	8 68E-10	1.33E-16	1 000	FWA-002	IE	2.19E-07	8 68E-10	4 04E-15	1 000	1.006
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	2.64E-06	8 68E-10				SYS	2.64E-06	8.68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-003	IE	2.19E-07	8 68E-10	1.33E-16	1 000	FWA-003	IE	2.19E-07	8.68E-10	4.04E-15	1.000	1.006
							IE-JI/S	5 38E-07	1 01E-08			
	SYS	2 64E-06	8 68E-10				SYS	2.64E-06	8.68E-10			
							SYS-JI/S	1 05E-05	1.01E-08			
FWA-004	None	0.00E+00	0 00E+00	0 00E+00	1 000	FWA-004	None	0 00E+00	0.00E+00	0 00E+00	1 000	1 000
FWA-005	None	0.00E+00	0 00E+00	0 00E+00	1.000	FWA-005	None	0 00E+00	0 00E+00	0 00E+00	1 000	1.000
FWA-006	None	0.00E+00	0.00E+00	0.00E+00	1.000	FWA-006	None	0 00E+00	0 00E+00	0 00E+00	1.000	1.000
FWA-007	IE	1 06E-06	8 68E-10	6 45E-16	1 000	FWA-007	IE	1.06E-06	8.68E-10	4.55E-15	1.000	1.008
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	7.91E-06	8 68E-10				SYS	7.91E-06	8 68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-008	IE	1.06E-06	8 68E-10	6 45E-16	1 000	FWA-008	IE	1.06E-06	8.68E-10	4.55E-15	1.000	1.008
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	7.91E-06	8.68E-10				SYS	7.91E-06	8 68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-009	IE	1.06E-06	8.68E-10	6.45E-16	1.000	FWA-009	IE	1.06E-06	8.68E-10	4.55E-15	1.000	1.008
							IE-JI/S	5.38E-07	1.01E-08			
	SYS	7.91E-06	8 68E-10				SYS	7.91E-06	8 68E-10			
							SYS-JI/S	1.05E-05	1.01E-08			
FWA-010	IE	5 06E-07	9 85E-09	3 44E-15	1.000	FWA-010	IE	5.06E-07	9.85E-09	3.44E-15	1.000	1.006
	SYS	1.48E-06	9 85E-09				SYS	1.48E-06	9.85E-09			
FWA-011	IE	5.06E-07	9 85E-09	3 44E-15	1 000	FWA-011	IE	5 06E-07	9.85E-09	3.44E-15	1.000	1 006
	SYS	1.48E-06	9.85E-09				SYS	1 48E-06	9 85E-09			
FWA-012	IE	5.06E-07	9 85E-09	3.44E-15	1.000	FWA-012	IE	5.06E-07	9.85E-09	3 44E-15	1.000	1 006
	SYS	1 48E-06	9.85E-09				SYS	1.48E-06	9.85E-09			
MSS-004	IE	1.63E-06	3.74E-08	4 25E-14	1 000	MSS-004	IE	1 63E-06	3 74E-08	7.52E-14	1.000	1.115
							IE-JI/S	1.95E-06	2.40E-08			
	SYS	7.90E-06	3.74E-08				SYS	7.90E-06	3.74E-08			
							SYS-JI/S	1.05E-05	2.40E-08			
MSS-005	IE	1.63E-06	3 74E-08	4.25E-14	1.000	MSS-005	IE	1.63E-06	3.74E-08	7.52E-14	1.000	1.099
							IE-JI/S	1 95E-06	2.40E-08			
	SYS	7.90E-06	3.74E-08				SYS	7.90E-06	3.74E-08			
							SYS-JI/S	1.05E-05	2.40E-08			
MSS-006	IE	1.63E-06	3.74E-08	4.25E-14	1.000	MSS-006	IE	1.63E-06	3.74E-08	7 52E-14	1.000	1.103
							IE-JI/S	1.95E-06	2.40E-08			
	SYS	7.90E-06	3.74E-08				SYS	7.90E-06	3.74E-08			
							SYS-JI/S	1 05E-05	2 40E-08			
MSS-013	IE	2.90E-07	6.61E-07	1.32E-13	1.000	MSS-013	IE	2.90E-07	6.61E-07	1.32E-13	1.000	1.188

Base, Combined Base BEZ, and BEZ Comparizon LERF Without Operator Action

Base ONLY LERF Without Operator Action						Combination Base & BEZ LERF Without Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITHOUT OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITHOUT OPERATOR ACTION RRW	WITHOUT OPERATOR ACTION RRW
	SYS	1.22E-06	6.61E-07				SYS	1.22E-06	6.61E-07			
MSS-014	IE	2.90E-07	6 61E-07	1.32E-13	1.000	MSS-014	IE	2.90E-07	6.61E-07	1.32E-13	1 000	1.196
	SYS	1.22E-06	6.61E-07				SYS	1.22E-06	6.61E-07			
MSS-015	IE	2.90E-07	6.61E-07	1.32E-13	1 000	MSS-015	IE	2.90E-07	6 61E-07	1.32E-13	1.000	1 199
	SYS	1.22E-06	6 61E-07				SYS	1.22E-06	6 61E-07			
MSS-016	IE-FB	2.90E-07	3.82E-07	7.64E-14	1.000	MSS-016	IE-FB	2.90E-07	3.82E-07	7.64E-14	1.000	1 041
	SYS-FB	1 22E-06	3.82E-07				SYS-FB	1.22E-06	3.82E-07			
MSS-017	IE-FB	2.90E-07	3.82E-07	7.64E-14	1.000	MSS-017	IE-FB	2.90E-07	3 82E-07	7 64E-14	1.000	1 041
	SYS-FB	1.22E-06	3.82E-07				SYS-FB	1.22E-06	3.82E-07			
MSS-018	IE-FB	2.90E-07	3.82E-07	7.64E-14	1.000	MSS-018	IE-FB	2 90E-07	3.82E-07	7.64E-14	1.000	1 041
	SYS-FB	1.22E-06	3 82E-07				SYS-FB	1 22E-06	3 82E-07			
MSS-019	SYS-FB	1.22E-06	3 82E-07	0.00E+00	1.000	MSS-019	SYS-FB	1 22E-06	3.82E-07	0 00E+00	1 000	1.000
MSS-020	SYS-FB	1 22E-06	3.82E-07	0.00E+00	1 000	MSS-020	SYS-FB	1.22E-06	3 82E-07	0 00E+00	1.000	1 000
MSS-021	SYS-FB	1.22E-06	3.82E-07	0.00E+00	1 000	MSS-021	SYS-FB	1.22E-06	3 82E-07	0 00E+00	1.000	1 000
MSS-022	IE	2.90E-07	1.74E-08	3 48E-15	1 000	MSS-022	IE	2.90E-07	1 74E-08	8.54E-15	1.000	1 017
							IE-JI/S	2 90E-07	7.90E-09			
							IE-PW	2 90E-07	1.74E-08			
	SYS	1.22E-06	1.74E-08				SYS	1.22E-06	1.74E-08			
							SYS-JI/S	1.22E-06	7.90E-09			
							SYS-PW	1.22E-06	1.74E-08			
MSS-023	IE	2 90E-07	1.74E-08	3 48E-15	1.000	MSS-023	IE	2.90E-07	1.74E-08	8.54E-15	1.000	1 019
							IE-JI/S	2.90E-07	7.90E-09			
							IE-PW	2.90E-07	1.74E-08			
	SYS	1.22E-06	1.74E-08				SYS	1.22E-06	1 74E-08			
							SYS-JI/S	1.22E-06	7 90E-09			
							SYS-PW	1.22E-06	1.74E-08			
MSS-024	IE	2.90E-07	1.74E-08	3.48E-15	1.000	MSS-024	IE	2.90E-07	1.74E-08	1 50E-14	1.000	1.040
							IE-JI/S	6.60E-07	7.90E-09			
							IE-PW	6 60E-07	1.74E-08			
	SYS	1.22E-06	1.74E-08				SYS	1.22E-06	1.74E-08			
							SYS-JI/S	1.48E-06	7 90E-09			
							SYS-PW	1.48E-06	1.74E-08			
MSS-025	None	0.00E+00	0 00E+00	0 00E+00	1.000	MSS-025	None	0 00E+00	0.00E+00	0 00E+00	1.000	1.000
MSS-026	IE	5.54E-07	2.19E-08	8.39E-15	1.000	MSS-026	IE	5 54E-07	2.19E-08	2 36E-14	1.000	1.062
							IE-JI/S	6.13E-07	1.38E-08			
							IE-PW	6.13E-07	2.19E-08			
	SYS	1.93E-06	2.19E-08				SYS	1.93E-06	2.19E-08			
							SYS-JI/S	3 36E-06	1.38E-08			
							SYS-PW	3 36E-06	2.19E-08			
MSS-027	IE-FB	2.90E-07	4 50E-07	9 00E-14	1.000	MSS-027	IE-FB	2.90E-07	4.50E-07	9.00E-14	1 000	1.046
	SYS-FB	1 22E-06	4.50E-07				SYS-FB	1.22E-06	4.50E-07			
MSS-028	IE-FB	2.90E-07	4.50E-07	9.00E-14	1.000	MSS-028	IE-FB	2.90E-07	4.50E-07	9.00E-14	1.000	1 046
	SYS-FB	1.22E-06	4.50E-07				SYS-FB	1.22E-06	4.50E-07			
MSS-029	IE-FB	2.90E-07	4.50E-07	9 00E-14	1.000	MSS-029	IE-FB	2.90E-07	4.50E-07	9.00E-14	1.000	1.046
	SYS-FB	1.22E-06	4.50E-07				SYS-FB	1.22E-06	4.50E-07			
MSS-030	None	0 00E+00	0.00E+00	0 00E+00	1.000	MSS-030	SYS-JI/S	1.22E-06	1 38E-08	0 00E+00	1.000	1.000
							SYS-PW	1.22E-06	2.19E-08			

Base, Combined Base BEZ, and BEZ Comparizon LERF Without Operator Action

Base ONLY LERF Without Operator Action					
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITHOUT OPERATOR ACTION RRW
MSS-031	None	0.00E+00	0 00E+00	0 00E+00	1 000
MSS-032	None	0.00E+00	0 00E+00	0 00E+00	1.000
MSS-033	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-034	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-035	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-036	None	0 00E+00	0 00E+00	0 00E+00	1.000
MSS-037	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-038	None	0 00E+00	0.00E+00	0.00E+00	1.000
MSS-039	None	0.00E+00	0.00E+00	0.00E+00	1.000
MSS-040	None	0.00E+00	0.00E+00	0 00E+00	1.000
MSS-041	IE	2.44E-08	1.19E-07	2 00E-15	1 000
	SYS	1.22E-06	1.19E-07		
MSS-042	IE	2.44E-08	1.19E-07	2.00E-15	1.000
	SYS	1.22E-06	1.19E-07		
MSS-043	IE	2.44E-08	1.19E-07	2 00E-15	1.000
	SYS	1.22E-06	1.19E-07		
MSS-044	SYS	1.22E-06	4 09E-07	0 00E+00	1.000
MSS-045	SYS	1.22E-06	4.09E-07	0.00E+00	1 000
MSS-046	SYS	1.22E-06	4.09E-07	0.00E+00	1.000
MSS-047	IE	6.60E-07	1.74E-08	7.99E-15	1.000
	SYS	3 55E-06	1.74E-08		
MSS-048	IE	6.60E-07	1 74E-08	7.99E-15	1 000
	SYS	3.55E-06	1.74E-08		
MSS-049	IE	6.60E-07	1.74E-08	7.99E-15	1.000
	SYS	3 55E-06	1.74E-08		
MSS-050	IE	2.90E-07	2.19E-08	4.38E-15	1 000
	SYS	1.22E-06	2.19E-08		
MSS-051	IE	2.90E-07	2.19E-08	4.38E-15	1.000
	SYS	1.22E-06	2.19E-08		
MSS-052	IE	2.90E-07	2.19E-08	4 38E-15	1.000
	SYS	1.22E-06	2.19E-08		
MSS-053	IE	5.54E-07	1.74E-08	6.67E-15	1.000
	SYS	1.93E-06	1.74E-08		

Combination Base & BEZ LERF Without Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITHOUT OPERATOR ACTION RRW	WITHOUT OPERATOR ACTION RRW
MSS-031	None	0.00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-032	None	0.00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-033	None	0.00E+00	0.00E+00	0.00E+00	1.000	1 000
MSS-034	None	0 00E+00	0 00E+00	0.00E+00	1.000	1.000
MSS-035	SYS-JI/S	1.22E-06	7.43E-07	0.00E+00	1 000	1.000
	SYS-PW	1.22E-06	2.17E-05			
MSS-036	None	0.00E+00	0 00E+00	0 00E+00	1.000	1.000
MSS-037	None	0.00E+00	0.00E+00	0.00E+00	1.000	1.000
MSS-038	None	0.00E+00	0.00E+00	0.00E+00	1 000	1.000
MSS-039	None	0.00E+00	0.00E+00	0.00E+00	1.000	1 000
MSS-040	None	0 00E+00	0 00E+00	0 00E+00	1.000	1.000
MSS-041	IE	2 44E-08	1.19E-07	2.00E-15	1.000	1.004
	SYS	1.22E-06	1.19E-07			
MSS-042	IE	2.44E-08	1.19E-07	2.00E-15	1 000	1 004
	SYS	1 22E-06	1.19E-07			
MSS-043	IE	2 44E-08	1.19E-07	2 00E-15	1 000	1 004
	SYS	1 22E-06	1.19E-07			
MSS-044	SYS	1.22E-06	4 09E-07	0 00E+00	1.000	1 000
MSS-045	SYS	1.22E-06	4.09E-07	0.00E+00	1.000	1.000
MSS-046	SYS	1.22E-06	4.09E-07	0 00E+00	1.000	1.000
MSS-047	IE	6 60E-07	1.74E-08	7 99E-15	1 000	1.017
	SYS	3 55E-06	1.74E-08			
MSS-048	IE	6 60E-07	1.74E-08	7.99E-15	1 000	1.025
	SYS	3 55E-06	1.74E-08			
MSS-049	IE	6.60E-07	1.74E-08	7.99E-15	1.000	1.016
	SYS	3 55E-06	1.74E-08			
MSS-050	IE	2 90E-07	2.19E-08	4.38E-15	1.000	1.008
	SYS	1.22E-06	2.19E-08			
MSS-051	IE	2.90E-07	2.19E-08	4.38E-15	1.000	1 007
	SYS	1.22E-06	2.19E-08			
MSS-052	IE	2.90E-07	2.19E-08	4 38E-15	1.000	1 009
	SYS	1.22E-06	2.19E-08			
MSS-053	IE	5.54E-07	1.74E-08	6.67E-15	1.000	1.018
	SYS	1.93E-06	1.74E-08			
BEZ-001MSS	IE	6.57E-07	3.74E-08	4.98E-14	1 000	1.063
	IE-JI/S	1 95E-06	2 40E-08			
	SYS	3 55E-06	3 74E-08			
	SYS-JI/S	1 05E-05	2 40E-08			
BEZ-002MSS	IE	6.57E-07	3.74E-08	4.98E-14	1.000	1.067
	IE-JI/S	1.95E-06	2.40E-08			
	SYS	3.55E-06	3.74E-08			
	SYS-JI/S	1.05E-05	2.40E-08			
BEZ-003MSS	IE	6 57E-07	3.74E-08	4.98E-14	1.000	1 058
	IE-JI/S	1.95E-06	2.40E-08			
	SYS	3.55E-06	3.74E-08			
	SYS-JI/S	1.05E-05	2 40E-08			

Base, Combined Base BEZ, and BEZ Comparizon LERF Without Operator Action

Base ONLY LERF Without Operator Action						Combination Base & BEZ LERF Without Operator Action						BEZ Only RRW
SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITHOUT OPERATOR ACTION RRW	SEGMENT ID	TREATMENT	PSA RUN VALUES (POINT ESTIMATE)	SRRA FAILURE PROBABILITY (@ 40 YEARS) (POINT ESTIMATE)	TOTAL SEGMENT PIPING LERF	WITHOUT OPERATOR ACTION RRW	WITHOUT OPERATOR ACTION RRW
						BEZ-004MSS	IE	2.87E-07	5.96E-08	1.18E-14	1.000	1.014
							SYS	1.22E-06	5.96E-08			
						BEZ-005MSS	IE	2.87E-07	5 96E-08	1.18E-14	1 000	1.014
							SYS	1.22E-06	5.96E-08			
						BEZ-006MSS	IE	2.87E-07	5.96E-08	1.18E-14	1 000	1.014
							SYS	1.22E-06	5.96E-08			
						BEZ-007SDS	None	0.00E+00	0 00E+00	0 00E+00	1.000	1.000
						BEZ-008SDS	None	0 00E+00	0.00E+00	0.00E+00	1.000	1.000
						BEZ-009SDS	None	0 00E+00	0 00E+00	0 00E+00	1.000	1.000
						BEZ-010FWS	IE	2.19E-07	2.20E-12	4.12E-15	1 000	1.006
							IE-JI/S	5.38E-07	1.06E-08			
							SYS	2.64E-06	2.20E-12			
							SYS-JI/S	1.05E-05	1 06E-08			
						BEZ-011FWS	IE	2.19E-07	2.20E-12	4.12E-15	1.000	1 006
							IE-JI/S	5.38E-07	1.06E-08			
							SYS	2.64E-06	2 20E-12			
							SYS-JI/S	1.05E-05	1.06E-08			
						BEZ-012FWS	IE	2.19E-07	2.20E-12	4.12E-15	1.000	1 006
							IE-JI/S	5.38E-07	1.06E-08			
							SYS	2 64E-06	2.20E-12			
							SYS-JI/S	1.05E-05	1.06E-08			
						BEZ-013FWS	IE	1.43E-07	1.44E-08	1 42E-15	1.000	1.003
							SYS	1.22E-06	1 44E-08			
						BEZ-014FWS	IE	1 43E-07	1.44E-08	1.42E-15	1.000	1.003
							SYS	1 22E-06	1.44E-08			
						BEZ-015FWS	IE	1 43E-07	1.44E-08	1 42E-15	1 000	1.003
							SYS	1.22E-06	1.44E-08			
						BEZ-016FWS	None	0 00E+00	0 00E+00	0 00E+00	1.000	1 000

ENCLOSURE 3

U.S. Nuclear Regulatory Commission Email from Mr. Girija Shukla to Mr. Dennis Weakland, Mr. Gordan Bischoff, et al, "Proposed WOG HELB Submittal Contents (WCAP-14572)", October 4, 2002.

From: Girija Shukla[SMTP:GSS@nrc.gov]
Sent: Friday, October 04, 2002 12:50 PM
To: weaklandd@firstenergycorp.com; gordon.c.bischoff@us.westinghouse.com; balkeykr@westinghouse.com; sepp1ha@westinghouse com; vavre1kj@westinghouse.com
Cc: Stephen Dinsmore; Stephen Dembek
Subject: Proposed WOG HELB Submittal Contents (WCAP-14572)

In the 9/25 meeting, the WOG requested that the staff identify what the contents should be for the WOG submittal Attached is the suggested submittal contents.

In summary:
1) A full template submittal on the stand alone application to the HELB piping
2) A list of all HELB segments, the quantitative results for each segment, and any differences between the stand-alone versus all-inclusive results (aside from RRW) for the HELB segments.

Thanks

- Girija

WOG Addendum Pilot Submittal Contents:

In its March 8, 2001, letter, the staff requested a pilot application of the WOG's proposed risk-informed methodology to the HELB piping. As documented in the meeting minutes dated October 10, 2001, the staff further clarified that the pilot submittal should include the results of applying the WOG methodology to the HELB population of segments as a stand-alone analysis as well as part of the total population of segments as proposed by the WOG. During the September, 25, 2002, meeting with the staff, the WOG indicated that they did not think a pilot submittal was needed and, after some discussion about the March 8, 2001 letter, requested that the staff identify the content of pilot application submittal.

There is a standard format and content for information provided for staff review of the application of the WCAP methodology to a population of segments and that is the current template submittals as illustrated by the Beaver Valley RI-ISI submittal dated July 24,2002. The pilot application should included a template submittal describing the application of the WCAP methodology to the population of segments in the HELB program, and only to the population of the segments in the HELB program

In order to fully investigate the implications of applying the methodology to the HELB piping alone versus applying it to the total population of segments, additional information should also be provided. This should include, for each segment, the failure frequencies for the ranking evaluation (without ISI), the conditional CDP and LERP result, and the RRWs. If any of the failure frequencies or conditional CDP or CLERP results differ between the stand-alone and the combined application (the RRWs will clearly be different), both sets of values and the reasons for the change should be discussed

G. S. Shukla
Project Manager
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

301- 415-8439/ Fax 301-415-3061/ gss@nrc gov

ENCLOSURE 4

Hand mark-up of the additional changes on the original mark-up provided in reference 1.

Westinghouse Non-Proprietary Class 3

WCAP - 14572
Revision 1-NP-A
Addendum 1
Markup

Addendum to "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report" to Address Changes to Augmented Inspection Requirements

Westinghouse Electric Company LLC

Addendum to "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report" to Address Changes to Augmented Inspection Requirements

Markup

N.B. Closky

K.R. Balkey

~~December 1999~~ ~~May 2000~~ NOVEMBER 2002

Approved:_____

GARY A. BRASSART ~~J.M. Brennan~~, Manager
Reliability and Risk Assessment

Work performed for the Westinghouse Owners Group under ~~MUHP-5091 and~~ MUHP-5200 AND 5907

This document is the property of and contains information owned by Westinghouse Electric Company LLC and/or its subcontractors and suppliers. It is transmitted to you in confidence and trust, and you agree to treat this document in strict accordance with the terms and conditions of the agreement under which it was provided to you.

Westinghouse Electric Company LLC
P.O. Box 355
Pittsburgh, PA 15230-0355

©2000 Westinghouse Electric Company LLC
All Rights Reserved

TABLE OF CONTENTS

LIST OF TABLES v

COPYRIGHT NOTICE ix

LIABILITY STATEMENT xi

EXECUTIVE SUMMARY xiii

ACKNOWLEDGEMENTS xv

1 INTRODUCTION 1-1

2 APPLICATION SPECIFICS 2-1

3 SPECIFIC GUIDANCE FOR HELB AND MELB AUGMENTED ISI EXAMINATION EVALUATION AS PART OF THE RISK-INFORMED ISI PROGRAM 3-1

3.1 Background 3-1

3.2 Specific Guidance for HELB and MELB ISI Inclusion ..... 3-~~23~~

4 CONCLUSIONS 4-1

5 REFERENCES 5-1

LIST OF TABLES

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements 2-2

COPYRIGHT NOTICE

This report bears a Westinghouse copyright notice. You as a member of the Westinghouse Owners Group are permitted to make the number of copies of the information contained in this report which are necessary for your internal use in connection with your implementation of the report results for your plant(s) in your normal conduct of business. Should implementation of this report involve a third party, you are permitted to make the number of copies of the information contained in this report which are necessary for the third party's use in supporting your implementation at your plant(s) in your normal conduct of business, recognizing that the appropriate agreements must be in place to protect the proprietary information for the proprietary version of the report. All copies made by you must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

LIABILITY STATEMENT

This report was prepared by Westinghouse as an account of work sponsored by the Westinghouse Owners Group (WOG). Neither the WOG, any member of the WOG, Westinghouse, nor any person acting on behalf of any of them:

- Makes any warranty or representation whatsoever, expressed or implied, (I) with respect to the use of any information, apparatus, method, process, or similar item disclosed in this report, including merchantability, and fitness for a particular purpose, (II) that such use does not infringe on or interfere with privately owned rights, including the party's intellectual property, or (III) that this report is suitable to any particular user's circumstance; or

- Assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if the WOG or any WOG representative has been advised of the possibility of such damages) resulting from any selection or use of this report or any information, apparatus, process or similar item disclosed in this report.

EXECUTIVE SUMMARY

By letter dated December 15, 1998 from Thomas Essig, U.S. Nuclear Regulatory Commission, to Mr. Lou Liberatori, Chairman, Westinghouse Owners Group (reference 1), the NRC forwarded a Safety Evaluation Report (SER) finding the Westinghouse Owners Group (WOG) risk-informed inservice inspection (ISI) methodology for piping to be acceptable. Currently, the WOG Topical Report and the NRC's Safety Evaluation state that the application of the methodology is approved as an alternative to the ASME Section XI ISI requirements and do not include changes to augmented piping inspection programs that cover some degradation mechanisms that may have been separately required by NRC.

This addendum to WCAP-14572, Revision 1-NP-A, dated February 1999, provides additional guidance related to changing the augmented inspection regulatory requirements using the WOG risk-informed ISI methodology (RI-ISI), as an option.

The WOG RI-ISI methodology ~~is~~ SIGNIFICANT directly applicable to the consideration of augmented inspection programs; no ~~specific~~ changes to the overall process are required to address augmented inspection programs. The augmented inspection programs are already credited in the methodology without changing the actual regulatory requirements.

This addendum to the RI-ISI process permits, as an option, the revision of selected augmented inspection regulatory requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) exclusion examinations), where safety impacts can be shown to be maintained or enhanced. Thus, the augmented inspections are subsumed into the RI-ISI program. Changes to these augmented requirements would be evaluated by individual utilities using the appropriate regulatory change mechanisms (e.g., 10CFR~~50.55a~~, 50.59).

WHERE APPLICABLE OR ADDRESSED AS AN INDIVIDUAL APPLICATION OF THE METHODOLOGY.

The risk-informed ISI methodology for the HELB/MELB application is consistent with the basic requirements for protection against dynamic effects of postulated pipe ruptures defined in General Design Criterion 4 of Appendix A to 10 CFR Part 50. The consequences associated with dynamic effects, including the effects of pipe whip and discharging fluids, are addressed via a thorough evaluation (including plant walkthrough) of the areas of concern. The demonstration that the probability of fluid system rupture is extremely low under conditions consistent with the design basis for the piping is performed via the probabilistic structural mechanics evaluation using SRRA models, which are consistent with leak-before-break fracture mechanics analysis.

ACKNOWLEDGEMENTS

The authors acknowledge with appreciation the following Westinghouse Owners Group representatives:

- T. R. Satyan-Sharma (AEP)
- Dennis Weakland (First Energy)
- Ray West (Northeast Utilities)
- Alex McNeill (Virginia Power)

1.0 INTRODUCTION

By letter dated December 15, 1998 from Thomas Essig, U.S. Nuclear Regulatory Commission, to Mr. Lou Liberatori, Chairman, Westinghouse Owners Group (NRC, 1998), the Nuclear Regulatory Commission (NRC) forwarded a Safety Evaluation Report (SER) finding the Westinghouse Owners Group (WOG) risk-informed inservice inspection (ISI) methodology for piping (WCAP-14572, Revision 1) to be acceptable. Currently, the WOG Topical Report and the NRC's Safety Evaluation state that the application of the methodology is approved as an alternative to the ASME Section XI ISI requirements and do not include changes to augmented piping inspection programs that cover some degradation mechanisms that may have been required by NRC. Specifically, the WCAP and SER state that the report should not be taken as a basis to change augmented inspection programs.

Per the transcript of the September 2, 1999 meeting of the NRC Advisory Committee on Reactor Safeguards in which the Electric Power Research Institute risk-informed ISI methodology was discussed, the NRC stated that "Basically all of the programs that are currently addressed by augmented programs will be included or subsumed into the risk-informed methodology. The only exceptions are the intergranular stress corrosion cracking (IGSCC) Category B through G welds and the flow-assisted corrosion (FAC) program. So the programs such as the thermal fatigue augmented inspection programs or the stress corrosion cracking program, localized corrosion program, programs like that have been subsumed into the risk-informed ISI program."

As stated in the NRC's SER for the WOG RI-ISI methodology (NRC, 1998), "For calculating risk rankings, augmented programs such as erosion-corrosion and stress corrosion cracking programs are credited when the augmented program is deemed adequate to detect relevant degradation mechanisms. Augmented programs are also credited in the change of risk evaluation for both ASME Section XI programs and RI-ISI programs." In effect, the WOG RI-ISI methodology already addresses the impact of augmented inspection programs.

This addendum to the WOG RI-ISI process (WCAP-14572, Revision 1-NP-A, dated February 1999) permits, as an option, the revision of selected augmented inspection regulatory requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. Thus, the augmented inspections are subsumed into the RI-ISI program. Changes to these augmented requirements would be evaluated using the appropriate regulatory change mechanisms (e.g., 10CFR50.55a, 50.59) and would be submitted by individual utilities as part of the RI-ISI example submittal (NEI, 1999).

2.0 APPLICATION SPECIFICS

The application of WCAP-14572, Revision 1-NP-A to augmented inspection program requirements is in accordance with RG-1.174 (NRC, 1998) criteria and addresses the following programs:

- Thermal fatigue, including stratification (NRC Bulletins 88-08 and 88-11 and Information Notice 93-020) (NRC, 1988 & 1993)
- Stress corrosion cracking program for PWRs and intergranular stress corrosion cracking (IGSCC) Category A for BWRs (NRC Bulletin 79-17, Generic Letter 88-01 and NUREG-0313 (NRC, 1979 & 1988)); other IGSCC categories remain unchanged
- Inspections in high energy line break (HELB) and moderate energy line break (MELB) exclusion zones
- Other NRC-mandated plant-specific augmented piping inspection programs (e.g., flow assisted corrosion) as submitted to and approved by NRC on a plant specific basis. As part of this application, the licensee's submittal would have to address why the approach is applicable to the augmented program and how the methodology was applied.

Table 1 provides additional clarification and process detail changes with respect to the specific steps in the application of the WCAP-14572, Revision 1-NP-A methodology.

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Executive Summary		*(insert on page iii after bullets)* *The RI-ISI process also permits, as an option, the revision of selected augmented inspection requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. Changes to these augmented requirements would be evaluated by individual utilities using the appropriate regulatory change mechanisms (e.g., 10CFR50.55a, 50.59.).*
Page 4, Section 1.1, Program Objectives/ Summary of Regulatory Requirements and Compliance	This report documents an alternative to the current ASME Section XI program for piping. The risk-informed ISI program will be substituted for the current examination program on piping. Additionally, the alternative program will not be limited to ASME Class 1 or Class 2 piping but will now encompass the high safety significant piping segments identified through the process regardless of ASME Class. *This report provides an alternative inspection location selection method for NDE and does not affect current Owner-defined augmented programs.*	*This report provides an alternative inspection location selection method for NDE and allows for changing the requirements of current augmented inspection programs.*
Page 13, Table 1.4-1	It provides an alternative inspection location selection method for NDE and does not affect Owner-defined augmented programs.	*It provides an alternative inspection location selection method for NDE and allows for changing the requirements of current augmented inspection programs.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 14, Table 1.4-1	The proposed change is an alternative to the ASME Section XI Code as referenced by 10CFR50.55a(a)(3).	*The proposed change is an alternative to the ASME Section XI Code as referenced by 10CFR50.55a(a)(3) and, as an option, to the current augmented inspection regulatory requirements.*
Page 51, Section 3.2, Scope Definition	A full scope program.... Consistent agreement...	*(insert between the two paragraphs)* *In addition, a decision should be made as to whether or not to include changes to augmented inspection program requirements as part of the program.*
Page 81, Section 3.5.5, Consideration of Other Piping Reliability Programs	It is important to recognize the distinction between risk-informed alternative ASME Section XI examinations and other examinations and monitoring performed under an augmented program. *The alternative inspection proposed pertains only to the ASME Section XI pipe weld examination program (Categories B-F, B-J, C-F-1, C-F-2, and applicable Class 3 and Non Class piping).* Augmented examination requirements would remain unaffected. There may be cases where the risk-informed program identifies a piping segment not currently in an augmented program which may need to be added.	*The alternative inspection pertains to the ASME Section XI pipe weld examination program (Categories B-F, B-J, C-F-1, C-F-2, and applicable Class 3 and Non Class piping) and, as an option, to augmented inspection program requirements.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 105, Section 3.6.1, Risk-Ranking	For piping segments that are included in augmented programs (such as erosion-corrosion and stress corrosion cracking programs), the SRRA failure probabilities with ISI but without leak detection are used.	*For piping segments that are included in augmented inspection programs that will remain unchanged under the risk-informed ISI program, the SRRA failure probabilities with ISI but without leak detection are used.* *For piping segments that are included in augmented inspection programs that are being changed with this application, the SRRA failure probabilities without ISI and without leak detection are used.*
Page 168, Section 3.7.1, Structural Element Selection Matrix	Region 1 discussion All susceptible locations in the segment identified by the engineering subpanel as being likely to be affected by a known or postulated failure mechanism, and that are not already in an augmented program, must be examined. Segments with failure modes that have established augmented programs (e.g., flow-accelerated corrosion, intergranular stress-corrosion cracking) would be inspected in accordance with that existing program.	*All susceptible locations in the segment identified by the engineering subpanel as being likely to be affected by a known or postulated failure mechanism must be examined. Segments with failure modes that have established augmented programs would be inspected in accordance with the risk-informed ISI program, if these augmented examinations are being subsumed into the risk-informed ISI program, or by the existing augmented program if the requirements are not being changed.*
PAGE 144, SECTION 3.6.3 EXPERT PANEL	• PLANT-SPECIFIC EXPERT PANEL GUIDANCE SHOULD BE DEVELOPED FOR THIS PROCESS OR GUIDANCE FROM OTHER RISK-INFORMED APPLICATIONS (e.g., MAINTENANCE RULE) MAY BE USED AS PART OF THIS PROCESS TO ENSURE CONSISTENCY ACROSS THE RISK-INFORMED APPLICATIONS.	• ... ACROSS THE RISK-INFORMED APPLICATIONS • (ADD BULLET 1)

Page 144, Section 3.6.3 Expert Panel BULLET 1

Programs that consider piping classifications in addition to the piping designated as part of the Break Exclusion Region would perform additional screening for possible High Safety Significance classification. The screening would consist of the following for the segments that constitute the Break Exclusion Region:

1. Individual segment contribution to Core Damage Frequency is greater than or equal to 1E-8 per year.
2. Individual segment contribution to Large Early Release Frequency is greater than or equal to 1E-9 per year.
3. Break Exclusion Region inspections fall significantly below 10% of the total Break Exclusion Region scope.

The additional screening of the segments that constitute the Break Exclusion Region piping would result in additional inspections unless plant specific design features or analysis is specifically credited to mitigate any concerns and justify a low safety significance ranking.

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 190, Section 4, Inspection Program Requirements	Experience has shown that when an active degradation mechanism (such as IGSCC, thermal striping or flow-accelerated corrosion) is discovered, corrective actions and augmented programs are implemented to address the concern. Augmented inspection programs for these situations tend to have intervals less than 10 years. Through the RI-ISI process, situations may be identified on a plant-specific basis where an aggressive mechanism may potentially occur (e.g., back-leakage of hot water across a check valve into a piping segment containing cooler water, thereby inducing the potential for thermal striping). For these situations, the licensee may choose to either implement examinations more frequently than every 10 years (including the use of thermal monitors) or implement changes to minimize the potential for the identified phenomenon. If the licensee chooses to implement a program that will provide vital information more frequently than every 10 years, then that new information would have to be evaluated at the time that is obtained to determine if a change to the prior RI-ISI results is necessary.	*(add additional paragraph following paragraphs shown in previous column)* *The licensee can choose to subsume augmented programs by also permitting the revision of selected augmented inspection requirements, where the failure mechanism may not be as aggressive and where safety impacts can be shown to be maintained or enhanced. If this alternative is chosen, the licensee should ensure that the RI-ISI program includes a reasonable representation (balance) of augmented ISI examinations and ASME Section XI examinations. The Perdue statistical model is used to determine the minimum number of ASME Section XI exams to support a reasonable representation, where appropriate.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 213, Section 4.4.2, Risk/Safety Evaluation	For piping segments that are part of augmented programs (such as erosion-corrosion and stress corrosion cracking), the SRRA failure probabilities with ISI are used (no change from previous calculations).	*For piping segments that are included in augmented inspection programs that will remain unchanged under the risk-informed ISI program or for piping segments that will be examined under the RI-ISI program (including subsumed augmented inspections), the SRRA failure probabilities with ISI but without leak detection are used.* *For piping segments that are not included in the RI-ISI program and/or for which augmented examinations are being removed, the SRRA failure probabilities without ISI and without leak detection are used.*
Page 237, Section 5, Plant-Specific Application Process	This section provides the framework for applying the risk-informed methods to a specific plant for piping inservice inspection.	*This section provides the framework for applying the risk-informed methods to a specific plant for piping inservice inspection, including both ASME Section XI and augmented inspection program requirements.*
Page 246, Section 6.1, Report Summary and Relationship to NRC RG-1.174	This process meets the intent of the framework developed by the NRC and key steps and principles of the general regulatory guide and standard review plan (R.G.-1.174) as described in Sections 1.4 and 6.2.	*(insert new sentence at end of second paragraph)* *The process can be applied to both ASME Section XI and augmented inspection requirements.*

3.0 SPECIFIC GUIDANCE FOR HELB AND MELB AUGMENTED ISI EXAMINATION EVALUATION AS PART OF THE RISK-INFORMED ISI PROGRAM

3.1 BACKGROUND

Current design criteria for the postulation and protection of pipe breaks in high energy lines (and in some cases, moderate energy) have been developed over a period of time and the requirements vary from plant-to-plant when applied inside and outside containment. General Design Criterion 4 (GDC-4) of Appendix A to 10 CFR Part 50 provides the basic requirements for protection against dynamic effects of postulated pipe ruptures:

> "Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping."

As part of this evolution, augmented ISI examinations have been permitted to provide assurance of protection in specific instances where the installation of restraints or shields is not practical. Plants have also identified break exclusion zones such as in certain high energy piping systems in the containment penetration areas where augmented ISI has been allowed to assure protection. These augmented inspections usually comply with the requirements of the applicable edition of Section XI of the ASME Code and addenda. However, the frequency of these inspections can be increased over that required by Section XI, such that some plants inspect these locations three times during each 10-year inspection interval.

Augmented ISI for high energy line break (HELB)/moderate energy line break (MELB) requirements are addressed in NRC Standard Review Plan 3.6.1, 3.6.2 and 6.6 (NRC, 1990, 1981, 1981) and plant specific SAR commitments. SRP 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," states that "the plant design for protection against piping failures outside containment is reviewed to assure that such failures would not cause the loss of needed safety functions of safety-related systems and to assure that the plant can be safely shut down in the event of such failures. This review includes high energy and moderate energy fluid system piping outside of containment." SRP 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping" states that the staff review covers "the implementation of criteria dealing

with special features, such as augmented inservice inspection programs or the use of special protective devices such as pipe whip restraints. ..." SRP 3.6.2 references MEB 3-1 and also SRP sections 5.2.4 and 6.6 with respect to staff review areas.

MEB 3-1 states that "

> "It is recognized that pipe rupture is a rare event which may only occur under unanticipated conditions, such as those which might be caused by possible design, construction, or operation errors; unanticipated loads or unanticipated corrosive environments. Our observation of actual piping failures have indicated that they generally occur at high stress and fatigue locations, such as at terminal ends of a piping system at its connection to the nozzles of a component. The rules of this position are intended to utilize the available piping design information by postulating pipe ruptures at locations having relatively higher potential for failure, such that an adequate and practical level of protection can be achieved."

-A provision exists for an applicant to propose acceptable alternative method for complying with specified portions of the NRC SRP 3.6.1 section V and SRP 3.6.2 which states "Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission's regulations."

~~These augmented inspections usually comply with the requirements of the applicable edition of Section XI of the ASME Code and addenda. However, the frequency of these inspections can be increased over that required by Section XI such that some plants inspect these locations three times during each 10-year inspection interval.~~

~~The majority of HELB and MELB augmented exams are generally associated with the Class 2 piping systems; therefore, a risk-informed ISI program that includes Class 2 piping (i.e., a Class 1&2 or full scope risk-informed ISI program) is usually necessary to perform this application.~~

Most FSARs describe the HELB/MELB evaluation. In addition, the FSAR and some Technical Specifications describe these augmented inspections. For example, one FSAR states:

> "In specific instances where the installation of restraints or shields is not practical, adequate assurance of protection is provided by an augmented inservice inspection program on specific welds selected on the basis of pipe stress analysis.
>
> The augmented inservice inspection will comply, to the extent practical within the limitations of design, geometry, and materials of construction of the components, to the requirements in those editions of Section XI of the ASME Boiler and Pressure Vessel Code and addenda..."

The risk-informed ISI program is based on the actual piping failures that have occurred during plant operation. Most of the failures have been at locations other than those with high design stress or high fatigue usage factors. This is part of the premise of revising the ASME Section XI ISI program with a risk-informed program. This same premise applies to the changes requested for the augmented HELB/MELB break exclusion examinations.

The precedent exists for allowing inservice inspection in lieu of other provisions to protect against postulated piping failures. The risk-informed ISI program as described in the next section provides a re-evaluation of the postulated consequences along with the postulated likelihood of failure to reallocate and possibly reduce the number of inservice examinations performed for the HELB/MELB augmented inspection program. This guidance still meets the intent of the NRC's standard review plans.

3.2 SPECIFIC GUIDANCE FOR HELB AND MELB ISI INCLUSION

This evaluation can be performed concurrently with the application of the RI-ISI program (e.g., Class 1 and 2 ASME Section XI) or can be performed following completion of the program. The majority of HELB and MELB augmented exams are generally associated with the Class 2 piping systems; therefore, a risk-informed ISI program that includes Class 2 piping (i.e., a Class 1&2 or full scope risk-informed ISI program) is usually necessary to perform this application.

The following subsections describe the process steps as related to the RI-ISI process described in WCAP-14572, Revision 1-NP-A. The step descriptions are intended to supplement and further explain the risk-informed ISI application to HELB/MELB augmented inspection program.

Scope Definition

The program scope is evaluated to include those systems for which HELB break exclusion ISI is performed. The scope of the program can include Class 1, Class 2, Class 3 and nonCode piping.

Segment Definition

The piping segments defined in the RI-ISI program are reviewed to identify which piping segments are impacted by the augmented ISI program. Any further refinement of the piping segments is also performed. The definition of piping segments is further described in WCAP-14572-Revision 1-NP-A, section 3.3.

Consequence Evaluation

This analysis evaluates system interactions due to piping failures. The following potential pipe failure-induced conditions are considered:

1. Flooding

2. Water Spray

3. Pipe whip

4. High environmental temperatures (e.g. Steam line break)

5. Jet impingement

The indirect effects assessment is accomplished through an investigation of existing plant documentation on pipe breaks, flooding, and plant layout along with a focussed plant walkthrough. The process is described in WCAP-14572-Revision 1-NP-A, section 3.4.2 but is summarized below.

An in-depth review of the requirements for break exclusion zones and supporting design basis documentation with respect to postulated consequences and locations is performed based on the ~~current risk-informed ISI~~ piping segments and their postulated consequences. PLANT DOCUMENTS OR APPROPRIATE REFERENCE DOCUMENTS THAT IDENTIFY THE REQUIREMENTS FOR POSTULATING AND ASSESSING THE STRUCTURAL INTERACTIONS (e.g. HINGE POINTS, JET CONES, ETC.) AND CONSEQUENCES RESULTING FROM PIPING FAILURES MAY BE USED TO ASSESS POSTULATED DAMAGE. Indirect effects occur from conditions such as pipe whip, jet impingement, flooding resulting from pipe breaks or leaks. The indirect effects to be considered include:

- Failures that cause an initiating event such as a LOCA or reactor trip
- Failures that disable a single train or system
- Failures that disable multiple trains or systems
- Failures that cause any combination above

An example of an indirect effect is the failure of a service water pipe which sprays an electrical cabinet that supplies power to the reactor coolant pumps, shorts the electrical supply which causes the pump to trip and ultimately causes a reactor trip.

The following summarizes the process steps:

For the Pre-walkthrough

- Review existing documents which examine the local effects of piping failures for the systems in scope of the program,
- Identify other systems/trains affected by a failure in each area,
- Identify plant areas for plant walkthrough,
- Document evaluation, and
- Develop walkthrough sheets for key areas

For the Walkthrough:

- Perform walkthrough and document results, actions, issues

For the Post Walkthrough,

- Evaluate results
- Resolve actions
- Map indirect effects to piping segments and identify the required leak or rupture failure probabilities

Initially, the plant is divided into areas such as those defined within the plants 10CFR50 Appendix R report, HELB/MELB evaluations, or other area designations. If needed for better delineation, these areas are further subdivided into smaller enclosures. The major safety equipment (e.g., pumps, motor-operated valves, electrical cabinets, etc.) is identified for each area.

This information is used to assess where major safety equipment is located within the plant that would have an impact on core damage or large early release. The evaluation is carried out on a building by building, area by area basis.

Areas throughout each building are eliminated from evaluation (similar to that performed in the internal flooding PSA screening) if:

- no major equipment is contained in an area or
- no piping or fluid source runs through or near an area.

The evaluation of pipe whip, jet impingement, and high environmental temperature is performed using the guidance provided below. This guidance is consistent with Westinghouse Systems Standard Design Criteria 1.19 (Westinghouse, 1980), WCAP-8951 (Mendler, 1979), U.S. NRC MEB 3-1 (NRC, 1987) and ANSI/ANS-58.2 (ANSI, 1988).

Pipe Whip and Jet Impingement Guidance

Pipe whip and jet impingement effects apply to breaks or ruptures that are postulated to occur in high energy piping systems, or portion of a system, where both or either of the following conditions are met during normal plant operating conditions:

- maximum operating pressure exceeds 275 psig, or
- maximum operating temperature exceeds 200°F

Note: These criteria are based on plant-specific criteria usually contained in a plant's FSAR.. Piping systems that operate above these limits for only a relatively short period (for example, less than approximately 2%) of the time during which they perform their intended function, may be classified as moderate energy.

Existing documents (e.g., UFSAR or hazards evaluation), are reviewed to examine where high energy line break locations have already been postulated and where devices, (e.g., whip restraints and jet shields), have already been installed to protect vital safety-related equipment

Each area is documented to identify areas that are not of concern and those areas that are of potential concern.

In addition, prior to the walkthrough, the fluid conditions and the pipe sizes in the high energy piping of interest are identified in order to determine what length of pipe is required to form a hinge and the magnitude of the jet forces resulting from postulated breaks. The location of orifices that would limit the amount of energy emanating from a postulated break are also determined. Initial piping and fluid conditions can be obtained from the piping isometrics, line lists, and system description documents. Plant layout drawings or ALARA layout drawings can assist in the pre-walkthrough evaluation, which focuses on which areas of the plant to include in the walkthrough.

During the walkthrough, assume that breaks may occur at all possible ~~locaitons~~ LOCATIONS along the high energy piping runs;

- *circumferential breaks* should be postulated to occur individually at pipe-to-fitting welds, branch run-to-main run welds, branch run-to-fitting welds, and at other terminal ends[1]; circumferential breaks need not be postulated in piping runs of a nominal diameter equal to or less than 1"

- *longitudinal breaks* should be postulated at welded attachments (e.g., lug, stanchion) at the centerline of the welded attachment with an area equal to the pipe surface area that is bounded by the attachment weld. Longitudinal breaks need not be postulated in piping runs of a nominal diameter less than 4" and longitudinal breaks need not be postulated at terminal ends

[1]Terminal end is that section of piping originating at a structure or component (e.g., a vessel or component nozzle or structural piping anchor) which acts as an essentially rigid constraint to the piping thermal expansion. In-line fittings, such as valves, are not assumed to be anchored

and are not terminal ends.

- For each high energy piping run that has the potential to whip or cause jet impingement, as a result of a postulated break, look for the following types of protection to exist in the areas that could be impacted by these effects:

  * Separation distances between required systems and components and piping that are used to mitigate potential core damage effects

  * provision of piping enclosures (e.g., sleeves)

  * provision of component enclosures (e.g., walls or cubicles)

  * provision of system redundant design features (such as isolation valves)

  * design of required systems and components to withstand the effects of the postulated pipe rupture

  * provision of additional protection such as restraints and barriers

- For high energy piping that has the potential to whip following a postulated break, the following considerations should be noted:

  - the portions of piping that may form a hinge will not become missiles

  - a whipping pipe that has the potential to impact other piping will not rupture lines of equal or greater size; however, it should be assumed that a through-wall crack may develop in a line that is impacted by a whipping pipe of the same size

- The evaluation of fluid jets emanating from postulated breaks on nearby structures and components shall consider the effects of jet loading, fluid temperature, and moisture on the targets impinged upon. The jet shape and direction should be established using the schematics of jets discharging from various pipe breaks. Targets more than 10 pipe diameters away from the break location need not be considered for jet impingement impacts.

From the walkthrough, the indirect effects from pipe failures within the plant are identified. Additional information identified during the walkthrough is obtained and evaluated. If indirect effects are identified, then they are matched with piping segments.

~~A plant walkdown of the affected piping may be performed to confirm information provided in existing design basis documentation.~~

Any additions ~~changes~~ necessary to the postulated consequences are identified and incorporated into the analyses and the PRA model is used to estimate the conditional core damage ~~frequency~~/large early release ~~frequency~~ (CDF/LERF) probability/frequency.

Piping Failure Probability Assessment

The Westinghouse structural reliability and risk assessment software (SRRA) is used to estimate the piping failure probabilities associated with each piping segment. The SRRA model is based on probabilistic structural mechanics models. SRRA models also predict the progress of degradation and/or crack growth as a function of time while quantitatively accounting for the impact of random loadings, such as earthquakes. SRRA uses Monte-Carlo simulation with importance sampling to calculate the probability of failure for type 304 and 316 stainless steel piping (due to fatigue crack growth and stress corrosion cracking) or for carbon steel piping (due to fatigue crack growth and loss of thickness due to wastage, such as flow-assisted corrosion).

All significant degradation mechanisms present in a piping segment along with the operating characteristics, environment, and loading conditions are evaluated as part of the failure probability assessment. When more than one degradation mechanism is present, the combination of all significant degradation mechanisms produces the limiting failure probability.

Failure probability calculations are performed for

- small leak (through wall flaw)
- large system disabling leak or initiating event
- full break (rupture) (where pipe whip is a concern)

In addressing piping segments where changes may be proposed at locations that are currently examined per HELB or MELB augmented inspection programs, the above failure probability calculations that are performed need to be consistent with fracture mechanics analysis methods for demonstrating leak-before-break. These changes include moving or reducing inspection locations or extending the frequency of examination. The failure probability calculations also need to demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping. To be consistent with leak-before-break methods, the probability of rupture should also be several orders of magnitude lower than the small leak probability (that represents the probability of a through-wall crack).

A detailed review of the piping failure probabilities used in the risk-informed ISI program for those ~~the~~ segments impacted by break exclusion zones is performed with respect to postulated failure mechanisms and any credit for the augmented ISI program(s). Any new failure

probabilities that are required for evaluation of the indirect effects are identified and then are calculated using the Westinghouse SRRA software (Westinghouse, 1999).

Risk Evaluation

The results from the consequence evaluation and failure probability assessment are reviewed to identify the impact on the risk evaluation and risk ranking calculations. The identification of the potential re-ordering of the high safety-significant (HSS) piping segments based on modifying the ~~removing~~ credit for the augmented ISI program is performed. This information is then provided to the plant expert panel.

In performing the risk evaluation for this program, the process described in WCAP-14572, Revision 1-NP-A section 3.6.1 is performed with the following conditions applied:

- For segments in which the augmented program is postulated to be removed, the failure probability without ISI is to be used in the risk ranking.
- For segments in which spray or jet impingement is a postulated indirect consequence failure mode, the failure probability to be used is the SRRA small leak (small leak = through wall flaw) probability.
- For segments in which pipe whip is the postulated indirect consequence failure mode, the failure probability to be used is the SRRA full break (rupture) probability.
- For segments in which environmental effects are the postulated indirect consequence failure mode, the failure probability to be used is the SRRA small leak (small leak = through wall flaw) probability, OR AN ALTERNATE WHERE APPROPRIATELY JUSTIFIED DUE TO SPATIAL CONSIDERATIONS BASED ON LEAK RATE.

Expert Panel Categorization

The suggested changes to the risk-informed ISI program and the augmented ISI program are presented to the plant expert panel for final determination of which piping segments are high safety significant (HSS) and should receive examination. The expert panel findings are documented. More details regarding the expert panel considerations ~~X~~ ARE provided in WCAP-14572, Revision 1-NP-A, sections 3.6.2 and 3.6.3.

Structural Element/NDE Selection

Based on the changes proposed by the plant expert panel to the piping segments identified as HSSC, the number of structural elements to be examined and the nondestructive examination (NDE) methods are identified based on the guidance provided in WCAP-14572,

Revision 1-NP-A, sections 3.7 and 4.0. The change in risk calculations ARE based on inputs from the risk ranking calculations, the piping segments which are in the current RI-ISI program and those that are proposed to be added to address the augmented ISI, are evaluated to ensure the program does not result in an increase in risk and meets the guidance in NRC RG-1.174 (NRC, 1998).

When changing the HELB and MELB exclusion examinations by subsuming the exams into the RI-ISI program, the licensee should ensure that the RI-ISI program includes a reasonable representation (balance) of augmented ISI examinations and ASME Section XI examinations. The Perdue statistical model is used to determine the minimum number of ASME Section XI exams to support a reasonable representation, where appropriate.

NRC Submittal

~~The Nuclear Energy Institute (NEI) has developed an example submittal (~20 pages) which has been reviewed and approved by the NRC through a series of meetings in late 1998 and early 1999. The example submittal was provided by NEI to the industry in a March 9, 1999 letter. This document provides the basis for the summary report that will be submitted to the NRC for the risk-informed ISI program. The submittal addresses examinations required by ASME Section XI as well as any augmented examinations that are addressed by the risk-informed ISI program.~~

~~It is expected that the HELB/MELB evaluation would be submitted as part of the risk-informed ISI program and discussed in the section 2.2 in the example submittal titled, "Augmented Programs." In addition, it is expected that FSAR and/or Technical Specification changes would be required for program implementation.~~

Implementation and Feedback

The implementation and feedback section of WCAP-14572, Revision 1-NP-A would also apply to the revised augmented inspection program ~~as it would be subsumed into the risk-informed ISI program~~.

THE RISK-INFORMED ISI APPLICATION WOULD BE EVALUATED USING 10CFR50.59. THE RESULTING DOCUMENTS WOULD BE RETAINED AS PART OF THE PERMANENT PLANT RECORD, AS PART OF THE EXISTING RISK-INFORMED ISI PROGRAM. SHOULD THE RISK-INFORMED ISI HELB/MELB BE THE ONLY APPLICATION OF THIS WCAP AT THE SITE, A SUMMARY SUBMITTAL REPORT CONSISTENT WITH THE NUCLEAR ENERGY INSTITUTE (NEI) TEMPLATE SHALL BE SUBMITTED TO THE NRC.

4.0 CONCLUSIONS

The WOG RI-ISI methodology is directly applicable to the consideration of augmented inspection programs; no ~~specific~~ SIGNIFICANT changes to the overall process are required to address augmented inspection programs. The augmented inspection programs are already credited in the methodology without changing the actual regulatory requirements.

This addendum to the RI-ISI process permits, as an option, the revision of selected augmented inspection regulatory requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. The risk-informed ISI methodology for the HELB/MELB application is consistent with the basic requirements for protection against dynamic effects of postulated pipe ruptures defined in General Design Criterion 4 of Appendix A to 10 CFR Part 50. The consequences associated with dynamic effects, including the effects of pipe whip and discharging fluids, are addressed via a thorough evaluation (including plant walkthrough) of the areas of concern. The demonstration that the probability of fluid system rupture is extremely low under conditions consistent with the design basis for the piping is performed via the probabilistic structural mechanics evaluation using SRRA models, which are consistent with leak-before-break fracture mechanics analysis.

-Thus, the augmented inspection programs, as identified in this addendum report, are RIGOROUSLY ASSESSED VIA THE METHODOLOGY APPROVED IN WCAP-14572 AND THE 10CFR50.59 PROCESS ~~subsumed into the RI-ISI program. Changes to these augmented requirements would be evaluated by individual utilities using the appropriate regulatory change mechanisms (e.g., 10CFR50.55a, 50.59).~~

5.0 REFERENCES

American Nuclear Society, "Design Basis for Protection of Light Water Nuclear Power Plants Against the Effects of Postulated Pipe Rupture," ANSI/ANS-58.2-1988, 1988.

Mendler, O.J., "Method of Analysis and Evaluation of Jet Impingement Loads from Postulated Pipe Breaks," Westinghouse Electric Corporation, WCAP-8951, Revision 0, April 1979.

Nuclear Energy Institute, Letter from Stephen D. Floyd, Nuclear Energy Institute, to NEI Administrative Points of Contact containing "Example Submittal For Plants that Follow the WOG Methodology (WCAP-14572)," dated March 9, 1999.

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

U.S. Nuclear Regulatory Commission, NRC Bulletin No. 88-11, Pressurizer Surge Line Thermal Stratification, December 20, 1988.

U.S. Nuclear Regulatory Commission, NRC Information Notice 93-20, Thermal Fatigue Cracking of Feedwater Piping to Steam Generators, March 24, 1993.

U.S. Nuclear Regulatory Commission, Standard Review Plan, NUREG-0800, Chapters 3.6.1, 3.6.2, and 6.6, October 1990, July 1981, July 1981, respectively.

U.S. Nuclear Regulatory Commission, Branch Technical Position MEB 3-1, "Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment," Revision 2, June 1987.

U.S. Nuclear Regulatory Commission, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," NUREG-0313, Rev. 2, Washington, D.C., January 1988.

U.S. Nuclear Regulatory Commission, IE Bulletin 79-17, "Pipe Cracks in Stagnant Borated Water Systems at PWR Plants," July 26, 1979.

U.S. Nuclear Regulatory Commission Generic Letter 88-08, "Thermal Stresses in Piping Connected to Reactor Coolant Systems," June 22, 1988.

U.S. Nuclear Regulatory Commission, NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping (Generic Letter 88-01), January 1988.

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

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

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

Westinghouse Owners Group, Letter from Louis F. Liberatori, Jr., Chairman, Westinghouse Owners Group, to Chief, Information Management Branch, U.S. Nuclear Regulatory Commission, Westinghouse Owners Group Transmittal of Approved Topical Reports: WCAP-14572 Revision 1-NP-A (Non-Proprietary) "WOG Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report" and WCAP-14572 Revision 1-NP-A, Supplement 1 (Non-Proprietary) "Westinghouse Structural Reliability and Risk Assessment (SRRA) Model for Piping Risk-Informed Inservice Inspection"(MUHP-5091), March 8, 1999.

ENCLOSURE 5

Final version of WCAP-14572, Revision 1-NP-A
Addendum 1, "Addendum to Westinghouse Owners Group
application of Risk-Informed Methods to Piping Inservice
Inspection Topical Report to Address Changes to
Augmented Inspection Requirements"

Westinghouse Non-Proprietary Class 3

WCAP - 14572
Revision 1-NP-A
Addendum 1

Addendum to "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report" to Address Changes to Augmented Inspection Requirements

Westinghouse Electric Company LLC

Addendum to "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report" to Address Changes to Augmented Inspection Requirements

N.B. Closky

K.R. Balkey

November 2002

Approved: _____
Gary A. Brassart, Manager
Reliability and Risk Assessment

Work performed for the Westinghouse Owners Group under MUHP-5200 and 5907

This document is the property of and contains information owned by Westinghouse Electric Company LLC and/or its subcontractors and suppliers. It is transmitted to you in confidence and trust, and you agree to treat this document in strict accordance with the terms and conditions of the agreement under which it was provided to you.

Westinghouse Electric Company LLC
P.O. Box 355
Pittsburgh, PA 15230-0355

©2002 Westinghouse Electric Company LLC
All Rights Reserved

TABLE OF CONTENTS

LIST OF TABLES v

COPYRIGHT NOTICE ix

LIABILITY STATEMENT xi

EXECUTIVE SUMMARY xiii

ACKNOWLEDGEMENTS xv

1 INTRODUCTION 1-1

2 APPLICATION SPECIFICS 2-1

3 SPECIFIC GUIDANCE FOR HELB AND MELB AUGMENTED ISI EXAMINATION EVALUATION AS PART OF THE RISK-INFORMED ISI PROGRAM 3-1

3.1 Background 3-1

3.2 Specific Guidance for HELB and MELB ISI Inclusion 3-3

4 CONCLUSIONS 4-1

5 REFERENCES 5-1

LIST OF TABLES

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements 2-2

COPYRIGHT NOTICE

This report bears a Westinghouse copyright notice. You as a member of the Westinghouse Owners Group are permitted to make the number of copies of the information contained in this report which are necessary for your internal use in connection with your implementation of the report results for your plant(s) in your normal conduct of business. Should implementation of this report involve a third party, you are permitted to make the number of copies of the information contained in this report which are necessary for the third party's use in supporting your implementation at your plant(s) in your normal conduct of business, recognizing that the appropriate agreements must be in place to protect the proprietary information for the proprietary version of the report. All copies made by you must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

LIABILITY STATEMENT

This report was prepared by Westinghouse as an account of work sponsored by the Westinghouse Owners Group (WOG). Neither the WOG, any member of the WOG, Westinghouse, nor any person acting on behalf of any of them:

- Makes any warranty or representation whatsoever, expressed or implied, (I) with respect to the use of any information, apparatus, method, process, or similar item disclosed in this report, including merchantability, and fitness for a particular purpose, (II) that such use does not infringe on or interfere with privately owned rights, including the party's intellectual property, or (III) that this report is suitable to any particular user's circumstance; or

- Assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if the WOG or any WOG representative has been advised of the possibility of such damages) resulting from any selection or use of this report or any information, apparatus, process or similar item disclosed in this report.

EXECUTIVE SUMMARY

By letter dated December 15, 1998 from Thomas Essig, U.S. Nuclear Regulatory Commission, to Mr. Lou Liberatori, Chairman, Westinghouse Owners Group (reference 1), the NRC forwarded a Safety Evaluation Report (SER) finding the Westinghouse Owners Group (WOG) risk-informed inservice inspection (ISI) methodology for piping to be acceptable. Currently, the WOG Topical Report and the NRC's Safety Evaluation state that the application of the methodology is approved as an alternative to the ASME Section XI ISI requirements and do not include changes to augmented piping inspection programs that cover some degradation mechanisms that may have been separately required by NRC.

This addendum to WCAP-14572, Revision 1-NP-A, dated February 1999, provides additional guidance related to changing the augmented inspection regulatory requirements using the WOG risk-informed ISI methodology (RI-ISI), as an option.

The WOG RI-ISI methodology is directly applicable to the consideration of augmented inspection programs; no significant changes to the overall process are required to address augmented inspection programs. The augmented inspection programs are already credited in the methodology without changing the actual regulatory requirements.

This addendum to the RI-ISI process permits, as an option, the revision of selected augmented inspection regulatory requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) exclusion examinations), where safety impacts can be shown to be maintained or enhanced. Thus, the augmented inspections are subsumed into the RI-ISI program where applicable or addressed as an individual application of the methodology. Changes to these augmented requirements would be evaluated by individual utilities using the appropriate regulatory change mechanisms (e.g., 10CFR50.59).

The risk-informed ISI methodology for the HELB/MELB application is consistent with the basic requirements for protection against dynamic effects of postulated pipe ruptures defined in General Design Criterion 4 of Appendix A to 10 CFR Part 50. The consequences associated with dynamic effects, including the effects of pipe whip and discharging fluids, are addressed via a thorough evaluation (including plant walkthrough) of the areas of concern. The demonstration that the probability of fluid system rupture is extremely low under conditions consistent with the design basis for the piping is performed via the probabilistic structural mechanics evaluation using SRRA models, which are consistent with leak-before-break fracture mechanics analysis.

ACKNOWLEDGEMENTS

The authors acknowledge with appreciation the following Westinghouse Owners Group representatives:

- T. R. Satyan-Sharma (AEP)
- Dennis Weakland (FirstEnergy Nuclear Operating Company)
- Ray West (Dominion)
- Alex McNeill (Dominion)

1.0 INTRODUCTION

By letter dated December 15, 1998 from Thomas Essig, U.S. Nuclear Regulatory Commission, to Mr. Lou Liberatori, Chairman, Westinghouse Owners Group (NRC, 1998), the Nuclear Regulatory Commission (NRC) forwarded a Safety Evaluation Report (SER) finding the Westinghouse Owners Group (WOG) risk-informed inservice inspection (ISI) methodology for piping (WCAP-14572, Revision 1) to be acceptable. Currently, the WOG Topical Report and the NRC's Safety Evaluation state that the application of the methodology is approved as an alternative to the ASME Section XI ISI requirements and do not include changes to augmented piping inspection programs that cover some degradation mechanisms that may have been required by NRC. Specifically, the WCAP and SER state that the report should not be taken as a basis to change augmented inspection programs.

Per the transcript of the September 2, 1999 meeting of the NRC Advisory Committee on Reactor Safeguards in which the Electric Power Research Institute risk-informed ISI methodology was discussed, the NRC stated that "Basically all of the programs that are currently addressed by augmented programs will be included or subsumed into the risk-informed methodology. The only exceptions are the intergranular stress corrosion cracking (IGSCC) Category B through G welds and the flow-assisted corrosion (FAC) program. So the programs such as the thermal fatigue augmented inspection programs or the stress corrosion cracking program, localized corrosion program, programs like that have been subsumed into the risk-informed ISI program."

As stated in the NRC's SER for the WOG RI-ISI methodology (NRC, 1998), "For calculating risk rankings, augmented programs such as erosion-corrosion and stress corrosion cracking programs are credited when the augmented program is deemed adequate to detect relevant degradation mechanisms. Augmented programs are also credited in the change of risk evaluation for both ASME Section XI programs and RI-ISI programs." In effect, the WOG RI-ISI methodology already addresses the impact of augmented inspection programs.

This addendum to the WOG RI-ISI process (WCAP-14572, Revision 1-NP-A, dated February 1999) permits, as an option, the revision of selected augmented inspection regulatory requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. Thus, the augmented inspections are subsumed into the RI-ISI program. Changes to these augmented requirements would be evaluated using the appropriate regulatory change mechanisms (e.g., 10CFR50.55a, 50.59) and would be submitted by individual utilities as part of the RI-ISI example submittal (NEI, 1999).

2.0 APPLICATION SPECIFICS

The application of WCAP-14572, Revision 1-NP-A to augmented inspection program requirements is in accordance with RG-1.174 (NRC, 1998) criteria and addresses the following programs:

- Thermal fatigue, including stratification (NRC Bulletins 88-08 and 88-11 and Information Notice 93-020) (NRC, 1988 & 1993)

- Stress corrosion cracking program for PWRs and intergranular stress corrosion cracking (IGSCC) Category A for BWRs (NRC Bulletin 79-17, Generic Letter 88-01 and NUREG-0313 (NRC, 1979 & 1988)); other IGSCC categories remain unchanged

- Inspections in high energy line break (HELB) and moderate energy line break (MELB) exclusion zones

- Other NRC-mandated plant-specific augmented piping inspection programs (e.g., flow assisted corrosion) as submitted to and approved by NRC on a plant specific basis. As part of this application, the licensee's submittal would have to address why the approach is applicable to the augmented program and how the methodology was applied.

Table 1 provides additional clarification and process detail changes with respect to the specific steps in the application of the WCAP-14572, Revision 1-NP-A methodology.

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Executive Summary		*(insert on page iii after bullets)* *The RI-ISI process also permits, as an option, the revision of selected augmented inspection requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. Changes to these augmented requirements would be evaluated by individual utilities using the appropriate regulatory change mechanisms (e.g., 10CFR50.55a, 50.59.).*
Page 4, Section 1.1, Program Objectives/ Summary of Regulatory Requirements and Compliance	This report documents an alternative to the current ASME Section XI program for piping. The risk-informed ISI program will be substituted for the current examination program on piping. Additionally, the alternative program will not be limited to ASME Class 1 or Class 2 piping but will now encompass the high safety significant piping segments identified through the process regardless of ASME Class. *This report provides an alternative inspection location selection method for NDE and does not affect current Owner-defined augmented programs.*	*This report provides an alternative inspection location selection method for NDE and allows for changing the requirements of current augmented inspection programs.*
Page 13, Table 1.4-1	It provides an alternative inspection location selection method for NDE and does not affect Owner-defined augmented programs.	*It provides an alternative inspection location selection method for NDE and allows for changing the requirements of current augmented inspection programs.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 14, Table 1.4-1	The proposed change is an alternative to the ASME Section XI Code as referenced by 10CFR50.55a(a)(3).	*The proposed change is an alternative to the ASME Section XI Code as referenced by 10CFR50.55a(a)(3) and, as an option, to the current augmented inspection regulatory requirements.*
Page 51, Section 3.2, Scope Definition	A full scope program.... Consistent agreement...	*(insert between the two paragraphs)* *In addition, a decision should be made as to whether or not to include changes to augmented inspection program requirements as part of the program.*
Page 81, Section 3.5.5, Consideration of Other Piping Reliability Programs	It is important to recognize the distinction between risk-informed alternative ASME Section XI examinations and other examinations and monitoring performed under an augmented program. *The alternative inspection proposed pertains only to the ASME Section XI pipe weld examination program (Categories B-F, B-J, C-F-1, C-F-2, and applicable Class 3 and Non Class piping).* Augmented examination requirements would remain unaffected. There may be cases where the risk-informed program identifies a piping segment not currently in an augmented program which may need to be added.	*The alternative inspection pertains to the ASME Section XI pipe weld examination program (Categories B-F, B-J, C-F-1, C-F-2, and applicable Class 3 and Non Class piping) and, as an option, to augmented inspection program requirements.*
Page 105, Section 3.6.1, Risk-Ranking	For piping segments that are included in augmented programs (such as erosion-corrosion and stress corrosion cracking programs), the SRRA failure probabilities <u>with ISI but without leak detection</u> are used.	*For piping segments that are included in augmented inspection programs that will remain unchanged under the risk-informed ISI program, the SRRA failure probabilities <u>with ISI but without leak detection</u> are used.* *For piping segments that are included in augmented inspection programs that are being changed with this application, the SRRA failure probabilities <u>without ISI and without leak detection</u> are used.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements		
Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 144, Section 3.6.3, Expert Panel	• Plant-specific expert panel guidance should be developed for this process or guidance from other risk-informed applications (e.g., Maintenance Rule) may be used as part of this process to ensure consistency across the risk-informed applications.	• *Plant-specific expert panel guidance should be developed for this process or guidance from other risk-informed applications (e.g., Maintenance Rule) may be used as part of this process to ensure consistency across the risk-informed applications.* • *Programs that consider piping classifications in addition to the piping designated as part of the Break Exclusion Region would perform additional screening for possible High Safety Significance classification. The screening would consist of the following for the segments that constitute the Break Exclusion Region:* *1. Individual segment contribution to Core Damage Frequency is greater than or equal to 1E-8 per year.* *2. Individual segment contribution to Large Early Release Frequency is greater than or equal to 1E-9 per year.* *3. Break Exclusion Region inspections fall significantly be low 10% of the licensed total Break Exclusion Region scope.* *The additional screening of the segments that constitute the Break Exclusion Region piping would result in additional inspections unless plant specific design features or analysis is specifically credited to mitigate any concerns and justify a low safety significance ranking.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements		
Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 168, Section 3.7.1, Structural Element Selection Matrix	Region 1 discussion All susceptible locations in the segment identified by the engineering subpanel as being likely to be affected by a known or postulated failure mechanism, and that are not already in an augmented program, must be examined. Segments with failure modes that have established augmented programs (e.g., flow-accelerated corrosion, intergranular stress-corrosion cracking) would be inspected in accordance with that existing program.	*All susceptible locations in the segment identified by the engineering subpanel as being likely to be affected by a known or postulated failure mechanism must be examined. Segments with failure modes that have established augmented programs would be inspected in accordance with the risk-informed ISI program, if these augmented examinations are being subsumed into the risk-informed ISI program, or by the existing augmented program if the requirements are not being changed.*
Page 190, Section 4, Inspection Program Requirements	Experience has shown that when an active degradation mechanism (such as IGSCC, thermal striping or flow-accelerated corrosion) is discovered, corrective actions and augmented programs are implemented to address the concern. Augmented inspection programs for these situations tend to have intervals less than 10 years. Through the RI-ISI process, situations may be identified on a plant-specific basis where an aggressive mechanism may potentially occur (e.g., back-leakage of hot water across a check valve into a piping segment containing cooler water, thereby inducing the potential for thermal striping). For these situations, the licensee may choose to either implement examinations more frequently than every 10 years (including the use of thermal monitors) or implement changes to minimize the potential for the identified phenomenon. If the licensee chooses to implement a program that will provide vital information more frequently than every 10 years, then that new information would have to be evaluated at the time that is obtained to determine if a change to the prior RI-ISI results is necessary.	*(add additional paragraph following paragraphs shown in previous column)* *The licensee can choose to subsume augmented programs by also permitting the revision of selected augmented inspection requirements, where the failure mechanism may not be as aggressive and where safety impacts can be shown to be maintained or enhanced. If this alternative is chosen, the licensee should ensure that the RI-ISI program includes a reasonable representation (balance) of augmented ISI examinations and ASME Section XI examinations. The Perdue statistical model is used to determine the minimum number of ASME Section XI exams to support a reasonable representation, where appropriate.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements		
Affected Page/Section	**Current**	**Clarification to Address Augmented Programs**
Page 213, Section 4.4.2, Risk/Safety Evaluation	For piping segments that are part of augmented programs (such as erosion-corrosion and stress corrosion cracking), the SRRA failure probabilities with ISI are used (no change from previous calculations).	*For piping segments that are included in augmented inspection programs that will remain unchanged under the risk-informed ISI program or for piping segments that will be examined under the RI-ISI program (including subsumed augmented inspections), the SRRA failure probabilities with ISI but without leak detection are used.* *For piping segments that are not included in the RI-ISI program and/or for which augmented examinations are being removed, the SRRA failure probabilities without ISI and without leak detection are used.*
Page 237, Section 5, Plant-Specific Application Process	This section provides the framework for applying the risk-informed methods to a specific plant for piping inservice inspection.	*This section provides the framework for applying the risk-informed methods to a specific plant for piping inservice inspection, including both ASME Section XI and augmented inspection program requirements.*
Page 246, Section 6.1, Report Summary and Relationship to NRC RG-1.174	This process meets the intent of the framework developed by the NRC and key steps and principles of the general regulatory guide and standard review plan (R.G.-1.174) as described in Sections 1.4 and 6.2.	*(insert new sentence at end of second paragraph)* *The process can be applied to both ASME Section XI and augmented inspection requirements.*

3.0 SPECIFIC GUIDANCE FOR HELB AND MELB AUGMENTED ISI EXAMINATION EVALUATION AS PART OF THE RISK-INFORMED ISI PROGRAM

3.1 BACKGROUND

Current design criteria for the postulation and protection of pipe breaks in high energy lines (and in some cases, moderate energy) have been developed over a period of time and the requirements vary from plant-to-plant when applied inside and outside containment. General Design Criterion 4 (GDC-4) of Appendix A to 10 CFR Part 50 provides the basic requirements for protection against dynamic effects of postulated pipe ruptures:

> "Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping."

As part of this evolution, augmented ISI examinations have been permitted to provide assurance of protection in specific instances where the installation of restraints or shields is not practical. Plants have also identified break exclusion zones such as in certain high energy piping systems in the containment penetration areas where augmented ISI has been allowed to assure protection. These augmented inspections usually comply with the requirements of the applicable edition of Section XI of the ASME Code and addenda. However, the frequency of these inspections can be increased over that required by Section XI, such that some plants inspect these locations three times during each 10-year inspection interval.

Augmented ISI for high energy line break (HELB)/moderate energy line break (MELB) requirements are addressed in NRC Standard Review Plan 3.6.1, 3.6.2 and 6.6 (NRC, 1990, 1981, 1981) and plant specific SAR commitments. SRP 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," states that "the plant design for protection against piping failures outside containment is reviewed to assure that such failures would not cause the loss of needed safety functions of safety-related systems and to assure that the plant can be safely shut down in the event of such failures. This review includes high energy and moderate energy fluid system piping outside of containment." SRP 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping" states that the staff review covers "the implementation of criteria dealing with special features, such as augmented inservice inspection programs or the use of special protective devices such as pipe whip restraints. ..." SRP 3.6.2 references MEB 3-1 and also SRP sections 5.2.4 and 6.6 with respect to staff review areas.

MEB 3-1 states that "

> "It is recognized that pipe rupture is a rare event which may only occur under unanticipated conditions, such as those which might be caused by possible design, construction, or operation errors; unanticipated loads or unanticipated corrosive environments. Our observation of actual piping failures have indicated that they generally occur at high stress and fatigue locations, such as at terminal ends of a piping system at its connection to the nozzles of a component. The rules of this position are intended to utilize the available piping design information by postulating pipe ruptures at locations having relatively higher potential for failure, such that an adequate and practical level of protection can be achieved."

A provision exists for an applicant to propose acceptable alternative method for complying with specified portions of the NRC SRP 3.6.1 section V and SRP 3.6.2 which states "Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission's regulations."

Most FSARs describe the HELB/MELB evaluation. In addition, the FSAR and some Technical Specifications describe these augmented inspections. For example, one FSAR states:

> "In specific instances where the installation of restraints or shields is not practical, adequate assurance of protection is provided by an augmented inservice inspection program on specific welds selected on the basis of pipe stress analysis.
>
> The augmented inservice inspection will comply, to the extent practical within the limitations of design, geometry, and materials of construction of the components, to the requirements in those editions of Section XI of the ASME Boiler and Pressure Vessel Code and addenda..."

The risk-informed ISI program is based on the actual piping failures that have occurred during plant operation. Most of the failures have been at locations other than those with high design stress or high fatigue usage factors. This is part of the premise of revising the ASME Section XI ISI program with a risk-informed program. This same premise applies to the changes requested for the augmented HELB/MELB break exclusion examinations.

The precedent exists for allowing inservice inspection in lieu of other provisions to protect against postulated piping failures. The risk-informed ISI program as described in the next section provides a re-evaluation of the postulated consequences along with the postulated likelihood of failure to reallocate and possibly reduce the number of inservice examinations performed for the HELB/MELB augmented inspection program. This guidance still meets the intent of the NRC's standard review plans.

3.2 SPECIFIC GUIDANCE FOR HELB AND MELB ISI INCLUSION

This evaluation can be performed concurrently with the application of the RI-ISI program (e.g., Class 1 and 2 ASME Section XI) or can be performed following completion of the program. The majority of HELB and MELB augmented exams are generally associated with the Class 2 piping systems;

therefore, a risk-informed ISI program that includes Class 2 piping (i.e., a Class 1&2 or full scope risk-informed ISI program) is usually included but is not required to perform this application.

The following subsections describe the process steps as related to the RI-ISI process described in WCAP-14572, Revision 1-NP-A. The step descriptions are intended to supplement and further explain the risk-informed ISI application to HELB/MELB augmented inspection program.

Scope Definition

The program scope is evaluated to include those systems for which HELB break exclusion ISI is performed. The scope of the program can include Class 1, Class 2, Class 3 and nonCode piping.

Segment Definition

The piping segments defined in the RI-ISI program are reviewed to identify which piping segments are impacted by the augmented ISI program. Any further refinement of the piping segments is also performed. The definition of piping segments is further described in WCAP-14572-Revision 1-NP-A, section 3.3.

Consequence Evaluation

This analysis evaluates system interactions due to piping failures. The following potential pipe failure-induced conditions are considered:

1. Flooding
2. Water Spray
3. Pipe whip
4. High environmental temperatures (e.g. Steam line break)
5. Jet impingement

The indirect effects assessment is accomplished through an investigation of existing plant documentation on pipe breaks, flooding, and plant layout along with a focussed plant walkthrough. The process is described in WCAP-14572-Revision 1-NP-A, section 3.4.2 but is summarized below.

An in-depth review of the requirements for break exclusion zones and supporting design basis documentation with respect to postulated consequences and locations is performed based on the piping segments and their postulated consequences. Plant documents or appropriate reference documents that identify the requirements for postulating and assessing the structural interactions (e.g. hinge points, jet cones, etc.) and consequences resulting from piping failures may be used to assess postulated damage. Plant documents or appropriate reference documents that identify the requirements for postulating and assessing the structural interactions (e.g., hinge points, jet cones, etc.) and consequences resulting from piping failures may be used to assess postulated damage.

Indirect effects occur from conditions such as pipe whip, jet impingement, flooding resulting from pipe breaks or leaks. The indirect effects to be considered include:

- Failures that cause an initiating event such as a LOCA or reactor trip
- Failures that disable a single train or system
- Failures that disable multiple trains or systems
- Failures that cause any combination above

An example of an indirect effect is the failure of a service water pipe which sprays an electrical cabinet that supplies power to the reactor coolant pumps, shorts the electrical supply which causes the pump to trip and ultimately causes a reactor trip.

The following summarizes the process steps:

For the Pre-walkthrough

- Review existing documents which examine the local effects of piping failures for the systems in scope of the program,
- Identify other systems/trains affected by a failure in each area,
- Identify plant areas for plant walkthrough,
- Document evaluation, and
- Develop walkthrough sheets for key areas

For the Walkthrough:

- Perform walkthrough and document results, actions, issues

For the Post Walkthrough,

- Evaluate results
- Resolve actions
- Map indirect effects to piping segments and identify the required leak or rupture failure probabilities

Initially, the plant is divided into areas such as those defined within the plants 10CFR50 Appendix R report, HELB/MELB evaluations, or other area designations. If needed for better delineation, these areas are further subdivided into smaller enclosures. The major safety equipment (e.g., pumps, motor-operated valves, electrical cabinets, etc.) is identified for each area.

This information is used to assess where major safety equipment is located within the plant that would have an impact on core damage or large early release. The evaluation is carried out on a building by building, area by area basis.

Areas throughout each building are eliminated from evaluation (similar to that performed in the internal flooding PSA screening) if:

- no major equipment is contained in an area or
- no piping or fluid source runs through or near an area.

The evaluation of pipe whip, jet impingement, and high environmental temperature is performed using the guidance provided below. This guidance is consistent with Westinghouse Systems Standard Design Criteria 1.19 (Westinghouse, 1980), WCAP-8951 (Mendler, 1979), U.S. NRC MEB 3-1 (NRC, 1987) and ANSI/ANS-58.2 (ANSI, 1988).

Pipe Whip and Jet Impingement Guidance

Pipe whip and jet impingement effects apply to breaks or ruptures that are postulated to occur in high energy piping systems, or portion of a system, where both or either of the following conditions are met during normal plant operating conditions:

- maximum operating pressure exceeds 275 psig, or
- maximum operating temperature exceeds 200°F

Note: These criteria are based on plant-specific criteria usually contained in a plant's FSAR.. Piping systems that operate above these limits for only a relatively short period (for example, less than approximately 2%) of the time during which they perform their intended function, may be classified as moderate energy.

Existing documents (e.g., UFSAR or hazards evaluation), are reviewed to examine where high energy line break locations have already been postulated and where devices, (e.g., whip restraints and jet shields), have already been installed to protect vital safety-related equipment.

Each area is documented to identify areas that are not of concern and those areas that are of potential concern.

In addition, prior to the walkthrough, the fluid conditions and the pipe sizes in the high energy piping of interest are identified in order to determine what length of pipe is required to form a hinge and the magnitude of the jet forces resulting from postulated breaks. The location of orifices that would limit

the amount of energy emanating from a postulated break are also determined. Initial piping and fluid conditions can be obtained from the piping isometrics, line lists, and system description documents. Plant layout drawings or ALARA layout drawings can assist in the pre-walkthrough evaluation, which focuses on which areas of the plant to include in the walkthrough.

During the walkthrough, assume that breaks may occur at all possible locations along the high energy piping runs;

- *circumferential breaks* should be postulated to occur individually at pipe-to-fitting welds, branch run-to-main run welds, branch run-to-fitting welds, and at other terminal ends[1]; circumferential breaks need not be postulated in piping runs of a nominal diameter equal to or less than 1"

- *longitudinal breaks* should be postulated at welded attachments (e.g., lug, stanchion) at the centerline of the welded attachment with an area equal to the pipe surface area that is bounded by the attachment weld. Longitudinal breaks need not be postulated in piping runs of a nominal diameter less than 4" and longitudinal breaks need not be postulated at terminal ends

- For each high energy piping run that has the potential to whip or cause jet impingement, as a result of a postulated break, look for the following types of protection to exist in the areas that could be impacted by these effects:

    * Separation distances between required systems and components and piping that are used to mitigate potential core damage effects

    * provision of piping enclosures (e.g., sleeves)

    * provision of component enclosures (e.g., walls or cubicles)

    * provision of system redundant design features (such as isolation valves)

    * design of required systems and components to withstand the effects of the postulated pipe rupture

    * provision of additional protection such as restraints and barriers

[1]Terminal end is that section of piping originating at a structure or component (e.g., a vessel or component nozzle or structural piping anchor) which acts as an essentially rigid constraint to the piping thermal expansion. In-line fittings, such as valves, are not assumed to be anchored and are not terminal ends.

- For high energy piping that has the potential to whip following a postulated break, the following considerations should be noted:

  - the portions of piping that may form a hinge will not become missiles

  - a whipping pipe that has the potential to impact other piping will not rupture lines of equal or greater size; however, it should be assumed that a through-wall crack may develop in a line that is impacted by a whipping pipe of the same size

- The evaluation of fluid jets emanating from postulated breaks on nearby structures and components shall consider the effects of jet loading, fluid temperature, and moisture on the targets impinged upon. The jet shape and direction should be established using the schematics of jets discharging from various pipe breaks. Targets more than 10 pipe diameters away from the break location need not be considered for jet impingement impacts.

From the walkthrough, the indirect effects from pipe failures within the plant are identified. Additional information identified during the walkthrough is obtained and evaluated. If indirect effects are identified, then they are matched with piping segments.

Any additions necessary to the postulated consequences are identified and incorporated into the analyses and the PRA model is used to estimate the conditional core damage /large early release (CDF/LERF) probability/frequency.

<u>Piping Failure Probability Assessment</u>

The Westinghouse structural reliability and risk assessment software (SRRA) is used to estimate the piping failure probabilities associated with each piping segment. The SRRA model is based on probabilistic structural mechanics models. SRRA models also predict the progress of degradation and/or crack growth as a function of time while quantitatively accounting for the impact of random loadings, such as earthquakes. SRRA uses Monte-Carlo simulation with importance sampling to calculate the probability of failure for type 304 and 316 stainless steel piping (due to fatigue crack growth and stress corrosion cracking) or for carbon steel piping (due to fatigue crack growth and loss of thickness due to wastage, such as flow-assisted corrosion).

All significant degradation mechanisms present in a piping segment along with the operating characteristics, environment, and loading conditions are evaluated as part of the failure probability assessment. When more than one degradation mechanism is present, the combination of all significant degradation mechanisms produces the limiting failure probability.

Failure probability calculations are performed for

- small leak (through wall flaw)

- large system disabling leak or initiating event

- full break (rupture) (where pipe whip is a concern)

In addressing piping segments where changes may be proposed at locations that are currently examined per HELB or MELB augmented inspection programs, the above failure probability calculations that are performed need to be consistent with fracture mechanics analysis methods for demonstrating leak-before-break. These changes include moving or reducing inspection locations or extending the frequency of examination. The failure probability calculations also need to demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping. To be consistent with leak-before-break methods, the probability of rupture should also be several orders of magnitude lower than the small leak probability (that represents the probability of a through-wall crack).

A detailed review of the piping failure probabilities used in the risk-informed ISI program for those segments impacted by break exclusion zones is performed with respect to postulated failure mechanisms and any credit for the augmented ISI program(s). Any new failure probabilities that are required for evaluation of the indirect effects are identified and then calculated using the Westinghouse SRRA software (Westinghouse, 1999).

Risk Evaluation

The results from the consequence evaluation and failure probability assessment are reviewed to identify the impact on the risk evaluation and risk ranking calculations. The identification of the potential re-ordering of the high safety-significant (HSS) piping segments based on modifying the credit for the augmented ISI program is performed. This information is then provided to the plant expert panel.

In performing the risk evaluation for this program, the process described in WCAP-14572, Revision 1-NP-A section 3.6.1 is performed with the following conditions applied:

- For segments in which the augmented program is postulated to be removed, the failure probability without ISI is to be used in the risk ranking.

- For segments in which spray or jet impingement is a postulated indirect consequence failure mode, the failure probability to be used is the SRRA small leak (small leak = through wall flaw) probability.

- For segments in which pipe whip is the postulated indirect consequence failure mode, the failure probability to be used is the SRRA full break (rupture) probability.

- For segments in which environmental effects are the postulated indirect consequence failure mode, the failure probability to be used is the SRRA small leak (small leak = through wall flaw) probability or an alternate where appropriately justified due to spatial considerations based on leak rate.

Expert Panel Categorization

The suggested changes to the risk-informed ISI program and the augmented ISI program are presented to the plant expert panel for final determination of which piping segments are high safety significant

(HSS) and should receive examination. The expert panel findings are documented. More details regarding the expert panel considerations are provided in WCAP-14572, Revision 1-NP-A, sections 3.6.2 and 3.6.3.

Structural Element/NDE Selection

Based on the changes proposed by the plant expert panel to the piping segments identified as HSS, the number of structural elements to be examined and the nondestructive examination (NDE) methods are identified based on the guidance provided in WCAP-14572, Revision 1-NP-A, sections 3.7 and 4.0. The change in risk calculations based on inputs from the risk ranking calculations, the piping segments which are in the current RI-ISI program and those that are proposed to be added to address the augmented ISI, are evaluated to ensure the program does not result in an increase in risk and meets the guidance in NRC RG-1.174 (NRC, 1998).

When changing the HELB and MELB exclusion examinations by subsuming the exams into the RI-ISI program, the licensee should ensure that the RI-ISI program includes a reasonable representation (balance) of augmented ISI examinations and ASME Section XI examinations. The Perdue statistical model is used to determine the minimum number of ASME Section XI exams to support a reasonable representation, where appropriate.

NRC Submittal

The risk-informed ISI application would be evaluated using 10CFR50.59. The resulting documents would be retained as part of the permanent plant record, as part of the existing risk-informed ISI program. Should the risk-informed ISI HELB/MELB be the only application of this WCAP at the site, a summary submittal report consistent with the Nuclear Energy Institute (NEI) template shall be submitted to the NRC.

Implementation and Feedback

The implementation and feedback section of WCAP-14572, Revision 1-NP-A would also apply to the revised augmented inspection program.

4.0 CONCLUSIONS

The WOG RI-ISI methodology is directly applicable to the consideration of augmented inspection programs; no significant changes to the overall process are required to address augmented inspection programs. The augmented inspection programs are already credited in the methodology without changing the actual regulatory requirements.

This addendum to the RI-ISI process permits, as an option, the revision of selected augmented inspection regulatory requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. The risk-informed ISI methodology for the HELB/MELB application is consistent with the basic requirements for protection against dynamic effects of postulated pipe ruptures defined in General Design Criterion 4 of Appendix A to 10 CFR Part 50. The consequences associated with dynamic effects, including the effects of pipe whip and discharging fluids, are addressed via a thorough evaluation (including plant walkthrough) of the areas of concern. The demonstration that the probability of fluid system rupture is extremely low under conditions consistent with the design basis for the piping is performed via the probabilistic structural mechanics evaluation using SRRA models, which are consistent with leak-before-break fracture mechanics analysis.

Thus, the augmented inspection programs, as identified in this addendum report, are rigorously assessed via the methodology approved in WCAP-14572 and the 10CFR50.59 process.

5.0 REFERENCES

American Nuclear Society, "Design Basis for Protection of Light Water Nuclear Power Plants Against the Effects of Postulated Pipe Rupture," ANSI/ANS-58.2-1988, 1988.

Mendler, O.J., "Method of Analysis and Evaluation of Jet Impingement Loads from Postulated Pipe Breaks," Westinghouse Electric Corporation, WCAP-8951, Revision 0, April 1979.

Nuclear Energy Institute, Letter from Stephen D. Floyd, Nuclear Energy Institute, to NEI Administrative Points of Contact containing "Example Submittal For Plants that Follow the WOG Methodology (WCAP-14572)," dated March 9, 1999.

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

U.S. Nuclear Regulatory Commission, NRC Bulletin No. 88-11, Pressurizer Surge Line Thermal Stratification, December 20, 1988.

U.S. Nuclear Regulatory Commission, NRC Information Notice 93-20, Thermal Fatigue Cracking of Feedwater Piping to Steam Generators, March 24, 1993.

U.S. Nuclear Regulatory Commission, Standard Review Plan, NUREG-0800, Chapters 3.6.1, 3.6.2, and 6.6, October 1990, July 1981, July 1981, respectively.

U.S. Nuclear Regulatory Commission, Branch Technical Position MEB 3-1, "Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment," Revision 2, June 1987.

U.S. Nuclear Regulatory Commission, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," NUREG-0313, Rev. 2, Washington, D.C., January 1988.

U.S. Nuclear Regulatory Commission, IE Bulletin 79-17, "Pipe Cracks in Stagnant Borated Water Systems at PWR Plants," July 26, 1979.

U.S. Nuclear Regulatory Commission Generic Letter 88-08, "Thermal Stresses in Piping Connected to Reactor Coolant Systems," June 22, 1988.

U.S. Nuclear Regulatory Commission, NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping (Generic Letter 88-01), January 1988.

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

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

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

Westinghouse Owners Group, Letter from Louis F. Liberatori, Jr., Chairman, Westinghouse Owners Group, to Chief, Information Management Branch, U.S. Nuclear Regulatory Commission, Westinghouse Owners Group Transmittal of Approved Topical Reports: WCAP-14572 Revision 1-NP-A (Non-Proprietary) "WOG Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report" and WCAP-14572 Revision 1-NP-A, Supplement 1 (Non-Proprietary) "Westinghouse Structural Reliability and Risk Assessment (SRRA) Model for Piping Risk-Informed Inservice Inspection"(MUHP-5091), March 8, 1999.