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EPRI

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Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Extension of Risk-Informed Inservice Inspection (RI-ISI) Methodology

Dear Dr. Sheron:

The USNRC approved the EPRI Risk-Informed Inservice Inspection (RI-ISI) methodology for generic application in 1999 (Reference 1). Since that time, its application has received widespread acceptance in the industry as a means to focus resources on risk significant components and eliminate unnecessary occupational exposures (Reference 2).

In parallel with these applications, EPRI has continued research and development efforts to further the effectiveness of risk and performance based technologies and hence risk-informed regulation. To support communication and technical discussion on these efforts, EPRI staff, member utilities and NEI staff have met periodically with USNRC staff.

The purpose of this letter is to forward the attached information to support our mutual objective of efficient and effective review of these extensions of the EPRI RI-ISI methodology. The first attachment contains a draft report documenting the extension of the EPRI RI-ISI process (Reference 3). This report provides the basis and process for extending the RI-ISI methodology as an acceptable alternative to augmented inspection programs for break exclusion requirements (BER) typically identified via Standard Review Plan sections 3.6.1 and 3.6.2. Per previous discussions with USNRC staff, this process has been applied at two sites (one BWR and one PWR).

Attachments 2 and 3 present additional insights gained from more recent applications of the EPRI RI-ISI methodology. The second attachment provides additional criteria for assessing the susceptibility of piping to thermal fatigue. The criteria is being applied by some licensees that have RI-ISI submittals underway and is provided herein for generic approval thereby avoiding the need for future plant specific approvals.

The third attachment discusses the impact of RI-ISI programs relative to the implementation of repair and replacement activities. This topic is also being discussed at ASME Section XI.

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Finally, as you aware, the Material Reliability Project is developing plans for addressing the generic implications of the VC Summer event. Included in these plans is an assessment of the potential impact of the VC Summer event on current and future RI-ISI applications. The existing RI-ISI process includes a living program component. As such, it is our intent to incorporate any lessons learned from this event into the RI-ISI process, as applicable.

We look forward to your review of the attached and welcome a meeting in the near future to discuss any comments you or your staff may have.

Sincerely,

Frank Ammirato, for

Pat O'Regan
EPRI Risk Informed Inspection Program Manager

cc: S. Ali (USNRC)
F. Ammirato (EPRI)
R. Bradley (NEI)
G. Holahan (USNRC)
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References:

1. SAFETY EVALUATION REPORT related to "Revised Risk-Informed Inservice Inspection Procedure" (EPRI TR-112657, Rev. B July 1999), dated October 28, 1999.

2. NEI letter from Anthony Pietrangelo to Dr. Brian Sheron (USNRC), dated October 20, 2000.

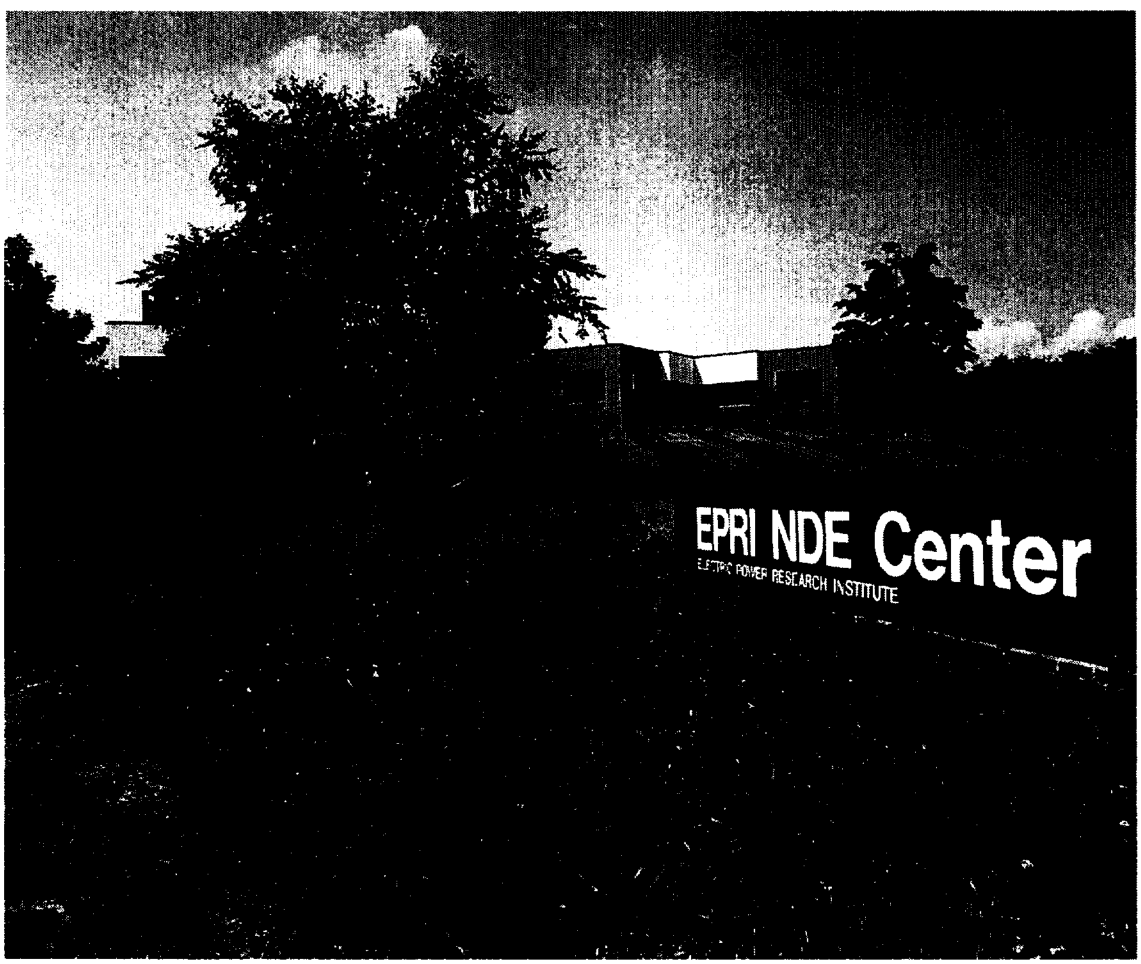
3. *Revised Risk-Informed Inservice Inspection Evaluation Procedure*, EPRI, Palo Alto, CA: 1999. EPRI TR-112657, Rev. B-A

Attachments:

1. Applications of Risk and Performance Technology, Volume 1
2. TASCS Severity Assessment
3. Preservice Inspection Elements

Applications of Risk and Performance Technology

Volume 1 - Break Exclusion Requirements



Applications of Risk and Performance Technology Volume 1 - Break Exclusion Requirements

DRAFT

CONTENTS

1
INTRODUCTION AND PURPOSE

General Design Criteria 4 (Reference 1) requires that structures, systems, and components important to safety be designed to accommodate the effects of postulated accidents, including appropriate protection against the dynamic and environmental effects of postulated pipe ruptures.

Paraphrasing from NUREG-1061 (Reference 14), "design basis accident", or maximum hypothetical accident" have been terms used to describe what was generally known as the double-ended guillotine break (DEGB). The concept was originated by the US Atomic Energy Commission for the multiple purpose of sizing containments and establishing "accident" doses and later for sizing emergency core cooling systems. The original concept was quite straightforward; namely an instantaneous DEGB of a major pipe in the primary system of a light-water reacto r would maximize the fluid release and establish an upper bound for the design pressure established for a containment.

Later changes in regulatory philosophy tended to shift the DEGB from a hypothetical accident to one with increasing credibility. It was a relatively short step from the hypothetical to a belief in randomly occurring major pipe breaks.

The Nuclear Regulatory Commission has issued a number of documents that provide criteria for implementing the above requirement, including the scope of applicable systems, locations to postulate breaks, methods for analyzing pipe whip forces and displacements, design of rupture restraints, and methods for evaluating the integrity of components subjected to the pipe rupture loads.

In determining the locations at which breaks are to be postulated in high energy piping, the regulatory guidance provides special rules for break exclusion regions (a.k.a. "no break zone"), including containment penetration areas. There are a variety of terms that have been developed to identify these special rules including break exclusion requirements (BER), no break zones (NBZ), high energy break exclusion region (HEBER), high stress welds, augmented inspections, etc. These rules provide licensees the option of not specifying breaks in these regions provided additional requirements are met. The requirements for not specifying breaks in these areas consist of:

- maintaining design stresses low (i.e. below BER acceptance criteria),
- minimizing welded attachments,
- minimizing the number of branch connections,

- postulation of pipe breaks upstream and downstream of the "no break zone",
- increased number of inspections in the "no break zone" region.

It should be noted that at the time of the Giambusso letter (Reference 2) and the issuance of the applicable Standard Review Plan sections, inservice inspection requirements of ASME Section XI were in their formative stages of development and application. In addition, augmented inspection programs that factored in actual operating experience, for example Generic Letter 89-08 for flow assisted corrosion (FAC) and TR-103581 for thermal stratification, cycling and striping (TASCS), had not been foreseen.

The purpose of this report is to revisit the inspection sample size of the BER augmented inspection programs. In doing so, this report has reviewed plant operating experience since the early seventies, developed an understanding of the performance history of this program as well as its application across the industry.

The goal of this report is to, as warranted, recommend a reasonable inspection sample size taking into account the safety benefit associated with BER inspection programs and plant specific design features while maintaining an adequate level of defense-in-depth. Although existing evidence and analyses have identified the potential for catastrophic pipe breaks (i.e. double ended guillotine breaks) as vanishingly low for this scope of piping, prudence dictates that a reasonable inspection sample size, and a process for determining that sample size, be developed. In support of this goal, two example plant applications (see Appendix A and B) were conducted to assure that the defined process is robust and can be consistently applied to both BWR and PWR plants.

2
HISTORICAL PERSPECTIVE

2.1 Purpose/Introduction

The purpose of this section is to provide a historical perspective on the break exclusion requirements (BER) as applied to high-energy piping, including containment penetration areas. Most of the formative regulatory guidance specific to BER programs comes from the early days of Nuclear Power, generally in the 1972 to 1975 time frame, prior to any significant history of nuclear plant operations. Knowledge of the frequency of occurrence and speed of progression of various degradation mechanisms in plant operating environments and the adequacy of various sampling plans could not have been incorporated into the regulatory guidance. Neither could specific consequence insights from later risk assessments (e.g. PRA). Inspection criteria were conservatively set beyond the requirements of ASME XI to provide a perceived reduction in the probability of breaks in the exclusion zone. For some plants, the development of regulations and guidance in this area has resulted in an inspection burden that exceeds that required by ASME Section XI. Augmented inspection requirements can be as high as 100% of welds every ten years versus the ASME XI requirements of 7.5% (Class 2) and 25% (Class 1) every ten years. Not all plants have been as severely impacted as other plants since plant specific requirements vary as described below:

a. Regulatory guidance varied over time as various plants were licensed,
b. Plants conducted specific evaluations at the time of plant licensing to obtain relief,
c. Plants varied in their interpretation of the regulations – generally in two specific areas
    1. Various assumptions related to the boundary of the augmented ISI zone.
    2. Conservatively definition of the augmented ISI boundary even when the design of the plant incorporates the effects of a break.

2.2 NRC Design Criteria

General Design Criteria 4 (Reference 1) requires that structures, systems, and components important to safety be designed to accommodate the effects of postulated accidents, including appropriate protection against the dynamic and environmental effects of postulated pipe ruptures.

The Nuclear Regulatory Commission has issued a number of documents that provide criteria for implementing the above requirement. These include the scope of applicable systems, locations

to postulate breaks, methods for analyzing pipe whip forces and displacements, design of rupture restraints, and methods for evaluating the integrity of components subjected to the pipe rupture loads. In determining the locations at which breaks are to be postulated in high energy piping, the regulatory guidance provides special rules for excluding postulated breaks (e.g. containment penetration areas). These rules on the one hand recognize that these areas may require extra protection (e.g. to ensure the integrity of the containment and the operability of the isolation valves). On the other hand, the rules give the option of not specifying breaks in these regions, so that pipe break mitigation devices, such as whip restraints, need not be constructed in these areas. One of the requirements for not specifying breaks in these regions is to perform 100% inspections of welds in this area. These inspections are made part of the 10-year inservice inspection plan and are identified as "augmented" inspections.

2.3 Break Exclusion Criteria

There are several NRC documents that provide guidance on the subject of postulation of break locations in high-energy lines. They are all reasonably consistent in their philosophy, the main differences being in their scope, and in some cases, revisions to the allowable stress values.

The first document that provided information on how to implement GDC 4 was known as the **"Giambusso Letter"** (Reference 2), issued by the AEC in 1972. Points relevant to the scope of this report are the following:

1. High Energy Lines are defined as lines where the service temperature is 200° F or higher or the design pressure is above 275 psi.
2. Limited criteria for determining pipe break locations is provided. Exemptions are provided for piping one inch diameter and under from postulating circumferential breaks and under four inches from postulating longitudinal breaks.

Regulatory Guide 1.46 (Reference 3) was issued in May 1973 by the AEC. It gives the first comprehensive description of the piping stress allowables to be used in postulating break locations. The scope was inside containment and it has since been superseded. Relevant points were the following:

1. The High Energy Line definition is changed slightly to include piping with service temperatures over 200° F.
2. Breaks should be postulated at terminal ends, defined as connections to component nozzles, header pipes, and other points of rigid constraint.
3. Breaks should be postulated at intermediate points where the stresses exceed levels that are generally based on 80% of the primary membrane plus secondary stress allowables of the ASME Code (Reference 4); or where fatigue usage exceeds 0.1.
4. If there are not two points that exceed the stress limitations, then two arbitrary intermediate break points (AIBs) are to be selected at "reasonable" locations.

The next guidance document to be issued was the "**O'Leary Letter**" (Reference 15). The main thrust of this document was the protection of the safety components from the effects of the

breaks. However, it is notable because it is the first document that refers to a no-break zone. Paragraph A.4 of Appendix A states,

> "For those portions of the piping passing through primary containment penetrations and extending to the first outside isolation valve, pipe breaks need not be postulated provided such piping is conservatively reinforced and restrained beyond the valve such that, in the event of a postulated pipe break outside containment, the transmitted pipe loads will neither impair the operability of the valve nor the integrity of the piping or the containment penetration. (A terminal end of such piping is considered to originate at this restraint location.)"

Although no details of the no-break zone design criteria are given, this paragraph summarizes the philosophy of the no-break zone. It states that: (1) it extends to the first isolation valve; (2) a restraint needs to be placed beyond the isolation valve to protect the piping in the zone from the effects of a break outside the zone; and (3) that the restraint is considered to be the terminal end break location.

In November 1975 the NRC issued **Standard Review Plan 3.6.1** (Reference 5), which detailed the criteria the USNRC would use to review the adequacy of individual plant designs for compliance with GDC 4. It included **Branch Technical Position ASB 3-1**, which provided the design requirements. BTP ASB 3-1 attached the O'Leary Letter as an Appendix. Thus the no-break zone philosophy described above was made part of the Branch Technical Position, which was in turn made part of the Standard Review Plan. Other notable items are the following:

1. Paragraph 2.c of the SRP states "ASB identifies portions of high and moderate energy fluid system piping between containment isolation valves that are subject to the recommendations of item B.2.c of BTP ASB 3-1. MEB reviews the design of these portions of piping in connection with the review of break locations and dynamic effects of piping failures under SRP Section 3.6.2."

2. Item B.2.c of BTP ASB 3-1 states, "Fluid system piping in containment penetration areas should be designed to meet the break exclusion provisions contained in item B.1.b of BTP MEB 3-1."

3. The end of Paragraph 3 of the SRP states "The Materials Engineering Branch (MTEB) reviews inservice inspection aspects of piping within protective structures or guard pipes, between containment isolation valves, as part of its primary review responsibility for SRP Section 6.6."

4. BTP ASB 3-1 gives criteria for postulating break locations, which includes terminal ends, points with stress above 80% of ASME Code allowables, and arbitrary intermediate breaks. The definition of high energy lines is repeated.

5. The BTP states that plants with construction permit applications before July 1975 may instead comply with either the O'Leary Letter or the Giambusso Letter, depending on the CP date.

Thus this SRP refers to SRP 3.6.2 and MEB 3-1 for the details of the rules for pipe break postulation in the no break zones. The only reference to inservice inspection is limited to the piping between the containment isolation valves.

Standard Review Plan 3.6.2 (Reference 6) was also issued in November 1975 and is the primary document for determining the locations of postulated breaks. It refers to Branch Technical Position MEB 3-1. MEB 3-1 provides the stress allowables and other requirements for break location determination, and the details on the containment penetration no-break zone design criteria. Key points are the following:

1. Paragraph B.1.b gives the rules for the no-break zone. The heading is High-Energy Fluid Systems Piping / Fluid System Piping in Containment Penetration Areas. It states:

   "Breaks and cracks need not be postulated in those portions of piping from the containment wall to and including the inboard or outboard isolation valves provided they meet the following requirements..."

2. The Code requirements to be met are:

   (a) ASME Code Section III, Subarticle NE-1120 (deals with Code jurisdictional boundaries)

   (b) For Class 1 piping, pipe stresses in Subsection NB Equation 10 are limited to 2.4 S_m

   (c) Fatigue usage is limited to 0.1

   (d) The stresses in NB Equation 9 "due to loadings resulting from a postulated piping failure beyond these portions of piping" should not exceed 2.25 S_m

   (e) For Class 2 piping, the Subsection NC Equations 9 plus 10 stresses are limited to 0.8 (1.2 S_h + S_A)

   (f) The Equation 9 stresses for loads from a piping failure beyond this piping are limited to 1.8 S_h

3. Additional requirements to be met are:

   (a) Welded attachments should be avoided

   (b) The number of welds should be minimized; welds in guard pipes must be accessible for inservice examination

   (c) The length of containment penetration piping should be reduced to the minimum length practical

   (d) Pipe anchors should not be welded to the pipe unless they are analyzed for stresses and the welds are volumetrically examinable

   (e) Rules are provided for guard pipes

4. The final requirement is the augmented inservice inspection. It states:

   "A 100% volumetric inservice examination of all pipe welds should be conducted during each inspection interval as defined in IWA-2400, ASME Code, Section XI".

5. For areas beyond the containment isolation valve, the requirements are:
   (a) Breaks postulated at terminal ends
   (b) Breaks at points exceeding a stress of 2.4 S_m (Class 1) or 0.8 (1.2 S_h + S_A) (Class 2)
   (c) Breaks at two arbitrary intermediate points

Standard Review Plan 6.6 (Reference 7) gives guidance on inservice inspections of Class 2 components. Relevant sections are the following:

1. Paragraph I.7 mentions Augmented ISI to protect against postulated piping failures. It references SRP 3.6.1 and states that the inspection program is for high energy fluid systems between containment isolation valves.
2. Paragraph II.7 describes the Augmented ISI Program. It states: "For those portions of high energy fluid system piping between containment isolation valves, the extent of inservice examination completed during each inspection interval should provide 100% volumetric examination of circumferential and longitudinal pipe welds within the boundary of these portions of piping."
3. Paragraph II.8 allows exemptions per IWC-1220. IWC-1220 exempts all piping 4 inches in diameter or under from both volumetric and surface examination.

Generic Letter 87-11 (Reference 8) was issued by the NRC in June 1987. It contains a revision to MEB 3-1. The key aspects of this revision are:

1. Arbitrary intermediate breaks are eliminated.
2. The stress allowables for postulating breaks in Class 2 lines are increased according to the changes to Subsection NC of the ASME Code. The new allowable is 0.8 (1.8 Sh + SA).
3. The no-break zone criteria, including the augmented inspection requirements, are unchanged.

2.4 Summary Of Regulatory Requirements

The guidance documents cited above are quite consistent in their requirements for the no-break zone and the augmented ISI program. The requirements can be summarized as follows:

- It applies to only high energy fluid systems,
- For containment penetration areas, the no-break zone extends from the containment wall up to and including the inboard and outboard containment isolation valves,
- A no-break zone is not mandatory; the option to postulate breaks between the isolation valves and design for their consequences is always available,
- A whip restraint or anchor needs to be placed outside the no-break zone so as to limit the stresses in the no-break zone caused by a break outside the no-break zone. This restraint becomes the terminal end break location for the piping system,
- There are no other portions of piping systems where the augmented ISI program is required,

- Exemptions are provided in ASME Section XI. For Class 1 piping, IWB-2500 exempts piping under 4 inch NPS from volumetric examination and IWB-1200 exempts piping 1 inch and under from surface examination. For Class 2, IWC-1220 exempts some piping 4 inches and under from volumetric and surface examination.

2.5 PLANT SPECIFIC APPLICATIONS

As discussed earlier, BER programs vary throughout the industry. Many plants have performed specific reviews, evaluations and analyses to support existing programs. The main reasons for this disparity appear to be:

- timing of operating license,
- level of additional analyses,
- commitments beyond SRP requirements,
- conservative interpretation of SRP requirements

A more thorough review of the existing regulatory guidance and its application reveals that a number of locations could be eliminated. In general, these inspection locations are beyond the isolation valves, locations that were conservatively classified as high energy lines and/or locations where the break consequences have been analyzed and are acceptable. Since existing regulatory documents provide a basis for using a consequence based approach to limiting the scope of piping in the augment ISI program, this would not require generic relief but may involve a number of individual licensee submittals and accompanying NRC review.

Plant specific analyses have been conducted that include reviews of the design, test and operational factors that minimize the potential for break in the first place. As discussed in NUREG-1061, the concept of a double-ended guillotine break (DEGB) was originally used for sizing containments, establishing dose rates and sizing emergency core cooling systems. As regulatory philosophy changed with time, the perception of these hypothetical accidents shifted from incredible to credible.

The framework of these analyses has been to outline the actions taken during plant construction to ensure the quality of the initial installation (material controls, weld processes, radiographic & hydrostatic inspections, etc.). In addition, credit has been taken for analyses, operational reviews and procedures performed or put in place since plant startup that either provide additional understanding of the low frequency of larger breaks, reduce the frequency of breaks or provide assurance that a small leak will not progress to a larger event. In general, leak before break analysis, water hammer reviews, FAC inspections, fatigue analysis and periodic walkdowns are credited. Some additional PRA insight as to the potential for initiating events may also have been included.

As discussed above, if a break has been postulated and designed for, there is no requirement that it also be included in the augmented ISI program.

In summary, given the present state of knowledge (conservative design, ASME Section XI and other augmented inspection, FAC, degradation mechanism evaluation, consequence of failure, risk assessments), it is conceivable that if guidance for BER programs were to be developed anew in 2000, inservice inspection requirements would be significantly different.

As an example, one could envision that a piping inspection program that adequately manages, intergranular stress corrosion cracking (IGSCC), flow accelerated corrosion (FAC), thermal fatigue and provides for a reasonable level of defense in depth (say, 10% for important piping) would obviate the need for additional examinations due to BER or ASME Section XI requirements.

3
ADAPTATION OF THE RI-ISI EVALUATION PROCESS

3.1 Overview of the RI-ISI Process

This section identifies those portions of the traditional risk-informed inservice inspection (RI-ISI) process (Reference 9) that will require clarification and/or modification in order to support application to BER inspection programs. In this section, each step in the RI-ISI process is presented and the required change (if required) is identified.

The EPRI methodology for RI-ISI is depicted in Figure 3-1. The EPRI RI-ISI methodology is implemented by following a six-step process:

1. Definition of the RI-ISI program scope.
2. Failure Mode and Effects Analysis (FMEA) of Pipe Segments.
   - Evaluation of consequences of pipe failures.
   - Evaluation of pipe failure potential.
3. Characterization of risk segments.
4. Inspection element selection.
5. Evaluation of risk impact of changes to inspection program.
6. Incorporation of long term RI-ISI program.

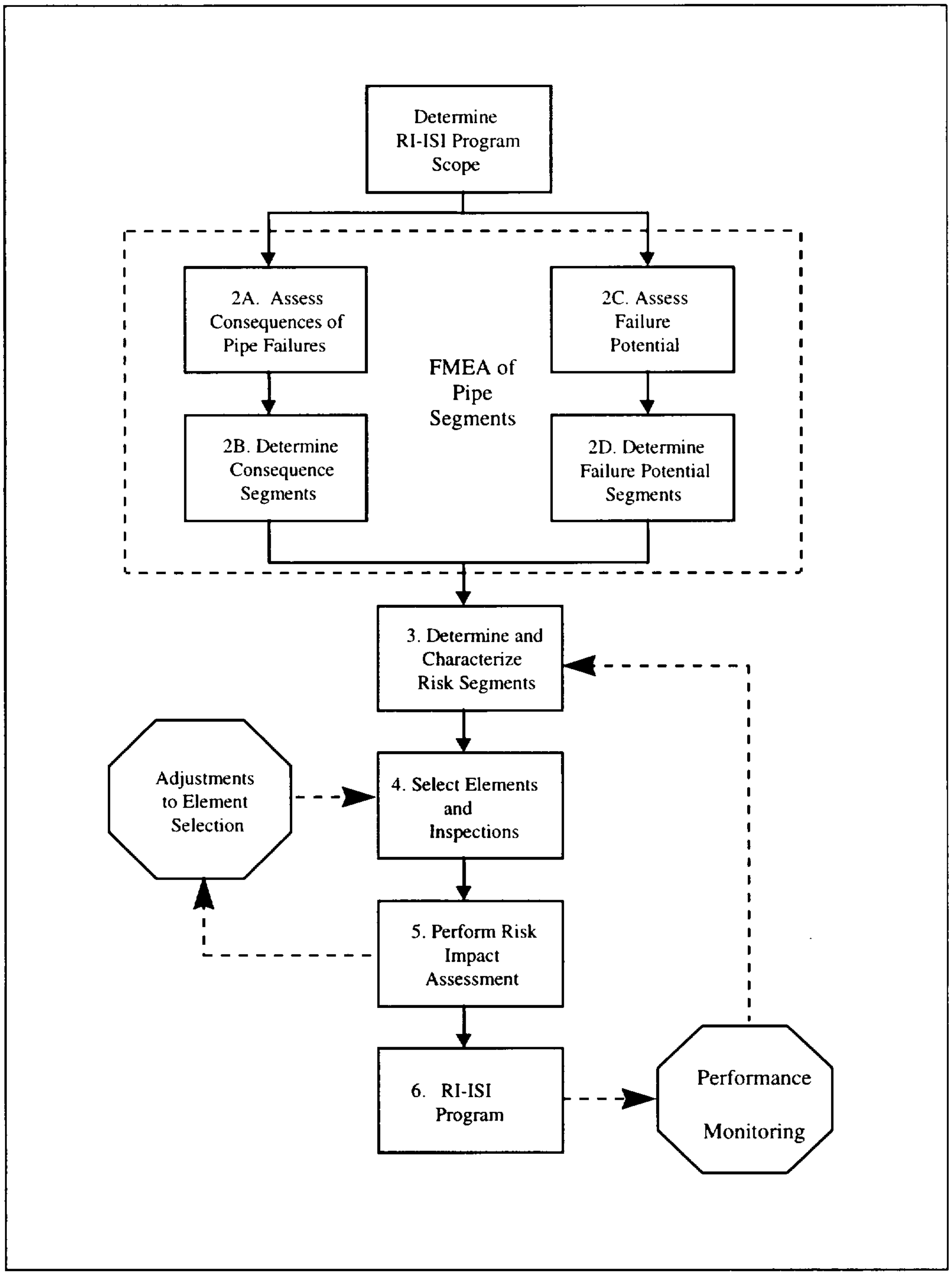


Figure 3-1
Overview of EPRI RI-ISI Methodology

Once the scope of application has been determined, the second step is to perform an FMEA of the piping systems within the RI-ISI program scope. In Figure 3-1 this step is broken down into four distinct sub-steps as this is where most of the resources are applied in implementing a risk informed inspection program. The FMEA is normally performed on a system by system basis

and leads to the definition of piping segments that have common potential for failure and common consequence potential. Segments with the same failure potential and same consequence potential are combined into risk segments in step 3.

The consequences of pipe rupture are measured in terms of the conditional probability of core damage given an assumed pipe rupture (CCDP) and the conditional probability of large early release given an assumed pipe rupture (CLERP). This is accomplished by identifying the impacts of the pipe rupture in terms of initiating events, system mitigation, containment response, and time of exposure of the pipe rupture conditions prior to detection and repair of the affected piping component. Evaluation of consequences is implemented in step 2A. The system piping is organized into contiguous segments, each having the same consequence potential. Guidance for performance of consequence assessments is provided in Section 3.3 of TR-112657, Rev B-A.

In a similar fashion, failure potential of each pipe location is assessed in terms of the relative potential for pipe rupture. The basis for assessing this potential is determined by evaluating physical and operating conditions necessary for various degradation mechanisms to become operative. Guidance for performance of steps 2C and 2D is provided in Section 3.4 of TR-112657, Rev B-A.

As discussed previously, piping segments with the same failure potential and consequence potential are defined as "risk segments."

Pipe elements within each segment are candidate locations to be selected for the inspection program based on the risk characterization of the segment to which each element belongs. Elements can be specific welds or locations of pipe that have been evaluated for susceptibility to a spectrum of damage mechanisms. In step 3, each segment is placed onto the appropriate place on the EPRI segment risk characterization matrix as described in Figure 3-2 based on three broad categories of failure potential (high, medium, or low) and four broad categories of consequence potential (high, medium, low, or none). Based on the combination of failure potential and consequence categories, each location on the risk matrix is assigned to one of three broad risk regions that are correlated to ranges of absolute levels of core damage frequency (CDF) and large early release frequency (LERF). Guidance for step 3 is provided in Section 3.5 of TR-112657, Rev B-A.

In step 4, the revised set of inspection requirements is defined. Specific locations on the risk matrix are selected for the inspection program based on the segment's risk ranking and a set of practical considerations that bear on the feasibility and effectiveness of the specific inspection. For those locations selected for NDE inspections, the inspections are focused on the type of degradation mechanism identified in step 2. The ability to focus the examination on specific damage mechanism(s) enhances the effectiveness of the retained inspections. All locations, regardless of risk classification and element selection results continue to be subjected to pressure and leak testing requirements.

POTENTIAL FOR PIPE RUPTURE PER DEGRADATION MECHANISM SCREENING CRITERIA	CONSEQUENCES OF PIPE RUPTURE IMPACTS ON CONDITIONAL CORE DAMAGE PROBABILITY AND LARGE EARLY RELEASE PROBABILITY			
	NONE	LOW	MEDIUM	HIGH
HIGH FLOW ACCELERATED CORROSION	LOW Category 7	MEDIUM Category 5	HIGH Category 3	HIGH Category 1
MEDIUM OTHER DEGRADATION MECHANISMS	LOW Category 7	LOW Category 6	MEDIUM Category 5	HIGH Category 2
LOW NO DEGRADATION MECHANISMS	LOW Category 7	LOW Category 7	LOW Category 6	MEDIUM Category 4

Figure 3-2
EPRI Matrix for Segment Risk Characterization

To meet the requirements of RG 1.174 and 1.178, it must be shown that the changes in risk due to changes in the inspection program do not pose a significant risk impact as determined by changes to CDF or LERF. The EPRI approach to RI-ISI has been designed to ensure that risk impacts associated with enhancements to the inspection program will be risk neutral. This is because by focusing inspections on high and medium risk locations and by gearing the examinations to those degradation mechanisms most likely to be observed, will exceed any risk increases associated with eliminating inspections from the current inspection program. Hence, significant adjustments to the locations that were initially selected in order to demonstrate that risk impact requirements are not exceeded, are not anticipated. Nonetheless, in this step, it must be confirmed that the initial selection of elements for the RI-ISI program does not produce an unfavorable and unacceptable risk impact. This is accomplished through a flexible process that may involve one or more of the following: application of qualitative criteria, bounding estimates of risk impacts, realistic estimates of risk impacts, and/or adjustments to the selection of elements to meet the risk acceptance criteria.

The following sections identifies those portions of the traditional risk-informed inservice inspection (RI-ISI) process (Reference 9) that will require clarification and/or modification in order to support application to BER inspection programs. Each step in the RI-ISI process is presented and the required change (if required) is identified.

The process described herein has been applied in two example plant applications. These applications, one to a BWR and one to a two unit PWR plant are documented in Appendix A and B, respectively.

3.2 Scope

3.2.1 Existing RI-ISI Process

Traditional RI-ISI applications are applied to a variety of piping scopes. These can consist of application to Class 1 piping only, Class 1 and 2 piping only, Class 1, 2 and 3 piping up to the entire plant. The application can also apply to a single system or multiple systems as well as to portions of a piping class. For example, ASME Code Case N560 applies to a subset of the Class 1 pressure boundary (i.e. examination category B-J, excluding socket welded connections).

3.2.2 Adaptation to BER Programs

Application of RI-ISI to BER Programs requires an understanding of the traditional RI-ISI scope that is or has been applied. It also requires an understanding of the existing plant BER program including its scope and licensing basis.

Most BER programs encompass main steam and feedwater piping that penetrates containment. For BWR plants, most of this piping tends to be Class 1 with some portions as Class 2 or non-code piping (e.g. NNS, BOP, Class 4). In BWR plants, this piping provides high pressure flow to the reactor (i.e. feedwater systems) and carries high pressure steam away from the reactor and to the turbine (main steam system). In PWR plants, most of this piping tends to be Class 2 with some portions as Class 3 or non-code piping (e.g. NNS, BOP, Class 4). Because PWRs use steam generators in a secondary cooling loop function, this piping is not in direct contact with primary coolant unless there is a primary to secondary leak path (e.g. steam generator tube leak). Different than in BWRs, this piping provides high pressure flow to the steam generators (i.e. feedwater systems) and carries high pressure steam away from the steam generators and to the turbine (main steam system). The steam generators and the rest of the primary loops provide the cooling and heat removal function directly to the reactor.

Although the feedwater and main steam system encompass the majority of BER programs, if not all, there are plants which may have a significant number of BER inspections in other systems. For example, reactor water cleanup in BWRs and CVCS in PWRs.

As discussed above, each application will need to define and understand the scope (systems and classes), programs (ASME SXI, BER, etc.) and licensing bases.

3.3 Consequence Evaluation

3.3.1 Existing RI-ISI Process

The purpose of this phase of the EPRI RI-ISI process is to evaluate pipe failures in terms of their impact on Core Damage Frequency (CDF) and Large Early Release Frequency (LERF). The consequence evaluation focuses on the impact of a pipe section failure (loss of pressure boundary integrity) on plant operation. This impact can be direct, indirect or a combination of both:

- Direct Impacts - A failure results in a diversion of flow and a loss of the train and/or system or an initiating event (such as a loss of reactor coolant or main feedwater line break).
- Indirect Impacts - A failure results in a flood, spray, or pipe whip, spatially affecting neighboring structures, systems and components or results in depletion of a tank and loss of the systems supplied by the tank.

The approach results in a comprehensive assessment of both direct and indirect effects for a spectrum of piping failures, from pipe leaks to ruptures. The consequences due to indirect effects and direct effects are treated explicitly.

Spatial effects are an example of indirect effects caused by pressure boundary failures. These include the effects of flood, spray, and pipe whip on equipment located in the vicinity of the break. Spatial consequences of the break are determined based on the location of the analyzed break and the relative position of important equipment. The presence of important equipment in a specific location are identified through these analyses and are confirmed by walkdowns, as necessary.

The possibility of isolating a break is also identified and accounted for as part of the consequence analysis. A break could be isolated by a protective check valve, a closed isolation valve, or it could be automatically isolated by an isolation valve that closes on a given signal. If not automatically isolated, a break can be isolated by an operator action, given successful diagnosis. The likelihood of isolating a break depends on the availability of isolation equipment, a means of detecting the break, the amount of time available to prevent specific consequences (e.g., flooding of the room or draining of the tank), and human performance. If isolation is feasible, the consequence assessment is conducted for both cases: successful and unsuccessful isolation.

Pilot and subsequent plant evaluations have shown that the large break scenarios (worst-case breaks) result in the most limiting consequences. However, the methodology was specifically developed to require that a spectrum of break sizes be evaluated so that, if smaller breaks can cause a measurable or the dominant consequence, they are identified and input into the risk ranking process.

Consequence Ranking and Categorization

The consequences of the piping failure described above are ranked into categories based on a combination of plant-specific PSA insights and results, and methodology lookup tables. The

methodology lookup tables were developed, in order to standardize and streamline the consequence ranking process.

Four consequence importance categories have been defined based upon PSA evaluation. They are: high, medium, low, and none. The high category represents events with a significant impact on plant safety, while the low category represents events with a minor impact on plant safety. The none category defines those locations that are typified by "abandoned in place" piping.

The consequence ranking philosophy, used in this methodology, can be summarized as follows:

High Consequence: Pressure boundary failures resulting in events that are important contributors to plant risk and/or pressure boundary failures which significantly degrade the plant's mitigative ability (e.g. ECCS function, containment performance).

Low Consequence: Pressure boundary failures resulting in anticipated operational events and/or pressure boundary failures which do not significantly impact the plant's mitigative ability.

Medium Consequence: This category is included to accommodate pressure boundary failures, which fall between the high and low rank.

None Consequence: This category includes failures that have no affect on risk, an example is abandoned in place piping.

The process of conducting a consequence evaluation is organized in four steps, as defined below:

1. Plant PSA models, systems, initiators and supporting analysis are evaluated. The initial consequence rank is established, based on the pressure boundary failure's impact on CDF.
2. Containment performance is evaluated. The previously established consequence rank is reviewed and adjusted to reflect the pressure boundary failures impact on containment performance, by evaluating CLERP or by evaluating the likelihood of containment bypass.
3. Shutdown operation is evaluated. The previously established consequence rank is reviewed and adjusted to reflect the pressure boundary failure's impact on plant operation during shutdown.
4. External events are evaluated. The previously established consequence rank is reviewed and adjusted to reflect the pressure boundary failure's impact on the mitigation of external events.

<u>Consequence Impact Groups and Configurations</u>

The consequence evaluation and ranking is organized into four basic consequence impact groups, with three corresponding operating configurations. Those consequence impact groups, configurations, and corresponding report sections are defined in Table 3-1.

Table 3-1
Definition of Consequence Impact Groups and Configurations

CONSEQUENCES		
Impact Group	**Configuration**	**Description**
Initiating Event	Operating	A PBF occurs in an operating (pressurized) system resulting in an initiating event
Loss of Mitigating Ability	Standby	A PBF occurs in a standby system and does not result in an initiating event, but degrades the mitigating capabilities of a system or train. After failure is discovered, the plant enters the Allowed Outage Time defined in the Technical Specification
	Demand	A PBF occurs when system/train operation is required by an independent demand
Combination	Operating	A PBF causes an initiating event with an additional loss of mitigating ability (in addition to the expected mitigating degradation due to the initiator)
Containment	Any	A PBF, in addition to the above impacts, also affects containment performance

The evaluation and ranking of the above consequence impact groups and configurations are discussed in the following sections.

Initiating Event Impact Group

The potential for pressure boundary failure to result in an initiating event or forced plant shutdown is evaluated. This is accomplished using a plant-specific list of initiating events from the plant PSA/IPE and design basis documentation, and could also include events that might not be explicitly modeled by either process.

An initiating event could occur as a result of a loss of fluid (e.g., LOCA, potential LOCA due to isolation valve failure, isolable LOCA, steam or feedwater line break, etc.), a loss of a system. (e.g., loss of charging, loss of service water cooling, etc.) or due to an indirect effect (e.g., spraying of an electrical bus, flooding of a room, etc.)

The importance of every initiating event, caused by the pipe failure, needs to be assessed in order to assign it to its appropriate consequence category. In order to rank the impact of one initiating event versus another, the plant's mitigating abilities need to be addressed. The plant's mitigating abilities are usually much more favorable for events which are anticipated during the plant lifetime than for the events not expected to occur during the plant's life. Also, different plants are sensitive to different types of events to differing degrees, depending on their mitigating abilities.

Loss of Mitigating Ability Impact Group

The potential for pressure boundary failure to degrade plant mitigating ability needs to be evaluated. This evaluation identifies those pipe failures that can result in a loss or degradation of a system and/or train, or possibly, multiple systems and/or trains.

A system and/or train can be lost either due to diversion of flow or due to secondary effects caused by the PBF. Both direct and indirect effects of pipe failure need to be evaluated to determine the affected systems. There are times when failure of the pipe does not result in a loss of system and/or train, but in a partial degradation of the system and/or train. Those cases also need to be analyzed.

During this analysis, the system safety function, the means of detecting a failure, test and maintenance practices, and technical specifications (i.e. limiting conditions for operation; LCO) associated with the system are identified. Possible automatic or operator actions to prevent or recover a loss of a system should also be identified and evaluated.

Combinations Impact Group

Guidelines for determining consequence categories for the combination consequence group are given in Table 3-11 of TR-112657, Rev B-A (reprinted as Table 3-2). This table applies to the evaluation of pipe failures, which cause both an initiating event and affect the mitigative ability of the plant, in addition to the expected and modeled effects of the initiator. For example, when a loss of an injection leg occurs with a LOCA, that is an expected LOCA effect on the mitigating ability, and typically is analyzed as a simple initiating event. If, in addition to the loss of an injection leg, the HPSI (or other injection system) operation is effected, that combination should be evaluated using Table 3-11 of TR-112657.

Table 3-2
Guidelines for Assigning Consequence Categories to Combinations of Consequence Impacts

Combination Event	Consequence Category
Initiating Event and less than 2 unaffected backup trains available for mitigation	**HIGH**
Initiating Event and at least 2, but less than 3, unaffected backup trains available for mitigation	MEDIUM (or IE category from Table 3-3, if higher)
Initiating Event and at least 3 unaffected backup trains available for mitigation	LOW (or IE category from Table 3-3, if higher)
Initiating Event and no additional mitigating ability affected	IE consequence category from Table 3-3
Containment Performance: If there is no containment barrier, the consequence category is affected as follows: ▪ 2 Unaffected backup trains and no containment barrier: medium becomes high. If the number of unaffected trains is between 2 and 3, medium is retained ▪ 3 Unaffected backup trains and no containment barrier: low becomes medium. If the number of unaffected trains is greater than 3, low is retained	

Containment Performance Impact Group

In addition to consequences affecting core damage potential, pressure boundary failures need to be evaluated for their impact on the containment performance such as their effects on large early release frequency (LERF). In the EPRI RI-ISI methodology, LERF is addressed in three ways:

- Pressure boundary failure impact on containment isolation.
- Pressure boundary failure impact on LOCA outside containment.
- Pressure boundary failure impact on early core melt and containment failure.

These LERF considerations are discussed below:

Impact on Containment Isolation: If the impact of pressure boundary failure leads to a loss of containment isolation, or containment bypass, the consequence categories in Table 3-5 and 3-11 of TR-112657, Rev B-A, based on the CCDP numerical criteria, would change in the cases which are defined in the tables. Changes are based on the CLERP numerical criteria. As long as there is an isolation valve available, or a closed system that provides containment isolation, the consequence category, based on the CCDP criteria, should not change.

LOCA Outside Containment: Certain pressure boundary failures can significantly increase the potential for a LOCA outside containment. Table 3-3, which is a reprint of Table 3-12 of TR-112657, Rev B-A, explicitly deals with those scenarios. Input to Table 3-3 is plant specific, and depends on the location of the break, available means of isolation, and information available about passive barriers (check valve leak detection, etc.). The rank in Table 3-3 is based on estimates of isolation boundary unavailability. Plant specific evaluations should confirm that

these unavailabilities are appropriate. If the plant specific evaluations do not confirm the rankings given in Table 3-3, then the licensee should adjust those rankings appropriately or develop an alternative argument to provide justification for using the original ranks from Table 3-3.

In Table 3-3, it is assumed that, given LOCA outside containment, there is still protection against a large early release, on the order of 0.1 or less. The assumption is a conservative one, because, given a LOCA outside containment, there are still recovery actions, ways to prevent a core melt, and mitigation means against an early or large release. This event illustrates why two active failures are ranked in the medium consequence rank.

Table 3-3
Example of Guidelines for Assigning Consequence Categories to Pipe Failures Resulting in Increased Potential for an Unisolated LOCA Outside of Containment

Protection Against LOCA Outside Containment	Consequence Category
One Active[1]	HIGH
One Passive[2]	HIGH
Two Active	MEDIUM
One Active, One Passive	MEDIUM
Two Passive	LOW
More than Two	NONE

Note 1: An Active Protection is presented by a valve that needs to close on demand.
Note 2: A Passive Protection is presented by a valve that needs to remain closed.

Impact on Early Core Melt and Containment Structural Failure: This event requires a more complex analysis, is often difficult to assess, and may not be modeled in many PSAs. Insights from the pilot applications have shown the following:

In the case of PWRs, the conditional probability of early containment failure is generally on the order of 0.1 or lower. The pressure boundary failures that can affect this conditional probability are usually those that affect containment cooling (for example, loss of containment spray or service water). Those pressure boundary failures, where CCDP is in the medium range, and higher than 1E-5, need to be specifically evaluated in order to estimate CLERP and assure that the CCDP based rank is still appropriate.

In the case of BWRs, the conditional probability of early containment failure is generally on the order of 0.1 or higher. In those cases, pressure boundary failures that affect specific safety functions that can present a significant containment challenge (loss of reactivity control, vapor suppression failure, loss of injection), and are bordering a critical CCDP range, need to be specifically evaluated in order to estimate CLERP and assure that the CCDP based rank is still appropriate.

3.3.2 Adaptation to BER Programs

In contrast to traditional RI-ISI applications which are intended to be best estimate evaluations, application to BER programs provides for bounding estimates and assumptions. This conservative application reduces the need to conduct resource intensive analyses, computations and their accompanying uncertainty.

By definition, BER piping is normally pressurized ("operating" configuration in Table 3-1), therefore the "Initiating" and "Combination" impact groups in Table 3-1 should be evaluated.

The consequence of failure of each circumferential weld in the BER scope is evaluated (i.e. pipe whip, jet impingement and other impacts). This is more conservative than the SRP requirement which requires that only terminal ends and some higher stressed locations be evaluated. In addition, as BER piping is almost exclusively low stress piping, only terminal ends breaks will need to be postulated due to SRP requirements. Whereas, with the RI-ISI evaluation, each weld within the run of piping will be assessed.

As discussed above, BER programs vary throughout the industry. The following issues related to the consequence evaluation process are highlighted in order to assure consistent application.

- Containment performance is an important aspect of having to utilize the BER assumption in design basis (e.g. single failure relative to containment isolation). Postulated breaks outside containment should not take credit for the outside containment isolation valve unless there is plant design and/or engineering analysis that supports equipment operability during the event. Likewise breaks inside containment should not credit equipment inside the containment unless plant design and/or engineering analysis provides justification. The following provides additional guidance:
  - The containment penetration is assumed to fail (containment bypass) if the penetration is not designed and analyzed for a double-ended guillotine pipe break (DEGB). Note that design features may be utilized to preclude DEGB loads on the penetration (e.g. encapsulated pipe designed to preclude a DEGB load on a penetration).
  - A break in a smaller line connected to a larger line that penetrates containment will not cause failure of the larger line or its penetration.
  - A break in a large line can whip and fail a smaller line and its penetration.
  - A break in a small line can not whip and fail a larger line and its penetration.
- Other Spatial Impacts (indirect effects) – Equipment in the area of the break are assumed to fail as a result of the break unless design/analysis justifies otherwise (e.g. see containment isolation above). The following provides additional guidance:
  - Physical separation can usually be credited with regard to the containment structure and isolation. For example, equipment inside containment can be credited with isolating a break outside containment. For high energy line breaks, only automatic isolation can usually be credited.

- Physical separation must be considered relative to jet impingement and pipe whip impacts that have not been previously analyzed. As an example, a postulated BER break should be assumed to fail a common wall with other rooms unless there is analysis justifying otherwise.
- Equipment Qualification (EQ) – Equipment in affected areas may have been qualified as part of an EQ program. If this equipment is to be credited in the RI-ISI evaluation, the harsh environment identified as part of the EQ profile (temperature, pressure humidity, jet impingement and pipe whip) will need to envelope (or equal) the environment created by the assumed RI-ISI break. Caution should be applied, in that, the RI-ISI break will always assume that equipment available to isolate the break has an inherent unreliability. That is, the RI-ISI evaluation looks at both successful and unsuccessful isolation (and the resultant environments).

3.4 Degradation Mechanism Evaluation

The previous section discusses the impact of postulated piping failures irrespective of the likelihood of failure. That is, the probability of failure is assumed to be 1.0 in the consequence evaluation. As discussed in Section 1 and Reference 14, the concept of a DEGB was originated by the US Atomic Energy Commission for the multiple purpose of sizing containments and establishing "accident" doses and later for sizing emergency core cooling systems. As time progressed, there was a philosophical shift from the hypothetical to a belief in randomly occurring major pipe breaks.

This section addresses the causes and potential (i.e. likelihood) of piping failures.

3.4.1 Existing RI-ISI Process

TR-112657, Rev B-A identifies those degradation mechanisms that need to be evaluated in support of a RI-ISI application. Analysis of operating characteristics, piping failure modes and service experience has shown that generally only piping systems susceptible to flow accelerated corrosion (FAC) have a measurable potential to produce larger leaks and breaks that are amenable to prevention via periodic non-destructive examination. These piping failures are the types of breaks that are of most interest to the application RI-ISI to the BER program. Because each plant has a program specifically developed to address FAC, RI-ISI developed inspection programs and leakage testing provide additional levels of defense in depth.

Leakage detection capabilities can be plant specific but typically include the following for the scope of piping involved in BER programs:

BWRs:

Inside Drywell

Reactor coolant leakage detection include:

- Primary containment atmosphere particulate and gaseous monitoring
- Primary containment sump flow monitoring

A leakage increase greater than 2 gpm over a 24-hour period in Mode 1 requires plant shutdown. A 5 gpm unidentified leakage requires plant shutdown. A 25 gpm identified leakage averaged over a 24-hour period requires plant shutdown.

Drywell temperature and pressure increases would be visible in the control room and are entry conditions into emergency operating procedures.

If the leakage is large enough or goes undetected, high drywell pressure and/or low RPV level are Scram input signals.

Inside Steam Tunnel

High steam tunnel temperature is monitored and will cause MSIV isolation if area temperature can not be controlled.

If the leakage is large enough, high steam flow and other MSIV isolation signals may occur including low RPV level, which are Scram input signals.

Inside Reactor Building

High area temperature increases would be visible in the control room and are entry conditions into emergency operating procedures. If the leakage is water, floor drain sump levels are also entry conditions into emergency operating procedures.

High area temperature is also an input to RCIC steam line isolation and RWCU isolation. For RCIC, if the leakage is large enough, high steam flow and other RCIC steam line isolation signals may occur including low RPV level, which is a Scram input signal. Also, for RWCU, isolation and Scram occurs on low RPV level.

PWRs:

Inside Containment

- containment temperature,
- containment pressure,
- containment sump.

Outside Containment

- MS/FW penetration room high temperature,
- steam generator pressure decrease,
- steam generator level,
- steam flow high,
- steam flow low.

The above signals feed into abnormal or emergency operating procedures and as applicable actuation logics which can lead to immediate plant scam, isolation valve closure and mitigative equipment response to the subject piping leaks and breaks.

Table 3-4 provides a reprint of the degradation mechanism criteria used in the traditional RI-ISI process. Locations (welds, fittings, etc.) identified as potentially susceptible to degradation are ranked in accordance with Table 3-5 (i.e. High, Medium or Low).

The power generation industry has experienced several significant piping failures (i.e. large breaks) that were caused by mechanisms other than FAC. These include a 32 inch seam welded steam line at Southern California's Mohave Station and a rupture of a seam welded hot reheat line at Detroit Edison's Monroe Station. These piping failures were due to creep, fatigue and/or a combination of creep/fatigue (References 10 and 11).

These types of failure, however, are not applicable to nuclear plant applications because of the significantly different operating characteristics in fossil power plant steam systems as compared to nuclear power plants. Operating conditions for these systems in nuclear power plants are in the range of 500-600 °F. While operating temperature ranges of greater than 900 °F, which are experienced in fossil plant applications, are necessary to cause creep to become operative.

3.4.2 Adaptation to BER Programs

To supplement the existing degradation mechanism evaluation process and to address more recent service experience a review of nuclear plant operating experience between January, 1995 and January, 2000 was conducted.

The results of this review are summarized in Table 3-6. As can be seen from this table, the existing RI-ISI process captures all of the mechanisms of interest that are amenable to prevention via periodic inservice inspection. Therefore, no change to the degradation mechanism evaluation process is necessary to support a BER application.

In February, 1999, the USNRC issued NUREG/CR-5750 (Reference 14) which presents an analysis of initiating event frequencies at US nuclear power plants based primarily on operating experience from 1987 through 1995. In this report nine events were identified under the

categories of "steam line break outside containment (K1)", "feedwater line break (K2)", or "steam line break inside containment (K3)". Table 3-7 summarizes these events.

As can be seen from Table 3-7, none of these events occurred in piping within the scope of BER programs. Of the nine events, only six are amenable to inservice inspection and each of these are best addressed by a flow accelerated corrosion inspection as opposed to a typical UT examination as done for BER purposes.

Independent from the above, the USNRC issued the GALL Report (Reference 22) in 1996. This purpose of this report was to conduct a systematic review of generic aging lessons learned (GALL) in order to assess materials and component aging issues related to continued operation and license renewal of operating reactors. This review encompassed more than 550 documents including but not limited to Nuclear Plant Aging Research reports, Generic Letters, Licensee Event Reports, Information Notices and Bulletins and industry reports.

This report provided a listing of aging related mechanisms including the various forms of corrosion and fatigue. In particular, in feedwater systems, the GALL report identified that thermally induced stresses and distortions may be need to be addressed. As previously discussed, the existing EPRI RI-ISI methodology explicitly accounts for these phenomena including plant specific configurations and operating practices. As such, no change to the degradation mechanism evaluation process is necessary to support application to BER programs.

As a final step, a review of inservice inspection history is a part of the traditional RI-ISI process. Therefore, for application to BER programs, BER specific examination results will also be reviewed and assessed for applicability to the RI-ISI process.

Table 3-4
Degradation Mechanism Criteria and Susceptible Regions

Degradation Mechanism		Criteria	Susceptible Regions
TF	TASCS	–NPS > 1 inch, and –pipe segment has a slope < 45° from horizontal (includes elbow or tee into a vertical pipe), and –potential exists for low flow in a pipe section connected to a component allowing mixing of hot and cold fluids, or –potential exists for leakage flow past a valve (i.e., in-leakage, out-leakage, cross-leakage) allowing mixing of hot and cold fluids, or –potential exists for convection heating in dead-ended pipe sections connected to a source of hot fluid, or –potential exists for two phase (steam/water) flow, or	Nozzles, branch pipe connections, safe ends, welds, heat affected zones (HAZs), base metal, and regions of stress concentration

Degradation Mechanism		Criteria	Susceptible Regions
		–potential exists for turbulent penetration into a relatively colder branch pipe connected to header piping containing hot fluid with turbulent flow, and –calculated or measured ΔT > 50°F, and –Richardson number > 4.0	
	TT	–operating temperature > 270°F for stainless steel, or –operating temperature > 220°F for carbon steel, and –potential for relatively rapid temperature changes including –cold fluid injection into hot pipe segment, or –hot fluid injection into cold pipe segment, and – |ΔT| > 200°F for stainless steel, or – |ΔT| > 150°F for carbon steel, or – |ΔT| > ΔT allowable (applicable to both stainless and carbon)	
SCC	IGSCC (BWR)	–evaluated in accordance with existing plant IGSCC program per NRC Generic Letter 88-01	Welds and HAZs
	IGSCC (PWR)	–austenitic stainless steel (carbon content ≥ 0.035%), and –operating temperature > 200°F, and –tensile stress (including residual stress) is present, and –oxygen or oxidizing species are present <u>OR</u> –operating temperature < 200°F, the attributes above apply, and –initiating contaminants (e.g., thiosulfate, fluoride or chloride) are also required to be present	

Degradation Mechanism		Criteria	Susceptible Regions
	TGSCC	–austenitic stainless steel, and –operating temperature > 150°F, and –tensile stress (including residual stress) is present, and –halides (e.g., fluoride or chloride) are present, and –oxygen or oxidizing species are present	Base metal, welds, and HAZs
	ECSCC	–austenitic stainless steel, and –operating temperature > 150°F, and –tensile stress is present, and –an outside piping surface is within five diameters of a probable leak path (e.g., valve stems) and is covered with non-metallic insulation that is not in compliance with Reg. Guide 1.36, OR -austenitic stainless steel, and -tensile stress is present, and –an outside piping surface is exposed to wetting from concentrated chloride-bearing environments (i.e., sea water, brackish water, or brine)	Base metal, welds, and HAZs
SCC (cont.)	PWSCC	–piping material is Inconel (Alloy 600), and –exposed to primary water at T > 570°F, and –the material is mill-annealed and cold worked, or –cold worked and welded without stress relief	Nozzles, welds, and HAZs without stress relief
LC	MIC	–operating temperature < 150°F, and –low or intermittent flow, and –pH < 10, and –presence/intrusion of organic material (e.g., Raw Water System), or –water source is not treated with biocides, or	Fittings, welds, HAZs, base metal, dissimilar metal joints (for example, welds and flanges), and regions containing crevices

Degradation Mechanism		Criteria	Susceptible Regions
	PIT	–potential exists for low flow, and –oxygen or oxidizing species are present, and –initiating contaminants (e.g., fluoride or chloride) are present	
	CC	–crevice condition exists (i.e., thermal sleeves), and –operating temperature > 150°F, and –oxygen or oxidizing species are present	
FS	E-C	–cavitation source, and –operating temperature < 250°F, and –flow present > 100 hrs./yr., and –velocity > 30 ft./sec., and –$(P_d - P_v) / \Delta P < 5$	Fittings, welds, HAZs, and base metal
	FAC	–evaluated In accordance with existing plant FAC program	per plant FAC program

Table 3-5
Ranking of Pipe Rupture Potential

Pipe Rupture Potential	Expected Leak Conditions	Degradation Mechanisms To Which The Segment is Susceptible
HIGH	Large	Flow Accelerated Corrosion (FAC)
MEDIUM*	Small	Thermal Fatigue Stress Corrosion Cracking (IGSCC, TGSCC, PWSCC, ECSCC) Localized Corrosion (MIC, Crevice Corrosion and Pitting) Erosion-Cavitation
LOW	None	No Degradation Mechanisms Present

* - Piping segments identified as prone to waterhammer (without corrective action) and susceptible to one of these mechanisms shall be assigned to the 'High' failure potential category.

Table 3-6
Recent Operating Experience Review

Number	Mechanism	System	Applicability to BER Application
1	Flow Accelerated Corrosion (FAC)	Moisture/Separator Reheater	Although the FAC mechanism is specifically addressed by RI-ISI program, this system is not typically within the scope of BER programs.
2	Flow Accelerated Corrosion (FAC)	Feedwater Heater	Although the FAC mechanism is specifically addressed by RI-ISI program, this system is not typically within the scope of BER programs.
3	Flow Accelerated Corrosion (FAC)/Impingement	Extraction Steam	Although the FAC mechanism is specifically addressed by RI-ISI program, this system is not typically within the scope of BER programs.
4	Fan Vibration	Instrument Air	Thrown blade caused high vibration on attached components. Vibration failures are amenable to prevention via periodic NDE inspection.
5	Impingement/Vibration	Feedwater Heater (tubes)	Non piping components
6	Leaking Relief Valve	CVCS	Not amenable to presentation via periodic NDE inspection.
7	Personnel Error (Maintenance)	EDG Fuel Oil	Maintenance personnel opened the pressure boundary; event not amenable to prevention via periodic NDE inspection.

Table 3-6
Recent Operating Experience Review

Number	Mechanism	System	Applicability to BER Application
8	Personnel Error (Maintenance)	Service Water	Valve Stem fell and severed 2 inch NPS service water line; event not amenable to prevention via periodic NDE inspection.
9	Personnel Error (Operations)	RHR	Resultant valve slam and pressure surge popped a relief valve; event not amenable to prevention via periodic NDE inspection.
10	Support Arrangement	RCP Seal leakoff	Failure occurred approximately 12 months after modification to the piping support arrangement.
11	Thermal Fatigue	RCS	Thermal fatigue explicitly evaluated by the RI-ISI process.
12	Unknown	Chiller Refrigerant	Application (small fittings/environment) not applicable to BER piping.
13	Vibration	Feedwater Heater (tubes)	Non piping component/event not amenable to prevention via periodic NDE inspection.

Table 3-7
NUREG/CR-5750 K1, K2 and K3 Events

Event Type [1]	Plant	LER #	Description	Amenable to ISI?	Addressed By Current RI-ISI Methodology	BER Scope Piping
K1	Palisades	87-016-0	Auxiliary operators opened the incorrect valves inadvertently over-pressurizing a system and causing the breach of a rupture disk.	No	N/A	No
K1	Perry	87-027-1	Failure of a three inch main steam drain line to main steam drain manifold due to high cycle vibration caused by steam flashing/water impingement.	Potential	YES – FAC	No
K1	ANO-2	89-006-0	A fourteen high pressure turbine extraction steam line ruptured due to flow accelerated corrosion.	Yes	Yes - FAC	No
K1	Byron-2	90-010-1	A one inch sample probe failed due to insufficient clearance for thermal expansion.	No	N/A	No
K1	DAEC	91-001-0	A two inch extraction steam drain line failed due to relative movement between itself and a larger twelve inch extraction stem line.	No	N/A	No
K1	Sequoyah-2	93-001-0	A three by six inch hole occurred in an extraction steam line caused by flow assisted corrosion.	Yes	Yes-FAC	No
K1	MP2	95-032-0	A combination of flow accelerated corrosion and water hammer failed an eight-inch heater drain line.	Yes	Yes-FAC	No

Event Type [1]	Plant	LER #	Description	Amenable to ISI?	Addressed By Current RI-ISI Methodology	BER Scope Piping
K2	MP3	90-030-02	Failure of two six-inch moisture separator drain lines due to flow accelerated corrosion.	Yes	Yes-FAC	No
K2	MP3	91-012-1	Failure of an eight inch reheater drain line due to flow accelerated corrosion.	Yes	Yes-FAC	No
K3	N/A	N/A	No Events Identified	N/A	N/A	N/A

(1) K1 – Steam line break outside containment

K2 – Feedwater line break

K3 – Steam line break inside containment

3.5 Risk Ranking

3.5.1 Existing RI-ISI Process

For the purposes of performing a RI-ISI evaluation, pipe segments are defined as a continuous run of pipe in which the following are true:

1. The consequence (direct and indirect impacts) of a postulated pipe break are the same at any location in the pipe segment, and
2. The potential degradation mechanisms present are the same at any location in the pipe segment, and
3. The pipe segment is located in the same area of the plant - spatial impacts are the same, and
4. The pipe segment consists of a continuous run of piping.

Segments are defined after both the consequence and degradation mechanism evaluations are completed. In the consequence evaluation, as in the degradation mechanism evaluation, consequence and degradation mechanism segments are defined, which are combined into final segments during the risk evaluation.

The risk of pipe segment failure is evaluated on the basis of the expected likelihood of the event and the expected importance of the consequence. The importance of the consequences is presented by the consequence categories. The likelihood of failure in this analysis is estimated based on the segment susceptibility to different degradation mechanisms and is represented by the degradation mechanism categories.

The graphical method presented in Figure 3-2 illustrates the effects of these two parameters and serves as a base for the selection of risk-important segments. This structure is known as the risk matrix.

The seven risk categories shown in Figure 3-2 are then further combined into three risk regions for more robust and more efficient utilization. Three risk regions also account for uncertainties in the risk categorization, and ensure that:

1. high consequence segments are considered for all likelihoods of failure, and
2. segments with the potential for large leaks (high likelihood of failure) are considered for all consequence categories (except "none").

Because of the risk ranges defined in the Risk Matrix, this methodology is less sensitive to implicit and explicit analysis assumptions, relative risk importance measure variations, etc.

The EPRI Methodology uses CDF and LERF (due to pipe failures) as fundamental risk metrics.

CDF (due to pipe failures) = [pipe failure frequency] * [CCDP]

LERF (due to pipe failures) = [pipe failure frequency] * [CLERP]

LERF is also used implicitly, by monitoring containment isolability and performance. If the consequence evaluation indicates an unfavorable impact on containment isolation or bypass performance, the risk category determined on the basis of CCDP alone is increased from low to medium, or from medium to high depending on the CCDP value. This ensures that the risk associated with LERF is controlled.

3.5.2 Adaptation to BER Programs

Although no change to the risk ranking process is required; the results of the application to BER programs may be different with respect to traditional RI-ISI results. Thus, a plant, which applies the RI-ISI process to BER programs after completion of a traditional RI-ISI application, may have to revisit the risk ranking of all welds in the RI-ISI application (e.g. Section XI scope plus BER scope). As a final step, the risk ranking should also be summarized for the "BER Only" scope to support element selection as described in the next section. Appendix A provides an example of risk ranking summary results for an example plant application.

3.6 Element Selection

3.6.1 Existing RI-ISI Process

It is anticipated that most licensee implementing a BER application will do so in concert with an ASME Code Case N578 (Reference 16) RI-ISI application to the Class 1 and/or Class 2 pressure boundary.

- The number of elements to be examined as part of the RI-ISI program depends on the risk category for the risk-significant segments. The following guidelines are to be used to determine the number of elements to be examined in each risk category for implementation of ASME Code Case N-578.
- All elements, regardless of risk category, are to be subjected to pressure/leak testing requirements.
- Volumetric examinations for RI-ISI purposes, are not required for those elements determined to be in risk category 6 or 7 (low risk category elements).
- For those elements that are in risk category 1, 3, 5, or 7 and are included in the existing plant FAC (Generic Letter 89-08 [23]) inspection program, the number, location, and the frequency of inspection are to be the same as the existing plant FAC inspection program. The existing FAC program is to remain unchanged, it is not subsumed in the EPRI RI-ISI program.

- For those elements that are in risk category 1, 2, 3, 5, 6, or 7 and are included in the existing plant IGSCC inspection program (category B through G - Generic Letter 88-01[24]), the number, location, and the frequency of inspection are to be the same as the existing plant IGSCC inspection program. Only IGSCC category A welds are subsumed into the EPRI RI-ISI program.

For elements determined to have degradation mechanisms other than those included in the existing plant FAC and IGSCC inspection programs, the following number of elements are to be volumetrically examined (beyond pressure/leak testing requirements) as part of the RI-ISI program.

- For risk category 1, 2, or 3, the minimum number of inspection elements in each category should be 25 percent of the total number of elements in each risk category (rounded up to the next higher whole number).
- For risk category 4 or 5, the number of inspection elements in each category should be 10 percent of the total number of elements in each risk category (rounded up to the higher whole number).

The selection of individual inspection elements depends on the degradation mechanism present, physical access constraints, radiation exposure, and cost considerations. An inspection-for-cause process shall be implemented at each inspection location. Therefore, examination methods, inspection volumes, and acceptance and evaluation criteria are to be designed specifically for the degradation mechanism(s) active at the inspection location.

3.6.2 Adaptation to BER Programs

While no changes to the element selection process are expected, consideration shall be given to the size of the final sample population size. If a plant is applying RI-ISI to BER programs after completion of the traditional RI-ISI, the risk category population sizes may change for BER systems since some welds may move to higher risk categories (e.g. risk category 6 to 4). Appendix A provides an example of the risk ranking and element selection results change for one application. In addition, the element selection process must consider the BER scope to ensure that this scope is appropriately covered during the element selection process. Again, Appendix A provides an example for an example plant.

Similar to traditional RI-ISI applications to Class 1 piping, it is expected that BER piping will tend to be grouped into three subsets. The first is brought about by the exceptional performance history of BER piping (see section 3.4) coupled with its typical high consequence of failure which results in the large number of elements being assigned to risk category 4 (10 percent inspection size). There is a second subset were a 25 percent sample is chosen due to a number of elements identified as potentially susceptible to some degradation mechanism (e.g. risk category 2, due to thermal fatigue). The third subset consists of those elements assigned to risk categories 6 or 7, which do not require volumetric NDE. As such, it is anticipated that unless plant specific design features control, inspection populations for BER programs to be approximately 10 percent of the current population.

If a situation occurs where a very large number of elements are assigned to low risk categories (i.e. Risk Categories 6 or 7) to the point that BER inspections fall substantially below 10 percent of the BER piping population, the basis for the low risk ranking should be investigated. Although BER piping is typically highly reliable (i.e. low failure potential), inspection percentages significantly below 10% should not be expected unless plant design features have been incorporated to specifically address assumed breaks in the BER region.

In summary, the element selection process should satisfy the following criteria:

- The percentage requirements for high risk (25%) and medium risk (10%) must be satisfied for the complete RI-ISI Program scope population including BER.
- The percentage requirements for high risk (25%) and medium risk (10%) must be satisfied for the "BER Only" scope population.
- The number of BER inspections should not be significantly less than 10% of the BER scope unless plant design features justify otherwise.

3.7 Risk Impact Assessment

3.7.1 Existing RI-ISI Process

TR-112657, Rev B-A provides guidance and acceptance criteria for assuring the new inspection programs meet the guidance set forth in Regulatory Guide 1.174. The guidance and criteria contained in TR-112657, Rev B-A provides an acceptable process for application of RI-ISI to BER programs.

3.7.2 Adaptation to BER Programs

The risk impact assessment shall be conducted in a two step fashion. The first is to include the BER scope of piping with the traditional RI-ISI application (e.g. Class 1 and 2 piping). The second step is to assess the changes to the BER program alone. Both cases need to meet the acceptance criteria define in TR-112657.

3.8 Plant Specific Submittals

3.8.1 Existing RI-ISI Process

Plants wishing to implement a traditional RI-ISI program utilize the 'template submittal' process (References 12 and 13). This process commits the licensee to conducting the RI-ISI evaluations in accordance with the approved topical report (Reference 9). Additional requirements include identifying any deviations to the approved topical, identifying any additional changes to licensee commitments, Technical Specifications, FSAR, etc. and a statement on PRA quality.

3.8.2 Adaptation to BER Programs

BER programs are typically defined in the Updated Final Safety Analysis Report (UFSAR). As such, changes to the UFSAR need to be conducted consistent with individual licensee's UFSAR change control process. Typically, this will include a 50.59 evaluation (References 19 and 20).

It is envisioned that upon USNRC generic approval of this report, licensees will conduct evaluations consist with this document and use that evaluation (together with this report) as the technical basis for supporting a 50.59 evaluation.

As such, no formal submittal of the RI-ISI evaluations (for BER programs) or a template to the USNRC is expected. However, the USNRC would be notified of the adoption of a RI-ISI BER program through the licensees' periodic 50.59 summary report.

Changes to licensing basis documents other than the UFSAR (e.g., Technical Specifications) may require USNRC review and approval. Therefore, licensees need to review all relevant documentation and notify the USNRC, as appropriate.

4
SUMMARY AND CONCLUSIONS

This report provides the process that is to be used to support application of risk-informed inservice inspection (RI-ISI) to break exclusion region (BER) programs. It has been developed to support USNRC generic review and approval and subsequent use by individual licensees.

In this report, each step in the RI-ISI process has been reviewed and clarifying documentation has been provided.

Two example plant applications have been conducted to assure that the defined process is robust and can be consistently applied to both BWRs and PWRs.

Appendix A provides the application to Nine Mile Point, Unit 2.

Appendix B provides the application to Calvert Cliff, Units 1 & 2.

Appendix C provides a comparison to Regulatory Guide 1.174.

5
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17. Not Used

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23. Generic Letter 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," dated May 2, 1989.

24. Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," dated January 25, 1988.

6 APPENDICES

APPENDIX A - Nine Mile Point, Unit 2

APPENDIX B - Calvert Cliff, Units 1 and 2

APPENDIX C - Regulatory Guide 1.174 Comparison

ACRONYMS and ABBREVIATIONS

GLOSSARY

APPENDIX A

Nine Mile Point, Unit 2 (NMP2)

Application

A.1 Introduction

This appendix presents the application of risk-informed inservice inspection (RI-ISI) process to break exclusion regions (BER) augmented inspection programs. The purpose of this appendix is to assess the BER augmented inspection program at a boiling water reactor (BWR) plant. Appendix B to this report provides an example application to a pressurized water reactor (PWR) plant.

A.2 NMP2 BER Program

Consistent with the Standard Review Plan (SRP, References A.1 and A.2), pipe breaks are not postulated in certain high-energy lines that are normally pressurized during power operation. This is referred to as break exclusion region piping (BER). The NMP2 USAR describes an inspection of 100% of the circumferential welds in this piping every 10-year inspection interval.

A.3 BWR Plant Application

A.3.1 NMP2

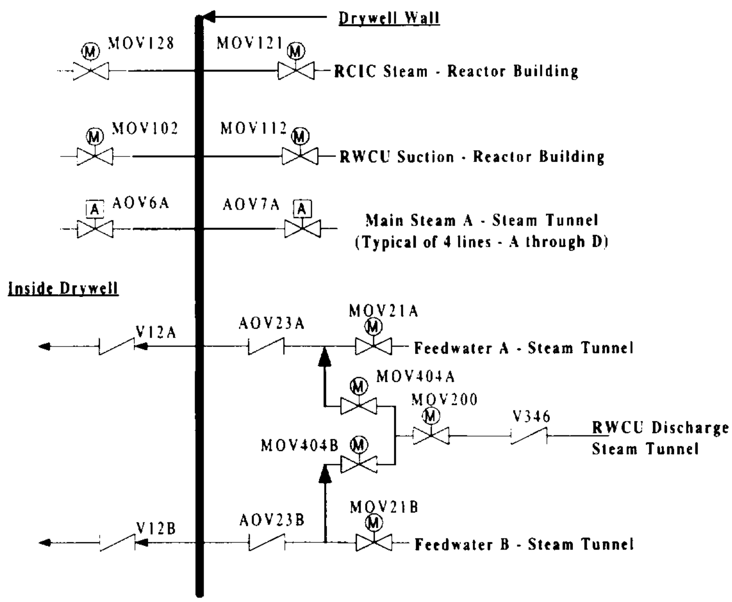
NMP2 is a nuclear steam supply system (NSSS) single cycle, forced circulating BWR-5 design, rated at 1144 megawatts electric, with a Mark II containment. The NSSS supplier was General Electric and Stone & Webster Engineering Corporation designed the balance of plant, with commercial operation starting April 5, 1988.

A.3.2 Scope of Application

The BER scope at NMP2 includes welds between the inside containment isolation valve and the outside containment isolation valve (the boundary actually extends beyond each of these valves to include welds out to the first pipe rupture restraint) as summarized below:

- Four main steam (MSS) lines
- One RCIC (ICS) steam line
- One reactor water cleanup (WCS) suction line
- Two feedwater (FWS) lines and connected reactor water cleanup (WCS) discharge out to V346

The following simplified diagram identifies the piping under evaluation.



A.3.3 Consequence Evaluation

The baseline RI-ISI consequence evaluation is judged to represent the best estimate consequence assessment associated with the BER scope of piping. Table A-1 summarizes the baseline RI-ISI consequence evaluation results for the BER scope. The baseline RI-ISI consequence analysis was conducted per Reference A6. This analysis included consideration of initiating event impacts (e.g. Tables 3-2 and 3-3 of the main body of this report), plant specific PRA success criteria (See Figures A-1 through A-5), and containment performance (e.g. containment bypass per Table 3-3). Table A-3 summarizes the baseline RI-ISI consequence evaluation results for all of the BER welds. The evaluation contained in this Appendix determines and documents changes to these baseline consequence results based on the BER evaluation criteria in the main report and using the same acceptance criteria described in the main report. For example, if a containment bypass scenario increases to greater than 1E-5 CCDP, the consequence would be revised from "Medium" to "High" (CCDP = CLERP for containment bypass and if >1E-5, ranking criteria requires a High consequence rank). The evaluation results are summarized in Tables A-2 and A-3.

To conservatively incorporate the BER Program into the RI-ISI Program, the RI-ISI baseline evaluation will be supplemented per the criteria discussed in the main body of this report. To accomplish this supplemental evaluation in a cost-effective manner, engineering judgments are made based on existing plant calculations and design, and as necessary additional conservative assumptions are made.

To conduct this evaluation, Reference A4 was reviewed to assess the plant design and analysis relative to BER criteria. For Standard Review Plan considerations, pipe breaks were not analyzed for the specific BER locations. However, the following summarizes important observations and assumptions from this review:

- Piping penetrations have not been evaluated for a beyond design basis BER double-ended guillotine break (DEGB). Therefore, the analysis contained herein conservatively assumes there is the potential that the penetrations could fail as described below.
- Containment isolation valves are not qualified for a beyond design basis BER break in the immediate area. Therefore, no credit is taken for isolation as follows:
  - Failure of a BER weld inside the drywell is assumed to prevent the inside drywell isolation valve from working (i.e. it is assumed to fail to close). In effect, welds between the isolation valve and the drywell wall are re-assigned to the consequence category of an unisolable LOCA inside the drywell.
  - Failure of a BER weld outside the drywell is assumed to prevent the outside drywell isolation valve from working (i.e. it is assumed to fail to close). In effect, welds beyond the outside drywell isolation valve are re-assigned to the consequence category of welds between the drywell and the outside isolation valve, which are not isolable via the outside isolation valve.
- For the design basis, over pressurizing the steam tunnel compartment directly outside the drywell was not explicitly analyzed for a break in this location. However, over pressure failure of the steam tunnel/reactor building structures due to BER breaks are judged unlikely. This is based upon a review of other breaks downstream of the BER scope of piping (vent areas, design, and margins) indicating that the structure could withstand breaks in the unanalyzed area without gross structural failure. Even so, for purposes for this analysis, the spatial impact due to failure of walls and structures on equipment in the local area are assessed.
- Structural design considers jet impingement loads. The immediate steam tunnel/reactor building structures directly outside the drywell are similar in design to structures analyzed for jet impingement. Therefore, jet impingement loads caused by assumed BER breaks are not assumed capable of failing these structures.
- The impact of a pipe whipping into the immediate steam tunnel/reactor building structures has not been analyzed. Therefore, it is assumed that structural failure due to pipe impact will occur for large main steam and feedwater piping. Thus, the likelihood and consequences of this event is considered in this application.

Based on the above design review and Reference A6, changes in the consequence assignments for the BER scope of piping determined in the baseline RI-ISI is evaluated. The following summarizes the results of this review (also see Table A-2 summary and Table A-3 for list of all BER welds and identified changes in the consequence assignments):

1. Smaller diameter piping inside the Drywell connected to larger diameter piping is not assumed capable of causing penetration or equipment failure (MSS-C-02). These are small

2-inch NPS connections to the main steam lines. Therefore, the CCDP and CLERP values are not changed. Figure A-1 would apply to the evaluation of this small steam piping.

2. Smaller diameter piping outside the Drywell (in the Steam Tunnel) connected to larger diameter piping is not assumed capable of causing penetration, structural, or equipment failure (WCS-C-07). This is 8 inch NPS piping that connects to main feedwater lines (26 inch NPS). Therefore, the CCDP and CLERP values are not changed. Breaks in the Steam Tunnel are less significant in comparison to breaks in the Reactor Building. Two feedwater check valves in series reduce the probability of isolation failure. Figure A-3 applies to the evaluation of this piping when isolation is successful. Figure A-5 applies to the evaluation of this piping when isolation is unsuccessful, but the CCDP must also include the probability that 2 series check valves fail to close.

3. The CLERP values are set equal to the CCDP values for all other BER welds. That is, the BER piping failure (double-ended guillotine break) is assumed to fail its containment penetration. This is conservative for most if not all welds in the BER scope.

4. No change in the CCDP values is required for welds inside the Drywell beyond the inboard isolation valve that communicate with the Steam Tunnel (FWS-C-01A & 01B and MSS-C-01A through 01D). Leakage from the Drywell to the Steam tunnel would have no additional consequences beyond that assessed in the baseline evaluation. Leakage into the steam tunnel is minor in comparison to a LOCA outside containment. Also, the LOCA inside the drywell CCDP does not credit equipment in the steam tunnel or turbine building. Figure A-2 applies to this evaluation.

5. The CCDP values were increased for welds located inside the Drywell beyond the inboard isolation valve that communicate with the Reactor Building (ICS-C-06 and WCS-C-03). The CCDP value was increased to 0.01 based on engineering judgment. Leakage through a penetration into the reactor building pipe chase is judged to be comparable to a large isolable break in the Reactor Building (pipe chase). This break has been analyzed as part of the design basis. The reactor building is a large open structure allowing significant communication between elevations all the way up to the refueling level. Figure A-4 shows the simplified success criteria and backup trains available for these events. As shown, there are at least 2 backup trains for all functions.

6. The CCDP value was increased for welds located inside the Drywell between the inboard isolation valve and the Drywell (FWS-C-02A & 02B, ICS-C-07, MSS-C-03A through 03D, and WCS-C-04). The CCDP value was set equal to the value beyond the isolation valve in items 4 and 5.

7. No change in the CCDP value was required for welds between the Drywell penetration and the outboard isolation valve in the Reactor Building (ICS-C-08 and WCS-C-05). Pipe whipping and jet impingement causing core damage for the isolation success case is enveloped by the isolation failure case (piping is close to the Drywell wall within pipe chase). Given successful isolation, any leakage from the Drywell through the penetration is minor (no LOCA) in comparison to the initial break condition, which is considered in design. Figure A-4 applies to the isolation success case (RCIC is unavailable due to break or high

area temperature trip). For the isolation failure case, core damage is assumed with CCDP and CLERP set equal to the probability of a MOV failing to close inside the Drywell.

8. The CCDP value was increased for welds between the Drywell penetration and the outboard isolation valve in the Steam Tunnel (FWS-C-03A & 03B and MSS-C-04A through 04D). The CCDP was increased to 0.01. For the case where the inboard isolation valve fails to close this isolation failure probability alone is less than 0.01 (core damage is assumed for the isolation failure case). Even for this case, the probability of structural failure and core damage is less than 1.0 (Figure A-5 would apply). For the isolation success case, even if a structural wall is assumed to fail, the blow down and leakage of steam into the reactor building is limited (i.e., a significant portion is expected to propagate through the steam tunnel). Also, electrical equipment in the reactor building in the vicinity of these walls is not critical to safe shutdown. The building is large on all elevations with large openings, which allows communication all the way up to the refueling level. Electrical equipment critical to safe shutdown in the PRA is not located at these higher elevations. Figure A-3 would apply to this evaluation. Even if it is assumed that one safe shutdown division fails due to the environment, the other division provides a backup train and supports the 0.01 CCDP.
9. The CCDP value was increased for welds beyond the outboard isolation valve (FWS-C-04A & 04B, FWS-C-05A & 5B, ICS-C-09, MSS-C-06, and WCS-C-06). The CCDP value was set equal to the value between the Drywell and outboard isolation valve in items 7 and 8.

A.3.4 Degradation Mechanism Evaluation

As discussed in section 3.4 of the main report, the existing RI-ISI degradation mechanism evaluation process captures all of the mechanisms of interest from a BER perspective. In addition, plant specific RI-ISI applications review past inspection history to assure actual operating experience is consistent with the results of the degradation mechanism evaluation. This has been completed for the NMP2 application with no changes identified as being required to the degradation mechanism evaluation. The degradation mechanisms identified for this scope of piping are identified in Table A-3.

A.3.5 Risk Ranking

As discussed in section 3.5 of the main report, risk segments are defined based upon the results of the consequence and degradation mechanism evaluations. Table A-2 provides the results of the risk ranking for the BER application. Table A-2 also provides a comparison between the baseline RI-ISI and the application to the augmented BER inspection program.

Figures A-6 through A-8 provide a summary of the risk ranking for three cases:

- Figure A-6 provides a summary of the risk ranking results after completion of the traditional RI-ISI evaluation of the Class 1 and 2 ISI Section XI Program. The number of welds in each risk category for each system is provided. The number in parenthesis indicates how may welds need to be selected per the element selection criteria in Section 3.6 of the main report.

- Figure A-7 provides a summary of the risk ranking results for the same Class 1 and 2 ISI program after completion of the BER evaluation. Figure A-7 replaces Figure A-6 and the element selection process must be adjusted to account for BER evaluation changes. If the RI-ISI evaluation had been initially conducted according to both the traditional and BER evaluation criteria, Figure A-7 would be generated with no need for Figure A-6. The number in parenthesis indicates how may welds need to be selected per the element selection criteria in Section 3.6 of the main report. The following summarizes changes to Figure A-6 in developing Figure A-7:

  - Risk Category 5B FWS: all 17 welds were moved to risk category 2 based on the BER evaluation. Two additional welds must be selected as result of this change. Two of the 17 welds were already selected based on the traditional RI-ISI analysis in Figure A-6. Two more of the total of 48 welds in Figure A-7 must be selected.

  - Risk Category 6B FWS: all 6 welds were moved to risk category 4 based on the BER evaluation. One additional weld must be selected from risk category 4 as result of this change.

  - Risk Category 6B ICS: 2 welds were moved to risk category 4 based on the BER evaluation. No additional welds must be selected from risk category 4 as result of this change.

  - Risk Category 6B MSS: 30 welds were moved to risk category 4 based on the BER evaluation. Three additional welds must be selected from risk category 4 as result of this change.

  - Risk Category 6B WCS: 2 welds were moved to risk category 4 based on the BER evaluation. One additional weld must be selected from risk category 4 as result of this change.

Figure A-8 provides a summary of the risk ranking results when the "BER Only" scope is considered. Again, the number of welds in each risk category for each system is provided. The number in parenthesis indicates how may welds need to be selected per the element selection criteria in Section 3.6 of the main report. If the actual number of welds previously selected to satisfy the selection process above (Figures A-6 and A-7) is different from the one in parenthesis, this value is provided in brackets.

A.3.6 Element Selection

As described in section 3.6 of the main report, the element selection process must satisfy several criteria as summarized below:

- Complete RI-ISI scope (Class 1 and 2 Section XI and BER) - adjustments were made to the traditional element selection process based upon the complete (i.e. larger) RI-ISI program

scope and risk ranking (Figure A-7). Section A.3.5 describes the risk ranking changes (development of Figure A-7) and adjustments made to element selection.

- BER Only scope – Figure A-8 summarizes the number of BER welds that must be selected to satisfy the selection criteria when only BER welds are considered (number in parenthesis). If the selection process for the complete scope in Figure A-8 does not include enough BER welds, the selection process for the complete scope (Figure A-7) was adjusted to include a sample of BER welds that satisfies Figure A-8. Another option would be to select additional welds to satisfy Figure A-8. The requirements have been met and due to the nature of the process in a couple of cases more welds were selected than actually required (when different; actual values are provided in brackets).
- 10% Criteria - Section 3.6 of the main report cautions that the inspection population of the BER scope should not be significantly below 10% unless plant design features have been incorporated to specifically address assumed breaks in the BER region. For the NMP2 application, more than 12 % of the BER welds must be selected (Figure A-8, 17 of 135 must be selected based upon the requirements in parenthesis). Based upon the actual selection (number in brackets used when different from requirement), more than 14 % of the BER welds were selected (Figure A-8, 20 of 135 selected).

A.3.7 Risk Impact Assessment

Two types of risk assessments are presented in this section. In Section A.3.7.1, a traditional risk assessment of the BER topic is performed to estimate the frequency of core damage and large, early release frequency (CDF and LERF). The purpose of this assessment is to provide a perspective on the relative risk significance of the BER topic irrespective of the inspection sample size. In Section A.3.7.2, a change in risk (delta risk) assessment is performed on the proposed BER inspection program in accordance with Regulatory Guide 1.174 (Reference A5) and the EPRI TR-112657 criteria (Reference A6).

A.3.7.1 Plant Specific Risk Assessment of the BER Topic

This risk assessment considers the frequency and consequence of the more likely pipe breaks (i.e., non-DEGB) as described in NUREG/CR-5750 (Reference A9). In addition, the DEGB case is also evaluated. The following assumptions are used in the assessment provided in this section:

- The total frequency (event/year) for small and medium LOCAs recommended in NUREG/CR-5750 (Reference A9) is 5E-4/year and 4E-5/year, respectively. In the analysis provided in this section, the BER scope is a much smaller scope of piping. Therefore, the NUREG/CR-5750 values are reduced by a factor of 10 (i.e., assumes that the BER scope is 10% of total).
- Small and Medium LOCAs are postulated (SLOCA and MLOCA). The CCDP for MLOCA is greater than large LOCA at NMP2; therefore, using the MLOCA CCDP value is conservative. The CLERP for a large LOCA is slightly higher, but the initiating event frequency is also less than medium LOCA and therefore will have a negligible impact.

- Valve failure probabilities and conditional core damage probabilities (CCDP) are based on the NMP2 PRA.
- Postulated BER breaks in the drywell are conservatively assumed to cause the unavailability of the inside containment isolation valve. If core damage occurs due to these breaks, there is a containment isolation valve outside the drywell that is protected from the break.
- BER breaks outside the drywell are conservatively assumed to cause the unavailability of the outside containment isolation valve. If core damage occurs due to these breaks, there is containment isolation valve inside the drywell that is protected from the break.
- The drywell penetration is designed to remain leak tight given a break beyond the BER boundary, however, the penetrations are not designed for a high energy break within the BER region (e.g., pipe whip loads). For the more likely pipe breaks (i.e. not a DEGB), it is assumed that the penetration survives the break.
- Even though this scope of piping is break exclusion (per SRP 3.6.2), a crack (equivalent to single-ended pipe rupture) is postulated in the main steam or feedwater piping in the main steam tunnel (pipe whip, jet impingement, and single failure not considered) (Reference A4, USAR page 3.6A-14a) to show that all safety related functions are met. This is consistent with the RI-ISI analysis.
- Unisolated breaks in the reactor building are assumed to cause core damage (unanalyzed) due to spatial impacts.
- Unisolated breaks in the steam tunnel are assumed to fail all equipment in both the steam tunnel and turbine building due to spatial impacts.
- Only core damage frequency (CDF) is estimated in the evaluation below. Large early release frequency (LERF) is addressed qualitatively relative to CDF. For example, LERF is clearly less than CDF for BER welds inside the drywell and LERF can be assumed equal to CDF for the unisolated BER breaks outside drywell.

For the DEGB assessment, the following additional assumptions are applicable:

- The drywell penetration is designed to remain leak tight given a break beyond the BER boundary, however, the penetrations are not designed for a high energy break within the BER boundary (e.g., pipe whip loads). It is assumed that a double-ended-guillotine break (DEGB) could create sufficiently extreme loads to effect the penetration.
- The frequency of DEGB is <<3E-5/year (the value for large LOCA in NUREG/CR-5750, Reference A9). Comprehensive studies (References A10 and A11) have shown that the frequency of a double-ended guillotine break is extremely low (~1E-10/year). When the evaluation is limited to just the BER scope of piping (e.g., 10%), the frequency becomes even less.
- CCDP values consistent with the consequence assessment in Section A.3.3 are used.
- A transient (e.g., turbine trip) induced pipe failure event is assumed to be bounded by the LOCA frequency used in this analysis. The probability of pipe failure over a reduced

exposure time, given an independent initiating event is judged to be comparable to or smaller than that assumed in this analysis.

Risk Assessment for Locations Inside the Drywell

The risk of a BER break in the drywell is estimated as follows (piping between the inboard isolation valve and the drywell wall is treated the same as piping beyond the inboard valve).

LOCA Size	LOCA Frequency	Inside Drywell	
		CCDP	CDF
SLOCA	5E-5	*1.2E-5*	6.4E-10
MLOCA	4E-6	2.3E-4	9.2E-10
DEGB	1E-8	0.01	1E-10

CCDP values are taken from the RI-ISI baseline evaluation, except for the DEGB case, which is described in Section A.3.3. Except for the DEGB case, LERF is less than CDF because there is an isolation valve outside the drywell.

For the DEGB scenario, it is assumed that the drywell penetration is effected and leaks. This increases the probability of LERF and additional environmental impacts outside the containment (i.e., a CCDP increase). The 0.01 CCDP used for the DEGB case is based on failure of the penetration that interfaces with the reactor building as described in Section A.3.3. This is conservative for penetrations that interface with the steam tunnel because even if it is assumed all equipment in the steam tunnel and turbine building are effected, the MLOCA CCDP could be used instead of the assumed DEGB value of 0.01. Therefore, the above table conservatively envelops the DEGB case for steam tunnel penetrations.

Risk Assessment for Locations in the Steam Tunnel – Steam Break

The risk of a BER break in the steam tunnel is estimated as follows for steam piping (MSS) in the steam tunnel (piping between the outboard isolation valve and the drywell wall is treated the same as piping beyond the outboard valve):

LOCA Size	LOCA Frequency	MOV Isolation	CCDP Basis (RI-ISI Baseline)	ST (steam)	
				CCDP	CDF
SLOCA	5E-5	S = 1.0	Table 3-1, MSIV	*2.0E-6*	1E-10
		F = 2.3E-3	Table 3-4, I-MLOCA-MSS-ST	*3.0E-5*	<1E-10
MLOCA	4E-6	S = 1.0	Table 3-1, MSIV	*2.0E-6*	<1E-10
		F = 2.3E-3	Table 3-4, I-MLOCA-MSS-ST	*1.0E-3*	<1E-10
DEGB	1E-8	S = 1.0	Section A.3.3	*0.01*	1E-10
		F = 2.3E-3	Section A.3.3	*1.0*	<1E-10

CDF is assumed equal to LERF for the isolation failure case in the above table. LERF would be less than CDF for the isolation success case.

Risk Assessment for Locations in the Steam Tunnel – Liquid Break

The risk of a BER break in the steam tunnel is estimated as follows for liquid piping (FWS and WCS discharge) in the steam tunnel (piping between the outboard isolation valve and the drywell wall is treated the same as piping beyond the outboard valve):

LOCA Size	LOCA Frequency	CV Isolation	CCDP Basis RI-ISI Baseline	ST (liquid)	
				CCDP	CDF
SLOCA	5E-5	S = 1.0	Table 3-3, FWS-MSIV	*1.0E-5*	5E-10
		F = 1.3E-4	Table 3-4, I-MLOCA-FWS-ST	*1.0E-2*	<1E-10
MLOCA	4E-6	S = 1.0	Table 3-3, FWS-MSIV	*1.0E-5*	<1E-10
		F = 1.3E-4	Table 3-4, I-MLOCA-FWS-ST	*1.0E-2*	<1E-10
DEGB	1E-8	S = 1.0	Section A.3.3	*0.01*	1E-10
		F = 1.3E-4	Section A.3.3	*1.0*	<1E-10

CDF is assumed equal to LERF for the isolation failure case in the above table. LERF would be less than CDF for the isolation success case.

Risk Assessment for Locations in the Reactor Building

The risk of a BER break in the reactor building (ICS steam and WCS suction) is estimated as follows (piping between the outboard isolation valve and the drywell wall is treated the same as piping beyond the outboard valve).

LOCA Size	Frequency	MOV Isolation	CCDP Basis RI-ISI Baseline	Reactor Bldg	
				CCDP	CDF
SLOCA	5E-5	S = 1.0	Table 3-3, ICS-Scram	*1.8E-6*	<1E-10
		F = 2.3E-3	Table 3-4, I-MLOCA-SC	*1.0*	1.2E-7
MLOCA	4E-6	S = 1.0	Table 3-3, ICS-Scram	*1.8E-6*	<1E-10
		F = 2.3E-3	Table 3-4, I-MLOCA-SC	*1.0*	9.2E-9
DEGB	1E-8	S = 1.0	Section A.3.3	*<0.01*	<1E-10
		F = 2.3E-3	Section A.3.3	*1.0*	<1E-10

CDF is assumed equal to LERF for the isolation failure case in the above table. LERF would be less than CDF for the isolation success case.

Based on the above analysis, an unisolated small pipe break in the reactor building is most important because of potential environmental impacts on safety equipment. Still, this risk (on the order of 1E-7/year) is relatively low and includes only a few welds. Most of the BER scope has a CDF that is clearly less than 1E-7/year, which is considered a low risk. This risk is also dominated by a high frequency small LOCA rather than a low frequency DEGB. However, the assumed CCDP value of 1.0 for an unisolated LOCA in the reactor building pipe chase is clearly conservative.

A.3.7.2 Change in Risk Assessment for the Proposed BER Inspection Program

This assessment estimates the change in risk between the present augmented inspection program and the proposed risk-informed inservice inspection program for the BER scope of piping. Limits are imposed by the EPRI Methodology (TR-112657, Reference A6) to ensure that changes to the ISI Program meet the requirements of Regulatory Guide 1.174 (Reference A5). Licensing commitment changes must result in a risk reduction or an increase in risk must be small enough to be considered risk neutral. With regard to increases, the criteria established requires the cumulative change in core damage frequency (CDF) and large, early release frequency (LERF) be less than 1E-7 and 1E-8 per year per system, respectively. If this is not met for all systems, the total CDF and LERF should not exceed 1E-6 and 1E-7, respectively.

The analysis presented herein is conducted in accordance with the EPRI RI-ISI Methodology (Reference A6). All the welds in the NMP2 BER Program are listed in Table A-3. The following paragraphs summarize the information provided in Table A-3.

- BER Column - "Yes" identifies welds selected as part of the original baseline ASME Section XI inspection scope. "Ber" identifies additional BER welds in the BER program, but not in the ASME Section XI inspection scope.
- RI-ISI Column – "Yes" identifies welds selected to satisfy the element selection requirements identified in Sections A.3.5 and A.3.6 for the total scope of ASME Section XI and BER programs.

The change in risk between the two inspection programs is estimated with the following equation per Reference A6:

$$\Delta R = N_s*POD_s*R - N_r*POD_r*R$$

Where: N_s is the number of inspections in the existing inspection program

N_r is the number of inspections in the proposed RI-ISI program

POD_s is the probability of detection associated with the existing inspection XI program

POD_r is the probability of detection associated with the proposed RI-ISI program

R is the risk associated with the inspected location (independent of ISI program)

Two calculations are performed as summarized below:

- Best Estimate – based on an improved POD for RI-ISI.
- No POD Improvement – no credit for POD improvement.

Break frequencies are based on References 9 and 14 of the methodology (Reference A6) where 1E-8/weld year is used when there is no degradation mechanism and 2E-7/weld year is used when there is a degradation mechanism other than FAC.

CCDP and CLERP values estimated in the consequence evaluation, as adjusted in Section A.3.3 and Tables A-2 and A-3 are used for all calculations.

The PODs used in the calculations are as follows (Reference A6):

- The "No POD Improvement" case utilizes a POD equal to 0.5 for all examinations.
- The "Best Estimate" case that credits POD improvements utilize the following POD:
  - Section XI welds with Thermal Fatigue identified use POD=0.3
  - RI-ISI welds with Thermal Fatigue identified use POD=0.9
  - All other welds use POD=0.5

The delta risk assessment is performed for two cases:

1. The BER program consolidated into the RI-ISI program as a single inspection program,
2. The BER program only.

For case 1, the change in risk results is summarized in Table A-4 for each of the 4 systems that contain BER welds. The table also includes the impact from other system within the NMP2 RI-ISI program that do not have BER piping. The "Total All Systems" results include systems with BER piping and without BER piping. In other words, this is the net result for the new RI-ISI Program which includes Class 1, 2 and BER piping. .

For case 2, the change in risk results is summarized in Table A.5 for only the 4 systems that contain BER piping.

Both results show that the risk acceptance criteria are met after consolidating the BER Program into the RI-ISI program.

From a sensitivity perspective, the low risk conclusion is most sensitive to the 0.01 CCDP/CLERP value used for a DEGB in the Steam Tunnel. For example, if the CCDP/CLERP value is reduced to 1E-3 (i.e., a more realistic probability), the total change in risk decreases from 8E-9/year to 8E-10/year. Also, as this value is increased, risk increases linearly as shown in the following table.

	Best Estimate		CCDP Increase		CLERP Increase	
	CCDP = 0.01 CLERP = 0.01		CCDP=0.1	CCDP=1	CLERP=0.1	CLERP=1
BER System	CDF	LERF	CDF	CDF	LERF	LERF
FWS – Feedwater	6.6E-09	6.6E-09	6.6E-08	6.6E-07	6.6E-08	6.6E-07
ICS – RCIC	1.6E-10	1.6E-10	1.5E-09	1.5E-08	1.5E-09	1.5E-08
MSS – Main Steam	1.2E-09	1.2E-09	1.2E-08	1.2E-07	1.2E-08	1.2E-07
WCS – Reactor Water Cleanup	1.5E-10	1.5E-10	1.0E-09	1.0E-08	1.0E-09	1.0E-08
Total BER Systems	**8.1E-09**	**8.1E-09**	**8.1E-08**	**8.1E-07**	**8.1E-08**	**8.1E-07**

Even if the CCDP value is increased to 0.1, the acceptance criterion is met at the system level. If the CCDP value is increased to 1.0, the plant level (total) acceptance criterion is met, but the system level criterion is exceeded for FWS and MSS. If the CLERP value is increased to 0.1, the plant level (total) acceptance criterion is met, but the system level criterion is exceeded for FWS and MSS. If CLERP value were increased to 1.0, the plant level acceptance criterion would not be met.

The above demonstrates that the key assumption (CCDP/CLERP=0.01 for DEGB in the steam tunnel) does not effect the basic conclusion that the risk acceptance criteria are met after consolidating the BER Program into the RI-ISI program.

A.4 Summary and Conclusion

The following summarizes the results and conclusions of the above evaluation:

- NMP2 complies with the SRP criteria (References A1 and A2) for the break exclusion region piping. It was determined that the existing plant design and arrangement has margin and safe shutdown is likely for most postulated breaks in the BER scope of piping.
- An assessment of the overall contribution of the BER topic to plant risk determined it to be low risk (i.e., <1E-7/year).
- The change in risk associated with a revised BER inspection sample size is low and consistent with NRC and EPRI TR-112657 acceptance criteria (i.e., <1E-7/year).
- Re-definition of the BER inspection sample size is considered risk neutral per Regulatory Guide 1.174 and EPRI TR-112657 criteria.

A.5 References

A1. NUREG-0800, Rev 1-July 1981, SRP 3.6.1 "Plant Design For Protection Against Postulated Piping Failures in Fluid Systems Outside Containment" including Branch Technical Position ASB 3-1

A2. NUREG-0800, Rev 1-July 1981, SRP 3.6.2 "Determination of Rupture Locations and Dynamic Effects Associated With the Postulated Rupture of Piping" including Branch Technical Position MEB 3-1

A3. NUREG-0800, Rev 1-July 1981, SRP 6.6 "Inservice Inspection of Class 2 and 3 Components"

A4. NMP2 USAR, Revision 9, Sections 3.6 and 6.6, and Appendix 3C

A5. RG 1.174, July 1998, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis"

A6. EPRI TR-112657 "Revised Risk-Informed Inservice Inspection Evaluation Procedure" Final Report, Rev. B-A, December 1999.

A7. Not used.

A8. Not used

A9. NUREG/CR-5750, "Rates of Initiating Events at U.S. Nuclear Power Plant:1987-1995" 2/99

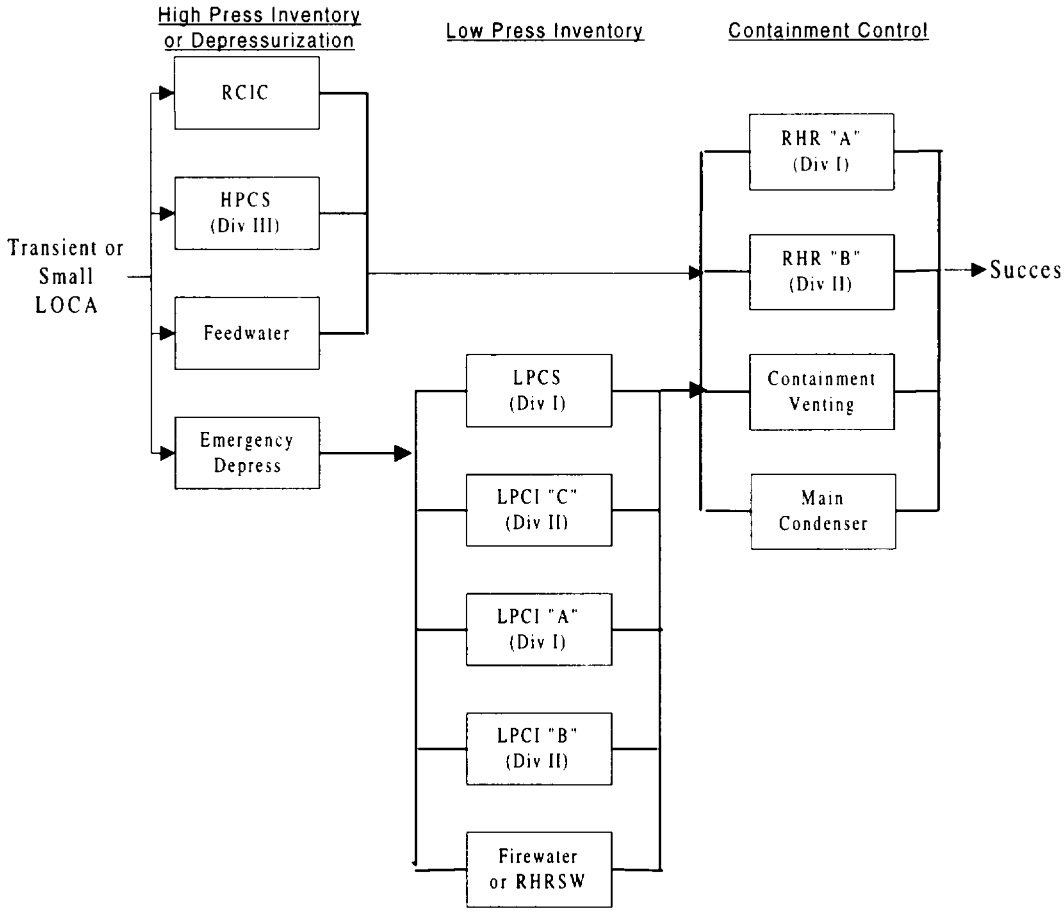
A10. NUREG/CR-4792 Volume 2, "Probability of Failure in BWR Reactor Coolant Piping" 3/89

A11. NUREG-1061 Volume 3, "Report of the USNRC Piping Review Committee – Evaluation of Potential for Pipe Break" 11/84

A12. Not Used

A13. Not used

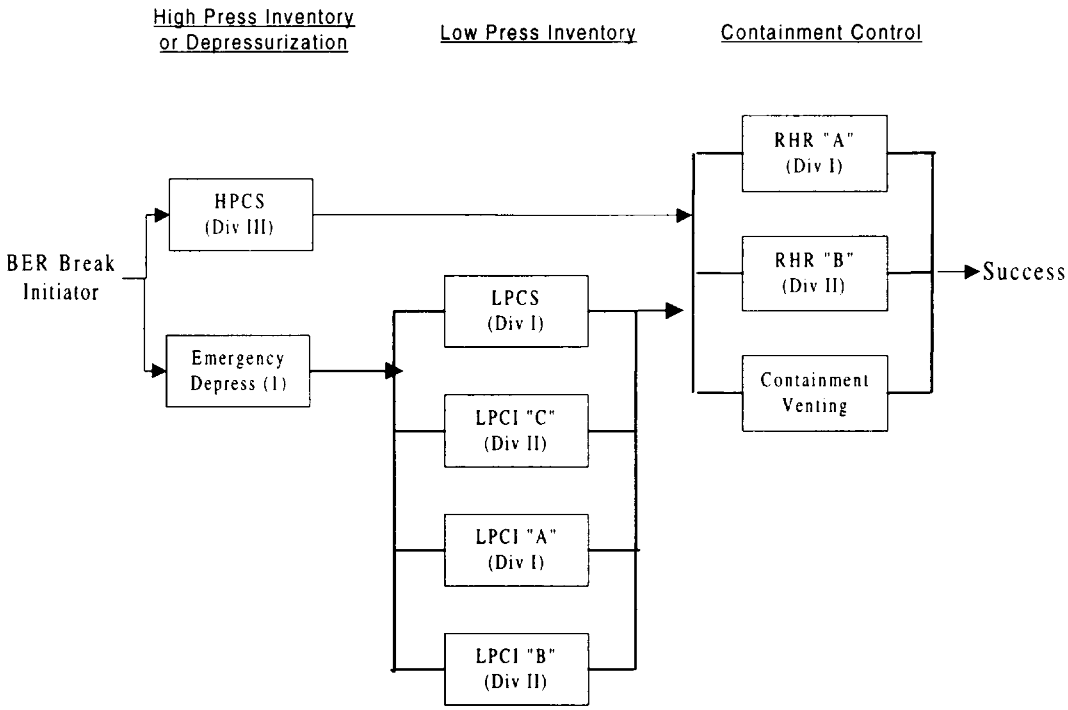
Figure A-1 Simplified Success Criteria for Small LOCA in Drywell



(1) Reactivity control success criteria is not shown

(2) Vapor suppression function is also required for small LOCA, but is not shown

Figure A-2 Simplified Success Criteria for Medium & Large LOCA in Drywell

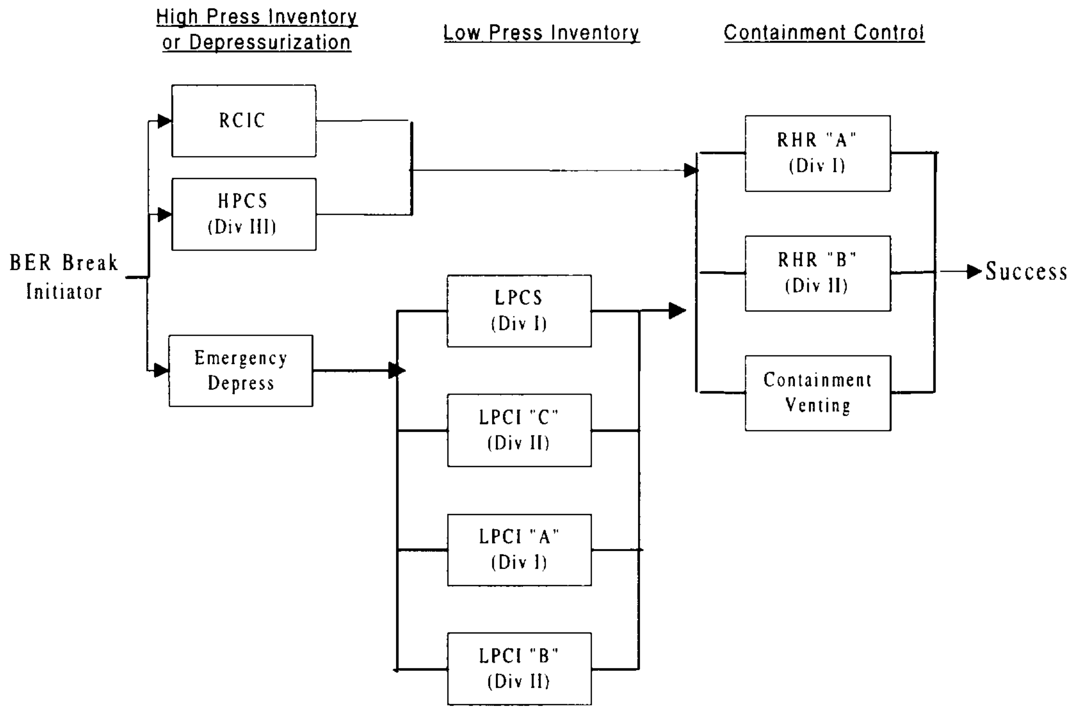


(1) Large LOCA success criteria is the same except Emergency Depressurization is guaranteed success

(2) Reactivity control success criteria is not shown

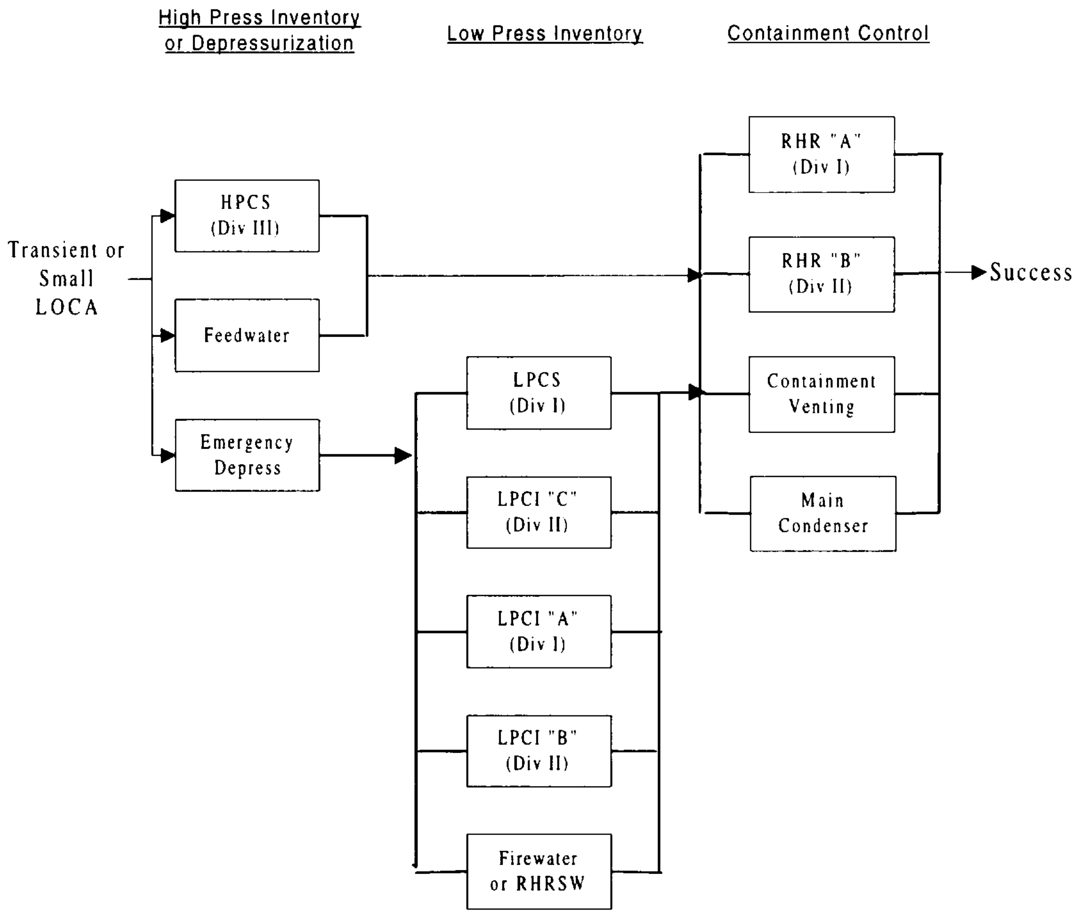
(3) Vapor suppression function is also required, but is not shown

Figure A-3 Simplified Success Criteria for Successful Isolated LOCA in Steam Tunnel



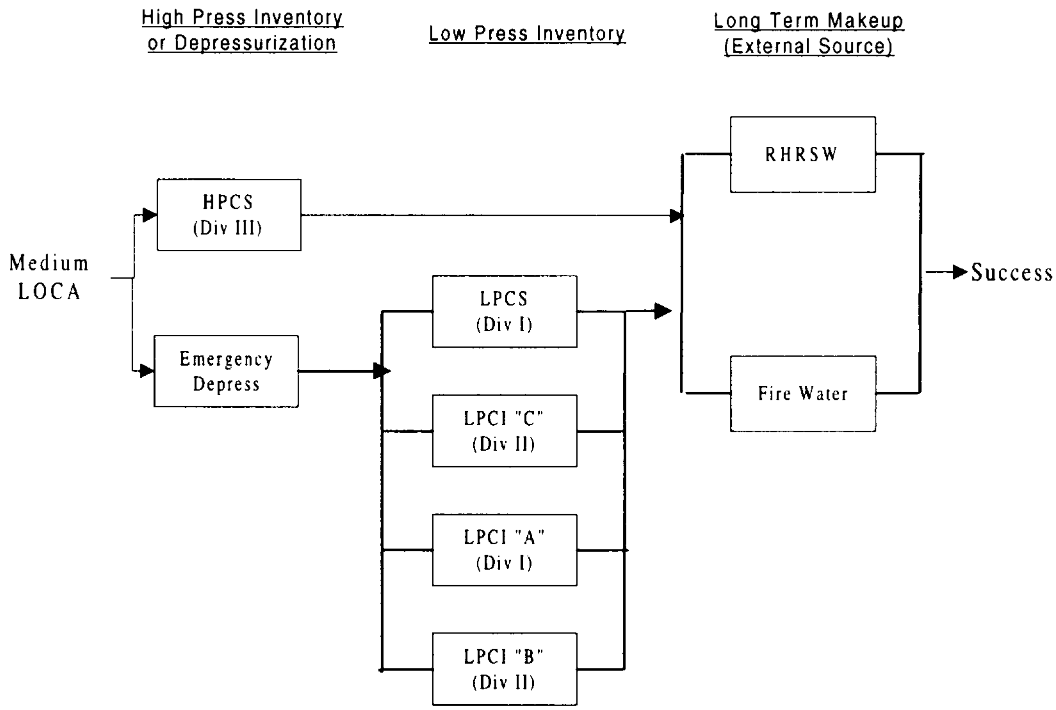
(1) Reactivity control success criteria is not shown

Figure A-4 Simplified Success Criteria for Successful Isolated LOCA in Reactor Building



(1) Reactivity control success criteria is not shown

Figure A-5 Simplified Success Criteria for Medium and Large Unisolated LOCA in Steam Tunnel



(1) Reactivity control success criteria is not shown

(2) For water LOCA (feedwater break), only service water to RHR (RHRSW) is credited.

(3) Large LOCA success criteria is the same except Emergency Depressurization is guaranteed success

(4) For the BER evaluation of large piping (FWS and MSS), CCDP=1 for the unisolated case.

(5) CCDP=1 for unisolated BER breaks in the reactor building.

Figure A-6 – Risk Ranking & Element Selection Summary (Traditional Baseline RI-ISI)

NMP2 Risk Ranking Summary		Consequence Evaluation *Conditional Core Damage Potential*		
		LOW	MEDIUM	HIGH
Degradation Mechanism Assessment ***Pipe Rupture Potential***	HIGH	Category 5A – Medium ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 0 ICS – 0 ISC – 0 MSS – 0 RCS – 0 RDS – 0 RHS – 0 RPV – 0 SLS – 0 WCS – 0 Total - 0 Elements	Category 3 – High ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 0 ICS – 0 ISC – 0 MSS – 0 RCS – 0 RDS – 0 RHS – 0 RPV – 0 SLS – 0 WCS – 0 Total - 0 Elements	Category 1 – High ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 0 ICS – 0 ISC – 0 MSS – 0 RCS – 0 RDS – 0 RHS – 0 RPV – 0 SLS – 0 WCS – 0 Total - 0 Elements
	MEDIUM	Category 6A – Low ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 0 ICS – 0 ISC – 0 MSS – 0 RCS – 0 RDS – 0 RHS – 16 RPV – 0 SLS – 0 WCS – 0 Total – 16 Elements	Category 5B – Medium ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 17 (2) ICS – 3 (1) ISC – 3 (1) MSS – 10 (1) RCS – 0 RDS – 0 RHS – 225 (23) RPV – 0 SLS – 7 (1) WCS – 29 (3) Totals 294 Elements Selected (32)	Category 2 – High ASS – 0 CSH – 11 (3) CSL – 8 (2) DER – 1 (1) FWS – 31 (8) ICS – 9 (3) ISC – 3 (1) MSS – 0 RCS – 0 RDS – 1 (1) RHS – 26 (7) RPV – 21 (6) SLS – 3 (1) WCS – 18 (5) Totals 132 Elements Selected (38)

	LOW	Category 7 – Low ASS – 0 CSH – 4 CSL – 4 DER – 2 FWS – 0 ICS – 1 ISC – 0 MSS – 8 RCS – 0 RDS – 0 RHS – 104 RPV – 0 SLS – 0 WCS – 8 Total – 131 Elements	Category 6B – Low ASS – 4 CSH – 164 CSL – 114 DER – 0 FWS – 6 ICS – 223 ISC – 11 MSS – 238 RCS – 0 RDS – 76 RHS – 540 RPV – 1 SLS – 26 WCS – 17 Total – 1420 Elements	**Category 4 – Medium** **ASS – 0** **CSH – 6 (1)** **CSL – 10 (1)** **DER – 0** **FWS – 47 (5)** **ICS – 41 (5)** **ISC – 2 (1)** **MSS – 84 (9)** **RCS – 106 (11)** **RDS – 1 (1)** **RHS – 77 (8)** **RPV – 12 (2)** **SLS – 14 (2)** **WCS – 89 (9)** **Totals** **489 Elements** **Selected (55)**

Figure A-7 – Risk Ranking & Element Selection Summary (Traditional + BER RI-ISI)

NMP2 Risk Ranking Summary		**Consequence Evaluation** ***Conditional Core Damage Potential***		
		LOW	**MEDIUM**	**HIGH**
Degradation Mechanism Assessment ***Pipe Rupture Potential***	**HIGH**	**Category 5A – Medium** **ASS – 0** **CSH – 0** **CSL – 0** **DER – 0** **FWS – 0** **ICS – 0** **ISC – 0** **MSS – 0** **RCS – 0** **RDS – 0** **RHS – 0** **RPV – 0** **SLS – 0** **WCS – 0** **Total - 0 Elements**	**Category 3 – High** **ASS – 0** **CSH – 0** **CSL – 0** **DER – 0** **FWS – 0** **ICS – 0** **ISC – 0** **MSS – 0** **RCS – 0** **RDS – 0** **RHS – 0** **RPV – 0** **SLS – 0** **WCS – 0** **Total - 0 Elements**	**Category 1 – High** **ASS – 0** **CSH – 0** **CSL – 0** **DER – 0** **FWS – 0** **ICS – 0** **ISC – 0** **MSS – 0** **RCS – 0** **RDS – 0** **RHS – 0** **RPV – 0** **SLS – 0** **WCS – 0** **Total - 0 Elements**
	MEDIUM	Category 6A – Low ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 0 ICS – 0 ISC – 0 MSS – 0 RCS – 0 RDS – 0 RHS – 16 RPV – 0 SLS – 0 WCS – 0 Total – 16 Elements	**Category 5B – Medium** **ASS – 0** **CSH – 0** **CSL – 0** **DER – 0** **FWS – 0** **ICS – 3 (1)** **ISC – 3 (1)** **MSS – 10 (1)** **RCS – 0** **RDS – 0** **RHS – 225 (23)** **RPV – 0** **SLS – 7 (1)** **WCS – 29 (3)** **<u>Totals</u>** **277 Elements** **Selected (30)**	**Category 2 – High** **ASS – 0** **CSH – 11 (3)** **CSL – 8 (2)** **DER – 1 (1)** **FWS – 48 (12)** **ICS – 9 (3)** **ISC – 3 (1)** **MSS – 0** **RCS – 0** **RDS – 1 (1)** **RHS – 26 (7)** **RPV – 21 (6)** **SLS – 3 (1)** **WCS – 18 (5)** **<u>Totals</u>** **149 Elements** **Selected (42)**
	LOW	Category 7 – Low ASS – 0 CSH – 4 CSL – 4 DER – 2 FWS – 0 ICS – 1 ISC – 0 MSS – 8 RCS – 0 RDS – 0 RHS – 104 RPV – 0 SLS – 0 WCS – 8	Category 6B – Low ASS – 4 CSH – 164 CSL – 114 DER – 0 FWS – 0 ICS – 221 ISC – 11 MSS – 208 RCS – 0 RDS – 76 RHS – 540 RPV – 1 SLS – 26 WCS – 15	**Category 4 – Medium** **ASS – 0** **CSH – 6 (1)** **CSL – 10 (1)** **DER – 0** **FWS – 53 (6)** **ICS – 43 (5)** **ISC – 2 (1)** **MSS – 114 (12)** **RCS – 106 (11)** **RDS – 1 (1)** **RHS – 77 (8)** **RPV – 12 (2)** **SLS – 14 (2)** **WCS – 91 (10)** **<u>Totals</u>** **529 Elements**

		Total – 131 Elements	Total – 1380 Elements	**Selected (60)**

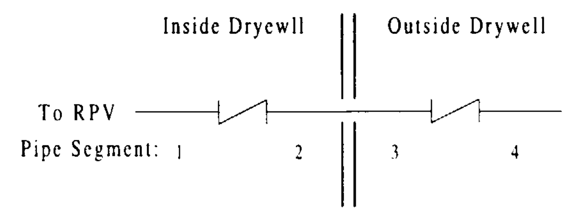
Figure A-8 – Risk Ranking & Element Selection Summary (BER Only)

NMP2 Risk Ranking Summary		Consequence Evaluation *Conditional Core Damage Potential*		
		LOW	MEDIUM	HIGH
Degradation Mechanism Assessment *Pipe Rupture Potential*	HIGH	Category 5A – Medium 0 BER Welds	Category 3 – High 0 BER Welds	Category 1 – High 0 BER Welds
	MEDIUM	Category 6A – Low 0 BER Welds	Category 5B – Medium ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 0 ICS – 0 ISC – 0 MSS – 0 RCS – 0 RDS – 0 RHS – 0 RPV – 0 SLS – 0 WCS – 29 (3) Totals 29 BER Welds Selected 3	Category 2 – High ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 23 (6)[7] ICS – 0 ISC – 0 MSS – 0 RCS – 0 RDS – 0 RHS – 0 RPV – 0 SLS – 0 WCS – 0 Totals 23 BER Welds Selected 7
	LOW	Category 7 – Low 0 BER Welds	Category 6B – Low ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 0 ICS – 1 ISC – 0 MSS – 2 RCS – 0 RDS – 0 RHS – 0 RPV – 0 SLS – 0 WCS – 15 Totals 18 BER Welds Selected 0	Category 4 – Medium ASS – 0 CSH – 0 CSL – 0 DER – 0 FWS – 6 (1) ICS – 7 (1)[3] ISC – 0 MSS – 46 (5) RCS – 0 RDS – 0 RHS – 0 RPV – 0 SLS – 0 WCS – 6 (1) Totals 65 BER Welds Selected 10

Table A-1 RI-ISI Results for BER Welds

System	Segment Location 1			Segment Location 2			Segment Location 3			Segment Location 4			Total Welds
	Consequence	Category	Welds	Consequence	Cons	Welds	Consequence	Cons	Welds	Consequence	Cons	Welds	
FWS	1A & 1B	HIGH	6	2A & 2B	MEDIUM	3	3A & 3B	MEDIUM	4	4A,4B,5A,5B	MEDIUM	16	29
ICS (Steam)	6 MSS-C-02	HIGH MEDIUM	1 1	7	MEDIUM	2	8	HIGH	1	9	HIGH	3	8
MSS	1A through 1D 2	HIGH MEDIUM	16 2	3A through 3D	MEDIUM	6	4A through 4D	MEDIUM	16	6	MEDIUM	8	48
WCS (Suction)	3	HIGH	1	4	MEDIUM	2	5	HIGH	2	6	HIGH	1	6
WCS (Discharge)	-	-	0	-	-	0	-	-	0	7	MEDIUM	44	44
TOTAL			27			13			23			72	135

The BER welds can be viewed as being in one of four segment locations as shown in this figure. Check valves are shown in the simplified figure, but they could be motor operated valves, air operated valves, or any combination of isolation valves (see Section A.3.2). Each system containing BER welds at NMP2 are summarized in Table A-1 below.



Distribution of BER Welds by Class and Category

System	Total	Class 1/BJ			Class 2/C-F-2	Class 3	Class 4
		B9.11	B9.31	B9.32	C5.51		
FWS	29	25	2	0	0	0	2
ICS	8	4	0	1	3	0	0
MSS	48	42	0	2	4	0	0
WCS	50	46	0	0	0	4	0
Totals	135	117	2	3	7	4	2

Note that NMP2 does not have long seam welds (B9.12) in the BER scope

Table A-2 Summary of BER Evaluation									
				RI-ISI			BER Evaluation Changes		
Sys	Cons ID	Location	Description	Cons	RC	Welds	RC	CCDP Change	CLERP Change
FWS	FWS-C-01	Drywell	downstream of inboard isolation valve	High	2	6	2	None (3)	CLERP=CCDP (1)
	FWS-C-02	Drywell	upstream of inboard isolation valve	Medium	5	3	2	High (2) (3) CCDP same as FWS-C-01	CLERP=CCDP (1)
	FWS-C-03	Steam Tunnel	downstream of outboard isolation valve	Medium	5	4	2	High, CCDP = 0.01 (6)	CLERP=CCDP (1)
	FWS-C-04	Steam Tunnel	Upstream of outboard isolation valve	Medium	5	10	2	High, (2) (6) CCDP same as FWS-C-03	CLERP=CCDP (1)
				Medium	6	4	4	High, (2) (6) CCDP same as FWS-C-03	CLERP=CCDP (1)
	FWS-C-05	Steam Tunnel	Upstream of outboard isolation valves	Medium	6	2	4	High, (2) (6) CCDP same as FWS-C-03	CLERP=CCDP (1)
ICS	MSS-C-02	Drywell	Upstream of inboard isolation valve (2 inch)	Medium	6	1	6	None – 2 inch pipe	none – 2 inch pipe
	ICS-C-06	Drywell	Upstream of inboard isolation valve	High	4	1	4	CCDP = 0.01 (4)	CLERP=CCDP (1)
	ICS-C-07	Drywell	Downstream of inboard isolation valve	Medium	6	2	4	High (2) (4) CCDP same as ICS-C-06	CLERP=CCDP (1)
	ICS-C-08	RB Pipe Chase	Upstream of outboard isolation valve	High	4	1	4	None (5)	CLERP=CCDP (1)
	ICS-C-09	RB Pipe Chase	Downstream of outboard isolation valve	High	4	3	4	High, (2) (5) CCDP same as ICS-C-08	CLERP=CCDP (1)
MSS	MSS-C-01	Drywell	Upstream of inboard isolation valve	High	4	16	4	None (3)	CLERP=CCDP (1)
	MSS-C-02	Drywell	Upstream of inboard isolation valve (2 inch)	Medium	6	2	6	None – 2 inch pipe	none - 2 inch pipe
	MSS-C-03	Drywell	Downstream of inboard isolation valve	Medium	6	6	4	High (2) (3) CCDP same as MSS-C-01	CLERP=CCDP (1)
	MSS-C-04	Steam Tunnel	Upstream of outboard isolation valve	Medium	6	16	4	High, CCDP = 0.01 (6)	CLERP=CCDP (1)
	MSS-C-06	Steam Tunnel	Downstream of outboard isolation valve	Medium	6	8	4	High, (2) (6) CCDP same as MSS-C-04	CLERP=CCDP (1)
WCS	WCS-C-03	Drywell	Upstream of inboard isolation valve (suction)	High	4	1	4	CCDP = 0.01 (4)	CLERP=CCDP (1)
	WCS-C-04	Drywell	Downstream of inboard isolation valve (suction)	Medium	6	2	4	High (2) (4) CCDP same as WCS-C-03	CLERP=CCDP (1)
	WCS-C-05	RB Pipe Chase	Upstream of outboard isolation valve (suction)	High	4	2	4	None (5)	CLERP=CCDP (1)
	WCS-C-06	RB Pipe Chase	Downstream of outboard isolation valve (suction)	High	4	1	4	High, (2) (5) CCDP same as WCS-C-05	CLERP=CCDP (1)
	WCS-C-07	Steam Tunnel	Upstream of FWS (return line)	Medium	5	29	5	None – 8 inch to 26 inch	none - 8 inch to 26 inch
				Medium	6	15	6	None – 8 inch to 26 inch	none - 8 inch to 26 inch

1. Drywell penetration failure is conservatively assumed due to double-ended guillotine break (DEGB).
2. Containment isolation valve is conservatively assumed to fail open.
3. No additional PRA impacts if penetration fails and Drywell environment leaks into the steam tunnel.

4. Leakage into RB through the pipe chase may be bounded by postulated high-energy line breaks in this area. Equipment is qualified for breaks in the pipe chase (successful isolation), safety equipment is not in the vicinity and is unlikely to be impacted in this very large building. Although impacts may be minimal, this is unanalyzed; a CCDP of 0.01 is judged to be conservative.
5. CCDP and CLERP are based on failure probability of the inside isolation valve to close. For the case where the inside containment isolation valve isolates successfully, pipe break loads in the pipe chase due to DEGB are not judged significant since this is a short section of pipe close to Drywell wall. Also, leakage into pipe chase from Drywell (through penetration) is judged minor in comparison to the breaks analyzed in the pipe chase. Failure to isolate case is still judged to dominate CCDP.
6. DEGB events are not analyzed for this piping (FWS is 24 inch and MSS is 26 inch). A review of NMP2 calculations indicate that compartment walls are unlikely to fail due to pressurization, the structure considers jet impingement loads, similar walls are analyzed for loads associated with DEGB. Therefore, it was determined that the structure may survive a DEGB (not evaluated). Even if a wall failed, key safety equipment is not in the local area near the walls. ECCS equipment is in the Auxiliary Bays, electrical buses are outside the general RB, and key instrument racks are not located on the elevation where the walls that could fail due to pipe whip. The general RB is very large with sufficient venting to the refueling level (key PRA equipment is not located here). Based on considerations of plant design, it is judged likely that all ECCS would survive. A conservatively high CCDP of 0.01 is used as a preliminary value in the delta risk analysis.

Table A-3 All 135 BER Welds & Summary of Analysis Results

System	Weld Number	BER	RI-ISI	CoCAT	CoITEM	DM	Baseline RI-ISI Results					BER Evaluation		
							Cons Cat	Cons ID	CCDP	CLERP	RC	CCDP	CLERP	RC
FWS	2FWS-47-13-VW003	Ber	Yes	B-J	B9.31	CC	MEDIUM	FWS-C-04A	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-16-VW003	Ber		B-J	B9.31	CC	MEDIUM	FWS-C-04B	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-13-FW010	Ber	Yes	B-J	B9.11	TASCS	HIGH	FWS-C-01A	2.E-04	5.E-06	2	2.E-04	2.E-04	2
FWS	2FWS-47-13-FW014	Yes	Yes	B-J	B9.11	TASCS	HIGH	FWS-C-01A	2.E-04	5.E-06	2	2.E-04	2.E-04	2
FWS	2FWS-47-13-SW003	Yes	Yes	B-J	B9.11	TASCS	HIGH	FWS-C-01A	2.E-04	5.E-06	2	2.E-04	2.E-04	2
FWS	2FWS-47-16-FW014	Yes	Yes	B-J	B9.11	TASCS	HIGH	FWS-C-01B	2.E-04	5.E-06	2	2.E-04	2.E-04	2
FWS	2FWS-47-16-FW010	Ber	Yes	B-J	B9.11	TASCS	HIGH	FWS-C-01B	2.E-04	5.E-06	2	2.E-04	2.E-04	2
FWS	2FWS-47-16-SW003	Yes		B-J	B9.11	TASCS	HIGH	FWS-C-01B	2.E-04	5.E-06	2	2.E-04	2.E-04	2
FWS	2FWS-47-13-FW009	Ber		B-J	B9.11	TASCS	MEDIUM	FWS-C-02A	9.E-06	3.E-07	5B	2.E-04	2.E-04	2
FWS	2FWS-47-13-VWZ4A-SWA	Yes		B-J	B9.11	TASCS	MEDIUM	FWS-C-02A	9.E-06	3.E-07	5B	2.E-04	2.E-04	2
FWS	2FWS-47-16-FW009	Yes		B-J	B9.11	TASCS	MEDIUM	FWS-C-02B	9.E-06	3.E-07	5B	2.E-04	2.E-04	2
FWS	2FWS-47-13-FW007	Ber		B-J	B9.11	TASCS	MEDIUM	FWS-C-03A	1.E-05	1.E-06	5B	0.01	0.01	2
FWS	2FWS-47-13-FW008	Yes		B-J	B9.11	TASCS	MEDIUM	FWS-C-03A	1.E-05	1.E-06	5B	0.01	0.01	2
FWS	2FWS-47-16-FW008	Yes		B-J	B9.11	TASCS	MEDIUM	FWS-C-03B	1.E-05	1.E-06	5B	0.01	0.01	2
FWS	2FWS-47-16-FW007	Ber		B-J	B9.11	TASCS	MEDIUM	FWS-C-03B	1.E-05	1.E-06	5B	0.01	0.01	2
FWS	2FWS-47-13-FW017	Yes	Yes	B-J	B9.11	TASCS	MEDIUM	FWS-C-04A	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-13-FW006	Ber		B-J	B9.11	TASCS	MEDIUM	FWS-C-04A	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-16-FW006	Ber		B-J	B9.11	TASCS	MEDIUM	FWS-C-04B	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-16-SW011	Yes		B-J	B9.11	TASCS	MEDIUM	FWS-C-04B	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-13-VW001	Ber		B-J	B9.11	TASCS, CC	MEDIUM	FWS-C-04A	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-13-VW002	Ber		B-J	B9.11	TASCS, CC	MEDIUM	FWS-C-04A	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-16-VW002	Ber		B-J	B9.11	TASCS, CC	MEDIUM	FWS-C-04B	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-16-VW001	Ber		B-J	B9.11	TASCS, CC	MEDIUM	FWS-C-04B	1.E-05	4.E-07	5B	0.01	0.01	2
FWS	2FWS-47-13-SW011	Yes		B-J	B9.11	N	MEDIUM	FWS-C-04A	1.E-05	4.E-07	6B	0.01	0.01	4
FWS	2FWS-47-13-FW003	Yes		B-J	B9.11	N	MEDIUM	FWS-C-04A	1.E-05	4.E-07	6B	0.01	0.01	4
FWS	2FWS-47-16-SW010	Yes		B-J	B9.11	N	MEDIUM	FWS-C-04B	1.E-05	4.E-07	6B	0.01	0.01	4
FWS	2FWS-47-16-FW003	Yes	Yes	B-J	B9.11	N	MEDIUM	FWS-C-04B	1.E-05	4.E-07	6B	0.01	0.01	4
FWS	2FWS-47-13-FW002	Ber		na	na	N	MEDIUM	FWS-C-05A	1.E-05	4.E-07	6B	0.01	0.01	4
FWS	2FWS-47-16-FW002	Ber		na	na	N	MEDIUM	FWS-C-05B	1.E-05	4.E-07	6B	0.01	0.01	4

Table A-3 All 135 BER Welds & Summary of Analysis Results														
							Baseline RI-ISI Results					BER Evaluation		
System	Weld Number	BER	RI-ISI	CoCAT	CoITEM	DM	Cons Cat	Cons ID	CCDP	CLERP	RC	CCDP	CLERP	RC
ICS	2ICS-57-09-FW005	Ber		B-J	B9.11	N	HIGH	ICS-C-06	2.E-04	5.E-06	4	0.01	0.01	4
ICS	2ICS-57-09-FW006	Ber		B-J	B9.11	N	MEDIUM	ICS-C-07	2.E-06	5.E-08	6B	0.01	0.01	4
ICS	2ICS-57-09-FW007	Yes		B-J	B9.11	N	MEDIUM	ICS-C-07	2.E-06	5.E-08	6B	0.01	0.01	4
ICS	2ICS-57-09-FW008	Yes		B-J	B9.11	N	HIGH	ICS-C-08	2.E-03	2.E-03	4	2.E-03	2.E-03	4
ICS	2ICS-57-09-SW016	Ber	Yes	C-F-2	C5.51	N	HIGH	ICS-C-09	4.E-05	4.E-05	4	2.E-03	2.E-03	4
ICS	2ICS-57-09-FW009	Yes	Yes	C-F-2	C5.51	N	HIGH	ICS-C-09	4.E-05	4.E-05	4	2.E-03	2.E-03	4
ICS	2ICS-57-09-SW015	Ber	Yes	C-F-2	C5.51	N	HIGH	ICS-C-09	4.E-05	4.E-05	4	2.E-03	2.E-03	4
ICS	2ICS-57-09-FW027	Yes(1)		B-J	B9.32	N	MEDIUM	MSS-C-02	1.E-05	4.E-06	6B	1.E-05	4.E-06	6B
MSS	2MSS-01-13-SW013	Yes	Yes	B-J	B9.11	N	HIGH	MSS-C-01A	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-13-SW010	Yes	Yes	B-J	B9.11	N	HIGH	MSS-C-01A	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-13-FW005	Yes	Yes	B-J	B9.11	N	HIGH	MSS-C-01A	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-13-FW026	Yes	Yes	B-J	B9.11	N	HIGH	MSS-C-01A	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-14-FW004	Yes		B-J	B9.11	N	HIGH	MSS-C-01B	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-14-FW026	Yes		B-J	B9.11	N	HIGH	MSS-C-01B	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-14-FW027	Yes		B-J	B9.11	N	HIGH	MSS-C-01B	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-14-SW015	Yes		B-J	B9.11	N	HIGH	MSS-C-01B	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-15-FW027	Yes		B-J	B9.11	N	HIGH	MSS-C-01C	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-15-FW005	Yes		B-J	B9.11	N	HIGH	MSS-C-01C	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-15-SW014	Yes	Yes	B-J	B9.11	N	HIGH	MSS-C-01C	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-15-FW026	Ber		B-J	B9.11	N	HIGH	MSS-C-01C	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-16-SW013	Yes		B-J	B9.11	N	HIGH	MSS-C-01D	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-16-SW010	Yes		B-J	B9.11	N	HIGH	MSS-C-01D	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-16-FW026	Yes		B-J	B9.11	N	HIGH	MSS-C-01D	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-16-FW005	Yes		B-J	B9.11	N	HIGH	MSS-C-01D	2.E-04	5.E-06	4	2.E-04	2.E-04	4
MSS	2MSS-01-13-FW008	Yes		B-J	B9.11	N	MEDIUM	MSS-C-03A	2.E-06	8.E-08	6B	2.E-04	2.E-04	4
MSS	2MSS-01-13-FW025	Yes		B-J	B9.11	N	MEDIUM	MSS-C-03A	2.E-06	8.E-08	6B	2.E-04	2.E-04	4
MSS	2MSS-01-14-FW025	Yes		B-J	B9.11	N	MEDIUM	MSS-C-03B	2.E-06	8.E-08	6B	2.E-04	2.E-04	4
MSS	2MSS-01-15-FW025	Yes		B-J	B9.11	N	MEDIUM	MSS-C-03C	2.E-06	8.E-08	6B	2.E-04	2.E-04	4
MSS	2MSS-01-16-FW008	Yes		B-J	B9.11	N	MEDIUM	MSS-C-03D	2.E-06	8.E-08	6B	2.E-04	2.E-04	4
MSS	2MSS-01-16-FW025	Yes		B-J	B9.11	N	MEDIUM	MSS-C-03D	2.E-06	8.E-08	6B	2.E-04	2.E-04	4

Table A-3 All 135 BER Welds & Summary of Analysis Results														
							Baseline RI-ISI Results					BER Evaluation		
System	Weld Number	BER	RI-ISI	CoCAT	CoITEM	DM	Cons Cat	Cons ID	CCDP	CLERP	RC	CCDP	CLERP	RC
MSS	2MSS-01-13-SW015	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04A	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-13-FW022	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04A	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-13-FW009	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04A	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-13-FW021	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04A	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-14-FW021	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04B	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-14-FW009	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04B	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-14-FW022	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04B	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-14-SW019	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04B	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-15-FW021	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04C	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-15-FW009	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04C	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-15-SW018	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04C	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-15-FW022	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04C	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-16-FW009	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04D	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-16-FW022	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04D	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-16-SW015	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04D	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-16-FW021	Yes		B-J	B9.11	N	MEDIUM	MSS-C-04D	2.E-06	2.E-06	6B	0.01	0.01	4
MSS	2MSS-01-16-FW020	Ber		C-F-2	C5.51	N	MEDIUM	MSS-C-06	2.E-06	8.E-08	6B	0.01	0.01	4
MSS	2MSS-01-13-FW020	Ber		C-F-2	C5.51	N	MEDIUM	MSS-C-06	2.E-06	8.E-08	6B	0.01	0.01	4
MSS	2MSS-01-14-FW020	Ber		C-F-2	C5.51	N	MEDIUM	MSS-C-06	2.E-06	8.E-08	6B	0.01	0.01	4
MSS	2MSS-01-16-SW020	Yes		B-J	B9.11	N	MEDIUM	MSS-C-06	2.E-06	8.E-08	6B	0.01	0.01	4
MSS	2MSS-01-15-SW020	Yes		B-J	B9.11	N	MEDIUM	MSS-C-06	2.E-06	8.E-08	6B	0.01	0.01	4
MSS	2MSS-01-13-SW020	Yes		B-J	B9.11	N	MEDIUM	MSS-C-06	2.E-06	8.E-08	6B	0.01	0.01	4
MSS	2MSS-01-14-SW022	Yes		B-J	B9.11	N	MEDIUM	MSS-C-06	2.E-06	8.E-08	6B	0.01	0.01	4
MSS	2MSS-01-15-FW020	Ber		C-F-2	C5.51	N	MEDIUM	MSS-C-06	2.E-06	8.E-08	6B	0.01	0.01	4
MSS	2MSS-01-14-SW014	Yes(1)		B-J	B9.32	N	MEDIUM	MSS-C-02	1.E-05	4.E-06	6B	1.E-05	4.E-06	6B
MSS	2MSS-01-15-SW013	Yes(1)		B-J	B9.32	N	MEDIUM	MSS-C-02	1.E-05	4.E-06	6B	1.E-05	4.E-06	6B
WCS	2WCS-09-06-FW004	Ber	Yes	B-J	B9.11	N	HIGH	WCS-C-03	2.E-04	5.E-06	4	0.01	0.01	4
WCS	2WCS-09-06-FW006	Yes		B-J	B9.11	N	MEDIUM	WCS-C-04	8.E-07	1.E-08	6B	0.01	0.01	4
WCS	2WCS-09-06-FW005	Ber		B-J	B9.11	N	MEDIUM	WCS-C-04	8.E-07	1.E-08	6B	0.01	0.01	4
WCS	2WCS-09-06-FW008	Ber		B-J	B9.11	N	HIGH	WCS-C-05	2.E-03	2.E-03	4	2.E-03	2.E-03	4

Table A-3 All 135 BER Welds & Summary of Analysis Results														
							Baseline RI-ISI Results					BER Evaluation		
System	Weld Number	BER	RI-ISI	CoCAT	CoITEM	DM	Cons Cat	Cons ID	CCDP	CLERP	RC	CCDP	CLERP	RC
WCS	2WCS-09-06-FW007	Yes		B-J	B9.11	N	HIGH	WCS-C-05	2.E-03	2.E-03	4	2.E-03	2.E-03	4
WCS	2WCS-09-06-FW022	Ber		na	na	N	HIGH	WCS-C-06	4.E-05	4.E-05	4	2.E-03	2.E-03	4
WCS	2WCS-09-14-SW028	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW029	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW027	Yes	Yes	B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW026	Ber	Yes	B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW030	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW017	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW018	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW025	Yes	Yes	B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW031	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW032	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW033	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW035	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW036	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW038	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW039	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW040	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW041	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW034	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-SW043	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW014	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW015	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW013	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW029	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW041	Yes		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW042	Ber		B-J	B9.11	TASCS	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW044	Yes		B-J	B9.11	TASCS, FAC	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW043	Ber		B-J	B9.11	TASCS, FAC	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW039	Yes		B-J	B9.11	TASCS, FAC	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B

Table A-3 All 135 BER Welds & Summary of Analysis Results

System	Weld Number	BER	RI-ISI	CoCAT	CoITEM	DM	Baseline RI-ISI Results					BER Evaluation		
							Cons Cat	Cons ID	CCDP	CLERP	RC	CCDP	CLERP	RC
WCS	2WCS-09-14-FW040	Yes		B-J	B9.11	TASCS, FAC	MEDIUM	WCS-C-07	1.E-05	4.E-07	5B	1.E-05	4.E-07	5B
WCS	2WCS-09-14-FW009	Ber		B-J	B9.11	FAC	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW032	Ber		B-J	B9.11	FAC	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-SW023	Ber		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-SW022	Yes		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW021	Ber		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW006	Ber		na	na	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW007	Ber		na	na	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW008	Ber		na	na	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW011	Ber		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW012	Ber		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW017	Ber		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW024	Ber		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW037	Yes		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW038	Yes		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B
WCS	2WCS-09-14-FW016	Ber		B-J	B9.11	N	MEDIUM	WCS-C-07	1.E-05	4.E-07	6B	1.E-05	4.E-07	6B

(1) surface examination only

Yes = Baseline RI-ISI Analysis

Ber = Included in BER Analysis

DM = Degradation Mechanism

RC = Risk Category

Table A-4 Delta Risk Summary When BER is Included in RI-ISI Program									
						Delta Risk (1/yr)			
	Risk		Degradation	Inspected		Best Estimate		No POD Improvement	
System	Category	Consequence	Mechanisms	SXI + BER	RI-ISI	CDF	LERF	CDF	LERF
FWS – Feedwater	2	High	TASCS	12	10	-2.5E-10	-1.3E-10	4.6E-11	2.4E-11
	4	High	None	2	5	-3.5E-12	-7.5E-14	-3.5E-12	-7.5E-14
	6 to 4	High	None	6	1	2.5E-10	2.5E-10	2.5E-10	2.5E-10
	5 to 2	High	TASCS	11	1	3.0E-09	3.0E-09	7.1E-09	7.1E-09
			TASCS,CC	4	0	2.4E-09	2.4E-09	4.0E-09	4.0E-09
			CC	2	1	1.0E-09	1.0E-09	1.0E-09	1.0E-09
Total						**6.4E-09**	**6.6E-09**	**1.2E-08**	**1.2E-08**
ICS – RCIC	2	High	TT, TASCS	4	3	-6.9E-11	-1.5E-12	2.3E-11	5.0E-13
	4	High	None	12	5	6.2E-11	5.6E-11	6.2E-11	5.6E-11
	6 to 4	High	None	2	0	1.0E-10	1.0E-10	1.0E-10	1.0E-10
	5	Medium	TT, TASCS	0	1	-2.5E-11	-9.0E-13	-1.4E-11	-5.0E-13
Total						**6.8E-11**	**1.5E-10**	**1.7E-10**	**1.6E-10**
MSS – Main Steam	4	High	None	45	12	3.8E-11	1.3E-11	3.8E-11	1.3E-11
	6 to 4	High	None	30	0	1.2E-09	1.2E-09	1.2E-09	1.2E-09
	5	Medium	TASCS	0	1	-2.2E-12	-7.2E-13	-1.2E-12	-4.0E-13
Total						**1.2E-09**	**1.2E-09**	**1.2E-09**	**1.2E-09**
WCS – RWCU	2	High	TASCS	0	5	-2.1E-10	-4.5E-12	-1.2E-10	-2.5E-12
	4	High	None	7	5	3.3E-11	3.1E-11	3.3E-11	3.1E-11
	6 to 4	High	None	2	0	1.0E-10	1.0E-10	1.0E-10	1.0E-10
	5	Medium	TASCS	25	3	9.6E-12	2.8E-13	2.2E-11	8.8E-13
			TASCS,FAC	4	0	2.4E-12	9.6E-14	4.0E-12	1.6E-13
Total						**-6.2E-11**	**1.3E-10**	**4.4E-11**	**1.3E-10**
Non BER Systems						**-5.8E-10**	**3.0E-10**	**9.5E-10**	**3.2E-10**
Total All Systems						**7.1E-09**	**8.4E-09**	**1.5E-08**	**1.4E-08**

Risk category 6 BER welds added to risk category 4 and risk category 5 BER added to risk category 2 based on the BER analysis.

SXI = Section XI

Table A-5 Delta Risk Summary for BER Scope Only									
						Delta Risk (1/yr)			
	Risk		Degradation	Inspected		Best Estimate		No POD Improvement	
System	Category	Consequence	Mechanisms	BER	RI-ISI	CDF	LERF	CDF	LERF
FWS – Feedwater	2	High	TASCS	6	5	-1.2E-10	-1.2E-10	2.3E-11	2.3E-11
	6 to 4	High	None	6	1	2.5E-10	2.5E-10	2.5E-10	2.5E-10
	5 to 2	High	TASCS	11	1	3.0E-09	3.0E-09	7.1E-09	7.1E-09
			TASCS,CC	4	0	2.4E-09	2.4E-09	4.0E-09	4.0E-09
			CC	2	1	1.0E-09	1.0E-09	1.0E-09	1.0E-09
Total						**6.6E-09**	**6.6E-09**	**1.2E-08**	**1.2E-08**
ICS – RCIC	2	High	TT, TASCS	0	0	0	0	0	0
	4	High	None	5	3	6.2E-11	6.0E-11	6.2E-11	6.0E-11
	6 to 4	High	None	2	0	1.0E-10	1.0E-10	1.0E-10	1.0E-10
	5	Medium	TT, TASCS	0	0	0	0	0	0
Total						**1.6E-10**	**1.6E-10**	**1.6E-10**	**1.6E-10**
MSS – Main Steam	4	High	None	16	5	1.3E-11	1.3E-11	1.3E-11	1.3E-11
	6 to 4	High	None	30	0	1.2E-09	1.2E-09	1.2E-09	1.2E-09
	5	Medium	TASCS	0	0	0	0	0	0
Total						**1.2E-09**	**1.2E-09**	**1.2E-09**	**1.2E-09**
WCS – RWCU	2	High	TASCS	0	0	0	0	0	0
	4	High	None	4	1	3.5E-11	3.2E-11	3.5E-11	3.2E-11
	6 to 4	High	None	2	0	1.0E-10	1.0E-10	1.0E-10	1.0E-10
	5	Medium	TASCS	25	3	9.6E-12	3.8E-13	2.2E-11	8.8E-13
			TASCS,FAC	4	0	2.4E-12	9.6E-14	4.0E-12	1.6E-13
Total						**1.5E-10**	**1.3E-10**	**1.6E-10**	**1.3E-10**
Total BER Systems						**8.1E-09**	**8.1E-09**	**1.4E-08**	**1.4E-08**

Risk category 6 BER welds added to risk category 4 and risk category 5 BER added to risk category 2 based on the analysis.

APPENDIX B

Calvert Cliffs Nuclear Power Plants (CCNPP)

Application

B.1 Introduction

This appendix presents the application of the risk-informed inservice inspection (RI-ISI) process to break exclusion regions (BER) augmented inspection programs. The purpose of this appendix is to assess the BER augmented inspection program at a pressurized water reactor (PWR) plant. Appendix A to this report provides an example application to a boiling water reactor (BWR) plant.

B.2 Calvert Cliff Nuclear Power Plant (CCNP) BER Program

Consistent with the Standard Review Plan (SRP, References B1 and B2), pipe breaks are not postulated in certain high-energy lines that are normally pressurized during power operation. This is referred to as break exclusion region piping (BER) in this report and at CCNPP it is designated as high-energy line break (HELB) piping. CCNPP has committed to inspect 100% of BER (BER is used in place of HELB in this analysis) piping welds that are not encapsulated every 10-year interval (Reference B4, UFSAR Section 10A.1.5).

B.3 PWR Plant Application

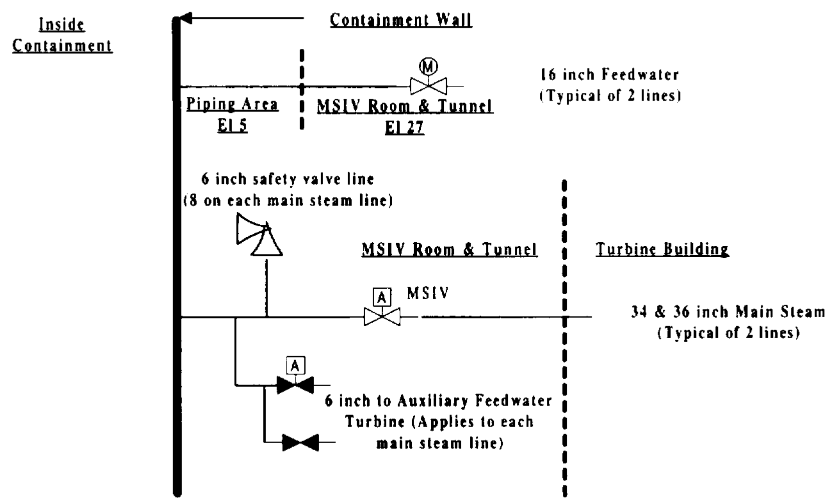
B.3.1 CCNPP, Units 1 and 2

CCNPP is a two-unit site. Both units are approximately 830 megawatts (electric). Each unit consists of a 2 loop pressurized water reactor and the containment for each unit is of the large dry type. Commercial operation began in 1975 for Unit 1 and in 1977 for Unit 2. The NSS supplier was Combustion Engineering and the A/E was Bechtel.

B.3.2 Scope of Application

The BER scope at CCNPP includes welds outside containment in the main steam and feedwater systems (MS and FW). These systems provide the secondary heat removal function by supplying water to the Steam Generators and carrying steam from the Steam Generators to the turbine.

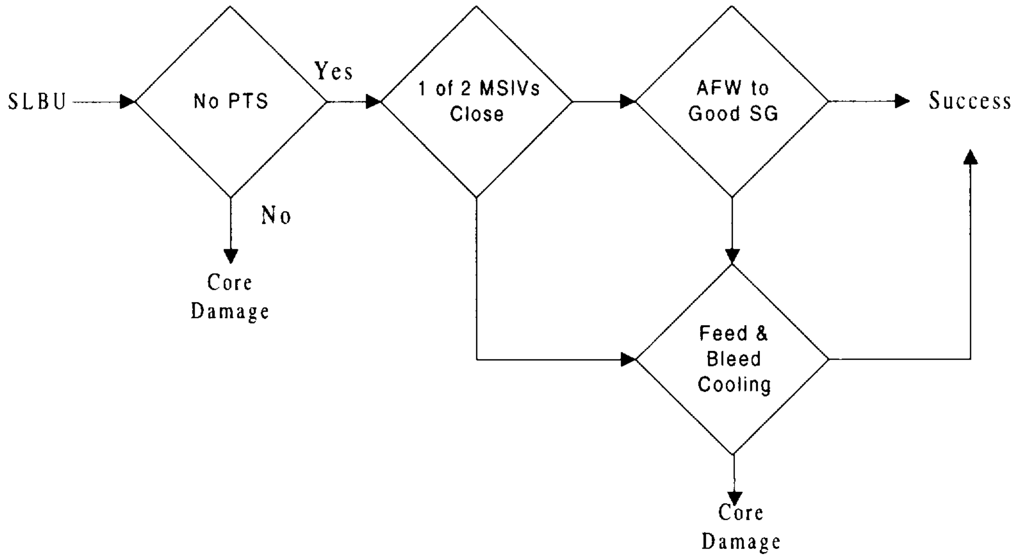
The following simplified diagram identifies the piping under evaluation.



B.3.3 Consequence Evaluation

The baseline RI-ISI consequence evaluation is judged to represent the best estimate consequence assessment associated with the BER scope of piping. Tables B-1 and B-2 summarize the baseline RI-ISI consequence evaluation results for the BER scope. The baseline RI-ISI consequence analysis was conducted per Reference B6. This analysis included consideration of initiating event impacts (e.g. Tables 3-2 and 3-3 of the main body of this report), plant specific PRA success criteria (See Below), and containment performance (e.g. containment bypass per Table 3-3). The evaluation contained in this Appendix determines and documents changes to these baseline consequence results based on the BER evaluation criteria in the main report and using the same acceptance criteria described in the main report. For example, if a CCDP increases to greater than 1E-4 CCDP, the consequence would be revised from "Medium" to "High". The evaluation results are summarized in Tables B-1 and B-2.

The following provides a simple explanation of success paths (e.g., immediate reactor trip is required and not shown) for an unisolable main steam line break upstream of a MSIV (SLBU) in the MSIV room. This simple drawing can be used to explain the 7E-5 CCDP for such breaks in the baseline RI-ISI evaluation. This BER evaluation of the "beyond design basis double ended guillotine break" of large non-encapsulated pipe assumes that both MSIVs fail to close. Thus, the CCDP for this event is controlled by the probability that operators do not provide feed and bleed cooling (once through cooling) before core damage occurs. A 0.1 CCDP is used for these beyond design basis events, which also includes consideration of potential spatial impacts.



To conservatively incorporate the BER Program into the RI-ISI Program, the RI-ISI baseline evaluation will be supplemented per the criteria discussed in the main body of this report. To accomplish this supplemental evaluation in a cost-effective manner, engineering judgments are made based on existing plant calculations and design, and as necessary additional conservative assumptions are made.

To conduct this evaluation, Reference B4 was reviewed to assess the plant design and analysis relative to BER criteria. Table B-1 summarizes this review for BER piping sections. Among the actions taken by CCNPP to respond to BER criteria are:

- Protecting the containment and other structures by encapsulating postulated pipe break locations and providing pipe whip restraints.
- Providing a large vent in the MSIV room thereby protecting it from over pressurization and propagation of steam into adjacent safety related rooms.
- Postulating pipe breaks and cracks, providing jet impingement protection and qualification of equipment. As discussed in the main body of this report, SRP pipe break criteria do not require pipe breaks to be postulated in low stress areas, however in application of RI-ISI to BER programs, these break are conservatively postulated (i.e. beyond SRP requirments).

As is typical in a RI-ISI evaluation, both core damage and containment performance (CCDP and CLERP) are considered. Due to the BER piping configuration, the failure of one containment isolation barrier can not be prevented for postulated breaks between the containment wall and the outside isolation valve. However, a passive failure of piping inside the containment coincident with the BER failure is required to fail the containment isolation function.

Based on the above design review and consideration of Reference B6, most of the BER scope piping will have no change in its consequence assignment as determined in the baseline RI-ISI evaluation. The following discussion and the information provided in Table B-1 summarizes why this is so:

1. All postulated break locations have been encapsulated in guard pipe. Therefore, all encapsulated piping is designed and analyzed such that there is no impact on the consequences evaluated. This is true for the double-ended guillotine break (DEGB).
2. Four and six inch non-encapsulated branch connections are analyzed in Reference B4. These smaller dead end pipe connections are not judged to represent a significant pipe whip concern and they can not impact the larger piping. There is no impact on the baseline consequence evaluation.
3. Longitudinal (slot) breaks are also postulated and analyzed in Reference B4. Thus, postulated seam weld failures in the BER scope are evaluated; a DEGB scenario does not apply to seam welds.
4. Breaks in the turbine building have been evaluated in Reference B4 and can be shown to have no impact on the baseline consequence evaluation.

The remaining BER scope consists of large (main flow path) non-encapsulated main steam and feedwater circumferential welds. As stated above, if one were to use SRP criteria, this piping would be assumed <u>not</u> to fail (i.e. the piping meets the SRP low stress criteria). However, if this piping is postulated to fail catastrophically as required by the RI-ISI application to BER programs, it could result in additional beyond design basis consequences. This remaining piping is evaluated further below:

- Because there is an installed vent and a weaker wall by design into the turbine building, over pressurization of the MSIV room into adjacent safety areas is unlikely.
- Jet impingement and pipe whip could impact walls causing propagation into adjacent areas. Although additional analysis may prove this to be unlikely, it was conservatively assumed that propagation would occur.
- For purposes of this evaluation, the DEGB event can be considered unanalyzed (i.e., pipe whip and jet impingement could cause failure of the MSIV room wall and propagate to adjacent safety-related areas) for this remaining non-encapsulated pipe and additional impact on mitigating systems must be considered further. For this piping, a high CCDP (0.1) and CLERP (6E-3) is used. The CLERP value is based on the containment performance CLERP/CCDP value of 6E-2 from the baseline RI-ISI. This is reasonable because the containment penetration is protected and analyzed and there is a passive pipe boundary inside containment. The 0.1 CCDP is based on conservative engineering judgment for an event that has not been analyzed.

Table B-1 summarizes both the baseline RI-ISI consequence evaluation and this BER consequence evaluation. Table B-2 summarizes the revised CCDP/CLERP values based on this

BER evaluation. As shown, some pipe segments have moved from "Medium" to "High" consequence. The following summarizes the BER evaluation:

1. For the beyond design basis DEGB case above, no credit is taken for the outside containment isolation valves in the MSIV room even though they are qualified for breaks postulated in accordance with SRP criteria. However, there is a passive pipe barrier inside containment to ensure containment isolation. There is also a check valve inside containment in each feedwater line. For this large piping, which is not encapsulated and not analyzed for a DEGB, a high CCDP (0.1) and CLERP (6E-3) is used as described above.
2. The highest CCDP (7E-5) and CLERP (4E-6) in the baseline RI-ISI evaluation is used for piping that is encapsulated and/or analyzed as part of the design basis (e.g., DEGB for circumferential weld and longitudinal break for seam welds). This incorporates no credit for the outside isolation valve in the applicable steam line as a containment isolation barrier and treats all breaks as an unisolable steam line break (i.e., a break between containment wall and MSIV). As shown in Tables B-1 and B-2, this has no impact on the consequence assignment.

Table B-2 summarizes the results of the BER consequence evaluation including the number of welds effected. Tables B-3 and B-4 list the BER scope piping for both units with the following information:

- **BER**: a "1" indicates that the weld is being inspected as part of the BER program.
- **RI-ISI**: a "1" indicates that the weld was selected as part of RI-ISI program, based on BER considerations.
- **Encapsulated**: a "yes" indicates that the weld is encapsulated and needs no further evaluation. A "no" indicates that weld is not encapsulated and requires further evaluation.
- **Consequence**: this column provides the baseline RI-ISI consequence ID.
- **New Impact**: either "no" or "yes" is provided with a basis indicated for each. Note that even for the "no" cases, CCDP and CLERP are set to values consistent with not taking credit for the outside containment isolation valve.
- **CCDP & CLERP**: values are provided based on the baseline consequence evaluation as adjusted above.

B.3.4 Degradation Mechanism Evaluation

As discussed in section 3.4 of the main report, the existing RI-ISI degradation mechanism evaluation process captures all of the mechanisms of interest from a BER perspective. In addition, plant specific RI-ISI applications review past inspection history to assure actual operating experience is consistent with the results of the degradation mechanism evaluation. This has been completed for the CCNPP application with no changes identified as being required to the degradation mechanism evaluation. There are no degradation mechanisms identified for this scope of piping.

B.3.5 Risk Ranking

As discussed in section 3.5 of the main report, risk segments are defined based upon the results of the consequence and degradation mechanism evaluations. As shown in Table B-1 all the BER scope piping was determined to have a "Medium" consequence in the baseline evaluation. Thus, all the BER scope piping was risk category 6 in the baseline evaluation (no degradation mechanism per Section B.3.4). Table B-2 provides the results of the risk ranking effort for this BER application. Table B-2 identifies the segments that move from risk category 6 to risk category 4 as a result of this evaluation. The following summarizes the risk ranking before and after the BER evaluation when the complete scope of Section XI and BER programs are integrated. Risk ranking for the "BER Only" scope is also summarized below:

Evaluation	System	Number of Welds by Risk Category Unit1 (Unit 2)				
		1 through 3	4	5	6	7
Traditional RI-ISI	MSS	0	0	0	280 (243)	0
	FWS	0	0	11 (10)	50 (41)	0
Traditional + BER	MSS	0	16 (10)	0	264 (233)	0
	FWS	0	4 (4)	11 (10)	46 (37)	0
BER Only Scope	MSS	0	16 (10)	0	226 (199)	0
	FWS	0	4 (4)	0	15 (11)	0

As shown, the only change from the traditional RI-ISI evaluation is the movement of welds from Risk Category 6 to 4.

B.3.6 Element Selection

The element selection process described in section 3.6 of the main report requires that both the integrated RI-ISI results (Traditional + BER) and the BER Only scope be considered in determining the number of welds to be selected. As shown in section A.3.5, both cases require the following additional weld selections:

- FWS: one weld must be selected from Risk Category 4.
- MSS: two welds (one for Unit 2) must be selected from Risk Category 4.

There is also a caution in section 3.6 of the main report that an inspection population significantly below 10% should not be expected unless plant design features have been incorporated to specifically address assumed breaks in the BER region. For the CCNPP application, the following provides a summary comparison for Unit 1 (Unit 2 is in parentheses when different):

Weld Scope	Number Of Welds	Number of Inspections		Percent This Evaluation	Number of Inspections Based on 10% Criteria
		Old Program	This Evaluation		
Encapsulated	84 (55)	0	0	NA	NA
Non Encapsulated	177 (169)	177 (169)	3 (2)	1.7 (1.2)	18 (17)

Total	261 (224)	-	-	-	27 (23)

Based on the CCNPP application, only 1 to 2 percent of inspectable (non-encapsulated) welds must be inspected for BER purposes. Plant specific design features and analysis justifies this result as summarized below:

- 32% (25% for Unit 2) of the BER total population is the more important large encapsulated piping. The plant chose this design approach with additional analysis and qualification of equipment to ensure low risk rather than performing ISI inspections. Thus, it can be concluded that by design more than 32% (25% Unit 2) of the BER scope, which is also the most important piping (DEGB could cause most harm) is still protected and is equivalent or possibly better than the additional ISI option.
- 60% (69% Unit 2) of the BER total population is non-encapsulated smaller piping or seam welds. The plant has been analyzed for these breaks rather than just designating the pipe BER and doing nothing (an option). Picking no welds for inspection for this scope is justified based on the plant specific design and analysis (demonstrates very low risk).
- 8% (6% Unit 2) of the BER total population is non-encapsulated large piping where a DEGB is beyond the design basis and unanalyzed. These large circumferential welds are judged to be the most risk significant based on this evaluation. More than 10% of this scope has been chosen for inspection in accordance with element selection criteria (10% of risk category 4).

As seen in the table below, plant design features and the inspection determined via the RI-ISI application provide significant margin with respect to BER effects. The delta risk assessment in section B.3.7.2 further demonstrates the non-risk significant impact of the above element selection results.

Total No. of Welds	No. of Welds Encapsulated	No. of Welds Selected for Inspection	Encapsulated plus Inspections	Percent of Total
Unit 1 – 261	84	3	87	33
Unit 2 – 224	55	2	57	25

B.3.7 Risk Impact Assessment

Two types of risk assessments are presented in this section. In Section B.3.7.1, a traditional risk assessment of the BER topic is performed to estimate the frequency of core damage and large, early release frequency (CDF and LERF). The purpose of this assessment is to provide a perspective on the relative risk significance of the BER topic irrespective of the inspection sample size. In Section B.3.7.2, a change in risk (delta risk) assessment is performed on the proposed BER inspection program in accordance with Regulatory Guide 1.174 (Reference B5) and the EPRI TR-112657 criteria (Reference B6).

B.3.7.1 Plant Specific Risk Assessment of the BER Topic

This risk assessment considers the frequency of the more likely pipe breaks (i.e., non-DEGB) as described in NUREG/CR-5750 (Reference B7). Then, the DEGB case is also evaluated. The following assumptions are used in the assessment provided in this section:

- The frequency (event/year) for steam line or feedwater line break/leak (PBF) used in this analysis is 1E-3/year based on NUREG/CR-5750 (Reference B7) and as summarized below:
  - For steam line break/leak inside containment (SLBI, K3), a value of 1E-3/year is recommended based on no events in the experience database.
  - For steam line break/leak outside containment (SLBO, K1), a value of 1E-2/year is recommended based on 7 events in the database. However, most of the events contained in the database are on smaller piping (e.g., 1 to 3 inch nominal pipe size) and did not occur in the BER scope (see Table 3-7 in main report). A value of 1E-3/year is used based on no significant events in the BER scope (i.e., similar to SLBI with no events).
  - For feedwater line break/leak (FLB, K2), a value of 3.4E-3/year is recommended based on 2 events in the database. However, both events resulted in manual scram, which indicates the events were not large breaks. In addition, they occurred in reheater (2 inch) and moister separator (8 inch) lines, which are not in the portion of main feedwater designed to BER requirements. A value of 1E-3/year is used based on no significant events in the BER scope (i.e., similar to SLBI with no events).

- In this analysis, the BER scope is a smaller scope of piping versus all feedwater and main steam piping, and the BER piping is designed to more stringent standards than the non-safety related piping in the turbine building. Therefore the failure frequency of 1E-3/year used in the analysis is overly conservative.
- That portion of BER piping connected to the containment penetration is encapsulated, restrained, designed, and analyzed to ensure that the containment penetrations as well as other structures and equipment are protected and qualified (Reference B4).
- Failure of small piping connections to main steam (e.g., safety valves, auxiliary feedwater, and etc.) are judged to be within the Reference B4 analysis in that adjacent walls are protected and safe shutdown can be assured.
- CCDP and CLERP values are based on the CCNPP PRA and are provided in the baseline consequence evaluation.

Pipe Break/Leak Risk Assessment

As shown in Table B-1, the baseline RI-ISI evaluation shows that the BER scope of piping is expected to have a "Medium' Consequence. Plant design protects containment and other safety related areas, and equipment in the MSIV room is also protected and/or qualified for this more likely pipe break. Thus, the CCDP and CLERP values in Table B-1 can be used for this evaluation. CDF and LERF is the product of these consequence ranks and pipe break failure frequency.

Utilizing the highest CCDP and CLERP in Table B-1 from the baseline consequence evaluation, the following risk can be estimated:

CDF = PBF * CCDP = 1E-3/year * 7E-5 = 7E-8/year

LERF = PBF * CLERP = 1E-3/year * 4E-6 = 4E-9/year

These results satisfy a low risk conclusion.

DEGB Assessment

For the DEGB assessment, the following additional assumptions beyond those discussed above apply:

- Based on Reference B4, a double-ended-guillotine break (DEGB) would be necessary in non-encapsulated piping to create sufficiently extreme loads (e.g., pipe whip and jet impingement) to effect adjacent auxiliary building structures. Encapsulated pipe and smaller branch connections have been analyzed for BER type of breaks (i.e., DEGB).
- The frequency of DEGB is <<1E-3/year (the value for break/leak in NUREG/CR-5750 for SLB). Comprehensive studies (References B9 and B10) have shown that the frequency of a double-ended guillotine break is extremely low (~1E-10/year).

- Seam welds are not judged to present a DEGB risk as longitudinal (slot) breaks are analyzed in Reference B4 to assure that walls are protected and safe shutdown can be assured.
- For DEGB, credit is taken for the MSIV room and steam tunnel venting to the turbine building (and the installed vent to atmosphere) such that adjacent walls will not fail due to over pressure. Reference B4 conservatively neglected the relief path to the turbine building and it may not be needed (an analysis to determine whether it is required for the non-encapsulated circumferential DEBG case has not been performed).
- No credit is taken for containment isolation valves outside containment even though they are qualified for breaks in encapsulated piping, slot breaks in non encapsulated piping, and other smaller line breaks (e.g., safety valve lines and auxiliary feedwater steam supply lines).
- Unisolated breaks in the MSIV room or steam tunnel or turbine building are assumed to fail all equipment in the turbine building due to spatial impacts.
- If core damage occurs due to a break outside containment, there is a passive pipe barrier inside containment (also a check valve in the feedwater lines). In addition, as described above, plant design ensures that the containment penetration is protected.
- A transient (e.g., turbine trip) induced pipe failure event is assumed to be bounded by the SLB and FLB frequency used in this analysis. The probability of pipe failure over a reduced exposure time, given an independent initiating event is judged to be comparable or smaller than assumed in this analysis.
- An induced steam generator tube rupture due to a SLB or FLB is judged to be an unlikely contributor to LERF. A high-pressure core damage event is required and it must occur early relative to releases. Even if a limited number of tubes did break or leak, the CCDP value would not increase significantly and it would take numerous tube failures to cause a large release. These scenarios are judged to be comparable to or smaller in frequency than those already evaluated.

<u>DEGB Risk Assessment</u>

Based on the above evaluations, a DEGB in the non-encapsulated large piping in the MSIV/Steam tunnel areas is addressed. The pipe break/leak risk assessment above addresses all other piping. The following summarizes:

- Only the larger piping that is not encapsulated and that has not been analyzed for DEGB relative to pipe whip and jet impingement are likely to have a "High" consequence (CCDP greater than 1E-4). This piping is identified in Table B-1 by footnote (1).
- The frequency of DEGB is judged to be less than 1E-8/year as described above. Based on References B9 and B10, this frequency is more likely to be much less than 1E-8/year particularly when the fraction of piping of concern is evaluated more carefully.
- As described previously, failure of all safe shutdown trains due to steam propagation into adjacent areas is unlikely due to separation and the design of the MSIV room (large vent to

atmosphere and turbine building). Also, the walls may be capable of withstanding the loads. Thus, a CCDP value of at least 0.1 or less is judged likely.

Without additional detailed analysis, CDF risk is clearly less than 1E-8/year, which is considered a low risk.

B.3.7.2 Change in Risk Assessment for the Proposed BER Inspection Program

This assessment estimates the change in risk between the present augmented inspection program and the proposed risk-informed inservice inspection program for BER scope of piping. Limits are imposed by the EPRI Methodology (TR-112657, Reference B6) to ensure that changes to the ISI Program meet the requirements of Regulatory Guide 1.174 (Reference B5). Licensing commitment changes must result in a risk reduction or an increase in risk must be small enough to be considered risk neutral. With regard to increases, the criteria established requires the cumulative change in core damage frequency (CDF) and large, early release frequency (LERF) be less than 1E-7 and 1E-8 per year per system, respectively. If this is not met for all systems, the total CDF and LERF should not exceed 1E-6 and 1E-7, respectively.

The analysis presented herein is conducted in accordance with the EPRI RI-ISI Methodology (Reference B6). All the welds in the CCNPP BER Program are listed in Tables B-3 and B-4. A "1" in the BER column of Tables B-3 and B-4 identifies those welds being inspected under the ASME Section XI and BER programs. A "1" in the RI-ISI column indicates those welds chosen for inspection as a result of implementing Reference B6.

The change in risk between the two inspection programs is estimated with the following equation per Reference B6:

$$\Delta R = N_s*POD_s*R - N_r*POD_r*R$$

Where: N_s is the number of inspections in the existing Section XI program

N_r is the number of inspections in the proposed RI-ISI program

POD_s is the probability of detection associated with the existing Section XI program

POD_r is the probability of detection associated with the proposed RI-ISI program

R is the risk associated with the inspected location (independent of ISI program)

Two calculations are performed as summarized below:

- Best Estimate – based on an improved POD for RI-ISI.
- No POD Improvement – no credit for POD improvement.

Break frequencies are based on References 9 and 14 of the methodology (Reference B6) where 1E-8/weld year is used when there is no degradation mechanism and 2E-7/weld year is used when there is a degradation mechanism other than FAC.

CCDP and CLERP values estimated in the consequence evaluation, as adjusted in Section B.3.3 and Tables B-3 and B-4) are used for all calculations.

The PODs used in the calculations are as follows (Reference B6):

- The "No POD Improvement" case utilizes a POD equal to 0.5 for all examinations.
- The "Best Estimate" case that credits POD improvements utilize the following POD:
  - Section XI welds with Thermal Fatigue identified use POD=0.3
  - RI-ISI welds with Thermal Fatigue identified use POD=0.9
  - All other welds use POD=0.5

The following summarizes the results of the assessment (delta risk is in events/year):

Δ Risk Case	Unit 1		Unit 2	
	Δ CDF	Δ LERF	Δ CDF	Δ LERF
Best Estimate	8.5E-9	5.1E-10	6.0E-9	3.6E-10
No POD Improvement	8.5E-9	5.1E-10	6.0E-9	3.6E-10

Note that for the CCNPP application, no degradation mechanism was identified for the BER scope piping. Therefore, the "No POD Improvement" and "Best Estimate" cases are equivalent.

As shown in the above table there is a small increase in CDF and LERF risk from implementing the RI-ISI program. The 1E-7 and 1E-8 criteria for CDF and LERF at the system level are met.

From a sensitivity perspective, the low risk conclusion is most sensitive to the 0.1 CCDP value used for a non encapsulated DEGB of large piping. The 0.1 value is based upon judgments as to the propagation of the DEGB event. For example, if the CCDP value is reduced to 0.01, the change in CDF risk decreases to 8.5E-10/year for Unit 1 (6E-10 for Unit 2). Also, if this CCDP is set to 1.0, as there does not currently exist analysis/documentation that limits propagation of this DEGB, CDF risk increases to 8.5E-8/year for Unit 1 (6.0E-8 for Unit 2). This shows that the CCNPP design has significantly reduced the potential risk from the BER scope of piping.

B.4 Summary and Conclusions

The following summarizes the results and conclusions of the above evaluation:

- Plant specific design features mitigate a large number of postulated breaks.

- The risk (CDF/LERF) associated with the BER program is estimated at <1E-7/year, which is a low risk.
- The change in risk due to the proposed inspection program is <1E-8/year.
- The re-definition of the BER inspection sample size is considered risk neutral per Regulatory Guide 1.174 and EPRI TR-112657 criteria.

B.5 References

B1 NUREG-0800, Rev 1-July 1981, SRP 3.6.1 "Plant Design For Protection Against Postulated Piping Failures in Fluid Systems Outside Containment" including Branch Technical Position ASB 3-1

B2 NUREG-0800, Rev 1-July 1981, SRP 3.6.2 "Determination of Rupture Locations and Dynamic Effects Associated With the Postulated Rupture of Piping" including Branch Technical Position MEB 3-1

B3 NUREG-0800, Rev 1-July 1981, SRP 6.6 "Inservice Inspection of Class 2 and 3 Components"

B4 CCNPP UFSAR, Revision 26, Appendix 10A

B5 RG 1.174, July 1998, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis"

B6 EPRI TR-112657 "Revised Risk-Informed Inservice Inspection Evaluation Procedure" Final Report, Rev. B-A, December 1999.

B7 NUREG/CR-5750, "Rates of Initiating Events at U.S. Nuclear Power Plant: 1987-1995" 2/99

B8 Not used

B9 NUREG/CR-4792 Volume 2, "Probability of Failure in BWR Reactor Coolant Piping" 3/89

B10 NUREG-1061 Volume 3, "Report of the USNRC Piping review Committee – Evaluation of Potential for Pipe Break" 11/84

Table B-1 **RI-ISI Results & BER Evaluation Summary**

System	RI-ISI Consequence Summary					BER Evaluation Summary (6)		
	ID	Category	CCDP	CLERP	Segment Description	Encapsulated	Pipe Sizes	DEGB BER Impact on RI-ISI
FW	FW1A	Medium	5E-5	2E-6	Upstream of MOV-4516 in MSIV Room	No	16 inch FW	Assume failure of walls, unanalyzed, CDF (1)
	FW1	Medium	5E-5	2E-6	Downstream of MOV-4516 in MSIV Room	No	16 inch FW	Assume failure of walls, unanalyzed, CDF (1)
						Yes	16 inch FW	No impact (2)
	FW2	Medium	5E-5	2E-6	Downstream of MOV-4516 in SE Piping Area	Yes	16 inch FW	No impact (2)
	FW5A	Medium	5E-5	2E-6	Upstream of MOV-4517 in MSIV Room	No	16 inch FW	Assume failure of walls, unanalyzed, CDF (1)
	FW5	Medium	5E-5	2E-6	Downstream of MOV-4517 in MSIV Room	No	16 inch FW	Assume failure of walls, unanalyzed, CDF (1)
						Yes	16 inch FW	No impact (2)
	FW6	Medium	5E-5	2E-6	Downstream of MOV-4517 in SE Piping Area	Yes	16 inch FW	No impact (2)
MS	MS2	Medium	7E-5	4E-6	Upstream of CV-4043 & MOV-4070 in MSIV Room	No	34 & 36 inch MS	Assume failure of walls, unanalyzed, CDF (1)
							34 & 36 inch Seam	No impact (3)
							6 inch to AFW	No Impact (5)
							6 inch SV lines	No Impact (5)
							4 inch drain	No Impact (5)
						Yes	34 inch MS	No impact (2)
	MS2A	Medium	2E-5	1E-6	Downstream of CV-4043 in MSIV Room	No	34 inch MS	Assume failure of walls, unanalyzed, CDF (1)
							34 inch Seam	No impact (3)
							4 inch drain	No Impact (5)
						Yes	34 inch MS	No impact (2)
	MS2B	Medium	2E-5	1E-6	Downstream of CV-4043 in Turbine Building	No	34 inch MS	No impact (4)
	MS4	Medium	7E-5	4E-6	Upstream of CV-4048 & MOV-4071 in MSIV Room	No	34 & 36 inch MS	Assume failure of walls, unanalyzed, CDF (1)
							34 & 36 inch Seam	No impact (3)
							6 inch to AFW	No Impact (5)
							6 inch SV lines	No Impact (5)
							4 inch drain	No Impact (5)

System	RI-ISI Consequence Summary					BER Evaluation Summary (6)		
						Yes	34 inch MS	No impact (2)
	MS4A	Medium	2E-5	1E-6	Downstream of CV-4048 in MSIV Room	No	34 inch MS	Assume failure of walls, unanalyzed, CDF (1)
							34 inch Seam	No impact (3)
							4 inch drain	No Impact (5)
						Yes	34 inch MS	No impact (2)
	MS4B	Medium	2E-5	1E-6	Downstream of CV-4048 in Turbine Building	No	34 inch MS	No impact (4)
							4 inch drain	No Impact (5)

Notes:

(1) DEGB not postulated due to BER criteria (e.g., low stresses and not terminal end). Failure of auxiliary building walls and core damage is more likely. Containment penetration is protected by design.

(2) Encapsulated pipe is designed and analyzed to ensure safety equipment is protected from DEGB.

(3) Design and analysis considers horizontal breaks, which would apply to seam weld (safe shutdown is ensured).

(4) Pipe in turbine building analyzed to ensure safety equipment is protected from DEGB.

(5) Smaller lines connected to MS are analyzed and designed for circumferential break (single ended) to ensure safety equipment is protected.

(6) A break in the BER piping between the containment and outside containment isolation valve would impact the containment isolation function. In other words, the design and analysis appears to satisfy the BER analysis criteria, but the containment isolation function is effected. The BER RI-ISI requires that DEGB be assumed for all welds (e.g., low stress areas), which results in unanalyzed beyond design basis conditions (see note 1).

Table B-2 RI-ISI Results & BER Recommended CCDP/CLERP and Number of Welds

System	RI-ISI Consequence Summary					BER Evaluation Summary CCDP/CLERP and Number of Welds (note 1)			
	ID	Category	CCDP	CLERP	Segment Description	Encapsulated	Pipe Sizes	CCDP/CLERP	# of Welds Unit 1(Unit 2)
FW	FW1A	Medium	5E-5	2E-6	Upstream of MOV-4516 in MSIV Room	**No**	**16 inch FW**	**0.1/6E-3**	2 (1)
	FW1	Medium	5E-5	2E-6	Downstream of MOV-4516 in MSIV Room	**No**	**16 inch FW**	**0.1/6E-3**	0 (1)
						Yes	16 inch FW	7E-5/4E-6	2 (1)
	FW2	Medium	5E-5	2E-6	Downstream of MOV-4516 in SE Piping Area	Yes	16 inch FW	7E-5/4E-6	9 (7)
	FW5A	Medium	5E-5	2E-6	Upstream of MOV-4517 in MSIV Room	**No**	**16 inch FW**	**0.1/6E-3**	2 (1)
	FW5	Medium	5E-5	2E-6	Downstream of MOV-4517 in MSIV Room	**No**	**16 inch FW**	**0.1/6E-3**	0 (1)
						Yes	16 inch FW	7E-5/4E-6	2 (1)
	FW6	Medium	5E-5	2E-6	Downstream of MOV-4517 in SE Piping Area	Yes	16 inch FW	7E-5/4E-6	2 (2)
MS	MS2	Medium	7E-5	4E-6	Upstream of CV-4043 & MOV-4070 in MSIV Room	**No**	**34 & 36 inch MS**	**0.1/6E-3**	4 (3)
							34 & 36 inch Seam	7E-5/4E-6	7 (8)
							6 inch to AFW	7E-5/4E-6	16 (16)
							6 inch SV lines	7E-5/4E-6	40 (40)
							4 inch drain	7E-5/4E-6	1 (1)
						Yes	34 inch MS	7E-5/4E-6	26 (17)
	MS2A	Medium	2E-5	1E-6	Downstream of CV-4043 in MSIV Room	**No**	**34 inch MS**	**0.1/6E-3**	2 (2)
							34 inch Seam	7E-5/4E-6	4 (4)
							4 inch drain	7E-5/4E-6	0 (1)
						Yes	34 inch MS	7E-5/4E-6	7 (4)
	MS2B	Medium	2E-5	1E-6	Downstream of CV-4043 in Turbine Building	No	34 inch MS	7E-5/4E-6	9 (9)
	MS4	Medium	7E-5	4E-6	Upstream of CV-4048 & MOV-4071 in MSIV Room	**No**	**34 & 36 inch MS**	**0.1/6E-3**	6 (2)
							34 & 36 inch Seam	7E-5/4E-6	5 (6)
							6 inch to AFW	7E-5/4E-6	16 (15)
							6 inch SV lines	7E-5/4E-6	40 (40)
							4 inch drain	7E-5/4E-6	1 (1)
						Yes	34 inch MS	7E-5/4E-6	29 (17)

System	RI-ISI Consequence Summary					BER Evaluation Summary CCDP/CLERP and Number of Welds (note 1)			
	MS4A	Medium	2E-5	1E-6	Downstream of CV-4048 in MSIV Room	No	34 inch MS	0.1/6E-3	4 (3)
							34 inch Seam	7E-5/4E-6	8 (6)
							4 inch drain	7E-5/4E-6	0 (1)
						Yes	34 inch MS	7E-5/4E-6	7 (6)
	MS4B	Medium	2E-5	1E-6	Downstream of CV-4048 in Turbine Building	No	34 inch MS	7E-5/4E-6	9 (7)
							4 inch drain	7E-5/4E-6	1 (0)
								Total	261 (224)

Note 1 - CCDP/CLERP are used for delta risk analysis. Those sections of pipe (welds) shaded are moved from "Medium" to "High" consequence for element selection.

Table B-3 CCNPP Unit 1 BER Welds

ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
34-MS-1201 / 34-EB12-1001	1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	3			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	3LD			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	4LU			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	4			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	4LD-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	4LD-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	5LU-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	5LU-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	5			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	5LD			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	6LU			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	6			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	6LD			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	6/6-MS-1207			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	6BC-1			yes	MS2	No - Encap	7.0E-05	4.0E-06

Table B-3 CCNPP Unit 1 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
34-MS-1201 / 34-EB12-1001	7LU			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	7			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	7LD-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	7LD-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	8LU-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	8LU-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	8			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	8LD-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	8LD-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	8ALU-1	1		No	MS2	No - Seam	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	8ALU-2	1		No	MS2	No - Seam	7.0E-05	4.0E-06
34-MS-1201 / 34-EB12-1001	8A	1		No	MS2	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1201 / 34-EB12-1001	8ALD	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1	1		No	MS2	Yes - DEGB	1.0E-01	6.0E-03
36-MS-1201 / 36-EB12-1001	1LD	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1/6-RV-3992	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1/6-RV-3993	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1/6-RV-3994	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1/6-RV-3995	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1/6-RV-3996	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1/6-RV-3997	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1/6-RV-3998	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	1/6-RV-3999	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	2LU	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	2	1		No	MS2	Yes - DEGB	1.0E-01	6.0E-03
36-MS-1201 / 36-EB12-1001	2LD	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	2BC-4	1		No	MS2	No - 4 Inch	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	3LU	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-1201 / 36-EB12-1001	3	1	1	No	MS2	Yes - DEGB	1.0E-01	6.0E-03
6-RV-3992	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3992	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06

Table B-3 CCNPP Unit 1 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
6-RV-3992	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3992	4	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3993	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3993	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3993	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3993	4	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3994	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3994	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3994	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3994	4	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3995	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3995	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3995	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3995	4	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3996	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3996	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3996	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3996	4	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3997	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3997	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3997	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3997	4	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3998	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3998	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3998	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3998	4	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3999	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3999	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3999	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-RV-3999	4	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	9			Yes	MS2A	No - Encap	7.0E-05	4.0E-06

Table B-3 CCNPP Unit 1 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
34-MS-1201 / 34-EB1-1001	9LD-1			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	9LD-2			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	10LU-1			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	10LU-2			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	10			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	10LD	1		Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	11LU	1		No	MS2A	No - Seam	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	11	1		No	MS2A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1201 / 34-EB1-1001	11LD	1		No	MS2A	No - Seam	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	12LU	1		No	MS2A	No - Seam	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	12	1		No	MS2A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1201 / 34-EB1-1001	12LD	1		No	MS2A	No - Seam	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	13LU	1		No	MS2B	No -TB	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	13	1		No	MS2B	No -TB	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	13LD-1	1		No	MS2B	No -TB	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	13LD-2	1		No	MS2B	No -TB	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	14LU-1	1		No	MS2B	No -TB	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	14LU-2	1		No	MS2B	No -TB	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	14	1		No	MS2B	No -TB	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	14LD-1	1		No	MS2B	No -TB	7.0E-05	4.0E-06
34-MS-1201 / 34-EB1-1001	14LD-2	1		No	MS2B	No -TB	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	1	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	3	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	3A	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	3B	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	4N	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	5N	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	6	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	7	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1207 / 6-EB12-1007	7N	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06

Table B-3 CCNPP Unit 1 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
6-MS-1207 / 6-EB12-1007	8N	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1238 / 6-EB12-1038	1B	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1238 / 6-EB12-1038	1C	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1238 / 6-EB12-1038	1D	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1238 / 6-EB12-1038	1E	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1238 / 6-EB12-1038	2	1		No	MS2	No - 6 Inch	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	3			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	3LD			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	4LU			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	4			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	4LD-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	4LD-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	5LU-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	5LU-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	5			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	5LD			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	5/6-MS-1208			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	5BC-3			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	6LU			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	6			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	6LD			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	7LU			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	7			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	7LD			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	8LU			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	8			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	8LD-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	8LD-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	9LU-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06

Table B-3 CCNPP Unit 1 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
34-MS-1202 / 34-EB12-1002	9LU-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	9			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	9LD-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	9LD-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	10LU-1	1		No	MS4	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	10LU-2	1		No	MS4	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB12-1002	10	1	1	No	MS4	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1202 / 34-EB12-1002	10A	1		No	MS4	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1202 / 34-EB12-1002	10ALD	1		No	MS4	No - Seam	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1LD	1		No	MS4	No - Seam	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1	1		No	MS4	Yes - DEGB	1.0E-01	6.0E-03
36-MS-1202 / 36-EB12-1002	1A	1		No	MS4	Yes - DEGB	1.0E-01	6.0E-03
36-MS-1202 / 36-EB12-1002	1B	1		No	MS4	Yes - DEGB	1.0E-01	6.0E-03
36-MS-1202 / 36-EB12-1002	1/6-RV-4000	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1/6-RV-4001	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1/6-RV-4002	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1/6-RV-4003	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1/6-RV-4004	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1/6-RV-4005	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1/6-RV-4006	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1/6-RV-4007	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	1BC-4	1		No	MS4	No - 4 Inch	7.0E-05	4.0E-06
36-MS-1202 / 36-EB12-1002	2	1		No	MS4	Yes - DEGB	1.0E-01	6.0E-03
36-MS-1202 / 36-EB12-1002	2LU	1		No	MS4	No - Seam	7.0E-05	4.0E-06
6-RV-4000	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4000	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4000	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4000	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4001	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4001	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4001	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06

Table B-3 CCNPP Unit 1 BER Welds

ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
6-RV-4001	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4002	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4002	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4002	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4002	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4003	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4003	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4003	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4003	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4004	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4004	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4004	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4004	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4005	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4005	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4005	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4005	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4006	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4006	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4006	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4006	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4007	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4007	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4007	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-RV-4007	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	11			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	11LD-1			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	11LD-2			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	12LU-1			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	12LU-2			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	12			Yes	MS4A	No - Encap	7.0E-05	4.0E-06

Table B-3 CCNPP Unit 1 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
34-MS-1202 / 34-EB1-1002	12LD			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	13LU	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	13	1		No	MS4A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1202 / 34-EB1-1002	13LD	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	14LU	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	14	1		No	MS4A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1202 / 34-EB1-1002	14LD	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	15LU	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	15	1		No	MS4A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1202 / 34-EB1-1002	15LD	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	16LU	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	16	1		No	MS4A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-1202 / 34-EB1-1002	16LD	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	16BC	1		No	MS4A	No - 4 Inch	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	17LU	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	17	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	17LD-1	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	17LD-2	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	18LU-1	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	18LU-2	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	18	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	18LD-1	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-1202 / 34-EB1-1002	18LD-2	1		No	MS4B	No - TB	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	1	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	2	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	3	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	4	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	5	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	6	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	6A	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	6B	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06

Table B-3 CCNPP Unit 1 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
6-MS-1208 / 6-EB12-1008	7N	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	8N	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	9	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	10	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	10N	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1208 / 6-EB12-1008	11N	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1237 / 6-EB12-1037	1N	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
6-MS-1237 / 6-EB12-1037	2N	1		No	MS4	No - 6 Inch	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	1B	1		No	FW1A	Yes - DEGB	1.0E-01	6.0E-03
16-FW-1202 / 16-DB3-1002	1A	1	1	No	FW1A	Yes - DEGB	1.0E-01	6.0E-03
16-FW-1202 / 16-DB3-1002	1			Yes	FW1	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	2			Yes	FW1	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	3			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	4			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	5			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	6			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	7			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	8			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	9			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	9A			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1202 / 16-DB3-1002	10			Yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-1201 / 16-DB3-1001	1B	1		No	FW5A	Yes - DEGB	1.0E-01	6.0E-03
16-FW-1201 / 16-DB3-1001	1A	1		No	FW5A	Yes - DEGB	1.0E-01	6.0E-03
16-FW-1201 / 16-DB3-1001	1			Yes	FW5	No - Encap	7.0E-05	4.0E-06
16-FW-1201 / 16-DB3-1001	2			Yes	FW5	No - Encap	7.0E-05	4.0E-06
16-FW-1201 / 16-DB3-1001	3			Yes	FW6	No - Encap	7.0E-05	4.0E-06
16-FW-1201 / 16-DB3-1001	4			Yes	FW6	No - Encap	7.0E-05	4.0E-06

Table B-4 CCNPP Unit 2 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
34-MS-2001 / 34-EB12-2001	1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	1LU			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	1LD-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	1LD-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	2LU-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	2LU-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	2LD			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	2/4"			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	2/6-MS-2007			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	3LU			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	3			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	3LD-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	3LD-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	4LU-1			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	4LU-2			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	4			yes	MS2	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	4LD-1	1		No	MS2	No - Seam	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	4LD-2	1		No	MS2	No - Seam	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	5LU-1	1		No	MS2	No - Seam	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	5LU-2	1		No	MS2	No - Seam	7.0E-05	4.0E-06
34-MS-2001 / 34-EB12-2001	5	1	1	No	MS2	Yes - DEGB	1.0E-01	6.0E-03
36-MS-2001 / 36-EB12-2001	5LD	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	1/6-RV2-3992	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	1/6-RV2-3993	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	1/6-RV2-3994	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	1/6-RV2-3995	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	1/6-RV2-3996	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	1/6-RV2-3997	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	1/6-RV2-3998	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	1/6-RV2-3999	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06

Table B-4 CCNPP Unit 2 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
36-MS-2001 / 36-EB12-2001	2LU	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	2	1		No	MS2	Yes - DEGB	1.0E-01	6.0E-03
36-MS-2001 / 36-EB12-2001	2LD	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	2BC	1		No	MS2	No - 4 inch	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	3LU	1		No	MS2	No - Seam	7.0E-05	4.0E-06
36-MS-2001 / 36-EB12-2001	3	1		No	MS2	Yes - DEGB	1.0E-01	6.0E-03
6-RV2-3992	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3992	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3992	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3992	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3993	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3993	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3993	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3993	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3994	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3994	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3994	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3994	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3995	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3995	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3995	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3995	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3996	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3996	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3996	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3996	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3997	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3997	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3997	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3997	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3998	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06

Table B-4 CCNPP Unit 2 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
6-RV2-3998	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3998	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3998	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3999	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3999	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3999	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-RV2-3999	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	6	1		No	MS2A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-2001 / 34-EB1-2001	6LD-1	1		No	MS2A	No - Seam	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	6LD-2	1		No	MS2A	No - Seam	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	7LU-1			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	7LU-2			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	7			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	7LD			Yes	MS2A	No - Encap	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	8LU	1		No	MS2A	No - Seam	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	8	1		No	MS2A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-2001 / 34-EB1-2001	8LD	1		No	MS2A	No - Seam	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	8BC	1		No	MS2A	No - 4 inch	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	9LU	1		No	MS2B	No - TB	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	9	1		No	MS2B	No - TB	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	9LD-1	1		No	MS2B	No - TB	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	9LD-2	1		No	MS2B	No - TB	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	10LU-1	1		No	MS2B	No - TB	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	10LU-2	1		No	MS2B	No - TB	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	10	1		No	MS2B	No - TB	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	10LD-1	1		No	MS2B	No - TB	7.0E-05	4.0E-06
34-MS-2001 / 34-EB1-2001	10LD-2	1		No	MS2B	No - TB	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	1	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	1A	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	3	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06

Table B-4 CCNPP Unit 2 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
6-MS-2007 / 6-EB12-2007	4	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	5	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	6	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	7	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	7A	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	8R	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2007 / 6-EB12-2007	9	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2038 / 6-EB12-2038	1A	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2038 / 6-EB12-2038	1B	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2038 / 6-EB12-2038	1C	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2038 / 6-EB12-2038	1D	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
6-MS-2038 / 6-EB12-2038	2	1		No	MS2	No - 6 inch	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	1LU			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	1LD-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	1LD-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	2LU-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	2LU-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	2LD			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	2/4"			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	2/6-MS-2008			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	3LU			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	3			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	3LD-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	3LD-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	4LU-1			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	4LU-2			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	4			Yes	MS4	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	4LD-1	1		No	MS4	No - Seam	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	4LD-2	1		No	MS4	No - Seam	7.0E-05	4.0E-06

Table B-4 CCNPP Unit 2 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
34-MS-2002 / 34-EB12-2002	5LU-1	1		No	MS4	No - Seam	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	5LU-2	1		No	MS4	No - Seam	7.0E-05	4.0E-06
34-MS-2002 / 34-EB12-2002	5	1		No	MS4	Yes - DEGB	1.0E-01	6.0E-03
36-MS-2002 / 36-EB12-2002	5LD	1		No	MS4	No - Seam	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1BC	1		No	MS4	No - 4 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1/6-RV2-4000	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1/6-RV2-4001	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1/6-RV2-4002	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1/6-RV2-4003	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1/6-RV2-4004	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1/6-RV2-4005	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1/6-RV2-4006	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	1/6-RV2-4007	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	2LU	1		No	MS4	No - Seam	7.0E-05	4.0E-06
36-MS-2002 / 36-EB12-2002	2	1		No	MS4	Yes - DEGB	1.0E-01	6.0E-03
6-RV2-4000	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4000	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4000	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4000	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4001	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4001	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4001	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4001	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4002	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4002	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4002	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4002	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4003	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4003	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4003	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4003	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06

Table B-4 CCNPP Unit 2 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
6-RV2-4004	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4004	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4004	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4004	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4005	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4005	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4005	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4005	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4006	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4006	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4006	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4006	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4007	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4007	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4007	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-RV2-4007	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	6	1		No	MS4A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-2002 / 34-EB1-2002	6LD-1	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	6LD-2	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	7LU-1			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	7LU-2			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	7			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	7LD			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	8LU			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	8			Yes	MS4A	No - Encap	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	8LD	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	9LU	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	9	1		No	MS4A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-2002 / 34-EB1-2002	9LD	1		No	MS4A	No - Seam	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	9BC	1		No	MS4A	No - 4 inch	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	10LU	1		No	MS4A	No - Seam	7.0E-05	4.0E-06

Table B-4 CCNPP Unit 2 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
34-MS-2002 / 34-EB1-2002	10	1		No	MS4A	Yes - DEGB	1.0E-01	6.0E-03
34-MS-2002 / 34-EB1-2002	10LD-1	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	10LD-2	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	11LU-1	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	11LU-2	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	11	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	11LD-1	1		No	MS4B	No - TB	7.0E-05	4.0E-06
34-MS-2002 / 34-EB1-2002	11LD-2	1		No	MS4B	No - TB	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	3	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	4	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	5	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	5A	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	5B	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	6	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	7	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	8	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	9	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	10R	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2008 / 6-EB12-2008	11	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2037 / 6-EB12-2037	1	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
6-MS-2037 / 6-EB12-2037	2	1		No	MS4	No - 6 inch	7.0E-05	4.0E-06
16-FW-2002, -2010 / 16-DB3-2002	1A	1	1	No	FW1A	Yes - DEGB	1.0E-01	6.0E-03
16-FW-2002, -2010 / 16-DB3-2002	1	1		No	FW1	Yes - DEGB	1.0E-01	6.0E-03
16-FW-2002, -2010 / 16-DB3-2002	2			yes	FW1	No - Encap	7.0E-05	4.0E-06
16-FW-2002, -2010 / 16-DB3-2002	3			yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-2002, -2010 / 16-DB3-2002	4			yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-2002, -2010 / 16-DB3-2002	5			yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-2002, -2010 / 16-DB3-2002	6			yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-2002, -2010 / 16-DB3-2002	7			yes	FW2	No - Encap	7.0E-05	4.0E-06

Table B-4 CCNPP Unit 2 BER Welds								
ISI/Plant Lines	Weld	BER	RI-ISI	Encapsulated	Consequence	New Impact	CCDP	CLERP
16-FW-2002, -2010 / 16-DB3-2002	8			yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-2002, -2010 / 16-DB3-2002	9			yes	FW2	No - Encap	7.0E-05	4.0E-06
16-FW-2001, -2009 / 16-DB3-2001	1A	1		no	FW5A	Yes - DEGB	1.0E-01	6.0E-03
16-FW-2001, -2009 / 16-DB3-2001	1	1		no	FW5	Yes - DEGB	1.0E-01	6.0E-03
16-FW-2001, -2009 / 16-DB3-2001	2			yes	FW5	No - Encap	7.0E-05	4.0E-06
16-FW-2001, -2009 / 16-DB3-2001	2A			yes	FW6	No - Encap	7.0E-05	4.0E-06
16-FW-2001, -2009 / 16-DB3-2001	3			yes	FW6	No - Encap	7.0E-05	4.0E-06

APPENDIX C

Conformance with Regulatory Guide 1.174

C.1 Introduction

The purpose of this section is to discuss how application of the EPRI risk-informed inservice inspection (RI-ISI) methodology to the break exclusion region (BER) augmented inspection program is expected to conform to applicable regulatory guidance.

C.2 Conformance with RG 1.174

As noted in Section 2 of RG 1.174, an acceptable approach to risk informed decision making must ensure that the following principles are met:

1. "The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change, i.e., a "specific exemption under 10 CFR 50.12 or a "petition for rulemaking" under 10 CFR 2.802.
2. The proposed change is consistent with the defense-in-depth philosophy.
3. The proposed change maintains sufficient safety margins.
4. When proposed changes result in an increase in core damage frequency or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.
5. The impact of the proposed change should be monitored using performance-based strategies.

A discussion of how the EPRI method for RI-ISI addresses each of these principles is summarized below:

C.2.1 Meeting Current Regulations

For traditional RI-ISI applications, licensees perform evaluations consistent with the approved topical report and request relief per 10CFR50 using the appropriate "template submittal process.

This report addresses the application of RI-ISI to define an alternative inspection sample size for augmented inspection programs developed for break exclusion region (BER) piping. All other aspect of the BER programs and accompanying regulations are not impacted by this application. As such, EPRI does not anticipated that there will be any unique regulatory considerations associated with this application, and therefore, expects that future risk informed applications to BER programs that use the EPRI approach will adhere to the appropriate regulatory requirements.

C.2.2 Maintenance of Defense-in-Depth Philosophy

The EPRI approach to RI-ISI meets the NRC requirements to maintain defense. To address these defense in depth issues, it is instructive to characterize the role that piping systems play in the defense in depth design principle and to review the potential changes in piping system performance that could be conceivably brought about. This provides a context for evaluating each aspect of defense-in-depth.

The piping systems in a nuclear power plant contribute to defense in depth in two important ways: The piping of the reactor coolant system and systems that directly interface with the RCS provide one of the sets of barriers in the barrier defense in depth arrangement. This barrier protects the release pathway from the reactor core to containment release pathways and part of it is responsible for protecting against potential containment bypass pathways. The second way piping contributes to defense in depth is its role in the protection of the core through providing critical safety functions that require that piping system integrity.

The role that inspection programs can play in determining the risk significance of piping systems is rather limited and well defined. Piping inspections can play a role in identifying defects and degradation in piping system elements. When defects and degradation damage are found and repaired, pipe failures are precluded and the probability of pipe rupture reduced. In addition, pipe inspections and leak tests and detection processes have the potential of correcting pipe problems and reducing the safety function unavailabilities due to pipe failures. Hence, changes in inspection programs which normally lead to both enhancements and reductions to inspection scope and approach are limited to potential changes in failure frequency and rupture frequency, but do not directly change in any way the consequences of an assumed pipe failure.

It is conceivable that changes to the inspection program could have an impact on rupture frequencies, however current service experience dictates that this impact is in turn limited by the fact that pipe failures can be caused by degradation mechanisms, severe loading conditions, or some combination of these. The vast majority of severe loading condition failures such as vibration fatigue, water hammer, frozen pipes and human error are not amenable to mitigation by inspections that are geared towards finding damage produced by an active degradation mechanism. In addition and as importantly, the pressure boundary integrity of the piping within the scope of BER augmented inspection programs has been shown to be highly reliable and therefore not amenable to reductions in failure frequency due to additional augmented inspections.

C.2.2.1 Reasonable Balance Between Prevention and Mitigation

The application of the EPRI RI-ISI methodology maintains the balance between prevention and mitigation in the following respects. First, the risk matrix that is employed to characterize the safety significance is two-dimensional. As such the roles that segments play in rupture likelihood and consequences of assumed pipe ruptures are independently examined and considered. The scheme to assign elements of the matrix to defined high, medium and low

safety significance in fact gives equal weight to consideration of rupture potential and consequence. Even if the rupture potential is low, the segment can still have a medium safety significance if the consequences of the pipe rupture, independently considered, are high. In fact this matrix approach does a much better job of preserving defense in depth than an approach based on risk importance measures. The Fussell-Vesely or risk reduction worth of a pipe segment can be made low if either the pipe rupture frequency or the pipe consequence are assessed to be sufficiently low. Also, if there are errors (or conservatisms) that understate (or overstate) either of these components the overall safety significance of the segment can be hidden much more easily.

C.2.2.2 Preservation of Redundancy, Independence and Diversity

Implementation of a RI-ISI program using the EPRI approach should have no impact on available redundancy, independence and diversity of barriers. The role that consideration of degraded containment isolation and bypass protection play in the consequence analysis in the EPRI method ensures that the current barrier for defense in depth is maintained. As discussed in the main body of the report and shown in the plant examples containment performance is a key parameter in using the EPRI RI-ISI methodology.

C.2.2.3 Preservation of Common Cause Defenses

The most significant common cause issue associated with piping system reliability is the potential for spatial dependencies and consequential failures of systems and components resulting from piping failures and ruptures. A systematic evaluation of these effects is included in the consequence assessment as described in this report. Full implementation of the EPRI methodology will ensure that the probability of common cause failures due to piping unreliability will be adequately considered in the risk informed inspection program.

C.2.2.4 Defenses Against Human Errors

There is no apparent connection that we can identify between the proposed changes to a risk informed inspection program and the existing defenses against common cause and human errors beyond the observation that a risk-informed inspection programs provides a greater understanding of the causes of piping unreliability and in response defines more appropriate inspection techniques.

C.2.2.5 Avoidance of Over Reliance on Programmatic Activities

Currently the EPRI RI-ISI process is approved for the integration of ASME Section XI inspection with a number of augmented inspections for (e.g. thermal fatigue, FAC, IGSCC, MIC) into a single risk-informed approach. The application of RI-ISI to BER programs, is expected to

achieve additional programmatic enhancement to the inspection programs. Hence, there is not an over-reliance on programmatic aspects in the defense in depth provisions of RI-ISI.

In summary, application of RI-ISI should if anything, enhance the defense in depth aspects of the inspection program. The EPRI approach to RI-ISI offers particular advantages in this area in that rupture frequency and consequences are independently assessed thereby creating a better balance between prevention and mitigation. The insights from application of RI-ISI about the balance between prevention and mitigation are actually more robust than available from results of existing PSAs, mainly because pipe ruptures in PSAs are limited to only a few selected locations in the reactor coolant system, main steam and feedwater systems, and the scope of the internal flooding analyses. The consideration of piping system failure modes and effects in a risk informed inspection program are more comprehensively considered and documented than typically found in most PSAs. If anything, RI-ISI programs should increase the ability to examine the balance between prevention and mitigation afforded by piping system integrity.

C.2.2 Maintenance of Safety Margins

The only codes or standards that will be impacted by application of RI-ISI to BER programs will be sample size of the inspection population. The technical basis for the EPRI RI-ISI approach as applied to other inspection populations has been documented and approved by the USNRC. Application of RI-ISI to BER programs will ensure that the risk impact of changes to the inspection program will be consistent with Reg Guide 1.174 acceptance criteria. In addition, as only the inspection sample size is being revisited, existing safety analyses will not be impacted by implementation of RI-ISI.

C.2.3 Risk Impacts of Implementing RI-ISI

This report provided the results of two example plant applications of the EPRI RI-ISI methodology to BER augmented inspection programs. In both cases the impact on risk was shown to be negligible.

EPRI recognizes the need for future applications to also be able to demonstrate that they are in compliance. This report, together with the main report (TR-112657, Rev B-A) provides the guidance necessary to demonstrate that risk impacts are acceptable and in conformance with applicable guides and review plans for risk informed decision-making.

The EPRI approach to RI-ISI is structured with the characteristic that no significant risk increases should be expected.

C.2.4 Monitoring Program

The application of RI-ISI to BER augmented inspection programs will be used by plant personnel to define the scope of a risk-informed piping inservice inspection program. This scope

is defined by the piping segments (e.g., high, medium, and low risk segments), inspection elements locations, inspection methods, examination volumes, acceptance and evaluation criteria. Previous plant specific operating history and piping system inspection and service experience is a key input to the element selection process. The Licensee is expected to incorporate the results of these RI-ISI evaluation into plant specific program procedures that are consistent with the performance-based implementation and monitoring strategies specified in Regulatory Guide RG 1.174. Hence there are no unique aspects of the EPRI method in so far as monitoring requirements are concerned.

7 ACRONYMS A N D ABBREVIATIONS

AOT	Allowed Outage Time
AOV	Air-operated Valve
ARI	Alternate Rod Insertion
ASME	American Society of Mechanical Engineers
ATWS	Anticipated Transient Without Scram
BWR	Boiling Water Reactor
CCDP	Conditional Core Damage Probability
CDF	Core Damage Frequency
CLERP	Conditional Large Early Release Probability
CRD	Control Rod Drive
CS	Core Spray
CV	Check Valve
DB	Design Basis
ECCS	Emergency Core Cooling System
EPRI	Electric Power Research Institute
FMEA	Failure Modes and Effects Analysis
FW	Feedwater
HPCI	High Pressure Coolant Injection
IE	Initiating Event
IPE	Individual Plant Examination
ISI	Inservice Inspection
LERF	Large Early Release Frequency
LLOCA	Large Loss of Coolant Accident
LCO	Limiting Condition(s) for Operation
LOC	Loss of Condenser

LOCA	Loss of Coolant Accident
LOF	Loss of Feedwater
LPCI	Low Pressure Coolant Injection
MLOCA	Medium Loss of Coolant Accident
MOV	Motor-operated valve
MS	Main Steam
MSD	Manual Shutdown
MSIV	Manual Safety Injection Valve
MV	Manual Valve
P&IDs	Piping and instrumentation drawings
PBF	Pressure Boundary Failure
PDS	Plant Damage State
PRA	Probabilistic Risk Assessment
PSA	Probabilistic Safety Assessment
PWR	Pressurized Water Reactor
RAI	Request for Additional Information
RC	Release Category
RCS	Reactor Coolant System
RCIC	Reactor Core Isolation Cooling
RECIRC	Reactor Recirculation
RHR	Residual Heat Removal
RI-ISI	Risk Informed - Inservice Inspection
RPS	Reactor Protection System
RPT	Reactor Protection Trip
RPV	Reactor Pressure Vessel
RWCU	Reactor Water Cleanup
SBLC(SLC)	Standby Liquid Control
SDC	Shutdown Cooling
SRV	Safety Relief Valve
TT	Turbine Trip

GLOSSARY

ALLOWED OUTAGE TIME (AOT). The number of hours the plant may operate under a pre-defined configuration (e.g. inoperable equipment) as controlled by the limiting condition(s) for operation (LCO) in the Technical Specifications.

AVAILABILITY. The probability that a component or system will perform a specified function or mission under given conditions at a required time.

BACKUP SYSTEM. See mitigating system.

CONDITIONAL CORE DAMAGE PROBABILITY (CCDP). Conditional probability of a core damage, given an independent event (in this analysis, a pipe break).

CONDITIONAL LARGE EARLY RELEASE PROBABILITY (CLERP) Conditional probability of a large early release, given an independent event (in this analysis, a pipe break).

CONSEQUENCE. The impact or the ultimate result of an event. Consequences can be measured in terms of impact on public health and safety, impact on the environment, and cost or damage to the facility. Consequence measures typically considered in the nuclear industry are core damage frequency and magnitude of release (source term).

CONTAINMENT BYPASS. Events that lead to a direct release of radioactive material to the environment bypassing the containment boundary.

CONTAINMENT ISOLATION FAILURE. The containment failure mode that results from a failure to isolate all lines that penetrate the containment.

CORE DAMAGE FREQUENCY. An estimated frequency of occurrence of events leading to core damage.

CORE DAMAGE. Uncovery and heatup of the reactor core to the point where damage to reactor fuel elements or cladding is anticipated.

EXTERNAL EVENT. An event that initiates outside of plant systems and results in the perturbation of steady-state plant operation (e.g., seismic event, tornado, etc.).

FAILURE MODES AND EFFECTS ANALYSIS (FMEA). A detailed technique specifically designed to identify the failure of an analyzed component, the impacts of the failure on operations, the system and surrounding components, and controls for limiting the likelihood of such failures.

INITIATING EVENT. An event that perturbs steady-state plant operation or normal shutdown evolution resulting in a plant transient and challenge to control and safety systems. Based on its origin, an initiating event can be an internal or external event.

INSERVICE INSPECTION (ISI). An inspection performed after preservice inspections and test runs are satisfactorily completed and the system or component has been certified or accepted for normal service operation. The objective of such inspections is to detect degradation that might have occurred during plant operation.

INTERFACING SYSTEMS LOCA (ISLOCA). A breach in a system that interfaces with the reactor coolant system (RCS) and could cause a loss of coolant accident, if the breach is not isolated from the RCS. Such a breach could be caused if valves fail to isolate the RCS from an interfacing system not designed for the higher RCS pressure. When portions of an interfacing system are located outside the containment, ISLOCA can result in a radioactive release that bypasses the containment. Those ISLOCAs are referred to as a V-sequence.

INTERNAL EVENT. An event that initiates within plant systems and results in the perturbation of steady-state plant operation (e.g., loss of coolant, loss of heat sink, etc.)

LARGE EARLY RELEASE. A radioactive release from the containment which is both large and early. Large is defined as involving the rapid, unscrubbed release of airborne aerosol fission products to the environment. Early is defined as occurring before the effective implementation of the off-site emergency response and protective actions.

LIKELIHOOD. Probability or frequency of an event. In this analysis, likelihood is defined as the expected frequency in events per unit time.

LIMITING CONDITION(s) FOR OPERATION (LCO). A set of operable/inoperable equipment defined in the Technical Specifications, which allows continued plant operation for a limited amount of time.

MITIGATING SYSTEM. Any plant system whose operation is required to mitigate consequences of an initiating event or plant transient. If one of the mitigating systems is disabled, remaining mitigating systems are referred to as backup systems.

PIPING SEGMENT. Continuous length of piping with the same degradation mechanism and failure consequence.

PIPING SYSTEM. An assembly of piping segments. The system has defined functions, as described in the plant FSAR and controlled drawings. A piping system might include one or more AMSE Code classes.

PRESSURE BOUNDARY FAILURE. Piping element failures involving ruptures or leakage that result in a reduction or loss of the element pressure-retaining capability.

PROBABILISTIC RISK ASSESSEMENT (PRA). A quantitative assessment of risk. For nuclear power plant application, the risk is associated with plant operation and maintenance. Risk is measured in terms of the frequency of occurrence of various events, leading to a consequence of interest (e.g., core damage or release of radioactive material).

PROBABILISTIC SAFETY ASSESSMENT (PSA). See probabilistic risk assessment.

PROBABILITY. A numerical measure of the state of confidence about the outcome of an event.

RECOVERY ACTION. An operator action performed to mitigate or reduce the consequence of an event.

RISK. A measure of the potential for loss of damage. The risk of an event encompasses the expected frequency (the number of events per unit time) and expected damage (the magnitude of a consequence).

SEGMENTS. See piping segment.

SPATIAL EFFECTS. The indirect impact of an event affecting other systems and components in the spatial vicinity. These effects include flooding, spray, pipe whip, jet impingement, etc.

V-SEQUENCE. See interfacing system LOCA (ISLOCA).

TASCS Methodology

- Additional Screen -

Table 3-16 of EPRI TR-112657 contains criteria for assessing the potential for thermal stratification, cycling and striping (TASCS). Key attributes for horizontal or slightly sloped piping greater than 1" nominal pipe size (NPS) include:

1. Potential exists for low flow in a pipe section connected to a component allowing mixing of hot and cold fluids, or
2. Potential exists for leakage flow past a valve, including in-leakage, out-leakage and cross-leakage allowing mixing of hot and cold fluids, or
3. Potential exists for convective heating in dead-ended pipe sections connected to a source of hot fluid, or
4. Potential exists for two phase (steam/water) flow, or
5. Potential exists for turbulent penetration into a relatively colder branch pipe connected to header piping containing hot fluid with turbulent flow,

AND

$\Delta T > 50°F$,

AND

Richardson Number > 4 *(this value predicts the potential buoyancy of a stratified flow)*

These criteria, based on meeting a high cycle fatigue endurance limit with the actual ΔT assumed equal to the greatest potential ΔT for the transient, will identify all locations where stratification is likely to occur, but allows for no assessment of severity. As such, many locations will be identified as subject to TASCS where no significant potential for thermal fatigue exists. The critical attribute missing from the existing methodology that would allow consideration of fatigue severity is a criterion that addresses the potential for fluid cycling. The impact of this additional consideration on the existing TASCS criteria is presented below.

- **Turbulent Penetration TASCS**

  Turbulent penetration typically occurs in lines connected to piping containing hot flowing fluid. In the case of downward facing lines, significant top-to-bottom ΔTs can develop in horizontal sections within about 25 pipe diameters and the conditions can potentially be cyclic. Therefore, TASCS is considered for this configuration. For an upward or horizontal facing branch line connected to the hot fluid source, natural convective effects will fill the line with hot water. In the absence of in-leakage towards the hot fluid source, this will result in a well-mixed fluid condition where significant top-to-bottom ΔTs will not occur. Therefore TASCS is not considered for these configurations. Even in fairly long lines, where some heat loss from the outside of the piping will tend to occur and some fluid stratification may be present, there is no significant potential for cycling. The effect of TASCS will not be significant under these conditions and can be neglected.

- **Low Flow TASCS**

  In some situations, the transient startup of a system (e.g., RHR suction piping) creates the potential for fluid stratification as flow is established. In cases where no cold fluid source exists, the hot flowing fluid will fairly rapidly displace the cold fluid in stagnant lines, while fluid mixing will occur in the piping further removed from the hot source and stratified conditions will exist only briefly as the line fills with hot fluid. As such, since the situation is transient in nature, it can be assumed that the criteria for thermal transients (TT) will govern.

- **Valve Leakage TASCS**

  Sometimes a very small leakage flow can occur outward past a valve into a line with a significant temperature difference. However, since this is a generally a "steady-state" phenomenon with no potential for cyclic temperature changes, the effect of TASCS is not significant and can be neglected.

- **Convection Heating TASCS**

  Similarly, there sometimes exists the potential for heat transfer across a valve to an isolated section beyond the valve, resulting in fluid stratification due to natural convection. However, since there is no potential for cyclic temperature changes in this case, the effect of TASCS is not significant and can be neglected.

In summary, these additional considerations for determining the potential for thermal fatigue as a result of the effects of TASCS provide an allowance for the consideration of cycle severity in assessing the potential for TASCS effects.

Impact of Risk-Informed Inservice Inspection Program Upon Pre-Service Inspection Requirements

General Background: TR-112657 provides alternative requirements for identifying the number and type of inservice examinations for piping. The examination methods and volumes identified are specifically designed to inspect for a particular type of degradation (e.g. thermal fatigue, flow accelerated corrosion). These examination volumes and methods are not always consistent with more traditional Section XI criteria for piping examinations. The general intent of TR-112657 was that all other relevant aspects of Section XI programs would remain unaffected by the RI-ISI program.

Since NRC acceptance of TR-122657 in October of 1999, significant experience has been gained by the industry with respect to the implementation of RI-ISI programs. The following items are provided to further clarify several lessons learned.

Item 1 - Background:

In addition to inservice inspections, examinations may be carried out in response to repair and replacement activities. Typically, these examinations are conducted either using the method that detected the flaw (in the case of repairs) or in accordance with the original (i.e,. traditional) inservice inspection plan.

Applicability to RI-ISI Programs:

It is the intent of RI-ISI programs that examinations be conducted using the methods and volumes used to detect the flaw for repair activities and be conducted in accordance with the RI-ISI methods and volumes for replacement activities. In each case, as the existing Section XI programs (i.e. non RI-ISI) provide an adequate level of safety, licensees may default to these examinations methods and volumes, as necessary.

Item 2 Background:

Pre-service examinations are required to be conducted on a percentage of components depending upon their safety classification (e.g,. Class 1 versus Class 2).

Applicability to RI-ISI Programs:

Pre-service examinations are only required to be conducted on components selected for inservice inspection, regardless of pipe class. The licensee may wish to extend this scope of pre-service examinations to other (non-selected) components as the potential exists that future examinations may result in sample expansion.