NMC
Committed to Nuclear Excellence

Palisades Nuclear Plant
Operated by Nuclear Management Company, LLC

March 1, 2002

10 CFR 50.55a(a)(3)(i)

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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DOCKET 50-255 - LICENSE DPR-20 - PALISADES NUCLEAR PLANT
RELIEF REQUEST: ALTERNATE ASME CODE, SECTION XI, RISK-INFORMED INSERVICE INSPECTION PROGRAM

In accordance with 10 CFR 50.55a(a)(3)(i), Nuclear Management Company, LLC (NMC) requests approval to implement a Risk-Informed Inservice Inspection (RI-ISI) Program for Palisades. NMC proposes the RI-ISI Program as an alternate to the current American Society of Mechanical Engineers (ASME) Code, Section XI inservice inspection requirements for piping. The program is based on Westinghouse Topical Report, WCAP-14572, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," Revision 1-NP-A and WCAP-14572, Supplement 1, "Westinghouse Structural Reliability and Risk Assessment (SRRA) Model for Piping Risk-Informed Inservice Inspection," Revision 1-NP-A.

The proposed alternative RI-ISI Program provides an acceptable level of quality and safety. The proposed alternative RI-ISI Program also describes an alternate method for examination of high safety significant segments that contain socket welds in piping with a nominal diameter of two inches or less. The proposed program plan is attached.

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Palisades is in the second period of the third ASME Section XI inspection interval of the current ISI Plan. NMC requests Nuclear Regulatory Commission approval of the alternate RI-ISI Program by December 6, 2002 to support implementation during the next refueling outage.

SUMMARY OF COMMITMENTS

This letter contains the following commitment:

Scheduled examinations under the RI-ISI program will examine at least 66% of the required remaining locations by the end of the third period (conclusion of third inspection interval).

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Enclosure

ENCLOSURE

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES PLANT
DOCKET 50-255

RISK-INFORMED INSERVICE INSPECTION PIPING PROGRAM SUBMITTAL

41 Pages

RISK-INFORMED INSERVICE INSPECTION (RI-ISI) PROGRAM SUBMITTAL

PALISADES NUCLEAR PLANT
Nuclear Management Company, LLC

February 2002

RISK-INFORMED INSERVICE INSPECTION PROGRAM PLAN

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1. INTRODUCTION / RELATION TO NRC REGULATORY GUIDE 1.174

1.1 Introduction

Inservice inspections (ISI) are currently performed on piping to the requirements of the ASME Boiler and Pressure Vessel Code Section XI, 1989 Edition as required by 10CFR50.55a. The unit is currently in the third inspection interval as defined by the Code for Program B.

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

As a risk-informed application, this submittal meets the intent and principles of Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis." Further information is provided in Section 3.10 relative to defense-in-depth.

1.2 PSA Quality

The Palisades Level 1 and Level 2 probabilistic safety assessment (PSA) model, Version PSAR1A, dated April 2000, was used to evaluate the consequences of piping failures during operation in Modes 1 and 2. The base core damage frequency (CDF) and base large, early release frequency (LERF) from this version of the PSA model are 5.5E-05/yr and 3.9E-08/yr, respectively.

The PSA model has been extensively reviewed, including a detailed self-assessment in April 2000, and a Combustion Engineering Owners Group (CEOG) peer review in May 2000. Overall, the evaluation concluded that the PSA model reflects the plant "as built" and "as operated" configuration. The peer review evaluated eleven areas and found two areas that were deemed inadequate. The other areas were all Exceeds Expectations, Meets Expectations, or Marginal. The two areas classified as inadequate were incomplete documentation of the various aspects of the PSA and failure to perform a thorough dependency analysis for the human actions modeled in the PSA. The first weakness is administrative. The peer review team noted that the documentation in place was thorough, but did not conform to the format required by procedures. Primarily, the independent technical review and approvals were not completed for the supporting engineering analyses. Currently, all of the required supporting engineering analyses have the documentation completed. The second weakness related to the appropriateness of the magnitude of human error probabilities used in the model given the possibility that dependent operator actions may not have been adequately considered. A detailed evaluation of the human action dependencies has subsequently been performed. The evaluation concluded that "[t]he relatively small increase in the overall CDF contributed by the dependency in human actions is an indication that dependency between human actions within important accident sequences are low and that the PSA already accounted for any significant dependency among critical actions in the modeling development

process. It is also important to note that the evaluation is bounding based on the methodology used and that opportunities exist to remove further some of the conservatism by assessing more human error combinations. However, additional evaluation is not considered necessary due to the already small increase in CDF."

During the past year, NMC addressed and closed out the identified areas of deficiency, bringing the Palisades PSA in line with industry best practices.

PSA model updates are scheduled for 36-month intervals to ensure that there is a major model update at least once for every two refueling cycles. The administrative guidance for this activity is contained in Palisades engineering guidelines.

2. PROPOSED ALTERNATIVE TO ISI PROGRAM

2.1 ASME Section XI

ASME Section XI Categories B-F, B-J, C-F-1 and C-F-2 currently contain the requirements for examining piping components via non-destructive examination (NDE). The Risk-Informed ISI (RI-ISI) program is a full scope program that includes ASME Class 1, 2, 3 and non-class piping systems. The alternative RI-ISI program for piping is described in WCAP-14572, A-Version. NMC proposes to substitute the RI-ISI program for the current examination program on piping in accordance with 10 CFR 50.55a(a)(3)(i). The proposed alternative provides an acceptable level of quality and safety. Additionally, the alternative program will not be limited to ASME Class 1 or Class 2 piping, but will encompass the high safety significant piping segments regardless of ASME Class. Other non-related portions of the ASME Section XI Code will be unaffected. WCAP-14572 provides the requirements defining the relationship between the risk-informed examination program and the remaining unaffected portions of ASME Section XI.

2.2 Augmented Programs

The augmented inspection programs remain unchanged.

3. RISK-INFORMED ISI PROCESSES

The processes used to develop the RI-ISI program are consistent with the methodology described in WCAP-14572.

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

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

As part of the risk evaluation described in Section 3.5, the uncertainty analysis as described in WCAP-14572, section 3.6.1 (on page 125) was performed and is now included as part of the base process.

Deviations

There are no significant deviations to the process described in WCAP-14572. Two minor deviations, however, are noted:

- A deviation on the use of a Westinghouse statistical (Perdue) model for four safety injection/refueling water tank and containment sump suction (SSS) piping segments was necessary. Four segments in the SSS system are in a category of thin-walled piping having low pressure, low temperature, low design stress, and low fatigue stress. Segments with these attributes are not appropriate for use with the Perdue model. As an alternative to running the Perdue model on these segments, a 7.5% sample was selected from each of the segments to provide a defense-in-depth inspection strategy that is consistent with a typical Section XI sample.

- The change in risk methodology, described in Section 3.10, deviated slightly from the methodology described in WCAP-14572. The WCAP-14572 methodology credits leak detection in the determination of failure probability of primary coolant system (PCS) segments located inside containment where radiation monitors and sump level will detect a leak. This methodology was expanded to include leak detection in the determination of failure probability for segments of systems that interface with the PCS and are located inside containment such that radiation monitors and sump level will detect a leak.

3.1 Scope of Program

The systems to be included in the risk-informed ISI program are provided in Table 3.1-1.

The following systems or portions of systems were evaluated and excluded from system scope consideration in the RI-ISI program:

- Domestic Water System
- Reactor Cavity Flood System
- Plant Heating Steam *

* Plant Heating Steam was initially excluded, but portions of the system were added to scope due to indirect consequence considerations.

The basis for exclusion of these systems from the program is in accordance with Section 3.2 of WCAP-14572.

3.2 Segment Definitions

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

The number of pipe segments defined for the 36 systems in the program scope are summarized in Table 3.1-1. The as-operated piping and instrumentation diagrams were used to define the segments.

3.3 Consequence Evaluation

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

3.4 Failure Assessment

Failure estimates were generated using industry failure history, plant specific failure history and other relevant information. An engineering team was established that had access to expertise from ISI, NDE, materials, stress analysis and system engineering. The team was trained in the failure probability assessment methodology and the Westinghouse Structural Reliability and Risk Assessment (SRRA) code, including identification of the capabilities and limitations as described in WCAP-14572, Revision 1-NP-A, Supplement 1. The SRRA code was used to calculate failure probabilities for the failure modes, materials, degradation mechanisms, input variables and uncertainties it was programmed to consider as discussed in the WCAP-14572 Supplement 1. The majority of the piping configurations included in the RI-ISI program could be adequately modeled using the SRRA code. Exceptions included mechanical connections (screwed or flanged connections) and piping with materials other than carbon and stainless steel. Five systems were not evaluated with the SRRA code because they had no consequences that could be quantitatively evaluated in the PSA model.

The engineering team assessed industry and plant experience, plant layout, materials, and operating conditions and identified the potential failure mechanisms and causes. Information was gathered from various sources by the engineering team to provide input for the SRRA model.

The SRRA code could not be used for all failure mechanisms or piping materials. In these instances, values were determined using alternative means. Generally, the SRRA code was used to give an approximation of the possible ranges of failure probability. For example, raw water systems such as critical and non-critical service water (CSW and NSW) and fire protection (FPS) are susceptible to pitting wear. Pitting is not a modeled mechanism in the SRRA code. However, the code does model wastage (erosion/corrosion) and fatigue. The probability for pitting wastage was determined by modeling these types of mechanisms so that an upper and lower bound failure probability could be established. The final probability selected was determined by the team members using the bounding information and industry experience.

The SRRA code was used for calculating failure probabilities for pressurized water stress corrosion cracking (PWSCC) susceptible plant piping. The results were compared with plant and industry failure data as described in WCAP-14572 Supplement 1. For wastage due to flow-assisted corrosion (FAC), the EPRI CHECWORKS program along with plant-specific FAC wall-thinning monitoring program data was used to coordinate the failure probability calculations with the existing plant program.

Sensitivity studies were performed to aid in determining representative input values when sufficient information was not available. Snubber failure history was also reviewed to identify any potential effects that could increase piping failure probability.

Table 3.4-1 summarizes the failure probability estimates for the dominant potential failure mechanism(s)/ combination(s) by system. Table 3.4-1 also describes why the degradation mechanisms could occur at various locations within the system. Full break cases are shown only when pipe whip is of concern.

Another consideration was whether a segment is addressed by augmented programs for either the stress corrosion cracking or erosion corrosion. This information has been used to determine which failure probability is used in the risk-informed ISI process. The effects of ISI of existing augmented programs are included in the risk evaluation used to assist in categorizing the segments. The failure probabilities used in the risk-informed process are documented and maintained in the plant records.

3.5 Risk Evaluation

Each piping segment within the scope of the program was evaluated to determine its core damage frequency (CDF) and large-early-release frequency (LERF) due to the postulated piping failure. Calculations were also performed assuming operator action or no operator action.

Once this evaluation was completed, the total pressure boundary CDF and LERF was calculated by summing across the segments for each system.

The uncertainty analysis as described in WCAP-14572, section 3.6.1 (on page 125) was performed and is now included as part of the base process. The results of these calculations

are presented in Table 3.5-1. The CDF due to piping failure without operator action is 8.12E-05/year, and with operator action is 5.63E-05/year. The LERF due to piping failure without operator action is 1.31E-07/year, and with operator action is 6.05E-08/year.

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

3.6 Expert Panel Categorization

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

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

- Probabilistic Safety Assessment (PSA engineer)
- Operations (Senior Reactor Operator or Shift Technical Advisor)
- Inservice Inspection (ISI)
- Maintenance Rule
- Design Engineering
- Plant & Industry Maintenance, Repair, and Failure History (System Engineer)

A minimum of 6 members or alternates filling the above positions constituted a quorum. This core team of panel members was supplemented by other experts, including a system engineer, as required for the piping system under evaluation.

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

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

The expert panel used a consensus process. During initial discussion, consensus was defined as a unanimous vote by the panel. The small number of segments resulting in a split vote initially were re-evaluated using a 2/3 (rounding conservatively) vote for consensus. Appropriate time for deliberation was allowed for each piping segment.

A non-voting individual attended each meeting to record the minutes. The minutes included the names of members and alternates in attendance and whether a quorum was present. The minutes contained relevant discussion summaries and the results of membership voting. The minutes are available as program records.

3.7 Identification of High Safety Significant Segments

The number of high safety significant segments for each system, as determined by the expert panel, is shown in Table 3.7-1. The same table also includes a summary of the risk evaluation identification of segments with high RRW values (≥ 1.005), segments with medium RRW values (1.005 > RRW ≥ 1.001), and segments with low RRW values (RRW < 1.001).

3.8 Structural Element and NDE Selection

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

The initial program being submitted addresses the high safety significant (HSS) piping components placed in regions 1 and 2 of Figure 3.7-1 in WCAP-14572. Region 3 piping components, which are low safety significant (LSS), may be considered in an owner defined program but are not considered part of the program requiring approval. Region 1, 2, 3 and 4 piping components will continue to receive Code required pressure testing, as part of the current ASME Section XI program. For the 799 piping segments that were evaluated in the RI-ISI program, Region 1 contains 84 segments, Region 2 contains 41 segments, Region 3 contains 171 segments, and Region 4 contains 469 segments. The remaining 34 segments were not categorized since they had no CDF/LERF values calculated because there were no consequences or they were not modeled in the PSA. Accordingly, failure probabilities were not determined. All 34 are LSS segments.

The number of locations to be inspected in an HSS segment was determined using a Westinghouse statistical (Perdue) model as described in section 3.7 of WCAP-14572, Revision 1-NP-A. Of the 125 HSS segments voted by the Expert Panel (note that an additional 5 HSS segments were added later for change in risk considerations – see section 3.10), 56 of the HSS piping segments in Region 1 and 13 of the HSS piping segments in Region 2 were evaluated using the Perdue model. The 56 segments that were not evaluated using the Perdue model included 44 segments containing socket welds, 4 segments that were completely 1A regions, 4 segments with a single weld, and 4 segments with thin-walled pipe exempt from Section XI inspection (a 7.5% sample from each thin walled segment was chosen instead). All 56 segments are outside the applicability of the model so the guidance in Section 3.7.3 of WCAP-14572, Revision 1-NP-A was followed.

The HSS segments categorized by the plant expert panel that contain socket welds consist of piping welds with a nominal diameter of two inches or less. The socket welds in these segments cannot be individually examined by any currently available NDE techniques that are appropriate for the degradation mechanism. Therefore, for these segments, a visual (VT-2) examination will be performed during the system pressure test each refueling outage.

Table 4.1-1 in WCAP-14752 was used as guidance in determining the examination requirements for the HSS piping segments. VT-2 visual examinations are scheduled in accordance with the station's pressure test program that remains unaffected by the risk-informed inspection program.

Additional Examinations

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

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

3.9 Program Relief Requests

Alternate methods are specified to ensure structural integrity in cases where examination methods cannot be applied due to limitations such as inaccessibility or radiation exposure hazard.

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

All the risk-informed examination locations that have been selected provide greater than 90% coverage. In instances where a location may be found at the time of the examination that it does not meet greater than 90% coverage, the process outlined in Section 4.0 of WCAP-14572 will be followed.

3.10 Change in Risk

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

The change in risk calculations were performed according to all the guidelines provided in WCAP-14572, section 4.4.2 (page 213). A comparison between the proposed RI-ISI program and the current ASME Section XI ISI program was made to evaluate the change in risk. NMC

evaluated the change in risk with the inclusion of the probability of detection as determined by the SRRA model. All four criteria for accepting the results discussed on pages 214 and 215 in WCAP-14572, section 4.4.2 were met after adjustments were made to add segments. This evaluation resulted in the addition of 5 piping segments to the scope (these are identified in Table 5-1).

The change in risk methodology deviated from the methodology for segments located inside containment and that interface with the PCS such that radiation monitors and sump level will detect a leak. For these segments, the failure probability "with ISI" for those being inspected by NDE and without ISI for those not being inspected is used along with credit for leak detection.

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

Defense-In-Depth

NMC will continue to perform a system pressure test and visual VT-2 examination for the PCS piping as currently required by the Code. In addition, the welds connecting the PCS hot and cold leg loop piping to the reactor vessel nozzles will continue to be inspected as part of the ASME Section XI vessel inspection program. This includes twelve PCS loop welds, two per nozzle.

New Information

Several shutdown cooling system (SDC) segments were revised to include consequences of an outside containment loss-of-coolant accident (LOCA). Additionally, based on Expert Panel comments from the first Expert Panel meetings, the proposed operator actions were removed from the analysis resulting in high RRW values for LERF both with and without operator actions. When revised risk ranking results (for all program segments) were presented to the Expert Panel for reconsideration, it was agreed that diagnosis of the outside containment LOCA event would occur and operator actions would be taken to mitigate the LERF consequences. These segments were voted LSS based on operator action. However, revised LERF with operator action values have not been generated and are not reflected in the risk values summarized herein or the change-in-risk analysis. The final results are considered conservative since all program segments that were originally voted HSS in the first expert panel meeting, when SDC operator action was credited, remain in the program and changes to the change-in-risk analysis are not significant.

4. IMPLEMENTATION AND MONITORING PROGRAM

Upon approval of the RI-ISI program, NMC will prepare procedures that comply with the guidelines described in WCAP-14572, to implement and monitor the program. The new program will be integrated into the existing ASME Section XI interval. Palisades Final Safety Analysis Report Update (FSAR) Section 6.9 will be updated to include the changes to the ISI program resulting from implementation of the RI-ISI program.

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

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

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

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

5. PROPOSED ISI PROGRAM PLAN CHANGE

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

The plant will be performing examinations on elements not currently required to be examined by ASME Section XI. Some examples of these additional examinations are provided below.

- Several elements currently classified as Non-Code Class will receive examination. These examinations will be in addition to applicable augmented inspection programs that will be continued. Non-Code Class systems, or portions of systems that are identified as having Non-Code Class piping segments requiring examination, include portions of the condensate system (CDS), heater and extraction drains system

(HED), and circulating water system (CWS). The ASME Section XI Code does not address Non-Code Class systems.

- Several elements currently classified as Class 3 will receive examination. Class 3 systems, or portions of systems that have Class 3 piping segments requiring examination, include portions of the auxiliary feedwater system (AFW) and critical service water system (CSW). The ASME Section XI Code does not require NDE (volumetric or surface) examinations on Class 3 systems.

- The ASME Section XI Code does not require volumetric and surface examinations of piping less than 3/8-inch wall thickness on Class 2 piping greater than 4-inch nominal pipe size (NPS). The welds are counted for percentage requirements, but not examined by NDE. The RI-ISI program will require examination of these welds. Examples where the risk informed process required examination and the Code did not are in the safety injection/refueling water & containment sump suction system (SSS).

The HSS segments that contain socket welds (piping with a nominal diameter of 2 inches or less) cannot be individually examined by any currently available NDE techniques that are appropriate for the degradation mechanism. Therefore, for these segments, a visual (VT-2) examination will be performed during the system pressure test each refueling outage.

The initial program will be started in the inspection period current at the time of program approval. The second inspection period of the third inspection interval ends on August 14, 2003. Scheduled examinations under the RI-ISI program will examine 66% of the required remaining locations by the end of the third period (conclusion of third inspection interval).

6. SUMMARY OF RESULTS AND CONCLUSIONS

A full scope RI-ISI application has been completed for Palisades. Upon review of the proposed RI-ISI examination program given in Table 5-1, an appropriate number of examinations are proposed for the high safety significant segments across the Class 1, Class 2, Class 3, and Non-Code piping systems. Resources to perform examinations currently required by ASME Section XI in the Class 1 and Class 2 portions of the plant piping systems are reduced and partly distributed to Class 3 and Non-Code piping segments that currently do not receive NDE. This proposed program change results in an overall risk reduction. Additionally, even within the Class 1 and Class 2 segments, some examinations are moved to different locations to address specific damage mechanisms postulated for the selected locations through appropriate examination selection and increase volume of examination.

Construction permits were issued for Palisades in 1966. At that time, the ASME Boiler and Pressure Vessel Code covered only the construction of nuclear vessels. Piping was generally constructed to the rules of United States Standards Committee document B31.1 and applicable nuclear code cases. Palisades was designed and constructed prior to the origination of the ASME code classifications (Class 1, 2, and 3). The system classifications for ISI are based on the guidance found in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants,"

Revision 3 (February 1976) and 10 CFR 50.55a. Because of the construction practices and classification requirements at that time, the Class 1 portions of the piping systems are comprised of many more small bore socket-welded piping lines than later vintage plants constructed to ASME Section III. Therefore, the population of butt-welded piping is smaller than later units, and the small bore lines can make a larger contribution to the overall risk of piping pressure boundary failure.

From a risk perspective, the PSA dominant accident sequences include small break LOCAs, station blackout, steam generator tube rupture, and anticipated transient without scram.

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

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

7. REFERENCES / DOCUMENTATION

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

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

Supporting Onsite Documentation

7.1 Segment Definition

- 7.1.1 EA-PSA-RI-ISI-99-AFW, Revision 2, "RI-ISI Segment Definition – Auxiliary Feedwater System"
- 7.1.2 EA-PSA-RI-ISI-00-BLD, Revision 2, "RI-ISI Segment Definition – Steam Generator Blowdown"
- 7.1.3 EA-PSA-RI-ISI-00-CCS, Revision 0, (Westinghouse calc note CN-RRA-99-37) "Piping Segment/Direct Consequence Definition for Palisades Component Cooling System"
- 7.1.4 EA-PSA-RI-ISI-99-CDS, Revision 2, "RI-ISI Segment Definition – Condensate and Main Condenser"
- 7.1.5 EA-PSA-RI-ISI-00-CIS, Revision 0, "RI-ISI Segment Definition – Containment Isolation System"
- 7.1.6 EA-PSA-RI-ISI-99-CSS, Revision 2, "RI-ISI Segment Definition for Containment Spray System (CSS)"
- 7.1.7 EA-PSA-RI-ISI-00-CVC, Revision 1, "RI-ISI Segment Definition – Chemical Volume & Control System"
- 7.1.8 EA-PSA-RI-ISI-00-EHC, Revision 1, "RI-ISI Segment Definition – Electro-Hydraulic Control System"
- 7.1.9 EA-PSA-RI-ISI-00-CWS, Revision 2, "RI-ISI Segment Definition – Circulating Water System"
- 7.1.10 EA-PSA-RI-ISI-00-DMW, Revision 1, "RI-ISI Segment Definition – Demineralized Makeup Water System"
- 7.1.11 EA-PSA-RI-ISI-00-FOS, Revision 2, "RI-ISI Segment Definition – Fuel Oil System"
- 7.1.12 EA-PSA-RI-ISI-00-FPA, Revision 1, "RI-ISI Segment Definition – Feedwater Purity Air"
- 7.1.13 EA-PSA-RI-ISI-00-FPS, Revision 2, "RI-ISI Segment Definition – Fire Protection System"
- 7.1.14 EA-PSA-RI-ISI-00-HED, Revision 1, "RI-ISI Segment Definition – Extraction Steam Heaters & Drains"
- 7.1.15 EA-PSA-RI-ISI-99-HPA, Revision 1, "RI-ISI Segment Definition for the High Pressure Air System (HPA)"
- 7.1.16 EA-PSA-RI-ISI-99-HPI, Revision 2, "RI-ISI Segment Definition for High Pressure Safety Injection System (HPI)"
- 7.1.17 EA-PSA-RI-ISI-00-HYM, Revision 1, "RI-ISI Segment Definition – Hydrogen Monitoring System"
- 7.1.18 EA-PSA-RI-ISI-99-IAS, Revision 2, "RI-ISI Segment Definition for the Instrument and Service Air System (IAS)"
- 7.1.19 EA-PSA-RI-ISI-99-LPI, Revision 2, "RI-ISI Segment Definition for Low Pressure Safety Injection (LPI) and Safety Injection Tanks (SIT) System"
- 7.1.20 EA-PSA-RI-ISI-00-LRW, Revision 0, "RI-ISI Segment Definition – Waste Gas System/Liquid Radioactive Waste"
- 7.1.21 EA-PSA-RI-ISI-99-MFW, Revision 2, "RI-ISI Segment Definition – Main Feedwater System"

7.1.22 EA-PSA-RI-ISI-00-MGS, Revision 2, "RI-ISI Segment Definition – Miscellaneous Gas System"

7.1.23 EA-PSA-RI-ISI-00-MSS, Revision 2, "RI-ISI Segment Definition – Main Steam System"

7.1.24 EA-PSA-RI-ISI-00-PCS, Revision 0, (Westinghouse calc note CN-RRA-99-13) "RI-ISI Segment/Direct Consequence Definition for Palisades, Primary Coolant System (PCS) and Pressurizer System (PZR)"

7.1.25 EA-PSA-RI-ISI-99-SCS, Revision 1, "RI-ISI Segment Definition – Shield Cooling System"

7.1.26 EA-PSA-RI-ISI-99-SDC, Revision 0, (Westinghouse calc note CN-RRA-99-33) "Piping Segment/Direct Consequences Definition for Palisades Shutdown Cooling System"

7.1.27 EA-PSA-RI-ISI-00-SFP, Revision 1, "RI-ISI Segment Definition – Spent Fuel Pool Cooling System"

7.1.28 EA-PSA-RI-ISI-99-SSS, Revision 1, "RI-ISI Segment Definition for SIRW & Containment Sump Suction (SSS) System"

7.1.29 EA-PSA-RI-ISI-99-SWS, Revision 3, "RI-ISI Segment Definition – Service Water System"

7.1.30 EA-PSA-RI-ISI-00-TGS, Revision 1, "RI-ISI Segment Definition – Turbine Generator System (TGS)"

7.1.31 EA-PSA-RI-ISI-00-UHS, Revision 1, "RI-ISI Segment Definition – Ultimate Heat Sink"

7.2 SRRA Analyses

7.2.1 EA-SRRA-AFW, Revision 0, "Structural Reliability and Risk Assessment for the Auxiliary Feed Water System (AFW)"

7.2.2 EA-SRRA-BLD, Revision 0, "Structural Reliability and Risk Assessment for the Steam Generator Blowdown System (BLD)"

7.2.3 EA-SRRA-CBA, Revision 0, "Structural Reliability and Risk Assessment for the Concentrated Boric Acid System (BLD)"

7.2.4 EA-SRRA-CCS, Revision 0, "Structural Reliability and Risk Assessment for the Component Cooling Water System (CCS)"

7.2.5 EA-SRRA-CDS, Revision 0, "Structural Reliability and Risk Assessment for the Condensate System (CDS)"

7.2.6 EA-SRRA-CIS, Revision 0, "Structural Reliability and Risk Assessment for the Containment Isolation System (CIS)"

7.2.7 EA-SRRA-CSS, Revision 0, "Structural Reliability and Risk Assessment for the Containment Spray System (CSS)"

7.2.8 EA-SRRA-CVC, Revision 0, "Structural Reliability and Risk Assessment for the Chemical and Volume Control System (CVC)"

7.2.9 EA-SRRA-CWS, Revision 0, "Structural Reliability and Risk Assessment for the Circulating Water System (CWS)"

7.2.10 EA-SRRA-DMW, Revision 0, "Structural Reliability and Risk Assessment for the Demineralized Makeup Water System (DMW)"

7.2.11 EA-SRRA-EHC, Revision 0, "Structural Reliability and Risk Assessment for the Electro-Hydraulic Control System (EHC)"

7.2.12 EA-SRRA-FOS, Revision 0, "Structural Reliability and Risk Assessment for the Fuel Oil System (FOS)"

7.2.13 EA-SRRA-FPS, Revision 1, "Structural Reliability and Risk Assessment for the Fire Protection System (FPS)"

7.2.14 EA-SRRA-HED, Revision 1, "Structural Reliability and Risk Assessment for the Heating and Extraction Drains (HED)"

7.2.15 EA-SRRA-HPA, Revision 0, "Structural Reliability and Risk Assessment for the High Pressure Air System (HPA)"

7.2.16 EA-SRRA-HPI, Revision 0, "Structural Reliability and Risk Assessment for the High Pressure Injection System (HPI)"

7.2.17 EA-SRRA-IAS, Revision 0, "Structural Reliability and Risk Assessment for the Instrument and Service Air System (IAS)"
7.2.18 EA-SRRA-LPI, Revision 1, "Structural Reliability and Risk Assessment for the Low Pressure Injection System (LPI)"
7.2.19 EA-SRRA-SIT, Revision 0, "Structural Reliability and Risk Assessment for the Safety Injection Tank System (SIT)"
7.2.20 EA-SRRA-LRW, Revision 0, "Structural Reliability and Risk Assessment for the Liquid Radioactive Waste System (LRW)"
7.2.21 EA-SRRA-MFW, Revision 0, "Structural Reliability and Risk Assessment for the Main Feed Water System (MFW)"
7.2.22 EA-SRRA-MGS, Revision 0, "Structural Reliability and Risk Assessment for the Miscellaneous Gas System (MGS)"
7.2.23 EA-SRRA-MSS, Revision 0, "Structural Reliability and Risk Assessment for the Main Steam System (MSS)"
7.2.24 EA-SRRA-PCS, Revision 0, "Structural Reliability and Risk Assessment for the Primary Coolant System (PCS)"
7.2.25 EA-SRRA-PZR, Revision 1, "Structural Reliability and Risk Assessment for the Pressurizer System (PZR)"
7.2.26 EA-SRRA-SDC, Revision 0, "Structural Reliability and Risk Assessment for the Shutdown Cooling System (SDC)"
7.2.27 EA-SRRA-SSS, Revision 0, "Structural Reliability and Risk Assessment for the SIRW and Containment Sump Suction System (SSS)"
7.2.28 EA-SRRA-SWS, Revision 0, "Structural Reliability and Risk Assessment for the Service Water System (SWS)"
7.2.29 EA-SRRA-TGS, Revision 0, "Structural Reliability and Risk Assessment for the Turbine Generator System (TGS)"
7.2.30 EA-SRRA-UHS, Revision 0, "Structural Reliability and Risk Assessment for the Ultimate Heat Sink System (UHS)"
7.2.31 EA-SRRA-Procedure, Revision 0, "Analysis Procedure for Structural Reliability and Risk Assessment (WIN-SRRA)"

7.3 EA-PSA-RI-ISI-00-INDIRECT, rev. 0 "RI-ISI Indirect Effects Evaluation"

7.4 EA-PSA-CDF-00-0028, Revision 0, "Quantification of ISI CDF Values"

7.5 EA-PSA-LERF-00-0027, Revision 0, "Quantification of ISI LERF Values"

7.6 EA-PSA-ISI-99-0023, Revision 0, "Leakage Calculation as a Function of Pressure and Pipe Diameter"

7.7 EA-PSA-RI-ISI-99-0012, Revision 0, "Risk Informed ISI – Large Disabling Leak Rate Calculations for Win-SRRA Inputs"

7.8 EA-PSA-ISI-99-0024, Revision 0, "Estimate of Snubber Failure Rates"

7.9 EA-PSA-2000-001, Revision 0, "PERDUE Model Software Validation"

7.10 EA-PSA-2000-002, Revision 0, "WIN-SRRA Software Validation"

7.11 EA-PSA-RI-ISI-00-29, (Westinghouse calc note CN-RRA-00-43 revisions 0,1, & 2), Revisions 0, "Palisades RI-ISI Risk Evaluation"

7.12 EA-PSA-RI-ISI-01-05, Revision 0, “Explanation of Inconsistencies and Errors in Main Steam CDF and LERF Surrogates.”

7.13 EA-PSA-RI-ISI-01-02, Revision 0, "RI-ISI PRA Runs Table and CDF and LERF X Ref Table Documentation."

7.14 Expert Panel Meeting Minutes, "RI-ISI Expert Panel Meeting, October 2000"

7.15 Expert Panel Meeting Minutes, “RI-ISI Expert Panel Meeting, May 2001”

7.16 EA-PSA-LERF-00-0033, rev. 1; "ISI ISLOCA LERF Analysis"

7.17 EA-PSA-RI-ISI-01-04, rev. 0; "Assessment of MSS, CSS, CWS and SRRA Changes on RI-ISI Segment Ranking"

7.18 EA-PSA-RI-ISI-01-21, rev.1; "RI-ISI Piping Segments with Revised RRW Values Requiring Expert Panel Review"

7.19 EA-SRRA-PCS- Hotlegs, rev. 0; "Structural Reliability and Risk Assessment for the Primary Coolant System Hot Leg Segments PCS-001 and PCS-002"

7.20 EA-PSA-RI-ISI-00-30 (Westinghouse calc note CN-RRA-00-60), rev.1, “Palisades RI-ISI Delta Risk Evaluation”

7.21 EA-PSA-RI-ISI-00-32, (Westinghouse calc note CN-RRA-00-66), rev. 1, "RI-ISI Perdue Model Calculations for Palisades”

7.22 “Palisades Scope of Risk-Informed Inservice Inspection Program”, Revision 1

7.23 EA-PSA-SAPH-00-0011, rev. 0, “Update of PSA Rev 1 Model to PSA Rev 1a”

7.24 EA-PSA-LERF-99-0020, rev. 0, “Re-Creation of Palisades IPE LERF Model”

Table 3.1-1 System Selection and Segment Definition					
System description	PSA	Section XI	Maintenance Rule	Number of Segments	Comments
AFW – Auxiliary Feedwater	Yes	Yes	Yes	27	Includes Chemistry Makeup to AFW
BLD – S/G Blowdown	No	Yes	Yes	15	
CBA Concentrated Boric Acid	Yes	Yes	Yes	15	
CCS – Component Cooling	Yes	Yes	Yes	90	
CDS – Condensate / Main Condenser	Yes	Yes	Yes	14	Condensate Storage Tank (CST) included in AFW
CIS – Containment Isolation	Yes	Yes	Yes	8	
CSS – Containment Spray	Yes	Yes	Yes	29	
CSW – Critical Service Water	Yes	Yes	Yes	35	
CVC – Chemical and Volume Control (Charging & Letdown)	Yes	Yes	Yes	38	
CWS – Circulating Water	Yes	No	Yes	16	
DMW – Demineralized Makeup Water	Yes	Yes	Yes	16	PSA model is from demineralizer to CST; Maintenance Rule (MR) includes makeup to CCS and Diesel Gen (DG) jacket water; ISI includes from CV2010 to CST
EHC – Electro-Hydraulic Control	No	No	No	1	Included in RI-ISI since EHC failure can cause plant trip
FOS – Fuel Oil	Yes	No	Yes	9	FOS to DG & fire pump day tanks included in MR; only to DG day tanks in PSA
FPA – Feedwater Purity Air	No	No	Yes	1	
FPS – Fire Protection	Yes	No	Yes	30	PSA includes FPS as backup to AFW, CSW and cooling for instrument air compressors
HED - Extraction Steam Heaters & Drains	Yes	No	Yes	9	Water side of heat exchangers (CDS system) included in PSA. Possible indirect consequences
HPA – High Pressure Air	Yes	No	Yes	47	
HPI – High Pressure Safety Injection	Yes	Yes	Yes	39	
HYM – Hydrogen Monitoring	No	Yes	Yes	2	
IAS – Instrument Air	Yes	Yes	Yes	19	Containment penetration piping is examined in ISI
LPI – Low Pressure Safety Injection	Yes	Yes	Yes	30	
LRW – Liquid Radwaste	No	Yes	Yes	4	Containment penetration piping is examined in ISI; included in MR for containment isolation & waste processing / monitoring
MFW – Main Feedwater	Yes	Yes	Yes	14	
MGS – Miscellaneous Gas	Yes	Yes	Yes	13	Nitrogen back-up to air valves included in PRA; Nitrogen and CO2 in MR: ISI program includes nitrogen overpressure for electrical penetrations
MSS – Main Steam	Yes	Yes	Yes	81	

Table 3.1-1 System Selection and Segment Definition					
System description	PSA	Section XI	Maintenance Rule	Number of Segments	Comments
NSW – Non-Critical Service Water	Yes	No	Yes	13	
PCS – Primary Coolant	Yes	Yes	Yes	48	
PZR – Pressurizer	Yes	Yes	Yes	21	
SCS – Shield Cooling	No	No	Yes	5	
SDC – Shutdown Cooling	Yes	Yes	Yes	38	
SFP – Spent Fuel Pool Cooling	No	Yes	Yes	5	
SIT – Safety Injection Tanks	Yes	Yes	Yes	16	
SSS – SIRW & Containment Sump Suction	Yes	Yes	Yes	46	
TGS – Turbine Generator System	No	No	Yes	2	Includes Turbine Lube Oil Sys, Turbine Seal Oil Sys, and hydrogen to the generator. None are in PSA, but all can lead to plant trip
UHS – Ultimate Heat Sink	Yes	No	Yes	1	Buried pipe but added to scope due to potential direct consequences
WGS – Waste Gas System	No	Yes	Yes	2	Containment penetration piping is examined in ISI; included in MR for containment isolation & waste gas collection, monitoring and batching
TOTAL				799	

Table 3.3-1 Summary of Postulated Consequences by System	
System	Summary of Consequences
AFW – Auxiliary Feedwater	The direct consequences postulated from AFW piping failures are blowing down of the steam generator(s), loss of one or more train of AFW, and loss of the Condensate Storage Tank (CST/T-2). Indirect consequences for this system included flooding of the AFW pump room, or the West Safeguards room.
BLD – S/G Blowdown	The direct consequences postulated from BLD piping failures include steam line breaks inside and outside containment, and loss of function of the BLD system. Significant indirect effects associated with the system include loss of all CCS due to environmental effects of a steam line break, and loss of instrument air due to pipe whip.
CBA - Concentrated Boric Acid	The direct consequences postulated from CBA piping failures include the loss of one or both boric acid pump trains. Indirect consequences for this system included the loss of one of the pumps due to flooding or spray.
CCS – Component Cooling	The direct consequences for CCS are associated with LOCCW (loss of component cooling water) as initiating events. There are separate initiating events for loss of CCS inside and outside of containment. There were a large number of indirect consequences associated with CCS segments. Most result from flooding in the East or West Engineered Safeguards rooms and some result from spray.
CDS – Condensate / Main Condenser	The direct consequences for CDS are associated with the loss of condensate and the loss of condensate pump initiating events (IE-LOCPA and IE-LOCPB). In addition, Loss of Main Condenser Vacuum initiating event (IE-LOMC) is considered for relevant segments (piping penetrating the hotwell/condenser). Indirect consequences include: loss of the AFW P-8A & P-8B pumps due to flooding of hotwell supply piping in the AFW rooms; loss of instrument air compressors due to environmental effects; and loss of numerous safety components due to jet impingement or High Energy Line Breaks (eg, safeguards bus, HPSI/LPSI MOV power, PCPs, charging pumps, etc).
CIS – Containment Isolation	For RI-ISI purposes, the Containment Isolation & Penetration system includes all the segments attached to containment penetrations that were not included in other systems. The direct consequences modeled were associated with Loss of containment function. There is also a segment (CIS-008) whose consequence is draining containment sump inventory. Losing inventory in the sump could lead to ESS pump failure. No indirect consequences different from the direct consequences were identified.
CSS – Containment Spray	Most CSS direct consequences were determined to be loss of one or more CSS pumps, loss of SIRW inventory, and depletion of the containment sump inventory. There were a large number of indirect consequences associated with the CSS system. The indirect consequences are all due to piping spray or flooding. Flooding consequences are limited to the associated Engineered Safeguards room, but the resulting flooding is assumed to fail all components in the room.
CSW – Critical Service Water	There are numerous direct consequences for the CSW. Failure in any piping of 6" or greater diameter was a failure of all SWS (IE-LOSWS). Failures in other segments of CSW piping are generally loss of a specific function of CSW (example: Loss of CSW to C-2A). There were numerous indirect consequences for CSW, the most significant being flooding of one of the safeguards rooms and flooding of the screenhouse. Indirect consequences were most often due to flooding, but some were the result of spray.
CVC – Chemical and Volume Control (Charging & Letdown)	CVC direct consequences for the Charging piping include loss of one, or all three Charging pumps. Direct consequences associated with Letdown piping include a Small Break LOCA initiator for all the piping upstream of the Letdown orifices. Piping downstream of the orifices results in a loss of Letdown. Indirect consequences for this system included the loss of one of the pumps due to spray.
CWS – Circulating Water	The direct consequences postulated for CWS are associated with LOMC (Loss of main condenser) as initiating events. There were a large number of indirect consequences associated with CWS segments. Flooding of buses 1A, 1B, 1E, and the Screenhouse were the most significant of the indirect consequences.
DMW – Demineralized Makeup Water	For RI-ISI, the DMW System is made up of all the piping attached to the Demineralized Water Storage Tank T-939 and the Primary System Makeup Storage Tank T-81. Piping attached to the Condensate Storage Tank that was not included in AFW segmenting is also included in the DMW system. The direct consequences modeled were associated with loss of the three tanks associated with the system (T-2, T-939, or T- 81) and/or loss of the ability to makeup to T-2. There were numerous indirect consequences associated with the DMW system mainly due to flooding. The largest number of indirect consequences occurs to components in and near the two Diesel Generator Rooms and Bus 1C room.

Table 3.3-1 Summary of Postulated Consequences by System	
System	Summary of Consequences
EHC – Electro-Hydraulic Control	The whole EHC system is included as one segment. The direct consequence identified for an EHC failure is an IE-TRANS-WC (turbine trip, transient with main condenser available) initiating event. No indirect consequences different from the direct consequences were identified.
FOS – Fuel Oil	The direct consequences modeled with FOS are associated with loss of makeup to T-25A or T-25B (diesel generator day tanks). There are no initiating events associated with the FOS system. No indirect consequences different from the direct consequences were identified.
FPA – Feedwater Purity Air	The whole FPA system is included as one segment. The direct consequence modeled for this system is associated with its Maintenance Rule function as a backup to instrument and service air. No indirect consequences result from failure of air systems. No conditional core damage probabilities were calculated for this system (not in PSA model).
FPS – Fire Protection	The direct consequences postulated for FPS are associated with loss of the FPS system. A handful of segments had failure of one pump as a consequence with most failures disabling the entire FPS system. There were a large number of indirect consequences associated with the FPS system, most the result of flooding or spray. Multiple equipment failures result from pipe failures in Bus 1C or 1D rooms, Cable Spreading room, AFW pump room, and Diesel Generator 1-1 or 1-2 rooms.
HED - Extraction Steam Heaters & Drains	There is only one HED segment with direct consequences, which is a Loss of Main Feedwater initiating event resulting from the loss of flow from the Heater Drain Pumps. The other segments are included because of indirect consequences resulting from high temperature, pipe whip, jet impingement, and spray. Indirect consequences include piping failures in the CCW room and turbine building (air compressors and cable trays).
HPA – High Pressure Air	The direct consequences identified for most HPA segments are usually associated with loss of HPA train availability or loss of HPA to specific loads (valves). A few of the segments did have IE-LOIA (Loss of Instrument Air) as a consequence for cross-connected piping. No indirect consequences were identified. Leakage of any size was assumed to be system disabling.
HPI – High Pressure Safety Injection	The HPI direct consequences modeled are associated with: loss of one of the HPI trains; insufficient ESS pump NPSH and/or loss of all Cont. sump inventory following RAS; and loss of SIRW inventory. There were a large number of indirect consequences identified for the HPI segments. The worst-case indirect consequences result from flooding in whichever Safeguards room the segment resides in. Failures of individual components also resulted from spray or jet impingement.
HYM – Hydrogen Monitoring	The entire HYM system is included in 2 segments, one segment for each independent channel. The only consequence associated with each segment is loss of the associated channel. No indirect consequences different from the direct consequences were identified. HYM is not in the PSA.
IAS – Instrument Air	The direct consequences postulated for IAS are associated with IE-LOIA initiating events and loss of instrument air for mitigation purposes. No indirect consequences were identified. Leakage of any size was assumed to be system disabling.
LPI – Low Pressure Safety Injection	There were a number of direct consequences modeled for the LPI system. Most of the segments had the consequence of failing one of the two LPI trains. Segments downstream of the HPI/LPI tie-in had consequences of loss of HPI and LPI (all or part). Based on the breakdown chosen between LPI and SDC, all LPI segments are in containment. Therefore, per the program criteria no indirect consequences different from the direct consequences were identified.
LRW – Liquid Radwaste	The only direct consequences modeled are loss of the entire LRW system. The only indirect consequence modeled is the flooding of Bus 1C room from the failure of one of the LRW segments.
MFW – Main Feedwater	The MFW direct consequences modeled are associated with loss of main feedwater initiating events and loss of the MFW safety functions. The segments downstream of the SG injection check valves are also MSLB initiating events. There are numerous indirect consequences associated with the MFW system due to high-energy line effects. The largest number of indirect consequences occurs to components in and near the instrument air compressors and the CCW room due to failure of MFW system piping in that room. There are indirect consequences associated with high temperature, spray, pipe whip, and jet impingement.
MGS – Miscellaneous Gas	The direct consequences modeled for MGS are those resulting from the loss of the nitrogen station associated with the segment under consideration. No indirect consequences different from the direct consequences were identified.

Table 3.3-1 Summary of Postulated Consequences by System	
System	Summary of Consequences
MSS – Main Steam	MSS direct consequences are associated with MSLB initiating events. There are also numerous mitigating consequences associated with loss of Main Steam (eg, loss of Main Feedwater). There were numerous indirect consequences associated with the MSS system due to high temperature, spray, pipe whip, and jet impingement. Indirect consequences to multiple systems result from piping failures in the CCW room and turbine building (air compressors and cable trays).
NSW – Non-Critical Service Water	There are numerous direct consequences for the NSW. Failure in any piping of 6" or greater diameter was a failure of all SWS (IE-LOSWS). Failures in other segments of NSW piping are generally loss of a specific NSW load. There are several indirect consequences for NSW, the most significant being flooding of the screenhouse. Indirect consequences were most often due to flooding, but some were the result of spray.
PCS – Primary Coolant	PCS direct consequences are associated with LOCAs (large, medium large, medium, and small) as initiating events. The number of LOCA cases considered for each segment is dependent on the pipe size of the segment. No indirect consequences were identified (inside containment).
PZR – Pressurizer	Direct consequences for PZR segments are associated with LOCAs (large, medium large, medium, and small) as initiating events. The number of LOCA cases considered for each segment is dependent on the pipe size of the segment. No indirect consequences were identified (inside containment).
SCS – Shield Cooling	Direct consequences modeled are associated with loss of the SCS, all or in part. No indirect consequences were identified. SCS is not in the PSA.
SDC – Shutdown Cooling	The direct consequences for SDC are associated with LOCAs (large, medium large, medium, and small) as initiating events, some of which are outside containment. The type(s) of LOCA cases considered for each segment is dependent on the pipe size. Other consequences include loss of SIRW inventory (failure of ESS pumps on RAS), and loss of LPI function. Indirect consequences include flooding in East or West Safeguards room and failures of individual components due to spray.
SFP – Spent Fuel Pool Cooling	The direct consequences postulated for piping failure in the SFP system are loss of cooling to the fuel pool. There are no indirect consequences associated with SFP piping.
SIT – Safety Injection Tanks	Consequences associated with the SIT's were typically loss of function for one SIT. No indirect consequences different from the direct consequences were identified.
SSS – SIRW & Containment Sump Suction	SSS direct consequences modeled are associated with loss of the SIRW inventory outside of containment, and loss of containment sump inventory. Failure of this system has large impact in function of ESS pumps. Indirect consequences include flooding in East or West Safeguards room and failures of individual components due to spray.
TGS – Turbine Generator System	The only direct consequence identified for a TGS failure is an IE-TRANS-WC (turbine trip, transient with main condenser available) initiating event. No indirect consequences different from the direct consequences were identified.
UHS – Ultimate Heat Sink	There is only one UHS piping segment. It has the consequence of loss of P-5, the Warm Water Recirc pump. No indirect consequences were identified.
WGS – Waste Gas	The only direct consequences modeled are loss of the entire WGS system. No indirect consequences.

Table 3.4-1 Failure Probability Estimates (without ISI)				
System	Dominant Potential Degradation Mechanism(s)/ Combination(s)	Failure Probability range at 40 years with no ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)*	
AFW	• Thermal Fatigue • Thermal Fatigue & Vibratory Fatigue • Thermal Fatigue, Striping/Stratification, & Flow Accelerated Corrosion (FAC)	1.05E-05 – 1.23E-03 1.02E-05 - 6.61E-03 7.27E-01	7.16E-08 – 2.12E-03 5.76E-05 – 7.81E-03 7.27E-01	Thermal Stratification/Striping and FAC failure mechanisms are only used for the segments that interface with the steam generators. Past FAC wear has been identified in the two segments and are included in the existing FAC program. For vibratory stress inputs, a reduction factor has been used for the infrequent usage of this piping system. AFW is operated only during plant startup and shutdown plus short periods of surveillance tests.
BLD	• Thermal Fatigue • Thermal Fatigue & Flow Accelerated Corrosion • Thermal Fatigue, Vibratory Fatigue & Flow Accelerated Corrosion • Thermal Fatigue & Striping/Stratification	1.10E-06 - 1.50E-04 1.57E-03 – 6.55E-02 1.57E-03 - 1.37E-01 1.44E-03	2.59E-10 – 5.63E-05 8.12E-04 – 6.55E-02 8.12E-04 - 1.37E-01 7.98E-05 – 1.15E-05	FAC is the dominant failure mechanism. The two-phase pipe flow has a strong potential to degrade the carbon steel pipe due to both FAC and vibration. BLD is included in the existing FAC program.
CBA	• Thermal Fatigue & Stress Corrosion Cracking	6.22E-02 - 9.98E-02	9.67E-04 – 2.75E-03	Piping is thin walled Schedule 10 and is potentially susceptible to IGSCC. Thermal Fatigue is input due to the system being kept at 160°F. Vibratory fatigue was input for CBA segments near the boric acid injection pumps.

Table 3.4-1 **Failure Probability Estimates (without ISI)**				
System	Dominant Potential Degradation Mechanism(s)/ Combination(s)	Failure Probability range at 40 years with no ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)*	
CCS	• Thermal Fatigue • Thermal Fatigue & Vibratory Fatigue	2.43E-07 - 3.22E-04 1.50E-06 - 5.70E-05	6.04E-14 - 1.10E-04 1.83E-08 - 9.70E-05	There is no strong degradation mechanism identified for this piping system. Fatigue is the dominant failure mechanism. Most of the piping segments are operated under a steady temperature and pressure conditions. Vibration was included for segments adjacent to the Component Cooling Water pumps.
CDS	• Thermal Fatigue • Thermal Fatigue & Flow Accelerated Corrosion • Thermal Fatigue, Vibratory Fatigue & Flow Accelerated Corrosion	3.04E-07 - 3.79E-04 3.20E-03 - 5.53E-02 4.52E-02	7.01E-11 – 2.43E-07 3.20E-03 - 5.53E-02 4.52E-02	FAC is the predominant degradation mechanism of this piping system. CDS is included in the existing FAC program. Waterhammer has been included to address pressure surges in the system following trip of the condensate and feedwater pumps. Vibration has been input to segments adjacent to the air ejector and gland seal condenser heat exchangers.
CIS	• Thermal Fatigue	2.60E-07 - 7.12E-06	N/A	The Containment Isolation System has no adverse failure mechanisms identified. A default value for thermal fatigue was used. Any leakage is considered system disabling, thus only the small leakage case was run.
CSS	• Thermal Fatigue • Thermal Fatigue & Vibratory Fatigue	6.64E-06 - 1.64E-04 1.88E-05 - 4.60E-04	3.42E-07 - 3.43E-06 5.21E-06 - 3.48E-04	Pump vibration during testing at a low flow condition has been noted in the past so a vibration input to segments adjacent to the CSS pumps and recirculation line has been included. No other active degradation mechanisms are identified.
CSW	• Wastage • Vibration and Wastage	1.32E-03 – 7.92E-02 7.85E-03 – 1.16E-02	7.13E-04 – 7.92E-02 7.85E-03 – 1.16E-02	Wastage included to account for MIC potential and slurry erosion from entrained sand. Vibration included in the vicinity of the Service Water Pumps and the Instrument Air Compressors.

Table 3.4-1
Failure Probability Estimates (without ISI)

System	Dominant Potential Degradation Mechanism(s)/ Combination(s)	Failure Probability range at 40 years with no ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)*	
CVC	• Thermal Fatigue	2.50E-07 – 1.51E-04	• SYS 3.10E-06 – 8.47E-05 • SBLOCA 2.47E-5 – 1.07E-04	SCC has only been applied to three segments that interface with the CBA system. Vibratory fatigue has been input for segments near the three charging pumps. Inputs for thermal fatigue were used for all system segments due to the relatively high operating temperature.
	• Thermal Fatigue & Vibratory Fatigue	1.11E-04 – 8.78E-04	• SYS 1.74E-05 – 3.87E-04 • SBLOCA 2.13E-04 – 5.00E-04	
	• Thermal Fatigue & Stress Corrosion Cracking	8.81E-02	• SYS 1.07E-03	
CWS	• Thermal Fatigue	4.47E-06 - 1.48E-04	7.01E-11 - 2.98E-07	Default values for mechanical and thermal fatigue were input since there is no structural degradation mechanism identified for CWS.
DMW	• Thermal Fatigue • Thermal Fatigue & Vibratory Fatigue	7.94E-07 - 1.80E-04 3.25E-06	5.13E-10 - 7.11E-05 7.04E-05	Vibratory stresses are imposed only on the pipe segments on the backwash pumps direct discharge lines. No vibration inputs were used for the other system pumps due to their infrequent usage.
EHC	• Thermal Fatigue & Vibratory Fatigue	5.95E-03	N/A	The entire EHC system is modeled as one segment. Any leakage is considered system disabling, thus only the small leakage case was run. The main potential for degradation is vibration adjacent to the positive displacement pumps.
FOS	• Mechanical Fatigue	8.29E-07 - 2.54E-06	5.61E-05 - 6.06E-05	Based on the very limited service, no vibratory stress was applied. There also has not been any history of leaks nor are there any known degradation mechanisms for this system. Mechanical fatigue input as a default mechanism.

Table 3.4-1 **Failure Probability Estimates (without ISI)**				
System	Dominant Potential Degradation Mechanism(s)/ Combination(s)	Failure Probability range at 40 years with no ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)*	
FPA	• Vibratory Fatigue	N/A	N/A	No Win-SRRA runs for FPA (not in PSA model). Vibration considered possible in vicinity of compressors.
FPS	• Thermal Fatigue and Wastage	1.00E-05 - 7.41E-03	1.00E-05 - 3.95E-03	To address the potential for raw water wastage in this stagnant system a conservative wastage factor was applied to all segments except two. These two segments are fuel oil supply to the fire pumps.
HED	• Thermal Fatigue • Thermal Fatigue & Flow Accelerated Corrosion	1.44E-04 - 2.08E-04 3.11E-02 - 1.06E-01	7.11E-09 – 4.20E-07 3.11E-02 - 1.06E-01	FAC is the dominant failure mechanism for the HED system. The system is very susceptible to pipe wall thinning and has had several piping sections worn and replaced during past operation. HED is in current FAC program.
HPA	• Thermal Fatigue • Thermal Fatigue & Vibratory Fatigue	6.63E-07 - 1.28E-03 6.50E-05	N/A	Any leakage is considered system disabling, thus only the small leakage case was run. Vibratory fatigue input for segments near the compressors.
HPI	• Thermal Fatigue • Thermal Fatigue & Vibratory Fatigue	9.87E-07 - 3.03E-04 9.90E-07 – 3.98E-04	4.38E-07 – 1.11E-04 4.59E-07 - 2.33E-04	Vibratory fatigue is input for segments near the HPI pumps. Otherwise the system is an infrequently used system with no significant degradation mechanisms
HYM	• Mechanical Fatigue	N/A	N/A	No Win-SRRA runs for HYM (not in PSA model). Mechanical fatigue indicated as a default mechanism.
IAS	• Mechanical Fatigue	1.60E-06 - 1.00E-05	N/A	Any leakage is considered system disabling, thus only the small leakage case was run. IAS has no adverse failure mechanisms identified, thus mechanical fatigue was input as a default mechanism.
LPI	• Thermal Fatigue • Thermal Fatigue, Stress Corrosion Cracking, and Thermal Striping / Stratification	3.11E-09 – 1.04E-07 2.22E-05 – 2.49E-04	4.77E-08 – 3.94E-05 8.58E-04 - 2.85E-03	Segments adjacent to the PCS have elevated temperatures and are potentially susceptible to SCC and Thermal Stratification/Striping. Water hammer has been included for segments near the PCS and SIT connections due to past experience.

Table 3.4-1 **Failure Probability Estimates (without ISI)**				
System	Dominant Potential Degradation Mechanism(s)/ Combination(s)	Failure Probability range at 40 years with no ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)*	
LRW	• Thermal Fatigue	6.94E-05	1.92E-05	No failure mechanisms identified for these systems. Default values for mechanical and thermal fatigue were input.
MFW	• Thermal Fatigue & Flow Accelerated Corrosion • Thermal Fatigue, Vibratory Fatigue & Flow Accelerated Corrosion	9.58E-04 - 1.93E-02 3.01E-03 – 3.90E-03	1.48E-04 - 3.90E-03 3.01E-03 - 3.90E-03	MFW piping has experienced FAC in the past and is included in the existing FAC program. Segments near the main feed pumps have the potential for vibration.
MGS	• Mechanical Fatigue	8.29E-07 - 1.00E-05	N/A	MGS has no adverse failure mechanisms identified. Mechanical fatigue was input as a default mechanism. Any leakage is considered system disabling, thus only the small leakage case was run.
MSS	• Thermal Fatigue • Thermal Fatigue & Flow Accelerated Corrosion	9.75E-05 5.63E-08 - 9.08E-02	2.61E-07 – 7.93E-07 8.71E-09 - 9.08E-02	The Main Steam system has had piping replaced in the past due to FAC and is in the current FAC program. FAC is the dominant failure mechanism for much of the system.
NSW	• Wastage	8.46E-08 – 9.27E-03	1.08E-07 – 9.27E-03	Wastage included to account for MIC potential and slurry erosion from entrained sand.

Table 3.4-1 **Failure Probability Estimates (without ISI)**				
System	Dominant Potential Degradation Mechanism(s)/ Combination(s)	Failure Probability range at 40 years with no ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)*	
PCS	• Thermal Fatigue	1.42E-06 – 2.74E-05	• SBLOCA 1.81E-05 – 9.55E-05	PWSCC was input for all segments containing inconel 600 material. Thermal stratification was considered for all loop pipe's branch lines except for those less than or equal to 1 inch nominal pipe size. Vibratory fatigue was only input for segments near the Primary Coolant Pumps.
	• Thermal Fatigue and Vibration	1.67E-07 – 3.02E-03	• LBLOCA, MLBLOCA, MBLOCA: 1.01E-07 • SBLOCA: 1.02E-07 – 3.18E-03	
	• Thermal Fatigue and Thermal Striping / Stratification	2.20E-06 – 5.29E-04	• SYS 1.04E-05 – 1.86E-04 • MLBLOCA: 9.98E-06 • MBLOCA: 7.34E-06 – 1.22E-05 • SBLOCA: 8.71E-06 – 2.24E-04 5.20E-04 - 8.35E-04 (PWSCC)	
	• Thermal Fatigue, Stress Corrosion Cracking, and Thermal Striping / Stratification	4.13E-03 – 5.36E-03	• SBLOCA 5.20E-04 – 8.35E-04	
	• Thermal Fatigue, Thermal Striping / Stratification, and Vibration	8.46E-04	• SYS 3.56E-04 • SBLOCA 3.46E-04	

Table 3.4-1
Failure Probability Estimates (without ISI)

System	Dominant Potential Degradation Mechanism(s)/ Combination(s)	Failure Probability range at 40 years with no ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)*	
PZR	• Thermal Fatigue • Thermal Fatigue & Stress Corrosion Cracking • Thermal Fatigue & Striping/Stratification	1.06E-06 – 1.03E-04 1.38E-03 – 2.10E-03 1.04E-05 – 8.43E-04	• SBLOCA: 3.93E-05 – 1.54E-04 • MBLOCA: 4.64E-05 – 3.80E-04 • SBLOCA: 1E-04 – 6.27E-04 • MLBLOCA 5.93E-06 • MBLOCA 6.12E-06 – 4.86E-05 • SBLOCA 6.04E-06 – 3.71E-04	All the large bore piping connected to the Pressurizer is have thermal stratification input as degradation mechanism except for the piping and nozzles within the upper head of the Pressurizer. PWSCC was input for all segments containing inconel 600 material.
SCS	• Wastage	N/A	N/A	No Win-SRRA runs for SCS. Not in PSA model. Wastage considered possible due to periodic stagnant flow.
SDC	• Thermal Fatigue • Thermal Fatigue & Striping/Stratification • Thermal Fatigue & Vibratory Fatigue	2.14E-06 - 2.47E-04 2.47E-04 3.30E-04 - 2.52E-03	2.48E-06 – 1.90E-04 3.94E-05 1.39E-04 - 9.69E-04	Shutdown Cooling piping has no known design deficiency. Thermal Stratification/Striping is applied at PCS loop drop leg and SDC heat exchanger bypass due to mixing of flows of different temperatures.
SFP	• Vibratory Fatigue	N/A	N/A	No Win-SRRA runs for SFP. Not in PSA model. Vibration considered possible in vicinity of pumps.
SIT	• Thermal Fatigue • Thermal Fatigue, Stress Corrosion Cracking, and Thermal Striping / Stratification	2.73E-05 - 4.21E-06 1.55E-04	7.10E-06 3.23E-04	Segments adjacent to the PCS have elevated temperatures and are assumed susceptible to SCC and Thermal Stratification/Striping. Water hammer has been included due to past experience.

Table 3.4-1
Failure Probability Estimates (without ISI)

System	Dominant Potential Degradation Mechanism(s)/ Combination(s)	Failure Probability range at 40 years with no ISI		Comments
		Small leak	Disabling leak (by disabling leak rate)*	
SSS	• Thermal Fatigue • Thermal Fatigue & Stress Corrosion Cracking	5.42E-06 – 1.32E-04 1.93E-03 – 3.27E-02	1.76E-08 – 7.00E-05 1.92E-04 – 5.62E-04	SSS has no predominant failure mechanisms. Two segments had a manufacturing flaw resulting in SCC and are being inspected under an augmented inspection program.
TGS	• Mechanical Fatigue	1.32E-06 - 3.32E-04	1.43E-04	Turbine Generator System consists of a single segment that models the lube oil piping. It is a low pressure and temperature system under benign service conditions. Mechanical fatigue was input as a default mechanism.
UHS	• Mechanical Fatigue	7.17E-07	1.11E-07	Ultimate Heat Sink System has virtually no thermal load and sees very low-pressure loading. Mechanical fatigue was input as a default mechanism.
WGS	• Mechanical Fatigue	N/A	N/A	No Win-SRRA runs for WGS. Not in PSA model. Mechanical fatigue was considered as a default mechanism.

Notes:
* Disabling leak rate – Large Break LOCA (LBLOCA), Medium Large Break LOCA (MLBLOCA), Medium Break LOCA (MBLOCA), Small Break LOCA (SBLOCA), and System Disabling Leak (SYS). When no leak rate is shown, this is the system disabling leak rate.

Table 3.5-1 Number of Segments and Piping Risk Contribution by System (without ISI)					
System	Number of Segments	CDF without Operator Action (/yr)	CDF with Operator Action (/yr)	LERF without Operator Action (/yr)	LERF with Operator Action (/yr)
AFW	27	1.41E-6	1.41E-6	2.70E-10	2.70E-10
BLD	15	3.54E-7	3.52E-7	4.84E-10	4.75E-10
CBA	15	4.25E-8	4.25E-8	4.00E-13	4.00E-13
CCS	90	8.86E-9	2.92E-9	7.23E-12	2.10E-12
CDS	14	1.56E-6	1.56E-6	1.78E-10	1.78E-10
CIS	8	1.60E-11	1.60E-11	1.46E-11	9.85E-14
CSS	29	2.48E-9	2.34E-9	4.95E-10	4.93E-10
CSW	35	2.22E-5	4.23E-7	5.20E-8	4.93E-10
CVC	38	2.06E-6	1.17E-8	1.55E-9	1.28E-10
CWS	16	3.06E-12	3.06E-12	8.04E-15	8.04E-15
DMW	16	8.58E-11	8.58E-11	1.71E-13	1.71E-13
EHC	1	5.61E-9	5.61E-9	7.22E-13	7.22E-13
FOS	9	1.81E-10	1.81E-10	9.85E-13	9.85E-13
FPA	1	0	0	0	0
FPS	30	1.20E-6	1.20E-6	5.94E-10	5.94E-10
HED	9	4.90E-7	4.90E-7	1.30E-9	1.30E-9
HPA	47	5.75E-8	5.75E-8	1.46E-10	1.46E-10
HPI	39	8.04E-9	1.65E-9	1.00E-10	1.00E-10
HYM	2	0	0	0	0
IAS	19	7.90E-10	7.97E-10	7.37E-13	6.46E-13
LPI	30	2.23E-8	2.23E-8	5.75E-13	5.75E-13
LRW	2	9.91E-12	9.91E-12	4.22E-14	4.22E-14
MFW	14	6.08E-8	6.26E-8	7.08E-11	7.08E-11
MGS	13	4.35E-13	4.35E-13	1.61E-15	1.61E-15
MSS	81	6.95E-6	6.95E-6	3.58E-10	3.58E-10
NSW	13	1.30E-6	3.23E-7	3.16E-9	9.46E-10
PCS	48	3.63E-5	3.63E-5	4.31E-8	4.31E-8
PZR	21	7.05E-6	7.05E-6	8.58E-9	8.58E-9
SCS	5	0	0	0	0
SDC	38	1.42E-8	4.10E-9	1.80E-8	2.94E-9
SFP	5	0	0	0	0
SIT	16	1.94E-12	1.94E-12	7.76E-17	7.76E-17
SSS	46	3.00E-8	2.95E-8	3.09E-10	2.67E-10
TGS	2	1.37E-10	1.37E-10	1.77E-14	1.77E-14
UHS	1	0	0	0	0
WGS	2	0	0	0	0
TOTAL	799	8.12E-5	5.63E-5	1.31E-7	6.05E-8

Table 3.7-1 Summary of Risk Evaluation and Expert Panel Categorization Results (includes segments made HSS due to Delta Risk results)							
System	Number of Segments with any RRW ≥ 1.005	Number of Segments with any RRW between 1.005 and 1.001	Number of Segments with all RRW < 1.001	Number of Segments with any RRW between 1.005 and 1.001 placed in HSS	Number of Segments with all RRW < 1.001 Selected for Inspection (placed in HSS)	Total Number of Segments Selected for Inspection (HSS Segments)	Number of Segments with any RRW ≥ 1.005 that were voted LSS
AFW	5	2	20	0	1	6	0
BLD	3	5	7	1	0	4	0
CBA	1	1	13	0	0	0	1 (see note 1)
CCS	0	0	90	0	0	0	0
CDS	2	2	10	0	0	2	0
CIS	0	0	8	0	0	0	0
CSS	0	9	20	0	0	0	0
CSW	9	10	16	2	2	10	3 (see note 2)
CVC	3	6	29	0	0	0	3 (see note 3)
CWS	0	0	16	0	2	2	0
DMW	0	0	16	0	0	0	0
EHC	0	0	1	0	0	0	0
FOS	0	0	9	0	0	0	0
FPA	0	0	1	0	0	0	0
FPS	2	4	24	3	0	4	1 (see note 4)
HED	3	4	2	3	0	6	0
HPA	0	2	45	0	0	0	0
HPI	0	0	39	0	0	0	0
HYM	0	0	2	0	0	0	0
IAS	0	0	19	0	0	0	0
LPI	0	0	30	0	8	8	0
LRW	0	0	4	0	0	0	0
MFW	0	1	13	0	0	0	0
MGS	0	0	13	0	0	0	0
MSS	11	17	53	9	3	22	1 (see note 5)
NSW	4	1	8	0	2	3	3 (see note 6)

Table 3.7-1
Summary of Risk Evaluation and Expert Panel Categorization Results
(includes segments made HSS due to Delta Risk results)

System	Number of Segments with any RRW ≥ 1.005	Number of Segments with any RRW between 1.005 and 1.001	Number of Segments with all RRW < 1.001	Number of Segments with any RRW between 1.005 and 1.001 placed in HSS	Number of Segments with all RRW < 1.001 Selected for Inspection (placed in HSS)	Total Number of Segments Selected for Inspection (HSS Segments)	Number of Segments with any RRW ≥ 1.005 that were voted LSS
PCS	20	12	16	8	1	29	0
PZR	13	2	6	2	2	15	2 (see note 7)
SCS	0	0	5	0	0	0	0
SDC	14	14	10	0	0	1	13 (see note 8)
SFP	0	0	5	0	0	0	0
SIT	0	0	16	0	0	0	0
SSS	1	2	43	2	15	18	0
TGS	0	0	2	0	0	0	0
UHS	0	0	1	0	0	0	0
WGS	0	0	2	0	0	0	0
TOTAL	**91**	**94**	**614**	**30**	**36**	**130**	**27**

Notes

Note Number	Number of Segments	Comment
1	1	High RRW for the common discharge header of the pumped concentrated boric acid (CBA) injection piping. Boration can still be performed with the Safety Injection & Refueling Water (SIRW) tank if CBA is unavailable.
2	3	Two segments have low RRW values for the with operator action cases. The Expert Panel has high confidence in the listed actions. The Expert Panel voted the other segment LSS based on a consensus that the importance ranking is overly conservative for the high RRW case (LERF with operator action).
3	3	All three segments were in the low safety significant category with operator action. Operator actions listed for CVC to isolate Letdown in the event of a pipe failure are credible actions.
4	1	Normally isolated segment. It requires local manual action to put line into service. A failure in this line would be easily identified and isolated.

<table>
<tr><th colspan="8">Table 3.7-1
Summary of Risk Evaluation and Expert Panel Categorization Results
(includes segments made HSS due to Delta Risk results)</th></tr>
<tr><th>System</th><th>Number of Segments with any RRW ≥ 1.005</th><th>Number of Segments with any RRW between 1.005 and 1.001</th><th>Number of Segments with all RRW < 1.001</th><th>Number of Segments with any RRW between 1.005 and 1.001 placed in HSS</th><th>Number of Segments with all RRW < 1.001 Selected for Inspection (placed in HSS)</th><th>Total Number of Segments Selected for Inspection (HSS Segments)</th><th>Number of Segments with any RRW ≥ 1.005 that were voted LSS</th></tr>
<tr><td>5</td><td>1</td><td colspan="6">The Expert Panel (EP) believed consequences and failure probabilities to be overly conservative for this segment, including the indirect consequences associated with cable trays.</td></tr>
<tr><td>6</td><td>3</td><td colspan="6">All three segments have low RRW with operator action. Expert Panel has high confidence in listed action.</td></tr>
<tr><td>7</td><td>2</td><td colspan="6">There are no active failure mechanism for these segments. Both segments are buttwelded. Past inspections have resulted in no identified failures and no identified degradation. Segments would be subject to the lowest temperature of all PCS/PZR segments.</td></tr>
<tr><td>8</td><td>13</td><td colspan="6">Four segments voted low based on high confidence of success for the operator action that would result in low safety significance RRW values. For the remaining segments there are no operator actions credited in the evaluation. However, the consensus of the expert panel is that operators could readily diagnose a failure (outside containment LOCA) and use non-proceduralized steps to help mitigate it. A pipe failure in these segments could be identified through a number of indications, including local radiation monitors, safeguard room sump level alarms, etc. Additionally, there are no active degradation mechanisms for these segments, there have been no past ISI failures in this system, and all butt-welds have been 100% radiographed. See Section 3.10 for a more detailed discussion.</td></tr>
</table>

Table 3.10-1 COMPARISON OF CDF/LERF FOR CURRENT SECTION XI AND RISK-INFORMED ISI PROGRAMS AND THE SYSTEMS WHICH CONTRIBUTED SIGNIFICANTLY TO THE CHANGE		
Case **(Systems Contributing ≥ 5% to Change)**	**Current Section XI**	**Risk-Informed**
CDF No Operator Action	5.72E-5	2.78E-5
PCS	1.88E-5	1.76E-5
CSW	2.22E-5	2.98E-6
MSS	6.95E-6	1.88E-6
CDF with Operator Action	3.3E-5	2.26E-5
PCS	1.88E-5	1.76E-5
MSS	6.95E-6	1.88E-6
PZR	1.16E-6	1.13E-6
LERF No Operator Action	1.36E-7	8.38E-8
PCS	2.23E-8	2.09E-8
CSW	5.20E-8	8.17E-9
SDC	1.80E-8	1.59E-8
SSS	3.02E-8	2.72E-8
LERF with Operator Action	6.65E-8	5.97E-8
PCS	2.23E-8	2.09E-8
SSS	3.09E-8	2.76E-8

Table 5-1

**STRUCTURAL ELEMENT SELECTION
RESULTS AND COMPARISON TO ASME SECTION XI
1989 EDITION REQUIREMENTS**

System	No. of High Safety Significant Segments (HSS Augmented Segments / Total Augmented Segments)	Dominant Degradation Mechanisms (note 3)	ASME Code Class	ASME Code Category	Weld Count (for HSS Segments only)		ASME XI Examination Methods Volumetric (Vol) and Surface (Sur)			RI-ISI	
					Butt	Socket (note 6)	Vol & Sur	Sur Only	Vol Only	SES Matrix Region	Number of Exam Locations (note 6)
AFW	6 (2/2)	TF*, VF*, FAC*, TS*	2 & 3	(note 7)	148	53	(note 7)	(note 7)	(note 7)	1A, 1B, 2	13
BLD	4	TF*, VF*, FAC*, TS	2 & non	(note 7)	14	62	(note 7)	(note 7)	(note 7)	1B	2 (note 2)
CBA	0	TF, SCC	2	(note 7)			(note 7)	(note 7)	(note 7)		0
CCS	0	TF, VF	2 & 3	(note 7)			(note 7)	(note 7)	(note 7)		0
CDS	2	TF*, VF, FAC*	3 & non		160		0	0	0	1B	2 (note 2)
CIS	0	TF	2	(note 7)			(note 7)	(note 7)	(note 7)		0
CSS	0	TF, VF	2	(note 7)			(note 7)	(note 7)	(note 7)		0
CSW	10	VF, Wastage	2 & 3	(note 7)			(note 7)	(note 7)	(note 7)	1B, 3	10 (notes 1&4)
CVC	0	TF, VF, SCC	1 & 2	(note 7)			(note 7)	(note 7)	(note 7)		0
CWS	2	TF*	Non		8		0	0	0	2	2
DMW	0	TF, VF	3 & non				0	0	0		0
EHC	0	TF, VF	Non				0	0	0		0
FOS	0	MF	Non				0	0	0		0
FPA	0	VF	Non				0	0	0		0
FPS	4	TF, Wastage*	Non		46		0	0	0	1B	4 (note 1)
HED	6	TF*, FAC*	Non		144		0	0	0	1B	6 (note 2)
HPA	0	TF, VF	Non				0	0	0		0
HPI	0	TF, VF	1 & 2	(note 7)			(note 7)	(note 7)	(note 7)		0
HYM	0	MF	Non				0	0	0		0

Table 5-1

STRUCTURAL ELEMENT SELECTION RESULTS AND COMPARISON TO ASME SECTION XI 1989 EDITION REQUIREMENTS

System	No. of High Safety Significant Segments (HSS Augmented Segments / Total Augmented Segments)	Dominant Degradation Mechanisms (note 3)	ASME Code Class	ASME Code Category	Weld Count (for HSS Segments only)		ASME XI Examination Methods Volumetric (Vol) and Surface (Sur)			RI-ISI	
					Butt	Socket (note 6)	Vol & Sur	Sur Only	Vol Only	SES Matrix Region	Number of Exam Locations (note 6)
IAS	0	MF	2 & non				0	0	0		0
LPI	8	TF*, TS*, SCC*	1 & 2	(note 7)	75		(note 7)	(note 7)	(note 7)	1A, 1B	16
LRW	0	TF	2 & non	(note 7)			(note 7)	(note 7)	(note 7)		0
MFW	0 (0/4)	TF, VF, FAC	2 & non	(note 7)			(note 7)	(note 7)	(note 7)		0
MGS	0	MF	2 & non				0	0	0		0
MSS	22 (0/7)	TF*, FAC*	2 & non	(note 7)	597		(note 7)	(note 7)	(note 7)	1A, 1B	24 (note 2)
NSW	3	Wastage*	Non		103		0	0	0	1B	3 (note 1)
PCS	29 (1/1)	TF*, VF*, TS*, SCC*	1	(note 7)	20	233	(note 7)	(note 7)	(note 7)	2	5
PZR	15 (2/2)	TF*, TS*, SCC*	1	(note 7)	50	96	(note 7)	(note 7)	(note 7)	1A, 1B, 2	10
SCS	0	Wastage	Non				0	0	0		0
SDC	1	TF*, VF, TS	1 & 2				(note 7)	(note 7)	(note 7)	4	1 (note 4)
SFP	0	VF	3	(note 7)			(note 7)	(note 7)	(note 7)		0
SIT	0	TF, TS, SCC	2	(note 7)			(note 7)	(note 7)	(note 7)		0
SSS	18 (0/2)	TF*, SCC	2	(note 7)	187	37	(note 7)	(note 7)	(note 7)	1B, 4	18 (note 4)
TGS	0	MF	Non				0	0	0		0
UHS	0	MF	Non				0	0	0		0
WGS	0	MF	2 & non				0	0	0		0
TOTAL	**130 (3/16)**			**2102**	**597**	**511**	**267**	**230**	**12**		**116**

Table 5-1 STRUCTURAL ELEMENT SELECTION RESULTS AND COMPARISON TO ASME SECTION XI 1989 EDITION REQUIREMENTS											
System	No. of High Safety Significant Segments (HSS Augmented Segments / Total Augmented Segments)	Dominant Degradation Mechanisms (note 3)	ASME Code Class	ASME Code Category	Weld Count (for HSS Segments only)		ASME XI Examination Methods Volumetric (Vol) and Surface (Sur)			RI-ISI	
					Butt	Socket (note 6)	Vol & Sur	Sur Only	Vol Only	SES Matrix Region	Number of Exam Locations (note 6)

Summary:
Currently ASME Section XI selects a total of 509 non-destructive exams while the proposed RI-ISI program selects a total of 116 exams resulting in a 77% reduction. The 116 RI-ISI exams are comprised of: 31 ASME Class 1 exams; 31 Class 2 exams; 15 Class 3 exams; and 39 non-class exams. See Note 6 for additional discussion of VT-2 exams.

Degradation Mechanisms:

MF – Mechanical Fatigue; TF – Thermal Fatigue; VF – Vibratory Fatigue; TS – Thermal Stratification/Striping; FAC – Flow Accelerated Corrosion; SCC – Stress Corrosion Cracking; Wastage – Slurry erosion or MIC attack

Notes for Table 5-1:

1. Seven CSW segments, three NSW segments, and four FPS segments have a primary degradation mechanism of wastage due to erosion and/or microbiologically induced corrosion (MIC) attack. These segments will be included in an inspection program for material wastage
2. Two BLD segments, two CDS segments, six HED segments, and 22 MSS segments are subject to Flow Accelerated Corrosion (FAC). These segments are or will be included in existing FAC program.
3. Dominant degradation mechanisms for the entire system are indicated. The mechanisms associated with the HSS segments are indicated with an asterisk (*). Plant documentation is available that identifies which degradation mechanism(s) apply to specific segments.
4. Five examinations added for change in risk considerations in the following systems: three in CSW, one in SSS, and one in SDC.
5. Augmented programs for erosion-corrosion and/or high energy line break continue.
6. A visual (VT-2) examination will be performed during the system pressure test each refueling outage for socket welds on HSS segments. The "Number of Exam Locations" column does not include the VT-2 exams. A total of 47 HSS segments contain socket welds that will receive VT-2 exams. 44 of the 47 segments are comprised entirely of socket welds.
7. See Table 5-2 for a breakdown of current ASME XI program examinations by code class and category. Maintenance Rule system boundary designations, as used in the RI-ISI program development, vary from ASME XI ISI system boundaries. Therefore, a system-by-system examination comparison between ASME XI and RI-ISI is not available.

TABLE 5-2 CURRENT ASME SECTION XI 1989 EDITION EXAMINATIONS						
Code Class	**Code Category**	**Total Weld Count** (Butt / Socket)	**Surface and Volumetric Examinations Required**	**Surface (only) Examinations Required**	**Volumetric (only) Examinations Required**	**Total Required Examinations** (Butt/Socket)
1	B-F	47 (42 / 5)	32	15	N/A	**47** (42 / 5)
1	B-J	753 (394 / 359)	77	124	12	**213** (112 / 101)
2	C-F-1	986 (920 / 66)	110	63	N/A	**173** (143 / 30)
2	C-F-2	316 (316 / 0)	48	28	N/A	**76** (76 / 0)
3	N/A	N/A	N/A	N/A	N/A	**N/A**
Non	N/A	N/A	N/A	N/A	N/A	**N/A**
Totals		**2102** (1672 / 430)	**267**	**230**	**12**	**509** (373 / 136)