OG-01-049

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

August 7, 2001

Document Control Desk (1L, 1A)
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Dr. Brian W. Sheron
Associate Director for Project Licensing and Technical Analysis

Subject: Westinghouse Owners Group
**Revised Example Template Submittal for Plants that Follow the WOG Risk Informed Inservice Inspection Methodology (WCAP-14572)**

References:

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

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

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

4. Letter from Robert Bryan, Jr., Chairman, Westinghouse Owners Group, to Dr. Brian Sheron, Associate Director for Project Licensing and Technical Analysis, U.S. Nuclear Regulatory Commission, "Westinghouse Owners Group, NRC's Interpretation of the Weld Inspection Requirements for the RI-ISI Program as Described in WCAP-14572 and Its Associated Safety Evaluation Report ," March 8, 2001.

Dear Dr. Sheron:

Attached for information only is a revised template for risk-informed inservice inspection (RI-ISI) submittals for WOG applications. The revisions are based on resolution of items



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discussed in Reference 4 and in numerous conference calls (including April 26, 2001, May 3, 2001, May 15, 2001, June 5, 2001 and July 18, 2001) between the Westinghouse Owners Group and the Nuclear Regulatory Commission (NRC) staff. This template submittal was previously provided by Reference 3.

As we understand, the changes to the template submittal will facilitate NRC's review of plant specific applications and will eliminate the use of a requirement to examine a minimum of 10% of Class 1 butt welds in RI-ISI programs using the WOG methodology. This template will be followed by plants that use the WOG risk-informed ISI methodology.

Please direct any questions or comments to Mr. Ken Balkey, Westinghouse, at (412)-374-4633, Mr. Paul Stevenson, Westinghouse, at (412)-374-6462 or Ms. Nancy Closky, Westinghouse, at (412)-374-5916.

We appreciate your consideration and we would be pleased to further discuss this matter with you by telecon or by meeting, as required. Please direct any questions to me at 423-751-8201.

Very truly yours,

Robert H Bryan

Robert Bryan, Jr., Chairman
Westinghouse Owners Group

attachment

OG-01-049
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All receive 1L, 1A

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# Example Submittal
# For Plants that Follow the WOG Methodology (WCAP-14572)

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

Revision 1

July 2001

RISK-INFORMED INSERVICE INSPECTION PROGRAM PLAN

Table of Contents



NOTE: *Items shown in italics reflect plant-specific information that needs to be provided in an actual risk-informed ISI submittal.*

# 1. INTRODUCTION/RELATION TO NRC REGULATORY GUIDE RG-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, Revision 1-NP-A, , "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," and WCAP-14572, Revision 1-NP-A, Supplement 1, "Westinghouse Structural Reliability and Risk Assessment (SRRA) Model for Piping Risk-Informed Inservice Inspection," (referred to as "WCAP-14572, A-version" for the remainder of this document). "

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

## 1.2 PRA Quality

The *plant-specific* Level 1 and Level 2 probabilistic risk assessment (PRA) model, *Version S7B dated June 1998* was used to evaluate the consequences of pipe ruptures 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 PRA model are *3.15E-05/yr* and *3.36E-06/yr*, respectively.

PRA model updates are scheduled for *18-month intervals to coincide with the refueling outages.* The administrative guidance for this activity is contained in our administrative procedures.

The RI-ISI evaluation included a determination that the PRA model and supporting documentation accurately reflects the current plant configuration and operational practices consistent with its intended application. *Furthermore, an evaluation based on the Appendix B of the EPRI PSA Applications Guide, was performed to confirm that the PRA conforms to the industry state-of-the-art with respect to completeness of coverage of potential scenarios.*

The PRA model has been extensively reviewed *including peer reviews during the IPE process and internal reviews during the PRA model updates.*

*During the NRC's review of the IPE, concerns were identified regarding the post-initiator human reliability analysis (HRA). Overly optimistic HRA probabilities and dependencies among multiple actions were not fully considered. The HRA analysis was revised to address these concerns in the June 1998 PRA version used in the RI-ISI program. In addition, several plant modifications and PRA model changes were not incorporated into the PRA in time to support this submittal. However, the RI-ISI Expert Panel was advised of these modifications and their impact through written descriptions for the piping systems. Therefore, these concerns were considered as part of the expert panel deliberations.*

# 2. PROPOSED ALTERNATIVE TO ISI PROGRAM

## 2.1 ASME Section XI

ASME Section XI Categories *B-F, B-J, C-F-1 and C-F-2* currently contain the requirements for examining (via NDE) piping components. *This current program is limited to ASME Class 1 and Class 2 piping.* The alternative risk-informed inservice inspection (RI-ISI) program for piping is described in WCAP-14572, A-Version . The RI-ISI program will be substituted for the current examination program on piping in accordance with 10 CFR 50.55a(a)(3)(i) by alternatively providing 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, A-version, 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. (If the plant's augmented programs are changed as a result of the RI-ISI program, these changes need to be described here.)*

# 3. RISK-INFORMED ISI PROCESSES

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

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

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

<u>Deviations</u>

*There are no significant deviations to the process described in WCAP-14572, A-Version. (If there are deviations to the methodology, they need to be described here. For example, significant deviations would include, but are not limited to, not addressing or modifying principal steps in the process such as the uncertainty analysis, the results evaluation, the statistical evaluation, the consequence calculations, or the worksheets supplied to the expert panel. All changes to quantitative criteria, such as the risk reduction worth cut-off criterion, the default values in the statistical analysis, and the evaluation of results criteria should be reported. If the deviation from the WCAP-14572, A-Version descriptions might have a significant impact on the results, or increase the sensitivity of the quantitative results of the probabilistic risk assessment, justification of the adequacy of deviations and alternative approaches should be provided.*

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

*The change in risk methodology described in Section 3.10 deviated from the methodology for segments located inside containment and that interface with the RCS such that radiation monitors and sump level will detect a leak. For these segments, the failure probability "with ISI" for those being inspected by NDE and without ISI for those not being inspected is used along with credit for leak detection.*

## 3.1 Scope of Program

The 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:*

- *Instrument Air (Compressed Air)*
- *Fire Protection System*
- *Containment Penetration Piping*

*The basis for exclusion of these systems from the program is documented in the site maintained documentation.*

## 3.2 Segment Definitions

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

The number of pipe segments defined for the *18* systems 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 utilizing industry failure history, plant specific failure history and other relevant information. *An engineering team is established that has access to expertise from ISI, NDE, materials, stress analysis and system engineering. The team was trained in the failure probability assessment methodology and the Westinghouse structural reliability and risk assessment (SRRA) code, including identification of the capabilities and limitations as described in 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 Supplement 1. All the* *piping configurations included in the RI-ISI program could be adequately modeled using the SRRA code.*

*The engineering team assesses industry and plant experience, plant layout, materials, operating conditions and identifies the potential failure mechanisms and causes. Information is 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 idea of where the possible ranges of failure probability would fall. For example pitting wear is not modeled in the SRRA code. However, the code does model wastage (erosion/corrosion) and fatigue. The probability for pitting wastage was bounded by these typesof mechanisms so that an upper and lower bound failure probability could be established. Thefinal probability was determined by the team members using this bounding information and industry experience.*

*The SRRA code was used for calculating failure probabilities for IGSCC of BWR plant piping. The results were compared with plant and industry failure data as described in WCAP-14572, A-version, Supplement 1. For wastage due to flow-assisted corrosion, 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 thedominant potential failure mechanism(s)/ combination(s) by system. Table 3.4-1 also describeswhy 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 either the plant stress corrosion cracking or erosion corrosion augmented programs. 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 as described on page 105 of WCAP-14572, A-version. 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 with and without operator action.

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

*The uncertainty analysis as described on WCAP 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 core damage frequency due to piping failure without operator action is 6.28E-05/year, and with* *operator action is 4.05E-06/year. The large early release frequency due to piping failure without operator action is 5.18E-06/year, and with operator action is 4.46E-07/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 PRA 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 Risk Assessment (PRA engineer)*
- *Operations (Senior Reactor Operator or Shift Technical Advisor)*
- *Inservice Inspection (ISI)*
- *Plant & Industry Maintenance , Repair, and Failure History (System Engineer)*

*A minimum of 4 members or alternates filling the above positions constituted a quorum. This core team of panel members was supplemented by other experts, including a metallurgist and piping stress engineer, as required for the piping system under evaluation.*

*The expert panel chairperson was appointed by the Nuclear Engineering Manager. The chairperson conducted and ruled on the proceedings of the meeting. The chairperson appointed an alternate chairperson from the panel if he was unable to attend a meeting.*

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

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

*A consensus process was used by the expert panel. Consensus is defined as unanimous during first consideration and 2/3 (rounding conservatively) of members or alternates present in the second or subsequent considerations. The chairperson shall allow appropriate time duration between considerations for deliberation.*

*The chairperson appointed someone to record the minutes of each meeting. The minutes included the names of members and alternates in attendance and whether a quorum was present. The minutes contained relevant discussion summaries and the results of membership voting. These minutes are available as program records.*

## 3.7 Identification of High Safety Significant Segments

The number of high safety significant segments for each system, as determined by the expert panel, is shown in Table 3.7-1 along with a summary of the risk evaluation identification of high safety significant segments.

## 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, A-Version. *Segments considered as "high failure importance" (Region 1) were identified as all segments being affected by an active failure mechanism or analyzed to be highly susceptible to a failure mechanism (probability of large leak at 40 years generally exceeds 1E-04).* Region 3 piping components, which are low safety significant, are to be considered in an Owner Defined Program and are not considered part of the program requiring approval. Region 1, 2, 3 and 4 piping components will continue to receive Code required pressure testing, as part of the current ASME Section XI program. *For the 515 piping segments that were evaluated in the RI-ISI program, Region 1 contains 70 segments, Region 2 contains 38 segments, Region 3 contains 153 segments, and Region 4 contains 254 segments.*

*The number of locations to be inspected in a HSS segment was determined using a Westinghouse statistical (Perdue) model as described in section 3.7 of WCAP-14572, A-Version. 55 of the HSS piping segments in Region 1 and 28 of the HSS piping segments in Region 2 were evaluated using the Perdue model. The 25 segments that were not evaluated using the Perdue model included 12 segments involving wastage degradation mechanisms, 2 segments that are subject to vibratory fatigue, 10 segments containing socket welds, and one segment where mitigative repairs have been made, all of which are outside the applicability of the model. For these 25 segments, the guidance in Section 3.7.3 of WCAP-14572, A-Version was followed.*

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

### *Additional Examinations*

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

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

## 3.9 Program Relief Requests

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 >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.*

*At this time, all the risk-informed examination locations that have been selected provide >90% coverage. In instances where a location may be found at the time of the examination that it does not meet >90% coverage, the process outlined in Section 4.1 of WCAP-14572, A-Version will be followed.*

*One previous relief request made in December 1995 regarding the inspection of an inaccessible location in the reactor coolant system is no longer required because this location is not included in the risk-informed ISI program. All other relief requests remain in place.*

## 3.10 Change in Risk

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

*The change in risk calculations were performed according to all the guidelines provided on page 213 of the WCAP.* A comparison between the proposed RI-ISI program and the current ASME Section XI ISI program was made to evaluate the change in risk. *The approach evaluated the change in risk with the inclusion of the probability of detection as determined by the SRRA model. All four criteria for accepting the results discussed on page 214 and 215 in the WCAP were met (or adjustments were made to add segments until the criteria were met). This evaluation resulted in the identification of 10 piping segments for which examinations are now required (systems identified in Table 5-1 via a footnote).*

*The change in risk methodology deviated from the methodology for segments located inside containment and that interface with the RCS such that radiation monitors and sump level will detect a leak. 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*

*The reactor coolant piping will continue to receive a system pressure test and visual VT-2 examination as currently required by the Code. Surface and volumetric examinations are proposed on the smaller reactor coolant piping as part of the RI-ISI program. Larger reactor coolant loop piping segments were retained in the program for "defense-in-depth" considerations. The locations selected were associated with the reactor vessel dissimilar metal welds. These locations were identified as being the area to inspect in the RI-ISI process, if the segment was chosen.*

*New Information*

*The final calculational review identified one segment (MS-10) as having a higher conditional consequence than previously analyzed due to indirect effects. A preliminary review of the revised numerical results indicate that the LERF results would make the segment High Safety Significant. The segment has been added to the program for inspection. However, its inclusion is not reflected in the change in risk analysis, associated charts, nor was it presented to the expert panel since it is qualitatively estimated to have a negligible impact.*

## 4. IMPLEMENTATION AND MONITORING PROGRAM

Upon approval of the RI-ISI program, procedures that comply with the guidelines described in WCAP-14572, A-Version, will be prepared to implement and monitor the program. The new program will be integrated into the existing ASME Section XI interval. *No changes to the Final Safety Analysis Report are necessary for program implementation.*

The applicable aspects of the 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 high safety significant locations in the program requirements regardless of their current ASME class.

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

A. Identify

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

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

5. PROPOSED ISI PROGRAM PLAN CHANGE

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

*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 auxiliary steam, steam generator blowdown, and feedwater. 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 auxiliary feedwater and component cooling water. 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 the suction lines to the charging pumps (high head safety injection).*

*The initial program will be started in the inspection period current at the time of program approval. For example the second inspection period of the third inspection interval for Unit 1 ends on October 14, 2000. If the program is approved such that a refueling outage remains in the second period, 66% of the required remaining examinations will be performed by the end of the inspection interval per the risk-informed inspection program.*

## 6. SUMMARY OF RESULTS AND CONCLUSIONS

***Blind Note: This section is intended to explain the appropriateness of the results of the RI-ISI program as related to plant design and operation. Items that should be covered include: the generation of nuclear power plant construction code, the design as it pertains to small bore piping resulting in a substantial number of socket welds, plant operational impacts, unique design features, etc. This type of information should be added to this section, as necessary, to ensure understanding of the results by plant personnel and NRC reviewers. This information provides the reviewer with a better understanding of the overall proposed risk0informed ISI program when comparing these plant results to other plant results.***

A *full* scope risk-informed ISI application has been completed for *Unit 1.* Upon review of the proposed risk-informed ISI examination program given in Table 5-1, an appropriate number of examinations are proposed for the high safety significant segments across the Class 1, *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 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 Unit 1 in 1968. 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. Unit 1 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, Revision 3 (February 1976), "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants" and 10 CFR 50.55a – Title 10, "Code of Federal Regulations – Energy." 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 PRA dominant accident sequences include station blackout, small LOCAs and steam generator tube rupture events with loss of core cooling from the secondary side.*

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

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

<u>Alternative To Above Paragraphs For Partial Scope Submittals</u>

A *partial scope (Class 1 or Class 1 and Class 2)* risk-informed ISI application has been completed for *Unit 1*. Upon review of the proposed risk-informed ISI examination program given in Table 5-1, an appropriate number of examinations are proposed for the high safety significant segments across the (*Class 1 or Class 1 and Class 2*) portions of the plant piping systems. *Resources to perform examinations currently required by ASME Section XI in the (Class 1 or Class 1 and Class 2) portions of the plant piping systems, though reduced, are distributed to address the greatest amount of risk within the scope. Thus, the change in risk principle of Regulatory Guide 1.174 is maintained. Additionally, the examinations performed will address specific damage mechanisms postulated for the selected locations through appropriate examination selection and increase volume of examination.*

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

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

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

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

7. REFERENCES/DOCUMENTATION

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

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

*Supporting Onsite Documentation*

*Calc. # SM-1124, Rev. 0, "Segment Definitions for RI-ISI Program"*

*Calc. # SM-1087, Rev. 1, "Risk-Informed Inservice Inspection Pilot Program - Quantification of Risk"*

*Calc. # SM-1088, Rev. 1, "Risk-Informed Inservice Inspection - Indirect Effects Analysis"*

*Calc. # SM-1090, Rev. 1, "Risk-Informed Inservice Inspection Pilot Program - Quantification of Large Early Release Frequency"*

*ET # MAT-97-0014, Rev. 0, "Estimated Failure Probabilities for Risk-Informed ISI "*

*Calc. Note # CN-RRA-019/97, Rev. 0, "Risk-informed ISI CDF and LERF Calculations"*

*Calc. Note # CN-RRA-024/97, Rev. 0, "MS Access database for the Risk Informed Inservice Inspection (RI ISI) Program"*

*Calc. Note # CN-RRA-025/97, Rev. 0, "Change in Risk Calculations for Risk-Informed ISI"*

*Calc. Note # CN-RRA-026/97, Rev. 0, "Risk-Informed ISI Perdue Model Calculations"*

*Calc. Note # CN-STD-97-027-R0, Rev. 0, "Risk-Informed ISI @Risk Uncertainty Simulation"*

| Table 3.1-1<br>System Selection and Segment Definition | | | |
|---|---|---|---|
| System Description | PRA | Section XI | Number of Segments |
| *1. AFW - Auxiliary Feedwater[3]* | *Yes* | *Yes* | *32* |
| *2. BD - Blowdown (S/G)* | *Yes* | *Yes[1,2]* | *12* |
| *3. CC - Component Cooling* | *Yes* | *Yes[2]* | *66* |
| *4. CH - Chemical & Volume Control[4]* | *Yes* | *Yes[2]* | *44* |
| *5. CN - Condensate* | *Yes* | *Yes[2]* | *9* |
| *6. CS - Containment Spray* | *Yes* | *Yes* | *16* |
| *7. CW - Circulating Water* | *Yes* | *Yes[2]* | *16* |
| *8. EE - Emergency Diesel Fuel Oil* | *Yes* | *No* | *7* |
| *9. FC - Fuel Pit Cooling[6]* | *No* | *Yes[1]* | *9* |
| *10. FW - Feedwater[3]* | *Yes* | *Yes[2]* | *20* |
| *11. MS - Main Steam* | *Yes* | *Yes[2]* | *38* |
| *12. RC - Reactor Coolant* | *Yes* | *Yes[2]* | *96* |
| *13. RH - Residual Heat Removal* | *Yes* | *Yes* | *11* |
| *14. RS - Recirculation Spray* | *Yes* | *Yes* | *13* |
| *15. SI - Safety Injection[5]* | *Yes* | *Yes* | *68* |
| *16. SW - Service Water* | *Yes* | *Yes[2]* | *54* |
| *17. VS - Ventilation[7]* | *Yes* | *Yes[1,2]* | *2* |
| *18. AS - Auxiliary Steam[8]* | *No* | *No* | *2* |
| *Total* | | | *515* |

| Table 3.1-1<br>System Selection and Segment Definition | | | |
|---|---|---|---|
| System Description | PRA | Section XI | Number of Segments |

*Notes:*
1. *System is exempt from current ASME Section XI examination requirements (Volumetric, surface, visual (VT-3)).*
2. *Portions of this system are not included in the Section XI program.*
3. *The feedwater and auxiliary feedwater systems are on combined dwgs.*
4. *Portions of the chem. & vol. Control system with high head safety injection.*
5. *Includes high head, low head, and the passive accumulator portions of SI.*
6. *Important during shutdown.*
7. *Includes high head, low head, and the passive accumulator portions of SI.*
8. *Important during shutdown.*
9. *Cooling water to control room HVAC.*
10. *Considered only for indirect effects*

Table 3.3-1
Summary of Postulated Consequences by System

| System | Summary of Consequences |
|---|---|
| *AFW - Auxiliary Feedwater* | *The direct consequences postulated from piping failures from this system are feedline/ steamline breaks, failure of up to two trains of AFW system and loss of the CST. Indirect effects were postulated for AFW segments AFW-037, AFW-038, AFW-039, AFW-040, AFW-041, and AFW-042 in which the normal and alternate steam supplies to the AFW turbine-driven pump result in a steam line break in the south valve vault resulting in the loss of SG #1 and #4 PORVs.* |
| *BD - Blowdown (S/G)* | *The direct consequences postulated from piping failures from this system include steam line breaks inside and outside containment, loss of normal and alternate steam supply to the TDAFW pump, and failure to isolate the system on a steam generator tube rupture.* |
| *CH - Chemical & Volume Control* | *The direct consequences associated with piping failures are reactor trip on low seal injection flow, small LOCA, loss of one or both CCP trains for injection, recirculation, and emergency boration, loss of RWST refill function, loss of RWST outside containment and loss of containment sump recirculation outside containment.* |
| *FW - Feedwater* | *The direct consequences postulated from piping failures from this system are loss of main feedwater restoration, loss of the normal and alternate steam supplies to the TDAFW pump, feedline breaks inside and outside containment, and steam flow/ feedwater flow mismatch resulting in a plant trip.* |
| *RC - Reactor Coolant* | *The direct consequences associated with piping failures are large, medium and/or small loss of coolant accidents (LOCAs) and loss of ECCS flow to one loop.* |

| Table 3.3-1<br>Summary of Postulated Consequences by System | |
|---|---|
| System | Summary of Consequences |
| *RH - Residual Heat Removal* | *The direct consequences associated with piping failures are the loss of one or both RHR trains for normal shutdown cooling and low pressure injection and recirculation, loss of RWST outside containment and loss of containment sump recirculation outside containment. Several segments involve LOCA initiating events (large, medium and small LOCAs).* |
| *SI - Safety Injection* | *The direct consequences associated with piping failures are the loss of accumulator injection, loss of one or both SI trains for injection and recirculation from either the charging system or safety injection system, loss of RWST outside containment and loss of containment sump recirculation outside containment. Several segments involve LOCA initiating events (large, medium and small LOCAs). An indirect consequence is postulated for one piping segment (SI-049, 24" RWST supply line) in which a piping failure could spray and thus fail the primary water makeup pumps/* |

| Table 3.4-1<br>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*<br>• *Thermal Fatigue, Striping/Stratification* | *2.1E-05 – 1.0E-04*<br>*4.6E-03 – 1.5E-02* | *1.6E-05 – 6.1E-04*<br>*1.8E-04-1.0E-02* | *Striping/stratification could occur at low-flow conditions near the interface with main feedwater.* |
| *BD* | • *Thermal & Vibratory Fatigue*<br>• *Thermal Fatigue, Vibratory Fatigue, & FAC* | *1.72E-03*<br>*5.6E-01* | *4.6E-03*<br>*5.6E-01* | *An augmented program for FAC exists for BD piping.* |
| *CH* | • *Thermal Fatigue*<br>• *Thermal Fatigue and Vibratory Fatigue* | *3.5E-06 – 6.7E-04*<br>*4.1E-06 – 8.7E-03* | *4.9E-06 – 2.8E-04*<br>*2.8E-05 – 5.6E-03* | *The configuration of the charging path to RCS loop 1 cold leg was identified as potentially susceptible to thermal cycling/fatigue failure when stagnant (NRC Bulletin 88-08). The potential for this failure has been eliminated by maintaining flow through the line. Flashing and cavitation occurs at the letdown orifices.* |
| *FW* | • *Thermal Fatigue & Vibratory Fatigue*<br>• *Erosion/Corrosion & Thermal Fatigue*<br>• *Erosion/Corrosion, Thermal Fatigue, Vibratory Fatigue, & Striping/Stratification* | *1.9E-04 – 4.6E-04*<br>*8.8E-08 – 4.4E-02*<br>*3.0E-04 – 4.7E-02* | *2.1E-04 – 1.1E-03*<br>*2.1E-04 – 3.5E-02*<br>*1.1E-03 – 3.5E-02* | *Thermal striping or stratification could occur at the FW nozzle of the steam generator. There have been observed leaks on the SG nozzle.*<br>*The locations where high flow velocities cause pipe wall thinning are in the FAC program. The piping can experience transient loads during a plant trip.* |

| Table 3.4-1<br>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)* | |
| *RC* | • *Thermal Fatigue*<br><br>• *Thermal Fatigue & Vibratory Fatigue*<br><br>• *Thermal Fatigue & Striping/Stratification* | *1.4E-09 – 8.7E-05*<br><br>*3.5E-06 – 1.2E-02*<br><br>*6.4E-04* | • *LLOCA 4.2E-06*<br>• *MLOCA 1.4E-06 – 9.1E-05*<br>• *SLOCA 5.0E-11 – 1.3E-03*<br><br>• *LLOCA 1.7E-06 – 4.2E-06*<br>• *MLOCA 9.3E-07 – 6.4E-05*<br>• *SLOCA 9.3E-07 – 7.1E-03*<br><br>• *LLOCA 6.6E-04*<br>• *MLOCA 6.6E-04*<br>• *SLOCA 6.6E-04* | *Thermal striping or stratification occurs in the pressurizer surge line.*<br>*Locations where the piping could experience large temperature changes are: the pressurizer surge line, tailpipes due to a PORV lifting, and at Charging nozzles. #4 is now used for normal charging rather than #1. #1 has a sleeve. #4 does not have a sleeve. Transient loads may occur in the tailpipes due to steam release from pressurizer relief valves.* |
| *RH* | • *Thermal Fatigue*<br><br>• *Thermal Fatigue & Vibratory Fatigue*<br><br>• *Thermal Fatigue, Vibratory Fatigue, & Striping/Stratification* | *4.9E-07 – 1.5E-04*<br><br>*9.8E-06 – 3.0E-03*<br><br>*6.4E-04* | *8.7E-05 – 2.2E-04*<br><br>• *SLOCA 2.3E-04*<br>• *SYS 3.6E-06 – 1.5E-04*<br><br>• *LLOCA 1.9E-05*<br>• *MLOCA 1.6E-05*<br>• *SLOCA 1.7E-05*<br>• *SYS 1.5E-04* | *NRC Bulletin 88-08 Supplement 3 identified potential thermal stratification/striping concerns for RHR piping connected to the RCL. This concern was evaluated and the RHR piping was determined not to be susceptible to unacceptable thermal stress levels.*<br>*System experiences temperature changes from ambient to 350°F when used for shutdown cooling.*<br>*Have had pressure transients on both units during pump tests caused by gas pockets in the discharge line. This is not classic water hammer, but the effects are similar.* |

| Table 3.4-1<br>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)* | |
| *SI* | • *Thermal Fatigue & Vibratory Fatigue*<br><br>• *Thermal Fatigue, Vibratory Fatigue, Striping/Stratification & Stress Corrosion Cracking*<br><br>• *Thermal Fatigue, Vibratory Fatigue & Striping/Stratification* | *6.6E-07 – 8.7E-03*<br><br>*1.3E-03 – 3.4E-02*<br><br>*4.2E-04 – 3.4E-02* | • *SLOCA 7.4E-07 – 3.4E-04*<br>• *SYS 7.4E-07 – 3.4E-04*<br><br>• *MLOCA 3.2E-04*<br>• *SLOCA 4.0E_04*<br>• *SYS 2.8E-04 – 1.4E-03*<br><br>• *LLOCA 2.8E-05*<br>• *MLOCA 2.8E-05 – 1.5E-05*<br>• *SLOCA 1.5E-05 – 6.4E-03*<br>• *SYS 5.3E-05 – 8.7E-03* | *There is vibration due to cavitation at valve 544. New orifices being added to reduce the vibration. Weld crack at check valve developed a leak. NRC Bulletin 88-08 identified potential thermal stratification/striping concerns for piping connected to the RCL The potential for gas pockets (due to nitrogen coming out of solution) at high points in the piping exists due to back-leakage through check valves.* |

*Notes:*
** - Disabling leak rate – LLOCA, MLOCA, SLOCA, and SYS (system disabling leak). When no leak rate is shown, this is the system disabling leak rate.*

| Table 3.5-1<br>Number of Segments and Piping Risk Contribution by System (without ISI) | | | | | |
|---|---|---|---|---|---|
| System | # of Segments | CDF without Operator Action (/yr) | CDF with Operator Action (/yr) | LERF without Operator Action (/yr) | LERF with Operator Action (/yr) |
| *ACC* | *15* | *4.68E-11* | *3.06E-11* | *2.76E-11* | *3.81E-11* |
| *AFW* | *32* | *6.54E-6* | *2.59E-7* | *2.66E-7* | *1.28E-8* |
| *AS* | *2* | *7.84E-9* | *7.84E-9* | *7.85E-9* | *7.85E-9* |
| *BD* | *12* | *4.60E-7* | *4.60E-7* | *2.68E-7* | *2.68E-7* |
| *CC* | *66* | *2.34E-8* | *1.90E-8* | *1.97E-8* | *1.60E-8* |
| *CH* | *44* | *2.73E-7* | *2.73E-7* | *1.54E-9* | *1.54E-9* |
| *CN* | *9* | *1.20E-6* | *4.27E-8* | *6.74E-8* | *1.13E-9* |
| *CS* | *16* | *1.42E-7* | *9.74E-9* | *1.21E-8* | *2.17E-9* |
| *CW* | *16* | *1.00E-7* | *1.00E-7* | *2.79E-9* | *2.79E-9* |
| *ECC* | *8* | *9.78E-11* | *9.78E-11* | *8.08E-12* | *8.08E-12* |
| *EE* | *7* | *5.56E-10* | *5.56E-10* | *7.82E-12* | *7.82E-12* |
| *FC* | *9* | *N/A* | *N/A* | *N/A* | *N/A* |
| *FW* | *20* | *4.76E-7* | *4.75E-7* | *2.51E-8* | *2.51E-8* |
| *HHI* | *27* | *8.05E-7* | *1.71E-7* | *7.17E-8* | *1.88E-8* |
| *LHI* | *18* | *8.79E-8* | *1.44E-9* | *7.43E-9* | *5.02E-11* |
| *MS* | *38* | *4.25E-7* | *4.25E-7* | *1.03E-8* | *1.03E-8* |
| *RC* | *96* | *1.61E-6* | *1.60E-6* | *4.56E-9* | *4.54E-9* |
| *RH* | *11* | *6.54E-8* | *6.54E-8* | *6.55E-8* | *6.55E-8* |
| *RS* | *13* | *3.81E-9* | *1.58E-9* | *5.85E-12* | *0* |
| *SW* | *54* | *4.37E-5* | *1.43E-7* | *4.13E-6* | *1.02E-8* |
| *VS* | *2* | *6.84E-6* | *0* | *2.24E-7* | *0* |
| *TOTAL* | *515* | *6.28E-5* | *4.05E-6* | *5.18E-6* | *4.46E-7* |

| Table 3.7-1<br>Summary of Risk Evaluation and Expert Panel Categorization Results | | | | | | |
|---|---|---|---|---|---|---|
| System | Number of segments with any RRW >1.005 | Number of segments with any RRW between 1.005 and 1.001 | Number of segments with all RRW < 1.001 | Number of segments with any RRW between 1.005 and 1.001 placed in HSS | Number of segments with all RRW < 1.001 selected for inspection | Total number of segments selected for inspection (High Safety Significant Segments) |
| *AFW* | *8* | *15* | *9* | *4* | *0* | *12* |
| *BD* | *0* | *4* | *8* | *2* | *0* | *2* |
| *CH* | *18* | *15* | *11* | *4* | *1* | *23* |
| *FW* | *0* | *5* | *15* | *3* | *0* | *3* |
| *RC* | *25* | *40* | *31* | *12* | *0* | *37* |
| *RH* | *1* | *3* | *7* | *0* | *0* | *1* |
| *SI* | *22* | *35* | *11* | *8* | *0* | *30* |
| *Total* | *74* | *117* | *92* | *33* | *1* | *108* |

| Table 3.10-1<br>COMPARISON OF CDF/LERF FOR CURRENT SECTION XI<br>AND RISK-INFORMED ISI PROGRAMS<br>AND THE SYSTEMS WHICH CONTRIBUTED SIGNIFICANTLY TO THE CHANGE | | |
|---|---|---|
| Case<br>(Systems Contributing to Change) | Current Section XI | Risk-Informed |
| CDF No Operator Action | *6.1E-05* | *5.3E-05* |
| • *AFW* | *6.5E-06* | *3.3E-06* |
| • *VS* | *6.8E-06* | *3.1E-06* |
| • *BD* | *4.6E-07* | *1.5E-07* |
| • *MS* | *4.1E-07* | *3.1E-07* |
| CDF with Operator Action | *2.3E-06* | *1.7E-06* |
| • *BD* | *4.6E-07* | *1.5E-07* |
| • *AFW* | *2.6E-07* | *7.8E-08* |
| • *MS* | *4.1E-07* | *3.1E-07* |
| LERF No Operator Action | *5.1E-06* | *4.6E-06* |
| • *BD* | *2.7E-07* | *9.0E-08* |
| • *VS* | *2.2E-07* | *1.0E-07* |
| • *AFW* | *2.7E-07* | *1.3E-07* |
| • *AS* | *7.9E-09* | *2.3E-11* |
| • *AFW* | *2.7E-07* | *1.3E-07* |
| • *FW* | *2.5E-08* | *1.6E-08* |
| • *HHI* | *5.1E-08* | *4.4E-08* |
| LERF with Operator Action | *3.6E-07* | *1.5E-07* |
| • *BD* | *2.7E-07* | *9.0E-08* |
| • *AFW* | *1.3E-08* | *5.0E-09* |
| • *AS* | *7.9E-09* | *2.3E-11* |

Table 5-1

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

| System | Number of High Safety Significant Segments (No. of HSS in Augmented Program / Total No. of Segments in Augmented Program) | Degradation Mechanism(s) | Class | ASME Code Category | Weld Count[j] | | ASME XI Examination Methods (Volumetric (Vol) and Surface (Sur)) | | RI-ISI[a] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Butt | Socket | Vol & Sur | Sur Only | SES Matrix Region | Number of Exam Locations |
| ACC | 0 | VF | Class 1 | B-J | 36 | 0 | 9 | 0 | - | 0 |
| AFW[c] | 11 (5 / 16) | Corrosion | Class 2 | C-F-2 | 80 | ~50 | 6 | 3 | 1A, 1B | 5 |
| | | | Class 3 | | | | 0 | 0 | | 3+3[e] |
| AS | 2 | TF | Non-Code | | | | 0 | 0 | 1A, 1B | 2 |
| BD[c] | 6 (6 / 12) | VF, FAC | Class 2 | C-F-2 | 54 | 0 | 0 | 0 | 1A, 1B | 3 |
| | | | Non-Code | | | | 0 | 0 | | 3 |
| CC | 6 | TF, VF | Class 3 | | | | 0 | 0 | 1A, 1B, 2 | 13+4[e] |
| CH | 8 (0 / 3) | TF, VF,SCC | Class 1 | B-J | 156 | ~60 | 39 | 6 | 1A, 1B, 2 | 12+6[b]+4[e] |
| | | | Class 2 | C-F-1 | 10 | ~20 | 0 | 0 | | 1+3[e] |
| CN[c] | 0 (0 / 6) | Wastage | N/A | | | | 0 | 0 | - | 0 |
| CS | 0 (0 / 2) | Wastage, SCC | Class 2 | C-F-1 | 120 | 0 | 9 | 0 | - | 2[h] |
| CW[d] | 4 | Wastage | N/A | | | | 0 | 0 | - | 0 |
| ECC | 7 (0 / 1) | Stratification | Class 1 | B-J | 16 | 0 | 4 | 0 | 1A, 1B, 2 | 12 |

Table 5-1

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

| System | Number of High Safety Significant Segments (No. of HSS in Augmented Program / Total No. of Segments in Augmented Program) | Degradation Mechanism(s) | Class | ASME Code Category | Weld Count[j] | | ASME XI Examination Methods (Volumetric (Vol) and Surface (Sur)) | | RI-ISI[a] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Butt | Socket | Vol & Sur | Sur Only | SES Matrix Region | Number of Exam Locations |
| | | | Class 2 | C-F-1 | 320 | 0 | 24 | 0 | | 1 |
| EE | 0 | Wastage/ Corrosion | N/A | | | | 0 | 0 | - | 0 |
| FC | 0 | TF, VF, SCC | N/A | | | | 0 | 0 | - | 0 |
| FW[c] | 13 (13 / 17) | Wastage,TF | Class 2 | C-F-2 | 80 | 0 | 6 | 0 | 1A, 1B | 0 |
| | | | Non-Code | | | | 0 | 0 | | 7 |
| HHI[c] | 14 (1 / 5) | TF, VF, SCC | Class 2 | C-F-2 | 450 | 0 | 63 | 0 | 1A, 1B, 2 | 15+2[h] |
| LHI[c] | 7 (1 / 1) | TF, VF, SCC | Class 2 | C-F-2 | 305 | ~20 | 23 | 4 | 1A, 1B, 2 | 7+3[b]+2[h] |
| MS[c] | 3 (3 / 23) | Wastage, TF | Class 2 | C-F-2 | 240 | 0 | 18 | 0 | 1A, 1B | 2+1[g] |
| RC | 11 | TF, VF, Strip/Strat, SCC | Class 1 | B-F | 18 | 0 | 18 | 0 | 1A, 1B, 2 | 9 |
| | | | | B-J | 584 | ~50 | 146 | 12 | | 11+10[h,i]+3[b] |
| RH | 4 | SCC, VF | Class 1 | B-J | 16 | 0 | 4 | 0 | 1A, 1B, 2 | 1 |
| | | | Class 2 | C-F-1 | 160 | 0 | 12 | 0 | | 4 |
| RS | 2 | TF, VF, SCC | Class 2 | C-F-1 | 54 | 0 | 4 | 0 | 1A, 1B | 2 |
| SW[d] | 8 | TF | Class 3 | | | | 0 | 0 | 1A, 1B | 5+3[e] |
| VS | 2 | TF, VF | Class 3 | | | | 0 | 0 | 1A, 1B, 2 | 2 |

Table 5-1

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

| System | Number of High Safety Significant Segments (No. of HSS in Augmented Program / Total No. of Segments in Augmented Program) | Degradation Mechanism(s) | Class | ASME Code Category | Weld Count[j] | | ASME XI Examination Methods (Volumetric (Vol) and Surface (Sur)) | | RI-ISI[a] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Butt | Socket | Vol & Sur | Sur Only | SES Matrix Region | Number of Exam Locations |
| TOTAL | 108 (29 / 89) | | Class 1 | B-F | 18 | 0 | 18 | 0 | | 9 NDE |
| | | | | B-J | 808 | ~110 | 202 | 18 | | 46 NDE+13 VIS |
| | | | Class 2 | C-F-1 | 664 | ~20 | 49 | 0 | | 10 NDE + 3 VIS |
| | | | | C-F-2 | 1209 | ~90 | 116 | 7 | | 36 NDE + 4 VIS |
| | | | Class 3 | | | | 0 | 0 | | 23 NDE + 10 VIS |
| | | | Non-Code | | | | 0 | 0 | | 12 NDE |
| | | | Total | | 2699 | ~220 | 385 | 25 | | 136 NDE + 30 VIS |

Table 5-1

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

| System | Number of High Safety Significant Segments (No. of HSS in Augmented Program / Total No. of Segments in Augmented Program) | Degradation Mechanism(s) | Class | ASME Code Category | Weld Count[j] | | ASME XI Examination Methods (Volumetric (Vol) and Surface (Sur)) | | RI-ISI[a] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Butt | Socket | Vol & Sur | Sur Only | SES Matrix Region | Number of Exam Locations |

*Summary: Current ASME Section XI selects a total of 385 non-destructive exams while the proposed RI-ISI program selects a total of 136 exams (166 - 30 visual exams), which results in a 65% reduction.*

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

*Notes for Table 5-1*

*a. System pressure test requirements and VT-2 visual examinations shall continue to be performed in all ASME Code Class 1, 2, and 3 systems.*
*b. VT-2 area exam at specific location.*
*c. Augmented programs for erosion-corrosion and/or high energy line break continue.*
*d. Pipe coatings program will be maintained.*
*e. VT-2 for entire segment.*
*f. UT thickness only.*
*g. Segment MS-34 has no weld; VT-2 for entire segment.*
*h. Ten examinations added for change in risk considerations.*
*i. Six examinations added for defense-in-depth at the reactor vessel outlet nozzle to pipe welds.*
*j. Section XI does not require NDE weld examination of Class 3 welds. The number of welds in Class 3 systems is not known.*