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STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

Standard Review Plan For the Review of Risk-Informed Inservice Inspection of Piping

SRP Chapter 3.9.8

September 2003

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STANDARD REVIEW PLAN

For the Review of Risk-Informed Inservice Inspection of Piping

FOREWORD

The U.S. Nuclear Regulatory Commission's PRA Policy Statement on probabilistic risk assessment (PRA) encourages greater use of this analysis technique to improve safety decisionmaking and improve regulatory efficiency. The NRC staff's Risk-Informed Regulation Implementation Plan (SECY-01-0218) describes activities now under way or planned to expand this use. These activities include, for example, providing guidance for NRC inspectors on focusing inspection resources on risk-important equipment.

This Standard Review Plan (SRP) chapter describes review procedures and acceptance guidelines for NRC staff reviews of proposed plant-specific, risk-informed changes to a licensee's inservice inspection (ISI) program for piping. The review procedures contained in this SRP are consistent with the approach for using probabilistic risk assessment in risk-informed decisions on plant-specific changes to the licensing basis described in Regulatory Guide 1.174 and acceptable methods for implementing a risk-informed ISI (RI-ISI) program described in Regulatory Guide 1.178. Licensees may propose RI-ISI programs consistent with the guidance provided in Regulatory Guide 1.178, propose an approach consistent with the methodologies approved by the NRC staff (WCAP-14572 and EPRI TR-112657), or maintain their ISI program in accordance with the American Society of Mechanical Engineers Code (ASME B&PVC) as referenced in 10 CFR 50.55a in 10 CFR Part 50, “Domestic Licensing Production and Utilization Facilities,” of the Code of Federal Regulations.

It is the NRC staff's intention to initiate rulemaking as necessary to permit licensees to implement RI-ISI programs, consistent with this SRP chapter, without having to get NRC approval of an alternative to the ASME Code requirements pursuant to 10 CFR 50.55a(a)(3). Until the completion of such rulemaking, the staff anticipates reviewing and approving each licensee's RI-ISI program as an alternative to the current Code required ISI program. As such, the licensee's RI-ISI program will be enforceable under 10 CFR 50.55a.

The current ASME Code inservice inspection requirements, as endorsed in 10 CFR 50.55a, have been determined to provide reasonable assurance that public health and safety will be maintained. The individual ASME Code committees concerned with inservice inspection continually review these inspection strategies to develop improvements to the existing Code requirements. Changes to the ASME Code, either as new Code editions or Code Cases, are subject to review and approval by the NRC to ensure that the new inspection requirements maintain an adequate level of public health and safety. A risk-informed inservice inspection program, if properly constructed, will also provide an acceptable level of quality and safety by evaluating and possibly improving the inspection effectiveness for the safety-significant piping (as identified by the licensee's integrated decisionmaking process) in conjunction with the relaxation of inspection requirements for the remaining piping.

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For the Review of Risk-Informed Inservice Inspection Applications

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For the Review of Risk-Informed Inservice Inspection Applications

3.9.8 RISK-INFORMED INSERVICE INSPECTION

REVIEW RESPONSIBILITIES

Primary: Materials and Chemical Engineering Branch (EMCB)
Secondary: Probabilistic Safety Assessment Branch (SPSB)

I. AREAS OF REVIEW

The purpose of this SRP is to describe the procedure that the NRC staff will use to review risk-informed inservice inspection (RI-ISI) programs for piping that are different from the current ISI programs at a nuclear power facility. In implementing risk-informed decisionmaking, the licensee must ensure that any proposed change to the ISI program or the regulation meets the following key principles:

1. The proposed change meets the current regulations unless it is explicitly related to the request for alternatives under 10 CFR 50.55a(a)(3) or a requested exemption or rule change, i.e., a "specific exemption" under 10 CFR 50.12 or a "petition for rulemaking" under 10 CFR 2.802.

2. The proposed change is consistent with the defense-in-depth philosophy.

3. The proposed change maintains sufficient safety margins.

4. When proposed changes result in an increase in core damage frequency or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

5. The impact of the proposed change should be monitored using performance measurement strategies.

Each of these principles should be considered in the risk-informed, integrated decisionmaking process. Given these principles of risk-informed decisionmaking, the staff has identified a four-element approach that forms the basis for evaluating proposed changes to a plant's ISI program based on risk-informed methods. These are: define the change, perform an engineering analysis, define the implementation and monitoring program, and submit the proposed change.

The first element involves the characterization of the proposed change. The licensee should identify the aspects of the plant's licensing bases that may be affected by the proposed change in ISI requirements, including, but not limited to, rules and regulations, final safety analysis report (FSAR), technical specifications, licensing conditions, and licensing commitments. The licensee should also identify all aspects and elements of the ISI program that it intends to modify in future evaluations without prior NRC approval of the change. Piping systems, segments, and welds that are affected by the change in the ISI program should be identified. Plant systems and functions that rely on the affected piping should also be identified. Industry and plant-specific information applicable to the piping degradation mechanisms that characterize the relative effectiveness of past inspections should be documented.

As part of the second element, the licensee should evaluate the proposed change with regard to the principles that the proposed change is consistent with the defense-in-depth philosophy, that sufficient margins are maintained, and that proposed increases in core damage frequency (CDF) and risk are small and are consistent with the intent of the Commission's Safety Goal Policy Statement as discussed in Regulatory Guide 1.174. This element consists of engineering evaluations, including traditional engineering analyses as well as PRAs. The PRA-based assessment of the proposed change should explicitly consider the affected piping segments and assess the impact on the CDF and large early release frequency (LERF) caused by changing the licensee's current ISI program. The results of the complementary traditional and PRA methods should be used in an integrated decisionmaking process.

The third element involves developing implementation and monitoring programs. The primary goal for this element is to assess the performance of piping under the proposed change by establishing performance-monitoring strategies to confirm the assumptions and analyses that were conducted to justify the change. Inspection scope, intervals, and techniques should be clearly defined. The inspection scope and techniques should address all relevant failure mechanisms that could significantly impact the reliability and integrity of the piping.

The fourth element involves documenting the analyses and submitting the request for NRC review and approval. The submittal is reviewed by NRC in accordance with this SRP.

The following areas related to the use of RI-ISI program for piping are reviewed.

I.1 Element 1: Define the Proposed Change to ISI Program

The licensee's RI-ISI submittal is reviewed to verify that the proposed changes to the ISI program have been defined in general terms. Those aspects of the plant's licensing bases that may be affected by the proposed change, including, but not limited to, rules and regulations, FSAR, technical specifications, and licensing conditions, are reviewed. In addition, licensing commitments are reviewed. Particular piping systems and welds that are affected by the change in inspection practices are reviewed. Specific revisions to inspection scope, schedules, locations, and techniques are reviewed. The licensee's program and procedures guiding the evaluations leading to future changes to the ISI program without prior NRC approval are reviewed.

Plant systems and functions that rely on the affected piping are also reviewed. The staff reviews available engineering studies, methods, codes, applicable plant-specific and industry data and operational experience, PRA findings, and research and analysis results relevant to the proposed change. Plant-specific experience with inspection program results is reviewed and characterization relative to the effectiveness of past inspections of the piping and the flaws that have been observed is reviewed.

I.2 Element 2: Engineering Analysis

As part of the second element, the staff will review the licensee's engineering analysis of the proposed changes. The purpose of the review is to determine whether defense in depth is maintained, sufficient safety margins are maintained, and that proposed increases in risk, and their cumulative effect, are small and do not cause the safety goals in the NRC Safety Goals Policy Statement to be exceeded. Regulatory Guide 1.174 and Regulatory Guide 1.178 provide guidance for the performance of this evaluation.

I.2.1 Traditional Analysis

The engineering analyses are reviewed to determine whether the impact of the proposed ISI changes is consistent with the principles that defense in depth and adequate safety margins are maintained.

The primary regulations governing ISI of piping are 10 CFR 50.55a and Appendix A to 10 CFR Part 50. The regulations reference other codes and requirements that define the elements of defense in depth and safety margins to ensure that structural integrity of piping is maintained. The staff reviews the licensee's assessment of whether the proposed changes meet the regulations.

The ASME Boiler and Pressure Vessel Code (B&PVC), Section XI, is referenced in 10 CFR 50.55a for the detailed requirements regarding piping ISI. Inspections required by ASME B&PVC Section XI are performed on a sample basis with additional inspections, in terms of locations as well as frequency, mandated in response to the detection of flaws. The objective of ISI is to identify conditions, such as flaw indications, that are precursors to leaks and ruptures in pressure boundaries that may impact plant safety. The staff reviews the licensee's bases for the assessment that the proposed change meets the intent of the ASME Code requirements.

Additional augmented inspection programs to address generic piping degradation problems have been recommended by the NRC to preclude piping failure and implemented by the industry. Notable examples of augmented programs for piping inspections are to address intergranular stress corrosion cracking (IGSCC) of stainless steel piping in boiling water reactors (BWRs) (NRC Generic Letter 88-01), thermal fatigue (NRC Bulletin 88-08, NRC Bulletin 88-11, NRC Information Notice 93-020), stress corrosion cracking in pressurized water reactors (PWR) (IE Bulletin 79-17), Service Water Integrity Program (NRC Generic Letter 89-13) and flow accelerated corrosion (FAC) in the balance of plant for both PWRs and BWRs (NRC Generic Letter 89-08). The manner in which the augmented inspection programs for piping are addressed is reviewed.

I.2.2 Probabilistic Risk Assessment

The scope, level of detail, and quality required of the PRA is commensurate with the emphasis that is put on the risk insights and on the role the PRA results play in the integrated decisionmaking process. If the justification for the change is based on well-founded traditional arguments supported by PRA insights, a limited PRA review may be warranted. However, if the justification for change is based on complex PRA arguments, the breadth and depth of the PRA review will be substantially greater. Only the parts of the PRA that are used to support the ISI change application need to be reviewed.

I.2.2.1 Scope of Piping Systems

The scope of piping included in the proposed RI-ISI program is reviewed. The current ISI requirements for nuclear power plant piping are specified in 10 CFR 50.55a, which incorporates, by reference, the requirements of ASME B&PVC Section XI. The extent to which the RI-ISI program scope incorporates ASME Class 1, 2 and 3 piping systems currently included in ASME B&PVC Section XI program and any balance of plant piping is reviewed. The process to select the scope of piping, justification for the scope, and the specific choice of piping selected is reviewed.

I.2.2.2 Piping Segments

The procedure for defining piping segments within the piping systems for the purpose of modeling a run of a pipe in a PRA or to define its ISI requirements is reviewed. The methods by which the failure consequences, such as an initiating event, loss of a train, loss of a system, or a combination thereof, are incorporated in the definition of segments are reviewed. In addition to the failure consequences, the procedure and criteria used to identify and document the degradation mechanisms that can be present in piping within the selected systems boundaries are reviewed.

The procedure by which the location of the piping in the plant, and whether inside or outside the containment, is taken into account in defining piping segments is reviewed. The selection of piping segments within the piping system boundaries is an iterative process that may be affected by degradation as well as consequence evaluation, which is not completed at the time of initial selection of piping segments within the selected piping systems. The procedure by which degradation mechanisms and consequences of piping segment failures are incorporated in the iterative process is reviewed.

I.2.2.3 Evaluating Pipe Failures with PRA

Pipe ruptures are traditionally modeled as initiators, and the failure of individual pipe segments or structural elements is not modeled in PRAs. The manner in which PRA, or the PRA results, is modified so that a more detailed treatment of the potential (or probability) of pipe failures and the influence of such failures on other systems is incorporated in the PRA is reviewed.

I.2.2.4 Piping Failure Potential

Segment failure potential may be a quantitative estimate for each segment, or segments may be categorized into groups based on similar degradation mechanism, environment, and failure modes. There are three failure modes:

1. Initiating event failures in which the failure directly causes a transient and may or may not also fail one or more plant trains or systems. Initiating event failures are characterized by failure frequency.

2. Standby failures are failures that cause the loss of a train or system but do not directly cause a transient. Standby failures are characterized by train or system unavailability for which shutdown may be required by technical specifications or limiting conditions for operation. Unavailability is a combination of failure frequency and exposure time.

3. Demand failures are failures accompanying a demand for a train or system and are usually caused by the transient induced loads on the segment during system startup. Demand failures are characterized by a probability per demand.

The approach used for the determination of failure potential of piping segments is reviewed. The manner in which past failure data, expert opinion, and probabilistic fracture mechanics is considered in determining the piping failure potential is reviewed. The determination of exposure time appropriate to standby failures is reviewed. It is expected that inspections will be performed in accordance with the schedule of Inspection Program A or Program B as specified in ASME B&PVC Section XI. When data analysis is utilized, appropriateness and completeness of data and whether data is taken over time is evaluated.

Probabilistic structural analysis techniques may be used to estimate a numerical frequency or probability of piping segment failure. This method uses conventional structural analysis techniques, such as fracture mechanics analysis, in combination with probabilistic methods, such as Monte-Carlo simulation. These techniques are implemented by computer codes to estimate failure probabilities as a function of time. The probabilistic structural analysis methodology for the determination of piping failure probabilities is reviewed to determine the appropriate application of fracture mechanics analysis and Monte-Carlo simulation techniques. Benchmarking of computer codes based on comparison with industry standard codes as well as operating experience is also reviewed. The applicant should demonstrate that the methodology is able to identify significant differences in failure frequencies or probabilities arising from differences in material properties and environmental influences such as the presence of known degradation mechanisms.

Alternatively, expert opinion or categorization based on degradation mechanisms may be used in conjunction with, or in lieu of, fracture mechanics analysis to assign each element into a small number of failure-potential categories: high, medium, or low for example. In such cases, the process and basis of failure-potential determination is reviewed.

For both quantitative estimates and classification into similar groups, the manner in which failure modes, applicable industry experience, piping material, degradation mechanisms, and various other parameters are identified and considered is evaluated. There are numerous uncertainties involved in performing an assessment of segment failure potential. The procedures for addressing these uncertainties when predicting failure potential are reviewed.

I.2.2.5 Consequences of Failure

Direct effects of piping failures include loss of coolant accidents (LOCA) or other flow diversions resulting in an initiator or a consequential loss of systems because of the inability to deliver sufficient flow because of the failed piping. Indirect effects include consequential failures of additional equipment, including equipment in other systems, because of effects such as pipe whip, jet impingement, flooding, or temperature. The procedure by which direct and indirect effects are characterized and documented is reviewed to verify that appropriate failure mechanisms and dependencies will be evaluated in the risk analysis.

I.2.2.6 Risk Impact of ISI Changes

The methodology used to characterize the change in risk caused by the proposed change in the ISI program is reviewed. Part of the basis for the acceptability of any RI-ISI program is a demonstration that established risk measures are not significantly increased by the proposed reduction in the number of inspections for selected piping. To demonstrate this, the process and methodology used to appropriately account for the change in the number of elements inspected and the effects of an enhanced inspection method are reviewed.

I.2.3 Integrated Decisionmaking

Acceptability of the impact of the proposed change in the ISI program is determined based on the review of the adequacy of the licensee's fulfillment of the five key principles as listed in Section I and discussed in detail in Regulatory Guide 1.174. The licensee's processes, procedures, and decision criteria to integrate, and to iterate on the integration as necessary, the different elements of the engineering analysis discussed in Sections I.2.1 and I.2.2 and the key principles are reviewed.

The assignment of pipe elements into safety-significant categories is an integral part of the risk-informed ISI process. Consequently, the categorization process and all qualitative and quantitative guidelines used to support the categorization are also reviewed.

Risk measures used to characterize and differentiate the risk contributions from the individual piping segments are reviewed. The techniques, criteria, and documentation used to develop and describe the risk measures are reviewed. The criteria for using these risk measures to categorize the safety significance of each pipe segment are reviewed. Consideration of absolute and relative figures of merit is reviewed. Review is focused on the criteria for risk significance determination for ISI at the pipe segment and structural element levels that are used to prioritize inspection locations. The procedure used to perform review of piping segments and piping structural elements to ensure that segments are appropriately ranked is reviewed.

The criteria and procedure used to define the number and location of structural elements within the piping segments that will be subject to ISI are reviewed. The comparison between the ISI program for piping under ASME B&PVC Section XI and the requested RI-ISI program is reviewed.

I.3 Element 3: Implementation and Monitoring Programs

The adequacy of the implementation and monitoring plans is reviewed. Inspection strategies are reviewed to ensure that failure mechanisms of concern have been addressed and there is a sufficiently high probability of detecting damage before structural integrity is impacted. The process by which the safety significance of piping segments is taken into account in defining the scope of the inspection program is reviewed. The inspection scope, examination methods, and methods of evaluation of examination results are reviewed with the objective of establishing whether the RI-ISI inspection program provides an acceptable level of quality and safety.

The criteria for selecting areas and volumes of safety significant piping structural elements for inspection are reviewed to ensure that the applicable degradation mechanisms are addressed. The methods by which the degradation mechanisms, postulated failure modes, and configuration of piping structural elements are incorporated in the inspection scope and inspection locations are reviewed. The manner in which significant stress concentration, geometric discontinuities, and generic as well as plant-specific pipe cracking experience is considered in selecting inspection locations is reviewed. Alternative methods to ensure structural integrity in cases in which examination methods cannot be applied because of limitations, such as inaccessibility or radiation exposure hazards, are reviewed.

In the context of the RI-ISI program, the sampling strategy is defined by the selection of structural elements that are proposed by the licensee for inclusion in the inspection. The reviewer will determine whether the criteria for the expansion of the sample size are acceptable and that sequential sampling is based on ISI findings and other evidence of structural degradation.

Inspection methods and acceptance standards used in the implementation of the RI-ISI program are reviewed. Inspection methods selected by the licensee should address the degradation mechanisms, pipe sizes, and materials of concern. The manner in which the degradation mechanism is taken into consideration in determining the suitability of examination methods such as visual, surface, and volumetric examination is reviewed. The extent to which the RI-ISI program incorporates inspection intervals, examination methods, and acceptance standards currently specified in the ASME B&PVC Section XI program is reviewed.

The reliability of any NDE method is dependent on the qualification of the inspection personnel. The RI-ISI program is reviewed to verify that inspection teams will meet industry codes and standards and use accepted methods and procedures.

The implementation plan for the RI-ISI program is reviewed to ensure that appropriate modifications of the ISI plan are developed if new or unexpected degradation mechanisms occur. The reviewer will ensure that the adequacy of the reliability of the implemented NDE methods is monitored.

II. ACCEPTANCE CRITERIA

The acceptance criteria for the areas of review described in Section I of this SRP are given below. Other approaches that can be justified to be equivalent to the stated acceptance criteria may be used. The staff accepts the risk-informed development of an inspection plan if the relevant requirements of 10 CFR 50.55a concerning ISI are complied with. The relevant requirements of 10 CFR 50.55a are:

1. Proposed alternatives to the ISI requirements of paragraphs of *10 CFR 50.55a*, which requires compliance with ASME B&PVC Section XI for ASME Code Class 1, 2, and 3 components, may be used when authorized by the Director of the Office of Nuclear Reactor Regulation.

2. The applicant must demonstrate that the proposed alternatives would provide an acceptable level of quality and safety.

General guidelines on judging the acceptability of the engineering evaluations and PRA used to support risk-informed applications are provided in Regulatory Guide 1.174 and SRP Chapter 19.0. A summary of acceptance guidelines for engineering evaluations and selected PRA issues specific to ISI is provided in Regulatory Guide 1.178.

II.1 Element 1: Define the Proposed Change to ISI Program

The licensee's RI-ISI submittal should have defined the proposed changes to the ISI program in general terms. The licensee should have confirmed that the plant is designed and operated in accordance with the currently approved requirements and that the PRA used in support of their RI-ISI program submittal reflects the actual plant. The licensee should identify those aspects of the plant's licensing bases that may be affected by the proposed change, including, but not limited to, rules and regulations, FSAR, technical specifications, and licensing conditions. In addition, the licensee should identify any changes to commitments. The licensee’s programs and procedures that guide future changes to the ISI program without prior NRC approval should provide for engineering analyses, internal reviews, and a degree of traceability consistent with the magnitude of the changes the licensee intends to make.

The particular piping systems, segments, and welds that are affected by the change in the ISI program should be identified. Specific revisions to inspection scope, schedules, locations, and techniques should also be identified. In addition, plant systems and functions that rely on the affected piping should be identified. Industry and plant-specific experience with inspection program results should be obtained and characterization relative to the effectiveness of past inspections of the piping and the flaws that have been observed should be described.

II.2 Element 2: Engineering Analysis

After the proposed changes to the licensee's ISI program have been defined, the licensee should conduct an engineering analysis of the proposed changes using a combination of traditional engineering analysis with supporting insights from a PRA. Regulatory Guides 1.174 and 1.178 provide guidance for the performance of this evaluation.

II.2.1 Traditional Analysis

The traditional engineering analyses conducted should assess whether the impact of the proposed ISI changes (individually and cumulatively) is consistent with the principles that defense in depth and adequate safety margins are maintained.

The primary regulations governing ISI of piping are 10 CFR 50.55a and Appendix A to 10 CFR Part 50. The intent of these regulations is to maintain the structural integrity of piping in a nuclear power plant. The regulations reference other codes and requirements that define the elements of a defense-in-depth philosophy to ensure the structural integrity of piping. For each of the regulations and licensing bases relevant to the ISI of piping, the licensee should ensure that the proposed changes to the ISI program do not deviate from the regulations and licensing bases.

ASME B&PVC Section XI is referenced in 10 CFR 50.55a for the detailed requirements regarding piping ISI. The objective of the ISI requirements of the ASME Code has been to identify conditions, such as flaw indications, that are precursors to leaks and ruptures in pressure boundaries that may impact plant safety. The licensee should verify that the proposed changes to the ISI program meet or exceed the intent of ASME B&PVC Section XI to identify conditions that are precursors to leaks and ruptures and to provide plans for additional and more frequent inspections in response to detection of flaws and degradation mechanisms. The plans for additional inspections following detection of a flaw should be targeted toward locations with the same degradation mechanism that may have contributed to the unacceptable flaw development.

The nuclear industry has implemented augmented inspection programs to address generic industry-wide piping degradation problems such as IGSCC and FAC. The licensee should identify whether the proposed changes in the ISI program affect previous licensee commitments for augmented inspection programs for piping degradation problems such as IGSCC and FAC.

II.2.2 Probabilistic Risk Assessment

The quality of the PRA should be compatible with the safety implications of the ISI change being requested and the degree that the justification of the change request depends on the PRA analysis. Guidance relating the acceptable scope, level of detail, and quality of the PRA analysis based on the anticipated change in risk can be found in Regulatory Guide 1.174, in Section 2.2.3, "Quality of PRA Analysis," and SRP Chapter 19.0, in Section III.2.2.4, "Quality of a PRA for Use in Risk-Informed Regulation."

The PRA performed should realistically reflect the actual design, construction, and operational practices and reflect the impact of previous changes made to the approved requirements. All calculations using the PRA model should be performed correctly and in a manner that is consistent with accepted practices. Limitations and approximations in the PRA and the PRA techniques that can influence the interpretation of the results required to support the ISI application should be clearly described and appropriately addressed. Parameter uncertainty, model uncertainty, and completeness uncertainty should be addressed in accordance with the guidelines of Regulatory Guide 1.174.

The programs and procedures regarding the long-term maintenance, update, and use of the PRA should be sufficient to ensure that any anticipated changes in the ISI program that do not require NRC notification or approval will always be based on an appropriately generated set of risk insights.

II.2.2.1 Scope of Piping Systems

The piping systems included in the RI-ISI program for the purpose of evaluating the impact of the proposed changes in the ISI program on total plant risk and for the purpose of screening to classify the safety significance of piping systems should be such that any proposed increases in CDF and risk are small and are consistent with the intent of the Commission's Safety Goal Policy Statement.

II.2.2.2 Piping Segments

An acceptable method for modeling a run of a pipe in a PRA or to define its ISI requirements is to divide the pipe run into segments. Portions of piping within the piping systems that have the same consequences of failure should be systematically identified. Consequences of failure include an initiating event, loss of a particular train, loss of a system, or a combination thereof. The location of the piping in the plant, and whether inside or outside the containment, should be taken into account in defining piping segments.

Piping sections subjected to the same degradation mechanism should be systematically identified. Most of the degradation mechanisms present in nuclear power plant piping are dependent on a combination of design characteristics, fabrication processes and practices, operating conditions, and service experience. The degradation mechanisms to be considered include, but may not be limited to, vibration fatigue, thermal fatigue, corrosion cracking, primary water stress corrosion cracking (PWSCC), IGSCC, microbiologically induced corrosion (MIC), erosion, cavitation, and FAC.

Piping segments should be defined taking into account the potential degradation mechanism and the consequence of failure at any point in the segment. Segments with the same consequences but a different degradation mechanism may be combined for consequence characterization, but the development of the inspection program should explicitly address the different degradation mechanisms within such segments. In addition, consideration should be given to identifying distinct segment boundaries at locations of branching points such as flow splits or flow joining points, locations of size changes, isolation valve, motor-operated valves (MOVs) and air-operated valves (AOVs). Distinct segment boundaries should be defined if the break potential is expected to be significantly different for various portions of piping.

II.2.2.3 Evaluating Pipe Failures with PRA

The licensee's methodology should systematically use risk insights from the PRA and PRA results to characterize the impact of each segment's failure on the plant's risk. The characterization should allow for the determination of the relative safety significance of the different pipe segments and should support the final determination regarding the impact of implementing the program on plant risk.

Generally, three or four primary system LOCA sizes and two steam line rupture locations that represent the spectrum of demands on the mitigating systems are modeled in PRAs. An internal events flooding analysis is also included in most PRAs performed in response to Generic Letter 88-20. Much of this analysis will be used as a basis for determining the consequence of pipe failures. The review should focus on the robustness of the above models and methods in the baseline PRA, as well as appropriate use of this information to investigate the impact of the change in risk that is due to RI-ISI implementation.

One acceptable approach is to investigate the change in risk due to an ISI program change is based on developing the pipe elements' failure potentials into probabilities, and integrating these probabilities into the existing quantitative PRA framework. The contribution to risk from each piping element may be ranked and the safety significance of the element determined.

An alternative acceptable approach is based on categorizing each segment's failure potential and the consequences of each segment's failures. These two elements of risk, failure potential and consequences, are then systematically combined to determine the safety significance of each segment.

II.2.2.4 Piping Failure Potential

The determination of the degradation mechanisms present at each weld within all pipe runs included in the scope of the submittal is central to the success of the ISI application. The process used to identify the degradation mechanism at each weld should be well defined, systematic and applied to all welds within the scope. The documentation and engineering evaluations upon which the process is based should be capable of supporting the identification of all applicable degradation mechanisms.

The determination of failure potential of piping segments, either as a quantitative estimate or a categorization into groups, should be based on appropriate design, operational, and inspection parameters in conjunction with the identified degradation mechanisms. The evaluation should include a determination of whether the potential failure of each segment is best characterized as a demand failure while responding to a plant transient or an operational failure which causes a plant transient.

When data analysis is utilized to develop a quantitative estimate, the data should be appropriate and complete. When elicitation of expert opinion is used in conjunction with, or in lieu of probabilistic fracture mechanics or data analysis, a systematic procedure should be developed for conducting such elicitation and a suitable team of experts should be selected and trained. When categorization based on the degradation mechanism is used, the justification for the relationship between the degradation mechanism and the assigned category should be appropriate and complete.

The assessment of piping failure potential should take into account uncertainties. These uncertainties include, but are not limited to, design versus fabrication differences, variation in material properties and strength, the effect of various degradation and aging mechanisms, variation in steady-state and transient loads, availability and accuracy of plant operating history, availability of inspection and maintenance program data, and capabilities of analytical methods and models to predict realistic results.

The methodology, process, and rationale used to determine the failure potential of piping segments should be reviewed and approved by the plant expert panel as part of its deliberations during the final classification of the safety significance of each segment. This process should be justified, documented, and included in the submittal. When computer codes are used to develop quantitative estimates, the techniques should be verified and validated against established industry codes.

II.2.2.5 Consequences of Failure

The impact on risk that is due to piping pressure boundary failure should consider both direct and indirect effects. Consideration of direct effects should include failures that cause initiating events or that disable single or multiple components, trains, or systems, or a combination of these effects. Indirect effects of pressure boundary failures that affect other systems, components, or piping segments, also referred to as spatial effects such as pipe whip, jet impingement, flooding, or consequential initiation of fire protection systems, should also be considered.

The direct and indirect effects of pipe failures should be characterized to incorporate appropriate failure mechanisms and dependencies into the PRA model. The possibility of different leak sizes ranging from minor leaks to full rupture should be considered. In general, the leak size resulting in the most severe consequence should be selected to characterize the consequence for each segment.

An acceptable method of incorporating pipe failures is to classify pipe failures as leaks, disabling leaks, and breaks. Each of these failure modes may be characterized with a different failure probability or potential and a corresponding potential for degrading system performance through direct or indirect effects or both. The time available for operator actions also depends on the break size, and this timing dependence should be recognized and incorporated into the analysis as appropriate.

II.2.2.6 Risk Impact of ISI Changes

The guidelines discussed in Regulatory Guide 1.174, in Section 2.2.5, “Comparison of PRA Results with the Acceptance Guidelines,” are applicable to ISI change requests. General guidance for reviewing the risk impact from changes to the current licensing basis can be found in SRP Chapter 19 in Section III.2.2.5, “Evaluation of Risk Impact.”

The methods used to determine the piping failure potential, the piping failure consequence, and the impact of the change in the number of inspections should together provide confidence that any increase in CDF or risk is small and acceptable in accordance with Regulatory Guide 1.174 guidelines and consistent with the intent of the Commission's Safety Goal Policy Statement. Increase in risk caused by changes in the ISI program could arise from a decrease in the number of welds inspected, reduced efficiency from simplified weld inspections, or both. Decreases in risk could arise from inspecting welds not currently being inspected in the program, improved weld inspections, or both. The greater the potential risk increase that is due to the proposed change in the ISI program (e.g., the larger the reduction in the number of welds to be inspected and of replacements of detailed inspections with simplified inspections), the more rigorous and detailed the risk analyses needed.

The licensee should demonstrate that principle four in Regulatory Guide 1.174 and Regulatory Guide 1.178 is met. Principle four states that proposed increases in CDF and risk should be small and consistent with the intent of the Commission’s Safety Goal Policy Statement. A direct evaluation of the fulfillment of principle four may be based on:

- Risk importance measures or bounding estimates capable of characterizing plant specific pipe element failure potential and consequences categories,

- A systematic process to combine failure potential and consequence to determine pipe element safety significance,

- Pipe segmentation and element inspection selection process that provides for changes in the ISI program based on the safety significance of the pipe element, and

- A discussion and evaluation of the aggregate risk impact of the set of changes requested in the ISI program, including an evaluation of uncertainty indicating that the uncertainties do not invalidate the conclusions.

Alternatively, principle four may be shown to be met by calculating the expected change in CDF and LERF. The expected change can be calculated using the baseline PRA and before change versus after change piping failure potential expressed as failure probabilities. An evaluation of the uncertainty in the results should be performed, which indicates that the uncertainties do not invalidate the conclusions.

II.2.3 Integrated Decisionmaking

The integrated decisionmaking must address all five key safety principles presented in Section I, "Areas of Review," in this SRP and should address each of the expectations discussed in Section 2, "An Acceptable Approach to Risk-Informed Decisionmaking," of Regulatory Guide 1.174. The integrated decisionmaking should also ensure that the proposed ISI program is consistent with the intent of each of the elements related to defense in depth and safety margins discussed in 2.2.1.1, "Defense in Depth," and 2.2.1.2, "Safety Margins," of Regulatory Guide 1.174. The results of the different elements of the engineering analysis discussed in Sections I.2.1 and I.2.2 must be considered in an integrated decisionmaking process.

For ISI application, traditional requirements are outlined in 10 CFR 50.55a and the General Design Criteria in Appendix A to 10 CFR Part 50. To be acceptable, the traditional engineering analysis should address all the relevant regulations and the licensing bases of the plant. The acceptability of the impact of the proposed change in the ISI program is based on the adequacy of the traditional engineering analysis, acceptable change in plant risk relative to the criteria, and the adequacy of the proposed implementation and performance monitoring plan. The intent of the ASME B&PVC to maintain integrity of reactor coolant system boundary by ISI should be preserved under the RI-ISI program.

An acceptable approach for the risk ranking of piping segments and elements is the use of risk reduction worth (RRW), risk achievement worth (RAW), conditional core damage probability (CCDP), conditional large early release probability (CLERP), or other importance measures. RRW is a measure of the maximum possible reduction in total CDF or LERF due to pressure boundary failures in plant piping systems that can result from making a component perfectly reliable. RAW, CLERP, and CCDP characterize the increase in risk associated with the pressure boundary failure. The risk ranking methodology must be able to systematically identify all safety- significant pipe segments within the scope of the RI-ISI program. Guidelines for using risk importance measures to categorize SSCs with respect to safety significance can be found in Appendix A, "Use Of Risk-Importance Measures To Categorize Structures, Systems, and Components with Respect to Safety Significance," to Regulatory Guide 1.174.

The classification of piping segments should be evaluated to determine whether any piping segment is inappropriately classified. Consideration should be given to the limitations resulting from the PRA structure, PRA scope, and risk-importance measures. Operational insights from previous inspection results, industry data on pipe failures, and Maintenance Rule impacts should also be taken into account. Piping that is subject to ISI under ASME B&PVC Section XI requirements but has no segments exceeding the piping segment screening criteria should be further reviewed. Each ASME Class coded system should have some segments inspected for defense-in-depth considerations.

The criteria for determining how many structural elements should be selected for inspection should be based on the safety significance of the segment and the failure potential within that segment. The potential for pipe failure directly drives the need for selecting elements for inspection and the location within a segment to be inspected. The sampling program for the selection of the number of elements to be inspected should be fully justified. Guidelines for an acceptable methodology for selection of structural elements for inspection within pipe segments are provided in the Regulatory Guide 1.178.

The intent of the ASME B&PVC to maintain integrity of the reactor coolant system boundary by ISI should be preserved under the RI-ISI program. Appropriate consideration should be given to implementation and performance monitoring strategies so that piping performance can be assessed under the proposed ISI program change to confirm the assumptions and analyses that were conducted to justify the ISI program change.

II.3 Element 3: Implementation and Monitoring Programs

Careful consideration should be given to implementation and performance-monitoring strategies. The primary goal of this element is to assess piping performance under the proposed RI-ISI program by establishing performance-monitoring strategies to confirm the assumptions and analyses that were conducted to justify the changes in the ISI program. As discussed in Regulatory Guide 1.178, performance monitoring encompasses feedback and modification of the RI-ISI program resulting from changes in plant design features, plant procedures, equipment performance, examination results, and individual plant and industry failure information.

Inspection scope and examination methods for the RI-ISI program should provide an acceptable level of quality and safety as stipulated in 10 CFR 50.55a(a)(3)(i). Inspection strategies should ensure that failure mechanisms of concern have been addressed and that there is a sufficiently high probability of detecting damage before structural integrity is impacted. Safety significance of piping segments should be taken into account in defining the inspection scope for the RI-ISI program.

Degradation mechanisms, postulated failure modes, and configuration of piping structural elements should be incorporated in the definition of the inspection scope and inspection locations. For piping segments that are included in the existing plant FAC or IGSCC (Category B-G) inspection programs, the inspection locations should be the same as in the existing programs. For segments not in these programs, inspection locations should be mainly based on specific degradation mechanism and industry as well as plant-specific cracking experience. Determination of inspection locations for segments with no known degradation mechanism but high failure consequence should be based on sensitized weld locations, stress concentration, geometric discontinuities, and terminal ends. Plant-specific pipe cracking experience should be considered in selecting inspection locations. To be acceptable, alternative examination methods should be specified to ensure structural integrity in cases where examination methods cannot be applied due to limitations, such as inaccessibility or radiation exposure hazards. System pressure tests and visual examination of ASME piping structural elements should continue to be performed regardless of whether the segments contain locations that have been classified as safety significant or low safety significant. Safety-significant non-Code piping should be treated as ASME Code Class piping for purposes of examination and pressure testing.

The qualifications of nondestructive examination (NDE) personnel, processes, and equipment should be demonstrated to be in compliance with ASME B&PVC Section XI. The acceptance criteria for flaw evaluation should meet the requirements of ASME B&PVC Section XI. For inspections outside the scope of Section XI, the acceptance criteria should meet existing regulatory guidance applicable to those programs.

The risk-informed inspection program should specify appropriate inspection intervals consistent with the relevant degradation rate if the data on the degradation mechanism suggest that an inspection interval shorter than that stated in the ASME Section XI is required. In such cases, inspection intervals should be sufficiently short so that degradation too small to be detected during one inspection does not grow to an unacceptable size before the next inspection is performed.

Updates to the RI-ISI program should be performed at least on a 10-year interval basis to coincide with the ISI requirements in ASME B&PVC Section XI. Significant changes to the PRA model, plant design feature changes, plant procedure changes, and equipment performance changes should be included for review in the RI-ISI program update if needed to support the update. Leakage, flaws, or indications identified during scheduled RI-ISI program NDE examinations and system pressure tests should be evaluated as part of the RI-ISI program update. Periodic updates of RI-ISI programs should include individual plant as well as industry failure information.

Appropriate modifications of the ISI plan should be developed if new or unexpected degradation mechanisms occur. The adequacy of the reliability of the implemented NDE methods should be monitored. The adequacy of NDE performance levels and inspection intervals along with the appropriateness of the selected ISI locations should be considered valid only if the ISI program is successful in detecting degradation before it leads to leakage or rupture of piping.

III. REVIEW PROCEDURES

The staff reviews the licensee’s proposed RI-ISI program to determine whether it appropriately describes the types of changes that the licensee can make without prior NRC approval and the types of changes that require NRC approval before implementation. The reviewer ensures that all changes are evaluated using the change mechanisms described in existing applicable regulations (e.g., 10 CFR 50.55a, 10 CFR 50.59, and Appendix B to 10 CFR 50 for safety-related structures, systems, and components) to determine whether NRC review and approval is required prior to implementation. Licensees may request a variety of ISI programs supported by various levels of analyses and evaluations. In general, the degree of freedom the licensee receives to make future changes to the ISI program without prior NRC approval depends on the level of sophistication of the plant practices and procedures supporting the change to RI-ISI. Some general guidance on determining which future changes are appropriate is given below.

- Changes to segment groupings, inspection intervals, and inspection methods that do not involve a change to the overall RI-ISI approach in which the overall RI-ISI approach was reviewed and approved by the NRC do not require specific review and approval prior to implementation provided that the effect of the changes on plant risk increase is insignificant. The overall ISI submittal should specify what types of changes without prior NRC approval are anticipated and describe how such changes will be developed, reviewed by plant personnel, documented, and implemented.

- Segment inspection method changes that involve the implementation of an NRC-endorsed ASME Code, NRC-endorsed Code Case, or published NRC guidance approved as part of the RI-ISI program do not require prior NRC approval.

- Inspection method changes that involve deviation from the NRC-endorsed Code requirements require NRC approval prior to implementation.

- Changes to the RI-ISI program that involve programmatic changes (e.g., changes to the categorization criteria or figure of merit used to categorize components, and changes in the acceptance guidelines used for the licensee's integrated decisionmaking process) require NRC approval prior to implementation.

Piping inspection method changes typically involve the implementation of an applicable ASME Code, Code Case, or other requirements approved by the NRC. Changes to the piping inspection methods for these situations do not require NRC approval. However, inspection method changes that involve deviation from the NRC-approved Code requirements require NRC approval prior to implementation.

For each area of review, the following review procedure is followed to ensure consistency in review so as to satisfy the requirements of acceptance criteria stated in Section II.

III.1 Element 1: Define the Proposed Change to ISI Program

The staff reviewer verifies that the licensee's RI-ISI submittal defines the proposed changes to the ISI program in general terms. The reviewer ensures that the licensee has confirmed that the plant is designed and operated in accordance with the approved requirements and that the PRA used in support of their RI-ISI program submittal reflects the actual plant. The reviewer verifies that the licensee has identified regulations and licensing commitments that impact the current ISI requirements. This includes, but is not limited to, rules and regulations, FSAR, technical specifications, licensing conditions, and licensing commitments. The reviewer also verifies that the piping systems, segments, and welds that are affected by the change in ISI program are identified. In addition, the description of the proposed change is reviewed to verify that plant systems and functions that rely on the affected piping have been identified. The characterization of the proposed change in the ISI program is reviewed to verify that the industry and plant specific information relevant to the piping degradation mechanisms has been considered. The description of the proposed change is also reviewed to verify that information that characterizes the relative effectiveness of past inspections and the types of flaws that have been identified has been considered. In addition, the reviewer verifies that specific revisions to existing inspection schedules, locations, and techniques have been described.

III.2 Element 2: Engineering Analysis

In the second element, the staff reviewer verifies that the licensee's engineering analysis of the proposed changes uses a combination of traditional engineering analysis with supporting insights from a PRA. To be acceptable, the licensee should have verified that defense in depth is maintained, sufficient safety margins are maintained, and that proposed increases in risk, and their cumulative effect, are small and do not cause the NRC Safety Goals to be exceeded. Regulatory Guides 1.174 and 1.178 provide guidance for the performance of this evaluation.

III.2.1 Traditional Analysis

The engineering analyses are reviewed to ensure that the impact of the proposed ISI changes is consistent with the principles that defense in depth and adequate safety margins are maintained in accordance with the acceptance criteria in subsection II.2.1.

The reviewer verifies that the proposed changes to the ISI program meet or exceed the intent of ASME B&PVC Section XI to identify conditions that are precursors to leaks and ruptures and that the ISI program provides plans for additional and more frequent inspections in response to detection of flaws and degradation mechanisms. The reviewer ensures that the licensee has demonstrated that there is no impact of the proposed changes in the ISI program on the augmented inspection programs for IGSCC (Category B-G) and FAC.

III.2.2 Probabilistic Risk Assessment

The PRA performed is reviewed in accordance with the acceptance criteria in Section II.2.2 to confirm that it realistically reflects the actual design, construction, and operational practices and reflects the impact of previous changes made to the approved requirements. The staff reviewer verifies that the following information is included in the submittal.

- The CDF and LERF estimates and the version, calculation, or other reference number that identifies which version of the PRA was used.

- A description of the process used to update the PRA to ensure that the PRA analyses adequately represent the current design, construction, operational practices, and operational experience of the plant and its owner.

- A description of the staff and industry reviews performed on the PRA.[1] Limitations, weakness, or improvements identified by the reviewers that could change the results of the PRA should be discussed. The resolution of the reviewer comments or an explanation of the insensitivity of the analysis used to support the submittal to the comment should be provided.

The reviewer verifies that the PRA version used to support the analysis is appropriately specified and that the licensee's process to update the PRA provides reasonable assurance that the results developed from the PRA appropriately reflect the current state of the plant. The reviewer should ensure that any prior review findings that may influence the parts of the PRA model or results supporting the ISI change request have been adequately addressed. If necessary to support the change request, a focused scope or a more detailed PRA review should be undertaken. General guidance for focused scope and more detailed PRA quality reviews is presented in Draft Regulatory Guide DG-1122.

III.2.2.1 Scope of Piping Systems

The scope of piping systems included in the RI-ISI program is reviewed in accordance with the acceptance criteria in Section II.2.2.1.

III.2.2.2 Piping Segments

Criteria and procedures used to establish piping segments within the piping systems are reviewed to determine whether consequences of failure, degradation mechanisms, and segment boundaries are properly considered for defining piping segments in accordance with the acceptance criteria given in Section II.2.2.3 of this SRP section.

III.2.2.3 Evaluating Pipe Failures with PRA

Acceptable approaches for evaluating pipe failures with PRA are provided in Section II.2.2.3. The approach used is reviewed to verify whether the sequence of events from new initiators is appropriately developed if piping segment failure introduces new initiating events. If the pipe segment

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[1]In April 2000, the Nuclear Energy Institute submitted a process (Letter to S.J. Collins, NRC) for peer review of licensee PRAs. It was submitted for staff review in the context of its use in categorizing structures, systems, and components with respect to special treatment requirements (i.e., supporting NRC's risk-informed Proposed Rulemaking To Add New Section 10 CFR 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems, and Components""Option 2" work (SECY-02-0176)). This process, when endorsed by the NRC, may also be of use in licensing basis changes (as well as other regulatory activities not addressed here); if so, future revisions of this SRP chapter may endorse this certification process for this purpose.

failure yields the same consequences as some other initiator already included in the PRA, the reviewer verifies that the risk from the original initiating event is appropriately represented in the ISI analysis.

If pipe failures are characterized by a set of PRA basic events used as surrogates representing the equivalent impact of the pipe failure, the basic events are reviewed to ensure that the surrogate is an adequate representation of the pipe segment failure and that the resulting risk insights are reflected in the ISI analysis. If surrogate basic events cannot be found, the analysis used to characterize the new failure events using the PRA models or results and extract representative risk insights is reviewed.

III.2.2.4 Piping Failure Potential

The processes and documentation used to identify the degradation mechanisms is reviewed to verify that they are sufficient and were systematically applied. The identified degradation mechanisms are reviewed to determine that the results are an appropriate characterization and were developed at a level of detail consistent with the use of the information to support the change request. These detailed results are also compared to the reported inspection locations to determine the relationship between the inspection location, strategies, and degradation mechanisms. The procedures used to determine the failure potential of piping segments are reviewed in accordance with the acceptance criteria in Section II.2.2.4 to verify that the appropriate failure frequency, demand failure, or unavailability mode was used to characterize the impact of failure, and that the determination of the quantitative estimate or group classification is appropriate to the failure mode. The licensee's treatment of uncertainties in failure potential determination and all conclusions are reviewed. The incorporation of the findings of the uncertainty analyses into the final decisionmaking process is reviewed.

When a computer code is used to develop a quantitative estimate, verification and validation of the computer code that implements the probabilistic fracture mechanics techniques is reviewed. When expert elicitation is used, the selection and training of the experts and the elicitation process is reviewed. When the failure potential is determined by classifying the failures into groups, the applicability of the classification scheme is reviewed.

III.2.2.5 Consequences of Failure

The reviewer verifies that the licensee has considered both direct and indirect effects of each segment failure. The guidelines for determining the direct and, in particular, the indirect effects of pipe failure on plant equipment should be reviewed. The reviewer should verify that these guidelines have been consistently applied and that the results of the analysis are well documented. Guidelines for evaluating the consequence of different leak sizes and selecting the most severe consequence should also be reviewed if applicable.

III.2.2.6 Risk Impact of ISI Changes

The risk impact of the proposed change in the ISI program is reviewed for compliance with the acceptance criteria in Section II.2.2 of this SRP section. The assessed change in risk due to ISI implementation should be evaluated in accordance with the guidelines in Section 2.2.2, "Evaluation of Risk Impact, Including Treatment of Uncertainties," of Regulatory Guide 1.174. The licensee's risk assessment is reviewed to verify that any proposed increases in CDF and risk are small and are consistent with the intent of the Commission's Safety Goal Policy Statement. Selection of piping segments is reviewed to ensure that assumptions guiding the spatial effects of pipe failures are applied consistently. It should reflect the current plant ISI program, and risk insights developed should arise from comparing the baseline with the proposed RI-ISI program implementation plant risk. Risk insights are reviewed to ensure that they appropriately account for the change in the number of elements inspected and, when feasible, the effects of an enhanced inspection method. The emphasis put on the risk insights and on the PRA results in the decisionmaking process is determined. The PRA is reviewed to verify that the scope, level of detail, and the quality of the PRA is commensurate with the role the risk and the change in risk results play in determining the acceptability of the requested ISI program.

III.2.3 Integrated Decisionmaking

Acceptance criteria for an integrated decisionmaking process are given in Section II.2.3. The process by which the traditional engineering analysis addresses the relevant regulations and the currently approved requirements of the plant is reviewed to confirm that the regulations are met and the intent of the ASME B&PVC to maintain integrity of reactor coolant system boundary by ISI is preserved under the RI-ISI program. The documentation providing input to the integrated decisionmaking process is reviewed to ensure that all applicable risk insights, key principles, and supporting elements were addressed and communicated to the final decisionmaking panel. The documentation of the panel deliberations, recommendations, and findings should be reviewed to ensure that all relevant risk-informed insights were incorporated into the final program description. After the RI-ISI program is approved and initiated, plant performance should be supported by inspection and analysis and maintained by programmatic activities goals by comparison against specific performance goals.

The acceptability of the selection of locations to be inspected is reviewed for compliance with the acceptance criteria in Section II.2.3 of this SRP. Risk measures used are reviewed to determine that appropriate thresholds are used to rank the safety significance of the piping segments. The risk ranking process is reviewed to ensure that it is capable of systematically identifying all safety significant pipe segments, including those that are not included under ASME B&PVC Section XI as appropriate.

The procedure used to further review piping segments and piping structural elements that may be inappropriately identified as low safety significant is reviewed to verify that the PRA limitations, operational insights, industry pipe failure data, and Maintenance Rule insights are taken into consideration. In addition, the procedures used to determine the ISI program for piping that are subject to ISI under ASME XI requirements but have no segments or piping structural elements exceeding the screening criteria are reviewed to ensure that they are in accordance with the acceptance criteria of Section II.2.3 of this SRP.

III.3 Element 3: Implementation and Monitoring Programs

The reviewer verifies that the inspection strategies address failure mechanisms of concern and that there is a sufficiently high probability of detecting damage before structural integrity is compromised. The reviewer verifies that the degradation mechanisms, postulated failure modes, and configuration of piping structural elements are incorporated in the definition of the inspection scope and inspection locations. Selected inspection locations are reviewed to confirm that stress concentration, geometric discontinuities, and terminal ends are considered in establishing the inspection locations. In addition, the reviewer verifies that plant-specific pipe cracking experience has been considered in selecting inspection locations. The reviewer also determines whether alternative examination methods are specified to ensure structural integrity when examination methods cannot be applied due to limitations, such as inaccessibility or radiation exposure hazard. The RI-ISI program is reviewed to ensure that system pressure tests and visual examination of piping structural elements is to be performed on all Class 1, 2, and 3 systems in accordance with ASME B&PVC Section XI Program, regardless of whether the segments contain locations that have been classified as safety significant or low safety significant. The RI-ISI program is reviewed to ensure that safety-significant non-Code Class piping is treated as ASME Code Class piping for purposes of examination and pressure testing.

The sample selection process is examined to verify that expansion of the sample size is in accordance with the acceptance criteria of Section II.2.1 of this SRP. Also, the additional examinations should be performed in accordance with the ASME Code. Currently, the ASME Code directs users to perform additional examinations during the current outage. Inspection methods selected by the licensee are examined to verify that they address the degradation mechanisms, pipe sizes, and materials of concern. The RI-ISI inspection program is reviewed to confirm that appropriate examination methods and intervals are used and acceptance standards meet the requirements of ASME B&PVC Section XI or existing regulatory guidance applicable to the piping system.

IV ELEMENT 4: DOCUMENTATION

The reviewer will review the licensee's submittal to ensure that it contains the documentation necessary to conduct the review described in this SRP (i.e., the documentation described in Regulatory Guide 1.178). The RI-ISI program and its updates should be maintained on site and available for NRC inspection consistent with the requirements of Appendix B to 10 CFR Part 50.

V EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that the evaluation is sufficiently complete and adequate to support conclusions of the following types, to be included in the staff's safety evaluation report.

The staff concludes that the licensee’s proposed RI-ISI program, as described in its submittal, will provide an acceptable level of quality and safety pursuant to 10 CFR 50.55a(a)(3)(i) with regard to the number of inspections, locations of inspections, and methods of inspections. This conclusion is based on the following findings.

The staff finds that the results of the different elements of the engineering analysis are considered in an integrated decisionmaking process. The impact of the proposed change in the ISI program is founded on the adequacy of the engineering analysis and acceptable change in plant risk in accordance with guidance in Regulatory Guides 1.174 and 1.178.

The licensee’s methodology also considers implementation and performance monitoring strategies. Inspection strategies ensure that failure mechanisms of concern have been addressed and that there is adequate assurance of detecting damage before structural integrity is affected. The risk significance of piping segments is taken into account in defining the inspection scope for the RI-ISI program.

System pressure tests and visual examination of piping structural elements will continue to be performed on all Class 1, 2, and 3 systems in accordance with the ASME B&PVC Section XI program. The RI-ISI program applies the same performance measurement strategies as existing ASME Code requirements and, in addition, increases the inspection volumes at weld locations that are exposed to thermal fatigue.

The licensee’s methodology provides for conducting an engineering analysis of the proposed changes using a combination of engineering analysis with supporting insights from a PRA. Defense in depth and quality are not degraded in that the methodology provides reasonable confidence that any reduction in existing inspections will not lead to degraded piping performance when compared to existing performance levels. Inspections are focused on locations with active degradation mechanisms as well as selected locations that monitor the performance of system piping.

The staff's review of the licensee's proposed RI-ISI program concludes that the program is an acceptable alternative to the current ISI program for Class 1 and Class 2 piping welds, which is based on ASME B&PVC Section XI requirements for Class 1 and Class 2 welds. Therefore, the licensee's request for relief is authorized pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that the request provides an acceptable level of quality and safety.

This safety evaluation authorizes application of the proposed RI-ISI program during the second ten-year ISI interval for licensee's Unit 1 and Unit 2.

VI IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant or licensee proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

VII. REFERENCES

Draft Regulatory Guide DG-1122, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," USNRC, November 2002.[1]

EPRI TR-112657, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," Electric Power Research Institute, Revision B-A, December 1999.

Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," USNRC, January 25, 1988.[2]

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[1]Single copies of regulatory guides, both active and draft, and draft NUREG documents may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555-0001, or by fax to (301)415-2289, or by email to <DISTRIBUTION@NRC.GOV>. Active guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161; telephone (703)487-4650; online <http://www.ntis.gov/ordernow>. Copies of active and draft guides are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)4154737 or (800)397-4209; fax (301)415-3548; email <pdr@nrc.gov>. Electronic copies of many regulatory guides are available on NRC's web site, <WWW.NRC.GOV>,

[2] Electronic copies are available on the NRC web site at <WWW.NRC.GOV> in the Document Collections under Generic Communications. Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike (first floor), Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or 1-(800)397-4209; fax (301)415-3548; e-mail <PDR@NRC.GOV>.

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Letter to S.J. Collins, NRC, from Ralph E. Beedle, NEI, with attached "Probabilistic Risk Analysis (PRA) Peer Review Guidance," Rev. A3, NEI 00-02, Prepared for NEI Risk-Based Applications Task Force by WOG/Westinghouse Electric Co., and B&WOG/Framatome Technologies, Inc., April 24, 2000.[3]

NRC Bulletin 79-17, “Pipe Cracks in Stagnant Borated Water Systems at PWR Plants,” USNRC, October 29, 1979.[2]

NRC Bulletin No. 88-01, “Defects in Westinghouse Circuit Breakers,” USNRC, February 5, 1988.[2]

NRC Bulletin No. 88-08, “Thermal Stresses in Piping Connected to Reactor Coolant Systems,” USNRC, June 22, 1988.[2]

NRC Bulletin No. 88-11, “Pressurizer Surge Line Thermal Stratification,” USNRC, December 20, 1988.[2]

NRC Information Notice 93-020, “Thermal Fatigue Cracking of Feedwater Piping to Steam Generators, USNRC, March 24, 1993.[2]

PRA Policy Statement, “Use of Probabilistic Risk Assessment Methods in Nuclear Activities: Final Policy Statement,” USNRC, *Federal Register,* Vol. 60, p. 42622 (60 FR 42622), August 16, 1995.

Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” USNRC, Revision 1, November 2002.[1]

Regulatory Guide 1.178, “An Approach for Plant-Specific Risk-Informed Decisionmaking for Inservice Inspection of Piping,” USNRC, Revision 1, September 2003.[1]

Safety Goal Policy Statement, “Safety Goals for the Operations of Nuclear Power Plants; Policy Statement,” USNRC, *Federal Register*, Vol. 51, p. 30028 (51 FR 30028), August 4, 1986.

SECY-01-0213, “Risk-Informed Regulation Implementation Plan,” USNRC, SECY-00-0213, October 16, 2000; updated January 2003 (SECY-03-0044).[4]

SECY-02-0176, Proposed Rulemaking To Add New Section 10 CFR 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems, and Components," USNRC, September 30, 2002.[4]

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[3] Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike (first floor), Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or 1-(800)397-4209; fax (301)415-3548; e-mail <PDR@NRC.GOV>.

[4] USNRC SECY papers are available electronically on the NRC's web page at <www.nrc.gov> under Commission's Activities.

SRP Chapter 19, "Use of Probabilistic Risk Assessment in Plant-Specific, Risk-Informed Decisionmaking: General Guidance," Revision 1 of Chapter 19 of the SRP, NUREG-0800, USNRC, November 2002.[1]

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