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An Exelon/British Energy Company

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

October 1, 2002
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U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 2055

Three Mile Island, Unit 1
Operating License No. DPR-50
NRC Docket No. 50-289

Subject: Third Ten-Year Interval Inservice Inspection (ISI) Program
Risk-Informed Inservice Inspection Program
Alternative to the ASME Boiler and Pressure Vessel Code
Section XI Requirements for Class 1 and 2 Piping Welds

References:

1. Electric Power Research Institute (EPRI) Topical Report (TR) 112657 Revision B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," dated December 1999.

2. Letter from W. H. Bateman (USNRC) to G. L. Vine (EPRI), "Safety Evaluation Report Related to EPRI Risk-Informed Inservice Inspection Evaluation Procedure (EPRI-TR-112657, Revision B, July 1999)," dated October 28, 1999.

3. Letter from M. P. Gallagher (AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission (USNRC), "Inservice Inspection (ISI) - Third Ten Year Inspection Interval Program Plan," dated August 2, 2001.

Dear Sir/Madam:

In accordance with 10 CFR 50.55a, "Codes and standards," paragraph (a)(3)(i), AmerGen Energy Company (AmerGen), LLC, is submitting a proposed alternative to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components", requirements for the selection and examination of Class 1 and 2 piping welds. The alternative proposed by Three Mile Island (TMI), Unit 1 uses Reference 1 methodology for a Risk-Informed Inservice Inspection (RISI) program approved by the U. S. Nuclear Regulatory Commission (NRC) to the extent and within the limitations specified in Reference 2.

AmerGen submitted the Third Ten-Year Interval Inservice Inspection Program to the U. S. Nuclear Regulatory Commission in the Reference 3 letter. The third ten-year interval began on April 20, 2001.

Relief Request No. RR-21 (Enclosure 1) and the RISI Program Summary for TMI, Unit 1 (Enclosure 2) demonstrate that the proposed alternative would provide an acceptable level of

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quality and safety, as required by 10 CFR 50.55a(a)(3)(i). The format of the TMI, Unit 1 RISI submittal is consistent with the Nuclear Energy Institute (NEI) and industry template developed for applications of the RISI methodology.

As required by Reference 1, AmerGen has completed a review of existing relief requests to determine if any should be withdrawn or modified due to changes that occur as a result of implementing the RISI Program. Two relief requests are affected.

Relief Request No. RR-00-01 (submitted in Reference 3), requesting approval to perform alternatives to Category B-F and B-J surface examinations of piping and nozzle to safe-end welds located inside the reactor vessel primary shield wall is withdrawn. RR-00-01 required ultrasonic examination of the full weld volume and adjacent ½ inch base metal on each side of the weld from the ID. The RISI program provides improved examination methods based on the expected degradation mechanism at the particular examination location. The methods, volumes, and areas to be used during examination will be implemented as required by the RISI Program.

Relief Request No. RR-13, submitted via Reference 3, requesting approval to use the alternative requirements of ASME Section XI Code Case N-598, has been modified to clarify applicability to RISI Examination Category R-A piping elements and is submitted herein as Enclosure 3.

The RISI Program will be incorporated during the Third Ten-Year Interval for TMI, Unit 1, and shall remain in effect until the completion of the interval for TMI, Unit 1, which is projected to end in 2011. At that time the TMI, Unit 1 ISI Programs will require updating for the Fourth Inservice Inspection Interval. Implementation of this RISI program will provide for fewer but more focused ASME Section XI piping weld inspections with little change in the risk to the public, while reducing occupational radiation exposure.

Approval of this proposed alternative is requested by September 15, 2003 in order to avoid costs associated with staging equipment and personnel necessary to perform the examinations.

If you have any questions, please contact us.

Very truly yours,

Michael P. Gallagher
Director, Licensing and Regulatory Affairs
Mid-Atlantic Regional Operating Group

Enclosure 1 - Relief Request No. RR-21
Enclosure 2 - Risk-Informed Inservice Inspection Program Plan – Three Mile Island, Unit 1
Enclosure 3 - Relief Request No. RR-13

cc: H. J. Miller, Administrator, Region I, USNRC
USNRC Senior Resident Inspector, TMI
T. G. Colburn, USNRC Senior Project Manager
File No. 02078

Enclosure 1

Relief Request No. RR-00-21

RELIEF REQUEST No. RR-00-21
Revision 0

I. SYSTEM/COMPONENT(S) FOR WHICH RELIEF IS REQUESTED

American Society of Mechanical Engineers (ASME) Code Class 1 and 2 piping welds under Examination Category B-F, B-J, C-F-1, and C-F-2. The Examination Item Numbers are B5.10, B5.20, B9.11, B9.21, B9.31, B9.32, B9.40, C5.11, C5.21, C5.51, C5.61, and C5.81.

II. CODE REQUIREMENTS FROM WHICH AN ALTERNATIVE IS REQUESTED

ASME Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 1995 Edition through the 1996 Addenda, Table IWB 2500-1, Examination Category B-F requires a volumetric and/or surface examination on all piping welds for Item Numbers B5.10, and B5.20.

Table IWB 2500-1, Examination Category B-J requires a volumetric and/or surface examination on all piping welds for Item Numbers B9.11, B9.21, B9.31, B9.32, and B9.40.

Table IWC 2500-1, Examination Categories C-F-1 and C-F-2 require volumetric and/or surface examinations for Item Numbers C5.11, C5.21, C5.51, C5.61, and C5.81.

IWB-2430, "Additional Examinations," requires that any indications revealed that exceed the acceptance standards of Table IWB-3410-1 shall be extended to include additional examinations during the same outage. The additional examinations shall include an additional number of welds, areas, or parts, that were scheduled to be performed during the same inspection period. If the additional examinations revealed any indications exceeding the acceptance standards of Table IWB 3410-1, the examination shall be further extended to include additional examinations during the same outage. The additional examinations shall include all remaining welds, areas, or parts of similar material and service subject to the same type of flaws or relevant conditions.

IWC-2430, "Additional Examinations," requires that any indications revealed that exceed the acceptance standards of Table IWC-3410-1 shall be extended to include additional examinations during the same outage. The additional examinations shall include an additional number of welds, areas, or parts equal to 20% of the number of welds, areas, or parts that are scheduled to be performed during the interval. If the additional examinations detect further indications exceeding the allowable standards of IWC-3410-1, the remaining number of welds, areas, or parts of similar material and service subject to the same type of flaws or relevant conditions shall be examined.

III. BASIS FOR ALTERNATIVE

This relief is requested pursuant to 10CFR50.55a, "Codes and standards", paragraph (a)(3)(i). The proposed alternative of utilizing the examination methodology and selection criteria of Electric Power Research Institute (EPRI) TR-112657, Rev. B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," along with evaluation and sample expansion requirement enhancements identified in ASME Code Case N-578-1, "Risk Informed Requirements for Class 1, 2, and 3 Piping, Method B," will provide an acceptable level of quality and safety.

RELIEF REQUEST No. RR-21
Revision 0, continued

In a letter from W. H. Bateman (USNRC) to G. L. Vine (EPRI), dated October 28, 1999, "Safety Evaluation Report Related to EPRI Risk-Informed Inservice Inspection Evaluation Procedure," the NRC stated that the topical report was acceptable for referencing in licensing applications.

In lieu of the evaluation and sample expansion requirements of EPRI TR-112657, Revision B-A, Section 3.6.6.2, "RI-ISI Selected Examinations," Three Mile Island, Unit 1 will utilize the requirements of Subarticle-2430, "Additional Examinations," which is contained in Code Case N-578-1. The alternative criteria for additional examinations contained in Code Case N-578-1 provides more guidance for examination method and categorization for parts to be examined.

IV. ALTERNATE PROVISIONS

TMI, Unit 1 proposes to utilize the proposed alternative described in Enclosure 2 to this submittal, "Risk Informed Inservice Inspection Program Summary, Three Mile Island, Unit 1."

V. IMPLEMENTATION SCHEDULE

Three Mile Island, Unit 1 will integrate the RISI Program into the ISI Program during the Third Ten-Year Interval for Three Mile Island, Unit 1, and it shall remain in effect until the completion of the interval for Three Mile Island, Unit 1, which is projected to end in 2011. At that time, the Three Mile Island, Unit 1 ISI Program will require updating for the Fourth Inservice Inspection Interval.

Enclosure 2

EXECUTIVE SUMMARY

Risk Informed Inservice Inspection Program Plan

Three Mile Island Nuclear Station
Unit 1

EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

1. INTRODUCTION

The objective of this submittal is to request the use of a risk-informed inservice inspection (RISI) program for Class 1 and Class 2 piping that is currently inspected as part of the ASME Section XI based ISI program, as an alternative to the 1995 Edition with the 96 Addenda of the ASME Section XI requirements for the remainder of the third inspection interval. The risk-informed process used in this submittal is described in EPRI RISI Topical Report (Reference 1). To strengthen the technical basis for this RISI program beyond the minimum requirements implied by the EPRI RISI Topical Report, a number of enhancements were made to the process that are described in the paragraphs below.

AmerGen plans to incorporate the RISI inspection program during the first period of the third inspection interval for Three Mile Island Nuclear Station Unit 1 (TMI-1). The third 10-year interval began on April 20, 2001 and is projected to end April 19, 2011.

As a risk-informed application, this submittal meets the intent and principles of Regulatory Guides 1.174 and 1.178 as well as those set forth in the EPRI RISI Topical Report and the NRC staff SER on the EPRI RISI method.

PRA Quality

The TMI PRA model used for the risk determinations for this regulatory application is an update to the "Individual Plant Examination (IPE)," submitted to the NRC by letter dated May 20, 1993. The IPE had been accepted by the NRC in a letter dated December 19, 1996. The NRC letter noted that the IPE submittal met the intent of Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities – 10 CFR 50.54(f)."

The TMI PRA (Reference 2) used in this analysis represents an update of that study. The TMI PRA addresses internal events at full power, and it includes internal flooding. For the Level 2 analysis (i.e., the containment analysis), a full Level 2 model with release categories covering various magnitudes and timing of the releases was employed. Large Early Release Frequency (LERF) was calculated from the Level 2 model.

Both the TMI PRA model and its supporting bases documentation were reviewed by a B&W OG Peer Review/Certification team in 2000. The review was conducted using a team of industry PRA experts, including an INPO reviewer. This independent review was performed to evaluate the quality of the PRA and completeness of the PRA documentation.

The PRA certification process assesses a PRA in eleven functional elements. Each element is graded on a scale of 1 to 4. A grade 2 indicates that risk significance determinations made by the PRA are adequate to support risk ranking applications. A grade of 4 indicates that the PRA "is usable as a primary basis for developing licensing positions", however, it is expected that few PRAs would currently have many elements eligible for this grade. The TMI 2000 Certification Team found that the scope of the PRA supports, at a minimum, PRA Applications through Grade 2 with contingencies. The Grade 2 contingencies were identified in three elements:

Maintenance and Update (MU), Containment Performance (L2) and Thermal Hydraulic Analysis (TH).

With respect to the Maintenance and Update (MU) element, the only contingency was to develop a formally documented Maintenance and Update procedure. This contingency has been addressed, since the Certification, by the adoption of the standard Exelon procedure, Full Power Internal Events PRA Model Update, at the TMI site. Currently, the TMI PRA is being updated in accordance with the steps of this procedure.

With respect to the Containment Performance (L2) element, four actions were identified: 1) complete work in validating key assumptions related to LERF, 2) review NUREG-1150 and plant-specific MAAP analyses to support LERF evaluation, 3) review fission product scrubbing analyses, and 4) improve overall documentation. Documentation is being addressed in accordance with the Exelon procedure, Risk Management Documentation, as part of the current update of the PRA. The remaining 3 items were immediately addressed by an effort to review and revise key Level 2 PRA modeling. This effort resulted in a reduction in the total LERF results. The noted revisions have been incorporated into the model used for this submittal.

Finally, the recommendation was made to provide better traceability between thermal-hydraulic analyses and success criteria as part of the Thermal Hydraulic (TH) element. The focus of the recommendation was on traceability and lack of references and not correctness. In fact, the review of the Accident Sequence Evaluation (AS) element notes that the success criteria are "consistent with reviewer expectations." To provide improved traceability, thermal hydraulic references, including new MAAP analyses, are being added to the PRA documentation as part of the current PRA update.

Exelon maintains and updates each of its PRA models to be representative of the respective as-built, as-operated plant. The previously described Maintenance and Update Procedure formalizes the PRA update process. The procedure defines the process for regular and interim updates for issues identified as potentially affecting the PRA. This process assures the present PRA reflects the current plant configuration and plant procedures.

Based on the results of past NRC Staff reviews and the B&W OG Certification Peer Review, Exelon is confident that the level of detail and quality of the TMI PRA fully supports this risk-informed regulatory application.

2. PROPOSED ALTERNATIVE TO CURRENT ISI PROGRAM REQUIREMENTS

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 these Class 1 and Class 2 piping components via Non Destructive Examination (NDE) methods.

2.2 Alternate RISI Program

The alternative RISI program for piping is described in EPRI RISI Topical Report. The RISI program will be substituted for the 1995 Edition with the 96 Addenda of ASME Section XI Code

Edition, examination program for Class 1 Category B-F, B-J welds and Class 2 Category C-F-1 and C-F-2 welds in accordance with 10 CFR 50.55a(a)(3)(i) by alternatively providing an acceptable level of quality and safety. Other portions of the ASME Section XI Code outside of this scope will be unaffected. The EPRI Topical Report provides the requirements for defining the relationship between the risk-informed examination program and the remaining unaffected portions of ASME Section XI.

2.3 Augmented Programs

As discussed in Section 6 of the EPRI Topical Report, certain augmented inspection programs may be integrated into the RISI program. Per Table 6-2 of the EPRI Topical Report, the issues raised by NRC Bulletins 88-08 and 88-11 and Information Notice 93-20 are all addressed by the evaluation of thermal fatigue that is part of the degradation assessment for RISI. These augmented programs are therefore subsumed in the RISI program. The following augmented programs were not subsumed into the RISI program and remain unaffected:

- Stagnant Borated Water Systems (IE Bulletin 79-17)
- Service Water Integrity Program (G.L. 89-13)
- Flow Accelerated Corrosion (FAC) (G.L. 89-08)
- High Energy Line Breaks (USNRC Branch Technical Position MEB 3-1)

Elements in the scope of this evaluation that were also covered by these augmented programs were included in the consequence assessment, degradation assessment, and risk categorization evaluations, to determine whether the affected piping was subject to damage mechanisms other than those addressed by the augmented program. If no other damage mechanism was identified, the element was removed from the RISI element selection population and retained in the appropriate augmented inspection program. In the Main Feedwater System, many of the elements covered by the FAC program were also assessed for the potential for other damage mechanisms that are evaluated as part of the EPRI RISI methodology.

2.4 Multiple Damage Mechanisms

The vast majority of pipe elements that were evaluated in the RISI evaluation were found to be susceptible to none of the damage mechanisms addressed in the EPRI RISI methodology. A number of elements were found to be susceptible to one specific damage mechanism, and a relatively small number were identified to be subject to the potential for two or more damage mechanisms. Specific examples are welds in the Main Feedwater System that are subject to both FAC and thermal fatigue, as well as welds in the Reactor Coolant and Safety Injection systems that have the potential for both stress corrosion cracking and thermal fatigue. If one of the damage mechanisms was FAC, the element was assigned to the High failure potential category to be consistent with the EPRI Topical Report. If that assignment led to the decision to select that element for inspection in accordance with the 25% sampling requirement, it was retained in the FAC program for inspection for FAC as well as inspected for the remaining damage mechanism as part of the RISI program. The potential for synergy between two or more damage mechanisms working on the same location was considered in the estimation of pipe failure rates and rupture frequencies which was reflected in the risk impact assessment.

3. RISK-INFORMED ISI PROCESS

The process used to develop the RISI program is consistent with the methodology described in the EPRI Topical Report for ASME Code Case N-578-1 applications. However, for the socket welds selected in the RISI, the examination method (VT-2) and examination frequency (each refueling outage) defined in Code Case N-578-1, Table 1 will be used. The process involves the following steps:

- Definition of RISI Program Scope
- Consequence Analysis
- Degradation Mechanism Assessment
- Risk Categorization
- Inspection Location Selection and NDE Selection
- Program Relief Requests
- Risk Impact Assessment
- Implementation and Monitoring Program

3.1 Definition of RISI Program Scope

The systems to be included in the RISI program are provided in Table 1. This scope covers ASME Class 1 and 2 piping systems within the scope of the existing ASME Section XI inspection program. The as-built and as-operated isometric and piping and instrumentation diagrams and additional plant information were used to define the system boundaries. The RISI evaluation system boundaries were defined using the system boundaries established in the existing plant ISI program.

3.2 Consequence Analysis

The consequences of pressure boundary failures were evaluated and ranked based on their impact on conditional core damage probability (CCDP) and conditional large early release probability (CLERP). The impact on these measures due to both direct and indirect effects was determined using the PRA model described in Section 1. Consequence categories (High, Medium or Low) were assigned according to Table 3-1 of the EPRI RISI Topical Report. One of the enhancements that was incorporated into this application of the EPRI RISI methodology was the direct use of the PRA models to support the estimation of CCDP and CLERP values for each pipe element in the scope of the RISI evaluation, in lieu of the consequence tables in the EPRI Topical Report. This step was taken to reduce some of the conservatisms inherent in the consequence tables and to support a more complete and realistic quantification of the risk impacts of the RISI program in comparison with previous applications of this methodology. Another motivation was to increase consistency with other risk informed applications at TMI-1 that directly utilize the plant-specific PRA models.

3.3 Degradation Mechanism Assessment

Failure potential was assessed using the deterministic criteria in the EPRI Topical Report to evaluate the potential for each damage mechanism that an ISI exam could identify, and be supported by industry failure history, plant-specific failure history, and other relevant information.

These failure estimates were determined using the guidance provided in the EPRI Topical Report.

Table 2 summarizes the degradation mechanism assessment by system for each damage mechanism that was identified as a potential failure cause. In addition, failure rates and rupture frequencies were assessed for each piping element within the scope of the RISI evaluation using information in Reference 4.

3.4 Risk Categorization

In the preceding steps, each element within the scope of the RISI program was evaluated to determine the consequences of its failure, as measured by CCDP and CLERP. Each element was also evaluated to determine its potential for pipe rupture based on the potential for degradation mechanisms that were identified. The results of the consequence assessment were then combined with the results of the degradation assessment, using the risk matrix shown in Figure 1. This provides a risk ranking and risk category for each element.

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

Figure 1
EPRI RISI Matrix for Risk Ranking of Pipe Segments (Reference 1)

The results of this evaluation in terms of the number of elements in each of the EPRI RISI risk categories per system are summarized in Table 3.

3.5 Inspection Location Selection and NDE Selection

In general, an ASME Code Case N-578-1 application of RISI, per the EPRI RISI Topical Report, requires that 25% of the elements that are categorized as "High" risk (Risk Category 1, 2, or 3) and 10% of the elements that are categorized as "Medium" risk (Risk Categories 4 and 5) be selected for inspection and appropriate non-destructive examination (NDE). Inspection locations are generally selected on a system-by-system basis, so that each system with "High" risk category elements will have approximately 25% of the system's "High" risk elements selected for inspection and similarly 10% of the elements in systems having "Medium" risk category welds will be selected. During the selection process, an attempt is made to ensure that all damage mechanisms and all combinations of damage mechanisms are represented in the elements selected for inspection. An element ranking process was used to incorporate several factors into the selection of specific elements to satisfy the above sampling percentages. These factors include whether the element has been previously selected for ISI exams, whether previous exams had indications of possible damage, presence of radiation fields in the vicinity of the elements, accessibility of the element for inspection, and numerical estimates of the pipe rupture frequencies at these locations. The results of the selection are presented in Table 4. Section 4 of the EPRI Topical Report and ASME Code Case N-578-1 (Reference 5) were used as guidance in determining the examination requirements for these locations with Code Case N-578-1 used to clarify the examination method and examination frequency for selected socket welds. From the Class 1 butt welded elements that were considered within the scope of the RISI evaluation at TMI-1, a total of 11.5% were selected for volumetric examination as part of the risk informed inspection program. As noted above, elements found to be susceptible to two or more damage mechanisms were given enhanced treatment by retaining them within the scope of the augmented program and in the risk informed program for the applicable damage mechanisms.

In addition, all in-scope piping components, regardless of risk classification, will continue to receive Code-required pressure and leak testing, as part of the current ASME Section XI program. VT-2 visual examinations are scheduled in accordance with the station's pressure and leak test program, which remains unaffected by the RISI program.

<u>Additional Examinations</u>

Examinations performed that reveal flaws or relevant conditions exceeding the applicable acceptance standards shall be extended to include additional examinations. The additional examinations shall include piping structural elements with the same postulated failure mode and the same or higher failure potential.

(1) The number of additional elements shall be the number of piping structural elements with the same postulated failure mode originally scheduled for that fuel cycle.

(2) The scope of the additional examinations may be limited to those high safety significant piping structural elements (i.e., Risk Group Categories 1 through 5) within systems, whose material and service conditions are determined by an evaluation to have the same postulated failure mode as the piping structural element that contained the original flaw or relevant condition.

If the additional required examinations reveal flaws or relevant conditions exceeding the referenced acceptance standards, the examination shall be further extended to include additional examinations.

(1) These examinations shall include all remaining piping elements whose postulated failure modes are the same as the piping structural elements originally examined.

(2) An evaluation shall be performed to establish when those examinations are to be conducted. The evaluation must consider failure mode and potential.

No additional examinations will be performed if there are no additional elements identified as being susceptible to the same root cause conditions.

For the inspection period following the period in which the original examination discovering the flaw or relevant condition was completed, the examinations shall be performed as originally scheduled.

3.6 Program Relief Requests

As required by Section 6.4 of EPRI TR-112657, Exelon has completed an evaluation of existing relief requests to determine if any should be withdrawn or modified due to changes that occur from implementing the RISI Program.

Relief Request No. RR-00-01, requesting approval to perform alternatives to Category B-F and B-J surface examinations of piping and nozzle to safe-end welds located inside the reactor vessel primary shield wall is withdrawn. RR-00-01 required ultrasonic examination of the full weld volume and adjacent ½ inch base metal on each side of the weld from the ID. The RISI program provides improved examination methods based on the expected degradation mechanism at the particular examination location. The methods, volumes, and areas to be used during examination will be implemented as required by the RISI Program.

For clarification, Relief Request No. RR-00-13, requesting approval to use alternative requirements to ASME Section XI examination percentage distributions across the inspection interval is now applicable to RISI Examination Category R-A piping elements. RR-00-13 provides alternatives to Section XI Table IWB-2412-1. The RISI Program references the same table for examination distributions. The approved alternatives to Table IWB-2412-1 in RR-00-13 still apply with the implementation of the RISI Program.

In instances where a location may be found at the time of the examination that does not meet the >90% coverage requirement, the process outlined in the EPRI Topical Report will be followed. If an examination with less than 90% coverage is to be credited, a new relief request will be generated to document the achieved coverage.

3.7 Risk Impact Assessment

The RISI program has been conducted in accordance with Regulatory Guide 1.174 and the EPRI methodology requirements consistent with Regulatory Guide 1.178, which were intended to result in a risk decrease, a risk neutral condition, or at most, a very small increase in risk as measured by changes in CDF and LERF.

The risk impact assessment performed in this RISI application included a comprehensive qualitative evaluation as well as a comprehensive quantitative evaluation of the changes in CDF due to changes in the ISI program for each piping segment in the scope of the RISI evaluation and changes in LERF for each system within the RISI scope. This is another enhancement that was made that goes well beyond the limited quantitative analyses that are needed to implement the method described in the EPRI Topical Report.

Individual elements were evaluated for consequence and degradation mechanism and then assigned to a risk category and risk ranking as part of the risk characterization step. The elements were then grouped by system and the changes in risk for each element were summed to provide the change in risk for the system due to increases and decreases in the number of exams and for the potential for increases in the NDE probability of detection where the "inspection for cause" principle was applied.

Per Section 3.7.2 of EPRI TR-112657, the Markov piping reliability analysis method was used to estimate the change in risk due to adding and removing locations from the inspection program. The actual CCDP and CLERP values calculated for each element in the consequence assessment was used in the risk impact calculation. Realistic quantitative estimates of failure frequencies, rupture frequencies, and risk impacts were performed for all elements within the scope of the RISI evaluation, in lieu of the qualitative analysis and bounding risk estimates that are permitted under most circumstances in the EPRI RISI Topical Report.

The changes to the ASME Section XI ISI program include changing the number and location of inspections within the risk segment, and in many cases improving the effectiveness of the inspection to account for the results of the RISI degradation mechanism assessment. For example, for locations subject to thermal fatigue, examinations are to be conducted on an expanded volume and are to be focused to enhance the probability of detection (POD) during the inspection process. For other damage mechanisms, this "inspection for cause" principle is also expected to favorably impact the POD.

Limits are imposed by the EPRI methodology (TR-112657) to ensure that the change in risk of implementing the RISI program meets the requirements of Regulatory Guides 1.174 and 1.178. The criteria established require that the cumulative increase in CDF and LERF be less than $1x10^{-7}$ and $1x10^{-8}$ per year per system, respectively. Meeting these limits is consistent with meeting Regulatory Guide 1.174 risk significant thresholds of $1x10^{-6}$ per year and $1x10^{-7}$ per year for changes in CDF and LERF, respectively, for a full plant scope RISI application.

The technical basis for the Markov model input parameters that were used in this evaluation are documented in the Tier 2 documentation (Reference 3). These parameters include a set of failure rates and rupture frequencies for piping systems in PWR plants subject to several degradation mechanisms that were identified for these systems as part of the degradation mechanism assessment. The failure rates and rupture frequencies that were used in this evaluation are from Reference 4.

Separate Markov calculations were performed for the change in CDF and the change in LERF. These calculations were performed so that pipe elements whose failure could create a potential containment failure or bypass concern were factored into the LERF evaluation. Unlike previous applications of the EPRI methodology, realistic estimates of CDF and LERF contributions and changes in CDF and LERF due to all changes in the RISI program were quantified for all pipe elements, in addition to a qualitative evaluation that is part of the EPRI procedure.

The results of the risk impact assessment for each system at TMI-1 are summarized in Table 6 and key aspects are plotted in Figures 2 and 3 for comparison against the risk significant criteria established in the EPRI RISI Topical Report. As seen in these figures and table, most of the systems exhibited small increases in CDF and LERF but these increases are much smaller than the risk acceptance criteria by a large margin except for RCS which is only slightly less than the acceptance criteria.

As a sensitivity case, an evaluation was performed assuming that all NDE exams were removed from the ISI program, indicating that the EPRI RISI risk significance thresholds still would not be exceeded for the sum of all systems although the MU system would exceed the individual system acceptance criteria.

As indicated above, the risk impact evaluation has demonstrated that no significant risk impacts will occur from implementation of the RISI program for the entire scope of Class 1 and 2 piping that was included in this evaluation. This satisfies the risk significance criteria of Regulatory Guide 1.174 and the EPRI RISI Topical Report.

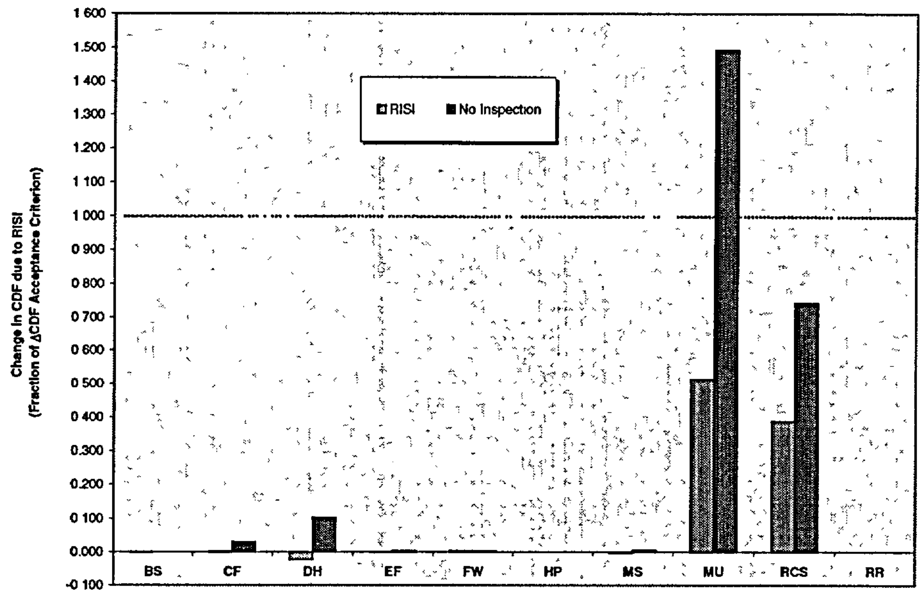

Figure 2
Change in Pipe Rupture CDF for TMI-1 Systems

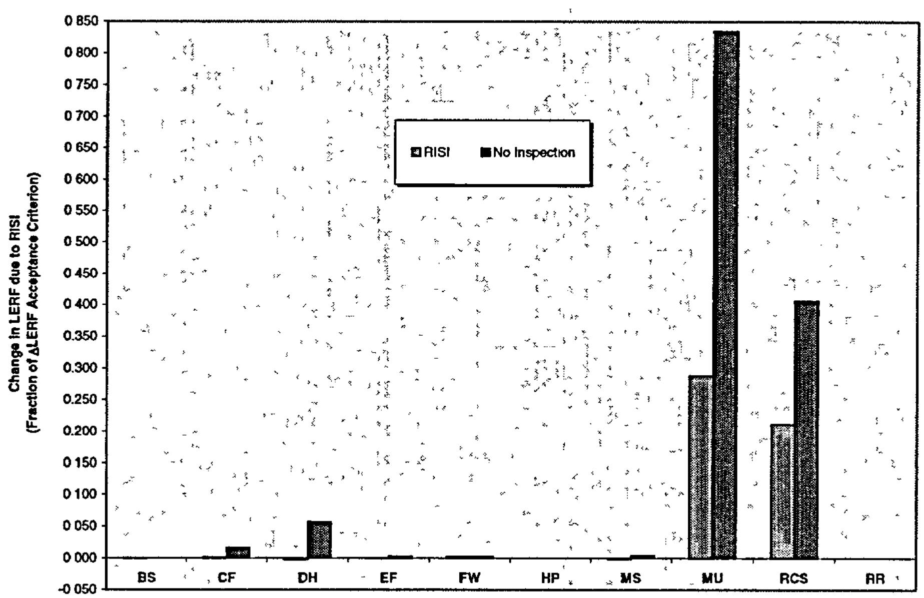

Figure 3
Change in Pipe Rupture LERF for TMI-1 Systems

Defense-In-Depth

The intent of the inspections mandated by ASME Section XI for piping welds is to identify conditions such as flaws or indications that may be precursors to leaks or ruptures in a system's pressure boundary. Currently, the process for picking inspection locations is based upon structural discontinuity and stress analysis results. As depicted in ASME White Paper 92-01-01 Rev. 1, "Evaluation of Inservice Inspection Requirements for Class 1, Category B-J Pressure Retaining Welds," this method has been ineffective in identifying leaks or failures. EPRI TR-112657 and ASME Code Case N-578-1 provide a more robust selection process founded on actual service experience with nuclear plant piping failure data.

This process has two key independent ingredients: (1) a determination of each location's susceptibility to degradation and (2) an independent assessment of the consequence of the piping failure. These two ingredients assure defense-in-depth is maintained. First, by evaluating a location's susceptibility to degradation, the likelihood of finding flaws or indications that may be precursors to leak or ruptures is increased. Secondly, the consequence assessment effort has a single failure criterion. As such, no matter how unlikely a failure scenario is, it is ranked High in the consequence assessment, and no lower than Medium in the risk assessment (i.e., Risk Category 4), if, as a result of the failure, there is no mitigative equipment available to respond to the event. In addition, the consequence assessment takes into account equipment reliability, with less credit given to less reliable equipment.

All locations within the reactor coolant pressure boundary will continue to receive a system pressure test and visual VT-2 examination as currently required by the Code regardless of its risk classification.

4. IMPLEMENTATION AND MONITORING PROGRAM

Upon approval of the RISI program, procedures that comply with the guidelines described in EPRI RISI Topical Report will be prepared to implement and monitor the program. The new program will be integrated into the first inspection period of the third inservice inspection interval for TMI-1. No changes to the Updated Final Safety Analysis Report are necessary for program implementation.

The applicable aspects of the ASME Code not affected by this change are to 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 are to be retained and modified to address the RISI process, as appropriate.

The RISI program is a living program requiring feedback of new relevant information to ensure the appropriate identification of high safety significant piping locations. Such relevant information would include major updates to the TMI-1 PRA model which could impact both the risk characterization and risk impact assessments, any new trends in service experience with piping systems at TMI-1 and across the industry, and new information on element accessibility that will be obtained as the risk informed inspections are implemented. The risk ranking of piping segments will be reviewed and adjusted on an ASME ISI "period" basis. This review will be documented internally, and the results need not be submitted to the NRC on the "period" frequency. We also understand that the RI-ISI program is a living program and its implementation will require feedback of new, relevant information to ensure the appropriate identification of safety significant piping locations. More frequent adjustment of the piping segment risk ranking may also be required as directed by future NRC bulletin or generic letter requirements, or by industry and plant-specific feedback.

5. PROPOSED ISI PROGRAM PLAN CHANGE

A comparison between the RISI program and 1995 Edition with the 96 Addenda of the ASME Section XI Code Edition program requirements for in-scope piping is provided in Table 4. The number of exams at TMI-1 is reduced from 356 Section XI program exams to 197 RISI program exams, a net reduction of 159 exams (45% reduction in number of exams); 11 of these 159 exams were eliminated from the FAC augmented program welds. The numbers of exams added to and removed from the ISI program in the High and Medium risk categories of the EPRI RISI risk ranking process serve to explain the qualitative nature of the risk impact assessment for each system as described in the previous tables and figures.

6. REFERENCES

1. EPRI, “Revised Risk-Informed Inservice Inspection Evaluation Procedure,” TR-112657, Rev. B-A, December 1999.
2. TMI Nuclear Station 2000 PRA Model TMIL2RV2, August 2000.
3. AmerGen Risk Informed Inservice inspection Evaluation, Three Mile Island Unit 1 – Final Report.
4. T.J. Mikschl and K.N. Fleming, “Piping System Failure Rates and Rupture Frequencies for Use in Risk informed Inservice Inspection Applications,” EPRI TR-111880, 1999, September 1999. *EPRI Licensed Material*
5. ASME Code Case N-578-1, “Risk-Informed Requirements for Class 1, 2, and 3 Piping, Method B, Section XI, Division 1,” approved by the ASME Main Committee, February 2000.

Table 1
System Selection for TMI-1

System Description	
(BS)	Reactor Building Spray
(CF)	Core Flood
(DH)	Decay Heat Removal
(EF)	Emergency Feedwater
(FW)	Main Feedwater
(HP)	Hydrogen Purge Discharge
(MS)	Main Steam
(MU)	Makeup & Purification
(RC, RV, PR)	Reactor Coolant
(RR)	Reactor Building Emergency Cooling Water

NOTE: This table shows the systems that contain welds that are Class 1 or Class 2 category B-J, B-F, C-F-1, C-F-2.

Table 2
Failure Potential Assessment Summary

System	Thermal Fatigue		Stress Corrosion Cracking				Localized Corrosion			Flow Sensitive	
	TASCS	TT	IGSCC	TGSCC	ECSCC	PWSCC	MIC	PIT	CC	E-C	FAC
BS											
CF											
DH						X				X	
EF											
FW											X
HP											
MS		X									X
MU	X	X									
RC[(1)]	X	X				X			X		
RR											

TASCS – thermal stratification, cycling and stripping, TT – thermal transients, IGSCC – intergranular stress corrosion cracking, TGSCC – transgranular stress corrosion cracking, ECSCC – external chloride stress corrosion cracking, PWSCC – primary water stress corrosion cracking, MIC – microbiologically influenced corrosion, PIT – pitting, CC – crevice corrosion, E-C – erosion-cavitation, FAC – flow accelerated corrosion

NOTE: This table shows the assessed failure mechanisms for each system. The RISI Program addresses the cumulative impact of all mechanism that were identified in each system.

(1) Includes systems RV and PR.

Table 3
Number of Elements (Welds) by Risk Category

	High Risk			Medium Risk		Low Risk	TOTAL
System	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6 or 7	All Categories
BS				111		2	113
CF				24			24
DH		5		125	5	262	397
EF				72		69	141
FW	86		4				90
HP						10	10
MS	60			146			206
MU		114		656	9	201	980
RC[1]		35		215			250
RR						223	223
TOTAL	146	154	4	1349	14	767	2434

NOTE: This table shows the results of the Risk Categorization. The risk categories are defined in Figure 3-4 of EPRI TR-112657 (Reference 1).

(1) Includes systems RV and PR.

Table 4
Number of Inspections by Risk Category

System	High Risk						Medium Risk				Low Risk		TOTAL	
	Category 1		Category 2		Category 3		Category 4		Category 5		Category 6 or 7		All Categories	
	Sec. XI	EPRI	Sec. XI	EPRI	Sec. XI	EPRI	Sec. XI	EPRI	Sec. XI	EPRI	Sec. XI	EPRI	Sec. XI	EPRI
BS							7	12				0	7	12
CF							6	3				0	6	3
DH			1	2			8	13	0	1	25	0	34	16
EF							8	8			4	0	12	8
FW	10	0			1	0						0	11	0
HP												0	0	0
MS	5	15					12	15				0	17	30
MU			35	29			118	66	1	1	31	0	185	96
RC(1)			15	10			54	22				0	69	32
RR											15	0	15	0
TOTAL	15	15	51	41	1	0	213	139	1	2	75	0	356	197

NOTE: This table provides a comparison of the RISI element selection to the original ASME Section XI program. The total number of inspections is significantly lower for the RISI program. Some RISI inspection locations are new when compared to the Section XI program, i.e., they were previously not addressed.

(1) Includes systems RCP, RPV, and PZR.

Table 5
Mean Failure Rates, Conditional Rupture Probabilities, and Rupture Frequencies Used in TMI-1 Risk Impact Assessment

Damage Mechanism	Parameter*	System						
		RC	DH, CF	BS	MU, HP	RR(1)	FW, EF	MS
Thermal Fatigue (TF)	λ_f	4.98E-05	3.86E-06	1.67E-06	6.53E-05	6.25E-05	4.16E-05	5.12E-06
	P⟨R|F⟩	5.56E-02	5.56E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02
	ρ_F	2.84E-06	2.09E-07	5.89E-08	2.32E-06	2.20E-06	1.47E-06	1.80E-07
Stress Corrosion Cracking (SC)	λ_f	1.88E-04	7.57E-04	4.20E-04	1.84E-04	2.88E-05	4.07E-05	9.64E-07
	P⟨R|F⟩	1.89E-02	1.89E-02	1.15E-02	1.15E-02	1.15E-02	1.15E-02	1.15E-02
	ρ_F	3.55E-06	1.43E-05	4.84E-06	2.12E-06	3.31E-07	4.71E-07	1.09E-08
Erosion-Cavitation (E-C)	λ_f	1.47E-05	1.23E-05	4.17E-06	8.26E-06	3.08E-05	1.95E-05	1.28E-06
	P⟨R|F⟩	5.56E-02	5.56E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02	3.53E-02
	ρ_F	8.11E-07	7.29E-07	1.47E-07	2.90E-07	1.08E-06	6.89E-07	4.49E-08
Design Construction Defects (DC)	λ_f	8.16E-06	6.53E-06	1.36E-07	2.87E-06	1.78E-06	6.89E-07	8.16E-07
	P⟨R|F⟩	4.76E-02	4.76E-02	1.95E-01	1.95E-01	1.95E-01	1.95E-01	1.95E-01
	ρ_F	3.86E-07	3.09E-07	2.60E-08	5.60E-07	3.48E-07	1.34E-07	1.59E-07
Basis for Estimates		Reference 4						

* Failure rates, λ_F, and rupture frequencies, ρ_F, given in units of events/weld-year, conditional rupture probabilities, P⟨R|F⟩, are dimensionless

(1) Includes systems RV and PR.

Table 6
Impact of RISI and No Inspections on CDF and LERF due to Pipe Ruptures for TMI-1 Systems

System	System CDF Events/Reactor-Year			ΔCDF Events/Reactor-Year			ΔLERF Events/Reactor-Year		
	Section XI	EPRI	No Inspection	EPRI	No Inspection	Acceptance Criterion	EPRI	No Inspection	Acceptance Criterion
BS	5.56E-10	5.42E-10	5.77E-10	-1.47E-11	2.05E-11	<1.0E-07	-1.14E-12	1.25E-12	<1.0E-08
CF	1.80E-08	1.83E-08	2.10E-08	2.09E-10	2.95E-09	<1.0E-07	1.57E-11	1.65E-10	<1.0E-08
DH	1.94E-07	1.91E-07	2.04E-07	-2.27E-09	1.03E-08	<1.0E-07	-2.30E-11	5.72E-10	<1.0E-08
EF	6.15E-09	6.12E-09	6.54E-09	-3.00E-11	3.94E-10	<1.0E-07	-2.25E-12	2.80E-11	<1.0E-08
FW	7.44E-09	7.79E-09	7.79E-09	3.56E-10	3.56E-10	<1.0E-07	2.47E-11	2.47E-11	<1.0E-08
HP	1.00E-14	1.00E-14	1.00E-14	1.00E-14	1.00E-14	<1.0E-07	1.00E-14	1.00E-14	<1.0E-08
MS	1.40E-08	1.38E-08	1.46E-08	-1.71E-10	6.39E-10	<1.0E-07	-9.90E-12	4.41E-11	<1.0E-08
MU	7.32E-07	7.83E-07	8.81E-07	5.13E-08	1.49E-07	<1.0E-07	2.88E-09	8.35E-09	<1.0E-08
RC(1)	4.03E-07	4.42E-07	4.77E-07	3.87E-08	7.41E-08	<1.0E-07	2.13E-09	4.06E-09	<1.0E-08
RR	2.05E-12	2.14E-12	2.14E-12	9.04E-14	9.04E-14	<1.0E-07	4.72E-15	4.72E-15	<1.0E-08
Total	1.37E-06	1.46E-06	1.61E-06	8.81E-08	2.38E-07	<1.0E-06	5.01E-09	1.32E-08	<1.0E-07

(1) Includes systems RV and PR.

Enclosure 3

Relief Request No. RR-13

AmerGen Energy Company
Three Mile Island Unit 1
Third 10-Year Interval
Request for Relief RR-00-13

COMPONENT IDENTIFICATION

Code Class:	Class 1, Class 2, and Class 3
Reference:	ASME, Section XI; 1995 Edition, 1996 Addenda; Tables IWB-2412-1, IWC-2412-1, IWD-2412-1, and IWF-2410-2
Examination Categories:	Not Applicable
Item Numbers:	Not Applicable
Description:	Alternative requirements to examination percentage completion.
Component Numbers:	Class 1, Class 2, and Class 3 components and supports and and Risk-Informed Inservice Inspection.

CODE REQUIREMENTS

ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1995 Edition with 1996 Addenda, Tables IWB-2412-1, IWC-2412-1, IWD-2412-1, and IWF-2410-2 list the required percentages that must be performed per inspection period in accordance with Inspection Program B. Per these tables, the number of examinations to be completed during the first period shall be between 16% and 34%. For the second period, the total number of examinations to be completed shall be between 50% and 67%, and by the end of the third period, 100% of the examinations for the interval shall be completed.

CODE REQUIREMENTS FROM WHICH AN ALTERNATIVE IS REQUESTED

An alternative is requested from the Code requirements for examination percentage completion identified in Tables IWB-2412-1, IWC-2412-1, IWD-2412-1, and IWF-2410-2. Class 1 and 2 piping elements included in the risk-informed section of the Three Mile Island ISI Program are identified in this request for alternative since the examinations of Examination Category R-A components are required to be completed in accordance with percentage requirements of ASME Section XI Table IWB-2412-1.

AmerGen Energy Company
Three Mile Island Unit I
Third 10-Year Interval
Request for Relief RR-00-13 (Cont.)

BASIS FOR ALTERNATIVE

Pursuant to 10 CFR 50.55a(a)(3)(i), an alternative is requested on the basis that the proposed alternative would provide an acceptable level of quality and safety.

The inspection program percentage tables of ASME Code Section XI were originally established such that approximately one-third of the non-deferred component examinations would be performed each period. The emergence of longer plant operating fuel cycles coincident with efforts to reduce the length of refueling outages have limited the amount of time available to perform examinations. These factors make it difficult to plan and complete the Code required percentages of examinations in allotted critical path time.

The alternative provision was developed to address these issues. Expansion of the range for examination completion percentages shown in Table 1 allows component examinations to be more evenly distributed between outages. In addition, this expansion minimizes the need to schedule excessive numbers of examinations during a specific outage, and allows for a more uniform distribution between outages that is more conducive to performing quality examinations. Repetitive costs associated with inspections, such as the erecting and disassembly of scaffolding, labor costs associated with acquiring inspectors each outage, can be minimized through balancing the inspection percentages.

Two additional factors were considered when evaluation the impact of the percentage requirements of Table 1 on plant safety. The first was that the existing examination percentage tables of Section XI allow up to 50% of the examinations to be performed in the second and third periods, but only 34% can be performed in the first period. Therefore, the Section XI Inspection Plan B schedules are biased towards delaying examinations until the end of the interval. The more flexible percentages required by Table 1 allows for more examinations to be performed earlier in the interval. This should improve safety because any degradation, should it exist, would be detected earlier in the interval.

The second factor that was considered was that some minimum amount of examinations should be required in each period. To address this consideration, Note 1, is included in the table, so the examinations will be required during all three inspection periods.

AmerGen Energy Company
Three Mile Island Unit I
Third 10-Year Interval
Request for Relief RR-00-13 (Cont.)

Based on the factors identified above, AmerGen considers that the alternative provisions provide an acceptable level of quality and safety.

PROPOSED ALTERNATIVE PROVISIONS

As an alternative to the Code requirements for the determination of examination percentage completion identified in Section XI Tables IWB-2412-1, IWC-2412-1, IWD-2412-1 and IWF-2410-2, AmerGen proposes the use of the examination percentages identified in Table 1 below.

Table 1

Inspection Interval	Inspection Period, Calendar Years of Plant Service Within the Interval	Minimum Examinations Completed, %	Maximum Examinations Credited, %
3rd	3	16	50
	7	50[1]	75
	10	100	100

NOTE:
(1) If the first period completion percentages for any examination category exceeds 34%, at least 16% of the required examinations shall be performed in the second period.

PERIOD FOR WHICH ALTERNATIVE IS REQUESTED

An alternative is requested for the third ten-year inspection interval of the Inservice Inspection Program for TMI Unit 1.