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DAEC Plant Support Center
Operated by Nuclear Management Company, LLC

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10 CFR Part 50
Section 50.55a

Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
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Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License No: DPR-49
Alternative to the ASME Boiler and Pressure Vessel Code Section XI Requirements for Class 1 and 2 Piping Welds Risk Informed Inservice Inspection Program

References:
1. Electric Power Research Institute (EPRI) Topical Report (TR) 112657 Revision B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure"
2. W. H. Bateman (NRC) to G. L. Vine (EPRI) letter dated October 28, 1999, transmitting "Safety Evaluation Report Related to EPRI Risk-Informed Inservice Inspection Evaluation Procedure (EPRI TR-112657, Revision B, July 1999)"

File: A-100, A-286

In accordance with the requirements of 10 CFR Part 50, Section 50.55a(a)(3)(i), Nuclear Management Company, LLC (NMC) hereby submits for NRC review and approval a proposed Risk Informed Inservice Inspection (RI-ISI) Program for the Duane Arnold Energy Center (DAEC). This RI-ISI Program is being submitted as an alternative to existing ASME Boiler and Pressure Vessel Code, Section XI requirements for the selection and examination of Class 1 and 2 piping welds. The implementation of the RI-ISI program will result in a reduction in piping weld examinations, with an associated reduction in occupational radiation exposure and little or no change in risk to the public due to piping failure.

The DAEC RI-ISI Program (Attachment 1) was developed in accordance with Electric Power Research Institute (EPRI) Topical Report TR-112657, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," Revision B-A (Reference 1) using the Nuclear Energy Institute (NEI) template methodology. Attachment 2 provides Alternative Request Number NDE-R043. The NRC acceptance of the EPRI TR-112657 report is discussed in Reference 2.

As discussed in the attached Program, the methodology for assessing thermal stratification, cycling and striping potential used in the DAEC RI-ISI submittal is the same as the methodology described in the EPRI letter to the NRC dated March 28, 2001.

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The Staff has previously approved several RI-ISI Programs based on methodology contained in EPRI Topical Report TR-112657, Revision B-A, including the RI-ISI Programs for Brunswick, Units 1 and 2 (Letter dated November 28, 2001, R. Correia, NRC, to J. Keenan, Carolina Power & Light Company, TAC NOS. MB1760 and MB1761).

The DAEC is currently in the second inspection period of the third ISI interval. NMC plans to implement the DAEC RI-ISI Program during the second period to support inspection activities during the next refueling outage (RFO) 18. In order to support planning activities associated with RFO 18, NMC requests NRC approval of the proposed alternative by October 1, 2002.

Please contact this office should you require additional information regarding this matter.

Sincerely,

Gary Van Middlesworth
Site Vice President

Attachment 1: Risk-Informed Inservice Inspection Program Plan for the DAEC
Attachment 2: Alternative Request Number: NDE-R043

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Attachment 1 to
NG-02-0259

RISK-INFORMED INSERVICE INSPECTION PROGRAM PLAN FOR THE DAEC

RISK-INFORMED INSERVICE INSPECTION PROGRAM PLAN

DUANE ARNOLD ENERGY CENTER - REVISION 0

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1. INTRODUCTION

The Duane Arnold Energy Center (DAEC) is currently in the third inservice inspection (ISI) interval as defined by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Section XI Code for Inspection Program B. DAEC plans to implement a risk-informed inservice inspection (RI-ISI) program in the middle of the second inspection period. Pursuant to 10 CFR 50.55a(g)(4)(ii), the applicable ASME Section XI Code for the third interval at DAEC is the 1989 Addition, no Addenda.

The objective of this submittal is to request the use of a risk-informed process for the inservice inspection of Class 1 and 2 piping. The RI-ISI process used in this submittal is described in Electric Power Research Institute (EPRI) Topical Report (TR) 112657 Rev. B-A "Revised Risk-Informed Inservice Inspection Evaluation Procedure." The RI-ISI application was also conducted in a manner consistent with ASME Code Case N-578 "Risk-Informed Requirements for Class 1, 2, and 3 Piping, Method B."

1.1 Relation to NRC Regulatory Guides 1.174 and 1.178

As a risk-informed application, this submittal meets the intent and principles of Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis" and Regulatory Guide 1.178, "An Approach for Plant-Specific Risk-Informed Decisionmaking Inservice Inspection of Piping". Further information is provided in Section 3.6.2 relative to defense-in-depth.

1.2 PSA Quality

The DAEC Level 1 and Level 2 Probabilistic Safety Assessment (PSA) was employed to evaluate the consequences of pipe ruptures in the risk-informed ISI assessment. The value used for base PSA Core Damage Frequency (CDF) is 1.2E-5 events per year and the value used for base PSA Large Early Release Frequency (LERF) is 9.0E-7 events per year. The original Individual Plant Examination (IPE) result was a CDF of 7.8E-6 that was reported to the NRC in 1992.

The NRC review of the DAEC IPE was issued in 1996. The Staff's Evaluation concluded the following regarding the DAEC IPE:

- The IPE is complete with respect to the information requested in Generic Letter 88-20 and associated Supplement 1;
- The IPE analytical approach is technically sound and capable of identifying plant-specific vulnerabilities;
- DAEC employed a viable means to verify that the IPE models reflect the current plant design and operation at the time of submittal to the NRC;
- The IPE had been peer-reviewed;
- DAEC participated in the IPE process;

- The IPE specifically evaluated the DAEC decay heat removal functions for vulnerabilities;

There were no areas of improvement to the PSA model that were identified by the NRC in their review of the plant's IPE submittal.

The internal events PSA used for the RI-ISI evaluation is based on a more current version of the PSA than the version used for the IPE. The PSA model has been through five major revisions since the submittal of the original IPE, and is currently on revision 4B.

In 1997, a BWR Owner's Group (BWROG) PSA Peer Certification Review was performed on the Revision 3B update of the PSA model. The overall conclusion was positive and said that the DAEC PSA can be effectively used to support applications involving relative risk significance. The "Facts and Observations" for DAEC have been evaluated, and are being addressed by the DAEC PSA Program. No substantial changes to the RI-ISI consequence conclusions are anticipated due to planned PSA model revisions to address these "Facts and Observations".

2. PROPOSED ALTERNATIVE TO CURRENT ISI PROGRAM REQUIREMENTS

2.1 ASME Section XI

ASME Section XI Examination Categories B-F, B-J, C-F-1 and C-F-2 currently contain the requirements for the nondestructive examination (NDE) of Class 1 and 2 piping components. The alternative RI-ISI program for piping is described in EPRI TR-112657. The RI-ISI program will be substituted for the current program for Class 1 and 2 piping (Examination Categories B-F, B-J, C-F-1 and C-F-2) in accordance with 10 CFR 50.55a(a)(3)(i) by alternatively providing an acceptable level of quality and safety. Other non-related portions of the ASME Section XI Code will be unaffected. EPRI TR-112657 provides the requirements for defining the relationship between the RI-ISI program and the remaining unaffected portions of ASME Section XI.

2.2 Augmented Programs

The following augmented inspection programs were considered during the RI-ISI application:

- The augmented inspection program for flow accelerated corrosion (FAC) per Generic Letter 89-08 is relied upon to manage this damage mechanism but is not otherwise affected or changed by the RI-ISI program.

- In April of 2001, DAEC incorporated the guidance contained in BWR Vessel and Internals Project Report No. BWRVIP-75. BWRVIP-75 provides alternative criteria to NRC Generic Letter 88-01 for the examination of welds subject to intergranular stress corrosion cracking (IGSCC). Both Generic Letter 88-01 and BWRVIP-75 specify examination extent and frequency requirements for austenitic stainless steel welds that are classified as Categories "A" through "G", depending on their susceptibility to IGSCC. In accordance with EPRI TR-112657, piping welds identified as Category "A" are considered resistant to IGSCC, and as such, are assigned a low failure potential provided no other damage mechanisms are present. The existing augmented inspection program for the other piping welds subject to IGSCC at the DAEC (e.g., Categories "B" through "G") remains unaffected by the RI-ISI submittal.

- The original DAEC design requirements for pipe breaks outside containment were based on the December 1972 Giambusso letter. Later under Environmental Qualification rule 10CFR50.49, high energy line break conditions were extended to several plant areas. In 1987, the NRC issued Generic Letter 87-11 which allows utilities to eliminate the consideration of the environmental and dynamic effects of arbitrary intermediate pipe breaks provided that the requirements of Branch Technical Position MEB 3-1, Revision 2 of the Standard Review Plan (NUREG-0800) were met. In 1992, in order to resolve some environmental qualification concerns, DAEC adopted the requirements of Generic Letter 87-11 to eliminate the postulation of arbitrary intermediate pipe breaks for high pressure coolant injection steam piping, reactor core isolation cooling steam piping, and reactor water clean-up return piping. This resulted in 10 additional Class 1 welds requiring examination outside the ASME Section XI or Generic Letter 88-01 (BWRVIP-75) Programs. This program is not affected or changed by the RI-ISI Program.

- The augmented inspection program for feedwater nozzle cracking per NUREG-0619 is implemented under the DAEC Updated Final Safety Analysis Report, Paragraph 5.2.4.2, and GENE-523-A71-0594, "Alternative BWR Feedwater Nozzle Inspection Requirements" as approved by the NRC Safety Evaluation dated 06/05/98. In addition to the nozzle examinations required by NUREG-0619, DAEC performs ultrasonic examinations on the nozzle-to-safe end and safe end-to-pipe welds on the feedwater and control rod drive return lines. This program is not affected orchanged by the RI-ISI Program.

3. RISK-INFORMED ISI PROCESS

The process used to develop the RI-ISI program conformed to the methodology described in EPRI TR-112657 and consisted of the following steps:

- Scope Definition
- Consequence Evaluation
- Failure Potential Assessment
- Risk Characterization
- Element and NDE Selection
- Risk Impact Assessment
- Implementation Program
- Feedback Loop

A deviation to the EPRI RI-ISI methodology has been implemented in the failure potential assessment for DAEC. Table 3-16 of EPRI TR-112657 contains criteria for assessing the potential for thermal stratification, cycling and striping (TASCS). Key attributes for horizontal or slightly sloped piping greater than 1" nominal pipe size (NPS) include:

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

AND

$\Delta T > 50°F$,

AND

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

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

➢ **Turbulent penetration TASCS**

Turbulent penetration typically occurs in lines connected to piping containing hot flowing fluid. In the case of downward sloping lines that then turn horizontal, significant top-to-bottom cyclic ΔTs can develop in the horizontal sections if the horizontal section is less than about 25 pipe diameters from the reactor coolant piping. Therefore, TASCS is considered for this configuration.

For upward sloping branch lines connected to the hot fluid source that turn horizontal or in horizontal branch lines, natural convective effects combined with effects of turbulence penetration will keep the line filled with hot water. If there is no potential for in-leakage towards the hot fluid source from the outboard end of the line, this will result in a well-mixed fluid condition where significant top-to-bottom ΔTs will not occur. Therefore TASCS is not considered for these configurations. Even in fairly long lines, where some heat loss from the outside of the piping will tend to occur and some fluid stratification may be present, there is no significant potential for cycling as has been observed for the in-leakage case. The effect of TASCS will not be significant underthese conditions and can be neglected.

- **Low flow TASCS**

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

- **Valve leakage TASCS**

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

- **Convection heating TASCS**

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

In summary, these additional considerations for determining the potential for thermal fatigue as a result of the effects of TASCS provide an allowance for the consideration of cycle severity in assessing the potential for TASCS effects. The above criteria has previously been submitted by EPRI for generic approval (Letter dated March 28, 2001, P.J. O'Regan (EPRI) to Dr. B. Sheron (USNRC), "Extension of Risk-Informed Inservice Inspection Methodology").

3.1 Scope of Program

The systems included in the RI-ISI program are provided in Table 3.1. The piping and instrumentation diagrams and additional plant information including the existing plant ISI program, were used to define the Class 1 and 2 piping system boundaries.

3.2 Consequence Evaluation

The consequence(s) of pressure boundary failures were evaluated and ranked based on their impact on core damage and containment performance (i.e., isolation, bypass and large early release). The impact on these measures due to both direct and indirect effects was considered using the guidance provided in EPRI TR-112657.

3.3 Failure Potential Assessment

Failure potential estimates were generated utilizing industry failure history, plant specific failure history, and other relevant information. These failure estimates were determined using the guidance provided in EPRI TR-112657, with the exception of the previously stated deviation.

Table 3.3 summarizes the failure potential assessment by system foreach degradation mechanism that was identified as potentially operative.

3.4 Risk Characterization

In the preceding steps, each run of piping within the scope of the program was evaluated to determine its impact on core damage and containment performance (i.e., isolation, bypass and large, early release) as well as its potential for failure. Given the results of these steps, piping segments are then defined as continuous runs of piping potentially susceptible to the same type(s) of degradation and whose failure will result in similar consequence(s). Segments are then ranked based upon their risk significance as defined in EPRI TR-112657.

The results of these calculations are presented in Table 3.4.

3.5 Element and NDE Selection

In general, EPRI TR-112657 requires that 25% of the locations in the high risk region and 10% of the locations in the medium risk region be selected for inspection using appropriate NDE methods tailored to the applicable degradation mechanism. In addition, per Section 3.6.4.2 of EPRI TR-112657, if the percentage of Class 1 piping locations selected for examination falls substantially below 10%, then the basis for selection needs to be investigated. For DAEC, the percentage of Class 1 welds initially selected per the RI-ISI process was 8.5% (57 of 669 welds). Although 8.5 % is not a significant departure from 10%, DAEC decided to add ten examination selections to increase the overall percentage of Class 1 selections to 10.0% (67 of 669 welds).

One additional factor that was considered during the evaluation was that the overall percentage of Class 1 selections included both socket and non-socket welds. Therefore, the final percentage of Class 1 selections was 10.0% when both socket and non-socket piping welds were considered. This percentage increases to 11.7% (65 of 557 welds) when considering only those piping welds that are non-socket welded. It should be noted that non-socket welds are subject to volumetric examination, so this percentage does not rely upon welds that are solely subject to a VT-2 visual examination.

In addition, as stated in TR-112657, the existing FAC augmented inspection program provides the means to effectively manage this mechanism. No additional credit was taken for any FAC augmented inspection program locations beyond those selected by the RI-ISI process to meet the sampling percentage requirements.

A brief summary is provided in the following table, and the results of the selection are presented in Table 3.5. Section 4 of EPRI TR-112657 was used as guidance in determining the examination requirements for these locations.

Unit	Class 1 Piping Welds[1]		Class 2 Piping Welds[2]		All Piping Welds[3]	
	Total	Selected	Total	Selected	Total	Selected
1	669	67[4]	908	3	1577	70

Notes

1. Includes all Category B-F and B-J locations.
2. Includes all Category C-F-1 and C-F-2 locations.
3. All in-scope piping components, regardless of risk classification, will continue to receive Code required pressure testing, as part of the current ASME Section XI program. VT-2 visual examinations are scheduled in accordance with the station's pressure test program that remains unaffected by the RI-ISI program.
4. The initial RI-ISI application yielded 57 weld selections in Class 1 piping. 10 welds were subsequently added to the initial selections to address the Class 1 selection percentage criteria described in Section 3.6.4.2 of EPRI TR-112657.

3.5.1 Additional Examinations

The RI-ISI program in all cases will determine through an engineering evaluation the root cause of any unacceptable flaw or relevant condition found during examination. The evaluation will include the applicable service conditions and degradation mechanisms to establish that the element(s) will still perform their intended safety function during subsequent operation. Elements not meeting this requirement will be repaired or replaced.

The evaluation will include whether other elements in the segment or additional segments are subject to the same root cause conditions. Additional examinations will be performed on those elements with the same root cause conditions or degradation mechanisms. The additional examinations will include high risk significant elements and medium risk significant elements, if needed, up to a number equivalent to the number of elements required to be inspected on the segment or segments during the current outage. If unacceptable flaws or relevant conditions are again found similar to the initial problem, the remaining elements identified as susceptible will be examined. No additional examinations will be performed if there are no additional elements identified as being susceptible to the same root cause conditions.

3.5.2 Program Relief Requests

An attempt has been made to select RI-ISI locations for examination such that a minimum of >90% coverage (i.e., Code Case N-460 criteria) is attainable. However, some limitations will not be known until the examination is performed, since some locations may be examined for the first time by the specified techniques.

In instances where locations are found at the time of the examination that do not meet the >90% coverage requirement, the process outlined in EPRI TR-112657 will be followed.

None of the existing DAEC relief requests are being withdrawn due to the RI-ISI application.

3.6 Risk Impact Assessment

The RI-ISI program has been conducted in accordance with Regulatory Guide 1.174 and the requirements of EPRI TR-112657, and the risk from implementation of this program is expected to remain neutral or decrease when compared to that estimated from current requirements.

This evaluation identified the allocation of segments into High, Medium, and Low risk regions of the EPRI TR-112657 and ASME Code Case N-578 risk ranking matrix, and then determined for each of these risk classes what inspection changes are proposed for each of the locations in each segment. The changes include changing the number and location of inspections within the segment and in many cases improving the effectiveness of the inspection to account for the findings of the RI-ISI degradation mechanism assessment. For example, for locations subject to thermal fatigue, examinations will be conducted on an expanded volume and will be focused to enhance the probability of detection (POD) during the inspection process.

3.6.1 Quantitative Analysis

Limits are imposed by the EPRI methodology to ensure that the change in risk of implementing the RI-ISI program meets the requirements of Regulatory Guides 1.174 and 1.178. The EPRI criterion requires that the cumulative change in core damage frequency (CDF) and large early release frequency (LERF) be less than 1E-07 and 1E-08 per year per system, respectively.

Duane Arnold conducted a risk impact analysis per the requirements of Section 3.7 of EPRI TR-112657. The analysis estimates the net change in risk due to the positive and negative influences of adding and removing locations from the inspection program. A risk quantification was performed using the "Simplified Risk Quantification Method" described in Section 3.7 of EPRI TR-112657. The conditional core damage probability (CCDP) and conditional large early release probability (CLERP) used for high consequence category segments were based on the highest evaluated CCDP (3E-03) and CLERP (3E-03), whereas, for medium consequence category segments, bounding estimates of CCDP (1E-04) and CLERP (1E-05) were used. The likelihood of pressure boundary failure (PBF) is determined by the presence of different degradation mechanisms and the rank is based on the relative failure probability. The basic likelihood of PBF for a piping location with no degradation mechanism present is given as x_o and is expected to have a value less than 1E-08. Piping locations identified as medium failure potential have a likelihood of $20x_o$. These PBF likelihoods are consistent with References 9 and 14 of EPRI TR-112657. In addition, the analysis was performed both with and without taking credit for enhanced inspection effectiveness due to an increased POD from application of the RI-ISI approach.

Tables 3.6-1 presents a summary of the RI-ISI program versus 1989 ASME Section XI Code Edition program requirements and identifies on a per system basis each applicable risk category. The presence of FAC and IGSCC was adjusted for in the performance of the quantitative analysis by excluding its impact on the risk ranking. However, in an effort to be as informative as possible, for those systems where FAC or IGSCC is present, Table 3.6-1 presents the information in such a manner as to depict what the resultant risk categorization is both with and without consideration of FAC or IGSCC. This is accomplished by enclosing the FAC or IGSCC damage mechanism, as well as all other resultant corresponding changes (failure potential rank, risk category and risk rank), in parenthesis. Again, this has only been done for information purposes, and has no impact on the assessment itself. The use of this approach to depict the impact of degradation mechanisms managed by augmented inspection programs on the risk categorization is consistent with that used in the delta risk assessment for the Arkansas Nuclear One, Unit 2 (ANO-2) pilot application. An example is provided below.

System	**Risk**		**Consequence Rank**	**Failure Potential**	
	Category	**Rank[(1)]**		**DMs**	**Rank**
FW	5 (3)	Medium (High)	Medium	TASCS, TT, (FAC)	Medium (High)

In this example if FAC is not considered, the failure potential rank is "medium" instead of "high" based on the TASCS and TT damage mechanisms. When a "medium" failure potential rank is combined with a "medium" consequence rank, it results in risk category 5 ("medium" risk) being assigned instead of risk category 3 ("high" risk).

In this example if FAC were considered, the failure potential rank would be "high" instead of "medium". If a "high" failure potential rank were combined with a "medium" consequence rank, it would result in risk category 3 ("high" risk) being assigned instead of risk category 5 ("medium" risk).

Note

1. The risk rank is not included in Table 3.6-1 but it is included in Table 5-2.

As indicated in the following table, this evaluation has demonstrated that unacceptable risk impacts will not occur from implementation of the RI-ISI program, and satisfies the acceptance criteria of Regulatory Guide 1.174 and EPRI TR-112657.

Risk Impact Results

System[1]	ΔRisk$_{CDF}$		ΔRisk$_{LERF}$	
	w/ POD	w/o POD	w/ POD	w/o POD
RPV	negligible	negligible	negligible	negligible
RCR	-6.65E-09	9.20E-10	-6.63E-09	9.29E-10
RWCU	negligible	negligible	negligible	negligible
RCIC	negligible	negligible	negligible	negligible
RHR	-5.10E-10	9.30E-10	-5.10E-10	9.30E-10
CS	3.45E-10	3.45E-10	3.45E-10	3.45E-10
HPCI	1.50E-11	1.50E-11	1.50E-11	1.50E-11
MS	1.20E-10	1.20E-10	1.20E-10	1.20E-10
FW	-1.58E-09	3.65E-10	-1.58E-09	3.47E-10
CRD	-1.50E-11	-1.50E-11	-1.50E-11	-1.50E-11
SLC	-1.50E-11	-1.50E-11	-1.50E-11	-1.50E-11
Total	**-8.28E-09**	**2.67E-09**	**-8.27E-09**	**2.66E-09**

Note

1. Systems are described in Table 3.1.

3.6.2 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 Code Case N-578 provide a more robust selection process founded on actual service experience with nuclear plant piping failure data.

This process has two key independent ingredients, that is, a determination of each location's susceptibility to degradation and secondly, 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 at worst 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, and less credit is given to less reliable equipment.

All locations within the Class 1 and 2 pressure boundaries 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 RI-ISI program, procedures that comply with the guidelines described in EPRI TR-112657 will be prepared to implement and monitor the program. The new program will be integrated into the third inservice inspection interval. No changes to the Technical Specifications or Updated Final Safety Analysis Report are necessary for program implementation.

The applicable aspects of the ASME Code not affected by this change will 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 will be retained and modified to address the RI-ISI process, as appropriate.

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

A. Identify

B. Characterize

C. (1) Evaluate, determine the cause and extent of the condition identified

   (2) Evaluate, develop a corrective action plan or plans

D. Decide

E. Implement

F. Monitor

G. Trend

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

5. PROPOSED ISI PROGRAM PLAN CHANGE

A comparison between the RI-ISI program and ASME Section XI Code 1989 Edition program requirements for in-scope piping is provided in Tables 5-1 and 5-2. Table 5-1 provides a summary comparison by risk region. Table 5-2 provides the same comparison information, but in a more detailed manner by risk category, similar to the format used in Table 3.6-1.

DAEC is currently in the middle of the second period in its third inspection interval. Up until this point, 38.7% of the examinations required by ASME Section XI have been completed for Examination Categories B-F, B-J, C-F-1, and C-F-2 piping welds. Beginning in the third refueling outage of the second period in the third interval, the examinations determined by the RI-ISI process will replace those formerly selected per ASME Section XI criteria. Since 38.7%

of the examinations have been completed thus far in the third interval, 61.3% of the RI-ISI examinations will be performed during the remaining refueling outages in the second and third periods so that 100% of the selected examinations are performed during the course of the interval. Subsequent ISI intervals will implement 100% of the examination locations selected per the RI-ISI program. Examinations will be dstributed between periods such that the period percentage requirements of ASME Section XI, paragraphs IWB-2412 and IWC-2412 are met.

6. REFERENCES/DOCUMENTATION

EPRI TR-112657, "Revised Risk-Informed Inservice Inspection Evaluation Procedure", Rev. B-A

ASME Code Case N-578, "Risk-Informed Requirements for Class 1, 2, and 3 Piping, Method B, Section XI, Division 1"

Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis"

Regulatory Guide 1.178, "An Approach for Plant-Specific Risk-Informed Decisionmaking Inservice Inspection of Piping"

Supporting Onsite Documentation

Structural Integrity Calculation/File No. NMC-01-330, "Degradation Mechanisms Evaluation for Class 1 and 2 Piping Welds at Duane Arnold Energy Center (DAEC)", Revision 1

Structural Integrity Calculation/File No. NMC-01-331, "Risk-Informed Inservice Inspection Consequence Evaluation of Class 1 and 2 Piping for Duane Arnold Energy Center", Revision 1

Structural Integrity Calculation/File No. NMC-01-332, "Risk Ranking Summary, Matrix and Report for the Duane Arnold Energy Center ", Revision 0

Structural Integrity Calculation/File No. NMC-01-333, "Risk Impact Analysis for the Duane Arnold Energy Center ", Revision 0

Structural Integrity File No. NMC-01-103-5, Record of Conversation No. ROC-003, "Minutes of the Element Selection Meeting for the Risk-Informed ISI Project at the Duane Arnold Energy Center ", Revision 0, dated October 11, 2001

DAEC Calculation/File No. MDL-M453-049, "DAEC Service History Review", Revision 0

Table 3.1 System Selection and Segment / Element Definition		
System Description	**Number of Segments**	**Number of Elements**
RPV – Reactor Pressure Vessel	11	31
RCR – Reactor Coolant Recirculation	56	189
RWCU – Reactor Water Clean-Up	14	54
RCIC – Reactor Core Isolation Cooling	7	41
RHR – Residual Heat Removal	53	486
CS – Core Spray	29	182
HPCI – High Pressure Coolant Injection	21	171
MS – Main Steam	48	251
FW – Feedwater	20	77
CRD – Control Rod Drive	8	62
SLC -- Standby Liquid Control	6	33
Totals	**273**	**1577**

Table 3.3

Failure Potential Assessment Summary

System[1]	Thermal Fatigue		Stress Corrosion Cracking				Localized Corrosion			Flow Sensitive	
	TASCS	TT	IGSCC	TGSCC	ECSCC	PWSCC	MIC	PIT	CC	E-C	FAC
RPV			X								
RCR	X	X	X						X		
RWCU			X								
RCIC											
RHR		X	X								
CS			X						X		
HPCI											
MS											X
FW	X	X							X		X
CRD											
SLC											

Note

1. Systems are described in Table 3.1.

Table 3.4 Number of Segments by Risk Category With and Without Impact of FAC and IGSCC														
System[1]	High Risk Region						Medium Risk Region				Low Risk Region			
	Category 1		Category 2		Category 3		Category 4		Category 5		Category 6		Category 7	
	With	Without	With	Without	With	Without	With	Without	With	Without	With	Without	With	Without
RPV									2[2]	0	9	11		
RCR			34[3]	31			0	3	13[4]	2	7	18	2	2
RWCU			1[5]	0			0	1	5[6]	0	7	12	1	1
RCIC											5	5	2	2
RHR			5[7]	4			4	5	1[8]	0	43	44		
CS			4[9]	2			4	6			21	21		
HPCI							6	6			13	13	2	2
MS					4[10]	0	4	4			40	44		
FW	14[11]	0	0	10	6[12]	0	0	4	0	3	0	3		
CRD							1	1			7	7		
SLC							1	1			5	5		
Total	14	0	44	47	10	0	20	31	21	5	157	183	7	7

Notes

1. Systems are described in Table 3.1.
2. These two segments become Category 6 after IGSCC is removed from consideration due to no other damage mechanisms being present.
3. Of these thirty-four segments, thirty-one remain Category 2 after IGSCC is removed from consideration due to the presence of other "medium" failure potential damage mechanisms, and three become Category 4 after IGSCC is removed from consideration due to no other damage mechanisms being present.
4. Of these thirteen segments, two remain Category 5 after IGSCC is removed from consideration due to the presence of another "medium" failure potential damage mechanism, and eleven become Category 6 after IGSCC is removed from consideration due to no other damage mechanisms being present.
5. This one segment becomes Category 4 after IGSCC is removed from consideration due to no other damage mechanisms being present.
6. These five segments become Category 6 after IGSCC is removed from consideration due to no other damage mechanisms being present.
7. Of these five segments, four remain Category 2 after IGSCC is removed from consideration due to the presence of another "medium" failure potential damage mechanism, and one becomes Category 4 after IGSCC is removed from consideration due to no other damage mechanisms being present.
8. This one segment becomes Category 6 after IGSCC is removed from consideration due to no other damage mechanisms being present.

Notes for Table 3.4 (cont'd)

9. Of these four segments, two remain Category 2 after IGSCC is removed from consideration due to the presence of another "medium" failure potential damage mechanism, and two become Category 4 after IGSCC is removed from consideration due to no other damage mechanisms being present.
10. These four segments become Category 6 after FAC is removed from consideration due to no other damage mechanisms being present.
11. Of these fourteen segments, ten become Category 2 after FAC is removed from consideration due to the presence of other “medium” failure potential damage mechanisms, and four become Category 4 after FAC is removed due to no other damage mechanisms being present.
12. Of these six segments, three become Category 5 after FAC is removed from consideration due to the presence of another “medium” failure potential damage mechanism, and three become Category 6 after FAC is removed due to no other damage mechanisms being present.

Table 3.5

Number of Elements Selected for Inspection by Risk Category Excluding Impact of FAC and IGSCC

System[1]	High Risk Region						Medium Risk Region				Low Risk Region			
	Category 1		Category 2		Category 3		Category 4		Category 5		Category 6		Category 7	
	Total	Selected	Total	Selected	Total	Selected	Total	Selected	Total	Selected	Total	Selected	Total	Selected
RPV											31	0		
RCR			77	20[2]			34	4+2[3]	5	1	69	0	4	0
RWCU							1	1[4]			51	0	2	0
RCIC											29	0	12	0
RHR			12	3[5]			9	2[6]			465	0		
CS			2	1[7]			22	3+5[8]			158	0		
HPCI							52	6			98	0	21	0
MS							60	6			191	0		
FW			19	5+3[9]			49	5	4	1	5	0		
CRD							2	1			60	0		
SLC							6	1			27	0		
Total			110	32			235	36	9	2	1184	0	39	0

Notes

1. Systems are described in Table 3.1.
2. These twenty welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Thermal transients were identified along with IGSCC as a potential damage mechanism for all twenty welds, while crevice corrosion was identified along with thermal transients for two of the welds. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examinations will include the requirements identified in EPRI TR-112657 for thermal transients and crevice corrosion, as applicable.
3. These six welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Four of these six welds were selected as part of the initial RI-ISI application, and the remaining two welds were selected to bring the overall percentage of Class 1 weld selections to 10%. Since IGSCC was the only potential damage mechanism identified for these six welds, the IGSCC examinations will be credited toward both programs.
4. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
5. These three welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Thermal transients were identified along with IGSCC as a potential damage mechanism for these welds. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examinations will include the requirements identified in EPRI TR-112657 for thermal transient examinations.

Notes for Table 3.5 (cont'd)

6. One of these two welds was selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
7. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Crevice corrosion was identified along with IGSCC as a potential damage mechanism for this weld. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examination will include the requirements identified in EPRI TR-112657 for crevice corrosion examinations.
8. Six of these eight welds were selected for examination by both the IGSCC Program and the RI-ISI Program. One of these six welds was selected as part of the initial RI-ISI application, and the remaining five welds were selected to bring the overall percentage of Class 1 weld selections to 10%. Since IGSCC was the only potential damage mechanism identified for these six welds, the IGSCC examinations will be credited toward both programs.
9. Five of these eight welds were selected for examination by both the NUREG-0619 Program and the RI-ISI Program. Two of these five welds were selected as part of the initial RI-ISI application, and the remaining three were selected to bring the overall percentage of Class 1 weld selections to 10%. For the two welds that were selected as part of the RI-ISI application, TASCS and crevice corrosion were identified as potential damage mechanisms. In order to be credited toward both the NUREG-0619 Program and the RI-ISI Program, the NUREG-0619 examinations will include the requirements identified in EPRI TR-112657 for TASCS and crevice corrosion examinations. For the three welds that were selected to bring the overall percentage of Class 1 selections to 10%, TASCS and crevice corrosion were identified as potential damage mechanisms. Although the NUREG-0619 examinations are included in the RI-ISI Program, they are not credited as risk-informed examinations in the risk impact analysis. As such, the NUREG-0619 examinations by themselves could be credited toward both programs. However, to ensure that all potential damage mechanisms are investigated, DAEC has elected to supplement the NUREG-0619 examinations for these three welds with the requirements identified in EPRI TR-112657 for TASCS and crevice corrosion examinations.

Table 3.6-1

Risk Impact Analysis Results

System[(1)]	Category	Consequence Rank	Failure Potential		Inspections			CDF Impact[(4)]		LERF Impact[(4)]	
			DMs	Rank	Section XI[(2)]	RI-ISI[(3)]	Delta	w/ POD	w/o POD	w/ POD	w/o POD
RPV	6a (5a)	Medium	None (IGSCC)	Low (Medium)	2	0	-2	negligible	negligible	negligible	negligible
RPV	6a	Medium	None	Low	1	0	-1	negligible	negligible	negligible	negligible
RPV Total								**negligible**	**negligible**	**negligible**	**negligible**
RCR	2 (2)	High	TT, CC, (IGSCC)	Medium (Medium)	8	2	-6	3.60E-10	1.80E-09	3.60E-10	1.80E-09
RCR	2 (2)	High	TT, (IGSCC)	Medium (Medium)	15	18	3	-7.02E-09	-9.00E-10	-7.02E-09	-9.00E-10
RCR	4 (2)	High	None (IGSCC)	Low (Medium)	2	0[(5)]	-2	3.00E-11	3.00E-11	3.00E-11	3.00E-11
RCR	5a	Medium	TASCS	Medium	0	1	1	-1.80E-11	-1.00E-11	-1.80E-12	-1.00E-12
RCR	6a (5a)	Medium	None (IGSCC)	Low (Medium)	4	0	-4	negligible	negligible	negligible	negligible
RCR	6a	Medium	None	Low	0	0	0	no change	no change	no change	no change
RCR	7a	Low	None	Low	0	0	0	no change	no change	no change	no change
RCR Total								**-6.65E-09**	**9.20E-10**	**-6.63E-09**	**9.29E-10**
RWCU	4 (2)	High	None (IGSCC)	Low (Medium)	0	0[(6)]	0	no change	no change	no change	no change
RWCU	6a (5a)	Medium	None (IGSCC)	Low (Medium)	5	0	-5	negligible	negligible	negligible	negligible
RWCU	6a	Medium	None	Low	3	0	-3	negligible	negligible	negligible	negligible
RWCU	7a	Low	None	Low	0	0	0	no change	no change	no change	no change
RWCU Total								**negligible**	**negligible**	**negligible**	**negligible**
RCIC	6a	Medium	None	Low	6	0	-6	negligible	negligible	negligible	negligible
RCIC	7a	Low	None	Low	1	0	-1	negligible	negligible	negligible	negligible
RCIC Total								**negligible**	**negligible**	**negligible**	**negligible**

Table 3.6-1

Risk Impact Analysis Results

System[1]	Category	Consequence Rank	Failure Potential		Inspections			CDF Impact[4]		LERF Impact[4]	
			DMs	Rank	Section XI[2]	RI-ISI[3]	Delta	w/ POD	w/o POD	w/ POD	w/o POD
RHR	2 (2)	High	TT, (IGSCC)	Medium (Medium)	3	1	-2	-6.66E-26	6.00E-10	-6.66E-26	6.00E-10
RHR	2	High	TT	Medium	3	2	-1	-5.40E-10	3.00E-10	-5.40E-10	3.00E-10
RHR	4 (2)	High	None (IGSCC)	Low (Medium)	1	1[7]	0	no change	no change	no change	no change
RHR	4	High	None	Low	3	1	-2	3.00E-11	3.00E-11	3.00E-11	3.00E-11
RHR	6a (5a)	Medium	None (IGSCC)	Low (Medium)	1	0	-1	negligible	negligible	negligible	negligible
RHR	6a	Medium	None	Low	37	0	-37	negligible	negligible	negligible	negligible
RHR Total								**-5.10E-10**	**9.30E-10**	**-5.10E-10**	**9.30E-10**
CS	2 (2)	High	CC, (IGSCC)	Medium (Medium)	2	1	-1	3.00E-10	3.00E-10	3.00E-10	3.00E-10
CS	4 (2)	High	None (IGSCC)	Low (Medium)	4	0[8]	-4	6.00E-11	6.00E-11	6.00E-11	6.00E-11
CS	4	High	None	Low	1	2	1	-1.50E-11	-1.50E-11	-1.50E-11	-1.50E-11
CS	6a	Medium	None	Low	13	0	-13	negligible	negligible	negligible	negligible
CS Total								**3.45E-10**	**3.45E-10**	**3.45E-10**	**3.45E-10**
HPCI	4	High	None	Low	7	6	-1	1.50E-11	1.50E-11	1.50E-11	1.50E-11
HPCI	6a	Medium	None	Low	7	0	-7	negligible	negligible	negligible	negligible
HPCI	7a	Low	None	Low	3	0	-3	negligible	negligible	negligible	negligible
HPCI Total								**1.50E-11**	**1.50E-11**	**1.50E-11**	**1.50E-11**
MS	4	High	None	Low	14	6	-8	1.20E-10	1.20E-10	1.20E-10	1.20E-10
MS	6a (3)	Medium	None (FAC)	Low (High)	0	0	0	no change	no change	no change	no change
MS	6a	Medium	None	Low	23	0	-23	negligible	negligible	negligible	negligible
MS Total								**1.20E-10**	**1.20E-10**	**1.20E-10**	**1.20E-10**

Table 3.6-1

Risk Impact Analysis Results

System[1]	Category	Consequence Rank	Failure Potential		Inspections			CDF Impact[4]		LERF Impact[4]	
			DMs	Rank	Section XI[2]	RI-ISI[3]	Delta	w/ POD	w/o POD	w/ POD	w/o POD
FW	2 (1)	High	TASCS, TT, (FAC)	Medium (High)	0	2	2	-1.08E-09	-6.00E-10	-1.08E-09	-6.00E-10
FW	2 (1)	High	TASCS, CC, (FAC)	Medium (High)	6	2	-4	-1.33E-25	1.20E-09	-1.33E-25	1.20E-09
FW	2 (1)	High	TASCS, (FAC)	Medium (High)	0	1	1	-5.40E-10	-3.00E-10	-5.40E-10	-3.00E-10
FW	4 (1)	High	None (FAC)	Low (High)	8	5	-3	4.50E-11	4.50E-11	4.50E-11	4.50E-11
FW	5a (3)	Medium	TASCS, (FAC)	Medium (High)	3	1	-2	-2.22E-27	2.00E-11	-2.22E-28	2.00E-12
FW	6a (3)	Medium	None (FAC)	Low (High)	3	0	-3	negligible	negligible	negligible	negligible
FW Total								**-1.58E-09**	**3.65E-10**	**-1.58E-09**	**3.47E-10**
CRD	4	High	None	Low	0	1	1	-1.50E-11	-1.50E-11	-1.50E-11	-1.50E-11
CRD	6a	Medium	None	Low	2	0	-2	negligible	negligible	negligible	negligible
CRD Total								**-1.50E-11**	**-1.50E-11**	**-1.50E-11**	**-1.50E-11**
SLC	4	High	None	Low	0	1	1	-1.50E-11	-1.50E-11	-1.50E-11	-1.50E-11
SLC	6a	Medium	None	Low	0	0	0	no change	no change	no change	no change
SLC Total								**-1.50E-11**	**-1.50E-11**	**-1.50E-11**	**-1.50E-11**
Grand Total								**-8.28E-09**	**2.67E-09**	**-8.27E-09**	**2.66E-09**

Notes

1. Systems are described in Table 3.1.
2. Only those ASME Section XI Code inspection locations that received a volumetric examination in addition to a surface examination are included in the count. Inspection locations previously subjected to a surface examination only were not considered in accordance with Section 3.7.1 of EPRI TR-112657.
3. Risk Category 4 (1) inspection locations selected for examination by both the FAC and RI-ISI Programs should not be included in the count since they do not represent additional examinations. This consideration was not applicable to the Duane Arnold RI-ISI application. Conversely, Risk Category 4 (2) inspection locations selected for examination by both the IGSCC Program and the RI-ISI Program should be included in both counts, but only those locations that were previously credited in the Section XI Program and are now being credited in the RI-ISI Program. This consideration was applicable to the Duane Arnold RI-ISI application. Lastly, only those inspection locations selected strictly for RI-ISI purposes are included in the count. Augmented IGSCC and NUREG-0619 inspection locations credited in Table 3.5 per Section 3.6.5 of EPRI TR-112657 were conservatively not considered. These augmented inspection locations are identified as “Other” selections in Tables 5-1 and 5-2.
4. Per Section 3.7.1 of EPRI TR-112657, the contribution of low risk categories 6 and 7 need not be considered in assessing the change in risk. Hence, the word “negligible” is given in these cases in lieu of values for CDF and LERF Impact. In those cases where no inspections were being performed previously via Section XI, and none are planned for RI-ISI purposes, “no change” is listed instead of “negligible”.
5. The four IGSCC Program and RI-ISI Program inspection locations selected for examination were not previously credited in the Section XI Program.

Notes for Table 3.6-1 (cont'd)

6. The IGSCC Program and RI-ISI Program inspection location selected for examination was not previously credited in the Section XI Program.
7. The IGSCC Program and RI-ISI Program inspection location selected for examination was previously credited in the Section XI Program.
8. The IGSCC Program and RI-ISI Program inspection location selected for examination was not previously credited in the Section XI Program.

Table 5-1

Inspection Location Selection Comparison Between 1989 ASME Section XI, No Addenda and EPRI TR-112657 by Risk Region

System[1]	Code Category	High Risk Region					Medium Risk Region					Low Risk Region				
		Weld Count	1989 Section XI		EPRI TR-112657		Weld Count	1989 Section XI		EPRI TR-112657		Weld Count	ASME Section XI		EPRI TR-112657	
			Vol/Sur	Sur Only	RI-ISI	Other[2]		Vol/Sur	Sur Only	RI-ISI	Other[2]		Vol/Sur	Sur Only	RI-ISI	Other[2]
RPV	B-F											8	2	6	0	
	B-J											23	1	1	0	
RCR	B-F	8	8	0	2[3]		2	2	0	0	2[4]					
	B-J	69	15	0	18[5]		37	0	4	5[6]		73	4	9	0	
RWCU	B-F											2	1	1	0	
	B-J						1	0	0	1[7]		51	7	5	0	
RCIC	B-J											27	7	0	0	
	C-F-2											14	0	0	0	
RHR	B-F	2	2	0	1[8]		1	1	0	1[9]						
	B-J	10	4	0	2		8	3	0	1		32	4	0	0	
	C-F-2											433	34	0	0	
CS	B-F	2	2	0	1[10]		4	4	0	0	4[11]					
	B-J						18	1	0	3[12]	1[13]	22	3	0	0	
	C-F-2											136	10	0	0	
HPCI	B-J						3	1	0	3		16	4	0	0	
	C-F-2						49	6	0	3		103	6	0	0	
MS	B-J						60	14	0	6		45	12	2	0	
	C-F-2											146	11	1	0	
FW	B-J	19	6	0	5	3[14]	53	11	0	6		5	3	0	0	

Table 5-1 (cont'd)

Inspection Location Selection Comparison Between 1989 ASME Section XI Code, No Addenda and EPRI TR-112657 by Risk Region

System[1]	Code Category	High Risk Region					Medium Risk Region					Low Risk Region				
		Weld Count	1989 Section XI		EPRI TR-112657		Weld Count	1989 Section XI		EPRI TR-112657		Weld Count	ASME Section XI		EPRI TR-112657	
			Vol/Sur	Sur Only	RI-ISI	Other[2]		Vol/Sur	Sur Only	RI-ISI	Other[2]		Vol/Sur	Sur Only	RI-ISI	Other[2]
CRD	B-F											2	0	2	0	
	B-J						2	0	2	1		31	0	5	0	
	C-F-2											27	2	0	0	
SLC	B-F											1	0	1	0	
	B-J						6	0	4	1		26	0	1	0	
Total	B-F	12	12	0	4		7	7	0	1	6	13	3	10	0	
	B-J	98	25	0	25	3	188	30	10	27	1	351	45	23	0	
	C-F-2						49	6	0	3		859	63	1	0	

Notes

1. Systems are described in Table 3.1.
2. The column labeled "Other" is used to identify augmented inspection program locations credited per Section 3.6.5 of EPRI TR-112657. The EPRI methodology allows augmented inspection program locations to be credited if the inspection locations selected strictly for RI-ISI purposes produce less than a 10% sampling of the overall Class 1 weld population. As stated in Section 3.5 of this template, DAEC added ten welds as examination selections to bring the overall percentage of Class 1 selections to 10%.
3. These two welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Thermal transients and crevice corrosion were identified along with IGSCC as potential damage mechanisms for these welds. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examinations will include the requirements identified in EPRI TR-112657 for thermal transient and crevice corrosion examinations.
4. These two welds were selected for examination by the IGSCC Program and by the RI-ISI Program to bring the overall percentage of Class 1 weld selections to 10%. Since IGSCC was the only potential damage mechanism identified for these welds, the IGSCC examinations will be credited toward both programs.
5. These eighteen welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Thermal transients were identified along with IGSCC as a potential damage mechanism for these welds. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examinations will include the requirements identified in EPRI TR-112657 for thermal transient examinations.
6. Four of these five welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for these welds, the IGSCC examinations will be credited toward both programs.
7. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.

Notes for Table 5-1 (cont'd)

8. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Thermal transients were identified along with IGSCC as a potential damage mechanism for this weld. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examination will include the requirements identified in EPRI TR-112657 for thermal transient examinations.
9. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
10. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Crevice corrosion was identified along with IGSCC as a potential damage mechanism for this weld. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examination will include the requirements identified in EPRI TR-112657 for crevice corrosion examinations.
11. These four welds were selected for examination by the IGSCC Program and by the RI-ISI Program to bring the overall percentage of Class 1 weld selections to 10%. Since IGSCC was the only potential damage mechanism identified for these welds, the IGSCC examinations will be credited toward both programs.
12. One of these three welds was selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
13. This one weld was selected for examination by the IGSCC Program and by the RI-ISI Program to bring the overall percentage of Class 1 weld selections to 10%. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
14. These three welds were selected for examination by the NUREG-0619 Program and by the RI-ISI Program to bring the overall percentage of Class 1 weld selections to 10%. For these welds, TASCS and crevice corrosion were identified as potential damage mechanisms. Although the NUREG-0619 examinations are included in the RI-ISI Program, they are not credited as risk-informed examinations in the risk impact analysis. As such, the NUREG-0619 examinations by themselves could be credited toward both programs. However, to ensure that all potential damage mechanisms are investigated, DAEC has elected to supplement the NUREG-0619 examinations for these three welds with the requirements identified in EPRI TR-112657 for TASCS and crevice corrosion examinations.

Table 5-2 Inspection Location Selection Comparison Between 1989 ASME Section XI Code, No Addenda and EPRI TR-112657 by Risk Category											
System[1]	**Risk**		**Consequence Rank**	**Failure Potential**		**Code Category**	**Weld Count**	**ASME Section XI**		**EPRI TR-112657**	
	Category	**Rank**		**DMs**	**Rank**			**Vol/Sur**	**Sur Only**	**RI-ISI**	**Other[2]**
RPV	6 (5)	Low (Medium)	Medium	None (IGSCC)	Low (Medium)	B-F	2	2	0	0	
						B-J	2	0	0	0	
RPV	6	Low	Medium	None	Low	B-F	6	0	6	0	
						B-J	21	1	1	0	
RCR	2 (2)	High (High)	High	TT, CC, (IGSCC)	Medium (Medium)	B-F	8	8	0	2[3]	
RCR	2 (2)	High (High)	High	TT, (IGSCC)	Medium (Medium)	B-J	69	15	0	18[4]	
RCR	4 (2)	Medium (High)	High	None (IGSCC)	Low (Medium)	B-F	2	2	0	0	2[5]
						B-J	32	0	0	4[6]	
RCR	5	Medium	Medium	TASCS	Medium	B-J	5	0	4	1	
RCR	6 (5)	Low (Medium)	Medium	None (IGSCC)	Low (Medium)	B-J	26	4	0	0	
RCR	6	Low	Medium	None	Low	B-J	43	0	9	0	
RCR	7	Low	Low	None	Low	B-J	4	0	0	0	
RWCU	4 (2)	Medium (High)	High	None (IGSCC)	Low (Medium)	B-J	1	0	0	1[7]	
RWCU	6 (5)	Low (Medium)	Medium	None (IGSCC)	Low (Medium)	B-F	1	1	0	0	
						B-J	22	4	0	0	
RWCU	6	Low	Medium	None	Low	B-F	1	0	1	0	
						B-J	27	3	3	0	
RWCU	7	Low	Low	None	Low	B-J	2	0	2	0	
RCIC	6	Low	Medium	None	Low	B-J	22	6	0	0	
						C-F-2	7	0	0	0	
RCIC	7	Low	Low	None	Low	B-J	5	1	0	0	
						C-F-2	7	0	0	0	

Table 5-2 (cont'd)
Inspection Location Selection Comparison Between 1989 ASME Section XI Code, No Addenda and EPRI TR-112657 by Risk Category

System[1]	Risk		Consequence Rank	Failure Potential		Code Category	Weld Count	ASME Section XI		EPRI TR-112657	
	Category	Rank		DMs	Rank			Vol/Sur	Sur Only	RI-ISI	Other[2]
RHR	2 (2)	High (High)	High	TT, (IGSCC)	Medium (Medium)	B-F	2	2	0	1[8]	
						B-J	2	1	0	0	
RHR	2	High	High	TT	Medium	B-J	8	3	0	2	
RHR	4 (2)	Medium (High)	High	None (IGSCC)	Low (Medium)	B-F	1	1	0	1[9]	
						B-J	1	0	0	0	
RHR	4	Medium	High	None	Low	B-J	7	3	0	1	
RHR	6 (5)	Low (Medium)	Medium	None (IGSCC)	Low (Medium)	B-J	1	1	0	0	
RHR	6	Low	Medium	None	Low	B-J	31	3	0	0	
						C-F-2	433	34	0	0	
CS	2 (2)	High (High)	High	CC, (IGSCC)	Medium (Medium)	B-F	2	2	0	1[10]	
CS	4 (2)	Medium (High)	High	None (IGSCC)	Low (Medium)	B-F	4	4	0	0	4[11]
						B-J	2	0	0	1[12]	1[13]
CS	4	Medium	High	None	Low	B-J	16	1	0	2	
CS	6	Low	Medium	None	Low	B-J	22	3	0	0	
						C-F-2	136	10	0	0	
HPCI	4	Medium	High	None	Low	B-J	3	1	0	3	
						C-F-2	49	6	0	3	
HPCI	6	Low	Medium	None	Low	B-J	7	2	0	0	
						C-F-2	91	5	0	0	
HPCI	7	Low	Low	None	Low	B-J	9	2	0	0	
						C-F-2	12	1	0	0	

Table 5-2 (cont'd)
Inspection Location Selection Comparison Between 1989 ASME Section XI Code, No Addenda and EPRI TR-112657 by Risk Category

System[1]	Risk		Consequence Rank	Failure Potential		Code Category	Weld Count	ASME Section XI		EPRI TR-112657	
	Category	Rank		DMs	Rank			Vol/Sur	Sur Only	RI-ISI	Other[2]
MS	4	Medium	High	None	Low	B-J	60	14	0	6	
MS	6 (3)	Low (High)	Medium	None (FAC)	Low (High)	B-J	7	0	2	0	
MS	6	Low	Medium	None	Low	B-J	38	12	0	0	
						C-F-2	146	11	1	0	
FW	2 (1)	High (High)	High	TASCS, TT, (FAC)	Medium (High)	B-J	8	0	0	2	
FW	2 (1)	High (High)	High	TASCS, CC, (FAC)	Medium (High)	B-J	8	6	0	2	3[14]
FW	2 (1)	High (High)	High	TASCS, (FAC)	Medium (High)	B-J	3	0	0	1	
FW	4 (1)	Medium (High)	High	None (FAC)	Low (High)	B-J	49	8	0	5	
FW	5 (3)	Medium (High)	Medium	TASCS, (FAC)	Medium (High)	B-J	4	3	0	1	
FW	6 (3)	Low (High)	Medium	None (FAC)	Low (High)	B-J	5	3	0	0	
CRD	4	Medium	High	None	Low	B-J	2	0	2	1	
CRD	6	Low	Medium	None	Low	B-F	2	0	2	0	
						B-J	31	0	5	0	
						C-F-2	27	2	0	0	
SLC	4	Medium	High	None	Low	B-J	6	0	4	1	
SLC	6	Low	Medium	None	Low	B-F	1	0	1	0	
						B-J	26	0	1	0	

Notes

1. Systems are described in Table 3.1.
2. The column labeled "Other" is used to identify augmented inspection program locations credited per Section 3.6.5 of EPRI TR-112657. The EPRI methodology allows augmented inspection program locations to be credited if the inspection locations selected strictly for RI-ISI purposes produce less than a 10% sampling of the overall Class 1 weld population. As stated in Section 3.5 of this template, DAEC added ten welds as examination selections to bring the overall percentage of Class 1 selections to 10%.
3. These two welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Thermal transients and crevice corrosion were identified along with IGSCC as potential damage mechanisms for these welds. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examinations will include the requirements identified in EPRI TR-112657 for thermal transient and crevice corrosion examinations.

Notes for Table 5-2 (cont'd)

4. These eighteen welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Thermal transients were identified along with IGSCC as a potential damage mechanism for these welds. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examinations will include the requirements identified in EPRI TR-112657 for thermal transient examinations.
5. These two welds were selected for examination by the IGSCC Program and by the RI-ISI Program to bring the overall percentage of Class 1 weld selections to 10%. Since IGSCC was the only potential damage mechanism identified for these welds, the IGSCC examinations will be credited toward both programs.
6. These four welds were selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for these welds, the IGSCC examinations will be credited toward both programs.
7. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
8. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Thermal transients were identified along with IGSCC as a potential damage mechanism for this weld. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examination will include the requirements identified in EPRI TR-112657 for thermal transient examinations.
9. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
10. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Crevice corrosion was identified along with IGSCC as a potential damage mechanism for this weld. In order to be credited toward both the IGSCC Program and the RI-ISI Program, the IGSCC examination will include the requirements identified in EPRI TR-112657 for crevice corrosion examinations.
11. These four welds were selected for examination by the IGSCC Program and by the RI-ISI Program to bring the overall percentage of Class 1 weld selections to 10%. Since IGSCC was the only potential damage mechanism identified for these welds, the IGSCC examinations will be credited toward both programs.
12. This one weld was selected for examination by both the IGSCC Program and the RI-ISI Program. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
13. This one weld was selected for examination by the IGSCC Program and by the RI-ISI Program to bring the overall percentage of Class 1 weld selections to 10%. Since IGSCC was the only potential damage mechanism identified for this weld, the IGSCC examination will be credited toward both programs.
14. These three welds were selected for examination by the NUREG-0619 Program and by the RI-ISI Program to bring the overall percentage of Class 1 weld selections to 10%. For these welds, TASCS and crevice corrosion were identified as potential damage mechanisms. Although the NUREG-0619 examinations are included in the RI-ISI Program, they are not credited as risk-informed examinations in the risk impact analysis. As such, the NUREG-0619 examinations by themselves could be credited toward both programs. However, to ensure that all potential damage mechanisms are investigated, DAEC has elected to supplement the NUREG-0619 examinations for these three welds with the requirements identified in EPRI TR-112657 for TASCS and crevice corrosion examinations.

ALTERNATIVE REQUEST NUMBER: NDE-R043

COMPONENT IDENTIFICATION

Code Classes:	1 and 2
References:	Table IWB-2500-1 ASME Section XI Code Case N-578
Examination Categories:	B-F, B-J, C-F-2
Item Numbers:	B5.10, B5.20, B5.130, B5.140, B9.11, B9.21, B9.31, B9.32, B9.40, C5.51, and C5.81.
Description:	All pressure retaining welds
Component Numbers:	See attached "Risked-Informed Inservice Inspection Plan, Duane Arnold Energy Center - Revision 0"

CODE REQUIREMENT

Section XI (1989 Edition), IWB-2500 (a) states, "Components shall be examined and tested as specified in Table IWB-2500-1. The method of examination for the components and parts of the pressure retaining boundaries shall comply with those tabulated in Table IWB-2500-1 except where alternate examination methods are used that meet the requirements of IWA-2240."

Table IWB-2500-1, Categories B-F and B-J requires 100% and 25% respectively of the total number of non-exempt welds.

Section XI (1989 Edition), IWC-2500 (a) states, "Components shall be examined and pressure tested as specified in Table IWC-2500-1. The method of examination for the components and parts of the pressure retaining boundaries shall comply with those tabulated in Table IWC-2500-1, except where alternate examination methods are used that meet the requirements of IWA-2240."

Table IWC-2500-1, Category C-F-1 does not apply to the DAEC. Category C-F-2 requires 7.5%, but not less than 28 welds to be selected for examination.

In addition, both Tables (IWB-2500-1 and IWC-2500-1) reference figures that convey the examination volume for each configuration that could be encountered.

An alternative is requested per 10CFR50.55a(a)(3)(i) to use Code Case N-578 and the EPRI Topical Report TR-112657B-A in lieu of the requirements for selection and examination of piping welds in Class 1 and 2 systems.

BASIS FOR ALTERNATIVE

The scope for ASME Section XI inservice inspection (ISI) programs is largely based on deterministic results contained in design stress reports. These reports are normally very conservative and may not be an accurate representation of failure potential. Service experience has shown that failures are due to either corrosion or fatigue and typically occur in areas not included in the plant's ISI program. Consequently, nuclear plants are devoting significant resources to inspection programs that provide minimum benefit.

As an alternative, significant industry attention has been devoted to the application of risk-informed selection criteria in order to determine the scope of inservice inspection programs at nuclear power plants. EPRI studies indicate that the application of these techniques will allow operating nuclear plants to reduce the examination scope of current ISI programs by as much as 60% to 80%, significantly reduce costs, and continue to maintain high nuclear plant safety standards.

The DAEC has reviewed the EPRI Methodology as documented in the NRC approved EPRI Topical Report TR-112657 and referenced in Code Case N-578 and believes that utilizing this methodology for the selection and subsequent examination of Class 1 and 2 piping welds will provide an acceptable level of quality and safety.

ALTERNATE EXAMINATION

As an alternative to existing Section XI requirements for piping weld selection and examination volumes, the DAEC will implement the alternative methods as specified in Code Case N-578 and EPRI TR-112657B-A.

APPLICABLE TIME PERIOD

Alternative is requested for the remainder of the third ten-year interval of the Inservice Inspection Program for DAEC, beginning with the last outage (RFO18) of the second period, as outlined in the "Risk-Informed Inservice Inspection Program Plan, Duane Arnold Energy Center - Revision 0".