OG-00-050

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

June 2, 2000

Mr. Steven Bloom
Project Manager for Westinghouse Owners Group
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Westinghouse Owners Group
Transmittal of Revised Pages for WCAP-14572, Revision 1-NP-A Addendum 1, "Addendum to Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report to Address Changes to Augmented Inspection Requirements" (Non-Proprietary) (MUHP-5200)

References:

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

2. Letter from Louis F. Liberatori, Jr., Chairman, Westinghouse Owners Group, to Mr. Steve Bloom, Project Manager for Westinghouse Owners Group, U.S. Nuclear Regulatory Commission, Westinghouse Owners Group Inclusion of Augmented Piping Inspection Programs into the WOG Risk-Informed ISI Program, October 14, 1999.

3. Letter from Louis F. Liberatori, Jr., Chairman, Westinghouse Owners Group, to Mr. Steve Bloom, Project Manager for Westinghouse Owners Group, U.S. Nuclear Regulatory Commission, Westinghouse Owners Group Inclusion of Augmented Piping Inspection Programs into the WOG Risk-Informed ISI Program - WCAP-14572, Revision 1-NP-A Addendum, December 21, 1999.

4. NRC Memorandum dated 5/3/00 To: Stuart A. Richards, From: Steven D. Bloom, Subject: Summary of March 8, 2000 Meeting with Westinghouse and Westinghouse Owners Group to Discuss Risk-Informed Inservice Inspection Addendum to WCAP-14572

5. Letter from Mr. Ronald M. Scroggins, U.S. Nuclear Regulatory Commission to Mr. Stephen D. Floyd, Nuclear Energy Institute, dated May 14, 1996.

Dear Mr. Bloom:

By letter dated December 15, 1998 from Thomas Essig, U.S. Nuclear Regulatory Commission, to Mr. Lou Liberatori, Chairman, Westinghouse Owners Group (reference 1), the NRC forwarded a Safety Evaluation Report

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(SER) finding the Westinghouse Owners Group (WOG) risk-informed inservice inspection (ISI) methodology for piping acceptable. Currently the WOG Topical Report and the NRC's Safety Evaluation state that the application of the methodology is approved as an alternative to the ASME Section XI ISI requirements and do not include changes to augmented piping inspection programs that cover some degradation mechanisms that may have been separately required by NRC. Specifically, the WCAP and SER state that the report should not be taken as a basis to change augmented piping inspection programs.

As a follow-up to our previous letter (reference 2) and based on the WOG / NRC meeting on this subject on November 23, 1999, we submitted an addendum to WCAP-14572, Revision 1-NP-A (reference 3) in December 1999. Based on comments and the eight specific questions presented at a second WOG / NRC meeting held on March 8, 2000 (reference 4), the WOG has agreed to make a number of changes to the topical report addendum. As requested by the staff, please find enclosed one (1) marked-up copy of WCAP-14572, Revision 1-NP-A Addendum 1, that clearly indicates those changes that will be incorporated into the approved version of the topical report addendum.

As part of the second meeting, the WOG was also asked to identify the current inspection history. Based on the compilation of data received from 11 WOG units which have HELB examinations, the total number of inspections performed to date exceeds 3000. These inspections have resulted in no reportable events. There have been no service-induced indications and only a small population of acceptable indications associated with manufacturing and construction.

As outlined in reference 5, the NRC waived the fees associated with the review of the initial WOG topical report, WCAP-14572. The NRC agreed that the waiver request for this document met criterion three of Footnote 4 to 10 CFR 170.21. This footnote states that fees will not be assessed for requests / reports submitted to the NRC as a means of exchanging information between industry organizations and the NRC for the purpose of supporting generic regulatory improvements or efforts. We believe the submitted addendum and its review also falls under criterion three of Footnote 4 to 10 CFR 170.21. In addition, in the December 1999 submittal letter of this addendum (reference 3, paragraph 3) we noted we believed this submittal and its review should be fall under criterion three of Footnote 4 to 10 CFR 170.21. Therefore, we request continuation of the waiver of the review fees for WCAP-14572, Revision 1-NP-A Addendum 1 under criterion three of Footnote 4 to 10 CFR 170.21.

In the near term, to support utilities that are actively applying the WOG risk-informed piping ISI methodology, we respectfully request that the NRC issue an addendum to the original SER (reference 1). Specifically, we request approval to allow augmented piping inspection programs, as defined in the revised addendum to the WOG Topical Report, to be included or subsumed into the risk-informed piping ISI methodology

Continued refinement of risk-informed piping ISI programs, such as inclusion of the various augmented programs into an integrated risk-informed piping ISI program, will enhance safety while also reducing the costs of these programs.

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Technical questions / comments should be directed to Mr. Ken Balkey, Westinghouse, at (412)-374-4633 or Ms. Nancy Closky, Westinghouse, at (412)-374-5916. Questions related to the request for continuation of the review fee waiver should be directed to me at 914-681-6262 or Mr. Andrew Drake, WOG Project Manager, at 412-374-6207.

Very truly yours,

Karl Jacobs, Chairman
Westinghouse Owners Group

enclosure

cc: (All 1L)

Dr. Brian Sheron, NRC
Mr. Jack Strosnider, NRC
Mr. Gary Holahan, NRC
Mr. Richard Wessman, NRC
Dr. Goutam Bagchi, NRC
Dr. Syed Ali, NRC
Mr. Stephen Dinsmore, NRC
Mr. Stephen Dembek, NRC
Mr. Ralph Beedle, NEI
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Mr. Alex Marion, NEI
WOG Steering Committee
WOG Materials Subcommittee
WOG Risk-Based Technology Working Group

Westinghouse Non-Proprietary Class 3

WCAP - 14572
Revision 1-NP-A
Addendum 1
Markup

Addendum to "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report" to Address Changes to Augmented Inspection Requirements

Westinghouse Electric Company LLC

Addendum to "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report" to Address Changes to Augmented Inspection Requirements

Markup

N.B. Closky

K.R. Balkey

~~December 1999~~ May 2000

Approved:______________________________
J. M. Brennan, Manager
Reliability and Risk Assessment

Work performed for the Westinghouse Owners Group under ~~MUHP-5091 and~~ MUHP-5200

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ACKNOWLEDGEMENTS

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- T. R. Satyan-Sharma (AEP)
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- Alex McNeill (Virginia Power)

1.0 INTRODUCTION

By letter dated December 15, 1998 from Thomas Essig, U.S. Nuclear Regulatory Commission, to Mr. Lou Liberatori, Chairman, Westinghouse Owners Group (NRC, 1998), the Nuclear Regulatory Commission (NRC) forwarded a Safety Evaluation Report (SER) finding the Westinghouse Owners Group (WOG) risk-informed inservice inspection (ISI) methodology for piping (WCAP-14572, Revision 1) to be acceptable. Currently, the WOG Topical Report and the NRC's Safety Evaluation state that the application of the methodology is approved as an alternative to the ASME Section XI ISI requirements and do not include changes to augmented piping inspection programs that cover some degradation mechanisms that may have been required by NRC. Specifically, the WCAP and SER state that the report should not be taken as a basis to change augmented inspection programs.

Per the transcript of the September 2, 1999 meeting of the NRC Advisory Committee on Reactor Safeguards in which the Electric Power Research Institute risk-informed ISI methodology was discussed, the NRC stated that "Basically all of the programs that are currently addressed by augmented programs will be included or subsumed into the risk-informed methodology. The only exceptions are the intergranular stress corrosion cracking (IGSCC) Category B through G welds and the flow-assisted corrosion (FAC) program. So the programs such as the thermal fatigue augmented inspection programs or the stress corrosion cracking program, localized corrosion program, programs like that have been subsumed into the risk-informed ISI program."

As stated in the NRC's SER for the WOG RI-ISI methodology (NRC, 1998), "For calculating risk rankings, augmented programs such as erosion-corrosion and stress corrosion cracking programs are credited when the augmented program is deemed adequate to detect relevant degradation mechanisms. Augmented programs are also credited in the change of risk evaluation for both ASME Section XI programs and RI-ISI programs." In effect, the WOG RI-ISI methodology already addresses the impact of augmented inspection programs.

This addendum to the WOG RI-ISI process (WCAP-14572, Revision 1-NP-A, dated February 1999) permits, as an option, the revision of selected augmented inspection regulatory requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. Thus, the augmented inspections are subsumed into the RI-ISI program. Changes to these augmented requirements would be evaluated using the appropriate regulatory change mechanisms (e.g., 10CFR50.55a, 50.59) and would be submitted by individual utilities as part of the RI-ISI example submittal (NEI, 1999).

2.0 APPLICATION SPECIFICS

The application of WCAP-14572, Revision 1-NP-A to augmented inspection program requirements is in accordance with RG-1.174 (NRC, 1998) criteria and addresses the following programs:

- Thermal fatigue, including stratification (NRC Bulletins 88-08 and 88-11 and Information Notice 93-020) (NRC, 1988 & 1993)
- Stress corrosion cracking program for PWRs and intergranular stress corrosion cracking (IGSCC) Category A for BWRs (NRC Bulletin 79-17, Generic Letter 88-01 and NUREG-0313 (NRC, 1979 & 1988)); other IGSCC categories remain unchanged
- Inspections in high energy line break (HELB) and moderate energy line break (MELB) exclusion zones
- Other NRC-mandated plant-specific augmented piping inspection programs (e.g., flow assisted corrosion) as submitted to and approved by NRC on a plant specific basis. As part of this application, the licensee's submittal would have to address why the approach is applicable to the augmented program and how the methodology was applied.

Table 1 provides additional clarification and process detail changes with respect to the specific steps in the application of the WCAP-14572, Revision 1-NP-A methodology.

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Executive Summary		*(insert on page iii after bullets)* *The RI-ISI process also permits, as an option, the revision of selected augmented inspection requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. Changes to these augmented requirements would be evaluated by individual utilities using the appropriate regulatory change mechanisms (e.g., 10CFR50.55a, 50.59.).*
Page 4, Section 1.1, Program Objectives/ Summary of Regulatory Requirements and Compliance	This report documents an alternative to the current ASME Section XI program for piping. The risk-informed ISI program will be substituted for the current examination program on piping. Additionally, the alternative program will not be limited to ASME Class 1 or Class 2 piping but will now encompass the high safety significant piping segments identified through the process regardless of ASME Class. *This report provides an alternative inspection location selection method for NDE and does not affect current Owner-defined augmented programs.*	*This report provides an alternative inspection location selection method for NDE and allows for changing the requirements of current augmented inspection programs.*
Page 13, Table 1.4-1	It provides an alternative inspection location selection method for NDE and does not affect Owner-defined augmented programs.	*It provides an alternative inspection location selection method for NDE and allows for changing the requirements of current augmented inspection programs.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 14, Table 1.4-1	The proposed change is an alternative to the ASME Section XI Code as referenced by 10CFR50.55a(a)(3).	*The proposed change is an alternative to the ASME Section XI Code as referenced by 10CFR50.55a(a)(3) and, as an option, to the current augmented inspection regulatory requirements.*
Page 51, Section 3.2, Scope Definition	A full scope program.... Consistent agreement...	*(insert between the two paragraphs)* *In addition, a decision should be made as to whether or not to include changes to augmented inspection program requirements as part of the program.*
Page 81, Section 3.5.5, Consideration of Other Piping Reliability Programs	It is important to recognize the distinction between risk-informed alternative ASME Section XI examinations and other examinations and monitoring performed under an augmented program. *The alternative inspection proposed pertains only to the ASME Section XI pipe weld examination program (Categories B-F, B-J, C-F-1, C-F-2, and applicable Class 3 and Non Class piping).* Augmented examination requirements would remain unaffected. There may be cases where the risk-informed program identifies a piping segment not currently in an augmented program which may need to be added.	*The alternative inspection pertains to the ASME Section XI pipe weld examination program (Categories B-F, B-J, C-F-1, C-F-2, and applicable Class 3 and Non Class piping) and, as an option, to augmented inspection program requirements.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 105, Section 3.6.1, Risk-Ranking	For piping segments that are included in augmented programs (such as erosion-corrosion and stress corrosion cracking programs), the SRRA failure probabilities with ISI but without leak detection are used.	*For piping segments that are included in augmented inspection programs that will remain unchanged under the risk-informed ISI program, the SRRA failure probabilities with ISI but without leak detection are used.* *For piping segments that are included in augmented inspection programs that are being changed with this application, the SRRA failure probabilities without ISI and without leak detection are used.*
Page 168, Section 3.7.1, Structural Element Selection Matrix	Region 1 discussion All susceptible locations in the segment identified by the engineering subpanel as being likely to be affected by a known or postulated failure mechanism, and that are not already in an augmented program, must be examined. Segments with failure modes that have established augmented programs (e.g., flow-accelerated corrosion, intergranular stress-corrosion cracking) would be inspected in accordance with that existing program.	*All susceptible locations in the segment identified by the engineering subpanel as being likely to be affected by a known or postulated failure mechanism must be examined. Segments with failure modes that have established augmented programs would be inspected in accordance with the risk-informed ISI program, if these augmented examinations are being subsumed into the risk-informed ISI program, or by the existing augmented program if the requirements are not being changed.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 190, Section 4, Inspection Program Requirements	Experience has shown that when an active degradation mechanism (such as IGSCC, thermal striping or flow-accelerated corrosion) is discovered, corrective actions and augmented programs are implemented to address the concern. Augmented inspection programs for these situations tend to have intervals less than 10 years. Through the RI-ISI process, situations may be identified on a plant-specific basis where an aggressive mechanism may potentially occur (e.g., back-leakage of hot water across a check valve into a piping segment containing cooler water, thereby inducing the potential for thermal striping). For these situations, the licensee may choose to either implement examinations more frequently than every 10 years (including the use of thermal monitors) or implement changes to minimize the potential for the identified phenomenon. If the licensee chooses to implement a program that will provide vital information more frequently than every 10 years, then that new information would have to be evaluated at the time that is obtained to determine if a change to the prior RI-ISI results is necessary.	*(add additional paragraph following paragraphs shown in previous column)* *The licensee can choose to subsume augmented programs by also permitting the revision of selected augmented inspection requirements, where the failure mechanism may not be as aggressive and where safety impacts can be shown to be maintained or enhanced. If this alternative is chosen, the licensee should ensure that the RI-ISI program includes a reasonable representation (balance) of augmented ISI examinations and ASME Section XI examinations. The Perdue statistical model is used to determine the minimum number of ASME Section XI exams to support a reasonable representation, where appropriate.*

Table 2-1 Additional Clarification for WCAP-14572, Revision 1-NP-A to Allow Changes to Augmented Inspection Requirements

Affected Page/Section	Current	Clarification to Address Augmented Programs
Page 213, Section 4.4.2, Risk/Safety Evaluation	For piping segments that are part of augmented programs (such as erosion-corrosion and stress corrosion cracking), the SRRA failure probabilities with ISI are used (no change from previous calculations).	*For piping segments that are included in augmented inspection programs that will remain unchanged under the risk-informed ISI program or for piping segments that will be examined under the RI-ISI program (including subsumed augmented inspections), the SRRA failure probabilities with ISI but without leak detection are used.* *For piping segments that are not included in the RI-ISI program and/or for which augmented examinations are being removed, the SRRA failure probabilities without ISI and without leak detection are used.*
Page 237, Section 5, Plant-Specific Application Process	This section provides the framework for applying the risk-informed methods to a specific plant for piping inservice inspection.	*This section provides the framework for applying the risk-informed methods to a specific plant for piping inservice inspection, including both ASME Section XI and augmented inspection program requirements.*
Page 246, Section 6.1, Report Summary and Relationship to NRC RG-1.174	This process meets the intent of the framework developed by the NRC and key steps and principles of the general regulatory guide and standard review plan (R.G.-1.174) as described in Sections 1.4 and 6.2.	*(insert new sentence at end of second paragraph)* *The process can be applied to both ASME Section XI and augmented inspection requirements.*

3.0 SPECIFIC GUIDANCE FOR HELB AND MELB AUGMENTED ISI EXAMINATION EVALUATION AS PART OF THE RISK-INFORMED ISI PROGRAM

3.1 BACKGROUND

Current design criteria for the postulation and protection of pipe breaks in high energy lines (and in some cases, moderate energy) have been developed over a period of time and the requirements vary from plant-to-plant when applied inside and outside containment. General Design Criterion 4 (GDC-4) of Appendix A to 10 CFR Part 50 provides the basic requirements for protection against dynamic effects of postulated pipe ruptures:.

> "Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping."

As part of this evolution, augmented ISI examinations have been permitted to provide assurance of protection in specific instances where the installation of restraints or shields is not practical. Plants have also identified break exclusion zones such as in certain high energy piping systems in the containment penetration areas where augmented ISI has been allowed to assure protection. These augmented inspections usually comply with the requirements of the applicable edition of Section XI of the ASME Code and addenda. However, the frequency of these inspections can be increased over that required by Section XI, such that some plants inspect these locations three times during each 10-year inspection interval.

-Augmented ISI for high energy line break (HELB)/moderate energy line break (MELB) requirements are addressed in NRC Standard Review Plan 3.6.1, 3.6.2 and 6.6 (NRC, 1990, 1981, 1981) and plant specific SAR commitments. SRP 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," states that "the plant design for protection against piping failures outside containment is reviewed to assure that such failures would not cause the loss of needed safety functions of safety-related systems and to assure that the plant can be safely shut down in the event of such failures. This review includes high energy and moderate energy fluid system piping outside of containment." SRP 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping" states that the staff review covers "the implementation of criteria dealing with special features, such as augmented inservice inspection programs or the use of special protective devices such as pipe whip restraints. ..." SRP 3.6.2 references MEB 3-1 and also SRP sections 5.2.4 and 6.6 with respect to staff review areas.

MEB 3-1 states that "

> "It is recognized that pipe rupture is a rare event which may only occur under unanticipated conditions, such as those which might be caused by possible design, construction, or operation errors; unanticipated loads or unanticipated corrosive environments. Our observation of actual piping failures have indicated that they generally occur at high stress and fatigue locations, such as at terminal ends of a piping system at its connection to the nozzles of a component. The rules of this position are intended to utilize the available piping design information by postulating pipe ruptures at locations having relatively higher potential for failure, such that an adequate and practical level of protection can be achieved."

–A provision exists for an applicant to propose acceptable alternative method for complying with specified portions of the NRC SRP 3.6.1 section V and -SRP 3.6.2 which states "Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission's regulations."

~~These augmented inspections usually comply with the requirements of the applicable edition of Section XI of the ASME Code and addenda. However, the frequency of these inspections can be increased over that required by Section XI such that some plants inspect these locations three times during each 10-year inspection interval.~~

~~The majority of HELB and MELB augmented exams are generally associated with the Class 2 piping systems; therefore, a risk-informed ISI program that includes Class 2 piping (i.e., a Class 1&2 or full scope risk-informed ISI program) is usually necessary to perform this application.~~

Most FSARs describe the HELB/MELB evaluation. In addition, the FSAR and some Technical Specifications describe these augmented inspections. For example, one FSAR states:

> "In specific instances where the installation of restraints or shields is not practical, adequate assurance of protection is provided by an augmented inservice inspection program on specific welds selected on the basis of pipe stress analysis.
>
> The augmented inservice inspection will comply, to the extent practical within the limitations of design, geometry, and materials of construction of the components, to the requirements in those editions of Section XI of the ASME Boiler and Pressure Vessel Code and addenda..."

The risk-informed ISI program is based on the actual piping failures that have occurred during plant operation. Most of the failures have been at locations other than those with high design stress or high fatigue usage factors. This is part of the premise of revising the ASME Section XI ISI program with a risk-informed program. This same premise applies to the changes requested for the augmented HELB/MELB break exclusion examinations.

The precedent exists for allowing inservice inspection in lieu of other provisions to protect against postulated piping failures. The risk-informed ISI program as described in the next section provides a re-evaluation of the postulated consequences along with the postulated likelihood of failure to reallocate and possibly reduce the number of inservice examinations performed for the HELB/MELB augmented inspection program. This guidance still meets the intent of the NRC's standard review plans.

3.2 SPECIFIC GUIDANCE FOR HELB AND MELB ISI INCLUSION

This evaluation can be performed concurrently with the application of the RI-ISI program (e.g., Class 1 and 2 ASME Section XI) or can be performed following completion of the program. The majority of HELB and MELB augmented exams are generally associated with the Class 2 piping systems; therefore, a risk-informed ISI program that includes Class 2 piping (i.e., a Class 1&2 or full scope risk-informed ISI program) is usually necessary to perform this application.

The following subsections describe the process steps as related to the RI-ISI process described in WCAP-14572, Revision 1-NP-A. The step descriptions are intended to supplement and further explain the risk-informed ISI application to HELB/MELB augmented inspection program.

Scope Definition

The program scope is evaluated to include those systems for which HELB break exclusion ISI is performed. The scope of the program can include Class 1, Class 2, Class 3 and nonCode piping.

Segment Definition

The piping segments defined in the RI-ISI program are reviewed to identify which piping segments are impacted by the augmented ISI program. Any further refinement of the piping segments is also performed. The definition of piping segments is further described in WCAP-14572-Revision 1-NP-A, section 3.3.

Consequence Evaluation

This analysis evaluates system interactions due to piping failures. The following potential pipe failure-induced conditions are considered:

1. Flooding

2. Water Spray

3. Pipe whip

4. High environmental temperatures (e.g. Steam line break)

5. Jet impingement

The indirect effects assessment is accomplished through an investigation of existing plant documentation on pipe breaks, flooding, and plant layout along with a focussed plant walkthrough. The process is described in WCAP-14572-Revision 1-NP-A, section 3.4.2 but is summarized below.

An in-depth review of the requirements for break exclusion zones and supporting design basis documentation with respect to postulated consequences and locations is performed based on the ~~current risk-informed ISI~~ piping segments and their postulated consequences.

Indirect effects occur from conditions such as pipe whip, jet impingement, flooding resulting from pipe breaks or leaks. The indirect effects to be considered include:

- Failures that cause an initiating event such as a LOCA or reactor trip
- Failures that disable a single train or system
- Failures that disable multiple trains or systems
- Failures that cause any combination above

An example of an indirect effect is the failure of a service water pipe which sprays an electrical cabinet that supplies power to the reactor coolant pumps, shorts the electrical supply which causes the pump to trip and ultimately causes a reactor trip.

The following summarizes the process steps:

For the Pre-walkthrough

- Review existing documents which examine the local effects of piping failures for the systems in scope of the program,
- Identify other systems/trains affected by a failure in each area,
- Identify plant areas for plant walkthrough,
- Document evaluation, and
- Develop walkthrough sheets for key areas

For the Walkthrough:

- Perform walkthrough and document results, actions, issues

For the Post Walkthrough,

- Evaluate results
- Resolve actions
- Map indirect effects to piping segments and identify the required leak or rupture failure probabilities

Initially, the plant is divided into areas such as those defined within the plants 10CFR50 Appendix R report, HELB/MELB evaluations, or other area designations. If needed for better delineation, these areas are further subdivided into smaller enclosures. The major safety equipment (e.g., pumps, motor-operated valves, electrical cabinets, etc.) is identified for each area.

This information is used to assess where major safety equipment is located within the plant that would have an impact on core damage or large early release. The evaluation is carried out on a building by building, area by area basis.

Areas throughout each building are eliminated from evaluation (similar to that performed in the internal flooding PSA screening) if:

- no major equipment is contained in an area or
- no piping or fluid source runs through or near an area.

The evaluation of pipe whip, jet impingement, and high environmental temperature is performed using the guidance provided below. This guidance is consistent with Westinghouse Systems Standard Design Criteria 1.19 (Westinghouse, 1980), WCAP-8951 (Mendler, 1979), U.S. NRC MEB 3-1 (NRC, 1987) and ANSI/ANS-58.2 (ANSI, 1988).

Pipe Whip and Jet Impingement Guidance

Pipe whip and jet impingement effects apply to breaks or ruptures that are postulated to occur in high energy piping systems, or portion of a system, where both or either of the following conditions are met during normal plant operating conditions:

- maximum operating pressure exceeds 275 psig, or
- maximum operating temperature exceeds 200°F

Note: These criteria are based on plant-specific criteria usually contained in a plant's FSAR.. Piping systems that operate above these limits for only a relatively short period (for example, less than approximately 2%) of the time during which they perform their intended function, may be classified as moderate energy.

Existing documents (e.g., UFSAR or hazards evaluation), are reviewed to examine where high energy line break locations have already been postulated and where devices, (e.g., whip restraints and jet shields), have already been installed to protect vital safety-related equipment

Each area is documented to identify areas that are not of concern and those areas that are of potential concern.

In addition, prior to the walkthrough, the fluid conditions and the pipe sizes in the high energy piping of interest are identified in order to determine what length of pipe is required to form a hinge and the magnitude of the jet forces resulting from postulated breaks. The location of orifices that would limit the amount of energy emanating from a postulated break are also determined. Initial piping and fluid conditions can be obtained from the piping isometrics, line lists, and system description documents. Plant layout drawings or ALARA layout drawings can assist in the pre-walkthrough evaluation, which focuses on which areas of the plant to include in the walkthrough.

During the walkthrough, assume that breaks may occur at all possible locaitons along the high energy piping runs;

- *circumferential breaks* should be postulated to occur individually at pipe-to-fitting welds, branch run-to-main run welds, branch run-to-fitting welds, and at other terminal ends[1]; circumferential breaks need not be postulated in piping runs of a nominal diameter equal to or less than 1"

- *longitudinal breaks* should be postulated at welded attachments (e.g., lug, stanchion) at the centerline of the welded attachment with an area equal to the pipe surface area that is bounded by the attachment weld. Longitudinal breaks need not be postulated in piping runs of a nominal diameter less than 4" and longitudinal breaks need not be postulated at terminal ends

[1]Terminal end is that section of piping originating at a structure or component (e.g., a vessel or component nozzle or structural piping anchor) which acts as an essentially rigid constraint to the piping thermal expansion. In-line fittings, such as valves, are not assumed to be anchored

and are not terminal ends.

- For each high energy piping run that has the potential to whip or cause jet impingement, as a result of a postulated break, look for the following types of protection to exist in the areas that could be impacted by these effects:

    * Separation distances between required systems and components and piping that are used to mitigate potential core damage effects

    * provision of piping enclosures (e.g., sleeves)

    * provision of component enclosures (e.g., walls or cubicles)

    * provision of system redundant design features (such as isolation valves)

    * design of required systems and components to withstand the effects of the postulated pipe rupture

    * provision of additional protection such as restraints and barriers

- For high energy piping that has the potential to whip following a postulated break, the following considerations should be noted:

    - the portions of piping that may form a hinge will not become missiles

    - a whipping pipe that has the potential to impact other piping will not rupture lines of equal or greater size; however, it should be assumed that a through-wall crack may develop in a line that is impacted by a whipping pipe of the same size

- The evaluation of fluid jets emanating from postulated breaks on nearby structures and components shall consider the effects of jet loading, fluid temperature, and moisture on the targets impinged upon. The jet shape and direction should be established using the schematics of jets discharging from various pipe breaks. Targets more than 10 pipe diameters away from the break location need not be considered for jet impingement impacts.

From the walkthrough, the indirect effects from pipe failures within the plant are identified. Additional information identified during the walkthrough is obtained and evaluated. If indirect effects are identified, then they are matched with piping segments.

~~A plant walkdown of the affected piping may be performed to confirm information provided in existing design basis documentation.~~

Any additions ~~changes~~ necessary to the postulated consequences are identified and incorporated into the analyses and the PRA model is used to estimate the conditional core damage ~~frequency~~/large early release ~~frequency~~ (CDF/LERF) probability/frequency.

Piping Failure Probability Assessment

The Westinghouse structural reliability and risk assessment software (SRRA) is used to estimate the piping failure probabilities associated with each piping segment. The SRRA model is based on probabilistic structural mechanics models. SRRA models also predict the progress of degradation and/or crack growth as a function of time while quantitatively accounting for the impact of random loadings, such as earthquakes. SRRA uses Monte-Carlo simulation with importance sampling to calculate the probability of failure for type 304 and 316 stainless steel piping (due to fatigue crack growth and stress corrosion cracking) or for carbon steel piping (due to fatigue crack growth and loss of thickness due to wastage, such as flow-assisted corrosion).

All significant degradation mechanisms present in a piping segment along with the operating characteristics, environment, and loading conditions are evaluated as part of the failure probability assessment. When more than one degradation mechanism is present, the combination of all significant degradation mechanisms produces the limiting failure probability.

Failure probability calculations are performed for

- small leak (through wall flaw)
- large system disabling leak or initiating event
- full break (rupture) (where pipe whip is a concern)

In addressing piping segments where changes may be proposed at locations that are currently examined per HELB or MELB augmented inspection programs, the above failure probability calculations that are performed need to be consistent with fracture mechanics analysis methods for demonstrating leak-before-break. These changes include moving or reducing inspection locations or extending the frequency of examination. The failure probability calculations also need to demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping. To be consistent with leak-before-break methods, the probability of rupture should also be several orders of magnitude lower than the small leak probability (that represents the probability of a through-wall crack).

A detailed review of the piping failure probabilities used in the risk-informed ISI program for those ~~the~~ segments impacted by break exclusion zones is performed with respect to postulated failure mechanisms and any credit for the augmented ISI program(s). Any new failure probabilities that are required for evaluation of the indirect effects are identified and then ~~are~~ calculated using the Westinghouse SRRA software (Westinghouse, 1999).

Risk Evaluation

The results from the consequence evaluation and failure probability assessment are reviewed to identify the impact on the risk evaluation and risk ranking calculations. The identification of the potential re-ordering of the high safety-significant (HSS) piping segments based on modifying the ~~removing~~ credit for the augmented ISI program is performed. This information is then provided to the plant expert panel.

In performing the risk evaluation for this program, the process described in WCAP-14572, Revision 1-NP-A section 3.6.1 is performed with the following conditions applied:

- For segments in which the augmented program is postulated to be removed, the failure probability without ISI is to be used in the risk ranking.
- For segments in which spray or jet impingement is a postulated indirect consequence failure mode, the failure probability to be used is the SRRA small leak (small leak = through wall flaw) probability.
- For segments in which pipe whip is the postulated indirect consequence failure mode, the failure probability to be used is the SRRA full break (rupture) probability.
- For segments in which environmental effects are the postulated indirect consequence failure mode, the failure probability to be used is the SRRA small leak (small leak = through wall flaw) probability.

Expert Panel Categorization

The suggested changes to the risk-informed ISI program and the augmented ISI program are presented to the plant expert panel for final determination of which piping segments are high safety significant (HSS) and should receive examination. The expert panel findings are documented. More details regarding the expert panel considerations is provided in WCAP-14572, Revision 1-NP-A, sections 3.6.2 and 3.6.3.

Structural Element/NDE Selection

Based on the changes proposed by the plant expert panel to the piping segments identified as HSS~~C~~, the number of structural elements to be examined and the nondestructive examination (NDE) methods are identified based on the guidance provided in WCAP-14572, Revision 1-NP-A, sections 3.7 and 4.0. The change in risk calculations based on inputs from the risk ranking calculations, the piping segments which are in the current RI-ISI program and those that are proposed to be added to address the augmented ISI, are evaluated to ensure the program does not result in an increase in risk and meets the guidance in NRC RG-1.174 (NRC, 1998).

When changing the HELB and MELB exclusion examinations by subsuming the exams into the RI-ISI program, the licensee should ensure that the RI-ISI program includes a reasonable representation (balance) of augmented ISI examinations and ASME Section XI examinations. The Perdue statistical model is used to determine the minimum number of ASME Section XI exams to support a reasonable representation, where appropriate.

NRC Submittal

The Nuclear Energy Institute (NEI) has developed an example submittal (~20 pages) which has been reviewed and approved by the NRC through a series of meetings in late 1998 and early 1999. The example submittal was provided by NEI to the industry in a March 9, 1999 letter. This document provides the basis for the summary report that will be submitted to the NRC for the risk-informed ISI program. The submittal addresses examinations required by ASME Section XI as well as any augmented examinations that are addressed by the risk-informed ISI program.

It is expected that the HELB/MELB evaluation would be submitted as part of the risk-informed ISI program and discussed in the section 2.2 in the example submittal titled, "Augmented Programs." In addition, it is expected that FSAR and/or Technical Specification changes would be required for program implementation.

Implementation and Feedback

The implementation and feedback section of WCAP-14572, Revision 1-NP-A would also apply to the revised augmented inspection program as it would be subsumed into the risk-informed ISI program.

4.0 CONCLUSIONS

The WOG RI-ISI methodology is directly applicable to the consideration of augmented inspection programs; no specific changes to the overall process are required to address augmented inspection programs. The augmented inspection programs are already credited in the methodology without changing the actual regulatory requirements.

This addendum to the RI-ISI process permits, as an option, the revision of selected augmented inspection regulatory requirements (including high energy line break (HELB) exclusion and moderate energy line break (MELB) examinations), where safety impacts can be shown to be maintained or enhanced. The risk-informed ISI methodology for the HELB/MELB application is consistent with the basic requirements for protection against dynamic effects of postulated pipe ruptures defined in General Design Criterion 4 of Appendix A to 10 CFR Part 50. The consequences associated with dynamic effects, including the effects of pipe whip and discharging fluids, are addressed via a thorough evaluation (including plant walkthrough) of the areas of concern. The demonstration that the probability of fluid system rupture is extremely low under conditions consistent with the design basis for the piping is performed via the probabilistic structural mechanics evaluation using SRRA models, which are consistent with leak-before-break fracture mechanics analysis.

-Thus, the augmented inspection programss, as identified in this addendum report, are subsumed into the RI-ISI program. Changes to these augmented requirements would be evaluated by individual utilities using the appropriate regulatory change mechanisms (e.g., 10CFR50.55a, 50.59).

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