October 24, 2002

MEMORANDUM TO: Michael Johnson, Branch Chief
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

THRU: Mark Rubin, Section Chief**/RA/**
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

FROM Stephen Dinsmore, Senior Reliability and Risk Analyst**/RA/**
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: PALISADES RISK-INFORMED INSERVICE INSPECTION (RI-ISI) SITE AUDIT, SEPTEMBER 12 AND 13, 2002

On September 12 - 13, 2002, the plant project manager, Johnny Eads, and I audited the documentation developed by Palisades to support Nuclear Management Company's March 1, 2002, risk-informed inservice inspection relief request. Review of the documentation was guided by the documentation requirements in WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-informed Methods to Piping Inservice Inspection Topical Report," Chapter 5.10, "Documentation." The review concentrated on the documentation related to the probabilistic risk assessment (PRA) evaluation, PRA results, and use of the results to support the proposed RI-ISI program. The documentation used to support the estimation of pipe failure frequencies using the structural reliability and risk assessment computer code was reviewed for consistency and completeness.

It was found most efficient to identify a segment and follow all the stages of evaluation for the segment. This approach identifies the information available and illustrates the ability to trace or recreate the evaluation of a segment from initial identification and definition, thorough the consequence evaluation, failure probability estimation, importance measure calculations, information presented to the expert panel, deliberations by the expert panel, evaluation with the Perdue method as applicable, and selection of the elements for inspection by the element selection panel. The documentation includes comprehensive, dated paper reports and computer files. The site engineering staff was able to quickly and fully identify all requested information indicating that the information was readily available although the somewhat complex documentation system would require some training and effort to learn.

CONTACT: Stephen Dinsmore. NRR/DSSA/SPSB
415-8482

Details of the audit are provided in the attachment. In general, the available documentation was consistent with the required documentation, comprehensive, and well organized. The quality and the content of the documentation provide assurance that the information required to develop and support a risk-informed alternative to the requirements of ASME Section XI was collected, evaluated, and documented.

The only documentation weakness noted during the audit was that the requirements for expert panel member qualification and training, and expert panel composition was contained in a guidance document and not captured within a procedure. We suggested that the guidance be incorporated into a procedure as the Maintenance Rule expert panel guidance and description was incorporated into a procedure.

The expert panel's deliberations supporting the reduction of 27 segments from the HSS category based on the quantitative PRA results to LSS based on the expert panel's evaluation was audited. Almost all the segments were placed in LSS based on discarding the PRA results that do not credit operator actions to isolate the ruptured pipe and otherwise mitigate the resulting transient. Documentation of these deliberations was generally limited to one or two sentences reporting, for example, the "high confidence" of the operation's representative "in the ability of the operators to correctly identify and take the listed recovery actions." In general, the staff position is that discarding PRA results require a greater degree of evaluation than illustrated by the meeting minutes. Discarding results that do not credit operator actions requires specific information of the indication available to the operators, the time available, and the spatial requirements of the actions. In response to an RAI, the licensee reduced the number of segments placed into LSS from 27 to five. The documentation provided to justify placing the remaining five segments in LSS was more extensive than any documentation in the meeting minutes and review of the acceptability of the final placement of the five segments will be done as part of the review of the relief request.

The audit identified an apparent deviation from the WCAP methodology. The WCAP methodology combines pipe elements into segments whose failure has the same consequence. The WCAP requires that the segment failure frequency be estimated by combining all degradation mechanisms and worst case operating conditions in the entire segment into one "representative" weld, and using the failure frequency estimated for that weld to represent the failure frequency of the segment. According to information observed during the audit, however, the licensee identified the worst case sub-segment defined by pipe-size, combined the degradation mechanism from that sub-segment into the "representative" weld, and used the failure frequency for the sub-segment to represent the failure frequency of the segment. Discussion with the licensee indicated that this is standard Westinghouse application and that Westinghouse has been using this technique on all RI-ISI submittals.

At the exit meeting, the high level of quality and detail in the RI-ISI submittal on-site documentation was noted. The audit of the documentation requires no further licensee input. The observation that guidance for the expert panel was not proceduralized was discussed with the licensee. The licensee indicated that they would consider including the guidance in a procedure. The weakness in the expert panel's justifications for placing nominally HSS segments in LSS based on the perceived ease of the operators' actions was confirmed. This issue was moot, however, because the licensee placed all but five of the segments back into HSS. Sufficient documentation to support a review of the justification for placing the remaining five segments in LSS was provided in an RAI response and will be reviewed as part of the review of the submittal. The issue regarding the apparent deviation from the methodology whereby sub-segments instead of segments were defined and parameterized was identified at the exit meeting as an issue that requires supplemental information to close. The staff and the licensee will pursue the resolution of this issue.

Attachment: Attachment 1

At the exit meeting, the high level of quality and detail in the RI-ISI submittal on-site documentation was noted. The audit of the documentation requires no further licensee input. The observation that guidance for the expert panel was not proceduralized was discussed with the licensee. The licensee indicated that they would consider including the guidance in a procedure. The weakness in the expert panel's justifications for placing nominally HSS segments in LSS based on the perceived ease of the operators' actions was confirmed. This issue was moot, however, because the licensee placed all but five of the segments back into HSS. Sufficient documentation to support a review of the justification for placing the remaining five segments in LSS was provided in an RAI response and will be reviewed as part of the review of the submittal. The issue regarding the apparent deviation from the methodology whereby sub-segments instead of segments were defined and parameterized was identified at the exit meeting as an issue that requires supplemental information to close. The staff and the licensee will pursue the resolution of this issue.

Attachment: Attachment 1

DISTRIBUTION: SPSB r/f
SDinsmore
MRubin
JEads
ESullivan
TChen
AKeim
PPatnaik
SMalik

Accession#ML022980266 NRR-106
G:SPSB\Dinsmore\RIISI_audit.wpd

OFFICE	SPSB	SPSB:SC
NAME	SDinsmore:	MRubin
DATE	10/22/02	10/24/02

OFFICE RECORD COPY

DETAILED AUDIT DISCUSSION

Text from the WCAP providing the documentation requirements is in italic. The staff's observations are indented and in normal text.

SCOPE DEFINITION

- Boundary is clearly identified for all segments
- System functions are clearly and fully defined for all boundary segments

Each system had its own folder that contained description of the systems, the parts of the systems modeled in the PRA, and P&ID's. Much of this information was also reflected in the Worksheets provided to the Expert Panel to support their discussion on each segment.

SEGMENT DEFINITION

- Within the boundary, all segments and segment boundaries are clearly documented

The segments were defined in several places in text, (e.g., "between valve x and the containment wall") as well as on marked up P&IDs. The licensee stated that they were in the process of "marking" the segment in computer graphic files but that this was a long term process. For some segments, the boundaries of multiple sub-segments were observed that were used to develop the failure frequency of the segment. Discussions on the reason for the existence of sub-segments resulted in the identification of the apparent deviation from the WCAP methodology that requires that segments are evaluated as a single entity.

CONSEQUENCE EVALUATION

- Consequence in terms of failed equipment, functions are defined for each segment.

The consequence evaluations were comprehensive and extensive. There were two binders of system walkdown results that provided extensive tables with lists of equipment that is expected to fail due to the failure of the segment. Each segment included a list of equipment (as applicable) for environment and dynamic effects such pipe whip, high temperature, and jet impingement. There was no audit of the walkdown of the site to evaluate the list of failed equipment that would fail from dynamic effects and the environment. However, the extensive lists of equipment failures for a number of segment failures indicates that the methodology was identifying equipment failures.

Direct effects, represented by components that would lose function because pump flow was diverted or suction lost were identified in another table.

Operator actions that could mitigate the rupture were described in terms of equipment that could be manipulated such as closing one or more valves. However time frames identifying how long an operator had available to mitigate the effects of a break,

indications that would be available to the operator to identify the break, procedures that would guide the operator to perform the appropriate action, and locations of the equipment were not provided in the documentation.

FAILURE PROBABILITY ESTIMATION

Minimal directed review of the documentation that supported the development of the failure frequencies was performed due to the lack of reviewer expertise in these areas. It was noted that each system had a SRRA documentation file that supported the SRRA calculations. The contents of these files were briefly reviewed and provided the insights reported below.

- Gather design basis information

This aspect was not reviewed in the audit

- Review industry experience

This aspect was not reviewed in the Audit.

- Insights into any potential piping problems

This aspect was not reviewed in the Audit.

- Analysis team and qualification of the team

The analysis team was trained by Westinghouse. The licensee plans to do further SRRA calculations in-house. Documentation of the qualifications of the trained individuals or training records was not reviewed in the audit.

- Determine likely failure mode(s)

The SRRA calculations appeared to include all failure modes (leak, disabling leak, rupture). The consequences in terms of failed equipment were identified for each failure mode.

- Select candidate location(s)

Selection of candidate locations was not review during the audit.

- Gather detailed data for probability of failure analysis

The SRRA input includes a reference to other plant documentation where, for example, the disabling leak rate can be found. In most cases the disabling leak rate was taken as 10% of the total flow. For example, the MFW has a pump flow of 13500gpm so the disabling leak rate of 1350gpm was used. The identification and characterization of degradation mechanisms were not reviewed during the audit.

- *Calculate probabilities of failure*

The inputs and the results of the SRRA calculations for all segments and sub-segments were available.

- *Calculate probabilities of failure for the statistical model as needed*

There was extensive documentation on the Perdue model inputs and results for all of the high safety-significant segments.

- *Document locations and probabilities*

The failure probability (frequency) is for each segment not for a specific location. The element selection process documentation included weld specific labels for the welds to which inspections were assigned.

CONSEQUENCE AND RISK ESTIMATES

- *Identify impact on PSA model*

Extensive list of direct and indirect effect failures for each segment.

- *Identify surrogate component*

The link between each segment and the surrogate component is in an EXCEL spreadsheet. The EXCEL entry for each component includes all the surrogate components associated with the segment for each of the different failure modes of the segment (failure on demand, failure causing an initiating event, failure during mission time).

- *Obtain conditional CCDP/CLERP with operator action, without operator action*

The EXCEL spread sheets can produce an input file for the PRA computer code that identifies, for each segment, all the components that should be failed and, as applicable the specific initiating event caused by the piping failure, the mitigating function that would fail on demand by the segment failure, or the failure during the required mission time. The output CCDPs and CLERPs are collected in another spread sheet that includes the segment failure frequency and is used to estimate the RRWs.

- *Integrate pressure boundary failure probability/rate*

Integrated in spreadsheets

- *Calculate segment piping pressure boundary CDF/LERF*

Integrated in spreadsheets

- *Calculate total piping pressure boundary core damage frequency (and LERF)*

Integrated in spreadsheets.

- Calculate importance measures

Integrated in spreadsheets.

- Calculate segment Risk Reduction Worth importance measure

Integrated in spreadsheets.

- Calculate segment Risk Achievement Worth measures

Integrated in spreadsheets.

- Evaluate important PSA and failure probability factors through sensitivity studies and uncertainty studies, as appropriate

The inclusion of sensitivity studies was not specifically pursued during the audit. No results or discussions of these types of sensitivity studies were observed during the audit.

- Evaluate the effects of the Uncertainty Analysis

The uncertainty analysis required by the WCAP method is integrated in the spread sheet.

EXPERT PANEL CATEGORIZATION

- Consider the PSA and failure probability information and associated uncertainties

The worksheets provided to the expert panel closely followed the examples in the WCAP (pages B-22 to B-40). The system level worksheets included a list identifying all segments with RRWs between 1.001 and 1.005 (e.g., those segment that the Topical recommend be brought to the expert panel's attention as potentially HSS). There were extensive discussions documented about why each of these segments were kept in LSS or placed in HSS.

- Consider other deterministic considerations
- Shutdown risk Evaluation
- External events' evaluation
- Other accident scenarios
- Component operating history

Shutdown functions were systematically addressed in the worksheets but the first round of worksheets (there was a second round limited to those segments whose RRWs increased above 1.001 due to comments by the first round expert panel) did not systematically address external events. External events were addressed in the final worksheets and did not have an impact.

- Plant operation and maintenance insights

This aspect was not reviewed in the Audit

- *Design basis analysis*

This aspect was not reviewed in the Audit

- *Other deterministic insights*

This aspect was not reviewed in the Audit

- *Conduct expert panel sessions and document results*

The expert panel reportedly spent almost 10 days on evaluation of the results. The discussion included fairly comprehensive descriptions of possible operator actions to mitigate the break, for example

> "Operator could isolate the break by closing CV-1318, CV 1359, and CV 0845. All NSW would be lost be, but all CSW would be recovered."

The bases for the expert panel discarding the without operator action RRW as not credible was however, normally very weak. For example,

> "The Ops representative on the expert panel expressed high confidence in the ability of operators to correctly identify and take listed recovery actions."

The expert panel also discussed other deterministic characteristics, For example, one system engineer expressed concern that although primary water stress corrosion cracking was "considered" during calculation of the failure frequency, it was intentionally omitted from the computer calculations and the expert panel decided that the segment with an RRW of 1.001 was placed in HSS.

- *Membership and qualifications of the expert panel members*

There was description of the expert panel qualifications and on the process to be used during deliberations but one weakness noted by the audit team was that the guidance for the RI-ISI expert panel was not proceduralized. There is a procedure for the maintenance rule expert panel and the licensee, in response to comments, indicated that they might make the RI-ISI panel guidance into a procedure but this is not necessary for approval of the current program because the guidance in the guidance document was appropriate.

- *Meeting minutes and attendance*

The meeting minutes include the names of the attendees/alternates, that a quorum was present, summaries of discussions relevant to voting, results of votes. The meeting minutes identified which votes were split votes but not the specific vote. The meeting minutes were distributed for concurrence.

STRUCTURAL ELEMENT SELECTION

- *Identify where the segment falls on the structural element matrix.*

The WCAP "Region" where each HSS segment was along with the number of welds required to be inspected according to the region and the Perdue results were provided as input to a sub-panel. The sub-panel selected the locations and reported back to the Expert Panel which provided final concurrence on the evaluation

- Determine the number of inspections required in each segment using the statistical model, if appropriate (identify probabilities used in structural model).

There were Perdue input/output files available for all the HSS segments that could be evaluated with the Perdue method (some segments cannot be evaluated with the Perdue method).

- Verify that the locations with the highest failure potential within a segment are identified for examination.

The documentation provided from the SRRA analyses sometimes suggested welds for inspection, apparently based on the highest failure potential. The sub-panel would generally choose these locations although in some cases alternative locations were selected based on discussion. Also in some cases where inspection locations were required by the methodology but there were no recommended locations, the sub-panel apparently went to the location to find the most "sensitive" areas

- Document the results and present to the full expert panel for final review and approval.

There was an "engineering" sub-panel that selected the welds for inspection. The final selection was concurred upon by the Expert Panel.

- The NDE selected for each element selected is linked to WCAP Table

This was not reviewed during this audit

CHANGE IN RISK REQUIREMENTS

- Location of change in risk calculations (spreadsheets)

The final written report included all the change in risk calculations and reference dated computer spreadsheet files that included all the parameters required to perform the calculation.

- Traceability of segment, consequence, selected PRA equation, selected failure frequency, CCDP, CLERP, with operator action, without operator action, final results

The documentation system includes comprehensive, dated paper reports and computer files. The site engineering staff was able to quickly and fully identify all requested information indicating that the information was readily available once the somewhat complex documentation system was learned.

- Documented results of comparison with different acceptance criteria.

The comparison of the result with the acceptance criteria was fully documented in a written report. This report also referred to specific rows, columns, and individual cells of spreadsheet files that identified where the results that needed to be compared to the acceptance criteria could be found.

PRA QUALITY REVIEW

This aspect was not reviewed during the audit.

PLANS, PROCEDURES, AND ASSESSMENT FORMS FOR MONITORING THE PROGRAM

This aspect was not reviewed during the audit.

ASME CODE REQUIRED DOCUMENTATION

This aspect was not reviewed during the audit.