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U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D. C. 20555

Perry Nuclear Power Plant
Docket No. 50-440
Supplemental Information
on Snubber Optimization
of the Feedwater System

Gentlemen:

On October 18, 1991, the Cleveland Electric Illuminating Company (CEI) informed the NRC staff by letter PY-CEI/NRR-1374L of our plans to implement a snubber optimization program for the Perry Nuclear Power Plant (PNPP), Unit 1, during refueling outage 3 (RFO3). The four major goals of our snubber optimization program were explained to the NRC staff at that time: improve safety, reduce occupational radiation exposure, decrease maintenance costs, and improve system reliability. The RFO3 snubber optimization efforts, which focused on systems within the Unit 1 drywell, including the Feedwater system, have since been completed.

The October 18, 1991 letter also informed the NRC staff of the ASME code guidance which would be utilized during implementation of the snubber optimization program. One of the analytical techniques used for snubber optimization was the application of ASME Code Case N-411-1, " Alternative Damping Values for Seismic Damping of Piping, Section III, Division 1, Class 1, 2, and 3." Code Case N-411-1 is recognized in Regulatory Guide (R.G.) 1.84, "Design and Fabrication Code Case Acceptability, ASME Section III, Division 1." This Code Case was approved on February 20, 1986, and was endorsed by the NRC in R.G. 1.84 Revision 25, dated May 1988. R.G. 1.84 contains five conditions which must be met to implement Code Case N-411-1. CEI committed to meeting these conditions, including the fifth condition which requires the performance of a case-specific evaluation for application of the Code Case on piping in which intergranular stress corrosion cracking (IGSCC) has occurred, and NRC review of the case-specific evaluation. This evaluation was performed for the Feedwater system because indications had been detected in the N4C and N4E Feedwater nozzle-to-safe end weldments during the performance of Inservice Inspection (ISI) ultrasonic examinations during RFO2.

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The Feedwater nozzle indica ions were previously reported to the NRC staff by letters PY-CEI/NRR-1264L da . November 26, 1990, with followup inf ation provided by letters PY-CEI/NRR-133/L dated March 25, 1991, PY-CEI/NRR-1374L dated October 18, 1991, and PY-CEI/NRR-1463L dated March 4, 1992 and by direct presentations to the NRC staff on February 21, 1991 and April 15, 1992. Th Feedwater nozzle indications were re-examined during RF03 both prior to and following application of Mechanical Stress Improvement Process (MSIP) in accordance with the guidance provided in Generic Letter (GL) 88-01 and NUREG-0313, Revision 2. The results of the post-MSIP examinations revealed no significant change in the size of the existing indications and no new reportabl indications. Although the presence of IGSCC co not be definitively confirmed, the Feedwater indications were cons atively assumed, for analysis purposes, to have been IGSCC related, and the Code Case N-411-1 evaluation was performed.

The results of this evaluation, along with the results of the ultrasonic examinations of the Feedwater nozzle indications obtained during RF03, were included in a Summary Technical Report, "Evaluation Of Flaw Indication(s) In The Perry Feedwater Nozzle To Safe-End Welds Examined During RF03" which was provided to the NRC staff by Attachment to letter PY-CEI/NRR-1491L dated May 8, 1992. Based on a request for additional information made by the NRC staff in subsequent telephone conferences dated May 15, 1992, we are hereby supplementing our prior response by providing a summary of the methodology involved and the results obtained in the application of our snubber optimization program to the Feedwater system (Enclosure 1).

If you have any questions, please feel free to call.

Sincerely,

Steven Kensicki for MDL

Michael D. Lyster

MDL:CJF:sc

Attachment

cc: NRC Project Manager
NRC Resident Inspector Office
NRC Region III

OVERVIEW OF PERRY FEEDWATER SNUBBER OPTIMIZATION

A. EVALUATION

The Cleveland Electric Illuminating Company (CEI) contracted General Electric (GE) to perform snubber optimization analysis for several piping systems, including the ASME Code Class 1 portion of the Feedwater system inside the drywell. This analysis permitted the elimination of certain selected feedwat.r system snubbers. The major purposes f this program are to reduce occupational radiation exposure and to increase the overall safety and reliability of the piping systems while reducing plant maintenance and inspection costs. By eliminating snubbers located inside the drywell, a significant source of occupational radiation exposure caused by periodic functional testing and maintenance will also be eliminated. Removal of these active components will also improve system reliability, by eliminating potential snubber problems such as inadvertent lockup, bleed rate variance and hydraulic fluid leakage. The optimization results for the Feedwater system piping has been field implemented during RFO3 (currently in-progress), with plans for implementation of the remaining NSSS portions in RFO4. A brief synopsis of the snubber optimization methodologies used is provided below. Refer to Attachment 1, "Perry Snubber Reduction Project" (pages 13 through 21), for a more detailed discussion on the GE work scope.

1. Dynamic Methods

Key criteria used in the analysis are tabulated below:

Item	Criteria
- Damping	For the Feedwater piping, the ASME Code Case N-411-1 (Reference 1) damping values were applied with the Uniform Support Motion (US'') response spectra analysis method in rdance with Regulatory Guide (R.G. 1.84, Rev. 25 (Reference 2). Closely spaced modes were combined in accordance with R.C. 1.92 (Reference 3). Code Case N-411-1 was not mixed with R.G. 1.61 (Reference 4) damping criteria for the same load case.
- Cutoff Frequencies Acceleration Response Spectra (ARS)	Seismic - 33 Hz Other dynamic loads - 60 Hz
- Combination of 3 Direction Components	Square Root of the Sum of the Squares (SRSS)
- Response Spectrum Peak Broadening	P .s or minus 15% per R.G. 1.122 (ference 5)

2. Loadings

The Perry Updated Safety Analysis Report (USAR) defines transient events and combinations of these events which the affected piping systems must withstand (Reference 6).

The Feedwater piping system analysis considered the following loading conditions:

- Deadweight
- Internal Pressure
- Thermal Expansion
- Seismic Events - Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE)
- Pool Hydrodynamic Loads
- Annulus Pressurization Loads
- Dynamic Effects of Postulated Pipe Ruptures from other systems (jet impingement)
- Fluid Transients

NOTE: Load combination criteria remains the same as the existing system design specification/Perry USAR.

3. Miscellaneous Considerations

Additional considerations included:

- Pipe Rupture Adequacy
- Piping Displacement Envelope
- Valve Evaluations
- Equipment Nozzle Loads
- Anchor/Penetration Loads
- Appendage Evaluations
- Pipe Support Evaluation
- Welded Attachment Evaluations
- Small Diameter Branch Piping Evaluation

4. Use of Code Case N-411-1

Damping per Code Case N-411-1 meets the requirements as specified within Regulatory Guide 1.84, "Design and Fabrication Code Case Acceptability, ASME Section III, Division 1," Revision 25 through 27. R.G. 1.84 lists five (5) conditions which must be met in order to use this Code Case. Perry's Feedwater system snubber optimization complies with all five conditions.

a. Condition 1

Reanalysis of the Feedwater piping system for snubber optimization was done in full compliance with Condition 1. The Code Case damping was used completely and consistently.

b. Condition 2

Code Case N-411-1 damping values have only been used in those analyses in which current seismic spectra and procedures have been employed. Such use has been limited only to response spectra analysis. The Feedwater system reanalysis for snubber optimization has utilized response spectrum methodologies, thus fully satisfying the requirements of Condition 2.

c. Condition 3

The snubber optimization analysis for the Feedwater system has considered the effects of increased motion on existing clearances and on line mounted equipment. During startup testing, the piping system was walked down to verify existing clearances. The system was reviewed for maximum design movements plus one (1) inch additional clearance. All pipe support designs were reviewed to ensure that sufficient gap exists to accommodate the revised movement. The new movements were compared to the old movements at critical locations such as elbows and tees. This movement review is formally documented and verified. Only when the new movements are 1/2 inch larger than the existing movements is a field walkdown performed. For small bore piping (2 inches in diameter and smaller, i.e., root valves) when attached to a large bore pipe, the movement review of the large bore piping governs and therefore envelopes the small attached piping.

d. Condition 4

Condition 4 does not apply since the types of supports at issue [Code Case N-420 (Reference 7) supports] are not used at PNPP.

e. Condition 5

With respect to Condition 5, a case-specific evaluation is required, with NRC review, when Code Case N-411-1 is used on piping in which stress corrosion cracking has occurred. This case-specific evaluation has been performed for the Feedwater piping system even though the presence of IGSCC could not definitively be confirmed as the source of the indications previously identified in the N4C and N4E nozzle to safe-end welds. A summary of the results of this evaluation was documented in Summary Technical Report, "Evaluation Of Flaw Indication(s) In The Perry Feedwater To Safe-end Welds Examined During RF03," which was provided to the NRC staff by attachment to letter PY-CEI/NRR-1491L dated May 8, 1992 (Reference 8). A more detailed discussion of this evaluation is provided herein.

5. Code Compliance

All piping and pipe supports re-analyzed due to snubber optimization were required to meet the ASME Boiler and Pressure Vessel Code, Section III, Division 1 code of record within the existing system design specification or as otherwise provided within the pertinent design input for the specific scope of work.

The Feedwater system piping was originally analyzed to the 1977 Edition of the ASME Code (Reference 9), and the pipe supports were designed and installed to the 1974 Edition through Winter 1975 Addenda (Reference 10). The system was reanalyzed for snubber optimization by utilizing GE's ANSI-7 computer program, which had been updated to the 1983 Edition through Winter 1984 Addenda (Reference 11). The code of record for the Feedwater supports remained unchanged for snubber optimization.

A review of the 1983 and 1977 Editions of the ASME Section III piping analysis rules has been performed and independently verified. Any differences are "state-of-the-art" improvements in the understanding of piping failure modes and component stress distributions. The changes are neither more nor less conservative, but represent real improvements in knowledge of piping system behavior. None of the changes are linked to design; the component design standards B16.9, B16.11, B16.28, etc., did not change from 1977 to 1983, nor are the changes in stress rules linked to material, fabrication or inspection changes between 1977 and 1983.

In summary, the snubber optimization piping analysis for the Feedwater system was performed in accordance with ASME Code Section III, 1983 Edition through Winter 1984 Addenda. ASME Code Section III subsubarticle NCA-1140 allows such use of later code editions.

In view of the above, we find that the use of the 1983 Edition of the ASME Code Section III is justified. The 1983 Code represents a more current "state-of-the-art" view and understanding of piping and piping systems and is approved for use by the NRC. Because the 1977 Edition of the ASME Code is considered neither more nor less conservative than the 1983 Edition, it is considered acceptable to use the later code edition.

For purposes of the case-specific evaluation of the Feedwater system as discussed above (item 4), the following additional information concerning the Feedwater piping system is provided:

- Snubber type/size (pre and post snubber optimization) - See Table 1, "NSSS Feedwater Snubbers" (page 9).

- Snubber Optimization Analytical Model (page 10) which includes the existing location and orientation of snubbers.

- Summary of Feedwater piping peak stresses showing the calculated to allowable ratio - See Table 2, "Feedwater Piping Loop A Maximum Stresses (After Snubber Optimization)" (page 11).

- Summary of Feedwater snubber design loads prior to and after snubber optimization - See Table 3, "Comparison of Feedwater Snubber Loop A Design Loads (Prior to and After Snubber Optimization)" (page 12).

  NOTE: The Feedwater piping consists of two loops designated Loop A and Loop B. These two loops are symmetric. Loop A was analyzed, and therefore it is the Loop A analysis results which are presented in proprietary GE Design Report 23A6987, Revision 1, "Feedwater System Loop 'A' Piping and Equipment Load" (Reference 12). Due to symmetry, the results of the Loop A analysis are directly applicable to Loop B.

- Summary of Results (Post-optimization):

  - All piping meets the requirements of ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1983 Edition through Winter 1984 Addenda.

  - All pipe supports meet the requirements of ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1974 Edition through Winter 1975 Addenda.

The analysis performed by GE for the Feedwater System was reviewed by CEI to ensure compliance with all pertinent licensing basis documents for PNPP Unit 1. This review included a verification of the following items: design interface requirements, design conditions, break locations, fatigue, and loading conditions. CEI also utilized the Feedwater Analysis results to evaluate items such as: penetrations, supports, branch line connections, and the RPV nozzles. The PNPP Feedwater System was originally analyzed by GE. Only those changes necessary to perform snubber optimization were made.

Based on the review of information provided by GE, CEI determined the re-analysis to be acceptable. This information was used (on a partial basis) for determining the adequacy and acceptability of the piping, supports and structures following snubber optimization. All piping and supports meet ASME Code allowables and are in compliance with the PNPP Unit 1 licensing basis.

B. FEEDWATER SYSTEM CASE-SPECIFIC EVALUATION

The following is a listing of information previously submitted to the NRC staff by letter PY-CEI/NRR-1491L dated May 8, 1992:

- RF03 ultrasonic examination results of the N4C and N4E Feedwater nozzle indications.

- Mechanical Stress Improvement Process (MSIP) was applied to the subject N4C and N4E Feedwater nozzle to safe-end welds containing the indications.

- Confirmatory ultrasonic examination results following application of MSIP showed that the indications remained within the acceptance limits provided within NUREG-0313, Revision 2 (Reference 13), (max. "a/t" < 13%).

- Weldment reclassification from category "F" to category "E" in accordance with NUREG-0313, Revision 2.

Fracture analysis was performed by CEI prior to the third refueling outage with the interface loadings of snubber optimization fully considered. This analysis projected flaw sizes based on NRC constant crack growth rates and EPRI variable crack growth rates assuming 12,000 hours of operation until the fourth refueling outage. The acceptance criteria for flaw analysis was based on ASME Section XI, Appendix C, subparagraph C3320(c), 1986 Edition (Reference 14). The acceptance limit was demonstrated to be at an "a/t" equal to 60% and considered the normal, upset, emergency and faulted piping loads from the Feedwater piping snubber optimization analysis.

In summary, our case-specific evaluation concerning the Feedwater nozzle flaws has found:

- The flaw sizes are <13% a/t, which is well within the ASME Code acceptance limit of 60% a/t.

- The ASME Code acceptance limit considered normal, upset, emergency and faulted piping snubber optimization loads.

- Mechanical stress improvement has been applied to mitigate future flaw growth.

Based on the above, we have concluded that an adequate level of safety has been demonstrated and assured. Additionally, the weldments containing the mitigated flaws will be reinspected in the future in accordance with the schedule provided in NUREG-0313, Revision 2.

C. CONCLUSIONS

Based on the information provided above, the following conclusions have been reached:

- The NSSS snubber optimization analysis, as performed by GE and CEI, conforms to all Perry USAR allowable limits and all other pertinent design basis loading conditions.

- Code Case N-411-1 has been properly applied, with all conditions specified within Regulatory Guide 1.84 fully satisfied, including the case-specific evaluation for the Feedwater system due to the potential presence of IGSCC induced flaws.

- The evaluation of the RPV Feedwater nozzle indications reveals ample design (structural integrity) margin. This evaluation included proper consideration of revised worst-case loadings resulting from Feedwater snubber optimization. Further, mechanical stress improvement has been applied during RF03 to the subject feedwater nozzle to safe-end welds to mitigate future flaw propagation.

- There will be no adverse effect on overall plant safety due to implementation of snubber optimization. On the contrary, it is strongly believed that system/plant safety and reliability is enhanced due to the removal of components that have the potential for "failure" during normal plant operating conditions.

D. <u>REFERENCES</u>

1. ASME Boiler and Pressure Vessel Code, Code Case N-411-1, "Alternative Damping Values for Seismic Analysis of Piping, Section III, Division 1, Class 1, 2, and 3."

USNRC Regulatory Guide 1.84, Revision 25 - Design and Fabrication Code Case Acceptability ASME Section III, Division 1.

3. USNRC Regulatory Guide 1.92, Revision 1 - Combining Model Responses and Spatial Components in Seismic Response Analysis.

4. USNRC Regulatory Guide 1.61 - Damping Valves for Seismic Design of Nuclear Power Plants, October 1973.

5. USNRC Regulatory Guide 1.122 - Development of Floor Design Response Spectra for Seismic Design of Floor Supported Equipment for Components.

6. Perry Nuclear Power Plant, Updated Safety Analysis Report (USAR).

7. ASME Boiler and Pressure Vessel Code, Code Case N-420, "Linear Energy Absorbing Supports for Subsection NF, Classes 1, 2, and 3 Construction, Section III, Division 1."

8. PY-CEI/NRR-1491L, "Feedwater Nozzle Weld Indications (TAC No. 81879)," May 8, 1992.

9. ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1977 Edition.

10. ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1974 Edition through Winter 1975 Addenda.

11. ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1983 Edition through Winter 1984 Addenda.

12. GE Design Report 23A6987, Revision 1, "Feedwater System Loop 'A' Piping and Equipment Load" (Proprietary).

13. NUREG-0313, Revision 2, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping."

14. ASME Boiler and Pressure Vessel Code, Section IX, 1986 Edition.

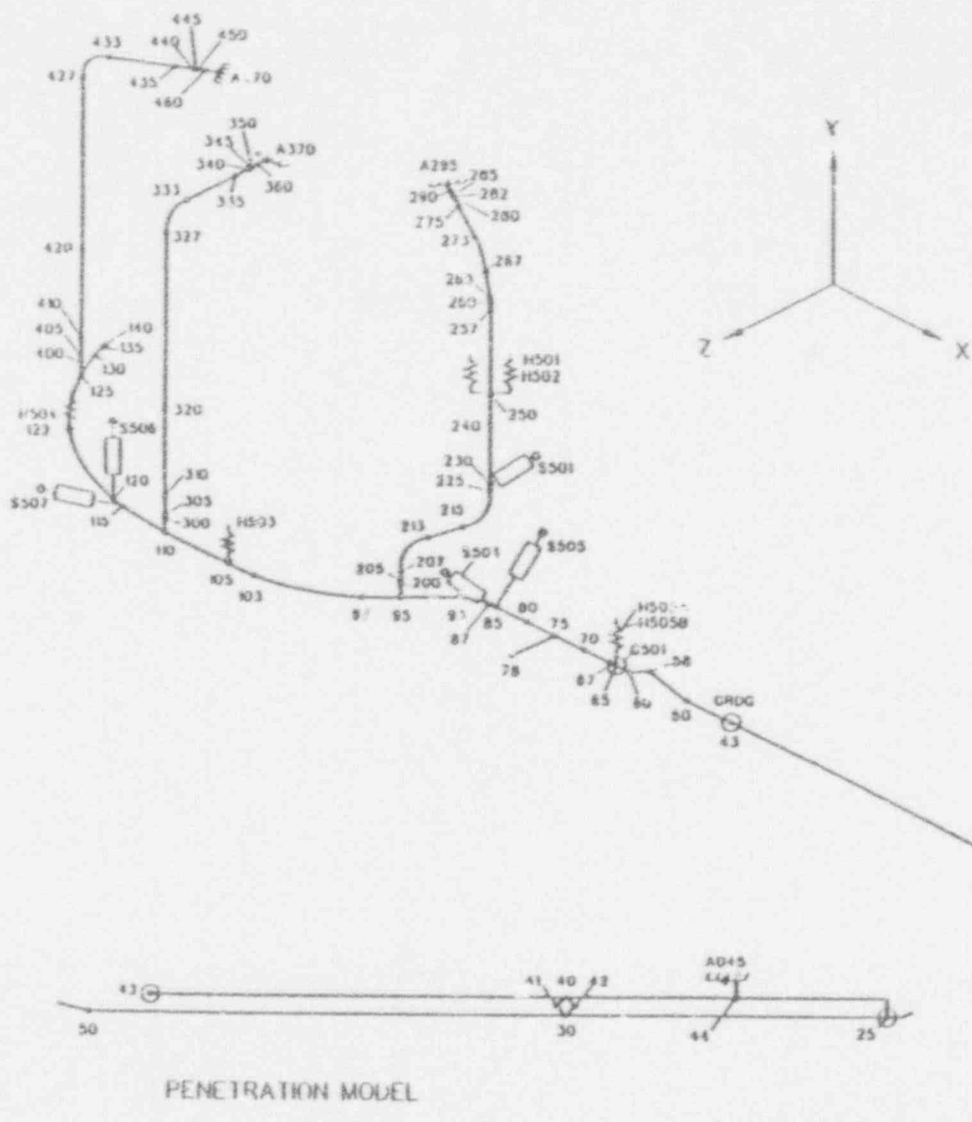
TABLE 1

NSSS FEEDWATER SNUBBERS

Mark Number	Loop	Size	Deleted
1N27H0001	A	50 KIP	No
1N27H0002	A	50 KIP	Yes
1N27H0004	A	50 KIP	No
1N27H0005	A	50 KIP	No
1N27H0006	A	70 KIP	No
1N27H0007	A	70 KIP	No
1N27H0008	A	30 KIP	Yes
1N27H0009	A	30 KIP	Yes
1N27H0025	A	70 KIP	Yes
1N27H0013	B	50 KIP	No
1N27H0014	B	50 KIP	Yes
1N27H0016	B	50 KIP	No
1N27H0017	B	50 KIP	No
1N27H0018	B	70 KIP	No
1N27H0019	B	70 KIP	No
1N27H0020	B	30 KIP	Yes
1N27H0021	B	30 KIP	Yes
1N27H0026	B	70 KIP	Yes

Notes : All snubbers are "E-Systems" Hydraulic Snubbers

FIGURE F2. PERRY FEEDWATER LOOP A STRESS ISOMETRIC (NODE) DIAGRAM



SNUBBER DESIGNATIONS

GE No.	Loop A	Loop B
S501	IN27-H001	IN27-H013
S504	-H004	-H016
S505	-H005	-H017
S506	-H006	-H018
S507	-H007	-H019

TABLE 2

FEEDWATER PIPING LOOP A MAXIMUM STRESSES (After Snubber Optimization)

Criteria	Loading	Limiting Stress Type	Allowable Stress (psi)	Maximum Calculated Stress (psi)	Node Location
Based on ASME B & PV Code, Section III, Subsection NB for SA-106 GR B @ 575°F S_y = 26,500 psi S_m = 17,700 psi					
For Normal and Upset Condition: $S_{limit} = 1.5\ S_m$	Normal and Upset Loads: 1. Weight of Structure 2. Pressure 3. Operating Basis Earthquake 4. SRV 5. Hydraulic	Primary Membrane Plus Bending	26,550	18,680	110
For Emergency Condition: $S_{limit} = 1.5\ S_y$	Emergency Loads: 1. Weight of Structure 2. Pressure 3. Operating Basis Earthquake 4. SRV 5. Hydraulic	Primary Membrane Plus Bending	39,750	22,140	110
For Faulted Condition: $S_{limit} = 1.5\ S_y$	Faulted Loads: 1. Weight of Structure Pressure 3. Operating Basis Earthquake 4. Annulus Pressurization 5. Hydraulic	Primary Membrane Plus Bending	39,750	33,090	110

Cummulative Usage Factor (Max) U = 0.64 Allowable: 1.0 Node Location: 110

TABLE 3

COMPARISON OF FEEDWATER SNUBBER LOOP A DESIGN LOADS
(Prior to and After Snubber Optimization)

Mark Number	Previous Design Loads, Kips (Prior to Snubber Optimization)	New Design Loads, Kips (After Snubber Optimization)	Ratio Previous/New
1N27H0001	34.6 (U)	10.8	3.2
	45.0 (E)	19.3	2.3
	62.3 (F)	31.0	2.0
1N27H0004	34.6 (U)	22.3	1.55
	45.0 (E)	26.5	1.70
	62.3 (F)	47.0	1.33
1N27H0005	54.2 (U)	19.2	2.8
	72.0 (E)	26.0	2.8
	97.5 (F)	45.3	2.2
1N27H0006	45.8 (U)	15.8	2.9
	60.9 (E)	29.8	2.0
	82.5 (F)	48.6	1.7
1N27H0007	70.0 (U)	28.6	2.4
	93.1 (E)	30.4	3.1
	142.1 (F)	82.2	1.7

(U) = Upset
(E) = Emergency
(F) = Faulted

ATTACHMENT 1

PERRY SNUBBER REDUCTION PROJECT

Project Summary White Paper

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May 1992

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INTRODUCTION

Hydraulic and mechanical snubbers are used extensively in Nuclear Power Plants to provide support to piping in the event of an earthquake or other dynamic transient such as a Loss-Of-Coolant-Accident (LOCA) or a Safety Relief Valve (SRV) discharge. Many plants have installed a large number of snubbers because of past conservative requirements. The significant number of snubbers in nuclear plants add to plant congestion and decrease piping system flexibility.

Because of the large numbers of snubbers and the complexity of their mechanisms, extensive inservice inspections, functional testing and maintenance programs have been established to ensure reliable snubber performance. These extensive programs result in increased levels of occupational radiation exposure (ORE) and increased plant operational costs.

Concern for these increases in exposure and in costs have led to the organization of piping Technical and Steering Committees by the Pressure Vessel Research Committee (PVRC) with active NRC and industry participation. Other Task Groups on Seismic Design and Dynamic Load/Load Combination under an NRC Piping Review Committee have also recognized the need for more current and realistic methods of dynamic analysis.

As a result of work by these committees and others, acceptable methods are now available to optimize nuclear plant piping suspension configurations. Optimization programs have now been performed by numerous utilities in which snubbers have either been eliminated or replaced by rigid struts.

Cleveland Electric Illuminating Company (CEI) has secured the services of GE Nuclear Energy (GE) to work jointly with CEI in the performance of such an optimization program for the Perry Nuclear Power Station. The major purposes of this program are to reduce occupational radiation exposure and to increase the overall safety of the piping systems while reducing plant maintenance and inspection costs.

This document describes the scope of services, the analytical methodology and criteria used and the results achieved by CEI and GE in the performance of the snubber reduction program.

1.0 ANALYSIS SCOPE

The scope of services for this program included reanalysis of the primary pressure boundary piping in the following systems:

- *Main Steam*
- *RCIC branch piping to Main Steam*
- *Recirculation*
- *RHR branch piping to recirculation*
- *RWCU*
- *Feedwater*
- *Inclined Fuel Transfer System*

The scope of services included a review and evaluation of interface loads from the piping to the supports and equipment attached to the piping in each system. This includes:

- *Supports (e.g. hangers, snubbers, rigid struts)*
- *Penetrations*
- *Guides*
- *Valves*
- *Pump/motor*
- *Nozzles*

Once analyses and interface evaluations were shown to satisfy Code requirements, the final phase of the program included an update of all drawings and documents affected by the reanalysis work. This included:

- *Piping Design Specification*
- *Piping Data Sheet and Certification*
- *Piping Stress Reports*
- *Suspension Drawings*
- *Support Calculations*
- *Pipe Break Design Report*
- *Interface Control Drawings*
- *USAR*

Additional documentation such as Field Disposition Instructions (FDI) and 10CFR 50.59 Safety Evaluations were prepared as necessary for the implementation of the program.

2.0 DYNAMIC METHODS

GE analyzed the piping systems listed above with the intent of recommending the elimination of snubbers. As an alternate to elimination, when displacements were minimal, a snubber could be replaced by a rigid strut. Replacement strut stiffnesses would utilize the same stiffness as for the snubber they would replace. The bases for achieving the snubber reduction was the application of current piping technology and methods acceptable to the NRC.

The load definitions and combinations that were used in the existing analyses and are documented in the Perry Updated Safety Analysis Report (USAR) were applied to the snubber reduction analyses.

GE analyzed all required seismic and hydrodynamic loads by the following method:

> *ASME Code Case N411-1 damping values were applied with the Uniform Support Motion (USM) response spectra analysis method in accordance with R.G. 1.84, Rev. 25. Closely spaced modes were combined in accordance with R.G. 1.92.*

The above method included high frequency modes per NUREG 1061, Volume 4, recommendations or SRP 3.7.2. The total combined response to high-frequency *modes is combined by the SRSS method with the total combined response from lower-frequency modes to determine the overall structural peak response.*

Response spectrum peaks were broadened ± 15%.

These methods were applied to selected piping systems as an alternative to the corresponding Regulatory Guides. When Code Case N-411-1 was used for earthquake or other dynamic loads, it was not mixed with R.G. 1.61 damping criteria for the same load case.

3.0. PIPING MODEL

GE utilized the piping models as were used in the existing as-built analyses for each piping system except that reviews of current piping as-built documents were utilized to update models where field changes had been made. Only minor modifications to models resulted from these reviews.

The mathematical model of the piping system used in the analysis included the piping, valves, pump/motor as appropriate, the suspension system for the piping and branch piping as applicable. Smaller lines (< 1/3 diameter of the main piping) such as sample lines and instrument lines do not affect the main piping response and therefore, were not included in the model.

The piping system is mathematically modeled to realistically reflect the static and dynamic reactions of the piping. The piping and equipment are represented in the model as a series of mass points (nodes) and interconnecting weightless springs. The mass points are generally selected so that their location coincides with the location of large masses. Mass points are spaced so that the elements between them will be of no greater length than a simple supported beam with uniformly distributed mass having a natural frequency equal to the cut-off frequency of the analysis. The nature of the seismic loads (low frequency) is such that they reach the Zero Period Acceleration (ZPA) by 33 Hz. Hydrodynamic loads are high frequency in nature and have reached the ZPA by 60 Hz. The seismic and hydrodynamic loads are combined in accordance with the load combinations as specified in the piping Design Specification.

4.0 ANALYSIS

GE's proprietary computer program, PISYS, was used to calculate the response of the piping system to all of the static and dynamic loads defined in the Design Specification. The output from the PISYS program was evaluated by another GE proprietary computer program, ANSI7, to solve the stress intensity equations of ASME III, Subarticle NB-3650 and to calculate the combined interface loads on the applicable pipe mounted/attached equipment.

Thermal gradients are conservatively calculated using the ANSI7 computer program by assuming an infinite heat transfer film coefficient with a linear process fluid temperature change equal to the step change defined for the load set. The radial gradients are computed idealizing the pipe wall as a flat plate. Longitudinal gradients are computed separately analyzing two sections and selecting the greatest temperature difference that occurs during the transient.

Fatigue requirements are satisfied according to ASME Section III analysis Subsection NB-3650, Equation 14, and according to MEB 3-1 criteria.

5.0 LOAD COMBINATIONS

Load combination criteria used were in accordance with the existing as-built design specifications and the Perry USAR.

6.0 LOAD CONSIDERATIONS FOR PIPING ANALYSES

The snubber reduction analyses utilized the following loads as were used in the existing piping analysis and as documented in the Perry USAR or design documents:

6.1 Weight, Pressure and Thermal Expansion, and/or Contraction

6.2 Pressure-Temperature cycle charts (Load Histograms)

6.3 Dynamic loads inertia spectra used in the existing analyses were converted to ASME Code Case N411-1 damping values.

6.4 Fluid Transients:

For those systems where applicable, GE considered transient loads due to valve opening or closure and steam discharge.

6.5 Jet Loads:

Piping analyses included jet load considerations in the same manner as were performed for the existing as-built analyses.

6.6 Functional Capability:

Functional Capability and Operability of piping and components following optimization were confirmed in accordance with NEDO-21985.

7.0 CONSIDERATIONS AS A RESULT OF PIPING ANALYSES

7.1 Pipe Rupture:

Pipe rupture was evaluated for the snubber reduction analysis results to assure that MEB 3-1 criteria were satisfied.

These reviews demonstrated that there were no changes in the locations of previously postulated breaks and that alterations to the previously designed pipe whip protection were not required.

Arbitrary Intermediate Break (AIB) locations were identified for deletion and the applicable documents including the Perry USAR were revised, as appropriate.

7.2 Jet Impingement:

Jet impingement calculations were not affected by the snubber reduction analyses.

7.3 Piping Displacements:

New piping displacements (thermal + inertia) were limited to the existing displacements plus 1/2" in order to assure that an adequate space envelope exists around the installed pipe.

7.4 Valve Evaluations:

The new valve accelerations were compared with the present design allowables to assure that the existing valve qualification was maintained.

For MSIV and SRV qualifications, revised required response spectra (RRS) will be generated using GE's proprietary computer program ERSIN. The revised RRS will be compared to the existing TRS to assure the validation of the present qualifications.

7.5 Equipment Nozzle Loads:

Loads applied to equipment nozzles were evaluated and their acceptability documented in the stress reports for the final configuration with the optimized suspension.

7.6 Anchors and Penetrations:

Anchor and penetration loads after optimization were shown to be less than the Design Allowable Load (DAL) for all analyzed loading conditions.

7.7 Appendages:

Accelerations for all inertial load cases were supplied to CEI for root valve and I/C branch line qualifications. Three components of acceleration, rotation and displacement for each analyzed load case were provided. These accelerations were then utilized by CEI to verify the root valve and I/C branch line qualifications.

7.8 Welded Attachments:

All welded attachments for the piping systems were qualified and the qualifications documented in the applicable stress reports.

8.0. SUPPORT EVALUATIONS

Calculated loads to supports were submitted to CEI for review and evaluation. Screening criteria for loads as defined by CEI to GE for support loads were as follows:

Governing Load Case For DAL	*Load Case Restrictions*
1. Normal or Upset (N)	*E ≤ 1.33 (N)* *F ≤ 1.80 (N)*
2. Emergency (E)	*N ≤ 0.752 (E)* *F ≤ 1.353 (E)*
3. Faulted (F)	*N ≤ 0.556 (F)* *E ≤ 0.739 (F)*

Reviews by CEI demonstrated that structural steel and support loads did not exceed design allowable loads.

9.0. CODE COMPLIANCE

The following listing (but not limited to) of codes, standards and regulatory requirements formed the bases for the snubber reduction program:

9.1 Codes and Standards:

9.1.1 ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1983 Edition with Winter 1984 Addenda (Class 1 Piping).

9.1.2 ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1983 Edition with Winter 1984 Addenda (Class 2 Piping and Class 1 and 2 Supports).

9.1.3 ASME Boiler and Pressure Vessel Code, Code Case N-122, Stress Indices for Integral Structural Attachments, Class 1 Section III, Division 1.

9.1.4 ASME Boiler and Pressure Vessel Code, Code Case N-319, Alternate Procedure for Evaluation of Stresses in Butt Weld Elbows in Class 1 Piping, Section III, Division 1.

9.1.5 ASME Boiler and Pressure Vessel Code, Code Case N-411-1, Alternative Damping Values for Seismic Analysis of Piping, Section III, Division 1, Class 1, 2, and 3.

9.2 Regulatory Requirements:

9.2.1 10CFR21, Reporting of Defects and Non-Compliance.

9.2.2 10CFR50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants.

9.2.3 USNRC Regulatory Guide 1.84, Revision 25 - Design and Fabrication Code Case Acceptability, ASME Section III Division 1.

9.2.4 USNRC Regulatory Guide 1.92, Revision 1 - Combining Modal Response and Spatial Components in Seismic Response Analysis.

9.2.5 Standard Review Plan NUREG 0800.

10.0 RESULTS AND CONCLUSIONS

The analyses completed have been shown to satisfy all requirements of the ASME Code Section III, Subsection NB 3600. Interfaces to all attached and mounted equipment have been shown to satisfy Code requirements. Loadings on nozzles have been reviewed and demonstrated to be acceptable. Existing qualifications have been maintained. Affected documents and drawings have been updated to reflect the suspension changes resulting from the snubber reduction analyses.

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