TECHNICAL EVALUATION REPORT

AUDIT FOR MARK I CONTAINMENT LONG-TERM PROGRAM — STRUCTURAL ANALYSIS FOR OPERATING REACTORS

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT NUCLEAR STATION UNIT 1

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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

1. INTRODUCTION

The capability of the boiling water reactor (BWR) Mark I containment suppression chamber to withstand hydrodynamic loads was not considered in the original design of the structures. The resolution of this issue was divided into a short-term program and a long-term program.

Based on the results of the short-term program, which verified that each Mark I containment would maintain its integrity and functional capability when subjected to the loads induced by a design-basis loss-of-coolant accident (LOCA), the NRC staff granted an exemption relating to the structural factor of safety requirements of 10CFR50, 55(a).

The objective of the long-term program was to restore the margins of safety in the Mark I containment structures to the originally intended margins. The results of the long-term program are contained in NUREG-0661 [1], which describes the generic hydrodynamic load definition and structural acceptance criteria consistent with the requirements of the applicable codes and standards.

The objective of this report is to present the results of an audit of the Nine Mile Point Nuclear Power Station plant-unique analysis (PUA) report with regard to structural analysis. The audit was performed using a moderately detailed audit procedure developed earlier [2] and attached to this report as Appendix A. The key items of the audit procedure are obtained from "Mark I Containment Program Structural Acceptance Criteria Plant Unique Analysis Application Guide" [3], which meets the criteria of Reference 1.

2. AUDIT FINDINGS

A detailed presentation of the audit for Nine Mile Point Nuclear Power Station Unit 1 is provided in Appendix A, which contains information with regard to several key items outlined in the audit procedure [2]. Based on this detailed audit, it is concluded that certain items in the Nine Mile Point PUA report [4] indicated noncompliance with the requirements of the criteria [3] and that several aspects of the analysis required further information. Based on this conclusion, the Licensee was requested to provide information with regard to several items contained in Appendix B of this report. An additional set of questions covering torus attached piping was sent to the Licensee and is also contained in Appendix B of this report. All responses [5] were presented and discussed at a meeting attended by the NRC, its consultants, and the Licensee and held at Teledyne Engineering Services on August 24, 1984. At the meeting, a detailed discussion of each response was conducted, and each was deemed satisfactory.

Request Item 1

The Licensee provided report TR-5320-2 [6], summarizing the analysis of torus attached piping. The report was considered satisfactory except for a few concerns which gave rise to an additional set of questions, to which the Licensee has responded [5] (see Items 1 through 5 below).

Additional Request Item 1

In this response, the Licensee indicated that, although the AISC code was used to design drywell steel instead of the ASME code, measures were taken to make the analysis consistent with the ASME code: yield strengths were reduced because of high temperatures, as required by the ASME code; piping supports were analyzed according to subsection NF of the ASME code; ASME weld allowables were used.

This response is satisfactory.

Additional Request Item 2

In this response, the Licensee provided sketches showing the support locations of SRV piping on drywell steel. The boundary conditions of the computer models of the drywell steel were also explained.

This response is satisfactory.

Additional Request Item 3

In this response, the Licensee indicated that the spherical shell portion of the beam seat computer model at elevation 259 feet (Fig. 2-13 in PUA report [6]) was restrained tangentially on all four sides. Also, an analysis by Niagara Mohawk showed that the choice of fixed or simply supported boundary conditions will not significantly affect stress results.

The Licensee's response has resolved this concern.

Additional Request Item 4

In this response, the Licensee stated that one branch line, part of the post-accident sampling line, was exempted from analysis by the 10% rule of Section 6.20 [3]. The Licensee concluded, by engineering judgment, that the stresses in this branch line would not exceed 10% of the allowable stress (the branch is 120 feet from the torus and the maximum displacement is 0.002 inches).

This response is satisfactory.

Additional Request Item 5

In this response, the Licensee explained why a single stress result appears for certain pairs of TAP lines in Table 3-1 of the PUA report [6]. Most pairs represent one drywell/wetwell vacuum breaker line, one number designating the torus penetration and the other designating the vent penetration. One pair, XS-334/335, represents two identical core spray pump test lines. Only the maximum result was reported

The Licensee's response has resolved this concern.

Additional Request Item 6

In this response, the Licensee indicated that the outside diameter (OD) for piping system XS-346 is 3/4 inches and its schedule is 40.

This response is satisfactory.

Additional Request Item 7

In this response, the Licensee provided a description of the method for evaluating fatigue in the torus shell. This was reviewed and judged satisfactory. The Licensee also provided the highest usage factors at torus penetrations.

The response is satisfactory.

Request Item 2

In this response, the Licensee indicated that vacuum breaker valve analysis is not required since plant-unique load evaluation shows valves will not cycle due to Mark I dynamic loads.

Since the criteria for vacuum breaker modifications are not addressed in Reference 3, the vacuum breaker evaluations are outside the scope of this technical evaluation report (TER). This issue will still be examined as part of the Mark I Long-Term Program and will be addressed in a separate TER.

The Licensee's response is satisfactory.

Request Item 3

In this response, the Licensee stated that typical fatigue data for piping were included in the data used for the generic presentation to the NRC [7]. Also, the fatigue usage factors for the Nine Mile Point plant are small and a plant-unique analysis is not required.

The Licensee's response is satisfactory.

Request Item 4

The Licensee indicated that all pumps and valves have been reviewed for operability, which was established by maintaining pipe stress at the component below level B allowable stress, per Section 5.5 of Reference 3. Tables 2-4 and 3-4 in report TR-5320-2 [6] summarize operability results.

This response is satisfactory.

Request Item 5

Regarding tensile forces in the torus support columns, the Licensee indicated that the nonlinear analysis required by Section 6.4c of the criteria [3] was intended for plants that did not have anchor restraints where torus uplift was possible; but at the Nine Mile Point plant, uplift forces are resisted by anchor bolts, producing a linear system for analysis purposes. The Licensee also stated that a nonlinear analysis was performed in the short-term program, before anchor bolts were installed.

The Licensee's response has resolved this concern.

Request Item 6

The Licensee indicated that, except in a few piping analyses in which seismic results were combined by the square root of the sum of the squares (SRSS) with other dynamic loads, all dynamic loads were added absolutely, assuming worst-case phasing.

This response is satisfactory.

Request Item 7

The Licensee confirmed that the vent ring header supports were considered class MC components. This response has resolved this concern.

Request Item 8

In this response, the Licensee provided a list of references used to derive the allowable stresses presented in the PUA report [4]. References are listed according to the component analyzed and include the applicable ASME Boiler and Pressure Vessel code sections. These references have been reviewed and found acceptable.

The Licensee's response has resolved this concern.

Request Item 9

The Licensee reviewed the bounding technique used to determine the controlling load cases presented in the PUA report [4]: the most important considerations were that for shells, level A and B allowables are the same, and the higher stress allowables for earthquake loads were not used because these loads are small. Also, a table was provided to indicate which combinations were bounded by which other combinations. This response is satisfactory.

Request Item 10

In this response, the Licensee claimed that its use of a 1/20 segment model to analyze torus shell stresses for asymmetric loads (horizontal earthquake, SRV, chugging) was justified because the effect of asymmetric loads on shell stress is very small and the conservatism involved in using symmetric boundary conditions for each torus segment compensates for the suppression of asymmetric response. The Licensee also believes that the smaller finite element sizes of the segment model produce higher and more accurate stresses than would a coarser 180° model.

The Licensee's response has resolved this concern.

Request Item 11

Regarding the analysis of the vent system for asymmetric loads, the Licensee compared an analysis on a 180° model to an analysis on a 45° model. The results showed that the 45° model produced higher stresses. This was attributed to conservative methods used to apply loads to the 45° model. The Licensee concluded that it was justified in using a 45° model instead of a 180° model in analyzing the vent system. This response is satisfactory.

Request Item 12

The Licensee was asked to indicate conservatisms in the analysis to show that high stresses in the torus shell, saddle-to-saddle weld, ring-girder weld to torus, and monorail column and baseplate weld would not exceed allowables if a different analytical approach were to be used. The Licensee responded as follows: the torus shell used an 84% non-exceedance probability (NEP) for design basis accident (DBA) condensation oscillation harmonic combination, whereas the recommended harmonic combination is 50% NEP; the high saddle to shell weld stress is a local phenomenon caused by the pattern of finite element mesh in the computer model; the ring-girder weld to torus shell analysis compared load combination 25 (Table 1 of the PUA report [4]) with the Level A allowable, whereas the allowable should be Level C; the monorail weld stress was compared with the yield stress allowable instead of the Level D allowable limit, which would have resulted in an additional 20% margin.

The Licensee's response has resolved this concern.

Request Item 13

In this response, the Licensee provided the technical basis for obtaining the static degree of freedom for the torus model and a brief description of the boundary conditions. The response included the following major points:

- Five major nodal rings about the torus model circumference.
- Nodes spaced at 10° increments about the circumference to maintain an aspect ratio less than 2:1.
- Additional refinement required at shell intersection with ring girder and saddle to obtain local stresses.
- Static degrees of freedom (SDOF) = 2475.
- Boundary conditions for the cross-sectional plane are: two in-plane moments and the normal translation.

The Licensee's response has resolved this concern.

Request Item 14

In explaining why four harmonics were considered for torus shell stresses due to condensation oscillation and only three were considered for the supports, the Licensee referred to Structural Mechanical Associates Report 12101.04-R001D. Based on a statistical study using full-scale test facility data, this report concluded that the condensation oscillation design response should use the absolute sum of the three highest harmonics. The Licensee used the absolute sum of the four highest harmonics for torus shell stresses to bound the full-scale testing facility test data.

The Licensee's response has resolved this concern.

Request Item 15

In this response, the Licensee indicated that pre-chug bounds post-chug for saddle and column loads. However, generic testing showed torus shell stress at mid bay, bottom dead center to be bounded by post-chug. This apparent inconsistency is explained by examining the type of stress being considered at mid bay, bottom dead center. This stress is a combination of membrane and bending stress, and the bending portion is likely the result of local shell flexibility, which would not increase column loads.

The Licensee's response is satisfactory.

Request Item 16

Regarding the calculation of torus stresses due to SRV line discharges, the Licensee stated that SRV dry structure techniques were extensively studied by the Mark I program which found excellent correlation of calculated-to-measured shell stress. Also, several conservatisms were included in the actual SRV analysis: maximum shell pressure and maximum frequency were combined into one bounding case; the maximum frequency was increased by 40% to account for possible frequency shifts; the maximum frequency and maximum shell pressures that were combined were for worst cases, not necessarily for the same line; multiple line actuation was accounted for by direct addition of pressures, assuming all lines produced the worst combined load.

This response is satisfactory.

Request Item 17

Because the fatigue analysis of the torus depended upon the operator initiating a procedure to end chugging within 15 minutes of a small break accident, the Licensee was asked to provide precautionary measures in case the operator failed to act. The Licensee responded that the NRC and the TMI BWR Owners Group were reviewing the plant emergency procedure guides and that the Nine Mile Point plant would implement the emergency procedure guides as necessary.

This response is satisfactory.

Request Item 18

In this response, the Licensee provided the ASME B&PV code sections used to calculate stress for the vent header columns, vent pipe/vent header intersection, vent pipe/drywell intersection, vent header mitre joint, and main vent pipe. These code sections were reviewed and found to be appropriate.

The Licensee's response is satisfactory.

Request Item 19

In this response, the Licensee indicated that the hand analysis of the vent header deflector considered a simply supported beam with no overhang and a uniformly distributed weight with a superimposed triangular distribution. The overhang were considered separately and the results combined with the beam results. A dynamic load factor of 1.0 was determined.

The Licensee's response has resolved this concern.

Request Item 20

The Licensee was asked to explain how relative timing between pool swell water impact loadings on the vent system were maintained to preserve an accurate representation of the longitudinal and circumferential wave sweep. The response indicated that a detailed finite element model of the vent system was used and a computer program was written to calculate modal time histories. Longitudinal and circumferential wave sweep was developed using load definition report methodology.

The Licensee's response has resolved this concern.

Request Item 21

In this response, the Licensee indicated that a stiffness matrix for the vent header/vent pipe intersection was obtained from a detailed finite element model of the intersection. This stiffness matrix was input directly into the vent beam model.

This response is satisfactory.

Request Item 22

In this response, the Licensee confirmed that thermal stress was considered in the evaluation of the main vent/drywell intersection and that SSE seismic loads were considered in the primary local membrane stress.

The Licensee's response has resolved this concern.

Request Item 23

In this response, the Licensee indicated that the stress intensification factors (SIF) used in the fatigue evaluation of the vent system were obtained as follows: the vent header/vent pipe intersection SIF was provided by GE Report NEDE-21968, "Analysis of Vent Pipe - Ring Header Intersection," April 1979; the vent pipe/drywell penetration SIF was based on Welding Research Council Bulletin 107-Appendix B; the vent header/downcomer intersection SIF was based on a finite element model of the vent system.

Request Item 24

In this response, the Licensee explained how dynamic effects of structures attached to the ring girder were considered. The quencher support beam was included in the SRV piping model, and the dynamic effects were accounted for in the dynamic analysis. The monorail was analyzed using a dynamic load factor of 1.10, which was based on the natural frequency of the monorail and the applied frequency of the FROTH 1 load. The spray header system used a dynamic load factor of 1.0 because of the stiffness and high natural frequency of the spray header. The vent header column loads were obtained from a combination of events: pool swell impact and drag on the vent header, on which a dynamic analysis was performed; pool swell impact and drag on the vent header deflector, using a static analysis with a dynamic load factor of 1.0 (1.4-Hz loading frequency compared to a structural frequency of 25 Hz); and vent system thrust loads, using a static analysis and a dynamic load factor of 1.0.

The Licensee's response has resolved this concern.

Request Item 25

In explaining the dynamic analysis of the quencher and support system for chugging loads, the Licensee indicated that a harmonic analysis was performed using a unit load input for all individual frequency components from 1 to 31 Hz. The maximum pressure amplitude for chugging at each frequency was then multiplied by the results of the harmonic analysis at that frequency to obtain the response at that frequency.

The Licensee's response is satisfactory.

Request Item 26

Regarding the analysis of the quencher and the "added mass" effect of the surrounding water, the Licensee stated that the Y-quencher hydrodynamic mass was included in the analysis which combined occasional plus sustained loadings per equation 9 of ASME BPVC, Subsection NC. The maximum of pool swell, condensation oscillation, or chugging loads was added to equation 9, and the stress compared to the allowable. The quencher was assumed purged of water for analysis.

The Licensee's response is satisfactory.

Request Item 27

In explaining why four frequency contributions were considered for the condensation oscillation analysis of the quencher and supports and five were considered for the chugging analysis, the Licensee referred to Structural Mechanical Associates report 12101.05-R001. Based on a statistical study of full-scale testing facility data for chugging loads, this report concluded that five chugging harmonics must be combined to bound full-scale testing facility data. Request Item 14 covered the four frequency contribution for condensation oscillation.

Request Item 28

The response to this item was covered in response to Item 24.

Request Item 29

In this response, the Licensee indicated that the bellows was evaluated by comparison of deflections against manufacturer's allowables and that the dynamic response of the containment shell is less than 20% of the bellows' allowable deflection. Because of the low dynamic response of the containment with respect to the allowable bellows movement, the Licensee concluded that a dynamic analysis of the bellows was not necessary.

The Licensee's response is satisfactory.

Request Item 30

In this response, the Licensee provided some possible reasons for the discrepancy between predicted torus column loads and measured test loads due to SRV actuation. The salient points of the Licensee's response were some plants were initially tested without the saddles fully installed; a single bounding generic calibration factor (0.4) was used for all plants tested because addition of support saddles made later plant unique instrumentation impractical; analyzed column loads are high because of the assumed uniform load distribution used by the computer program.

The Licensee's response has resolved this concern.

3. CONCLUSIONS

Based on the audit of the Nine Mile Point Unit 1 plant-unique analysis report, it was concluded earlier that certain aspects required additional information. Based on the Licensee's responses to the request for additional information, it is concluded that the Licensee's structural analyses with regard to major plant modifications and the torus-attached piping conform to the criteria requirements. The Licensee's approach to the evaluation of piping fatigue conforms to the approach recommended by the Mark I Owner's Group, which has been accepted by the NRC. The evaluation criteria of the containment vacuum breaker modifications are not addressed in Reference 3 and are therefore outside the scope of this TER; however, this issue will still be examined as part of the Mark I Long-Term Program.

4. REFERENCES

1. NUREG-0661
"Safety Evaluation Report, Mark I Containment Long-Term Program Resolution of Generic Technical Activity A-7"
Office of Nuclear Reactor Regulation
USNRC
July 1980

2. Technical Evaluation Report
Audit Procedure for Mark I Containment Long-Term Program - Structural Analysis
Franklin Research Center, Philadelphia, PA
June 1982, TER-C5506-308

3. NEDO-24583-1
"Mark I Containment Program Structural Acceptance Criteria Plant Unique Analysis Application Guide"
General Electric Co., San Jose, CA
October 1979

4. Nine Mile Point Unit 1 Nuclear Generating Station
Plant Unique Analysis Report
TR-5320-1
Niagara Mohawk Power Company
Teledyne Engineering Services
October 5, 1983

5. Nine Mile Point Unit 1 Nuclear Generating Station
Review of Plant Unique Analysis Report for Nine Mile Point Unit 1
Niagara Mohawk Power Company
Teledyne Engineering Services
August 23, 1984

6. Nine Mile Point Unit 1 Nuclear Generating Station
Plant Unique Analysis Report of Torus Attached Piping
TR-5320-2
Niagara Mohawk Power Company
Teledyne Engineering Services
April, 1984

7. P. M. Kasik
"Mark I Piping Fatigue"
Presentation at the NRC Meeting, Bethesda, MD
September 10, 1982.

APPENDIX A

AUDIT DETAILS

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1. INTRODUCTION

The key items used to evaluate the Licensee's general compliance with the requirements of NUREG-0661 [1] and specific compliance with the requirements of "Mark I Containment Program Structural Acceptance Criteria Plant Unique Analysis Application Guide" [2] are contained in Table 2-1. This audit procedure is applicable to all Mark I containments, except the Brunswick containments, which have a concrete torus.

For each requirement listed in Table 2-1, several options are possible. Ideally, the requirement is met by the Licensee, but if the requirement is not met, an alternative approach could have been used. This alternative approach will be reviewed and compared with the audit requirement. An explanation of why the approach was found conservative or unconservative will be provided. A column indicating "Additional Information Required" will be used when the information provided by the Licensee is inadequate to make an assessment.

A few remarks concerning Tables 2-1 and 2-2 will facilitate their future use:

- o A summary of the audit as detailed in Table 2-1 is provided in Table 2-2, highlighting major concerns. When deviations are identified, reference to appropriate notes are listed in Table 2-1.
- o Notes will be used extensively in both tables under the various columns when the actual audits are conducted, to provide a reference that explains the reasons behind the decision. Where the criterion is satisfied, a check mark will be used to indicate compliance.
- o When a particular requirement is not met, the specific reasons for noncompliance will be given.

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach Conservative	Licensee Uses Alternate Approach Unconservative	NA	Remarks
1.2	All structural elements of the vent system and suppression chamber must be considered in the review.	✓						
	The following pressure retaining elements (and their supports) must be considered in the review:	✓						
	o Torus shell with associated penetrations, reinforcing rings, and support attachments	✓						
	o Torus shell supports to the containment structure	✓						
	o Vents between the drywell and the vent ring header (including penetrations therein)	✓						
	o Region of drywell local to vent penetrations	✓						
	o Bellows between vents and torus shell (internal or external to torus)	✓						
	o Vent ring header and the downcomers attached to it	✓						
	o Vent ring header supports to the torus	✓						
	o Vacuum breaker valves attached to vent penetrations within the torus (where applicable)						✓	
	o Vacuum breaker piping systems, including vacuum breaker valves attached to torus shell penetra-	✓		SEE NOTE 2				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN

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Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
1.2	(Cont.)							
	tions and to vent penetrations external to the torus (where applicable)							
	o Piping systems, including pumps and valves internal to the torus, attached to the torus shell and/or vent penetrations	✓		SEE NOTE 1				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	o All main steam system safety relief valve (SRV) piping	✓		"				"
	o Applicable portions of the following piping systems:							
	- Active containment system piping systems (e.g., emergency core cooling system (ECCS) and other piping required to maintain core cooling after loss-of-coolant accident (LOCA))	✓		"				"
	- Piping systems which provide a drywell-to-wetwell pressure differential (to alleviate pool swell effects)	✓		"				"
	- Other piping systems, including vent drains	✓		"				"
	o Supports of piping systems mentioned in previous item			"				"
	o Vent header deflectors including associated hardware	✓						

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach Conser-vative	Licensee Uses Alternate Approach Unconser-vative	NA	Remarks
1.2	(Cont.)							
	o Internal structural elements (e.g., monorails, catwalks, their supports) whose failure might impair the containment function	✓						
1.3	a. The structural acceptance criteria for existing Mark I containment systems are contained in the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Division 1 (1977 Edition), with addenda through the Summer 1977 Addenda [3] to be referred herein as the Code. The alternatives to this criteria provided in Reference 2 are also acceptable.	✓						
	b. When complete application of the criteria (item 1.3a) results in hardships or unusual difficulties without a compensating increase in level of quality and safety, other structural acceptance criteria may be used after approval by the Nuclear Regulatory Commission.	✓						

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach Conservative	Licensee Uses Alternate Approach Unconservative	NA	Remarks
2.1	a. Identify the code or other classification of the structural element	✓		SEE NOTE 7				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	b. Prepare specific dimensional boundary definition for the specific Mark I containment systems (Note: Welds connecting piping to a nozzle are piping welds, not Class MC welds)	✓						
2.2	Guidelines for classification of structural elements and boundary definition are as follows: (Refer to Table 2-3 and Table 2-4 for non-piping and piping structural elements, respectively, and to item 5 in this table for row designations used for defining limits of boundaries)							
	a. Torus shell (Row 1) - The torus membrane in combination with reinforcing rings, penetration elements within the NE-3334 [3] limit of reinforcement normal to the torus shell, and attachment welds to the inner or outer surface of the above members but not to nozzles, is a Class MC [3] vessel.	✓						

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach Conservative	Licensee Uses Alternate Approach Unconservative	NA	Remarks
2.2	(Cont.)							
	b. Torus shell supports (Row 1) - Subsection NF [3] support structures between the torus shell and the building structure, exclusive of the attachment welds to the torus shell; welded or mechanical attachments to the building structures (excluding embedments); and seismic constraints between the torus shell and the building structure are Class MC [3] supports.	✓						
	c. External vents and vent-to-torus bellows (Row 1) - The external vents (between the attachment weld to the drywell and the attachment weld to the bellows) including: vent penetrations within the NE-3334 [3] limit of reinforcement normal to the vent, internal or external attachment welds to the external vent but not to nozzles, and the vent-to-torus bellows (including attachment welds to the torus shell and to the external vents) are Class MC [3] vessels.	✓						

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach Conservative	Licensee Uses Alternate Approach Unconservative	NA	Remarks
2.2	(Cont.)							
	d. Drywell-vent connection region (Row 1) - Vent welded connections to the drywell (the drywell and the drywell region of interest for this program is up to the NE-3334 [3] limit of reinforcement on the drywell shell) are Class MC [3] vessels.	✓						
	e. Internal vents (Rows 2 and 3) - Are the continuation of the vents internal to the torus shell from the vent-bellows welds and include: the cylindrical shell, the closure head, penetrations in the cylindrical shell or closure head within the NE-3334 [3] limit of reinforcement normal to the vent, and attachment welds to inner or outer surface of the vent but not to nozzles.	✓						
	f. Vent ring header (Rows 4 and 5) and downcomers (Row 6) - Vent ring header including the downcomers and internal or external attachment welds to the ring header and the attachment welds to the downcomers are Class MC [3] vessels.	✓						

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
2.2	(Cont.)							
	- The portion of the downcomer within the NE-3334 [3] limit of reinforcement normal to the vent ring header and portion of the vent ring header within NE-3334 limit of reinforcement arc considered under Row 5.							
	g. Vent ring header supports (Row 7) - Subsection NF [3] supports, exclusive of the attachment welds to the vent ring header and to the torus shell, are Class MC [3] supports.	✓		SEE NOTE 7				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	h. Essential (Rows 10 and 11) and non-essential (Rows 12 and 13) piping systems - A piping system or a portion of it is essential if the system is necessary to assure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a shutdown condition, or the capability to prevent or mitigate the consequences of	✓		SEE NOTE 1				//

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
2.2	(Cont.) accidents which could result in potential off site exposures comparable to the guideline exposure of 10CFR100 [4]. Piping should be considered essential if it performs a safety-related role at a later time during the event combination being considered or during any subsequent event combination.							
	i. Active and inactive component (Rows 10-13) - Active component is a pump or valve in an essential piping system which is required to perform a mechanical motion during the course of accomplishing a system safety function.	✓		SEE NOTE 4				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	j. Containment vacuum breakers (Row 2) - Vacuum breakers valves mounted on the vent internal to the torus or on piping associated with the torus are Class 2 [3] components.	✓		SEE NOTE 2				"

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
2.2	(Cont.)							
	k. External piping and supports (Rows 10-13): - No Class 1 piping							
	- Piping external to and penetrating the torus or the external vents, including the attachment weld to the torus or vent nozzle is Class 2 [3] piping. The other terminal end of such external piping should be determined based on its function and isolation capability.	✓		SEE NOTE 1				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	- Subsection NF [3] support for such external piping including welded or mechanical attachment to structure; excluding any attachment welds to the piping or other pressure retaining component are Class 2 [3] supports.	✓		SEE NOTE 1				"
	l. Internal piping and supports (Rows 10-13) - Are Class 2 or Class 3 piping and Class 2 or Class 3 component supports.	✓		SEE NOTE 1				"
	m. Internal structures (Row 8) - Non-safety-related elements which are not pressure retaining, exclusive of attachment welds to any pressure retaining	✓						

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
2.2	(Cont.) member (e.g., monorails. ladders, catwalks, and their supports).							
	n. Vent deflectors (Row 9) - Vent header flow deflectors and associated hardware (not including attachment welds to Class MC vessels) are internal structures.	✓						
3.2	Load terminology used should be based on Final Safety Analysis Report (FSAR) for the unit or the Load Definition Report (LDR) [5]. In case of conflict, the LDR loads shall be used.	✓						
3.3	Consideration of all load combinations defined in Section 3 of the LDR [5] shall be provided.	✓						
4.3	a. No reevaluation for limits set for design pressure and design temperature values is needed for present structural elements.	✓						
	b. Design limit requirements used for initial construction following normal practice with respect to load definition and allowable stress shall be used for systems or	✓		SEE NOTE 8				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered In the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach Conservative	Licensee Uses Alternate Approach Unconservative	NA	Remarks
4.3	(Cont.) portions of systems that are replaced and for new systems.							
4.4	Service Limits and Design Procedures shall be based on the B&PV Code, Section III, Division 1 including addenda up to Summer 1977 Addenda [3], specifically:							See definition for Service Limits in Section 4 of Reference 2.
	a. Class MC containment vessels: Article NE-3000 [3]	✓		SEE NOTE 8				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	b. Linear-type component (Class 2 and 3) support - with three modifications to the Code: - For bolted connections, the requirements of Service Limits A and B shall be applied to Service Limits C and D without increase in the allowables above those applicable to Service Levels A and B; - NF-3231.1 (a) [3] is for primary plus secondary stress range;	✓		"				"

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NRC Contract No. NRC-03-81-130
FRC Project No. C5506
FRC Assignment No. 12
FRC Task No. 331
Plant Name NINE MILE POINT UNIT 1

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
	- All increases in allowable stress permitted by Subsection NF [3] are limited by Appendix XVII-2110(b) [3] when buckling is a consideration.							
	c. Class 2 and 3 piping, pumps, valves, and internal structures (also Class MC)	✓		SEE NOTES 1,2A				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
5.3	The components, component loadings, and service level assignments for Class MC [3] components and internal structures shall be as defined in Table 5-1 of Reference 2.	✓						
5.4	The components, component loadings, and service level assignments for Class 2 and Class 3 piping systems shall be defined in Table 5-2 of Reference 2.	✓		SEE NOTES 1,2,4				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
5.5	The definition of operability is the ability to perform required mechanical motion and functionality is the ability to pass rated flow.							
	a. Active components shall be proven operable. Active components shall be considered operable if Service Limits A or B or more conservative limits (if the original design criteria required it) are met.	✓		SEE NOTE 4				//

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
5.5	(Cont.)							
	b. Piping components shall be proven functional in a manner consistent with the original design criteria.	✓		SEE NOTES 1,2				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
6.1	Analysis guidelines provided herein shall apply to all structural elements identified in item 1.2 of this table.	✓						
	a. All loadings defined in subsection 3.2 of Reference 2 shall be considered.	✓						See Section 3.3 of this table.
	b. A summary technical report on the analysis shall be submitted to the NRC.	✓		SEE NOTE 1				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
6.2	The following general guidelines shall be applied to all structural elements analyzed:							
	a. Perform analysis according to guideline defined herein for all loads defined in LDR [5]. (For loads considered in original design, but not redefined by LDR, previous analyses or new analyses may be used.)	✓						
	b. Only limiting load combination events need be considered.	✓		SEE NOTE 9				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN

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Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach Conservative	Licensee Uses Alternate Approach Unconservative	NA	Remarks
6.2	(Cont.)							
	c. Fatigue effects of all operational cycles shall be considered.	✓		SEE NOTES 3, 17, 23				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	d. No further evaluation of structural elements for which combined effect of loads defined in LDR [5] produces stresses less than 10% of allowable is required. Calculations demonstrating conformance with the 10% rule shall be provided.	✓						
	e. Damping values used in dynamic analyses shall be in accordance with NRC Regulatory Guide 1.61 [6].	✓						
6.3	Structural responses for loads resulting from the combination of two dynamic phenomena shall be obtained in the following manner:							
	a. Absolute sum of stress components, or	✓		SEE NOTE 6				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	b. Cumulative distribution function method if absolute sum of stress components does not satisfy the acceptance criteria.	✓		"				"
6.4	Torus analysis shall consist of:							

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
6.4	(Cont.)							
	a. Finite element analysis for hydrodynamic loads (time history analysis) and normal and other loads (static analysis) making up the load combinations shall be performed for the most highly loaded segment of the torus, including the shell, ring, girders, and support.	✓		SEE NOTES 12,13, 14,15, 16				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	b. Evaluation of overall effects of seismic and other nonsymmetric loads shall be provided using beam models (of at least 180° of the torus including columns and seismic restraints) by use of either dynamic load factors or time history analysis.	✓		SEE NOTES 10,30				"
	c. Provide a non-linear time history analysis, using a spring mass model of torus and support if net tensile forces are produced in columns due to upward phase of loading.	✓		SEE NOTE 5				"
	d. Bijlaard formulas shall be used in analyzing each torus nozzle for effect of reactions produced by attached piping. If Bijlaard formulas are not	✓		SEE NOTE 1				"

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Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
6.4	(Cont.) applicable for any nozzle, finite element analysis shall be performed.							
6.5	In analysis of the vent system (including vent penetration in drywell, vent pipes, ring header, downcomers and their intersections, vent column supports, vent-torus bellows, vacuum breaker penetration, and the vent deflectors), the following guidelines shall be followed:							SEE NOTES 18, 22, 29 THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	a. Finite element model shall represent the most highly loaded portion of ring header shell in the "non-vent" bay with the downcomers attached.	✓						
	b. Finite element analysis shall be performed to evaluate local effects in the ring header shell and downcomer intersections. Use time history analysis for pool swell transient and equivalent static analysis for downcomer lateral loads.	✓		SEE NOTE 20				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN

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Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach Conservative	Licensee Uses Alternate Approach Unconservative	NA	Remarks
6.5	(Cont.)							
	c. Evaluation of overall effects of seismic and other nonsymmetrical loads shall be provided using beam models (of at least 180° of the vent system including vent pipes, ring header and column supports) by the use of either dynamic load factors or time history analysis.	✓		SEE NOTES 11,21				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN.
	d. Use beam models in analysis of vent deflectors.	✓		SEE NOTE 19				"
	e. Consider appropriate superposition of reactions from the vent deflectors and ring headers in evaluating the vent support columns for pool swell.	✓						
6.6	a. Analysis of torus internals shall include the catwalks with supports, monorails, and miscellaneous internal piping.	✓						
	b. It shall be based on hand calculations or simple beam models and dynamic load factors and equivalent static analysis.	✓		SEE NOTES 12,24, 28				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
6.6	(Cont.)							
	c. It shall consider Service Level D or E when specified by the structural acceptance criteria using a simplified nonlinear analysis technique (e.g., Bigg's Method).							
6.7	Analysis of the torus attached piping shall be performed as follows:							
	a. Designate in the summary technical report submitted all piping systems as essential or non-essential for each load combination.	✓		SEE NOTE 1				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	b. Analytical model shall represent piping and supports from torus to first rigid anchor (or where effect of torus motion is insignificant).	✓		//				//
	c. Use response spectrum or time history analysis for dynamic effect of torus motion at the attachment point, except for piping systems less than 6" in diameter, for which equivalent static analysis (using appropriate amplification factor) may be performed.	✓		//				//

Table 2-1. Audit Procedure for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Section No. [2]	Key Items Considered in the Audit	Criteria Met	Criteria Not Met	Addtl. Info. Reqd.	Licensee Uses Alternate Approach: Conservative	Licensee Uses Alternate Approach: Unconservative	NA	Remarks
6.7	(Cont.)							
	d. Effect of anchor displacement due to torus motion may be neglected from Equation 9 of NC or ND-3652.2 [3] if considered in Equations 10 and 11 of NC or ND-3652.3 [3].	✓		SEE NOTE 1				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
6.8	Safety relief valve discharge piping shall be analyzed as follows:							
	a. Analyze each discharge line.	✓		"				"
	b. Model shall represent piping and supports, from nozzle at main steam line to discharge in suppression pool, and include discharge device and its supports.	✓						
	c. For discharge thrust loads, use time history analysis.	✓		SEE NOTE 1				THE LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	d. Use spectrum analysis or dynamic load factors for other dynamic loads.	✓		SEE NOTES 1, 24, 25, 26, 27				"

Table 2-2. Audit Summary for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Structural Element	General Requirements: Code Classification	General Requirements: Loads	General Requirements: Service Limits	Analysis Requirements: Method of Analysis	Analysis Requirements: All Limiting Loads Considered	Analysis Requirements: Fatigue Effects	Analysis Requirements: Method of Combining Response	Analysis Requirements: Results	Remarks
a. Torus shell with associated penetrations, reinforcing rings, and support attachments	✓	✓	✓	✓	✓	✓	✓	✓	
b. Torus shell supports to the building structure	✓	✓	✓	✓	✓	✓	✓	✓	
c. Vents between the drywell and the vent ring header (including penetrations therein)	✓	✓	✓	✓	✓	✓	✓	✓	
d. Region of drywell local to vent penetrations	✓	✓	✓	✓	✓	✓	✓	✓	
e. Bellows between vents and torus shell (internal or external to torus)	✓	✓	✓	✓	✓	✓	✓	✓	
f. Vent ring header and the downcomers attached to it	✓	✓	✓	✓	✓	✓	✓	✓	
g. Vent ring header supports to the torus shell	✓	✓	✓	✓	✓	✓	✓	✓	
h. Vacuum breaker valves attached to vent penetrations within the torus (where applicable)	NA	NA	NA	NA	NA	NA	NA	NA	
i. Vacuum breaker piping systems, including vacuum breaker valves attached to torus shell penetrations and to vent penetrations external to the torus (where applicable)	*	*	*	*	*	*	*	*	VACUUM BREAKER VALVES ARE OUTSIDE THE SCOPE OF THIS TER
j. Piping systems, including pumps and valves internal to the torus, attached to the torus shell and/or vent penetrations	✓	✓	✓	✓	✓	✓	✓	✓	

Table 2-2. Audit Summary for Structural Acceptance Criteria of Mark I Containment Long-Term Program

Structural Element	General Requirements: Code Classification	General Requirements: Loads	General Requirements: Service Limits	Analysis Requirements: Method of Analysis	Analysis Requirements: All Limiting Loads Considered	Analysis Requirements: Fatigue Effects	Analysis Requirements: Method of Combining Response	Analysis Requirements: Results	Remarks
k. All main steam system safety relief valve (SRV) piping	✓	✓	✓	✓	✓	✓	✓	✓	
l. Applicable portions of the following piping systems:									
(1) Active containment system piping systems (e.g., emergency core cooling system (ECCS) suction piping and other piping required to maintain core cooling after loss-of-coolant accident (LOCA))	✓	✓	✓	✓	✓	✓	✓	✓	
(2) Piping systems which provide a drywell-to-wetwell pressure differential (to alleviate pool swell effects)	NA	NA	NA	NA	NA	NA	NA	NA	
(3) Other piping systems, including vent drains	✓	✓	✓	✓	✓	✓	✓	✓	
m. Supports of piping systems mentioned in previous item	✓	✓	✓	✓	✓	✓	✓	✓	
n. Vent header deflectors including associated hardware	✓	✓	✓	✓	✓	✓	✓	✓	
o. Internal structural elements (e.g., monorails, catwalks, their supports) whose failure might impair the containment function	✓	✓	✓	✓	✓	✓	✓	✓	

Table 2-3. Non-Piping Structural Elements

STRUCTURAL ELEMENT	ROW
External Class MC	
Torus, Bellows, External Vent Pipe, Drywell (at Vent), Attachment Welds, Torus Supports, Seismic Restraints	1
Internals Vent Pipe	
General and Attachment Welds	2
At Penetration (e.g., Header)	3
Vent Ring Header	
General and Attachment Welds	4
At Penetrations (e.g., Downcomers)	5
Downcomers	
General and Attachment Welds	6
Internals Supports	7
Internals Structures	
General	8
Vent Deflector	9

Table 2-4. Piping Structural Elements

STRUCTURAL ELEMENT	ROW
Essential Piping Systems	
With IBA/DBA	10
With SBA	11
Nonessential Piping Systems	
With IBA/DBA	12
With SBA	13

NOTES RELATED TO TABLES 2-1 AND 2-2

Note 1: The Licensee has not provided report TR-5321-2 summarizing the analysis of torus attached, internal, and SRV piping and the SRV vent line penetration. Also, no analysis has been provided for active containment piping such as the emergency core cooling system and other systems required to maintain core cooling after a loss-of-coolant accident (LOCA).

Note 2: The Licensee has not provided information on the analysis of the vacuum breaker valves.

Note 3: For the case of piping fatigue analysis, the NRC staff has requested the conclusions of a study presented at the NRC meeting [7] to be documented and submitted for NRC approval. If these conclusions are acceptable to the NRC, each PUA report would be required to indicate that the fatigue usage factors for the SRV piping system and the torus attached piping are sufficiently small that a plant-unique fatigue analysis of these piping systems is not warranted.

Note 4: With respect to equipment such as pumps and valves associated with piping, no information has been provided on its operability or whether it is considered active or inactive.

Note 5: The Licensee should indicate if any net tensile forces are produced in the torus support columns due to the upward phase of loading.

Note 6: Verification is required of the method by which loads resulting from two dynamic phenomona were combined.

Note 7: The code class of the vent ring header supports has not been specified as required by Section 2.1a of the criteria [2].

Note 8: The derivation of all allowable stresses and loads presented in the PUA report [8] must be clarified; the Licensee should specify the code section and formulas that were used.

Note 9: The Licensee should provide and justify the bounding technique used to determine all controlling load cases presented in the PUA report [8].

Note 10: With respect to Section 3.1 of the PUA report [8], the Licensee should justify the use of the 1/16 segment model instead of the 360° beam model to analyze the torus shell for stresses due to asymmetric loads, such as SRV discharge.

Note 11: The Licensee should justify the reasons for not considering a 180° beam model of the vent system in order to determine the effects of seismic and other nonsymmetric loads.

Note 12: The PUA report [8] indicates that the calculated values of the following stresses are very close to the respective allowables:

- o vent header column - axial stress
- o ring girder at outside column region - shell weld stress
- o catwalk support columns - bending stress.

The Licensee should indicate conservatisms in the analysis to show that these calculated values would not be exceeded if a different analytical approach were to be used.

Note 13: With respect to Section 3.1 of the PUA report [8], the Licensee should provide the technical basis for obtaining the static degrees of freedom for the torus model. Also, a brief description of the boundary conditions should be provided.

Note 14: In Section 3.2.2 of Reference 8, shell stresses were calculated by adding the absolute value of the four highest harmonics to the square root of the sum of the squares (SRSS) of the lower harmonics. However, in calculating loads on supports, only the three highest harmonics were added to the SRSS of the others. Explain the reasoning for this inconsistency. Also clarify whether 31 or 32 Hz (as specified in Appendix 2 [8]) is the cutoff frequency.

Note 15: In Section 3.2.3.2, page 31 of Reference 8, an explanation is required as to how the pre-chug bounds the post-chug for column and saddle loads while post-chug stress exceeds pre-chug stress by 53% and why the analysis for post-chug uses the pre-chug stress value.

Note 16: In Section 3.2.4 the PUA report [8], the Licensee stated that the dry structure analysis appeared to be acceptable since the correlation of calculated-to-measured shell stress was excellent. Provide data and plots to show the correlation. Indicate locations where the correlation was made and whether the comparison was obtained based on time history traces and/or frequency distribution.

Note 17: In Section 3.2.7 of the PUA report [8], the fatigue evaluation was based on assuming that the operator would use a procedure to end chugging within 15 minutes. Provide precautionary measures (if any) in case the operator fails to act after 15 minutes.

Note 18: With respect to Section 4.2 of the PUA report [8], the Licensee should provide a brief description of the stress calculation method for each of the following:

- o vent header support columns
- o vent pipe/vent header intersection
- o vent pipe/drywell intersection
- o vent header mitre joint
- o main vent pipe.

Note 19: The Licensee should provide a description of the hand analysis mentioned in Section 4.2 of the PUA report [8] that was used to calculate the effects of pool swell water impact on the vent header deflector. Also, the dynamic load factor used with the impact forces should be provided and justified.

Note 20: With respect to Section 4.3.1.1 of the PUA report [8], the Licensee should indicate how relative timing between the pool swell water impact loading on the vent system was maintained.

Note 21: With respect to the vent header beam model in Figure 4-4 in the PUA report [8], provide the technical basis and justification for the selection of stiffnesses to represent the vent header/vent pipe intersection.

Note 22: Regarding the fatigue evaluation of the vent system presented in Section 4.4.9 of the PUA report [8], the stress intensification factor applied to the total stress range should be provided and justified.

Note 23: The vent system fatigue results in Section 4.4.9 of the PUA report [8] give a usage factor of 0.98 for the vent header support. The Licensee should indicate conservatisms in the analysis to show that this calculated value would not be exceeded if a different analytical approach were to be used.

Note 24: In Section 5.3.3 of the PUA report [8], no dynamic load factors for input loads to the ring girder from the following structures were given:

- quencher support beam
- vent header support column
- monorail supports
- spray header supports.

All factors used should be provided and justified.

Note 25: The dynamic analysis of the quencher and support system for drag loads due to chugging which was mentioned in Section 6.3.3 [8] is unclear. The set of harmonic analyses and the method by which results for individual load conditions were determined should be explained more fully.

Note 26: With respect to the computer analysis of the quencher and supports mentioned in Section 6.3.3 [8], an explanation is required of how the mass of the structure was adjusted to account for the "added mass" effect of the surrounding water.

Note 27: The Licensee should indicate why only four maximum frequency contributions were considered in the condensation oscillation analysis of the quencher and supports (Section 6.3.4 [8]), whereas five were considered in the chugging analysis (Section 6.3.3 [8]).

Note 28: With respect to Sections 7.1.1 and 7.2.1 of the PUA report [8], the Licensee should indicate and justify all factors used to account for dynamic effects in the analysis of the catwalk and internal spray header.

Note 29: In the description of the dynamic characteristics of the bellows in Section 7.3.1 of the PUA report [8], the following passage appears:

> "We also expect that the convolutions will produce complex modes and stress patterns that will not couple efficiently with specific input frequencies, i.e., high dynamic response is not expected. Further, the "pogo" and "rolling" modes of the convolutions are non-linear, highly cross-coupled modes that would not be predicted by ordinary structural codes."

The Licensee should provide a detailed explanation to clarify this passage.

Note 30: With respect to the verification of the computer model used to evaluate torus shell stresses and support system loads due to SRV actuation (Appendix A, page A1-3 [8]) it was noted that the correlations of predicted column loads and measured column loads was generally off by about 50%. The Licensee should provide some possible reason for this discrepancy.

3. REFERENCES FOR APPENDIX A

1. NUREG-0661
"Safety Evaluation Report, Mark I Containment Long-Term Program
Resolution of Generic Technical Activity A-7"
Office of Nuclear Reactor Regulation
USNRC
July 1980

2. NEDO-24583-1
"Mark I Containment Program Structural Acceptance Criteria Plant Unique
Analysis Application Guide"
General Electric Co., San Jose, CA
October 1979

3. American Society of Mechanical Engineers
Boiler and Pressure Vessel Code, Section III, Division 1
"Nuclear Power Plant Components"
New York: 1977 Edition and Addenda up to Summer 1977

4. Title 10 of the Code of Federal Regulations

5. NEDO-21888 Revision 2
"Mark I Containment Program Load Definition Report"
General Electric Co., San Jose, CA
November 1981

6. NRC
"Damping Values for Seismic Design of Nuclear Power Plants"
Regulatory Guide 1.61
October 1973

7. P. M. Kasik
"Mark I Piping Fatigue"
Presentation at NRC Meeting, Bethesda, MD
September 10, 1982

8. Nine Mile Point Unit 1
Plant-Unique Analysis Report of the Torus Suppression Chamber, TR-5320-1
Revision 0
Niagra Mohawk Power company
October 1983

APPENDIX B

ADDITIONAL INFORMATION REQUIRED

FRANKLIN RESEARCH CENTER
DIVISION OF
ARVIN/CALSPAN
20th and Race Streets
Philadelphia, PA 19103

REQUEST FOR INFORMATION

Item 1: Provide piping report TR-5321-2. The following items must be covered adequately in order to satisfy the criteria:

- The analysis of applicable portions of ECCS and other piping systems required to maintain core cooling after a LOCA, vacuum breaker piping, and piping that provides drywell-to wetwell pressure differential.
- The classification of piping systems as essential or nonessential and by code class.
- Analytical models representing piping and supports from first rigid anchor (or where the effect of torus motion is insignificant).
- The analysis of torus piping penetrations.
- The use of time history or response spectrum analysis for dynamic effect of torus motion at piping attachment points.
- The code classification of piping supports and welds.

Item 2: Provide a summary of the analysis with regard to vacuum breaker piping systems and vacuum breaker valves; indicate whether they are considered Class 2 components as required by the criteria [1].

Item 3: Indicate whether fatigue usage factors for SRV piping and torus attached piping are sufficiently small that a plant-unique fatigue analysis is not warranted for piping. The NRC is expected to review the conclusions of a generic presentation [4] and determine whether it is sufficient for each plant-unique analysis to establish that the expected usage factors for fatigue analysis of piping are small enough to obviate a plant-unique fatigue analysis of piping.

Item 4: Indicate whether all active equipment associated with piping, such as pumps and valves, has been evaluated for operability and discuss the operability criteria.

Item 5: Indicate whether net tensile forces are produced in the torus support columns due to the upward phase of loading. If so, provide a nonlinear time history analysis using a spring mass model of the torus and support as required by the criteria [1].

Item 6: Indicate how loads resulting from different dynamic phenomena were combined.

Item 7: Specify the code class of the vent ring header supports.

Item 8: Specify the code sections and/or formulas used to derive all allowable stresses and loads presented in the PUA report [5] in the following sections:

3.3.1	page 41
3.3.2 through 3.3.5	pages 43 through 46
4.4.1 through 4.4.6	pages 66 through 69
4.4.8	page 70
5.4.1 through 5.4.2	page 82
6,4.1 through 6.4.3	pages 90 and 91
7.1.3.1 through 7.1.3.3	pages 96 and 97
7.2.3	pages 98 and 99
7.4.3	pages 102 and 103

Item 9: Provide and justify the bounding technique used to determine all controlling load cases presented in the PUA report [5] in the following sections:

3.3.1	page 41
3.3.2 through 3.3.5	page 42
3.3.3 through 3.3.5	pages 44 through 46
4.4.1 through 4.4.6	pages 66 through 69
4.4.8	page 70
5.4.1 and 5.4.2	page 82
6.4.1 through 6.4.3	pages 90 and 91
7.1.3.1 through 7.1.3.3	pages 96 and 97
7.2.3	page 98
7.4.3	page 102

Item 10: With respect to Section 3.1 of the PUA report [5], justify the use of the 1/16 segment model instead of the 360° beam model to analyze the torus shell for stresses due to asymmetric loads (horizontal earthquake, SRV, chugging).

Item 11: Provide and justify the reasons for not considering a 180° beam model of the vent system, as required by Section 6.5c of Reference 1, in order to determine the effects of seismic and other asymmetric loads.

Item 12: The PUA report [5] indicates that the following stresses are very close to the respective allowables:

- o torus shell primary membrane stress
- o saddle-to-shell weld stress
- o ring girder weld to torus stress (near outer column and saddle regions)

o monorail column and base plate weld stress.

Indicate conservatisms in the analysis to show that these calculated values would not be exceeded if a different analytical approach were to be used.

Item 13: With respect to Section 3.1 of the PUA report [5], provide the technical basis for obtaining the static degrees of freedom for the torus model. Also, provide a brief description of the boundary conditions.

Item 14: With respect to Section 3.2.2 of the PUA report [5], explain why the absolute values of the four highest harmonics were considered for shell stresses due to condensation oscillation, whereas only the three highest absolute values were considered in evaluating support loads. Also, clarify whether 31 or 32 Hz (as specified in Appendix 2 [5]) was used as the cutoff frequency.

Item 15: With respect to Section 3.2.3.2 of the PUA report [5], explain how the pre-chug load bounda the post-chug for column and saddle loads while post-chug stress exceeds pre-chug stress by 53% and why the analysis for post-chug uses the pre-chug stress value. It is recommended that the explanation be detailed enough to thoroughly clarify this issue.

Item 16: With respect to Section 3.2.4 of the PUA report [5], provide the data and plots showing the correlation between calculated and measured shell stress in the dry structure analysis. Indicate locations where the correlation was made and whether the comparison was obtained based on time history traces and/or frequency distributions.

Item 17: Regarding the fatigue evaluation of the torus presented in Section 3.2.7 [5], provide precautionary measures (if any) in case the operator fails to act after 15 minutes.

Item 18: With respect to Section 4.2 of the PUA report [5], provide a brief description of the stress calculation method for each of the following:

o vent header support columns
o vent pipe/vent header intersection
o vent pipe/drywell intersection
o vent header mitre joint
o main vent pipe.

Item 19: Provide a description of the hand analysis used to evaluate the effects of pool swell water impact on the vent header deflector. Also, provide and justify the dynamic load factors used with the impact forces (Section 4.2 [5]).

Item 20: With respect to Section 4.3.1.1 of the PUA report [5], indicate how relative timing between the pool swell water impact loadings on the vent system was maintained to preserve an accurate representation of the longitudinal and circumferential wave sweep.

Item 21: With respect to the vent header beam model shown in Figure 4-4 in the PUA report [5], indicate how the stiffnesses representing the vent header/vent pipe intersection were selected. Also, provide the technical basis and justification for the selection of these stiffnesses.

Item 22: Provide and justify the stress intensification factor used in the fatigue evaluation of the vent system, Section 4.4.9 of the PUA report [5].

Item 23: The vent system fatigue results in Section 4.4.9 of the PUA report [5] give a usage factor of 0.98 for the vent header support. Indicate conservatisms in the analysis to show that this calculated value would not be exceeded if a different analytical approach were to be used.

Item 24: Provide and justify all dynamic load factors used in the analysis of the ring girder (Section 5.3.3 [5]) for loads due to the attachment of the following structures:

- o quencher support beam
- o vent header support columns
- o monorail supports
- o spray header

Item 25: With respect to Section 6.3.3 of the PUA report [5], explain and provide the set of harmonic analyses. The Licensee stated, "Results for individual load conditions were determined by scaling individual frequency results of the computer analysis by the appropriate pressure amplitude." Please elaborate on this statement.

Item 26: With respect to the computer analysis of the quencher and supports in Section 6.3.3 [5], explain how the mass of the structure was adjusted to account for the "added mass" effect of the surrounding water.

Item 27: Indicate why only four maximum frequency contributions were considered in the condensation oscillation analysis of the quencher and supports (Section 6.3.4 [5]), whereas five were considered in the chugging analysis (Section 6.3.3 [5]).

Item 28: With respect to Sections 7.1.1 and 7.2.1 of the PUA report [5], indicate and justify all factors used to account for dynamic effects in the catwalk and internal spray header analysis.

Item 29: In the description of the dynamic characteristics of the bellows in Section 7.2.1 of the PUA report [5], the following passage appears:

> "We also expect that the convolutions will produce complex modes and stress patterns that will not couple efficiently with specific input frequencies, i.e., high dynamic response is not expected. Further, the "pogo" and "rolling" modes of the convolutions are non-linear, highly cross-coupled modes that would not be predicted by ordinary structural codes."

Provide a detailed explanation to clarify this passage.

Item 30: With respect to the verification of the computer model used to evaluate torus shell stresses and support system loads due to SRV actuation (Appendix A, p. A1-3 [5]) it was noted that the correlation of predicted column loads and measured column loads was generally off by about 50%. Provide some possible reason for this discrepancy.

REQUEST FOR INFORMATION
NINE MILE POINT UNIT 1
SRV AND TORUS-ATTACHED PIPING SYSTEMS

Item 1: Provide and justify any conservatisms (if there are any) to support the application of the AISC code for drywell steel instead of the ASME code.

Item 2: With reference to the computer models of the drywell steel in Figures 2-10, 2-11, and 2-12, provide drawings which show the support locations of SRV piping systems connected to drywell steel. Also, provide and justify the boundary conditions for these computer models.

Item 3: Provide and justify the boundary conditions for the beam seat computer model at elevation 259 ft in Figure 2-13 of the PUA report [6].

Item 4: With respect to Section 3.3.5 of the PUA report [6], provide calculations demonstrating conformance to the 10% rule of Section 6.2d [1] that exempted the piping system at Nine Mile Point Unit 1 from analysis.

Item 5: With respect to Table 3-1 of the PUA report [6], indicate whether different piping models and separate analyses have been used for large bore torus-attached piping systems XS-334 and 335, XS-313 and 317, XS-314 and 318, XS-315 and 319, and XS-316 and 320.

Item 6: Provide line size and schedule for small bore torus-attached piping system XS-346.

Item 7: With respect to Section 3.4.7 of the PUA report [6], provide the analytical results of the fatigue evaluation of torus shell penetrations.

Table 1. Structural Loading (from Reference 3)

Loads	Structures: Torus Shell	Structures: Torus Support System	Structures: Main Vents	Structures: Vent Header	Structures: Downcomers	Structures: SRV Piping	Other Wetwell Interior Structures: Above Norm Water Level	Other Wetwell Interior Structures: Above Bottom of Downcomers and Below Norm Water Level	Other Wetwell Interior Structures: Below Bottom of Downcomers
1. Containment Pressure and Temperature	X	X	X	X	X	X	X	X	X
2. Vent System Thrust Loads			X	X	X				
3. Pool Swell									
3.1 Torus Net Vertical Loads	X	X							
3.2 Torus Shell Pressure Histories	X	X							
3.3 Vent System Impact and Drag			X	X	X				
3.4 Impact and Drag on Other Structures			X			X	X		
3.5 Froth Impingement	X	X	X			X	X		
3.6 Pool Fallback						X	X	X	
3.7 LOCA Jet						X			X
3.8 LOCA Bubble Drag						X		X	X
4. Condensation Oscillation									
4.1 Torus Shell Loads	X	X							
4.2 Load on Submerged Structures						X		X	X
4.3 Lateral Loads on Downcomers				X	X				
4.4 Vent System Loads			X	X					
5. Chugging									
5.1 Torus Shell Loads	X	X							
5.2 Loads on Submerged Structures						X		X	X
5.3 Lateral Loads on Downcomers				X	X				
5.4 Vent System Loads			X	X					
6. T-Quencher Loads									
6.1 Discharge Line Clearing						X			
6.2 Torus Shell Pressures	X	X							
6.4 Jet Loads on Submerged Structures					X	X		X	X
6.5 Air Bubble Drag					X	X		X	X
6.6 Thrust Loads on T-Quencher Arms						X			
6.7 S/RVDL Environmental Temperature						X			
7. Ramshead Loads									
7.1 Discharge Line Clearing						⊠			
7.2 Torus Shell Pressures	⊠	⊠							
7.4 Jet Loads on Submerged Structures					⊠	⊠		⊠	⊠
7.5 Air Bubble Drag					⊠	⊠		⊠	⊠
7.6 S/RVDL Environmental Temperature						⊠			

X Loads required by NUREG-0661[2]

⊠ Not applicable.

REFERENCES FOR APPENDIX B

1. NEDO-24583-1
"Mark I Containment Program Structural Acceptance Criteria Plant Unique Analysis Application Guide"
General Electric Co., San Jose, CA
October 1979

2. NUREG-0661
"Safety Evaluation Report, Mark I Containment Long-Term Program Resolution of Generic Technical Activity A-7"
Office of Nuclear Reactor Regulation
July 1980

3. NEDO-21888 Revision 2
"Mark I Containment Program Load Definition Report"
General Electric Co., San Jose, CA
November 1981

4. P. M. Kasik
"Mark I Piping Fatigue"
Presentation at the NRC meeting, Bethesda, MD
September 10, 1982

5. James A. FitzPatrick Nuclear Power Plant
Plant-Unique Analysis Report of the Torus Suppression Chamber, TR-5321-1
Revision 0
New York Power Authority
Teledyne Engineering Services
August 1983

6. Nine Mile Point Unit 1
Plant-Unique Analysis Report of the Torus Attached Piping, TR-5320-2
Niagara Mohawk Power Company
Teledyne Engineering Services
April 1984