TECHNICAL EVALUATION REPORT

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

VERMONT YANKEE NUCLEAR POWER CORPORATION

VERMONT YANKEE NUCLEAR POWER STATION

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Prepared by

Franklin Research Center
20th and Race Streets
Philadelphia, PA 19103

Author: N. Subramonian, A. K. Le

FRC Group Leader: N. Subramonian

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: H. Shaw

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Prepared by:	Reviewed by:	Approved by:
N. Subramonian	S. Pandey	Gary Herman
Principal Author	Project Manager	Department Director (Acting)
Date: 9.27.83	Date: 9.27.83	Date: 9-27-83

Franklin Research Center
20th and Race Streets, Phila., Pa. 19103 (215) 448-1000

CONTENTS

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. Initial review of the plant-unique analysis (PUA) report for this TER was performed by M. Darwish and T. C. Stilwell of the Franklin Research Center.

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 Vermont Yankee 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 the "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 the Vermont Yankee Nuclear Power Station 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 was concluded earlier that certain items in the Vermont Yankee PUA report [4] indicated noncompliance with the requirements of the criteria [3] and several aspects of the analysis required further information. Based on this conclusion, the Licensee was requested to provide additional information on these aspects in order to indicate compliance with the criteria. The items contained in the request for additional information are attached to this report as Appendix B.

The Licensee responded [5] to all of the items contained in the request for additional information (Appendix B) except the items related to torus-attached piping, which will be addressed by the Licensee in a supplementary PUA report. After an initial review of these responses, a meeting was held with the Licensee to clarify certain aspects of Reference 5 and to verify the criteria and approach used by the Licensee for performing analysis of torus-attached piping, supports, and torus penetrations. A brief review of the Licensee's responses [5] and clarification obtained during the meeting with the Licensee is provided below.

<u>Request Item 1</u>

This request related to the Licensee's analysis of torus penetrations such as vent pipe/torus penetration and vacuum breaker line and reactor core isolation cooling line (RCIC) torus penetration. The Licensee's response indicated that a summary of analyses of these items will be included in the supplementary PUA report to be submitted by September 1983. During the meeting with the Licensee on August 9, 1983, the Licensee provided an outline of the criteria/approach used in the analysis which provides reasonable assurance that the Licensee's analysis conforms to the criteria requirements [3]. Hence, the concerns with regard to this item are resolved subject to a written report from the Licensee confirming that the criteria/approach outlined were applied in the actual analysis.

Request Item 2

In this response, the Licensee indicated that the effects of seismic and thermal response, which were not included in Reference 4, have been subsequently considered for the analysis of drywell/vent pipe intersection. The results of the analysis show that the stresses in that region do not exceed the criteria allowables. The Licensee's response to this item is technically adequate.

Request Item 3

In response to this item, the Licensee stated that the maximum calculated differential motion across the bellows is less than 10% of the rated movements for the rated number of cycles. Also, based on the manufacturer's fatigue data for unreinforced austenitic bellows, the permissible number of cycles for the design stress level is well in excess of the endurance limit (about 10^6 cycles). The Licensee's response to this item is technically adequate and meets the intent of the criteria [3] with regard to fatigue of bellows.

Request Item 4

In response to this item, the Licensee stated that wetwell/drywell vacuum breaker valves do not actuate during a chugging event at the Vermont Yankee plant, and hence no analysis beyond the original plant design scope is required at the present time. The criteria [3], however, require that vacuum breaker valves should be evaluated as Class 2 components. During the meeting with the Licensee on August 9, 1983, the Licensee outlined the original plant design criteria for vacuum breaker valves. The Licensee's approach is technically adequate and meets the intent of the criteria. Criteria for vacuum breaker modification were not addressed in Reference 3, and this issue is considered to be outside the scope of this TER. This issue is still a part of Mark I long-term program and will be reviewed separately by the NRC.

Request Item 5

With regard to this item, the Licensee indicated that a summary of the analysis techniques used, piping stresses, support loads, and required modifications will be provided in a supplementary PUA report to be submitted by September 1983. During the meeting with the Licensee on August 9, 1983, the Licensee provided an outline of the criteria/approach used in the analysis which provides reasonable assurance that the Licensee's analysis conforms to the criteria requirements [3]. Hence, concerns with regard to this item are resolved subject to a written report from the Licensee confirming that the criteria/approach outlined were applied in the actual analysis.

Request Item 6

In response to this item, the Licensee provided details of the safety relief valve (SRV) discharge line elbow support and an isometric drawing of the SRV discharge line. The Licensee's response resolved the concern with regard to this item.

Request Item 7

In response to this item, the Licensee indicated that the Vermont Yankee vent header deflector is a continuous structure through the 16 torus bays. The connection arrangement does not allow moment transfer at supports, and therefore the analysis was performed assuming each span to be simply supported. The non-vent bay analysis bounds that of the vent bay and was used conservatively for both. The Licensee's response is technically adequate and meets the criteria requirements.

Request Item 8

In response to this item, the Licensee provided a set of catwalk drawings. The Licensee's response resolved concerns with regard to this item.

Request Item 9

In this response regarding catwalk supports, the Licensee indicated that the new vertical support legs (4-in schedule 80 pipe) and the new diagonal braces (4-in schedule 80 pipe) have margins of safety against buckling of 13.35 and 4.07, respectively. The Licensee's response resolved concerns with regard to these supports.

Request Item 10

In this response, the Licensee provided sufficient information to assure that the effect of neglecting the offset (4 in wide) between the ring girder and mitre joint in the computer model was technically justified. A qualitative study indicates that the maximum membrane stress in the torus cannot occur in this offset region. There is no primary bending stress in the region (because of gross structural discontinuity), and it follows that maximum primary local plus bending stress in the region should be less than the maximum membrane stress. Thus, the main significance of this region may be for the case of fatigue, and hence the Licensee has conservatively used a stress-intensification factor of 4 (maximum required by the code) for this case. The Licensee's response adequately resolved the concerns with regard to this item.

Request Item 11

In response to this item, the Licensee indicated that the torus structure and major components were evaluated at a temperature of 200°F, which conservatively bounds the maximum temperature obtained from the plant-unique load definition. With regard to materials, the Licensee indicated that A516 Gr 70 was used for torus shell, support columns, ring girder, saddle support, earthquake restraints, vent pipe, vent header, and downcomers; that A333 Gr 1 was used for vent header support columns; and that A333 Gr 6 was used for the vent header deflector. The Licensee's response is satisfactory.

Request Item 12

In response to this item, the Licensee stated that all torus-attached piping systems at the Vermont Yankee plant have been classified as essential Class 2 piping systems and that all components associated with these systems are considered active for the purpose of these analyses and evaluations. The Licensee's response is technically adequate.

Request Item 13

In response to this item, the Licensee provided justification for neglecting post-chugging load on torus shell, pool swell drag LOCA jet forces on the vent header support columns, submerged structure drag for vent header support columns, drag forces on vent header support columns and intermediate break accident (IBA) condensation oscillation load on the vent header system. The Licensee's response is technically adequate. During the meeting with the Licensee on August 9, 1983, the Licensee indicated the approach used for considering the reaction load from attached piping on the torus shell. The Licensee's approach meets the intent of the criteria.

Request Item 14

This item relates to completion of the proposed modifications and a summary of relevant analyses. The Licensee indicated that, with regard to modified items pertaining to torus-attached piping, a summary will be included in the supplementary PUA report to be submitted by September 1983. With regard to catwalk modifications, the Licensee has outlined the modifications and provided the calculated stress values, which are well below the respective allowables. During the meeting with the Licensee on August 9, 1983, the Licensee provided an outline of the approach/criteria used for modifications related to torus-attached piping and indicated the expected date for submittal of the PUA report to be September 1983. The Licensee's responses have adequately resolved the concerns with regard to this item subject to submittal of the pertinent PUA report.

Request Item 15

In response to this item, the Licensee indicated that the conclusions of the Mark I Owners' Group generic study on piping fatigue are applicable to the Vermont Yankee piping analysis, which implies that no plant-specific piping fatigue analysis is warranted. The Licensee's approach is technically adequate.

Request Item 16

In response to this item, the Licensee provided a summary of analysis for miscellaneous internal piping and indicated that, in each case, the maximum stress in this piping is less than the respective criteria allowable. The Licensee's response resolved the concern with regard to this item.

Request Item 17

In response to this item, the Licensee confirmed that the fatigue analysis of the torus shell incorporated corrections in stress-range amplitudes and associated numbers of cycles to account for the interspersion of stress cycles of unlike character. Fatigue analysis of the torus-attached piping penetrations will be reported in a supplementary PUA report to be submitted by September 1983. During the meeting with the Licensee on August 9, 1983, the Licensee outlined the approach/criteria used for torus-attached piping penetrations and indicated that the supplementary PUA report will be submitted by September 1983. The Licensee's response to this item is satisfactory and meets the intent of the criteria subject to a written summary confirming the approach used for the torus-attached piping penetrations.

Request Item 18

In this response, the Licensee provided justifications for not considering certain asymmetric modes in the analytical model for torus. The Licensee indicated that the horizontal earthquake loads are considered using equivalent static analysis and hence only the SRV and asymmetric pre-chug loads need to be addressed with regard to this concern. Although these loads are not uniform, they always produce pressures that are in-phase in adjacent bays; therefore, their dynamic responses will be primarily controlled by symmetric modes. The Licensee's justification is technically adequate and the torus analytical model meets the intent of the criteria.

Request Item 19

In this response, the Licensee indicated that all combinations of structural responses due to separate dynamic loads have been analyzed using the absolute sum method. This approach is conservative and satisfies the criteria requirements.

Request Item 20

In this response, the Licensee indicated that the analysis of the SRV discharge line has been done in two separate parts. Analysis of the quenchers, quencher supports, and piping in the torus is reported in Reference 4, and the analysis of the vent pipe penetration and all upstream piping and supports will be reported in a supplementary PUA report. During the meeting with the Licensee on August 9, 1983, the Licensee outlined the approach/ criteria used for the analysis of the vent pipe penetration and all upstream piping and supports and indicated that the supplementary PUA report containing this information will be submitted by September 1983. The Licensee's approach and criteria for this item are technically adequate subject to a written submittal confirming that the approach outlined was used in the actual analysis.

Request Item 21

In this response, the Licensee indicated that the vacuum breaker piping and penetration analysis for the torus and vent pipe penetrations will be presented in the supplementary PUA report. During the meeting with the Licensee on August 9, 1983, the Licensee outlined the technical approach/ criteria used for this analysis and indicated that the supplementary PUA report containing a summary of this analysis will be submitted by Septemer

1983. The Licensee's response is technically adequate subject to a written submittal confirming that the approach outlined was used in the actual analysis.

Request Item 22

In response to this item, the Licensee indicated that the 45° segment model of the vent header and downcomer used in the analysis is conservative compared to a 180° segment vent system beam model. The combined seismic and chugging stresses of the 180° segment model are less than the combined stress of the 45° segment model because of the conservative assumptions used to apply antisymmetric chugging load on the 45° segment model. The Licensee's analysis is technically adequate and meets the intent of the criteria.

Request Item G1

In this response, the Licensee provided more details on the procedures used in the PUA report for fatigue evaluation. The Licensee indicated that the fatigue analysis of the torus was completed using the procedures outlined in Section NE-3221.5 of the ASME Code. The fatigue evaluations of torus-attached piping penetrations will be addressed in a supplementary PUA report to be submitted by the Licensee by September 1983. During the meeting with the Licensee on August 9, 1983, the Licensee outlined the approach/criteria used in the fatigue analysis of the torus-attached piping penetrations. The Licensee's approach is judged to be technically adequate based on information obtained during the meeting and subsequent clarifications.

Request Item G2

In response to this item, the Licensee indicated that, using the criteria recommended by Section NE-3221.5, it was determined that the thermal fluctuations during LOCA are not significant for fatigue analysis. The Licensee's response resolved the concern on this item.

3. CONCLUSIONS

Based on the audit of the Vermont Yankee Nuclear Power Station Plant Unique Analysis Report, it was concluded earlier that certain aspects required additional information. The Licensee's response [5] to the request for additional information and subsequent clarifications obtained during a meeting with the Licensee indicate that the Licensee's structural analysis with regard to major modifications is in general conformance to the criteria requirements [3]. The Licensee's analytical approach and criteria used for penetrations and associated equipment and components (as outlined during the meeting on August 9, 1983) conform to the requirements of the criteria. However, the approach outlined should be confirmed through the supplementary PUA report. If any deviations from the criteria are identified in the supplementary PUA report on torus-attached piping and penetrations, these will be resolved on a plant-specific basis. The Licensee's approach to 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. Vermont Yankee Nuclear Power Station
Plant Unique Analysis Report, Mark I Containment Program
Vermont Yankee Nuclear Power Corporation
November 30, 1982, TR-5319-1, Revision 0

5. J. B. Sinclair, Vermont Yankee Nuclear Power Corporation
Letter to D. B. Vassallo (NRC)
Subject: Request for Additional Information - Mark I Containment Long-Term Program
June 17, 1983

APPENDIX A

AUDIT DETAILS

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

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 Mark I containments except Brunswick Units 1 and 2 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:

- 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.
- 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.
- When a particular requirement is not met, the specific reasons for noncompliance will be given.
- Where the Licensee's response to the request for additional information provided satisfactory evidence for compliance with the criteria, an appropriate remark is made and the original audit finding is provided only for the sake of completeness.

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	✓		SEE NOTES 1 & 10				The Licensee's response have resolved this concern
	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	✓		SEE NOTE 2				The Licensee's response have resolved this concern
	o Bellows between vents and torus shell (internal or external to torus)	✓		SEE NOTE 3				The Licensee's response have resolved this concern
	o Vent ring header and the downcomers attached to it			SEE NOTES G1 & G2				The Licensee's response has resolved this concern
	o Vent ring header supports to the torus	✓						
	o Vacuum breaker valves attached to vent penetrations within the torus (where applicable)	✓		SEE NOTE 4				The Licensee's response have resolved this concern
	o Vacuum breaker piping systems, including vacuum breaker valves attached to torus shell penetra-	✓		SEE NOTE 4				The Licensee's response have 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
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 5				The Licensee's response has resolved this Concern
	o All main steam system safety relief valve (SRV) piping	✓		SEE NOTE 5				→ The Licensee's response has resolved this Concern ANALYSIS OF THE SRV TEE QUENCHER IS INCLUDED IN THE REPORT (SEE NOTES 6 & 20)
	o Applicable portions of the following piping systems:	✓		SEE NOTE 5				→ The Licensee's response has resolved this Concern
	- 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	✓		SEE NOTE 5				The Licensee's response has resolved this Concern
	o Vent header deflectors including associated hardware	✓		SEE NOTE 7				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
1.2	(Cont.)							
	o Internal structural elements (e.g., monorails, catwalks, their supports) whose failure might impair the containment function	✓		SEE NOTES 8 & 9				The Licensee's response has resolved this concern
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.	✓						The Licensee's response has resolved this concern
	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.	✓						EXCEPTIONS ARE CITED IN REF. 8 APPENDICES. APPENDIX A2 CITES ACCEPTABLE EVIDENCE.

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	✓						
	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)	✓						SEE NOTE 11
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 are 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.	✓						
	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 NOTES 5 & 12				Licensees 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
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 NOTES 5 & 12				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 4				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
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. - 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 NOTES 5 & 12				Licensee's response has resolved this concern
	l. Internal piping and supports (Rows 10-13) - Are Class 2 or Class 3 piping and Class 2 or Class 3 component supports.	✓		SEE NOTES 5 & 12				Licensee's response has resolved this concern
	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.	✓						SEE NOTE 7
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.	✓		SEE NOTE 13				Licensee's response has resolved this concern
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 14				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 11
	b. Linear-type component (Class 2 and 3) support - with three modifications to the Code:	✓						SEE NOTE 11
	- 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;	✓		SEE NOTE 11				Licensees response has resolved this concern
	- NF-3231.1 (a) [3] is for primary plus secondary stress range;							

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.	✓		SEE NOTE 9				The Licensee's response has resolved this concern
	c. Class 2 and 3 piping, pumps, valves, and internal structures (also Class MC)	✓		SEE NOTE 5				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.	✓		SEE NOTE 13				The Licensee's response has resolved this concern
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 NOTE 5				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.	✓		SEE NOTE 5				The Licensee's response has resolved this concern
	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.							

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.							
6.1	Analysis guidelines provided herein shall apply to all structural elements identified in item 1.2 of this table.							The Licensee response has resolved this concern
	a. All loadings defined in subsection 3.2 of Reference 2 shall be considered.	✓		SEE NOTE 13				See Section 3.3 of this table.
	b. A summary technical report on the analysis shall be submitted to the NRC.	✓		SEE NOTES 1, 3, 4, 5, 9 & 14				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.)	✓		SEE NOTE 13				The Licensee's response has resolved this concern
	b. Only limiting load combination events need be considered.	✓						

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 G1, 5 15 & 17				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.						✓	10% RULE NOT SPECIFICALLY INVOKED ALTHOUGH SOME LOADS ARE OMITTED AS NEGLIGIBLE
	e. Damping values used in dynamic analyses shall be in accordance with NRC Regulatory Guide 1.61 [6].	✓			SEE NOTE 24			The Licensee's response has resolved this concern
6.3	Structural responses for loads resulting from the combination of two dynamic phenomena shall be obtained in the following manner:	✓		SEE NOTE 19				The Licensee's response has resolved this concern
	a. Absolute sum of stress components, or							
	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 10 & 18				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.	✓						
	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.						✓	
	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				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
6.4	(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 NOTE 21				The Licensees' 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 23				The Licensees' 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
6.5	(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 NOTE 22				Licensee's response has resolved this concern
	d. Use beam models in analysis of vent deflectors.	✓		SEE NOTE 7				The Licensee's response has resolved this concern
	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.	✓		SEE NOTE 16				The Licensee's response has resolved this concern
	b. It shall be based on hand calculations or simple beam models and dynamic load factors and equivalent static analysis.	✓						

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:	✓		SEE NOTE 5				The Licensee's response has resolved this concern
	a. Designate in the summary technical report submitted all piping systems as essential or non-essential for each load combination.							
	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].							
6.8	Safety relief valve discharge piping shall be analyzed as follows:							
	a. Analyze each discharge line.	✓		SEE NOTES 6&20				Licensee's response has resolved this concern
	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.	✓						NOTE: LICENSEE INDICATES THAT MODEL OF SRV LINE TERMINATES AT THE DRYWELL JET DEFLECTOR.
	c. For discharge thrust loads, use time history analysis.	✓						
	d. Use spectrum analysis or dynamic load factors for other dynamic loads.	✓						

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)	✓	✓	✓	✓	✓	✓	✓	✓	
i. Vacuum breaker piping systems, including vacuum breaker valves attached to torus shell penetrations and to vent penetrations external to the torus (where applicable)	✓	✓	✓	✓	✓	✓	✓	✓	This evaluation is based on the Licensee's presentation and is subject to the submittal of a confirmatory report
j. Piping systems, including pumps and valves internal to the torus, attached to the torus shell and/or vent penetrations	✓	✓	✓	✓	✓	✓	✓	✓	"

Franklin Research Center
A Division of The Franklin Institute
20th and Race Streets, Phila., Pa. 19103 (215) 448-1000

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FRC Project No. C5506
FRC Assignment No. 12
FRC Task No. 320
Plant Name VERMONT YANKEE

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	✓	✓	✓	✓	✓	✓	✓	✓	This evaluation is based on the Licensee presentation and is subject to the submittal of a confirmatory report
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)	✓	✓	✓	✓	✓	✓	✓	✓	"
(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: Results for the following penetrations were not found:

- o Vent pipe torus intersection

  (Note: This penetration is connected through a bellows that will reduce penetration loading. Further, on page 97, the Licensee states that there is heavy shell reinforcement in that area.)

- o Vacuum breaker line and RCIC torus penetrations

  However, page 1, para. 1.0 states that analysis and results for piping attached to the torus... will be presented in a separate piping report.

  (The Licensee's response [10] resolved this concern.)

Note 2: The Licensee states (page 66) that seismic and thermal responses of the drywell were not available and therefore have not been included. (The Licensee's response [10] resolved this concern.)

Note 3: Para. NE 3365.2e of Section III of the ASME B&PV Code requires demonstration of the fatigue acceptability of the bellows, which was not reported in Reference 8. (The Licensee's response [10] resolved this concern.)

Note 4: The Licensee has not provided information on the analysis of the vacuum breaker valves and has not indicated that these are Class 2 components. (The Licensee's response [10] resolved this concern.)

Note 5: Except for the submerged portion of the SRV line and its tee quencher, analyses of piping systems are not included within this report. The Licensee intends to provide them in a separate report, TR-5319-2. (The Licensee's response [10] resolved this concern.)

Note 6: In the model, shown on Figure 6-1 of Reference 8 used for the analysis of the vent pipe and tee quencher, it appears that the line is supported at its elbow by a structure within the torus. This elbow support does not appear in any of the illustrations in the report nor is its presence mentioned in any of the descriptive text. (The Licensee's response [10] resolved this concern.)

Note 7: The Licensee has not indicated the end conditions assumed for the beam model of the vent header deflector shown in Figure 4-5 of Reference 8. These end conditions strongly affect the results and should therefore be described. (The Licensee's response [10] resolved this concern.)

Note 8: Figure 2-15 of Reference 8 represents an artist's sketch of a typical section of the catwalk and handrails, including the newly added 2-inch diameter steel pipe, diagonal braces, and their attachments to the catwalk. This sketch appears to indicate a rather poor design for the brace-to-catwalk attachment. (The Licensee's response [10] resolved this concern.)

Note 9: Section 7.1.3 (stress results and evaluation for catwalk components) of Reference 8 does not exhibit the margin of safety against buckling for either the 4-inch diameter Schedule 80 pipe supports or the 2-inch pipe brace. (The Licensee's response [10] resolved this concern.)

Note 10: It is not unreasonable to accept results as accurate when obtained for regions remote from locations where a structure is modeled with slight alterations made for analytical convenience, as was done for prediction of torus shell stresses in its unstiffened region using the model of Figure 3-1 of Reference 8. It is also not unreasonable to cite a detailed analysis of another structure as providing engineering evidence of the general behavior of a second similar structure of comparable dimensions.

However, the region of the miter joint (which incorporates two discontinuities--an offset ring and an abrupt angular change) is a prime candidate for maximum shell stresses. The prediction of stresses here as the sum of those generated from two models, neither of which represents the actual structure, requires fuller justification than the report provides.

This structure is redundant and the stress state is controlled by the relative stiffness of adjoining members--not necessarily by the thickness of any given member. Moreover, the justification provided (which relies on the Vermont Yankee shell thickness being less than that of the structure actually modeled) does not hold even for simple geometries, such as a tube between fixed suports under gravity-load. (The Licensee's response [10] resolved this concern.)

Note 11: The PUA report does not include a discussion, together with an accompanying list of components (and component interfaces), showing how code jurisdictional boundaries apply to the portions of the Vermont Yankee plant to be analyzed. However, the fact that Tables 2-3 and 2-4 are invoked as the basis of all analyses exhibits evidence of the Licensee's intent to apply the acceptance criteria of the relevant sections of the code.

In all stress evaluations, the numerical value of the stress limit actually used is given. Although this numerically stated limit should provide evidence that the proper criteria (code section and service limit) were used, traceability is lost because (in almost all cases) the ASTM designation of the component material is not provided nor is the metal temperature given. (The Licensee's response [10] resolved this concern.)

Note 12: The Licensee has not provided information indicating whether the torus attached piping and its supports have been classified as Class 2 or Class 3 piping, essential or non-essential piping systems, and whether a pump or valve associated with the piping mentioned above is an active or inactive component, and is considered operable. (The Licensee's response [10] resolved this concern.)

Note 13: With reference to Table 1 of Appendix B (enclosed), the Licensee should indicate if all loads have been considered in the analysis and/or provide justification if any load has been neglected. (The Licensee's response [10] resolved this concern.)

Note 14: Analysis of a number of the new modifications has yet to be provided, including Items 5, 6, 10, 12, and 15 of the key for Figures 2-3 and 2-4 of Reference 8. In addition, per page 9, final configuration of the catwalk is still under consideration. (The Licensee's response [10] resolved this concern.)

Note 15: The Licensee has not provided information on fatigue analysis for piping systems.

For the case of piping fatigue analysis, the NRC staff has requested the conclusions of a study presented at the NRC meeting [9] to be documented and submitted for NRC approval. If these conclusions are acceptable to the NRC, each PUA report will 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. (The Licensee's response [10] resolved this concern.)

Note 16: Compliance with the criteria, as shown in Section 6.6.a of Reference 8, is for items other than the miscellaneous internal piping yet to be furnished. (The Licensee's response [10] resolved this concern.)

Note 17: The Licensee has not indicated the procedures used for computing fatigue usage when a member is subjected to cyclic loadings of random occurrence, such as might be generated by excitations from more than one type of event (SSE and SRV discharge, for example). (The Licensee's response [10] resolved this concern.)

Note 18: With reference to the computer model for the 1/32 segment of the torus shown in Figure 3-1 of Reference 8 and the analysis performed using only symmetric boundary conditions, the Licensee has not justified the reasons for not considering skew symmetric boundary conditions in order to evaluate the effect of the resulting modes. (The Licensee's response [10] resolved this concern.)

Note 19: The report seems to imply use of the method of summations of absolute values when stresses from two or more simultaneous dynamic events contribute to the total stress, but nowhere specifically states this.

Specific comments addressing the method of summation used and its compliance with the probability of non-exceedance (PNE) criteria of 84% stated in para. 6.3b of Reference 2 should be incorporated into the text. (The Licensee's response [10] resolved this concern.)

Note 20: The Licensee has analyzed one SRV discharge line, but has not indicated that all such discharge lines are identical in configuration to the model or, alternatively, that the model investigated conservatively represents all lines. (The Licensee's response [10] resolved this concern.)

Note 21: Compliance with the criteria as shown in Section 6.5 of Reference 8 is for items other than the vacuum breaker penetration yet to be furnished. (The Licensee's response [10] resolved this concern.)

Note 22: The Licensee should justify that the 45° model of the vent header and downcomer used is adequate to meet the intent of the criteria which requires modeling not less than 180° of the header ring. (The Licensee's response [10] resolved this concern.)

Note 23: Additional information (GE Report NEDE 21968) has been requested on this item through the NRC channels. (The Licensee's response [10] resolved this concern.)

Note 24: Page 2 of the TES report indicates that 2% of the critical damping was generally used throughout the analysis unless stated otherwise. We note that the use of 2% critical damping for service conditions C and D is conservative, since in such cases damping of 4% is acceptable under Regulatory Guide 1.61. (The Licensee's response [10] resolved this concern.)

GENERAL NOTES

Note G1: From the description provided on pages 36 and 67 of Reference 8, it appears that the Licensee did not follow standard ASME Code procedures when computing cumulative fatigue usage. For example, the text seems to imply that (although a critical point evaluation is made) the critical point was selected, the critical transient times determined, and the stress range computed--all without benefit of the formation of any load combinations. Moreover, the text refers (on pages 63 and 68, for example) to "controlling loads" for fatigue, and presents (on page 39) a table listing "cumulative usage factors" independently specified for several events, but unsummed. All departures from standard code procedures should be fully documented and their effects on computed margins of safety assessed. (The Licensee's response [10] resolved this concern.)

Note G2: The report contains little reference to thermal stresses and thermal transients. In Section 4.3.6 of Reference 8, however, it is stated that vent system thermal stresses were assumed equal to those corresponding to steady state application of maximum vent system temperature. (The Licensee's response [10] resolved this concern.)

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"
October 1973
Regulatory Guide 1.61

7. American Society of Mechanical Engineers
Boiler and Pressure Vessel Code, Section III, Division 2
New York: 1977 Edition and Addenda up to Summer 1977

8. Vermont Yankee Nuclear Power Station
Plant Unique Analysis Report, Mark I Containment Program
Vermont Yankee Nuclear Power Corporation
November 30, 1982, TR-5319-1, Revision 0

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

10. J. B. Sinclair, Vermont Yankee Nuclear Power Corporation
Letter to D. B. Vassallo (NRC)
Subject: Request for Additional Information - Mark I Containment Long-Term Program
June 17, 1983

APPENDIX B

ORIGINAL REQUEST FOR INFORMATION

REQUEST FOR INFORMATION

TORUS, VENT SYSTEM, AND PIPING SYSTEM

Item 1: Provide a summary of the analysis and the results for the following penetrations:

- o vent pipe torus intersection
- o vacuum breaker line and RCIC torus penetration.

Item 2: Comment on the effect of the neglected loads indicated on page 66 of Reference 4 on the stress results for the drywell-to-vent penetration.

Item 3: Provide evidence that the fatigue criteria for the bellows as required by para. NE-3365-2, Section III of the ASME B&PV code are met.

Item 4: Provide a summary of the analysis with regard to the vacuum breaker valves; indicate whether they are considered Class 2 components as required by the criteria [1].

Item 5: Provide analyses of the piping systems not included within the report.

Item 6: Provide details of the construction of the SRV line as it exists in the Vermont Yankee plant, specifically in the region of the elbow support (if any).

Item 7: Describe the end conditions assumed for the beam model of the vent header deflector shown in page 4-5, how these were derived, and the sensitivity of maximum calculated stresses to boundary assumptions.

Item 8: Provide a detailed sketch of the actual diagonal brace-catwalk attachment, together with its stress analysis results.

Item 9: Provide the results of the buckling analysis including the margin of safety for the catwalk components, i.e., the 4-inch diameter Schedule 80 pipe supports and the 2-inch pipe brace.

Item 10: Provide full justification for the stress values shown as representative of those that may occur in the containment shell miter joint. Establish limits of maximum possible error.

Item 11: Provide a list of the component materials and their corresponding metal temperatures used for the stress limit selection.

Item 12: Indicate whether each torus attached piping and its supports have been classified as Class 2 or Class 3 piping, Class 2 or Class 3 component supports, and essential or non-essential piping systems.

Also, indicate whether a pump or valve associated with the piping mentioned above is an active or inactive component, and is considered operable.

Item 13: With reference to Table 1 of Appendix B, indicate whether all loads have been considered in the analysis and/or provide justification if any load has been neglected.

Item 14: Provide a summary of the analyses for the new modifications yet to be supplied; these include Items 5, 6, 10, 12, and 15 of the key for Figures 2.3 and 2.4 of Reference 4. In addition, if the final configuration of the catwalk is to be changed, update the analysis accordingly.

Item 15: Provide details of fatigue analysis for piping systems.

Indicate whether the fatigue usage factors for the SRV piping and the 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 [5] and determine whether it is sufficient for each plant-unique analysis to establish that the expected usage factors for piping are small enough to obviate a plant-unique fatigue analysis of the piping.

Item 16: Submit a summary of the analysis for the miscellaneous internal piping.

Item 17: The ASME Code provides an acceptable procedure for computing fatigue usage when a member is subject to cyclic loadings of random occurrence, such as might be generated by excitations from more than one type of event (SSE and SRV discharge, for example). This procedure requires correction of the stress-range amplitudes considered and the associated number of cycles in order to account for the interspersion of stress cycles of unlike character. State whether or not the reported usages reflect use of this method. If not, indicate the effect on reported results.

Item 18: Justify the reason for not considering skew symmetric boundary conditions in the analysis of the torus shown in Figure 3.1. Evaluate the effect of the thus-neglected modes.

Item 19: Specific comments addressing the method of summation used and its compliance with the probability of non-exceedance (PNE) criteria of 84% stated in para. 6.3b of Reference 1 should be incorporated into the text.

Item 20: Provide justification for analyzing only one SRV discharge line, as shown in Section 6.0 of Reference 4. Indicate whether all discharge lines are identical in configuration to the one modeled, and whether the model investigated is conservative enough to represent all lines.

Item 21: Submit a summary of the analysis for the vacuum breaker and its penetration.

Item 22: Justify that the 45° model of the vent header and downcomer used in the analysis is adequate to meet the intent of the criteria which requires at least 180°.

Justify the reasons for not considering skew symmetric boundary conditions to evaluate the effect of the resulting modes.

GENERAL

Item G1: Describe fully the procedures used to assess cumulative fatigue damage. In particular, address:

1. Where departures from standard code procedure were introduced.

2. How critical points were selected and how stress (or stress intensity) ranges were computed.

3. Which cyclic loads were omitted, if any, in these computations. For example, were thermal transients given consideration?

4. Whether cyclic amplitudes and the associated number of cycles were adjusted to account for the interspersion of cycles of unlike character.

5. How the cumulative usage factor was computed.

6. What impact departures from code procedures have on the margins of safety shown for each component for which cumulative usage was computed.

Item G2: Is the method described in Section 4.3.6 of Reference 4 for assessing thermal stress typical of all evaluations made in the report?

Please discuss the tacit assumption that either:

1. Thermal equilibrium is achieved before other significant mechanical loads are experienced by the structure.

   or

2. Maximum transient thermal stresses are conservatively bounded by the assumptions made.

Table 1. Structural Loading (from Reference :)

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						[X]			
7.2 Torus Shell Pressures	[X]	[X]							
7.4 Jet Loads on Submerged Structures					[X]	[X]		[X]	[X]
7.5 Air Bubble Drag					[X]	[X]		[X]	[X]
7.6 S/RVDL Environmental Temperature						[X]			

X Loads required by NUREG-0661[;;] and included in PUA report.

[X] 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. Vermont Yankee Nuclear Power Station
   Plant Unique Analysis Report, Mark I Containment Program
   Vermont Yankee Nuclear Power Corporation
   November 30, 1982, TR-5319-1, Revision 0

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