TECHNICAL EVALUATION REPORT

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

BOSTON EDISON COMPANY
PILGRIM STATION UNIT 1

NRC DOCKET NO. 50-203
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FRC PROJECT C5506
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FRC TASK 328

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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.

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 Pilgrim Station Unit 1 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 the Pilgrim 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 was concluded that certain items in the Pilgrim PUA reports [4, 5] 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 [6, 7] to all the items contained in the request for additional information (Appendix B), including the items related to torus-attached piping. After an initial review of these responses, meetings were held with the Licensee to clarify certain aspects of References 4 and 5 and to verify the criteria and approach used by the Licensee for performing analysis of torus-attached piping, supports, and the torus penetrations. A brief review of the Licensee's responses [6, 7] and clarification obtained during the meetings with the Licensee is provided below. It is worth noting that each item in References 6 and 7 was discussed in the August 9, 1983 and August 24, 1984 meetings, respectively.

Item 1

In response to this item, the Licensee stated that the vacuum breaker valves at the Pilgrim plant have been considered to be Class 2 for analysis purposes; hence, the Licensee's analysis conforms to the criteria [3] requirements. Criteria for vacuum breaker modification were not addressed in Reference 3, and this issue is considered to be ouside the scope of this TER. This issue is still a part of the Mark I Long-Term Program and will be reviewed by the NRC separately.

Item 2

In this response, the Licensee indicated that all torus piping systems have been considered to be essential for plant operation for each load combination. The torus motion has been applied to the piping system as a time history for all dynamic loads. During a meeting with the Licensee/consultant on August 9, 1983, an overview of the Licensee's analytical approach was presented. Subsequently, the Licensee submitted the PUA report for torus attached piping [5] which was reviewed, and a request for additional information was sent to the Licensee to which the Licensee responded during the meeting with the Licensee/consultant on August 24, 1984 [7]. See Responses 7.1 through 7.7 for detailed discussions of the Licensee's response.

Item 3

In this response, the Licensee indicated that the analysis of the SRV discharge line at the Pilgrim plant has been done separately for the portions of the piping within the torus and for all upstream piping (including vent pipe penetration) in order to provide early results for torus wetwell piping which is included in Reference 4. During a meeting with the Licensee/consultant on August 9, 1983, an overview of the Licensee's analytical approach was presented which indicated that the Licensee's approach conforms to the criteria requirements. Subsequently, the Licensee submitted the PUA report for torus attached piping [5] which was reviewed, and a request for additional information was sent to the Licensee to which the Licensee responded during the meeting with the Licensee/consultant on August 24, 1984 [7]. See Responses 7.1 through 7.7 for detailed discussions of the Licensee's response.

Item 4

During a meeting with the Licensee/consultant on August 9, 1983, an overview of the Licensee's analytical approach was presented which indicated that the Licensee's approach conforms to the criteria requirements. Subsequently, the Licensee submitted the PUA report for torus attached piping [5] which was reviewed, and a request for additional information was sent to the Licensee to which the Licensee responded during the meeting with the Licensee/consultant on August 24, 1984 [7]. See Responses 7.1 through 7.7 for detailed discussions of the Licensee's response.

Item 5

In response to this item, the Licensee indicated that all torus-attached piping systems at the Pilgrim plant have been classified as essential Class 2 piping systems and that all components associated with these systems are considered active for purposes of the required evaluations. The Licensee's approach is conservative and conforms to the criteria requirements.

Item 6

In response to this item, the Licensee provided justifications for choosing five of the load combinations to be the governing ones. The Licensee's response is technically adequate and meets the intent of the criteria.

Item 7

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

Item 8

In response to this item, the Licensee provided a drawing which indicates the actual saddle web and column support geometry. The Licensee's response has resolved the concerns with regard to this item.

Item 9

In response to this item, the Licensee provided copies of the actual computer plots for the 360° torus beam model which verify the accuracy of the computer model. The Licensee's response has resolved the concerns with regard to this item.

Item 10

In response to this item, the Licensee indicated that the ring girder web dimension should be 23.5 inches; Figure 5-1 of the PUA report [4] had shown this dimension to be 20.50 inches. This error in the illustration did not affect the analysis and hence the Licensee's response has resolved the concerns with regard to this item.

Item 11

In response to this item, the Licensee provided justifications for neglecting the following loads (the Licensee's justification is noted briefly in parentheses).

1. Torus shell - post-chugging load (this is bounded by pre-chug load)

2. Vent header support columns - pool swell drag and LOCA jet forces (they do not contribute to load combinations causing maximum stress)

   - drag forces due to chugging (they do not contribute to load combinations causing maximum stress)

   - drag forces due to condensation oscillation (condensation oscillation does not contribute to the maximum column loading)

3. Vent header system - condensation oscillation - IBA (these loads are bounded by DBA condensation oscillation or DBA chugging)

4. Catwalk structure - effects due to motion of catwalk attachment points at the ring girder (they are negligible)

5. Internal spray header - effects due to motion of attachment points at the ring girder (they are negligible).

The Licensee's response is technically adequate and meets the intent of the criteria.

Item 12

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 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.

Item 13

In response to this item, the Licensee indicated that the reactions from the vent deflectors and ring headers were superposed in the analysis of vent support columns for pool swell. The Licensee's response has resolved the concern with regard to this item.

Item 14

In this response, the Licensee provided justification for not considering certain asymmetric modes in the analytical model for torus. The Licensee indicated that the highest shell stresses will occur at load frequencies that are highly coupled to symmetric modes (where the ring girders do not move). Based on this, the Licensee has concluded that the analysis is conservative. The Licensee's approach is technically adequate and meets the intent of the criteria.

Item 15

In this response, the Licensee indicated that all combinations of responses due to dynamic loads were analyzed using the absolute sum method. The Licensee's approach conforms to criteria requirement.

Item 16

In this response, the Licensee indicated that, because Emergency Procedure Guidelines will be used at the Pilgrim Station, chugging is not expected to occur during a small break accident (SBA). Based on this fact, the Licensee's analysis excluded fatigue cycles due to SBA chugging. The Licensee's approach is technically adequate and meets the intent of the criteria.

Item 17

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.

Item 18

In this response, the Licensee indicated that ring girder analysis is conservative for the following reasons:

1. The ring girder flange in the model is smaller in area than the actual ring girder flange at the Pilgrim plant and will indicate conservative results.

2. The saddle in the 1/16 ring girder model used in the analysis has the abbreviated geometry and not the full saddle design of the Pilgrim plant. This will conservatively result in a concentration of load over a smaller saddle area. The Licensee's response has resolved the concerns with regard to this item.

Item 19

In response to this item, the Licensee indicated that the natural frequency of the ring girder in the lateral direction is much greater than the corresponding loading frequency and hence will prevent frequency interaction with dynamic loads. The Licensee's response has resolved the concerns with regard to this item.

Item 20

In this response, the Licensee indicated that adequate conservatisms have been incorporated into the analysis of ring girder shell welds in the outer column and saddle regions which can offset the high stress values in those locations. The Licensee's response has resolved the concerns with regard to this item.

Item 21

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.

Item 22

In this response, the Licensee indicated that stress range amplitudes and the associated number of cycles were corrected in the fatigue analysis of the torus shell to account for the interspersion of stress cycles of unlike character. During the meeting with the Licensee/consultant on August 9, 1983, the Licensee outlined the procedure used for fatigue analysis of the torus-attached piping and penetrations. See Item 7.5 for details.

Item 7.1

In response to this item, the Licensee confirmed that there are no SRV piping supports located in the main vent pipe. The Licensee's response has resolved the concerns with regard to this item.

Item 7.2

The Licensee stated that pressure was considered as a sustained load and is included in the DW term of the equations in Section 2.4.2 of the PUA report [5] for SRV load cases. The Licensee's response has resolved the concern with regard to this item.

Item 7.3

In response to this item, the Licensee indicated that five branch lines were analyzed separately using the 10% rule and in each branch analysis, the resulting stresses were less than 10% of the allowable. The Licensee's response is technically adequate and meets the intent of the criteria [3].

Item 7.4

The Licensee confirmed that the SSE seismic load is included in the evaluation of load case 25. The Licensee's response has resolved the concerns with regard to this item.

Item 7.5

In response to this item, the Licensee provided the analytical results for the three penetrations with the highest usage factors for small bore piping and large bore piping. The results indicated that the usage factors for these piping are less than the allowable factor. The Licensee's response is technically adequate.

Item 7.6

In response to this item, the Licensee stated that some piping lines are connected by a cross-over system or by having similar configurations; similar or identical designs were analyzed as a single line. Except for lines X-206C and X-206D, which were analyzed separately, the results were presented in Reference 7 and will be reported in Revision 1 of the PUA report, Table 3-2. The Licensee's response is technically adequate.

Item 7.7

In response to this item, the Licensee provided the analytical results for the small bore lines associated with penetrations X-218 and X-219 [7]. These results will be reported in Revision 1 of the PUA report, Table 3-2. The Licensee's response is technically adequate.

3. CONCLUSIONS

From the audit of the Pilgrim Station Unit 1 Plant Unique Analysis Report, it was concluded earlier that certain aspects required additional information. The Licensee's responses [6, 7] to the request for additional information and subsequent clarification obtained during meetings 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 by the Licensee during the meeting on August 9, 1983 and documented in Reference 5 conform to the requirements of the criteria. The Licensee's approach to evaluation of piping fatigue conforms to the approach recommended by Mark I Owner's Group, which has been accepted by the NRC. The evaluation criteria of the containment vacuum breaker valves is not addressed in Reference 3 and is 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. Pilgrim Station Unit 1
Plant-Unique Analysis Report of the Suppression Chamber
Mark I Containment Long-Term Program
Technical Report TR-5310-1
Boston Edison Company
October 27, 1982

5. Pilgrim Station Unit 1
Plant-Unique Analysis Report of the Torus Attached Piping
Mark I Containment Program
Technical Report TR-5310-2
Boston Edison Company
October 1983

6. W. D. Harrington
Letter to D. B. Vassallo (NRC) with attachment
Subject: Responses to NRC Request for Information
Boston Edison Company
July 13, 1983

7. Mark I Torus Program
Review of Plant Unique Analysis Report for Pilgrim I Nuclear Power Plant
Teledyne Engineering Services
August 23, 1984
(August 24, 1984 Meeting)

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:

- 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.

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)			SEE NOTE 1				LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	o Vacuum breaker piping systems, including vacuum breaker valves attached to torus shell penetra-			SEE NOTE 1				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.)							
	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 2			LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	o All main steam system safety relief valve (SRV) piping				SEE NOTE 3			LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	o Applicable portions of the following piping systems:				SEE NOTE 4			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 NOTES 1, 2, 3, 4			LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	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: 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	✓						
1.3	a. The structural acceptance criteri 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	✓						
	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.	✓						
	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 5				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.) 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 5				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 1				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 NOTE 2				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 NOTE 4				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.	✓						
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 11				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	✓						

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]	✓						
	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;	✓						

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)	✓						
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.	✓						
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				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.							
	a. All loadings defined in subsection 3.2 of Reference 2 shall be considered.			SEE NOTE 6				LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN See Section 3.3 of this table.
	b. A summary technical report on the analysis shall be submitted to the NRC.			SEE NOTES 1, 2, 3, 4, 5				LICENSEE'S RESPONSES HAVE RESOLVED THESE CONCERNS
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 6				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 7, 21, 22				LICENSEE'S RESPONSES HAVE RESOLVED THESE CONCERNS
	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:			SEE NOTE 15				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 8, 9, 10, 14, 16, 18, 19, 20				LICENSEE'S RESPONSES HAVE RESOLVED THESE CONCERNS
	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 NOTE 9				LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	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						✓	

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 17				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.	✓						

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 12				LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	d. Use beam models in analysis of vent deflectors.	✓						
	e. Consider appropriate superposition of reactions from the vent deflectors and ring headers in evaluating the vent support columns for pool swell.			SEE NOTE 13				LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
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.	✓						

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 4				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:			SEE NOTE 3				LICENSEE'S RESPONSE HAS RESOLVED THIS CONCERN
	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.							
	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			Analysis Requirements					Remarks
	Code Classification	Loads	Service Limits	Method of Analysis	All Limiting Loads Considered	Fatigue Effects	Method of Combining Response	Results	
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)	*	*	*	*	*	*	*	*	* CRITERIA FOR VACUUM BREAKER MODIFICATION HAS NOT BEEN ADDRESSED IN REFERENCE 2, AND HENCE THIS ISSUE IS OUTSIDE THE SCOPE OF THE PRESENT TER. HOWEVER, THIS ISSUE WILL STILL BE EXAMINED BY THE NRC AS A PART OF MARK I LONG TERM PROGRAM
i. Vacuum breaker piping systems, including vacuum breaker valves attached to torus shell penetrations and to vent penetrations external to the torus (where applicable)	✓	✓	✓	✓	✓	✓	✓	✓	
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			Analysis Requirements					Remarks
	Code Classification	Loads	Service Limits	Method of Analysis	All Limiting Loads Considered	Fatigue Effects	Method of Combining Response	Results	
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)	✓	✓	✓	✓	✓	✓	✓	✓	
(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 1. Structural Loading (from Reference 5)

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 [4]

[X] Not applicable.

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 information on the analysis of the vacuum breaker piping systems and the vacuum breaker valves attached to vent penetrations within the torus, and has not indicated that these are Class 2 components.

NOTE 2: The Licensee has not provided information on the analysis of torus attached piping systems.

NOTE 3: The Licensee has not provided information on the analysis of safety relief valve discharge piping.

NOTE 4: The Licensee has not provided information on the analysis of active containment system piping systems, piping systems which provide a drywell-to-wetwell pressure differential, and other internal piping systems.

NOTE 5: The Licensee has not provided information indicating whether the piping and its supports have been classified as Class 2 or Class 3 piping, or essential or non-essential piping systems, and whether a pump or valve associated with the piping is an active or inactive component, and is considered operable.

NOTE 6: The Licensee has not provided adequate justification for determining several load combinations used in the PUA report [8] to be the controlling load combinations.

NOTE 7: 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 systems and the torus attached piping are sufficiently small that a plant-unique fatigue analysis of these piping systems is not warranted.

NOTE 8: With reference to the finite element model of the torus including the shell, ring girders, and supports, it is not clear whether the saddle webs and the torus columns were welded together as shown in Figures 2-5, 2-11, 2-12, 3.1, and 3.2 of Reference 8. The Licensee should provide information showing the as-built configuration of the torus and its supports.

NOTE 9: With regard to the 360° torus beam model, the Licensee should provide information showing the finite element model actually used in the analysis and justify the reasons for those missing members in Figure 3.4 of the PUA report [8].

NOTE 10: With regard to the ring girder model presented in Reference 8, the dimensions shown in Figure 3.3 seem inconsistent with the dimensions shown in Figure 5-1. The Licensee should provide information showing the as-built dimensions of the ring girders.

NOTE 11: With reference to Table 1 of Appendix B, the Licensee should indicate if all loads have been considered in the analysis and/or provide justification if any load has been neglected.

NOTE 12: The Licensee should justify the reasons for not considering a 180° segment of the vent systems in order to determine the effects of seismic and other nonsymmetric loads.

NOTE 13: The Licensee should justify the reasons for not considering the superposition of reactions from the vent deflectors and ring headers in evaluating the vent support columns for pool swell.

NOTE 14: 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.

NOTE 15: The Licensee has not indicated that structural responses from any two dynamic phenomena have been combined using either their absolute sum or the cumulative distribution function method. The Licensee should provide justification for using any alternative methods to combine responses.

NOTE 16: The Licensee has not indicated the present status of the proposed study of plant procedures to ensure that the operator would depressurize the system within 15 minutes after chugging begins, since this is assumed for fatigue analysis with regard to chugging.

NOTE 17: With reference to page 70 of Reference 8, the Licensee has not provided justification for not considering stresses due to the seismic and thermal response of the drywell in analyzing the main vent drywell intersection.

NOTE 18: With reference to the 1/16 model used for the ring girder analysis, the Licensee should provide more details to justify the assumption that the dimensions of the torus at the Pilgrim plant are similar to the dimensions of the torus at the plant which was actually analyzed. The Licensee should compare the boundary conditions and the support systems of these torus structures.

NOTE 19: The Licensee should justify the assumptions, with regard to drag loads, that the columns, column gussets, and saddle would make the ring girder very stiff and would prevent frequency interaction with dynamic loads.

NOTE 20: With reference to the high values of actual loads in the ring girder-shell welds in the outer column and saddle regions, the Licensee should indicate any conservatism in the analysis which would ensure that the allowables will not be exceeded.

NOTE 21: The Licensee has not provided information on the fatigue evaluation of the bellows.

NOTE 22: 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).

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

8. Pilgrim Station Unit 1
   Plant-Unique Analysis Report of the Suppression Chamber
   Mark I Containment Long-Term Program
   Technical Report TR-5310-1
   Boston Edison Company
   October 27, 1982

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

Item 2: Provide a summary of the analysis of torus attached piping systems consisting of analytical models which represent piping and supports from torus to first rigid anchor (or where the effect of torus motion is insignificant), and classification of piping systems as essential or non-essential for each load combination. Also, indicate whether a response spectrum or time history analysis for dynamic effect of torus motion at the attachment points has been considered.

Item 3: Provide a summary of the analysis for each safety relief valve (SRV) discharge piping which should include the analytical model with piping and supports, from the nozzle at the main steam line to discharge in the suppression pool, and the discharge device and its supports. Also, the information should indicate that time history has been used for discharge thrust loads, and spectrum analysis or dynamic load factors for other loads. Justification should be provided if the above criteria are not met.

Item 4: Provide a summary of the analysis with regard to the active containment system piping systems, piping systems which provide a drywell-to-wetwell pressure differential, and other internal piping systems.

Item 5: Provide a list indicating whether all the piping systems and their supports have been classified as Class 2 or Class 3 piping, or essential or non-essential piping systems, and whether a pump or valve associated with the piping is an active or inactive component, and is considered operable.

Item 6: Provide justification for determining the load combinations indicated throughout the PUA report [2] to be the governing load combinations.

Item 7: 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 [3] 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 8: With regard to the finite element model of the torus, including the shell, ring girders, and supports, it is not clear whether the saddle webs and the torus columns were welded together as shown in Figures 2-5, 2-11, 2-12, 3.1, and 3.2 [2]. Provide information showing the as-built configuration of the torus and its supports.

Item 9: With regard to the 360° torus beam model, provide information showing the finite element model actually used in the analysis, which should not have missing members as shown in Figure 3.4 in the PUA report [2].

Item 10: With regard to the ring girder model, the dimensions shown in Figure 3.3 [2] seem inconsistent with the dimensions shown in Figure 5-2 [2]. Provide information showing the dimensions of the ring girder.

Item 11: 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 12: Provide and justify the reasons for not considering a 180° segment of the vent system in order to determine the effects of seismic and other nonsymmetric loads as required by the criteria [1].

Item 13: Provide and justify the reasons for not considering the superposition of reactions from the vent deflectors and ring headers in evaluating the vent support columns for pool swell.

Item 14: With reference to the computer model for the 1/32 segment of the torus shown in Figure 3-1 of Reference 2 and the analysis performed using only symmetric boundary conditions, provide justification for not considering skew symmetric boundary conditions in order to evaluate the effect of the resulting modes.

Item 15: Confirm that structural responses from any two dynamic phenomena have been combined using either their absolute sum or the cumulative distribution function method and provide justification for using any alternative methods to combine responses.

Item 16: Indicate the present status of the proposed study of plant procedures to ensure that the operator would depressurize the system within 15 minutes after chugging begins, since this is assumed for fatigue analysis with regard to chugging.

Item 17: With reference to page 70 of Reference 2, provide justification for not considering stresses due to seismic and thermal response of the drywell in analyzing the main vent drywell intersection.

Item 18: With reference to the 1/16 model used for the ring girder analysis, provide more details to justify the assumption that the dimensions of the torus at the Pilgrim plant are similar to the dimensions of the torus at the plant which was actually analyzed. Compare the boundary conditions and the support systems of these torus structures.

Item 19: Justify the assumption, with regard to drag loads, that the columns, column gussets, and saddle would make the ring girder very stiff and prevent frequency interaction with dynamic loads.

Item 20: With reference to the high values of actual loads in the ring girder-shell welds in the outer column and saddle regions, indicate any conservatism in the analysis which would ensure that the allowables will not be exceeded.

Item 21: Provide the fatigue evaluation of the bellows.

Item 22: The ASME Code provides an acceptance 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 of 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 7.1: With respect to Section 2.3.2 of the PUA report, TR-5310-2 (5), indicate whether any SRV piping supports are located in the main vent pipe. It so, explain how the stresses in the main vent wall, near the supports, were calculated.

Item 7.2: With respect to Section 2.4.2 of the PUA report, TR-5310-2 (5), indicate whether pressure (P) was considered in the SRV load cases.

Item 7.3: With respect to Section 3.3.5 of the PUA report, TR-5310-2 (5), provide calculations demonstrating conformance to the 10 rule of Section 6.2 d (1) that may have exempted some branch piping at the Pilgrim plant from analysis.

Item 7.4: Regarding the controlling load cases for torus attached piping vent given in Section 3.4.1 of the PUA report, TR-5310-2 (5), indicate whether seismic loads were considered in load case 25 (Table 1).

Item 7.5: With respect to Section 3.4.7 of the PUA report TR-5310-2 (5), provide the analytical results of the fatigue evaluation of torus shell penetrations.

Item 7.6: With respect to Tables 3-1 and 3-2 of the PUA report, TR-5310-2 (5), indicate whether the lines in each of the following sets are identical and explain why only one result appears for each set: X-222A and X-222B, X-222C and X-222D, X-206C and X-206D, X-209A and X-209D, X-214 and X-215, X-216 and X-217, X-218 and X-219, X-228D and X-228F, and X-240A, X-240B, X-241A, and X-241B.

Item 7.7: Provide the analytical results for the small bore lines associated with penetrations X-218 and X-219.

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						[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[2]

[X] Not applicable.

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