SRED-34

TECHNICAL EVALUATION REPORT ON BWR SUPPRESSION POOL TEMPERATURE TECHNICAL SPECIFICATION LIMITS: THE GENERIC ISSUES

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ABSTRACT

BNL's evaluation of the BWR Owner's Group (BWROG) technical basis for increasing the suppression pool temperature limiting condition for operation (LCO) is documented in this report. The evaluation is limited to those issues that can be considered to be generically applicable to all participating BWR plants. These include the effect of increased LCO on containment pressure and temperature response to LOCA, the effect on LOCA and SRV related pool hydrodynamic loads and the effect on reactor core cooling capability. Based on our review of this information, it is concluded that the requested increase in LCO is acceptable subject to certain restrictions which are delineated via a set of acceptance criteria.

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LIST OF ACRONYMS AND ABBREVIATIONS

BNL	Brookhaven National Laboratory
BWR	Boiling Water Reactor
BWROG	BWR Owners Group
CPS	Clinton Power Station
DBA	Design Basis Accident
DPC	Differential Pressure Control
FSTF	Full Scale Test Facility
GE	General Electric Company
LCO	Limiting Condition For Operation
LDR	Load Definition Report
LOCA	Loss Of Coolant Accident
NRC	Nuclear Regulatory Commission
RAI	Request for Additional Information
RHR	Residual Heat Removal
RSL	Reactor Scram Limit
RMS	Root-mean-square
SER	Safety Evaluation Report
SRV	Safety/Relief Valve
SSES	Susquehanna Steam Electric Station
TER	Technical Evaluation Report
TLR	Technical Letter Report
TS	Technical Specification

1.0 BACKGROUND AND INTRODUCTION

In BWR nuclear plants large pools of sub-cooled water are installed to provide pressure suppression during events that cause steam to discharge into the primary containment. The pool is designed to absorb and/or transfer to the Residual Heat Removal (RHR) system enough of the energy inventory resident in the reactor to preclude containment failure. Its sizing pre-supposes operation within prescribed limits of water volume and initial temperature.

To insure proper operation, the NRC staff imposes Technical Specification (TS) limits on these operating parameters. In particular, there has been in place for a number of years a LCO on the bulk pool temperature. The TS for the LCO currently varies from 90 to 95°F.

In the judgement of the BWROG, an increase in the LCO would improve plant safety and efficiency by reducing the frequency at which pool cooling needs to be initiated. They further judge that an increase in LCO to 100°F can be justified generically and they have provided the NRC staff with technical basis for this position via a General Electric Topical report[1]. In this report GE also suggests that an increase of the LCO to 110°F, the current Reactor Scram Limit (RSL), may also be justified but on a plant specific basis only. Note that in this latter case the increase would have the effect of eliminating any T/S for the LCO; i.e.: no requirement for initiating pool cooling prior to reactor scram would be imposed.

The information contained in Reference 1 was evaluated by BNL earlier[2]. As part of this evaluation, a request for additional information (RAI) was developed[2-4]. The response to the RAI[5] together with the earlier submittal[1] represents the total BWROG technical basis for increasing the LCO. In this report, an evaluation of the entire submittal is presented. It is followed by our conclusions relative to the merits of increasing the existing TS limit on the LCO. Both the generic increase to 100°F and the plant specific value of 110°F are considered. Our recommendation for suitable acceptance criteria is also provided.

2.0 THE GENERIC BWROG SUBMITTAL

This submittal[1] identifies four generic concerns that arise due to the proposed changes in the LCO. These are: containment pressure and temperature response to LOCA; LOCA-related hydrodynamic loads; SRV-related hydrodynamic loads; reactor core cooling capability. Within these broad categories, justification for increasing the LCO is presented, for the most part, by containment type; i.e.: Mark I, Mark II and Mark III. Table 1 lists the issues that are addressed there using an analogous format.

A detailed evaluation of the BWROG submittal may be found in an earlier BNL technical letter report[2]. It has been included here as Appendix A. Table 1 summarizes the status of the various issues following this evaluation. In particular, those items for which additional information was requested are highlighted. The table is self-explanatory and the remainder of this TER will be devoted to describing and evaluating the BWROG response to the RAI (Section 3), providing our overall conclusions (Section 4), and finally our recommendations for acceptance criteria (Section 5).

3.0 BWROG RESPONSE TO THE NRC RAI

For convenience, the RAI that was transmitted to the BWROG is reproduced here as Appendix B. The reader should refer to the appropriate sections for additional clarification relative to the issues raised. The BWROG response to the RAI,[5] being proprietary, could not be included here. However, a description of the response to each question is provided.

3.1 Response to Question 1

3.1.1 Description

The BWROG states that for Mark I plants the design pool swell loads derive from tests with peak drywell pressures 20% greater than would be expected under best estimate assumptions. This margin in drywell pressure corresponds to a 10% margin in pool swell loads. An increase in pool temperature from the test conditions (70 to 80°F) to an LCO value of 100°F implies an increase in pool swell loads of 6% based on Mark II test results. Accordingly, they assert that the increase is justified.

The response for Mark III plants is analogous. In this case the margins in drywell pressure/pool swell loads are stated to be 15% and 7%, respectively. Since the increase in the latter due to an increase in pool temperature from 70°F (tested condition) to 100°F is also 6%, the increased LCO should be acceptable.

3.1.2 Evaluation

We have reviewed the information cited in support of the BWROG position and concur that the margins in peak drywell pressure and pool swell loads are as stated. We also find acceptable the trends used to estimate the effect of pool temperature on the latter. It follows that the design procedures currently in place will provide a bound of pool swell loads that may arise in the event of a LOCA at a LCO of 100°F. An increase of the LCO to 110°F is also acceptable prima facie for Mark I plants since the corresponding increase in pool parameters (8%) would be still be bounded by the available margin (10%). For Mark III a slight exceedance (only 7% margin available) would be expected. However, we judge this to be a minor effect so that a 110°F is acceptable for all BWR plants with respect to pool swell loads.

The very small margins exhibited here, particularly for Mark III plants, need to be kept in mind in the event of any further request for relaxation of existing TS. In fact, these findings suggest that Table 4-1 of the BWROG submittal[1] be modified to reflect the fact that pool swell loads can also restrict the maximum allowable LCO.

3.2 Response to Question 2

3.2.1 Description

The response quantifies the effect of pool temperature by reporting the peak RMS amplitudes of the internal downcomer pressures and the corresponding peak values of differential (between downcomer pairs) pressure measured in the FSTF at the lowest (68°F) and highest (93°F) test temperature. These show a negligible effect (less than 1%). Also reported is a comparison between measured and predicted stresses indicating a margin of 12%. It is argued that the insensitivity exhibited by the measurements together with the large margin inherent in the design method justify an increase in the LCO to 100°F.

3.2.2 Evaluation

As discussed in Section 2.2.2.1 of Appendix A, the design CO pool boundary loads for Mark I plants derive from low temperature FSTF tests. In contrast, design loads for downcomers include results obtained at elevated temperature. This is because the original specification was not approved by the NRC staff for "tied" downcomers[6]. The need to develop an improved methodology thus gave the BWROG the opportunity to factor in the high temperature data.

Since the high temperature results corresponding to test M12 were included in the development of these NRC approved loads, resolution of the issue is facilitated. That is, we need to consider the applicability of the loads at a temperature less than 7°F higher than that tested. The insensitivity exhibited over a 25°F temperature increment coupled with the substantial margins in stress comparisons that are reported confirms their applicability not only at the requested LCO of 100°F but for the higher value of 110°F that the NRC staff may want to approve on a plant specific basis.

Two additional comments are appropriate here. First, we highlight the seeming anomaly that downcomer pressures are insensitive to pool temperature while corresponding pool boundary loads, as discussed in Section 2.2 of the Mark I SER supplement[7], exhibit an increasing trend (about 15%). This can be attributed to a model of larger bubbles oscillating at the end of the downcomers due to higher pool temperature. That is, the steam-water interface has to dilate to a greater extent so as to provide sufficient heat transfer area to compensate for the reduced steam condensing potential. The shift in fundamental CO frequency of the oscillations (from 6 to 5 Hz) is also consistent with this notion, as already noted[7].

The second comment relates to the applicability of these findings for BWR plants with "untied" downcomers. The NRC's Mark I SER[6] refers to a load specification for such structures. Furthermore, in the Acceptance Criteria, Section 4.4.3 of the Mark I LDR[8] is cited as providing a description of this load. However, the most recent version of this document (Revision 2) describes loads only for tied downcomers. We speculate that untied downcomers are no longer used in Mark I plants. However, since the BWROG response and our evaluation has not addressed this issue we make our approval of an increased LCO contingent on the use of tied downcomers. We do this via our recommended Acceptance Criteria (Section 5).

3.3 Response to Question 3

3.3.1 Description

The response is a restatement of the CO methodology described in GESSAR-II[9]. It differs only in that it specifies the initial pool temperature used to numerically evaluate the time dependence of the pressure amplitude and frequency of these loads as defined in Equation 3B.4-1 of the aforementioned document. This initial temperature is stated to be 100°F.

3.3.2 Evaluation

The methodology described in GESSAR-II has been approved by the staff[10]. Since this methodology employs an initial pool temperature equal to the requested LCO (100 degF), the modification is acceptable. Acceptability at the higher, plant-specific value of 110 degF would require further reevaluation using the higher entry temperature in the approved (GESSAR-II) analysis.

3.4 Response to Question 4

3.4.1 Description

This was a two part question: which Mark I plants used in-plant tests to develop SRV loads? what is their basis for justifying an increase in LCO? No reply is supplied for the first of these questions. For the latter, the response indicates that this basis will have to be provided by the individual plants.

3.4.2 Evaluation

There is very little to be said here. Our Acceptance Criteria will limit approval to those plants that utilize the generic methods. We would suggest that the NRC staff request a listing of the others and include it in any future SER that may be published.

3.5 Response to Question 5

3.5.1 Description

Regarding the Mark I differential pressure control (DPC) system, the response states that there is no significant effect of an increase in the LCO and, in any case, most plants no longer use these systems.

3.5.2 Evaluation

We consider this somewhat unresponsive since no basis for the stated position is provided. It is particularly difficult for us to evaluate any potential effect since, as noted in Section 2.5.1 of Appendix A, we do not have available a description of these systems. Accordingly, our acceptability of the proposed change will be restricted to plants not utilizing a DPC. We note this in Section 5.

3.6 Response to Question 6

3.6.1 Description

The response follows the recommendation made in the BNL letter report (Section 3.8 of Appendix A) in terms of the information that should be provided to support an increase in the LCO.

3.6.2 Evaluation

The technical justification that is provided demonstrates that sufficient margin exists in the load specification for the Mark II diaphragm reverse load to accommodate an increase in the LCO at least up to 110°F.

3.7 Response to Question 7

3.7.1 Description

As suggested in Section 3.9 of Appendix A the response notes that submerged structure loads and pool boundary loads are both driven by the same forcing function; i.e., the moving interface between pool water and pockets of air or steam located at the downcomer exit. Accordingly, approval of load methods for the boundaries tacitly implies the acceptability of the corresponding methods for submerged structures since both derive from the same source.

3.7.2 Evaluation

Since we have judged that the design methods for boundary loads provide sufficient margin to accommodate an increase in the LCO to 100°F and in some cases to 110°F, the corresponding methods for submerged structures can also be expected to accommodate these increases for the reasons cited in the response.

3.8 Response to Question 8

3.8.1 Description

The response parallels the arguments used in Section 2.5.4 of Appendix A and provides the additional information that the quencher thrust loads developed via the LDR methods[8] are applied by the individual plant engineers to structures that support the quenchers.

3.8.2 *Evaluation*

In Section 2.5.4 of Appendix A it was concluded that sufficient justification existed to permit the requested increase in LCO so long as there was assurance that the thrust loads on Mark I quenchers were used to evaluate the corresponding tie-down loads. Since the response provides this assurance, we consider this issue resolved.

4.0 CONCLUSIONS

Based on BNL's evaluation of the information supplied by the BWROG[1-5] as documented here and in the earlier letter report[2] we conclude that an increase in the LCO to 110°F is, with the exceptions noted below, technically justified for all BWR plants that utilize staff approved generic methods to evaluate containment response to DBA LOCAs and SRV discharges. Specifically, we find that in the areas of containment pressure and temperature response to LOCA, LOCA related pool dynamic loads, SRV related pool dynamic loads and reactor core cooling the effect of such an increase can be accommodated by existing margins in the load specifications and/or design criteria. It is emphasized that this acceptability is limited to the four areas cited which the BWROG identifies as generic for all BWR plants.

For BWR plants that continue to utilize a drywell-to-wetwell pressure differential for LOCA load mitigation, acceptability of the proposed change requires additional justification. This should take the form of a description of the systems/procedures employed to maintain the differential together with an estimate of how an increase in the LCO would influence system performance.

The limitations imposed by these conclusions are delineated more explicitly via the Acceptance Criteria listed in Section 5.

5.0 ACCEPTANCE CRITERIA

In Table 2 we itemize the generic issues examined in this TER that are impacted by a change in the LCO. Note that this listing is identical to that used in Table 1. For each of the issues, criteria are given which the staff can utilize to judge the acceptability of any particular applicant's basis for increasing their LCO. Compliance with these requirements would insure the staff's favorable finding in response to such a request. The entries given in Table 2 are, in short, the relevant Acceptance Criteria (AC).

We also identify in Table 2 several of the plants participating in the BWROG program that do not appear to be in compliance with the AC requirements as determined during BNL's evaluation. We do not think these non-compliances would be difficult to correct but we highlight them here for completeness. We recommend the NRC staff take special note of these cases and require the respective applicants to explicitly address these concerns.

6.0 REFERENCES

1. Mintz, S., "BWR Suppression Pool Temperature Technical Specification Limits", General Electric Report NEDO-31695, May 1989.

2. Economos, C. "BNL Evaluation of the Generic Issues Addressed in GE Report NEDO-31695 'BWR Suppression Pool Temperature Technical Specification Limits'", BNL Letter Report, May 1990.

3. FAX from C. Economos (BNL) to R. Anand (NRC) dated 6/12/1990.

4. FAX from C. Economos (BNL) to R. Anand (NRC) dated 6/20/1990.

5. Mintz S., "Response to NRC Questions on NEDO-31695", GE Report NEDC-31935P, March 1991.

6. U.S. Nuclear Regulatory Commission "Safety Evaluation Report, Mark I Containment Long Term Program, Resolution of Generic Technical Activity A-7," NUREG-0661, July 1980.

7. U.S. Nuclear Regulatory Commission "Safety Evaluation Report, Mark I Containment Long Term Program, Resolution of Generic Technical Activity A-7", NUREG-0661: Supplement No.1, August 1982.

8. General Electric Company, "Mark I Containment Program Load Definition Report," NEDO-21888, Revision 0, December 1978; Revision 2, November 1981.

9. General Electric Company, "General Electric Standard Safety Analysis Report (GESSAR-II)," Appendix 3B, Report No. 22A7007, February 1982.

10. U.S. Nuclear Regulatory Commission, "Mark III LOCA-related Hydrodynamic Load Definition," NUREG-0978, August 1984.

11. General Electric Company, "The General Electric Pressure Suppression Containment Analytical Model," NEDO-10320, April 1971; Supplement 1, May 1971; Supplement 2, January 1973.

12. Wheeler, A.J., "Mark I Containment Program Analytical Model for Computing Transient Pressures and Forces in the Safety-Relief Valve Discharge Line,"NEDE-23749-P, February 1978.

Table 1. Status of Generic Issues Following BNL Evaluation of the BWROG Submittal[1] (GE NEDO-31695)

Issue	Containment Type		Justification for Increase in LCO			Notes	Other Relevant Sections In...	
			Developed by BWROG(1)	Developed by BNL(2)	Requires Response to RAI(3)		BWROG Submittal	BNL Letter Report
Containment LOCA Pressure and Temperature	Mark I			2.1.1			3.1.1.1	3.1
	Mark II			2.1.2			3.1.1.1	
	Mark III			2.1.3		(4)	3.1.1.1	3.2
LOCA Pool Swell Loads	Mark I				1.			2.2.1; 3.3
	Mark II			2.2.1				
	Mark III				1.			2.2.1; 3.3
LOCA Condensation Oscillation Loads	Mark I	Torus Loads		2.2.2.1			3.1.1.2.1.1	
		Down-comer Loads			2.			2.2.2.1; 3.4
	Mark II		3.1.1.2.1.2					2.2.2.2
	Mark III				3.			2.2.2.3; 3.5
LOCA Chugging Loads	Mark I		3.1.1.2.2.1					2.2.3.1
	Mark II		3.1.1.2.2.2					2.2.3.2
	Mark III		3.1.1.2.2.3					2.2.3.3
SRV Condensation Loads	All					(5)	3.1.2.1	2.3.1
SRVDL Air Clearing Loads	All		3.1.2.2					2.3.2

Table 1. Status of Generic Issues Following BNL Evaluation of the BWROG Submittal[1] (GE NEDO-31695)

Issue	Containment Type	Justification for Increase in LCO			Notes	Other Relevant Sections In...	
		Developed by BWROG(1)	Developed by BNL(2)	Requires Response to RAI(3)		BWROG Submittal	BNL Letter Report
SRV Air Clearing Loads on Pool Boundaries	Mark I	3.1.2.3.1			(6)		2.3.3.1
	Mark II	3.1.2.3.2					2.3.3.2
	Mark III	3.1.2.3.3					2.3.3.3
Re[illegible]or Core Cooling Ca[illegible]bility	All	3.1.1.3.1					2.4
Differential Pressure Control	Mark I			5.			2.5.1; 3.7
Diaphragm Reverse Load	Mark II		2.5.2	6.			3.8
Submerged Structure Drag. Loads	All		2.5.3	7.			3.9
Quencher Tie Down Loads	All		2.5.4	8.			3.10
Reflood Transient	Mark I		2.5.5				3.11

LIST OF NOTES FOR TABLE 1

1) Numbers in this column refer to specific sections of the BWROG submittal[1]

2) Numbers in this column refer to specific sections of the BNL letter report (Appendix A)

3) Numbers in this column correspond to specific questions listed in the RAI (Appendix B)

4) The justification applies only to the Clinton Power Station. The BNL letter report notes that the Perry plant does not appear to be capable of any increase in the LCO. The NRC staff has elected to treat this as a plant-specific issue.

5) The influence of an increase in LCO on steam condensation loads, if any, is examined indirectly under the Task 1 effort of this project (FIN L-1226) which addresses the issue of T/S limits on local pool temperature.

6) The submittal only addresses the generic Mark I methods but lists as participating plants one which chose to develop its own plant-unique load definition via in-plant tests. This inconsistency was highlighted in the BNL letter report and is discussed further below.

Table 2. Acceptance Criteria for Increase of the LCO to 110°F

ISSUE	MARK I	MARK II	MARK III
Maximum LOCA Containment Pressure Temperature	 AC-1 AC-1	 AC-1 AC-1(A)	 AC-1 AC-1(B)
LOCA Pool Swell Loads	AC-2(C)	AC-2	AC-2(C)
LOCA CO Loads on Walls on Downcomers	AC-2 AC-2(D)	AC-2 NA	AC-2(E) NA
LOCA Chugging Loads	AC-2	AC-2	AC-2
SRV Condensation Loads	AC-3	AC-3	AC-3
SRVDL Air Clearing Loads	NA	NA	NA
SRV Air Clearing Loads on Pool Boundaries	AC-4(F)	AC-4	AC-4(E)
Reactor Core Cooling Capability	NA	NA	NA
Differential Pressure Control	(G)	NA	NA
Diaphragm Reverse Load	NA	AC-2	NA
Submerged Structure Drag Loads	AC-2 AC-3	AC-2 AC-3	AC-2(E) AC-3(E)
Quencher Tie Down Loads	AC-3	NA	NA
Reflood Transient	NA	NA	NA

LIST OF NOTES FOR TABLE 2

Definition of Acceptance Criteria A-1 to A-4

An increase of the limiting condition for operation on suppression pool temperature from current values up to but not to exceed 110°F is acceptable for all BWR plants that can demonstrate to the staff conformance with the following criteria:

AC-1 Using methods approved by the NRC staff (eg: Reference 11) and with the requested LCO as the initial suppression pool temperature, the maximum values of containment pressure and temperature estimated to occur in response to a DBA LOCA shall be shown not to exceed the corresponding design vales.

AC-2 All design LOCA-related pool hydrodynamic loads have been developed and applied in accordance with the generic methods approved by the NRC staff (as delineated in NUREGs 0487, 0661, 0808, 0978 and supplements).

AC-3 All SRV discharge lines which rout steam to the suppression pool are equipped with NRC staff approved quencher type devices as delineated in NUREG-0783.

AC-4 All SRV discharge lines which rout steam to the suppression pool are equipped with NRC staff approved quencher type devices as delineated in NUREG-0783 and all design SRV-related pool hydrodynamic loads have been developed and applied in accordance with the generic methods approved by the NRC staff (as delineated in NUREGs 0661 and 0802).

Definitions of Comments A to G and NA.

A Both participating MARK II plants (LaSalle, SSES) may not be in compliance with AC-1 if the LCO is increased to 110°F.

B Both participating Mark III plants (CPS, Perry) may not be in compliance with AC-1 if the LCO is increased to 110°F.

C Approval of any increase of the LCO beyond 110°F would require modification of the currently approved methods for development of these loads.

D No increase in the LCO is approved for plants with untied downcomers.

E Where appropriate, these design loads have to be reevaluated using the requested LCO as the initial suppression pool temperature.

F No increase in the LCO is approved for plants that have developed design values for these loads by means of in-plant SRV tests.

G No increase in the LCO is approved for plants that continue to utilize a drywell-to-wetwell pressure differential for LOCA load mitigation.

NA Indicates that this issue is not applicable or that the effect of increasing the LCO to 110°F is negligible.

Appendix A

BNL Evaluation of the Generic Issues Addressed in G.E. Report NEDO-31695 "BWR Suppression Pool Temperature Technical Specification Limits"

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BNL* EVALUATION OF THE GENERIC ISSUES ADDRESSED IN GE REPORT NEDO-31695 "BWR SUPPRESSION POOL TEMPERATURE TECHNICAL SPECIFICATION LIMITS"

by
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ABSTRACT

BNL's evaluation of the BWROG submittal that provides technical justification for increasing the suppression pool temperature limiting condition for operation (LCO) is documented. This evaluation is limited to those issues that the submittal characterizes as generically applicable to all participating BWR plants. These include the effect of increased LCO on containment pressure and temperature response to LOCA and LOCA and SRV related pool hydrodynamic loads. Also considered generically is the impact of this change on reactor core cooling capability. For the most part, the submittal satisfactorily addresses these generic issues. In those areas where some deficiency has been identified we would anticipate resolution via clarifying type information. No serious omissions are apparent to us at this time. A section detailing the information that is needed is included.

1.0 INTRODUCTION

The BWR Owners Group (BWROG) justification for revising the existing Technical Specification (TS) limit on the LCO for BWR plants is presented in GE Report NEDO-31695. The document identifies four concerns associated with this revision that are to be addressed generically. The intent of the presentation is to demonstrate that the TS limit can be changed from the current value of 90-95°F to 100°F.

The four concerns that are addressed are containment pressure and temperature response to LOCA, LOCA related hydrodynamic loads, SRV related hydrodynamic loads, and reactor core cooling capability. Within these broad categories the justification is presented, for the most part, by containment type; i.e.: Mark I, Mark II and Mark III. Our evaluation parallels this format. For each of the categories and subcategories we present a brief description of the BWROG basis followed by our evaluation and conclusion. In a number of instances, BNL has identified related issues that could be influenced by the proposed changes that are not addressed by the submittal. A description and evaluation of these is included in a separate section.

2.0 EVALUATION

As indicated above, this section will parallel the format used in NUREG-31695. The four major areas of concern will be considered in the same order. Within each of these, the evaluation will address the issue by containment type. In a fifth section, the additional concerns that we have identified and that were not covered in the BWROG submittal will be reviewed.

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*See Nomenclature for definition of abbreviations

2.1 Containment LOCA Pressure and Temperature

2.1.1 MARK I Plants

The submittal indicates that the current design limits for the MARK I containment are 56 psig and 281 F and that the participating MARK I plants could increase the LCO to 120°F and stay within these limits. It is stated that this conclusion derives from calculations that include the assumption that any increase in LCO causes an equal increase in peak suppression pool temperature. The nature of these calculations is unclear. If they are conventional FSAR type(1) the LCO would be an input and the peak temperature a calculated result. Another interpretation possible is that the peak temperature from existing FSAR calculations was simply incremented by whatever the proposed increase in LCO is. We examined this possibility for three plants (Hatch, Monticello, and Peachbottom) but the results did not clarify matters. For example, the Hatch FSAR shows a peak pool temperature of 200°F with an initial temperature of 95°F.(Figure 14.4-10c). An increase of 25°F (i.e.: from 95°F to 120°F) would then imply a peak temperature of 225°F. This is well below the stated (and confirmed by us) design limit of 281°F. The same result is found for the other plants (peak temperatures of 220°F and 215°F, respectively). The genesis of the 120°F limitation thus remains obscure. Fortunately, it is irrelevant for the present purpose since our evaluation is directed at a revised LCO of 100°F.

Based on our spot check of MARK I FSARs, we conclude that there is a very large margin (80-90°F) between suppression chamber design temperature and the corresponding peak LOCA value'. In our judgement, this margin can easily accommodate an increase in LCO from 90-95°F to 100°F in the absence of steam bypass'' The same is true for containment pressure where the margin is also substantial (100% or more). We conclude that for MARK I plants, an increase in LCO to 100°F will not result in an exceedance of design suppression chamber temperature or containment pressure.

2.1.2 Mark II Plants

The submittal indicates that the design limits for MARK II containments are typically 45 psig and 275°F and that the LCO for participating plants could be in-creased to 100°F without exceeding these limits. Here again the basis for this conclusion are calculations similar to those referred to above for the MARK I plants. Only two plants are listed as participants (Susquehanna and LaSalle). The FSAR for the first of these (SSES) indicates that the limits for the wetwell are 53 psig and 220 F (Table 6.2-1). The Lasalle FSAR (also Table 6.2-1) shows limits that agree with the BWROG submittal but employs an LCO of 100°F (Table 6.2-3). Also, Lasalle has requested a revised LCO of 110°F via a plant-specific submittal(2).

Because of the disparity between these two plants we examined the FSAR of one additional MARK II plant. The design limits for Limerick turn out to be very much like those for SSES (55 psig, 220 F-Table 6.2-1) but with an LCO of 95°F. A design temperature of 275°F thus appears atypically high.

The LaSalle FSAR shows a peak LOCA temperature of 200 F(Table 6.2-8). On the other hand, the SSES result is substantially higher(208 F-Table 6.2-5) despite an LCO which is 10 F less. Limerick exhibits the highest temperature(213 F-Table 6.2-6) with an intermediate value of LCO. If these LOCA temperatures are adjusted for a revised LCO they approach but stay below the design value(21811 F vs 220 F). They do imply a greater potential for steam bypass, however.

'Drywell temperature is a separate consideration and is taken up in Section 3.1 below.

''The increase in LCO implies a peak pool temperature as high as 205°F. This probably precludes steam by-pass but whether it actually occurs is an issue beyond the scope of this review.

As with the MARK I plants, the margins for suppression chamber pressure are substantial(30% or more). The drywell pressure and temperature response to LOCA is also bounded by a considerable margin. We conclude that for participating MARK II plants an increase in LCO to 100°F will not cause an exceedance of design containment temperature and pressure.

2.1.3 MARK III Plants

According to the submittal, the design parameters for the MARK III containment are generic at 15 psig and 185 F. It is also stated that of the two MARK III plants participating in the BWROG program (Perry and Clinton), only the latter can utilize an LCO of 100 F without exceeding these limits. Perry can only accommodate an LCO of 95°F.

We have confirmed the design limits cited by examining the FSARs for the two participating plants plus one other (Grand Gulf). The Clinton FSAR shows a LOCA peak temperature of 180°F with an LCO of 95°F (Table 6.2-4). An increase of the LCO to 100°F can therefore be accommodated by Clinton. Perry shows a peak LOCA temperature equal to the design limit (Table 6.2-1) and this result is associated with an LCO of 90°F. Thus, any increase above this value implies exceedance of design. Although not directly pertinent, the results for Grand Gulf are of some interest. That FSAR shows a peak LOCA temperature of 171°F with an LCO of 80°F, both very low values compared to the participating MARK III plants.

LOCA pressures for drywell and containment are well below design limits in all cases. LOCA drywell temperatures on the other hand are equal to design values (330°F). In principle therefore, any increase in LCO has some potential to cause an exceedance. However, we judge that any effect will be negligible since drywell temperature response to a LOCA is dominated by the steam/liquid discharge. This insensitivity is demonstrated by the identical results obtained for the three plants despite the wide variation in initial pool temperature (80 to 95°F).

Based on the above evaluation we conclude that the LCO for the Clinton MARK III plant can be increased to 100°F without causing an exceedance of design containment pressure and temperature. The information available to us does not permit us to conclude the same for the Perry plant. In Section 3.2 of this report a description of the information needed to allow us to arrive at a favorable conclusion is presented.

2.2 LOCA Related Hydrodynamic Loads

Three broad categories of these loads have been defined during the course of the NRC staff's evaluation of BWR containment capability. These include pool swell, condensation oscillation (CO), and chugging loads. A detailed description of these along with their genesis is given in NUREG-0661 for MARK I plants, NUREG-0487 and NUREG-0808 for MARK II plants, and NUREG-0978 for MARK III plants. These documents also include a description of the design loads that the NRC finds acceptable. We address each of these loads in the order indicated noting however, that the BWROG submittal does not treat pool swell explicitly beyond asserting that they are negligibly influenced by pool temperature.

2.2.1 Pool Swell Loads

As stated in the submittal, the first order influence on these loads is the drywell pressurization rate. However, the effect of pool temperature, although undoubtedly second order, is not negligible. This is borne out by the experimental results from the 4T(3) and JAERI(4) tests. The pool temperature in these tests, w[illegible]re a full scale MAR[illegible] g[illegible]etry was simulated, ranged from 70 to about [illegible]. Table [illegible] sh[illegible]s the effect of pool temperature on selected pool swell parameters as derived from these tests. Clearly, the influence is not negligible. Nonetheless, for MARK II plants we can conclude that an increase in LCO to 100°F will not result in an exceedance of existing design loads. This is because of the margins demonstrated by the comparisons shown in Reference 5. In this study the MARK II pool swell design loads, as modified by the NRC Acceptance Criteria(6), were used to predict pool swell response for all of the JAERI tests. A large margin was found at all temperatures. For example, the prediction for peak velocity at a pool temperature of 130 F was almost 30% higher than the observed value of 28.7 fps. For the other containments we cannot come to a conclusion for two reasons. First, the data base for these geometries apparently does not include examination of the effect of pool temperature(7-15). Furthermore, there is no indication at what temperature the tests were conducted. Thus, the extent to which the data base has to be extrapolated to accommodate an LCO of 100°F is not known. The additional information needed to arrive at a favorable conclusion for MARK I and MARK III containments is presented in Section 3.3.

2.2.2 *Condensation Oscillation (CO) Loads*

2.2.2.1 MARK I Plants

There are two types of CO loads to be considered; downcomer loads and submerged boundary loads (torus shell). The submittal does not make this distinction but simply states that a prediction for the CO loads at increased LCO was developed using data from the design basis FSTF tests(16) and from FSTF tests at elevated pool temperature(17). It is further stated that these results indicated that an LCO of 110 F could be accommodated without exceeding the NRC approved load definition.

Here again the nature of the analysis that was performed is unclear. For the torus shell, the NRC approved design load for CO(18) derives from a more or less direct application of the loads that were observed during one particular FSTF test conducted at an initial pool temperature of about 70°F(M8). Accordingly, the methodology is independent of pool temperature. We conclude therefore, that the analysis referred to differs from the accepted version and has neither been reviewed or approved by the NRC staff.

For submerged boundaries, an increase in LCO can be justified by making use of information currently available to us. Specifically, it has been shown (17) that application of the approved design load to the FSTF facility at conditions corresponding to the elevated pool temperature test (M-12,TP=95°F), where higher loads were observed, yields peak structural stresses and loads that exceeded measurements by at least 70% and by as much as 150%. In fact, the NRC staff's approval of the method is based on this consideration (19). In our judgement, sufficient margin is demonstrated in this comparison to allow a further, relatively small increment in pool temperature (5°F) without anticipating any exceedance of design capability. An increase in the LCO to 100°F is therefore acceptable as it relates to submerged boundary CO loads for MARK I containments.

The approved load definition for MARK I downcomer loads also derives from the FSTF tests(16,17). More specifically, it derives from the three liquid blowdown tests that Reference 19 characterizes as "worst case." The initial pool temperature in these tests was either 70°F (M8, M11B) or 95°F (M12). None of the relevant documents available to us indicates how the loads were affected by the temperature, however. Furthermore, we have no indication what sort of margin is provided by the load specification. Accordingly, we are not in a position at this time to come to a conclusion regarding the advisability of increasing the LCO. The information needed to complete our evaluation is outlined in Section 3.4.

2.2.2.2 MARK II Plants

For the MARK II configuration only submerged boundary loads need to be considered since CO downcomer loads are negligible (6). The submittal states that the generic load definition for submerged boundaries that is described in Reference 20 provides an envelope of all CO loads observed during the 4TCO test series (21). In these tests, the initial pool temperature ranged up to 114°F.

The load methodology given in Reference 20 has been approved by the NRC (22). Since it is able to bound loads at pool temperatures as high as 114°F, an increase in LCO to 100°F is acceptable for MARK II submerged boundary CO loads.

2.2.2.3 MARK III Plants

Here again CO loads have to be considered only for submerged boundaries. The submittal indicates that the specification for these loads(23) derives from a correlation of the results observed during the 1/3 scale PSTF tests(24). The correlation includes the pool temperature as a parameter. It is stated that this correlation was used to determine the effect of pool temperature and that, in this manner, it was established that the LCO could be increased to 100°F without exceeding the MARK III CO load definition.

The correlation cited has been approved by the NRC staff(25). However, the approved version specifies a restricted temperature range of applicability (90 to 135°F). It also specifies that the CO load definition be obtained by input of a temperature history that derives from use of a conventional DBA plant analysis (26). Presumably this requires specification of an initial pool temperature. Also, we would expect that the loads derived in this way would be applied to the containment structure (the loads are dynamic pressures) and the resulting structural response compared with structural capability. As we read the submittal, it is not clear that this is what was done using the propos:d new value of LCO(100°F). Therefore, we cannot complete our evaluation of this issue at this time. We indicate in Section 3.5 below the additional information needed for closure.

2.2.3 Chugging Loads

2.2.3.1 MARK I Plants

The BWROG submittal notes that the basis for chugging loads(submerged boundaries and downcomers) is the data from the FSTF tests(16,17). It is further noted that these data show that the chugging phenomenon ceases at pool temperatures above 135°F. It is argued that any increase in LCO will therefore simply result in a reduction of the chugging period without affecting the magnitude of the loads.

We have reviewed the pertinent documents and are in agreement with the BWROG position as stated in NEDO-31695. The approved chugging load definition is essentially a bound of loads observed over the entire spectrum of conditions encountered during the DBA LOCA. Our Figure 1, which has been excerpted from Reference (16), demonstrates this in a very succinct way. Note that design loads derive from Test M9 as noted. An LCO cf 100°F is clearly supported by this data base. We conclude that such an incr^ase is justified and acceptable.

PROPRIETARY FIGURE DELETED

Figure 1. Map of Experimental Conditions During Mark I FSTF Tests [16]

2.2.3.2 MARK II Plants

It is stated in the submittal that the generic chugging load for pool boundaries was developed from the full scale 4TCO tests(3), that the tests covered the entire range of conditions expected during a LOCA, and that the definition bounds all the observed chugging data. The submittal further states that, so long as the initial pool temperature does not exceed 110 F, LOCA conditions will be enveloped by the 4TCO test conditions.Our review of the pertinent documentation confirms the position of the BWROG. The load specification, which is presented in Reference 27, has been approved by the NRC (22). Our review of the test report (3) confirms that tests at pool temperatures up to 110°F were performed. We conclude that an increase of the LCO to 100 F is justified insofar as pool boundary loads are concerned.

For downcomer loads, it is noted that the specification was actually developed by the NRC staff(3,22). This design load incorporates the higher loads that are found to occur at lower pool temperatures. Since the trend of downcomer load magnitude with pool temperature is a decreasing one, an increase in LCO will not impact adversely on the MARK II containment's integrity during a LOCA event. We concur in this assessment and conclude that an LCO of 100°F is acceptable.

2.2.3.3 MARK III Plants

Although the MARK III configuration does not utilize downcomers as such, two distinct types of chugging loads still need to be addressed. In addition to those for the submerged boundaries, significant loading is experienced in the horizontal vents through which the LOCA steam discharge enters the suppression pool. For both of these loads, the increase in LCO is justified by noting that the design basis loads(23) represent a bound of all the chugging data observed during the PSTF tests(28). Since the test conditions therein enveloped those expected during a LOCA and since, with an LCO of 100°F, pool conditions would remain within the tested envelope, such an increase would be appropriate.

We have reviewed the pertinent documentation and conclude the stated BWROG position is acceptable. In approving the design loads(25), the NRC staff noted that the top vent loads were derived from atypically low pool temperature tests. This was done for conservatism since, as with the MARK II downcomers, the top vent loads tended to increase with decreasing pool temperature. Clearly, an increase in LCO here will enhance this conservatism. In its evaluation the staff also noted that, for submerged boundary loads, results from very high initial pool temperature (up to 170°F) tests were selected. Again, this was done for conservatism because these loads tended to increase with pool temperature. Since the data was obtained at conditions well above the proposed LCO the increase is justified and acceptable.

2.3 SRV Related Hydrodynamic Loads

The submittal considers three distinct loads under this general category; steam condensation loads, air clearing loads on the SRV discharge lines (SRVDL), and air clearing loads on pool boundaries. Only the latter are addressed by containment type.

2.3.1 Steam Condensation Loads

The position taken viz-a-viz the steam loads is that they simply will not arise so long as the participating plants employ quenchers as load mitigators. Also, explicit reference is made to the BWROG program which is intended to eliminate all limitations on local pool temperature(29). Based on these considerations, no adverse effect of any increase in LCO would be expected.

BNL's position on this issue is that it is more appropriate to address it under the Task 1 effort of this project. Our logic for this stance is that the steam loads are more directly related to local pool temperature. The link between the LCO and steam condensation loads is tenuous, at best.

2.3.2 SRVDL Air Clearing Loads

It is stated that the controlling variables for these loads are the steam flow rate, discharge line geometry, and submergence. Accordingly they will not be affected by the proposed change in the LCO.

We are in general agreement with the stated position. The approved calculation methods (eg: Reference 30) do not include TP as an input variable. Comparisons of measured stresses, etc. with predictions generated with these codes exhibit large margins(31). We do not expect any significant influence of a 10 F increment in LCO on these loads.

2.3.3 Pool Boundary Air Clearing Loads

2.3.3.1 MARK I Plants

The methodology used to develop these loads utilizes a semi-empirical analytical model(32). This analysis, which is implemented via the computer code QBUBBS, includes the initial pool temperature(TP) as a working variable. The submittal states that this methodology was applied to develop design loads using specific values of TP; 120°F for single valve actuations, the then extant LCO value for multiple valve actuations(MVA), and the plant-specific predicted value for ADS valve actuation. These choices are in accordance with Technical Specifications (T/S). It is noted that a change in LCO will not affect the first of these. For the MVA and ADS cases, QBUBBS was employed to estimate the effect of incrementing the original values of TP by 10°F. The increase in shell pressures was found to be small (about 2%). It is concluded that this is a negligible increase compared to the large margin provided by this methodology. Thus the proposed change is justifiable.

The NRC staff has made a detailed evaluation of the methodology referred to above(19). Its performance, as it relates to the trend with pool temperature, was characterized there as follows;...."Conservative trends prevail throughout the pool temperature range of interest, with the greatest conservatism exhibited at the higher values (>100°F)". We therefore consider an increase of the LCO to 100°F acceptable for all participating MARK I plants that employ this generic methodology.

We emphasize here that our findings apply only to those plants using the generic load methods as outlined in the MARK I LDR(18). According to the NRC staff's Acceptance Criteria(19), individual plants may choose to develop a load assessment by in-plant tests. The Pilgrim PUAR(33) indicates that this alternative was used. In the BWROG submittal, Pilgrim is listed as a participating plant. This inconsistency will require clarification as indicated in Section 3.6.

2.3.3.2 MARK II Plants

The submittal notes that MARK II plants can utilize either the MARK II T-quencher or the MARK III X-quencher as a SRV load mitigator. The load methods for the former, as described in References 34 and 35, derive from a bound of full scale data(36). Pool temperature in these tests ranged up to 130°F at simulated reactor pressure of up to 1300 psia. An LCO of 100°F is therefore justified for plants using T-quenchers.

The load methodology for MARK II plants using a X-quencher(23,35), employs a pressure amplitude-frequency envelope developed from the three highest amplitude pressure signatures observed during more than 200 in-plant SRV actuations. Since the NRC staff considers this method a more conservative one than that for the MARK II version(35), an LCO of 100°F is also justified here. Having been directly involved with the evaluation of these design loads including development of a series of modifications to insure conservatism(35), we are in a position to state, categorically, that there exists a sound technological basis for increasing the LCO to 100°F. The BWROG position relative to MARK II SRV air clearing loads is correct.

2.3.3.3 MARK III Plants

These plants utilize X-quenchers exclusively for load mitigation. The associated design loads are described in Reference 23. They were developed by means of a multiple regression analysis applied to a series of experiments where the entire spectrum of parameters affecting the air clearing loads were examined(37-39). The initial suppression pool temperature is one of the key controlling variables in this correlation. Containment capability was evaluated by exercising this method for five load cases. In all of these, the initial pool temperature was taken equal to or greater than 100°F. Therefore, an LCO of 100°F is appropriate for MARK III plants.

The design methods and load cases described have been approved by the NRC staff(35). Since these include the use of initial pool temperatures equal to or greater than 100°F, an LCO equal to that value is acceptable.

2.4 Reactor Core Cooling Capability

For this concern the submittal does not make any distinction for containment type. It simply cites certain analyses(40) where the sensitivity of peak fuel cladding temperature(PCT) to ECCS source water temperature has been examined. Since these studies indicated a very low sensitivity(6°F increase in PCT with 50°F increase in coolant temperature) the proposed increase in LCO would have a negligible effect on this aspect of ECCS capability.

The stated position has considerable merit. The calculations cited have been performed with an approved code that is demonstrably conservative and applicable to all BWR reactor classes(and therefore to all the participating plants). The insensitivity is plausible and not unexpected. An increase in LCO of 5 or 10 F will clearly have only a negligible effect on the PCT. These factors, along with the very large margin that exists between expected PCT and cladding capability provide adequate justification for the proposed increase in LCO.

2.5 Additional Generic Issues

In this section we list some additional issues that are influenced by the proposed change in LCO and that were not addressed in the BWROG submittal. In our judgement, they should be included in this generic evaluation even though, in some cases, they are generic only to a containment type. Where possible, we have researched the issue and made an evaluation ourselves. For those cases where this was not feasible, we describe the information needed for closure in Section 3. All of the concerns listed correspond to an issue that is covered in the safety evaluation reports issued by the NRC staff (6,19,22,25,35).

2.5.1 Differential Pressure Control

Some MARK I plants utilize a drywell-to-torus pressure differential to reduce pool swell loads(19). This operational feature has been approved by the NRC staff subject to a number of requirements as listed in the associated acceptance criteria.

We have made a number of efforts to obtain relevant information relating to this concern. Examination of FSARs, PUAGs, T/Ss has provided very little. Only one indirect reference was found. It indicated that the plant's inerting system was employed to provide the DPC. Discussions with BNL personnel knowledgeable in plant operations also did not provide any insight in that the existence of a DPC was unknown.

Without any description of the DPC system's makeup, it is not possible to evaluate the potential effect of a change in the LCO. That some effect is possible is intuitively clear. Maintenance of a given pressure differential within a closed system such as a BWR containment would be temperature dependent. The effect could very well be negligible but we are not in a position to conclude one way or the other. The information needed to close out this issue is described in Section 3.7.

2.5.2 Diaphragm Reverse Load

The NRC approved(22) diaphragm reverse load and its basis is described in Reference 40. It consists of an across-the-board application of a 5.5 psi upward pressure differential to the MARK II diaphragm floor. Reference 40 indicates that to arrive at this specification a correction for suppression pool temperature is required. Assuming that this correction was made using the original value of LCO (90 F), a further increment in the pressure differential would be required to accommodate an LCO of 100 F. Based on the trends developed in Reference 5, this increment would be 0.3 psi. This represents about a 5% increase in load. The comparisons of Reference 5 that were cited in Section 2.2.1 above exhibited margins that can readily accommodate such an increase. Furthermore, for the participating MARK II plants(LaSalle and SSES), the expected reverse load would be much less than the peak bounding value used by GE due to plant-specific parameters(DBA break size, suppression pool area, etc). Thus, we conclude that the proposed change in LCO is justified as it relates to the MARK II diaphragm reverse load. Nonetheless, the issue should be addressed in the BWROG for completeness. We include this as one of our recommendations in Section 3.8.

2.5.3 Submerged Structure Drag Loads

The distinction between these loads and submerged boundary loads is somewhat arbitrary. Both arise from the identical mechanism; the motion of a gas-liquid interface. The distinction is useful only because of geometric differences. These dictate the use of application techniques that are markedly different from those used for wetted boundaries. Regardless of these differences, the intensity of the loading is proportional to the strength of the source that characterizes the dynamic behavior of the interface.
An increment in the LCO will primarily influence loads through its effect on the source strength. Thus, in concluding that SRV pool boundary loads will not be unduly influenced by the proposed change in LCO (Section 2.3.3) we are saying the same about the influence on the source strength that gives rise to these loads. It follows that approval of this or any other boundary load implies approval of the corresponding submerged structure drag load. The converse is also true; a concern relating to a boundary load implies a concern for the associated drag load.

In Section 3.9 we describe what we feel is needed to close out this concern. The perspective delineated above will carry over into these recommendations.

2.5.4 Quencher Tie Down Loads

Quencher tie down loads (a.k.a. anchor loads) and quencher arm loads are at least as important, if not more so, than the loads experienced by the SRVDL (Section 2.3.2). Associated design specifications are given in References 34 and 23 for MARK II and MARK III, respectively. Approval of the former is given explicitly by the NRC staff in Reference 35. The basis for this approval involves comparison with test results from full scale SRV firings. The data was obtained at temperatures well above the proposed values of LCO. Acceptance of the MARK III specification is also implied since the MARK II method derives from the former.

For Mark I plants the LDR(18) discusses quencher thrust loads only; i.e.: tie down or anchor loads are not considered explicitly. The method is approved by the NRC staff(19) citing, as justification, conservatism in the first principles model and the large margins observed in stress levels as reported in Reference 41. Although the pool temperature does not play any role in these considerations, it is clear that its influence could be no more than second order. We judge that an increase in LCO of 10 F is not precluded here. This conclusion rests on the assumption that these conservative thrust loads carry over to corresponding tie down loads.

2.5.5 Reflood Transient

Consideration of a reflood transient for BWR hydrodynamic loads occurs only for MARK I plants. It is needed to initialize the QBUBBS model(32) for subsequent actuations'. The reflood model that was proposed(42) was evaluated by the NRC staff in NUREG-0661(19). It was found acceptable but with restrictions". The model includes the pool temperature as a working variable in a term that defines the heat transfer across the steam-water interface. Since it appears only as a difference (relative to steam temperature) we would expect the effect of a 10 F change to be minimal and bounded by the (+/-)40% frequency spread imposed via the staff's acceptance criteria(19).

3.0 COMMENTS,RECOMMENDATIONS,AND/OR REQUEST FOR ADDITIONAL INFORMATION

3.1 MARK I Drywell Temperature

In Section 2.1 we indicate that the FSAR for three plants were reviewed. In each case it was found that the peak LOCA temperature exceeded the design value. In one case (Hatch), the exceedance was 14 F. We acknowledge that this discrepancy(?) has no relevance to the issue of approving a change in LCO, but feel it should be highlighted for completeness.

3.2 Containment Temperature for the Perry Plant

The information available to us indicates that the design value is equal to the peak LOCA value with an LCO equal to 90°F. In order for us to approve an increase to 95°F as requested in the BWROG submittal, revised LOCA calculations should be submitted demonstrating that an exceedance will not occur with an LCO of 95°F. Alternately, it may be demonstrated that the exceedance does not compromise the structural and operating integrity of the containment and containment systems.

3.3 Pool Swell Loads

For MARK II plants, technical justification for resolution of this issue is given in Sections 2.2.1 and 2.5.2. A similar presentation should be includea in the BWROG submittal.

For MARK I and MARK III plants, additional information is needed for closure. First, the pool temperature conditions at which the data base for design load development was obtained should be reported. Then, an estimate of the effect of increasing pool temperature to 100 F should be developed. For this purpose we would find acceptable the use of the trends observed during the MARK II tests (3). Finally, a demonstration that the design loads have sufficient margin to accommodate these increases should be provided.

3.4 MARK I Co Downcomer Loads

A separate section should be included in the BWROG submittal that discusses the effect of increasing LCO on these loads. The information needed is an indication of how the loads observed during runs M8 and M11B compare with those that occurred during run M12. If they showed no trend or a decreasing trend then the existing load specification would be able to accommodate the proposed increase. A statement to that effect would suffice for closure. If the data exhibited an increasing trend on load amplitude or a significant effect on frequency content we would require that these be quantified and their effect on the load definition (Section 4.4.3,Reference 18) estimated. Approval of the increase in LCO would require a demonstration that there is sufficient margin in structural capability to cope with these changes.

3.5 MARK III Co Loads

For resolution of this issue, the effect of an increase in initial pool temperature on the forcing function for CO (Equation 3B.4-1 and/or Attachment F of Reference 23) needs to be examined.The effect on both the pressure amplitude A(t) and frequency f(t) is of interest. If the effect is small (a few percent) or beneficial (decreased amplitude/frequency bandwidth) the increase in LCO would be justified. If the effect is substantial (order of ten percent or more) additional justification is required. For this purpose the approach useo to respond to Question 3B.38 of Reference 23 would be suitable. It should also be demonstrated that the pool temperature stays within the approved limits (below 135 F).

3.6 SRV Loads for the Pilgrim Plant

If the Pilgrim plant has utilized in-plant test results for SRV design loads it cannot be included as one of the participants in the BWROG program. Moreover, the BWROG should provide a list of any other MARK I plants that fall into this category and indicate that they are also excluded from the program to this extent.

'SRV loads for MARK II and MARK III plants derive from test data so that a reflood transient is not needed for hydrodynamic loads within the wetwell.

"The method can only be used to estimate subsequent actuation bubble frequencies.

3.7 MARK I Differential Pressure Control

In our judgement, the BWROG submittal is incomplete without a discussion of this issue. We recommend that a section addressing it be added as part of the overall pool swell section recommended in Section 3.3 above. A description of how these DPCs operate should be supplied either in the submittal or via citation of appropriate references. An estimate of the effect on these systems due to the proposed change in the LCO should be provided even if it is negligible. The basis for these estimates should be included.

3.8 MARK II Diaphragm Reverse Load

The BWROG submittal is also incomplete without inclusion of a discussion of this issue. A section addressing it should also be added as part of an expanded pool swell section. The technical justification given in our Section 2.5.2 may be used for this purpose.

3.9 Submerged Structure Drag Loads

These loads are both LOCA and SRV related. A single subsection in a revised BWROG submittal (say 3.1.3) would suffice, however, to cover this issue. This is consistent with the format employed in two of the relevant NUREGs(6,19). The connection between source intensity, and boundary and drag loads as described in our Section 2.5.3 may be cited as the updated basis for a revised LCO. It would not be necessary to break down the discussion either by containment or blowdown type.

3.10 Quencher Tie Down Loads

A revised BWROG submittal should be supplemented by addition of a subsection with title "Air-Clearing Load on the Quencher" or some equivalent thereof. An updated basis for this load can follow along the lines given in our Section 2.5.4. A citation indicating that the MARK I quencher thrust loads described in the LDR are used to develop a design tie-down load should be included.

3.11 Reflood Transient

Inclusion of a subsection for this issue is optional. It has relevance for only one containment type and is only indirectly used for load definition. As long as this letter report becomes part of the official record, we can live without its inclusion in a revised BWROG submittal.

3.12 The LaSalle Plant-Generic or Plant Specific?

The BWROG should clarify for the NRC staff whether this plant is seeking approval for an LCO of 100 F as suggested in NEDO-31695 or for one equal to 110°F as indicated in Reference 2.

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Table 1. Effect of Pool Temperature (TP) on Pool Swell Parameters for the Mark II Configuration

Parameter	JAERI Tests		4T Tests	
	TP=70°F	TP=130°F	TP=70°F	TP=150°F
Bubble Pressure (psi)	32.8	34.0	NA	NA
Velocity (fps)	24.8	28.7	21.4	24.7
Pool Swell Height (ft)	19.5	20.5	11.6	13.5
Wetwell Pressure (psi)	31.0	34.4	27.3	31.3
Diaphragm Reverse Load (psi)	-0.7	2.6	-2.0	-0.1

NOTES: *4T data for velocity, pool swell height and wetwell pressure from Figures 5-7,5-8 and 5-20 of Reference 3, respectively. All other data excerpted from Reference 5.
*Comparisons are between tests with all conditions other than pool temperature nominally equal.

NOMENCLATURE

ADS	automatic depressurization system
BNL	Brookhaven National Laboratory
BWR	boiling water reactor
BWROG	BWR Owners Group
CO	condensation oscillation
DBA	design basis accident
ECCS	emergency core cooling system
FSAR	Final Safety Analysis Report
FSTF	Full Scale Test Facility
4TCO	Temporary Tall Test Tank CO
GE	General Electric Company
JAERI	Japan Atomic Energy Research Institute
LCO	limiting condition for operation
LOCA	loss-of-coolant accident
NRC	Nuclear Regulatory Commission
PSTF	Pressure Suppression Test Facility
PUAR	Plant Unique Analysis Report
QSTF	Quarter Scale Test Facility
SRV	safety/relief valve
SRVDL	SRV discharge line
SSES	Susquehanna Steam Electric Station
T/S	Technical Specification

Appendix B

NRC Request for Additional Information

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

July 17, 1990

Mr. John E. Torbeck, Program Manager
BWROG Suppression Pool Temperature Limit Committee
General Electric Nuclear Energy
175 Curtner Avenue
San Jose, California 95125

Dear Mr. Torbeck:

SUBJECT: BWR OWNER'S GROUP REPORT NEDO-31695 "BWR SUPPRESSION POOL TEMPERATURE TECHNICAL SPECIFICATION LIMITS"

The NRC staff and its consultant Brookhaven National Laboratory (BNL), have reviewed the General Electric Report NEDO-31695 entitled, "BWR Suppression Pool Temperature Technical Specification Limits." Based on our review, we find that additional information is needed to complete our review. Enclosure 1 is the request for additional information.

The request addresses eight distinct areas. All are concerned with containment hydrodynamic loads. Of these, five are LOCA related, two SRV related and one applies to both types of load phenomena. Only two of the issues are generic for all BWR plants (Q. No. 7 and 8). The remainder are generic to a containment type. All but two (Q. No. 3 and 4) involve loading consideration that were not discussed in NEDO-31695. Detailed comments addressing these remaining concerns are provided in each case by referral to appropriate sections excerpted from the preliminary BNL evaluation report (Enclosure 2).

If you have any questions concerning our request, please contact Raj Anand at 301-492-0858.

Sincerely,

C. McCracken

Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Technology

Enclosure:
As stated

cc: J. Kudrick

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Enclosure 1

REQUEST FOR ADDITIONAL INFORMATION
GENERAL ELECTRIC REPORT NEDO-31695
BWR SUPPRESSION POOL TEMPERATURE
TECHNICAL SPECIFICATION LIMITS

1. Provide an evaluation of the effect of an increase in the pool temperature Limiting Condition for Operation (LCO) on pool swell loads for Mark I and Mark III plants. The trends suggested by the Mark II experimental results may be used for this purpose. (2.2.1, 3.3)

2. Quantify the effect of an increase in the pool temperature LCO on Mark I Condensation Oscillation (CO) downcomer loads. Demonstrate that any increases that result can be accommodated by design. (2.2.2.1, 3.4)

3. Provide a more detailed description of the procedure used to qualify an increase in the pool temperature LCO as it relates to Mark III CO loads (Section 3.1.1.2.1 of NEDO-31695) (2.2.2.3, 3.5)

4. Provide a listing of all Mark I plants that have utilized in-plant tests to derive SRV design loads. Describe the technical basis for increasing the pool temperature LCO for these plants. (2.3.3.1, 3.6)

5. Provide an evaluation of the effect of an increase in the pool temperature LCO on Mark I differential pressure control systems. (2.5.1, 3.7)

6. Discuss the effect of an increase in the pool temperature LCO on the Mark II diaphragm reverse load. (2.5.2, 3.8)

7. Discuss the effect of an increase in the pool temperature LCO on submerged structure drag loads. (2.5.3, 3.9)

8. Discuss the effect of an increase in the pool temperature LCO on quencher tie-down loads (2.5.4, 3.10)

Numbers in parenthesis correspond to sections of BNL's preliminary evaluation report which constitutes an attachment to this RAI. They should be referred to for additional clarification.