Issue 108: BWR Suppression Pool Temperature Limits

DESCRIPTION

Historical Background

BWRs are equipped with SRVs to control primary system pressurization. Upon SRV actuation and following the clearing of air from the discharge lines, essentially pure steam is injected into the pool. Experiments indicate that the steam jet/water interface at the discharge line exist during this phase is relatively stationary when

the local pool temperature is low.[1] Thus, the condensation proceeds in a stable manner and no significant hydrodynamic loads are experienced. Continued steam blowdown into the pool will increase the local pool temperature. The condensation rates at the turbulent steam/water interface are eventually reduced to levels below those needed to readily condense the discharged steam. At this threshold level, the condensation process may become unstable; for example, steam bubbles may be formed and shed from the pipe exit, oscillate, collapse, and give rise to severe pressure oscillations which are then imposed on the pool boundaries.

Current practice for dealing with this phenomenon in BWRs is to restrict the allowable pool operating temperature so that the threshold temperature is not reached. This restriction is referred to as "the pool temperature limit." USI A-39 resolved, among other things, the concern about steam condensation behavior in the suppression pool of MARK I, II, and III containments. Resolution of this issue has been reported in

NUREG-0661[2] and NUREG-0487.[3] Criteria for the pool temperature limit were established and included in those reports. However, the staff also indicated that the evaluation of this issue would continue in an attempt to improve the criteria and that future progress would be reported.

NUREG-0783[4] presents the results of the staff evaluation of the safety issue concerning suppression pool temperature limits. Acceptance criteria for the pool temperature limits, the events and associated assumptions used to analyze pool temperature response, and the suppression pool temperature monitoring systems are included. The resolution applies to MARK I, II and III containments using the SRV quencher devices specified in

NUREG-0783.[5]

In a subsequent letter[6] to the NRC staff from the BWR Owners' Group, additional test data were summarized which forms the basis for a BWR Owners' Group proposal that the current local pool temperature limits for SRV discharge be eliminated. The BWR Owners' Group proposal will be contained

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[1] NEDO-21078, "Test Results Employed by GE for BWR Containment and Vertical Vent Loads," General Electric Company, October 1975.
[2] NUREG-0661, "Mark I Containment Long Term Program Safety Evaluation Report, Resolution of Generic Technical Activity A-7," U.S. Nuclear Regulatory Commission, July 1980, (Supplement 1) August 1982.
[3] NUREG-0487, "Mark II Containment Lead Plant Program Load Evaluation and Acceptance Criteria," U.S. Nuclear Regulatory Commission, November 1978, (Supplement 1) September 1980.
[4] NUREG-0783, "Suppression Pool Temperature Limits for BWR Containments," U.S. Nuclear Regulatory Commission, November 1981.
[5] NUREG-0783, "Suppression Pool Temperature Limits for BWR Containments," U.S. Nuclear Regulatory Commission, November 1981.
[6] Letter to T. Novak (U.S. Nuclear Regulatory Commission) from T. Pickens (BWR Owners' Group), "Agreements from BWROG/NRC Meeting on Suppression Pool Temperature Limit," October 16, 1984. [8410220072]

and supported in a forthcoming report to the staff which is expected in January 1985. It is the staff effort required for the review of BWR Owners'

Group report that is to be prioritized here.[7]

Safety Significance

It is assumed that the report will provide adequate technical justification that there is no risk increase and hence no safety significance associated with the elimination of the suppression pool temperature limits from the TS. This issue represents a reduction of NRC requirements and is a regulatory impact issue.

Possible Solution

A resolution of this issue would be the presentation of test data and analysis to demonstrate that suppression pool loads associated with SRV discharge are well within the containment design capability with the deletion of the suppression pool temperature limits.

PRIORITY DETERMINATION

Frequency/Consequence Estimate

A premise of this analysis is that there would be no increase in core-melt frequency as a result of the implementation of the resolution of this issue.

Cost Estimate

Industry Cost: The testing and analysis that support the BWR Owners' Group proposal are virtually completed and it is expected that the final report supporting the proposal will be submitted to the NRC staff in January 1985. The additional cost that can be anticipated for the industry is that associated with clarifications of the report and

responding to NRC staff questions. This is estimated to cost $50,000. In addition, there will be the licensee cost for the preparation of amendments to eliminate the suppression pool technical specifications on temperature limits. This cost is assumed to be approximately $15,000 per plant. Assuming that requests for this change is

made for 37 plants,[8] the total industry cost is estimated to be $555,000.

It is noted that the present plant technical specifications require a plant shutdown in the event that the suppression pool temperature exceeds 110F. A review of the LERs from 1974 to date reveals that in most cases the temperature excess in the suppression pool was caused by hot weather, testing of the HPCI system operability and, occassional operator errors or equipment failure for a total of approximately 22 reported events. Of these events, only two shutdowns were initiated because of violations of the suppression pool TS: Cooper Nuclear Plant (July 24, 1984) and Quad Cities Nuclear Plant No. 2 (August 16, 1983).

If shutdowns can be avoided at the rate indicated in the past, say, once every 9 years or so, the following estimate of cost savings can be made. It is assumed that the minimum downtime following a shutdown is 24 hours. For a shutdown that lasts for 24 hours and a cost of replacement power of $300,000 per day, the present worth (PW) of these savings at a real discount rate of 5%, over an average reactor plant lifetime of 28 years and assuming 1 shutdown every nine years, is given by:

PW	$= (\$300,000)(1 + 0.05)^{-9} + (\$300,000)(1 + 0.05)^{-18}$

[7] Memorandum for T. Speis from R. Bernero, "Proposed Generic Issue 'BWR Suppression Pool Temperature Limits,'" November 21, 1984. [8412030526]

[8] Memorandum for W. Minners from W. Butler, "Comments on Prioritization of Generic Issue 108, 'BWR Suppression Pool Temperature Limits,'" January 10, 1985. [8501160095]

	$+(\$300,000)(1 + 0.05)^{-27}$
	$= (\$300,000)(0.645 + 0.416 + 0.268)$
	$= (\$300,000)(1.33)$
	$= \$400,000$

Added to the cost saving in eliminating plant shutdowns would be the savings implied in the additional 20 cases of operating experience by the elimination of the need for suppression pool cooling by use of the RHR and/or core spray systems (LER 112, 8/2/83, Susquehanna 1) and which also reduces the challenges to this safety- related equipment. The cost of operating the necessary equipment to cool the suppression pool will be assumed to be $10,000 per event. Based on the past experience of about 15 events required over the 10-year span of LERs reviewed above, the present value (PW_1) of this cost with a real discount rate of 5% is given by:

$PW_1 = (\$10,000)(15/10)(0.05)^{-1}(1 - e^{-0.05t})$

For t = 28 years, PW_1 = $262,000. The present worth of the total cost savings to the industry is, therefore, estimated to be $(262,000 + 400,000) = $662,000. The present total cost to the industry for implementation of this change in technical specifications is estimated to be $(50,000 + 555,000) = $605,000.

In addition, it is noted in the DSI memorandum[9] that it is expected that the implementation of the proposal, if the NRC staff accepts it, will result in plant improvements by: (1) the elimination of monitoring requirements of the pool temperatures by plant operators during SRV discharge; (2) increased plant operator flexibility insofar as any necessary operator action could be delayed during SRV discharge, and (3) improved potential for additional strategies for plant control during ATWS and station blackout scenarios in which the use of the suppression pool without restrictions may provide enhanced plant control. These items represent benefits accruing from the elimination of the temperature limits, but the value of these benefits are somewhat offset by

the requirement of alternative suppression pool limits that will have to be established by the licensee for proper plant operation. These alternative limits, however, will be based on performance requirements such as NPSH, containment design factors, environmental qualification, and so forth, but not as a result of technical specification requirements so that the trade-off still represents a net benefit to the licensee.

NRC Cost: Based on a CSB memorandum,[10] it is expected that the NRC will require a technical assistance program effort in the review of the BWR Owners' Group report for a total estimated NRC cost of $90,000. The administrative NRC costs to process amendments for TS changes are in the order of 1 to 2 man-weeks/plant. For 37 BWRs, this will require 55 man-weeks at a cost of (55 x $2,270) = $125,000. Therefore, the total cost to the NRC is estimated to be $(90,000 + 125,000) = $215,000.

CONCLUSION

Based on the assumption that the elimination of suppression pool temperature limits can be adequately justified by the BWR Owners' Group data and analysis, it is concluded that a savings can accrue to the industry with an estimated present worth of $661,000 at a cost of approximately ($215,000 + $605,000) or $820,000 for both the NRC and the industry, with no increased risk to the public. In addition, there is some additional potential for the overall improvement of plant safety through some small but intangible

[9] Memorandum for T. Speis from R. Bernero, "Proposed Generic Issue 'BWR Suppression Pool Temperature Limits,'" November 21, 1984. [8412030526]
[10] Memorandum for W. Minners from W. Butler, "Comments on Prioritization of Generic Issue 108, 'BWR Suppression Pool Temperature Limits,'" January 10, 1985. [8501160095]

increase in plant operation flexibility as well as safety equipment reliability by the elimination of the suppression pool TS on temperature limits.

Therefore, it is concluded that the potential savings from the proposal initiated by the BWR Owners' Group are in the same order as the costs, so that NRC effort on this Regulatory Impact issue should have a low priority.