Enclosure

SAFETY EVALUATION REPORT BY THE OFFICE ON NUCLEAR REACTOR REGULATION

REGARDING THE MARK III CONTAINMENT RELATED ISSUES

SYSTEM ENERGY RESOURCES, INC.

GRAND GULF NUCLEAR STATION (GGNS), UNIT 1

DOCKET NO. 50-416

INTRODUCTION

In a letter dated May 8, 1982, Mr. John Humphrey, a former General Electric Company (GE) engineer, notified Mississippi Power and Light Company (MP&L) of certain safety concerns regarding the Grand Gulf Mark III containment design. The staff met with GE representatives and Mr. Humphrey to determine the character of these concerns and to establish an appropriate program for their resolution. All the Mark III plant applicants attended the meeting, including representatives of MP&L for the Grand Gulf Nuclear Station (GGNS). As discussed in SSER No. 4, the staff judged at that time the issue was confirmatory in nature, thus supporting full power operation of GGNS.

The staff has reviewed the information supplied by MP&L as well as generic submittals. These letters contain the licensee's responses to all the Humphrey concerns. Additional sources of relevant documents reviewed by the staff are listed in the References section at the end of the specific evaluations. The staff concludes that all the Humphrey Concerns have been satisfactorily resolved for the GGNS. As part of this resolution, MP&L will continue to prohibit the use of the RHR steam condensing mode until appropriate design modifications are fully implemented.

There are 66 individual Humphrey concerns covering 22 major areas (referred to as Action Plans by the Mark III Containment Issues Owners Group (CIOG)). Brookhaven National Laboratory (BNL) assisted the staff in evaluating several Humphrey concerns. The staff has endorsed the evaluation of those items that were provided by BNL. The body of this SER contains a description, evaluation, and staff conclusion for each Humphrey concern.

Humphrey Concerns 1.1, 1.2, 1.4, and 1.5

1.1 Presence of local encroachments, such as the TIP platform, the drywell personnel airlock and the equipment and floor drain sumps may increase the pool swell velocity by as much as 20 percent.

1.2 Local encroachments in the pool may cause the bubble breakthrough height to be higher than expected.

1.4 Piping impact loads may be revised as a result of the higher pool swell velocity.

1.5 Impact loads on HCU floor may be imparted and the HCU modules may fail, which could prevent successful scram if the bubble breakthrough height is raised appreciably by local encroachments.

Evaluation

The concern is that the presence of encroachments will tend to increase pool velocities and the breakthrough height relative to the unencroached pool, thereby causing increases in a variety of LOCA loads (including bulk and froth impact, and drag loads in the regions above the initial pool surface).

As a result of the 1/10-scale simulations of pool swell conducted by the Containment Issues Owners Group (CIOG) as reported in References 1.1.1 and 1.1.2, it has now been established that, for the most part, the effect of encroachment is to decrease pool swell velocities relative to an unencroached or clean suppression pool. BNL, our consultant, has reviewed all of this information and has prepared a separate Technical Evaluation Report on its findings (Reference 1.1.3).

Conclusion

The staff considers these issues closed for the GGNS because the 1/10-scale tests have confirmed that encroachment effects on pool swell behavior will not give rise to loading conditions that cannot be accommodated by the existing design basis.

References

1.1.1 Sets of slides provided by the CIOG to the NRC from the following 1/10-scale tests: (a) Clinton Tests F2R, R05, and F5; (b) Grand Gulf Tests E3; (c) Perry Test D2; (d) an unidentified clean pool test (see letter of 19 March 1985 from J. E. Torbeck to R. Pender; cc: J. Kudrick of NRC).

1.1.2 "Comparison of Velocities and Thicknesses of Water Column at Containment Wall for 1/10-Scale Pool Swell Tests," submitted by G. W. Smith of CIOG to H. R. Denton of NRC via letter of 15 May 1985.

1.1.3 Sonin, A. and Economos, C., "Resolution of the Humphrey Issues Relating to Pool Swell in Mark III Plants," BNL Technical Evaluation Report, February 1985.

Humphrey Concern 1.3

Additional submerged structure loads may be applied to submerged structures near local encroachments.

Evaluation

The loads addressed under this item fall into two categories: (1) loads on submerged boundaries (i.e., drywell wall, basemat, containment wall) and (2) loads on submerged structures, such as pipes and beams.

For loads on submerged boundaries the licensee's response is provided in Reference 1.3.1. A two dimensional simulation (SOLAV01) was used to determine the effect of encroachment. The simulation was for the GGNS geometry but with a pool width of 19 feet (corresponding to Pressure Suppression Test Facility (PSTF) geometry), rather than the actual plant width of more than 20 feet. Drywell wall pressure was unaffected by this change in simulation since the value was assumed equal to the peak drywell pressure. The calculations exhibit an increase of about 15% for containment wall and basemat pressures. It was stated that this increase is "easily bounded" by the existing design capability.

The licensee's submittal for submerged structure loads is given in Reference 1.3.2. The new loads were developed using the velocity field derived from the SOLAV01 simulation. The increased loads produced by the encroachments were stated to be within the code allowable limits including functional capability criteria (Reference 1.3.3).

Conclusion

The staff considers this concern to be resolved based on the stated margin between design and the loads estimated with a conservative (two dimensional) simulation of the encroachment effect.

References

1.3.1 Attachment 1 to MP&L Letter No. AECM-82/497 dated October 22, 1982 from L. F. Dale (MP&L) to H. R. Denton (NRC).

1.3.2 Attachment 1 to MP&L Letter No. AECM-82/574 dated December 3, 1982 from L. F. Dale (MP&L) to H. R. Denton (NRC).

1.3.3 Attachment 1 to MP&L Letter No. AECM-86/0175 dated August 14, 1986 from O. D. Kingsley, Jr. (MP&L) to H. R. Denton (NRC).

Humphrey Concern 1.6

Local encroachments on the steam tunnel may cause the pool swell froth to move horizontally and apply lateral loads to the gratings around the HCU floor.

Evaluation

The licensee has performed a potential flow analysis of the flow field through the HCU floor (Reference 1.6.1). This analysis assumed steady flow, (i.e., the liquid droplet velocities were equal to air) and all of the froth was allowed to pass through the openings in the HCU floor. The resulting lateral pressure differentials were found to be 0.45 psi on the beams and 0.30 psi on the gratings. Beams located at the edge of solid floor areas experienced a maximum horizontal pressure of 1.45 psi. All affected structures were stated "to be capable of withstanding the identified loads without deformation."

Conclusion

Considering that the additional stresses are modest even with the licensee's conservative flow analysis, the staff concludes that additional effort is unwarranted on this issue.

References

1.6.1 Attachment 1 to MP&L Letter No. AECM-82/497 dated October 22, 1982 from L. F. Dale (MP&L) to H. R. Denton (NRC).

Humphrey Concern 1.7

GE suggests that at least 1500 square feet of open area should be maintained in the HCU floor. In order to avoid excessive pressure differentials, at least 1500 square feet of open area should be maintained at each containment elevation.

Evaluation

The licensee indicates in Reference 1.7.1 that the MP&L design provides open areas on all floors above the HCU floor greater than the open area at the HCU floor. At the HCU floor 1538 square feet is provided which is greater than the required minimum.

Conclusion

Based on the above response, the staff considers this issue to be closed.

References

1.7.1 Attachment 2 to MP&L Letter No. AECM-86/0175 dated August 14, 1986 from O. D. Kingsley, Jr. (MP&L) to H. R. Denton (NRC).

Humphrey Concern 2.1

The annular regions between the safety relief valve lines and the drywell wall penetration sleeves may produce condensation oscillation (CO) frequencies near the drywell and containment wall structural resonance frequencies.

Evaluation

As stated above, the concern is that additional and unaccounted for suppression pool boundary loads may be produced by steam condensation at the exit of the sleeve annulus. However, the scope of this concern is expanded considerably by Humphrey in Reference 2.1.1. There it is speculated that, due to resonant coupling between the sleeve annulus CO and the sleeve annulus acoustics, the pressure loads at higher frequencies could be amplified.

The licensee has addressed this concern using the generic approach described in Reference 2.1.2. This approach is applicable to the Grand Gulf design. This methodology derives sleeve annulus CO loads by conservatively scaling the main vent CO load data base. The potential for resonant amplification of these loads was not addressed.

The use of the main vent CO data base for development of sleeve annulus loads cannot be rigorously defended because of substantial differences in geometry. However, based on the relative size of the steam/water interface that would exist at the sleeve annulus, it could be judged that any additional non-resonant loads that may occur will be second order relative to main vent loads. This judgement applies to both CO and chugging loads.

The added sleeve CO loads that were first proposed are substantial. For example, the peak-to-peak pressure amplitude (PPA) was about 20% of that used in the main vent load definition. They are also applied uniformly in the circumferential direction which represents a sizable conservatism. This is because there are roughly twice as many main vents as drywell penetration sleeves. These modifications are clearly more than second order. Thus, provided it could have been demonstrated that resonant amplification does not occur, the CO loads which were specified would have been considered adequate.

In an attempt to demonstrate the absence of such coupling, results from General Electric's 4TCO tests (Reference 2.1.3) were cited under the Clinton Power Station (CPS) docket (Reference 2.1.4). A review of this material indicated that the contrary was the case. That is, the data implied that the type of resonant coupling suggested by Mr. Humphrey was not only possible, but apparently had actually occurred. In fact, it can be inferred from this data that resonance causes about a two-fold increase in the basic CO loads.

As a result of this finding, a completely new methodology for the CO boundary loads was proposed, again under the CPS docket (Reference 2.1.4). This methodology was developed by GE utilizing the Mark I Full Scale Test Facility (FSTF) data base (2.1.5). This new design loading results in a substantial increase in the pressure loading at the higher end of the frequency spectrum (20-50 Hz). For example, in terms of an amplified response spectrum, the load intensity is about double the one first proposed. However, these new loads are shown to be bounded by other design basis loads. For example, on the drywell wall the sleeve CO load when added to the main vent CO is bounded by the chugging load specification. On the containment wall, the bound is provided with considerable margin by the pool swell boundary load.

The applicability of the FSTF data to the sleeve annulus loads involves considerable uncertainty because of the great disparity in geometries between the two designs. This applies not only for the steam-water interface at the respective pipe exits but, more importantly, for the acoustic path through which the mechanism that drives the CO phenomenon is transmitted. In fact, it is not completely apparent that for the FSTF case the system had actually achieved a condition of resonant coupling. This is because of the complexity of the FSTF vent system (i.e., the eight downcomers are connected to a vent header, which in turn is connected to a main vent which then connects to a simulated drywell). Because of this complexity, it is difficult to ascertain the effective relevant vent system natural frequency with sufficient precision.

Despite the uncertainties cited above, there are several factors that may be cited that compensate for any possible inadequacy. First, there is the qualitative evidence from the 4TCO tests (Reference 2.1.3) that, even when resonant coupling occurs, the load amplification is limited to less than a two-fold factor. Also, the generally conservative application of the available results provides increased confidence in the adequacy of the load determination method. For example, the pressure results observed on 24-inch diameter downcomers are taken directly and applied to the much smaller, 14-inch diameter, safety relief valve discharge line (SRVDL) sleeves. Also, in developing the loads on the suppression pool boundaries, the effective source (steam bubble) radius was assumed equal to that of the sleeve without taking into account the actual presence of the SRVDL itself. As shown in the recent submittal under the CPS docket (Reference 2.1.6), this results in a margin of over 30% in the loads that were developed. The staff concludes the margin would be even greater if the steam bubble were modeled more realistically (Reference 2.1.2). Additional conservatism stems from the use of conventional acoustic analysis techniques for determination of pressure attenuation from the source to the pool boundaries. And neglected dissipative mechanisms that are present in the suppression pool would further reduce the loads.

Insofar as the chugging loads are concerned, the staff has not received a description of these loads directly from MP&L, however, this information exists (Reference 2.1.7) and has been assessed by the Mark III Containment Issues Review Panel (Reference 2.1.8). The findings of this panel were that the proposed loads were only about 6% of the main vent chugging loads, and are easily bounded by the design loads. The staff is satisfied that this is the case. Note that resonance effects are not expected to play any role or influence the chugging phenomenon associated with the sleeve annulus.

Conclusions

The staff considers this safety concern to have been satisfactorily resolved because the conservatively estimated new loads have been demonstrated to be bounded by other design loads.

References

2.1.1 Humphrey Engineering, Inc., Letter dated June 17, 1982 from J. M. Humphrey (HEI) to A. Schwencer (NRC).

2.1.2 IPC Letter No. U-0714 dated May 25, 1984, from D. I. Herborn (IPC) to A. Schwencer (NRC).

2.1.3 Bird, P. F., et al., "4T Condensation Oscillation Test Program Final Test Report," General Electric Report NEDE-24811-P, May 1980.

2.1.4 IPC Letter No. U-600319, dated November 25, 1985, from F. A. Spangenberg (IPC) to W. R. Butler (NRC).

2.1.5 Fitzsimmons, G. W. et al.; "Mark I Containment Program - Full-Scale Test Program Final Report;" General Electric Report, NEDE-24539-P; April 1979.

2.1.6 IPC Letter No. U-600588; dated May 30, 1986; from F. A. Spanenberg (IPC) to W. R. Butler (NRC).

2.1.7 Enercon Letter No. RWE-OG-060; dated May 25, 1983; from R. W. Evans (Enercon) to B. R. Patel (Creare R&D).

2.1.8 Mark III Containment Issues Review Panel, "Assessment of Humphrey Concerns," CREARE R&D, Inc., Technical Memorandum TM-928; July 1984.

2.1.9 MP&L Letter No. AECM-86/0175; dated August 14, 1985; from O. D. Kingsley, Jr. (MP&L) to H. R. Denton (NRC).

Humphrey Concerns 2.2 and 2.3

2.2 The potential condensation oscillation and chugging loads produced through the annular area between the SRVDL and sleeve may apply unaccounted for loads to the SRVDL. Since the SRVDL is unsupported from the quencher to the inside of the drywell wall, this may result in failure of the line.

2.3 The potential condensation oscillation and chugging loads produced through the annular area between the SRVDL and sleeve may apply unaccounted for loads to the penetration sleeve. The loads may be at or near the natural frequency of the sleeve.

Evaluation

The concern is that the steam condensation process (CO + chugging) at the sleeve annulus exit will give rise to loads on the SRVDL and SRVDL sleeve analogous to the lateral loads experienced by Mark I and Mark II downcomers during postulated LOCA blowdowns, and that these structures have not been designed to accommodate them.

The licensee's specification for chugging loads is given in Reference 2.2.1. The load has a half-sinusoidal time dependence with a duration of 3 mseconds and a peak amplitude of 22.4 kips. This load was derived from the Mark II load methodology (Reference 2.2.2) as modified by the NRC staff's Acceptance Criteria (Reference 2.2.3). The load was developed by scaling down the peak amplitude to the outside diameter of the SRVDL sleeve and accounting for the fact that there are fewer chugs created by flow through the SRVDL sleeve annulus than exist during DBA blowdowns through the Mark II pressure suppression system (i.e., 20 SRVs for the GGNS vs. about 100 downcomers in a typical Mark II plant). Scaling down for pipe diameter is accomplished by assuming a 1.7 power dependence of the peak amplitude on diameter. Load reductions for fewer chug sources utilizes the staff approved statistical representation for these loads (Reference 2.2.3). The region of application of the load was also scaled down using a first power dependence on diameter.

The applicability of the Mark II results for the present application is somewhat uncertain due to the substantial geometric differences (straight down vs. inclined pipe and circular vs. annular cross section). The use of a 1.7 power dependence of peak amplitude on pipe diameter is somewhat less conservative than we would have preferred since the available data (Reference 2.2.4) exhibit exponent values that range from 0.7 to 1.7. On the other hand, no credit was taken for the presence of the SRVDL in the steam bubble. This provides a substantial conservatism that the staff judges more than compensates for any possible non-conservatism in selecting this exponent. Therefore, we find the approach reasonable.

The CO lateral loads are also presented in Reference 2.2.1. In this case the load is a harmonic with an amplitude equal to 630 lb, and a frequency ranging from 28 to 48 Hz. The load is applied as a point load to both the SRVDL and SRVDL sleeve at the end of the latter and perpendicular to the pipe center line. It is stated that application of this load leads to stresses that are within the code allowables, and that functional capability criteria is met for all affected structures.

These loads are developed from the same FSTF results used for CO boundary loads (see discussion under Humphrey Concern 2.1). In this case the pressure fluctuations observed in the downcomers are applied in an even more conservative manner than that used for the pool boundary loads. The additional conservatism stems from the development of a single harmonic amplitude to include the energy content from all frequencies associated with the selected worse case pressure time history. This results in an applied pressure amplitude more than 40% higher than the peak observed value (5 vs. 3.5 psi). Application of the specified load as a point load also represents a substantial conservatism since the unbalanced pressures on the structures are actually spread over an area roughly equal to that of the sleeve internal cross section.

Conclusion

The staff considers these concerns to be resolved because of the specification of conservative CO and chugging loads on the affected structures.

References

2.2.1 Attachment 3 to MP&L Letter No. AECM-86/0175 dated August 14, 1986, from O. D. Kingsley, Jr. (MP&L) to H. R. Denton (NRC).

2.2.2. Davis, W. M., "Mark II Main Vent Lateral Loads," GE Report NEDE-23806-P, October 1978.

2.2.3 Anderson, C., "Mark II Containment Program Load Evaluation and Acceptance Criteria," NRC NUREG-0808.

2.2.4 General Electric Letter MFN-050-80 dated February 29, 1980, from R. H. Buckholz (GE) to C. J. Anderson (NRC).

Humphrey Concerns 3.1, 3.3, 3.7

3.1 The design of the STRIDE (STandard Reactor Island DEsign) did not consider vent clearing, condensation oscillation, and chugging loads which might be produced by the actuation of the RHR heat exchanger relief valves.

3.3 Discharge from the RHR relief valves may produce bubble discharge or other submerged structure loads on equipment in the suppression pool.

3.7 The concerns related to the RHR heat exchanger relief valve discharge lines should also be addressed for all other relief lines that exhaust into the pool.

Evaluation

The concern is that, besides the main safety/relief valves (MSRV's), there are a number of other valves that discharge fluids into the suppression pool. As a result, they could produce loads analogous to those associated with MSRV discharges and/or LOCA blowdowns through downcomers. These loads have not been accounted for in plant design.

For the RHR system, flow though the heat exchanger relief valves can occur when it is operating in the steam condensing mode (SCM). During such operation, the heat exchanger is pressurized to about 200 psi by a pressure control valve (PCV). Should the PCV fail, resulting in elevated pressures, the heat exchanger relief valves would actuate at their setpoint (about 500 psi) and vent steam to the suppression pool via the relief valve discharge lines. Steam discharges would also be possible in the event that the relief valve itself was to fail open, although in this case the steam flow rates would be much less.

The initial response to this concern takes credit for the line pressurizing effect of the non-condensible vent flow that is bled from the heat exchanger to the discharge line during SCM operation (Reference 3.1.1.). The position taken was that this bleed flow clears the line of water so that water jet and air clearing loads are negligible (Reference 3.1.2). Since this evaluation, routing of this flow to the discharge line has been eliminated (Reference 3.1.3). In any case, the loads were recalculated without this potential load mitigating effect in Reference 3.1.4. It is stated that the methods employed to evaluate the loads are those developed for rams head type application (Ref. 3.1.5) suitably modified to account for an open ended pipe. All submerged structures were evaluated for these loads and found to be adequate.

For CO and chugging loads, the licensee utilized the generic methods employed by all the Mark III owners. A detailed description of these methods is given in References 3.1.1 and 3.1.6. Generally the method derives from conservative application of the Mark II CO and chugging loads methodologies. Source terms (i.e. forcing functions) are developed from conservative chugging and CO pressure signatures selected from the Mark II data base. These source terms are applied to the GGNS plant analysis without any modification to account for the difference in pipe diameter between the GGNS relief valve discharge line (10 inches) and that from the data base (24 inches in the test facility). This is a significant conservatism since it is well established that the source strengths scale with pipe area. The pressure loads generated using these sources were shown to be bounded by the design loads. The margins for submerged structures, in particular, were characterized as being "considerable" (Reference 3.1.6).

The adequacy of the CO load also needs to be judged in the context of the potential for unstable steam condensation; i.e., elevated pool temperatures. This aspect is discussed under Humphrey Concern 3.6.

A detailed description of lateral loads on the RHR discharge line due to chugging is given in Reference 3.1.1. The load is time dependent (half-sinusoid) with two values of peak amplitude (6.5 kips and 19.5 kips) corresponding to two different pulse durations (6 ms and 3 ms, respectively). The load is uniformly distributed over the lowest 4 feet of the discharge pipe. It is stated that this load specification derives from the Mark II lateral load definition given in NUREG-0808 (Reference 3.1.7), and that it differs only in that the peak amplitudes have been scaled down to account for the difference in diameter between the RHR discharge line (10 inches) and the standard Mark II downcomer (24 inches). This was accomplished by assuming peak amplitude to scale with the 0.7 power of pipe diameter. Application of this load gives resultant stresses that are within code upset allowable stresses (Reference 3.1.1).

The peak amplitudes selected by MP&L are not totally consistent with the staff approved load definition given in Reference 3.1.7. This is because the licensee does not recognize the modification that was applied to the Mark II load method of Reference 3.1.8 to account for the stochastic nature of the chugging phenomenon. Such a modification results in peak load amplitudes that vary according to the number of chugs that would be expected during a particular accident scenario and the desired non-exceedance probability. For example, for a DBA LOCA in a Mark II plant with a population of 100 downcomers, a peak design load of 65 kips was employed to insure that, statistically, no member of that population is likely to experience an exceedance of this load. This value is substantially higher than the maximum tip load observed experimentally (35.9 kips). It was this latter value that was scaled down by MP&L to obtain the design specification of 19.5 kips.

To evaluate the adequacy of the proposed load amplitude in this context, it is necessary to estimate the number of chugs the RHR discharge line can experience without an exceedance of the stated value of 19.5 kips. This was accomplished by using the method described in Reference 3.1.7. The result is a total of 4675 where we have utilized a more reasonable, but still conservative, linear dependence of load amplitude on pipe diameter. Even with a conservative estimate of one second between chugs (a more realistic number would be close to two seconds), chugging could proceed for well over an hour before a single exceedance of structural design capability would be expected. Thus, we would not expect serious exceedance of the available load capability to occur during the relatively small number of chugs that these structures may experience during the life of the GGNS.

One other misinterpretation of the approved Mark II methodology used by the licensee relates to the region over which the load was applied. The correct method would require the load to be uniformly distributed over a region 1 to 4 feet from the downcomer end. Furthermore, this region needs to be scaled down to account for the difference in pipe diameter. Both of these factors would tend to increase the applied bending moment somewhat, but the staff judges that sufficient margin exists in the load specification to accommodate this relatively minor deficiency.

Loads due to other steam discharges are considered to be bounded by the RHR heat exchanger relief valve loads. In general, this is a reasonable position given the relatively low flow rates and/or smaller discharge line diameters. A list of all such relief lines was provided in Reference 3.1.8 together with data characterizing their sizes and flow rates. One discharge line which has some potential for creating significant loading is the RCIC turbine exhaust line. In this case the flow rate/diameter combination could result in steam flux rates that are in the chugging regime. Significant loads due to the reflood and air/water clearing loads could also occur since this pipe has a relatively large diameter (20 inches).

The concerns we have enumerated for the RCIC exhaust line have not been addressed directly by the licensee. A "white paper" has been published, however, by the Containment Issues Owners Group (Ref. 3.1.9). This is intended to support the position that operating experience has shown that there are no dynamic load problems associated with operation of this system. The licensee endorses this "white paper," but with "clarifications" (Reference 3.1.10). These clarifications highlight the fact that during low power testing "chugging" was observed at the RCIC exhaust sparger vents which necessitated a modification of the design (the number of sparger holes was decreased). It is stated that this modification eliminated the observed chugging.

Conclusion

These issues are considered to be resolved for all dynamic loads associated with the RHR heat exchanger relief valve discharge line. This judgement is based on the conservatisms used for development of design values for these loads, and the margins exhibited by other design loads. The judgement is also contingent on the commitment by the licensee (Reference 3.1.11) to eliminate routing of the bleed flow into this discharge line.

As for the loads associated with RCIC operation, the staff judges that the long and favorable operating experience of the RCIC turbine exhaust line demonstrates the adequacy of the system. This system employs a load initiator (sparger), whereas the RHR relief valve discharge line does not. Therefore, the staff considers this issue satisfactorily resolved.

References

3.1.1 Attachment 1 to MP&L Letter No. AECM-83/0146 dated March 23, 1983, from L. F. Dale (MP&L) to H. R. Denton (NRC).

3.1.2 Attachment 1 to MP&L Letter No. AECM-82/574 dated December 3, 1982, from L. F. Dale (MP&L) to H. R. Denton (NRC).

3.1.3 MP&L Letter No. AECM-86/0012 dated January 28, 1986, from O. D. Kingsley, Jr. (MP&L) to H. R. Denton (NRC).

3.1.4 Meeting Handouts from NRC/Mark III/GE Meeting of May 19 and 20, 1983.

3.1.5 "Mark II Dynamic Forcing Function Information Report," NEDO-21061, Rev. 3, June 1978.

3.1.6 Ashley, G. K. and Leong, T. S.; "An Approach to Chugging. Assessment of RHR Steam Discharge CO in March III Containments;" Betchel Report; March, 1984.

3.1.7 Anderson, C., "Mark II Containment Program Load Evaluation and Acceptance Criteria," NRC NUREG-0808.

3.1.8 Attachment 1 to MP&L Letter No. AECM-82/353 dated August 19, 1982, from L. F. Dale (MP&L) to H. R. Denton (NRC).

3.1.9 Attachment 1 to MP&L Letter No. GWS-06-143 dated April 23, 1985, from G. W. Smith (MP&L) to H. R. Denton (NRC).

3.1.10 Attachment 6 to MP&L Letter No. AECM-86/0175 dated August 14, 1986, from O. D. Kingsley, Jr. (MP&L) to H. R. Denton.

3.1.11 MP&L Letter No. AECM-86/0143 dated May 16, 1986, from O. D. Kingsley, Jr. (MP&L) to H. R. Denton (NRC).

Humphrey Concern 3.2

The STRIDE design provided only 9 inches of submergence above the RHR heat exchanger relief valve discharge lines at low suppression pool levels.

Evaluation

The concern is that because of the relatively low submergence involved, steam condensation may not be complete, leading to steam bypass and failure of the pressure suppression system.

The licensee has addressed this concern using the generic approach common to all plants (Reference 3.2.1). The approach cites the full-scale data from the Humboldt Bay tests where it was shown that, over a wide range of steam flux rates, condensation was complete (i.e., no steam bypass and containment pressurization), even with the vertical vent pipe exit 2 feet above the pool surface.

In the same submittal, MP&L states that the minimum submergence is 9 inches, increasing to about 4.5 feet at normal operating conditions. Therefore, this is more than sufficient to insure complete condensation of any steam discharge that may occur via the RHR heat exchanger relief valve discharge lines.

Conclusion

The staff considers this issue satisfactorily resolved for the GGNS based on the full scale experimental results that have been cited.

References

3.2.1 MP&L Letter No. AECM-82/353 dated August 19, 1983, from L. F. Dale (MP&L) to H. R. Denton (NRC).

Humphrey Concern 3.4

The RHR heat exchanger relief valve discharge lines are provided with vacuum breakers to prevent negative pressure in the lines when discharging steam is condensed in the pool. If the valves experience repeated actuation, the vacuum breaker sizing may not be adequate to prevent drawing slugs of water back through the discharge piping. These slugs of water may apply impact loads to the relief valve or be discharged back into the pool at the next relief valve actuation and apply impact loads to submerged structures.

Evaluation

The concern is that the various steam discharge lines may not have been equipped with properly sized vacuum breakers. This is a credible concern in view of the historical development of the same issue for the MSRV's. Because the potential for subsequent actuations was not fully appreciated in the early stages, the MSRV discharge lines were originally equipped with undersized vacuum breakers. When very high reflood elevations were encountered during tests with subsequent actuation, it became evident that this was so, and much larger vacuum breakers were installed (from 1 inch to as much as 10 inches in diameter, or two at 6 inches in diameter).

In reference 3.4.1 the licensee states that the GGNS RHR heat exchanger discharge lines are equipped with what appears to be 1.5 inch vacuum breakers. This is contradicted by information supplied in Reference 3.4.2, where a 0.75 inch vacuum breaker is indicated. MP&L's reflood analysis, in Reference 3.4.2, reports the results obtained using a conventional analytic method (Reference 3.4.3) which shows reflood lengths exceeding 30 feet. This is a surprisingly high value but, according to the licensee, is well below any crucial element of the piping system (the vacuum breakers are located about 5 feet above the maximum reflood level). Piping and piping support dynamic loads were evaluated for a second pop at this peak reflood level using standard methods that are acceptable to the staff (Reference 3.4.4). It was stated that all structures were found to be adequate; all stresses were within upset allowables.

Conclusion

The staff considers this issue adequately addressed by the licensee and, therefore, closed.

References

3.4.1 Attached 1 to MP&L Letter No. AECM-82/353 dated August 19, 1982, from L. F. Dale (MP&L) to H. R. Denton (NRC).

3.4.2 Safwat, H. H., "GGNS RHR Relief Line Hydrodynamic Loads." Meeting Handouts from NRC/Mark III/GE meeting of May 19 and 20, 1983.

3.4.3 Ashley, G. K. and Howard, N. M.; "Vacuum Relief Valve Sizing in Condensing Steam Situations," Presented at ANS 24th Annual Meeting; June 18-22, 1978.

3.4.4 Ransom, V. H., et al.; "RELAP5/MOD1 Code Manual;" NUREG/CR-1826, EG&G Idaho, 1981. "Repipe Application Reference Manual," CDC, 1980.

Humphrey Concern 3.5

The RHR relief valves must be capable of correctly functioning following an upper pool dump, which may increase the suppression pool level as much as 5 feet, creating higher back pressures on the relief valves.

Evaluation

The purpose of the RHR relief valve on each RHR train is to prevent the overpressurization of the RHR heat exchanger should the control valve fail during operation of the RHR system in the steam condensing mode. An upper pool dump is a design-basis accident (DBA) mitigating scheme that will not be used in conjunction with the operation of the RHR system in the steam condensing mode, which is not utilized to mitigate DBA events. Therefore, multiple failures of safety-grade equipment would have to occur before the scenario postulated by Mr. Humphrey could occur. The staff does not consider this scenario credible.

Conclusion

The staff considers this issue to be satisfactorily resolved.

Humphrey Concern 3.6

If the RHR heat exchanger relief valves discharge steam to the upper levels of the suppression pool following a design basis accident, they will significantly aggravate suppression pool temperature stratification.

Evaluation

Although the concern suggests that these discharges will occur following a DBA, the licensee has indicated (Reference 3.6.1) that the RHR will not be used in the steam condensing mode during post-LOCA conditions. On the other hand, continuous steaming for an extended period under normal conditions is possible and could not only result in excessive containment pressurization via vertical thermal stratification, but introduces the potential for unstable steam condensation leading to excessive dynamic loading on the pool boundaries.

The licensee's response to this issue was provided in Reference 3.6.2. A demonstrably conservative model of thermal deposition, stratification and pool mixing was developed and applied using MP&L plant parameters. Based on this model, it was shown in Reference 3.6.3 that even after steaming at the very high flow rate assumed in the analysis for twenty minutes, the difference between the average pool surface temperature (131°F) and bulk temperature (107°F) was only about 24°F. We note also that the peak temperatures reported are just barely approaching levels that might imply unstable steam condensation loads; e.g., about 130°F for a straight down pipe. Accordingly, the staff concludes that this scenario could safely proceed for as much as twenty minutes without the need for any mitigating action. The licensee takes the position that because operation in the SCM is so operator intensive, detection of a failure and termination of the steam flow could be accomplished within two minutes. This appears to be somewhat optimistic, but the staff is satisfied that sufficient time is available to institute a number of actions which would effectively mitigate any adverse effects of this postulated failure.

Conclusion

The issue raised by the concern is considered to be satisfactorily resolved for the GGNS.

References

3.6.1 Yang, C. T.; Informal Response to Question during NRC/Mark III/GE Meeting; May 19-20, 1983.

3.6.2 MP&L Letter No. AECM-82/574 dated December 3, 1983, from L. F. Dale (MP&L) to H. R. Denton (NRC).

3.6.3 Meeting Handout "Response to Question 9.2," NRC/Mark III/GE Meeting; May 19-20, 1983.

Humphrey Concern 4.1

The present containment response analyses for drywell break accidents assume that the ECCS systems transfer a significant quantity of water from the suppression pool to the lower regions of the drywell through the break. This results in a pool in the drywell which is essentially isolated from the suppression pool at a temperature of approximately 135°F. the containment response analysis assumes that the drywell is assumed to be isolated and the remainder of the heat is discharged to the suppression pool, an increase in bulk pool temperature of 10°F may occur.

Evaluation

Analyzses were performed by General Electric for the Grand Gulf Nuclear Station, assuming the drywell pool is completely isolated at a temperature of 135°F. The bulk pool temperature increase due to this assumption was 10°F. This increase is less than the 20°F margin in peak bulk pool temperature shown by the Mark III owners in response to Humphrey Concern 4.4.

By MP&L letter dated October 22, 1982, additional analyses were performed that shows Mr. Humphrey's assumption about the initial drywell pool temperature is incorrect. If one assumes that the drywell pool is formed during the initial stages of the transient as postulated by Mr. Humphrey, the water in the drywell pool will be a combination of steam condensation from the drywell structures, ECCS water spillage, and the unflashed portion of the reactor vessel blowdown. The temperature of this mixture is calculated to be 230°F, which if isolated from the suppression pool, will result in lower suppression pool bulk temperatures.

Conclusion

The licensee has shown that the drywell pool temperature, when the drywell pool is isolated early as postulated by Mr. Humphrey, is higher than the peak suppression pool temperature and, therefore, will result in lower suppression pool temperatures. The increase in the peak bulk suppression pool temperature of 10°F when the drywell pool is assumed to be isolated at 135°F (which has been shown to be unrealistic) is within the identified pool temperature margins discussed under Humphrey Concern 4.4. The staff considers this issue satisfactorily resolved.

Humphrey Concern 4.2 and 9.1

4.2 The existence of the drywell pool is predicated upon continuous operation of the ECCS. The current Emergency Procedure Guidelines (EPGs) require the operators to throttle ECCS operation to maintain vessel level below level 8. Consequently, the drywell pool may never be formed.

9.1 The current FSAR analysis is based upon continuous injection of relatively cool ECCS water into the drywell through a broken pipe following a design basis accident. The EPGs direct the operator to throttle ECCS operation to maintain reactor vessel level at about level 8. Instead of releasing relatively cool ECCS water, the break will be releasing saturated steam, which might produce higher containment pressurizations than currently anticipated. Therefore, the drywell air which would have been drawn back into the drywell will remain in the containment, and higher pressure will result in both the containment and the drywell.

Evaluation

A conservative end-point analysis was performed for Grand Gulf (MP&L letter dated October 22, 1982) to determine the peak containment pressure assuming no redistribution of air between the drywell and containment (as postulated by Mr. Humphrey in Concern 9.1), and with the containment atmosphere and suppression pool temperatures at 181°F. Neglecting the temperature differences that would be present between the suppression pool and containment atmosphere is quite conservative. The resulting peak containment pressure was estimated to be 12.5 psig, which is below the design limit of 15 psig.

Another analysis was performed assuming a constant vessel water level, an initial upper pool temperature of 95°F, standard FSAR values of DBA main steam line break/loss of coolant analyses, and with all energy release going directly to the suppression pool. This analysis was performed to evaluate the effect on the suppression pool temperature transient and, thus, the containment pressure/temperature transient if no drywell pool was formed. The peak pool temperature resulting from this analysis was estimated to be 165°F, well below the 181°F used in the bounding containment pressure analysis discussed above.

Conclusion

The assumption of no formation of the drywell pool and no air return to the drywell does not result in higher than design containment pressure for Mark III plants, even with very conservative assumptions regarding heat transfer processes. The staff considers this issue satisfactorily resolved.

Humphrey Concern 4.3

All Mark III analyses presently assume a perfectly mixed uniform suppression pool. These analyses assume that the temperature of the suction to the RHR heat exchangers is the same as the bulk pool temperature. In actuality, the temperature in the lower part of the pool where the suction is located will be as much as 7.5° cooler than the bulk pool temperature. Thus, the heat transfer through the RHR heat exchanger will be less than expected.

Evaluation

To complete the statement of this concern, the following should be added; ... "and containment pressures and temperatures greater than expected."

Humphrey's basis for expecting a temperature difference of up to 7.5°F is unclear. The staff agrees that in the event of a postulated LOCA, the reality will be a thermally stratified pool. However, to decide what is the difference between bulk and RHR suction temperature requires an estimate of the degree of vertical stratification that will occur, together with knowledge of the RHR suction elevation. The first of these requirements was established to the staff's satisfaction during its evaluation of the GESSAR II containment loads (Reference 4.3.1). After a lengthy and detailed review process (Reference 4.3.2), the worst case vertical temperature profile proposed by the General Electric Company for design (Fig. 3BI-3 of Reference 4.3.3) was judged acceptable. The basis for this judgement is given in Reference 4.3.1. It implies that the profile is applicable only for a standard top vent submergence (~7.5 feet). In responding to Humphrey concerns 4.7 and 4.10 (see later), and the second requirement, the licensee indicates that the GGNS RHR suction is located at an elevation 10.5 feet above the basemat. Comparison with the temperature profile referred to above implies that the RHR suction temperature is greater than bulk temperature. Accordingly, this Humphrey concern is not relevant to the GGNS.

Conclusion

The staff considers this issue satisfactorily resolved for the GGNS. Since it has been shown that the suction temperatures would be higher than bulk temperatures.

References

4.3.1 "Mark III LOCA-Related Hydrodynamic Load Definition;" NUREG-0978; August, 1984.

4.3.2 Transcript of the ACRS Subcommittee on Fluid Hydraulic Dynamic Effects Meeting of September 24, 25, 1981.

4.3.3 General Electric Co., 22A707; "General Electric Standard Safety Analysis Report," (GESSAR-II); Appendix 3B through Amendment 1; February 25, 1982.

Humphrey Concerns 4.4 and 7.1

4.4 The long term analysis of containment pressure/temperature response assumes that the wetwell airspace is in thermal equilibrium with the suppression pool water at all times. The calculated bulk pool temperature is used to determine the airspace temperature. If pool thermal stratification were considered, the surface temperature, which is in direct contact with the airspace, would be higher. Therefore, the airspace temperature (and pressure) would be higher.

7.1 The containment is assumed to be in thermal equilibrium with a perfectly mixed, uniform temperature suppression pool. As noted under Humphrey Concern 4, the surface temperature of the pool will be higher than the bulk pool temperature. This may produce higher than expected containment temperatures and pressures.

Evaluation

The concern is similar to that associated with Humphrey Concern 4.3, except that the issue is the determination of the difference between pool surface temperature and pool bulk temperature. Based on the GESSAR-II temperature profile referred to previously, this difference is 8°F, in rough agreement with the 7.5°F difference cited by Mr. Humphrey in Concern 4.2. Apparently, this was the ΔT he was referring to and it was mistakenly cited in connection with the Bulk-to-RHR suction temperature difference.

The licensee's response to this concern is given in Reference 4.4.1. In this submittal, the issue is quantified by means of existing information and analyses. The results show that the effects of a 7 to 8°F difference between pool surface and bulk temperature would imply an increase in peak containment pressure and temperature of only 0.1 psi and 3°F, respectively. These modest differences are overwhelmed by the existing margins of 5 psi and 10°F that can be demonstrated to exist due to various conservatisms used in conventional containment response analyses.

Conclusion

Essentially, this effort has demonstrated once more that the use of a mean or bulk pool temperature is an acceptable simplification which facilitates calculation of containment response. The staff considers this issue to be closed.

References

4.4.1 Attachment to MP&L Letter No. AECM-82/353; dated August 19, 1982; from L. F. Dale (MP&L) to H. R. Denton (NRC).

Humphrey Concern 4.5

A number of factors may aggravate suppression pool thermal stratification. The chugging produced through the first row of horizontal vents will not produce any mixing from the suppression pool layers below the vent row. An upper pool dump may contribute to additional suppression pool temperature stratification. The large volume of water from the upper pool further submerges RHR heat exchanger effluent discharge which will decrease mixing of the hotter, upper regions of the pool. Finally, operation of the containment spray eliminates the heat exchanger effluent discharge jet which contributes to mixing.

Evaluation

The licensee's response to this concern was provided in Reference 4.5.1. It is referred to as Action Plan 14. This Action Plan was to utilize the following "Program for Resolution:"

1. Testing information will be submitted to demonstrate the effectiveness of chugging as a mixing mechanism in the suppression pool; and

2. Analyses will be submitted to demonstrate that the suppression pool does not experience significant stratification during containment spray, or following an upper pool dump.

The first of these items addresses the concern that chugging does not provide any mixing below the top vent. The test information that was supplied indicates that this is not correct. Measurements obtained from drag disks that had been installed in the PSTF facility indicated that flow reversals occur periodically in both the middle and bottom vents during the chugging phase of the steam blowdown. Although this is a qualitatively useful finding, the attempt to quantify pool turnover time from this information cannot be adequately determined. This is because the drag disk device requires careful calibration under even the best of circumstances (steady, uniform flow). Under the unsteady, highly non-uniform flow conditions that prevail within the vents during chugging, the notion that quantitatively correct values of flow velocities can be obtained using this procedure is questionable. Furthermore, even if one were to accept these quantitative estimates, their applicability for the case involving an upper pool dump, which can increase top vent submergence from 7.5 to as much as 12 feet, would be highly suspect.

As for the second item, no analytical information has been supplied by MP&L. Accordingly, we have developed a bounding scenario based on information developed from the licensee's FSAR and Reference 4.5.2. From these documents and drawings supplied by MP&L (Reference 4.5.3) the staff determined that the GGNS upper pool volume would increase the pool depth by about four feet. The upper pool water at the time of dump could be 125°F, and the suppression pool bulk temperature at the time of pool dump could be in the range 123°F to 127°F. The pool dump is accomplished by two 30 inch diameter, gravity fed drain lines that terminate about 20 feet above the suppression pool surface. These drain lines are located at azimuths of 35° and 313° which places them in close proximity to the RHR suction lines (azimuths 32° and 328°). Also, the dump is accomplished over a period of about 5 minutes.

If during this time interval no other mass or energy addition to the suppression pool occurs, the combined suppression bulk pool temperature would remain approximately the same. Accordingly, there would be no increase in thermal stratification relative to the pool surface-to bulk-temperature difference. The effect of a pool dump on thermal stratification as it relates to RHR suction is more difficult to estimate, but as a limiting case we can speculate that the upper pool water, because of its downward velocity and greater density, preferentially sinks to the bottom and displaces the hotter pool water. Except for the possibility of short circuiting, which we judge to be unlikely because of the high elevation of the GGNS RHR suction, this "cold-water-sinks-to-bottom" scenario represents a worst case in terms of the RHR suction temperature differential from bulk pool temperature. That is, by displacing the hotter water upward, the RHR suction temperature would be reduced to the maximum degree possible. Figure 4.5.1, which is based on a GESSAR II figure referenced under Humphrey concern 4.3, demonstrates this effect. Note especially that although the local temperature at the RHR suction elevation decreases, it still remains <u>higher</u> than the bulk pool temperature. This represents an important conservatism as was pointed out during the evaluation of Humphrey Concern 4.3. Thus, an upper pool dump also would not impact negatively on the RHR suction to bulk temperature difference in the GGNS.

The remaining concerns implied in the statement of this Humphrey concern are also taken account of in this evaluation. Because our arguments have used the worst case thermal stratification, i.e., the temperatures profile was developed without assuming RHR operations. Thus any RHR operation, however inefficient, will further improve mixing of the suppression pool.

<u>Conclusion</u>

The staff judges that an upper pool dump in the GGNS will not seriously increase pool thermal stratification. This is because the difference between upper pool and suppression pool bulk temperature at time of a dump is slight, and because the RHR suction in the GGNS is located at a high elevation (10.5 feet above the basemat) relative to the worst case temperature profile.

References

4.5.1 MP&L Letter No. AECM-82/353; dated August 19, 1982; from L. F. Dale (MP&L) to H. R. Denton (NRC).

4.5.2 Gunter, A. D. and Fuls, G. M.; "Clasix-3 Containment Response Sensitivity Analysis for the Mississippi Power & Light Grand Gulf Nuclear Station;" Offshore Power Systems Report No. OPS-37A15; December 1981.

4.5.3 Attachment 4 to MP&L Letter No. AECM-82/497; dated October 22, 1982; from L. F. Dale (MP&L) to H. R. Denton (NRC).

Humphrey Concern 4.6

The initial suppression pool temperature is assumed to be 95°F, while the maximum expected service water temperature is 90°F for all Grand Gulf accident analyses as noted in FSAR Table 6.2-50. If the service water temperature is consistently higher than expected, as occurred at Kuosheng, the RHR system may be required to operate nearly continuously in order to maintain suppression pool temperatures at or below the maximum permissible value.

Evaluation

The maximum calculated initial temperature of the standby service water basin is 70°F. This is based upon the worst case 24 hour period and worst 30 day meteorological conditions. The Grand Gulf analysis is presented in the licensee's submittal dated August 19, 1982.

During the normal plant operation (excluding test conditions), the analysis indicates the only possible mechanism to raise the pool temperature is leakage through the main steam safety relief valves. A simplified suppression pool heatup analysis assuming 20 lb/hr steam leakage from each of the main steam safety relief valves was performed by MP&L. The results of the analysis show that it would take 10 days for the suppression pool temperature to rise from 90°F to 95°F, and 2.3 hours for the RHR system (with 75°F service water temperature) to cool the pool back down to 90°F.

The staff has reviewed the initial conditions, assumptions, and analysis techniques utilized by the licensee with regard to this issue, and concludes that the RHR system is capable of maintaining the suppression pool temperatures below its Technical Specification value with only intermittent usage, even under the most severe normal operating conditions.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Safety Concerns 4.7 and 4.10

4.7 All analyses completed for the Mark III are generic in nature and do not consider plant specific interactions of the RHR suppression pool suction and discharge.

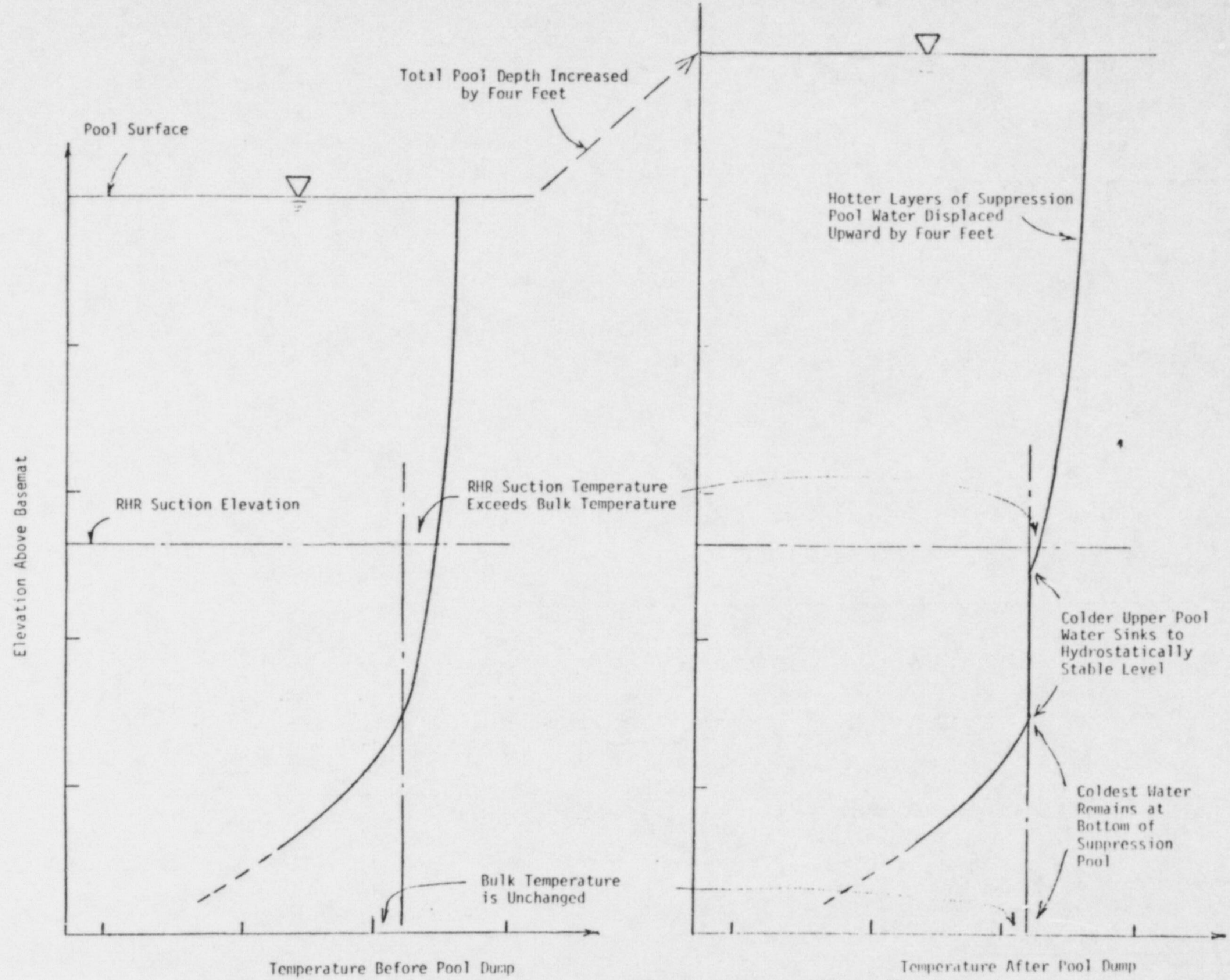

Figure 4.5.1 Bounding Scenario for GGNS Upper Pool Dump

4.10 Justify that the current arrangement of the discharge and suction points of the pool cooling system maximizes pool mixing.

Evaluation

The concern is if the RHR system's geometric arrangement for the suction and return lines is not properly designed, and the capability of the system to induce bulk mixing and remove thermal energy is not adequate.

The licensee has addressed these concerns via the generic approach developed for the Mark III Containment Issues Owners Group (Reference 4.7.1). The key element of this study was the Perry one-tenth-scale tests (Reference 4.7.2). In these tests, a number of related concerns were addressed systematically. These included short circuiting, development of bulk pool motion, ability to eliminate thermal stratification and the presence of isolated recirculation zones.

The staff has reviewed this information in detail and has concluded that the Perry one-tenth-scale tests correctly simulate design conditions in Mark III plants and, along with the other test information provided, include a sufficient range of parameters to encompass the GGNS plant unique features. Since the findings from the tests show that good mixing can be achieved, as well as the absence of short circuiting, the staff concludes that the GGNS RHR system can be expected to perform in a manner consistent with design assumptions.

Conclusion

The staff considers the issues raised by these concerns to be satisfactorily resolved for the GGNS.

References

4.7.1 Quadrex Corp.; "A Survey of Tests and Analyses on the Effectiveness of the RHR System in the Pool Cooling Mode;" Report No. QUAD-1-82-245, November, 1982.

4.7.2 Gilbert Associates, Inc.; "Model Study of Perry Nuclear Power Plant Suppression Pool - Final Report;" November 1977.

Humphrey Concern 4.8

Operation of the RHR system in the containment spray mode will decrease the heat transfer coefficient through the RHR heat exchangers due to decreased system flow. The FSAR analysis assumes a constant heat transfer rate from the suppression pool, even with operation of the containment spray.

Evaluation

The CIOG (using Grand Gulf as an example in an MP&L letter dated October 22, 1982) performed an analysis incorporating lower RHR heat exchanger heat transfer coefficients, due to operation of the containment spray system, into a realistic model both with and without full capacity steam bypass of the drywell. Both cases demonstrated that containment design conditions were not exceeded.

A simple end-point calculation was performed by the review panel. This approach has the advantage of removing the mitigating effects that the realistic assumptions had on the final results. The typical reduction in heat transfer capability due to spray actuation was determined to be approximately 8 percent. From the sensitivity studies performed to evaluate the impact of varying various input assumptions, the effect of reducing the RHR heat exchanger effectiveness by approximately 14 percent was to increase the peak suppression pool temperature by 6°F. Decreasing the heat exchanger capacity by 8 percent would increase the suppression pool temperature by 3 to 5°F. This increase is insignificant when compared to the FSAR conservatisms identified in the response to Humphrey Concern 4.4.

Conclusion

Both the realistic analysis performed by the Mark III owners and the end-point calculation technique provided by the review panel shows that the effect of containment spray actuation on the suppression pool temperature is insignificant. The staff considers this issue satisfactorily resolved.

Humphrey Concern 4.9

The effect on the long-term containment response and the operability of the spray system due to cycling the containment spray on and off to maximize pool cooling needs to be addressed. Also, provide and justify the criteria used by the operator for switching from the containment spray mode to pool cooling mode, and back again.

Evaluation

The implication by Mr. Humphrey is that the RHR system with a decreased heat transfer capacity due to containment spray usage, assuming a most limiting single failure, will not be able to control the suppression pool temperature response to a DBA. However, the response to Humphrey Concern 4.8 demonstrates that the RHR system, when limited as described above, can prevent the peak pool temperature from reaching the design limit of 185°F.

Conclusion

On the basis of the CIOG's response to Humphrey Concern 4.8, no need exists to provide specific criteria to switch from the containment spray mode to the pool cooling mode in order to maintain the suppression pool temperature below the design limit. The staff considers this issue to be satisfactorily resolved.

Humphrey Concern 5.1

The worst case of drywell-to-containment bypass leakage has been established as a small-break accident. An intermediate-break-accident will actually produce the most significant drywell-to-containment leakage prior to initiation of containment sprays.

Evaluation

The staff requires each Mark III owner to consider the entire spectrum of break sizes in their analyses of the drywell steam bypass issue. The staff reviews the assumptions and results of the spectrum of break sizes as part of the normal FSAR review. The details of the staff's evaluation of this topic are contained in Grand Gulf SER Section 6.2.1.7.

Conclusion

The staff is satisfied that the entire range of break sizes have been considered in evaluating the consequences of drywell steam bypass. The staff considers this issue closed.

Humphrey Concern 5.2

Under Technical Specification limits, bypass leakage corresponding to an equivalent area of 0.1 sq. ft. ($A/\sqrt{k}$) constitutes acceptable operating conditions. Smaller than IBA sized breaks can maintain break flow into the drywell for long time periods, however, because the RPV would be depressurized over a 6-hour period. Given, for example, an SBA with $A/\sqrt{k} = 0.1$, projected time period for containment pressure to reach 15 psig is 2 hours. In the latter 4 hours of the depressurization the containment would presumably experience ever-increasing overpressurization.

Evaluation

The concern appears related to absence of sprays to mitigate the consequences of steam bypass. However the Mark III containment spray systems were specifically added to the Mark III design to remove the heat addition to the containment from suppression pool steam bypass leakages to an equivalent area ($A/\sqrt{k}$) of approximately 1.0 sq. ft. This value is ten times higher than the Technical Specification value mentioned in the subject concern. Both the short-term and long-term effects of drywell steam bypass were evaluated by the licensee and reviewed by the staff, and found acceptable as part of the normal review process of the FSAR. Details of this staff's evaluation of this topic can be found in Section 6.2.1.7 of the SER.

Conclusions

The staff considers this issue satisfactorily resolved. Further details of the staff's evaluation of this topic are contained in Section 6.2.1.7 of the SER.

Humphrey Concern 5.3

Leakage from the drywell to containment will increase the temperature and pressure in the containment. The operators will have to use the containment spray in order to maintain containment temperature and pressure control. Given the decreased effectiveness of the RHR system in accomplishing this objective in the containment spray mode, the bypass leakage may increase the cyclical duty of the containment sprays.

Evaluation

The design, testing, and maintenance of the active portions of the RHR spray train in pool cooling systems provides confidence that the components should function. Furthermore, the switching process is not expected to challenge the ability of the individual components to perform their functions. In addition, the analysis performed for Humphrey Concern 4.8 shows that the containment sprays can be operated continuously without adverse consequences on the pool temperature response.

Conclusions

The staff considers this issue closed.

Humphrey Concern 5.4

Direct leakage from the drywell to the containment may dissipate hydrogen outside the region where the hydrogen recombiners take suction. The anticipated leakage exceeds the capacity of the drywell purge compressors. This could lead to pocketing of hydrogen exceeding the concentration limit of 4 percent by volume.

Evaluation

The design basis for the drywell mixing system, including the hydrogen compressors, is to pressurize the drywell to a pressure sufficient to force the drywell atmosphere through the top row of the suppression pool vents following a LOCA. This would allow the drywell air to be uniformly distributed into the wetwell containment area. However, the allowable Technical Specification for drywell bypass leakage is greater than the hydrogen mixing capacity. Thus, the drywell air may leak out of the drywell at locations other than originally intended. This concern could result in local pocketing of hydrogen, which could exceed the design concentration limit.

MPL has indicated that the only potentially significant leakage path would be through drywell penetrations. MPL asserts significant convective forces will be present to conclude that the potential for hydrogen pocketing is negligible. Moreover, the drywell penetrations are below the suction points of the recombiners.

In addition, the drywell mixing system will be initiated before the drywell hydrogen concentration reaches 4 percent by volume. Thus, there will be no possibility of hydrogen pockets forming in the containment due to drywell bypass leak paths exceeding 4 percent by volume.

Conclusions

The staff considers this issue satisfactorily resolved.

Humphrey Concern 5.5

Equipment may be exposed to local conditions which exceed the environmental qualification envelope as a result of direct drywell-to-containment bypass leakage.

Evaluation

Following a LOCA or MSLB design basis accident, the drywell temperature can be in excess of 300°F. The concern is that this superheated air/steam gas could pass through drywell leakage paths, bypassing the suppression pool and impinging on safety-related equipment located in the containment near the drywell wall. By letter dated August 19, 1982, MP&L has indicated that all non-NSSS safety-related equipment located inside the containment was qualified to the drywell temperature, except the drywell purge compressors. Since the drywell purge compressors are located on top of the drywell where there are no local sources of leakage, local conditions will not be expected to exceed its design limits. All of the NSSS safety-related equipment was not qualified to the drywell temperatures. Since the closest equipment item is seven feet from the nearest drywell penetration, MP&L indicates there is sufficient spacing to diffuse drywell gases from where this equpment is located.

The staff agrees that there will be a considerable amount of cooling of the drywell air as it passes through the postulated drywell leakage paths. This is because of the thickness of the wall and the relatively small leakage areas that could conceivably occur. The drywell concrete wall, including the drywell wall penetrations, are designed to form a leaktight barrier and direct the steam produced by design basis LOCA or MSLB conditions into the suppression pool. Thus, the staff does not believe it credible to postulate large cracks in the drywell wall or around penetrations that could lead to significant amounts of drywell air to enter the containment at the superheated temperature as postulated by Mr. Humphrey.

Conclusion

The staff considers this issue satisfactorily resolved because there should be no adverse effects on the safety of the plant due to the local high-temperature effects from steam bypass leakage from the drywell.

Humphrey Concerns 5.6 and 9.2

5.6 The test pressure of 3 psig specified for the periodic operational drywell leakage rate tests does not reflect additional pressurization in the drywell which will result from an upper pool dump. This pressure also does not reflect additional drywell pressurization resulting from throttling of the ECCS to maintain vessel level which is required by the current EPGs.

9.2 The continuous steaming produced by throttling the ECCS flow will cause increased direct leakage from the drywell to the containment. This could result in increased containment pressure.

Evaluation

The staff agrees that, under the conditions postulated by Mr. Humphrey, a pressure differential greater than the 3 psig used in the periodic operational drywell leakage rate tests could exist for a period of time for small steam line breaks. However, the maximum possible increase in the differential pressure due to the scenario postulated by Mr. Humphrey is approximately twice the test pressure, which would result in approximately twice the steam bypass leakage to the containment. The acceptance criteria for the periodic 3 psid test is 10 percent of the allowable bypass leakage. The large margin in the periodic test acceptance criteria is more than enough to offset the potential bypass leakage increases due to the increase differential pressure from an upper pool dump and ECCS throttling. All Mark III plants, including the GGNS, are required to use a bypass leakage capability that is approximately 10 times greater than the 3 psid periodic test acceptance criteria to demonstrate that the Mark III containment can withstand the maximum conceivable drywell steam bypass leakage.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 5.7

After an upper pool dump, the level of the pool will be 6 feet higher, and drywell-to-containment differential pressure will be greater than 3 psid. The drywell hydrogen purge compressor head is nominally 6 psid. The concern is that after an upper pool dump, the purge compressor head may not be sufficient to depress the weir annulus enough to clear the upper vents. In such a case, hydrogen mixing would not be achieved.

Evaluation

By letter dated May 28, 1982, MPL has indicated that the GGNS purge compressors operate at a nominal discharge differential pressure of 10 psig, therefore, ensuring adequate mixing.

Conclusion

The staff considers this issue resolved.

Humphrey Concern 5.8

The possibility of high temperatures in the drywell without reaching the 2 psig high-pressure scram level because of leakage through the drywell wall should be addressed.

Evaluation

The concern is that bypass leakage from the drywell during a transient that adds heat to the drywell (e.g., a small main steam line break) will reduce the drywell atmospheric mass, thus allowing high temperatures to exist without actuating the automatic reactor scram signals. The net result could be higher than design temperatures inside the drywell before actions are performed to mitigate the accident consequences.

To evaluate this possibility, the Mark III owners analyzed a spectrum of break sizes assuming full capability bypass leakage, heat transfer to the drywell heat sinks and conservative initial conditions. The bypass leakage used is very conservative at approximately 10 times greater than the Technical Specification values. A 10 minute interval was assumed for operator action to detect and manually respond to the transient. The limiting break size case resulted in an estimated peak drywell temperature at 10 minutes of 246°F, which is well below the drywell design temperature of 330°F.

The Mark III owners also provided a detailed description of the instrumentation and alarms available to inform the control room operator of high drywell temperature conditions and to indicate the probable cause of the temperature transient.

The operators will be able to distinguish between loss of drywell air coolers and small breaks in the reactor coolant system by using the instrument readouts and alarms for high drywell radiation, drywell pump levels, and narrow range drywell pressure indications.

In addition, analyses performed for the River Bend Station (SSER No. 2 Appendix K, NUREG-0989) which is generally applicable to the other Mark III plants for this Humphrey concern, shows that for even very small break sizes (0.008 ft^2) the 2 psig scram setpoint will be reached before drywell temperatures exceed the design value.

Conclusions

The analysis performed shows that adequate time and information exists to alert the operator to take the appropriate actions to prevent drywell temperatures from exceeding design values. Also, the 2 psig setpoint would automatically scram the plant before drywell temperatures reached the design value of 330°F. The staff considers this issue to be satisfactorily resolved.

Humphrey Concern 6.1

GE has recommended that the drywell purge compressors and the hydrogen recombiners be activated if the reactor vessel water level should drop to within 1 ft. of the top of the active fuel. This requirement was not incorporated in the emergency procedure guidelines.

Evaluation

The current emergency operating procedures as approved by the NRC, requires the control room operators to initiate the drywell mixing system when the drywell hydrogen concentration reaches 3 percent by volume. The concern raised by Mr. Humphrey has an involved history that is fully explained in the Review Panel's report. (Letter dated July 27, 1984, from L. A. England to H. R. Denton). Basically, this recommendation originated during discussions held between GE representatives and the NRC staff in 1981 on how to ensure timely initiation of the drywell purge compressors. At that time, the staff had expressed concerns relative to the hydrogen monitoring system's ability to measure the hydrogen concentration when the drywell atmosphere consisted of all steam (see Humphrey Concern 6.4). The recommendation outlined in this Humphrey concern was the proposed "fix" to the staff concern. However, none of the Mark III plants utilize hydrogen monitoring systems that have the limitation of the GE hydrogen monitors. Therefore, this recommendation to initiate the drywell compressors based on the reactor vessel water level is no longer relevant to the design basis accident hydrogen control issue.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 6.2

GE has recommended that an interlock be provided to require containment spray prior to starting the recombiners because of the large quantities of heat input to the containment. Incorrect implementation of this interlock could result in the inability to operate the recombiners without containment spray.

Evaluation

None of the Mark III plants have an interlock to require containment spray before starting the recombiners. This interlock recommendation was based on a design feature that was removed from the Mark III containment concept early in the design process. The staff agrees that the current MARK III design does not need spray actuation before recombiner initiation and considers this issue not applicable to any existing Mark III plant, including the GGNS.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concerns 6.3 and 6.5

6.3 The recombiners may produce "hot spots" near the recombiner exhausts that might exceed the environmental qualification envelope or the containment design temperature.

6.5 Discuss the possibility of local temperatures due to recombiner operation being higher than the temperature qualification profiles for equipment in the region around and above the recombiners. State what instructions, if any, are available to the operator to actuate containment sprays to keep this temperature below design values.

Evaluation

By letter dated August 19, 1982, MPL has reviewed the equipment arrangements at Grand Gulf and states that no safety-related equipment is located in the vicinity of the recombiners; i.e., the plume from the recombiner will be limited to approximately a 10° vertical cone. Thus, equipment will not be exposed to the higher temperatures.

The licensee indicates that the plant emergency procedures would require the operator to manually initiate containment spray before the temperature inside containment exceeds the design temperature of 185°F. This would ensure that long-term containment temperature is controlled, including the effects of continuous recombiner operation.

Conclusion

The staff considers this issue to be resolved.

Humphrey Concern 6.4

For the containment air monitoring system furnished by GE, the analyzers are not capable of measuring hydrogen concentrations at volumetric steam concentrations above 60 percent. Effective measurement is precluded by condensation of steam in the equipment.

Evaluation

None of the Mark III plants, including the GGNS, utilize the containment air monitoring system furnished by GE. By letter dated May 28, 1982, MP&L has indicated that failure due to condensation is precluded by the elevated temperature around the analyzers (i.e., the saturation temperatures is not expected to exceed 275° F).

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 7.1

This has been combined with and answered under Humphrey Concern 4.4

Humphrey Concern 7.2

The computer code used by GE to calculate environmental qualification parameters considers heat transfer from the suppression pool surface to the containment atmosphere. This is not in accordance with the existing licensing basis for Mark III environmental qualifications. Additionally, the bulk suppression pool temperature was used in the analysis instead of the suppression pool surface temperature.

Evaluation

The GE containment response computer code, SHEX, was only used to identify the margins in the results when using the staff's environmental qualification profile methodology contained in NUREG-0588. Moreover, containment sprays when activated will enhance interaction of the suppression pool and the containment atmosphere. All MARK III plants, including the GGNS, have used the NUREG-0588 qualifications parameters in the development of plant-unique environmental qualification curves, which the staff finds acceptable.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 7.3

The analysis assumes that the containment air space is in thermal equilibrium with the suppression pool. In the short term, this is nonconservative for the Mark III containment design due to adiabatic compression effects and the finite time required for heat and mass to be transferred between the pool and containment volumes.

Evaluation

The effect of the adiabatic compression effect has been calculated by MP&L (letter dated May 28, 1982) to be about 0.5 psi. This slight increase has no design significance for the Mark III containment because the limiting conditions for containment pressure buildup are reached in the long term, after this effect is completely gone.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 8.1

This issue is based on consideration that some Technical Specifications allow operation at parameter values that differ from the values used in assumptions for FSAR transient analyses. Normally, analyses are done assuming a nominal containment pressure equal to ambient (0 psig) and a temperature near maximum operating temperature (90°F), and do not limit the drywell pressure equal to the containment pressure. The Technical Specifications permit operation under conditions such as a positive containment pressure (1.5 psig), temperatures less than maximum (60 or 70°F), and drywell pressure can be negative with respect to the containment (-0.5 psid). All of these differences would result in transient responses different than the FSAR descriptions.

Evaluation

The basic question raised by Mr. Humphrey is have all the worst-case combinations of initial conditions have been considered in the FSAR analysis? The staff has considered the effects of initial conditions on the end results of various accidents, and has developed criteria for evaluating the initial conditions selected by nuclear power plant applicants. Basically, the staff's approach to this concern can be summarized as follows:

(1) Numerous analyses using computer codes developed to predict the plant response to various accident scenarios have shown which initial condition variations have a strong effect on the end results.

(2) If the initial conditions have a significant impact on the end results, then the staff requires that the most limiting values be used in the analysis. An example of this is the use of zero relative humidity in subcompartment analysis.

(3) If the initial conditions do not have much of an impact on the end results, the staff requests the applicant to use generally conservative values or expected values for the initial conditions. An example of this would be the effect of initial drywell temperatures on the peak calculated drywell temperatures.

(4) The margins that exist between the peak calculated values and the design values are intended, in part, to account for the uncertainties in the assumptions and analytical techniques utilized in the response analysis, including the uncertainties inherent in the initial conditions.

In response to Mr. Humphrey's concern, MP&L by letter dated December 3, 1982, has indicated that the results of the Grand Gulf containment initial condition end-point analysis shows that the containment design pressure is not exceeded. Moreover, the FSAR containment response analysis is excessively conservative (refer to the evaluation portion of Humphrey Concerns 4.1 and 4.4), which would sufficiently compensate for the variations in containment initial conditions.

Conclusion

The staff considers the analytical techniques employed by MP&L to be conservative, and there are significant margins between the peak calculated containment pressure and the design pressure. Therefore, the staff considers this issue satisfactorily resolved.

Humphrey Concerns 8.2 and 8.3

8.2 The draft Grand Gulf Technical Specifications permit operation of the plant with containment pressures ranging between 0 and -2 psig. Initiation of containment spray at a pressure of -2 psig may reduce the containment pressure by an additional 2 psig, which could lead to buckling and failures in the containment liner plate.

8.3 If the containment is maintained at -2 psig, the top row of vents could admit blowdown to the suppression pool during an SBA without a LOCA signal being developed.

Evaluation

The final Grand Gulf Technical Specifications limit the containment pressure range from -0.1 psid to 1.0 psid. This pressure range is the bounds evaluated for accidents at Grand Gulf. Inadvertent containment spray actuation is addressed in Section 6.2.1.5 of the SER and also under Humphrey Concern 8.4.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 8.4

Describe all of the possible methods, both before and after an accident, of creating a condition of low air mass inside the containment. Discuss the effects on the containment design external pressure of actuating the containment sprays.

Evaluation

By letter dated August 19, 1982, MP&L indicated that the greatest containment negative pressure condition would occur if there is a break in the reactor water cleanup (RWCU) system followed by actuation of the containment sprays. The resulting calculated negative pressure differential across the containment shell is less than 3.0 psi, which is the external pressure design value for the Grand Gulf containment. The MP&L submittal did not fully identify detailed analytical assumptions that were employed in the analysis. However, the staff has evaluated this Humphrey concern in the review of the Clinton Power Station, which is another Mark III with the same containment shell design value as Grand Gulf (i.e., with a 3.0 psi reverse design differential pressure). Also, the same scenario was determined to be the worst case for Clinton Power Station and resulted in a calculated negative pressure differential across the containment shell of about 2.0 psi. Therefore, the staff is confident that the peak containment negative pressure for the GGNS would be within the design limit. In addition, MP&L has indicated that the maximum negative differential pressure capability is actually 10 psi, thereby, illustrating that a significant margin exists.

Conclusion

The staff considers this issue closed.

Humphrey Concern 9.1

This concern was combined and answered with Humphrey Concern 4.2

Humphrey Concern 9.2

This concern was combined and answered with Humphrey Concern 5.6

Humphrey Concern 9.3

It appears that some confusion exists as to whether SBAs and stuck-open SRV accidents are treated as transients or design basis accidents. Clarify how they are treated, and indicate whether the initial conditions were set at nominal or licensing values.

Evaluation

By letter dated August 19, 1982, MP&L has stated that small-break accidents (SBAs) and stuck-open SRV accidents are treated as design basis accidents. The initial conditions used in the analysis of these accidents are the same conservative licensing values used for the double-ended rupture of a recirculation pipe.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 10.1

The suppression pool may overflow from the weir wall when the upper pool is dumped into the suppression pool. Alternatively, negative pressure between the drywell and the containment that occurs as a result of normal operation or sudden containment pressurization could produce a similar overflow. Any cold water spilling into the drywell and striking hot equipment may produce thermal failures.

Evaluation

MP&L has acknowledged that weir wall overflow could occur in the unlikely event of an inadvertent upper pool dump under pessimistically assumed initial conditions (i.e., the upper pool and the suppression pool both being at the high alarm setpoint levels in conjunction with a drywell vacuum relief initiation setpoint of -0.16 psig). The resultant drywell water level was calculated to be about 8 inches deep. This level is about 10 inches below the bottom steel of the recirculation line, but does submerge portions of the four RWCU drain lines (two lines of 2-inch diameter piping and two lines of 3/4-inch diameter piping).

In response to the potential for drywell flooding, MP&L has investigated various options for preventing overflow. The options included adjusting the drywell vacuum breaker setpoint, and reducing the level of the suppression pool and the upper pool. MP&L has determined that there are design constraints that make these operating adjustments infeasible. It should be noted that the affected piping in the drywell is protected by insulation. Furthermore, GE has performed a fatigue analysis for the CIOG that shows no damage for a LOCA inside the drywell occurs. This study was based on extreme flooding where the water level reached the top of the recirculation pump casing, and piping insulation was not considered. In addition, MP&L has performed stress calculations on the affected RWCU lines (2 inch and 3/4 inch) which indicates that they maintain their structural integrity following the overflow.

Conclusion

The staff considers this issue satisfactorily resolved.

References

10.1.1 MP&L Letter No. AECM-82/237; dated May 28, 1982; from L. F. Dale (MP&L) to H. R. Denton (NRC).

10.1.2 MP&L Letter No. AECM-82/353; dated August 19, 1982; from L. F. Dale (MP&L) to H. R. Denton (NRC).

10.1.3 MP&L Letter No. AECM-85/0046; dated February 25, 1985; from L. F. Dale (MP&L) to H. R. Denton (NRC).

10.1.4 MP&L Letter No. AECM-85/0233; dated October 4, 1985; from L. F. Dale (MP&L) to H. R. Denton (NRC).

10.1.5 MP&L Letter No. AECM-85/0376; dated November 27, 1985; from L. F. Dale (MP&L) to H. R. Denton (NRC).

Humphrey Concern 10.2

Describe the interface requirement (A42) that specifies that no flooding of the drywell shall occur. Describe your intended methods to follow this interface.

Evaluation

The interface requirement specifying that no drywell flooding shall occur is as follows:

> "The suppression pool weir wall height shall provide sufficient freeboard volume to accept a dump of the upper pool without resulting in overflow flooding into the drywell. The freeboard height shall be measured between the top of the weir wall and high water level (HWL) which is 7'6" above the top vent centerline."

The staff has evaluated each of the Mark III owner's intention to follow this interface requirement under Humphrey Concern 10.1.

Conclusion

The interface requirement addresses inadvertent upper pool dump, which is discussed under Humphrey Concern 10.1. The staff considers this issue satisfactorily resolved.

Humphrey Concern 11.0

Mark III load definitions are based upon the levels of the suppression pool and the drywell weir annulus being the same. The Grand Gulf Technical Specifications permit elevation differences between these pools. This may affect load definition for vent clearing.

Evaluation

By letter dated October 22, 1982, MP&L evaluated the effect of having a higher initial pressure in the containment than in the drywell on the load definitions for vent clearing. For pressure differentials in the other direction, the staff agrees that the vent clearing loads will be less severe than normal because the vents will clear sooner. The Technical Specification maximum values of the differential pressure as used by the Mark III owners in their analyses of the change in peak drywell pressure. The drywell pressure increase was about 1%, which is a negligible change.

Conclusion

The staff finds the effect of differential pressures between the drywell and containment to be negligible. The staff considers this issue satisfactorily resolved.

Humphrey Concern 12.0

The upper pool dumps into the suppression pool automatically following a LOCA signal with a 30-minute delay timer. If the signal that starts the timer disappears on the solid-state logic plants, the timer resets to zero, preventing upper pool dump.

Evaluation

MPL has indicated that this concern is not applicable to Grand Gulf; once the timer for suppression pool dump has been initiated, only operator intervention can prevent upper pool dump.

Conclusions

The staff considers this issue satisfactorily resolved.

Humphrey Concern 13.0

The "B" loop of the containment sprays includes a 90-second timer to prevent simultaneous initiation of the redundant containment sprays. Because of instrumentation drift in the sensing instrumentation and the timers, GE estimates that there is a 1 in 8 chance that the sprays will actuate simultaneously. Simultaneous actuation could produce negative pressure transients in the containment and aggravate temperature stratification in the suppression pool.

Evaluation

By letter dated May 28, 1982, MP&L has indicated that GGNS FSAR Section 6.2.1.1.4.2 contains an evaluation of inadvertent containment spray initiation and considered both spray trains being initiated simultaneously.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 14.0

A failure in the check valve in the LPCI line to the reactor vessel could result in direct leakage from the pressure vessel to the containment atmosphere. This leakage might occur as the LPCI motor-operated isolation valve is closing and the motor operated isolation valve in the containment spray line is opening. This could produce unanticipated increases in the containment pressure.

Evaluation

The scenario postulated by Mr. Humphrey requires a highly improbable sequence of events to occur. The break size in the reactor coolant system has to be large enough to introduce significant amounts of steam into the drywell, yet small enough so that the reactor vessel still has considerable pressure (300 to 400 psi) at the time the sprays would be actuated. The check valve in the train that is being transferred to the containment spray mode must fail. The possibility of this Humphrey concern occurring as a result of manual actuation of the containment spray can be ruled out because the operator is directed to secure the RHR loop to the reactor vessel before opening the valve admitting water to the containment spray headers. Failure of the operator to perform this written procedure correctly in conjunction with a failure of the check valve in the proper train is too improbable to be considered.

Automatic initiation of the transfer process would then have to occur for this Humphrey concern to happen, which means the containment pressure would have to reach 9 psig early in the transient (or the reactor vessel pressure will be too low to produce significant steam back flow through the RHR line). To reach 9 psig early in the transient, a significant amount of drywell steam bypass has to have occurred, which makes the chance of this sequence even more unlikely.

At the request of the staff, MP&L analyzed the consequences should this Humphrey concern occur by letter dated October 22, 1982. The transfer to the containment spray mode was assumed to occur when the reactor vessel pressure is equal to the RHR pump shutoff head, and the valve operating times used were representative of the startup test results for Grand Gulf. Because manual transfer to containment sprays was ruled out, as explained above, the scenario was started with the containment pressure equal to 9 psig, the setpoint for automatic transfer to the containment spray mode. Automatic transfer at higher containment pressures would require additional failures in the plant safety system, and was not considered to be credible. The pressure increase resulting from the steam addition to the containment airspace from the backflow through the containment spray headers during the time interval of the valves being open was calculated to be 0.8 psi. This small increase does not impact the design pressure of 15 psig since the total pressure would be less than 10 psig for this scenario. The large margin, 5 psig, is more than sufficient to cover the uncertainties in the licensee's analysis.

Conclusion

The analyses performed by MP&L demonstrates that this Humphrey concern does not challenge the design of the Mark III containment. The staff considers this issue satisfactorily resolved.

Humphrey Concern 15.0

The STRIDE plants had vacuum breakers between the containment and the secondary containment. With sufficiently high flows through the vacuum breakers to containment, vacuum could be created in the secondary containment.

Evaluation

This concern is not applicable to the Grand Gulf design since containment vacuum breakers are not included in the containment design.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 16

Some of the suppression pool temperature sensors are located (by GE recommendation) 3 to 12 inches below the pool surface to provide early warning of high pool temperature. However, if the suppression pool is drawn down below the level of the temperature sensors, the operator could be misled by erroneous readings, and the required safety action could be delayed.

Evaluation

The Mark III owners have committed to include in the plant emergency procedures to either require the operator to verify level in the suppression pool before reading suppression pool temperature, or specify which suppression pool temperature instruments can be used following an accident. The staff believes either of these approaches will prevent erroneous readings on the part of the operator, and, therefore, are acceptable.

Conclusion

Based on discussions with MP&L, the licensee chose the second option for the Grand Gulf emergency procedures. Thus, the staff considers this issue satisfactorily resolved.

Humphrey Concern 17.0

The EPGs contain a curve which specifies limitations on suppression pool level and reactor pressure vessel pressure. The curve presently does not adequately account for upper pool dump. At present, the operator would be required to initiate automatic depressurization when the only action required is the opening of one additional SRV.

Evaluation

By letter dated August 14, 1986, MP&L has indicated that an inadvertent upper pool dump is not expected to result in the suppression pool level exceeding the pool load limit curve. Operator action will be taken to prevent suppression pool level and/or RPV pressure from exceeding the load limit curve. This would include instructions to the operator to depressurize the RPV using other means than SRVs if the curve is exceeded.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 18.1

Failures of reflective insulation in the drywell may lead to blockage of the gratings above the weir annulus. This may increase the pressure required in the drywell to clear the first row of drywell vents and perturb the existing load definitions.

Evaluation

There are no gratings over the weir annulus at Grand Gulf.

Conclusion

This issue is resolved.

Humphrey Concern 18.2

Insulation debris may be transported through the vents in the drywell wall into the suppression pool. This debris could then cause blockage of the suction strainers.

Evaluation

This concern is addressed in Section 6.2.3 and Appendix C of the Grand Gulf SER, and in Generic Letter 85-22 which resolves Unresolved Safety Issues (USI) A-43. The conclusion reached by the staff is that the design minimizes the potential of clogging the pump suction strainers, and design changes are not warranted.

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 19.1

The chugging loads were originally defined on the basis of 7.5 feet of submergence over the drywell to suppression pool vents. Following an upper pool dump, the submergence will actually be 12 feet which may affect chugging loads.

Evaluation

The licensee's response to this concern is provided in Reference 19.1.1. In this submittal, physical arguments and analytical procedures are used to estimate the pressure field that would be generated on the suppression pool boundaries if the worst case chug from the Mark III data base were to occur with the top vent at a 12-foot submergence. The results were compared with the design values on an amplitude response spectrum (ARS) basis and shown to be bounded, except for local loads in the frequency range 15 to 32 Hz. For these conditions an exceedance of the design value amounting to 35% occurs on the basemat and about 15% on the containment wall. The licensee argues that these exceedances are not important because this is a local load affecting only the basemat and containment wall liners and that, because of the hydrostatic head to which the liner is subjected, "a negative pressure will never be imposed on the liner." Also, "since the liner is backed by concrete, no natural modes of vibration are excitable."

The staff notes the following:

- The use of an acoustic model in the analysis represents a significant conservatism;

- dissipative mechanisms not accounted for in such an analysis result in pressure attenuation which is much greater than predicted, this has been borne out convincingly by experimental results;

- application of the worst case chug to all vents, which is done for local loads, also represents a very significant conservatism;

- in a recent submittal by the Cleveland Electric Illuminating Co. (CEI) to address the concern relating to the combined effect of upper pool dump and encroachment on local chugging loads (Reference 19.1.2), it was shown that by postulating a maximum strength chug at the central vent and an average strength chug at adjacent vents, the design loads were capable of bounding the combined effect.

In summary, the margins inherent in the design load for chugging are very large. They can more than accommodate any increment in loading caused by off-design effects such as increased submergence due to upper pool dump.

Conclusion

The staff considers this issue satisfactorily resolved for GGNS.

References

19.1.1 MP&L Letter No. AECM-82/353 dated August 19, 1982 from L. F. Dale, MP&L, to H. R. Denton (NRC).

19.1.2 CEI Letter July 11, 1984 from M. R. Edelman, CEI, to B. J. Youngblood, NRC.

Humphrey Concern 19.2

The effect of local encroachments on chugging loads needs to be addressed.

Evaluation

The licensee's response to this concern is provided in Reference 19.2.1. In this submittal, physical arguments and analytical procedures are used to estimate the pressure field that would be generated on the suppression pool boundaries if the worst case chug from the Mark III data base were to occur at vents located below the GGNS TIP platform. The results were compared with the design values on an ARS basis, and shown to be bounded except for local loads in the frequency range 12 to 30 HZ. For these conditions an exceedance of the design value amounting to 60% occurs on the basemat and about 15% on the containment wall.

The licensee argues that these exceedances are not important because this is a local load affecting only the basemat and containment wall liners and that, because of the hydrostatic head to which the liner is subjected, it will not experience a "negative pressure in the frequency of exceedance." Also, "since the liner is backed by concrete everywhere, no natural modes in this range are excitable."

The staff notes the following:

- the use of an acoustic model in the analysis represents a significant conservatism;

- dissipative mechanisms not accounted for in such an analysis would result in pressure attenuation which is much greater than predicted. (this has been borne out convincingly by experimental results);

- application of the worst case chug to all vents, which is done for local loads, also represents a very significant conservatism;

- in a recent submittal by the CEI to address the concern relating to the combined effect of upper pool dump and encroachment on local chugging loads (Reference 19.2.2), it was shown that by postulating a maximum strength chug at the central vent and an average strength chug at adjacent vents, the design loads were capable of bounding the combined effect.

In summary, the margins inherent in the design load for chugging are very large. They can more than accommodate any increment in loading caused by off-design effects such as encroachment.

Conclusion

The staff considers this issue satisfactorily resolved for GGNS.

References

19.2.1 MP&L Letter No. AECM-82/574 dated December 3, 1983 from L. F. Dale, MP&L, to H. R. Denton (NRC).

19.2.2 CEI Letter July 11, 1984 from M. R. Edelman, CEI, to B. J. Youngblood, NRC.

Humphrey Concern 20

During the latter stages of a LOCA, ECCS overflow from the primary system can cause drywell depressurization and vent backflow. The GESSAR defines vent backflow, vertical impingement, and drag loads to be applied to drywell structures, piping, and equipment, but no horizontal loading is specified.

Evaluation

The reverse weir annulus flow will be directed vertically into the drywell. The only horizontal flow possible would be deflection of the rising water off structures above the weir wall, or from the gravity-induced lateral velocity gradients in the vertically rising water. Deflection of the vertically rising water would result in a spray type of impact load, which is not expected to result in any significant loads. The lateral movement of the rising water resulting from gravity is expected to be slight and not create any significant horizontal loads.

The staff does not consider it credible that the slight horizontal loads would be bounding loads on structures inside the drywell because of all the other load constraints on these structures (such as earthquake loads, reactor vessel blowdown loads, and dead loads).

Conclusion

The staff considers this issue satisfactorily resolved.

Humphrey Concern 21

Regulatory Guide 1.7 requires a backup purge hydrogen removal capability. This backup purge for Mark III is via the drywell purge line which discharges to the shield annulus, which in turn is exhausted through the standby gas treatment system. The containment air is blown into the drywell via the drywell purge compressor to provide a positive purge. The compressors draw from the containment; however, without hydrogen-lean air makeup to the containment, no reduction in containment hydrogen concentration occurs. It is necessary to ensure that the shield annulus volume contains a hydrogen lean mixture of air to be admitted to the containment via containment vacuum breakers.

Evaluation

This issue is not applicable to Grand Gulf because the backup purge compressor takes suction from outside the containment. Also, containment vacuum breakers are not included in the Grand Gulf design.

Conclusion

The staff considers this issue resolved.

Humphrey Concern 22.0

The EPGs currently in existence have been prepared with the intent of coping with degraded core accidents. They may contain requirements conflicting with design-basis accident conditions. Someone needs to carefully review the EPGs to assure that they do not conflict with the expected course of the design basis accident.

Evaluation

The emergency procedure guidelines (EPGs) have been prepared with the intent of coping with all types of accidents, including design-basis accidents and degraded core accidents.

The process of developing the EPGs includes input from experienced personnel from all utilities that own BWR plants and representatives from GE. The staff has reviewed, and is continuing to review potential improvements in the EPGs to ensure to the maximum extent possible, that no conflicts exist between the EPGs and the licensing basis accident analysis.

Conclusion

The staff considers this issue satisfactorily resolved.

ADDITIONAL CONCERNS

Questions relating to two additional concerns were developed by BNL. Although they have evolved from and are related to Humphrey Concern 19.0, they are not recognized as Humphrey concerns. To facilitate future reference, the staff uses the identifiers BNL-1 and BNL-2, to denote these concerns.

BNL-1

The effects of increased submergence and encroachment on local loads are additive. ARS comparisons showing the combined effect should be provided.

Evaluation

A generic response was developed for this concern and included in an earlier submittal for the Perry Nuclear Power Plant (Reference B.1.1.). As indicated in the evaluation provided for Humphrey Concern 19.1 and 19.2, by postulating the very reasonable assumption that a maximum strength chug occurred only at a central vent with average strength chugs at surrounding vents, local loads were estimated at levels which were adequately bounded by design assumptions.

Conclusion

The Mark III owners have provided an adequate demonstration that the design load for chugging has sufficient margin to accommodate the increment in loading caused by the combined effects of encroachment and increased submergence. The staff considers this issue to be closed.

References

B.1.1. CEI letter No. PY-CEI/NRR-0123L dated July 11, 1984 from M. R. Edelman (CEI) to B. J. Youngblood (NRC).

BNL-2

Upper pool dump increases the length of the water column within the main steam SRVDL. This will tend to increase pipe thrust loads during SRV actuation. Provide an analysis to this effect.

Evaluation

The licensee states in Reference B.2.1 that these thrust loads have been recalculated. These revised loads are stated to be "within the upset allowable stresses."

Conclusion

The staff considers this concern to be resolved.

References

B.2.1 MP&L letter AECM-83/0146 dated March 23, 1983 from L. F. Dale (MP&L) to H. R. Denton (NRC).