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NUCLEAR PRODUCTION DEPARTMENT

May 28, 1982

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Mr. Denton:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File L-860.0/0260
Containment Design Concerns
Raised by Mr. John Humphrey
AECM-82/237

Mississippi Power & Light Company (MP&L) is providing the enclosed information to address the technical questions concerning Mark III containments raised by Mr. John Humphrey. MP&L staff met with Mr. Humphrey on May 17, 1982, to discuss and clarify his technical questions. Based on the information obtained during this meeting, MP&L formulated the list of 22 specific technical questions presented in the enclosure. Because many of the questions have been posed by Mr. Humphrey in generic terms; i.e., applicable to the General Electric STRIDE design, MP&L has provided necessary clarifications as appropriate for the Grand Gulf Nuclear Station (GGNS).

MP&L, in conjunction with cognizant engineers from Bechtel and General Electric, reviewed the identified technical questions and evaluated their significance relative to GGNS. The conclusion of this review is that all of the technical questions have been adequately addressed for the GGNS Mark III containment design and no further action is necessary. The detailed results of these evaluations are presented in the enclosure.

Based on the results of our detailed review, MP&L does not believe that any new technical issues were identified in the list of questions. The phenomena and/or system performance characteristics identified in the questions have all been previously considered in the design of the GGNS containment. It appears that the questions may have arisen as a result of selective or unrealistic combinations of analytical assumptions and boundary conditions, test data, and system performance characteristics. This approach would suggest parameters or design values without any apparent consideration of the overall level of conservatism inherent in the containment design process.

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As affirmed by the review just completed, MP&L is committed to the assurance of a completely adequate and safe design for the GGNS and will take whatever steps are appropriate to maintain that assurance.

Yours truly,

John D. Richardson for
L. F. Dale
Manager of Nuclear Services

SHH/JDR:lm
Enclosure

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Issue 1 Effects of Local Encroachments on Pool Swell Loads

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 per cent.

Response

The major encroachment in the GGNS is the TIP platform which extends 10 feet radially into the wetwell and extends 22 feet along the drywell wall. The drywell personnel airlock extends only one foot into the wetwell and this encroachment is judged to be negligible. The GGNS equipment and floor drain sumps are located on the HCU floor outside the pool swell envelope. The total encroachment area created by the TIP platform could be conservatively estimated as a 220 $ft.^2$ rectangle. This represents less than four per cent of the total pool surface area of 6666 $ft.^2$.

General Electric's first evaluation of potential effects created by local encroachments was performed using an extremely conservative one dimensional analysis. The analysis assumed that the local encroachment was actually an annular ring projecting six feet from the drywell wall and employed conservative driving pressure transients. Results from the analysis indicated that the pool velocity would be increased between 8 and 20% due to the presence of the annular ring. A two dimensional analysis was then used to reduce the excessive conservatism in the one dimensional analysis. The two dimensional analysis retained the assumption that the local encroachment was a 6 feet wide annular ring but allowed for flow recovery above the top of the encroachment. This analysis predicted only a 6 per cent increase in pool velocity.

The two dimensional analysis remains excessively conservative. When the vents below the blockage clear, the flow will be multi-dimensional with air venting around all sides of the obstruction, thus reducing its effect. The distortions of the liquid as it distributes above the obstruction creates paths to vent the air bubble, relieve the accelerating force and decrease the flow velocity of the liquid layer. The pool swell design loads include adequate margin to accommodate any uncertainties in pool swell velocity produced by the effects of local encroachments.

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

Response

The TIP platform is the only significant encroachment into the pool for GGNS as noted in the response to concern 1.1. The liquid flow past the platform upper surface will start to distort and spread back over it. In containment impact load tests, it was observed that these distorted fluid surfaces strongly attenuate impingement loads on structures at higher elevations. Thus bubble breakthrough should occur sooner than would be expected if the mitigating effect of flow distortion and spread over the structures is neglected. The presence of catwalks above the suppression pool will further breakup the liquid flow decreasing bubble breakthrough elevation. The existing analysis conservatively neglects the existence of these catwalks.

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

Response

Substantial margins exist in the submerged structure loads which have been applied to all structures in the suppression pool. These margins are discussed in Appendix 6A of the GGNS FSAR. The margins exceed the maximum additional loads which could be produced by local encroachments.

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

Response

As noted in the response to concern 1.1, substantial increases in pool swell velocity which could increase impact loads are not credible. The breakup of the pool swell as the liquid redistributes above the obstructions should mitigate the possible impact loads. Also substantial margins exist in the impact loads which have been applied to piping above the pool. MP&L committed to design for impact loads produced by pool swell velocities of 60 ft/sec. This exceeds the NRC staff requirement to design for pool swell velocities of 50 ft/sec.

1.5 Impact loads on the 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.

Response

As noted in the response to concern 1.2, substantial increases in bubble breakthrough height are not credible. The HCU floor is located 12 feet above a minimum of 3 and an average of 8 feet horizontally away from the TIP platform. The presence of the catwalks immediately above the suppression pool will break up the pool swell flow. Consequently, the application of the impact loads to either the HCU floor, or the HCU modules, is inappropriate.

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

Response

The air flow may divert horizontally but entrained water should simply stagnate rather than flow horizontally. Structural steel beams below the grating will break up any lateral flow which does occur which will prevent application of loads on gratings. Because of the geometric configuration, horizontal flows due to redistribution around the HCU floor will always be opposed by horizontal flows from adjacent areas. These opposing flows will cancel most of the horizontal momentum required to redirect the flow vertically. A very simplified analysis shows the residual lateral force on the grating support structure is much less than the dead weight of these beams which is well within their design capability.

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 ft.^{2} of opening should be maintained at each containment elevation.

Response

GGNS design provides open areas of all floors above the HCU floor greater than the open area which assures adequate venting. Flow through higher elevation floors will be predominantly air, which causes insignificant pressure drops. There is a large amount of margin between the calculated and design drywell and wetwell peak pressures.

2. Safety Relief Valve Discharge Line Sleeves

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

Response

The flow area through the SRVDL sleeve annular openings is approximately 2.5% of the area of the top row of horizontal vents. Testing completed for GE shows that the magnitude of the pool wall loads produced by condensation oscillation is proportional to the ratio of vent area to pool surface area. Consequently the loads produced by the condensation oscillation at the SRVDL sleeve annular openings will be on the order of 2.5% of the design loads for condensation oscillation and chugging through the upper row of horizontal vents. Even if the frequency of the c.o. approaches structural resonances, the magnitude of the loads generated will be within the existing design margins.

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.

Response

The GGNS design for supporting the SRVDL includes two 8" diameter pinned supports that are located between the SRVDL sleeve and the quencher transition piece. These supports and the associated piping have been designed for the most adverse combination of earthquake, accident, and relief valve actuation loads including submerged structure loads, and loads produced by building dynamic response.

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 also be at or near the natural frequency of the sleeve.

Response

The Grand Gulf SRVDL sleeve is a 14" schedule 80 pipe that has been designed for the worst credible combination of earthquake, accident and relief valve loads included submerged structure and building response loads. The sleeve is capable of withstanding internal pressure loads in excess of 1000 psi. SRVDL condensation oscillation or chugging loads which could occur over a very small net area of the sleeve, whereas the horizontal vent condensation oscillation or chugging loads, which are substantially larger in amplitude, will affect the full length of the sleeve. Even if these SRVDL loads were at the natural frequency of the SRVDL sleeve, these loads are insignificant when compared to the other loads on the sleeve.

3. ECCS Relief Valve Discharge Lines Below the Suppression Pool Level

3.1 The design of the STRIDE plant did not consider vent clearing, condensation oscillation and chugging loads which might be produced by the actuation of these relief valves.

Response

The RHR would never be in a steam condensing mode during an accident situation. The only situation in which this mode would operate is during a controlled isolation. In this situation, the boundary pressures from other loads do not exist as they would during a SRV actuation. These relief valves are provided only to comply with the requirements for over pressure protection from Section III of the ASME code. It should be emphasized that the RHR heat exchanger pressure relief valve will only be actuated in the highly improbable event that the RHR pressure control valve fails and causes a high pressure condition in the heat exchanger shell.

In the GGNS design, the RHR heat exchanger is equipped with a 6" by 8" valve which activates when pressure exceeds 500 psia and discharges into a 10"-diameter line. The maximum steam flow is substantially less than the maximum main steam SRV flow rate. Since the line air volume is much less than the SRVDL air volume, the RHR bubble pressure will be much less than the SRV bubble pressure.

Additionally, in the GGNS plant, the exhaust is 13'10" above the pool bottom for the RHR relief line as compared with 5 feet for the SRV line. This will provide much more attenuation for the RHR bubble loads and this bubble will reach the surface much quicker. Therefore, the SRV steam condensation loads are bounding because of the large RHR attenuation.

The fact that the pool will be cool during this event (coupled with the low mass flowrate) precludes the potential for unstable oscillations.

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

Response

The GGNS design maintains a minimum submergence of 8 inches above the RHR relief valve discharge lines. The RHR system will not operate in the steam condensing mode when the suppression pool has been drawn down to the minimum level following an accident.

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

Response

The only essential equipment located near the discharge from the RHR relief valves is the RHR suction strainer which is approximately 10 feet below and three feet laterally beyond the discharge. These strainers are currently designed to withstand earthquake, second SRV actuation, condensation oscillation, chugging, and structural oscillation loads. Even if some portion of the strainer fails, redundant equipment trains are available to fulfill the requisite safety function. As noted in response to concern 3.1, the RHR system will not be in the steam condensing mode where relief valve actuations may occur under accident conditions. Therefore, this is not a safety 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.

Response

Rapid, sequential actuation of the RHR heat exchanger relief valves is a highly unlikely occurrence. Actuation of the relief valve can only occur if the pressure controller upstream of the heat exchanger fails, and the plant operators do not isolate the heat exchanger. The nature of this transient is such that the relief valve would lift and remain open until the operator isolates the heat exchanger or until the reactor pressure vessel is depressurized 10 per cent below the set point of the relief valve. As noted in the response to concern 3.3, the only essential equipment located so as to be affected from impact loads produced by discharges from these relief valves is the RHR strainer which is not required following actuation of the relief valve.

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 five feet creating higher back pressures on the relief valves.

Response

The design of the RHR heat exchanger relief valves is sufficient to account for the increased back pressure produced by upper pool dump.

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.

Response

As noted in the response to concern number 3.1, the RHR heat exchangers will not operate in the steam condensing mode under accident conditions. Therefore, the relief valves will not discharge steam to the upper levels of the pool under accident conditions.

4. Suppression Pool Temperature Stratification

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 pool is thoroughly mixed with the suppression pool. If the inventory in 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.

Response

Bounding analyses taking no credit for the drywell holdup water show a maximum effect on peak suppression pool temperature of 6°F. Many modeling conservatisms -- for example, assuming excess decay heat, and taking zero credit for containment structural heat sinks -- more than offset effects arising from entrapped drywell holdup volume. Accordingly, this item is not an open design issue.

4.2 The existence of the drywell pool is predicated upon continuous operation of the ECCS. The current emergency procedure guidelines require the operators to throttle ECCS operation to maintain vessel level below level 8. Consequently, the drywell pool may never be formed.

Response

Operator intervention to maintain vessel level below level 8 will serve to further mitigate concern 4.1. As a result, this issue is not a safety concern with respect to suppression pool temperature analysis.

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 7½°F cooler than the bulk pool temperature. Thus, the heat transfer through the RHR heat exchanger will be less than expected.

Response

Heat exchangers are sized with a 10°F margin (i.e., sized to limit peak pool temperature to 185 - 10 = 175°F) to allow explicitly for thermal stratification. In addition analyses utilize conservative assumptions, including initial maximum pool and service water temperatures, minimum RHR flow rates, conservative heat exchanger heat transfer coefficients, conservative decay heat curves, and take no credit for heat conduction out of the containment.

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.

Response

Standard containment analyses are performed with the simplifying assumption that the entire containment air space temperature is equal to the bulk suppression pool temperature. This assumption ignores stratification in both the suppression pool and the containment air space. If suppression pool stratification occurs, then the wetwell air space adjacent to the pool surface will be heated above the average containment temperature. These stratification effects are expected to be less than 10°F. A realistic model of heat and mass transfer between the suppression pool and the containment air space shows that the air space will be between 50° and 60°F cooler than the suppression pool at the time when pool temperature reaches its peak value. Numerous modeling conservatisms exist which more than compensate for stratification effects. These conservatisms include overstating the total energy input to the containment, ignoring effects of containment structural heat sinks which have a total heat capacity on the same order of magnitude as the entire suppression pool, and assuming a lower heat exchanger capability than actually exists. It is unrealistic to complicate the containment engineering analyses with second order effects such as stratification which are completely overshadowed by identified conservatisms in the analysis.

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.

Response

Considerable mixing will occur due to chugging in the drywell vents which are distributed around the entire drywell periphery. This mixing will involve the entire pool above the vents. SRV discharge near the pool basemat as the reactor is depressurized would also provide mixing and substantial heating of the lower pool regions. The effects of overhanging structures (partially submerged), SRV quenchers and piping, and any other submerged structures promote mixing of the pool circulation from RHR return flow. The operation of the drywell purge compressor will also produce considerable mixing in the pool by bubbling steam and non-condensibles at all the drywell vents. The time during which containment spray will be operated will be minimized to decrease any temperature stratification produced as a result of operation of the containment sprays.

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 GGNS 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 temperature at or below the maximum permissible value.

Response

This is a plant availability concern and not a safety concern. The maximum service water temperature is based upon a very conservative analysis of the site meteorology and heat transfer from the ultimate heat sink under worst case, bounding conditions. The peak service water temperature is extremely conservative and should not be reached during the life of the plant.

4.6 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.

Response

The RHR suppression pool suction and discharge are separated by 60 feet in the GGNS design. The discharge nozzle directs flow away from the RHR suction. No interaction between the suction and discharge will occur.

4.7 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.

Response

Operating procedures normally state that the RHR pool cooling should be operated when pool temperatures are elevated. Thus, once pressure reduction due to spray is achieved, the system would be returned to the suppression pool cooling mode.

Considerable margins exist in the RHR heat exchanger design. These margins include sizing to limit the pool temperature to 10°F below pool design basis temperature using maximum service water temperature and initial pool temperature. The sizing is also based upon minimum RHR system flow rates and a conservative fouling factor.

5. Drywell to Containment Bypass Leakage

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.

Response

Sensitivity studies of break size have been performed on GESSAR which show the drywell to containment pressure differential is about constant for a large range of break sizes, due to clearing of the horizontal vents. This differential coupled with the fact that containment spray will initiate after 13 minutes results in both SBA and IBA, yielding essentially the same leakage capability.

These containment analyses do not take credit for containment structural heat transfer which constitute a substantial heat sink and makes the $A/\sqrt{K}$ specification very conservative.

5.2 Under Technical Specification limits, bypass leakage corresponding to $A/\sqrt{K} = 0.1$ ft.^{2} constitute 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.

Response

The existing containment cooling systems will control containment pressure and temperature during early increases. If the containment pressure reaches 9 psig, the containment sprays automatically initiate. The operator can manually initiate containment sprays if the containment temperature rises faster than the containment pressure. Finally, the operator can initiate rapid reactor depressurization if containment temperatures and pressures continue to rise.

5.3 Leakage from the drywell to containment will increase the temperature and pressure in the containment. The operators will have to use the containments 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.

Response

This is not a safety concern. Detailed procedures have been developed for placing the RHR system in the containment spray mode, securing containment spray and placing the RHR system in the suppression pool cooling mode. Cycling between system modes, if required, will not adversely effect system performance.

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 which exceeds the concentration limit of 4% by volume.

Response

Any hydrogen which is released directly to the containment from the drywell will still be below elevation 184'6" which is 24 feet below the suction of the recombiners which are located on the operating floor deck at elevation 208' in the containment. Thus potential bypass leakage is bounded by the existing design. Drywell leak tests at 3 psig indicate a total leakage of 600 SCFM. This is well below the purge rate for the two compressors of 2360 SCFM.

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.

Response

The size of the containment volume will mitigate any potential local effects due to bypass leakage. Also the leakage is expected to be widely dispersed from a number of small sources as shown by the initial high and low pressure drywell leakage tests. Periodic inspections and tests to be conducted at a minimum of once every 18 months would identify any major sources of leakage.

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 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.

Response

The 3 psig test pressure which was selected represents the maximum pressure which can exist in the drywell prior to uncovering the vents under normal operating conditions. The recently completed drywell structural integrated leak test show leakages of 600 cfm at 3 psid and 3200 cfm at 30 psid, which were both substantially below allowable leakages. The pressurization which might be produced will be significant only until the horizontal vents, are uncovered at which point pressure will remain constant.

5.7 After upper pool dump, the level of the pool will be 6 feet higher, and drywell-to-containment differential pressure will be greater than 3 psi. The drywell H_2 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, H_2 mixing would not be achieved.

Response

The suppression level will be only two feet above the top of the horizontal vent at the time when the compressor will be actuated. The GGNS purge compressors operate at a nominal discharge head of 10 psid. This issue is not applicable to GGNS.

6. RHR Permissive on Containment Spray

6.1 General Electric had recommended that the drywell purge compressors and the hydrogen recombiners be activated if the reactor vessel water level drops to within one foot of the top of active fuel. This requirement was not incorporated in the emergency procedure guidelines.

Response

The emergency procedures for GGNS require the operator to energize the combustible gas control system if the reactor vessel level drops below the top of active fuel and cannot be restored. This will be sufficient to assure adequate control of any hydrogen produced as a result of the accident.

6.2 General Electric 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 inability to operate the recombiners without containment spray.

Response

No interlocks with containment spray were included in the recombiner actuation scheme for GGNS.

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

Response

The thermal plume from the recombiners will be well mixed with the upper containment atmosphere. There should be no localized effects.

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

Response

The GGNS hydrogen analyzers are not supplied by GE and measure thermal conductivity of samples at an elevated temperature of 275°F. This exceeds the saturation temperature of the environment around the analyzers which precludes measurement failure due to condensation.

7. Containment Pressure Response

7.1 The containment is assumed to be in thermal equilibrium with a perfectly mixed, uniform temperature suppression pool. As noted under topic 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.

Response

The response to this item was thoroughly addressed under concern 4.4.

7.2 The computer code used by General Electric 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 qualification. Additionally, the bulk suppression pool temperature was used in the analysis instead of the suppression pool surface temperature.

Response

The Grand Gulf environmental qualification limits were defined using bounding pressure/temperature FSAR histories developed from methods which conform to NUREG 0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment." The computer code referred to was used only to assess the margins inherent in the bounding analysis. The assessment of margin in these curves was performed using realistic heat and mass transfer co-efficients between the suppression pool and containment air space. These coefficients were obtained from standard heat transfer texts. Realistic values are appropriate to obtain margin. Even if more conservative coefficients were used, the results would simply fractionally decrease the margins presently identified. Use of the bulk suppression pool temperature instead of the surface temperature has at most a minimal effect on the over all margins identified.

7.3 The analysis assumes that the containment airspace is in thermal equilibrium with the suppression pool. In the short term this is non-conservative for Mark III due to adiabatic compression effects and finite time required for heat and mass to be transferred between the pool and containment volumes.

Response

The Mark III containment pressure is limited by long-term pool heatup, where the assumption of temperature equilibrium is very conservative. The effect of non-equilibrium on short-term pressures in the containment has been evaluated, and for design basis accident class breaks non-equilibrium effects increase the containment pressure by about ½ psi (about 10%) for the interval between 2 and 20 seconds into the transient. These secondary effects are easily overcome by other identified conservatisms in the method. The design is limited by long-term response where the thermal equilibrium assumption is conservative.

8. Containment Air Mass Effects

8.1 This issue is based on consideration that some Tech Specs 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) a temperature near maximum operating (90°F) and do not limit the drywell pressure equal to the containment pressure. The Tech Specs 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 response different than the FSAR descriptions.

Response

The analytical models are extremely conservative. For example, heat sinks and losses into major structures would decrease the calculated results shown in the GGNS FSAR. The significant parameters such as max. pressures and temperature predicted conservatively are all well below actual design values. Typically, pressure margins of 30-40% above peak predicted values are included; therefore, nominal values present no safety consequences.

8.2 The draft GGNS technical specifications permit operation of the plant with containment pressure 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.

Response

An accident which would require initiation of containment sprays would pressurize the containment well above 0 psig. It will not be possible to operate the plant at a containment pressure of less than approximately 2 inches of water due to operation of the continuous purge. The maximum negative pressure which can be produced by operation of the containment sprays in an accident condition occurs after a reactor water cleanup system pipe break in the containment. The containment analysis shows that the peak negative pressure is approximately -.7 psig. Even assuming that this negative pressure is produced when the plant is operating at -2 psig which is an excessively conservative assumption, the total negative pressure is still within the GGNS design negative pressure of -3 psig. Inadvertent operation of the containment sprays at elevated temperature, low relative humidity conditions which could produce significant containment negative pressure transients is not credible.

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.

Response

As noted in the response to concern 8.2, the containment will not be maintained at a -2 psig due to the operation of the containment purge. However, even if the purge was isolated and a -2 psig containment pressure condition could exist, the operator would be alerted to the fact that he has a serious condition such as an SBA by a series of alarms such as:

high drywell temperature
high suppression pool level
high suppression pool temperature (95°F)
drywell cooler leak detection
drywell floor drain sump leak detection

9. Final Drywell Air Mass

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 EPG's direct the operator to throttle ECCS operation to maintain reactor vessel level at about level 8. Thus, 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 pressures will result in both the containment and the drywell.

Response

The calculated drywell pressure due to the most severe accident is 21.8 psig and the Mark III drywell is designed to a pressure of 30 psig. This bounds the drywell pressures that can be calculated assuming any ECCS water spillover condition. DBA calculations of containment airspace pressure, assuming no spillover, yield the same endpoint pressures as SBA. The drywell and containment airspace pressures and temperatures are thus bounded by the envelope of DBA and SBA responses, irrespective of DBA ECCS water spillover.

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 pressures.

Response

The containment spray will be adequate to control any pressure increase associated with extended direct leakages from the drywell to the containment.

10. Drywell Flooding Caused by Upper Pool Dump

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

Response

A weir overflow evaluation was performed for the following conditions:

1. Maximum suppression pool level of 111'-10"
2. Maximum upper pool level of 208'-1" (which is 3" above the weirs)
3. Tech Spec drywell negative pressure of -0.1 psid

The maximum amount of overflow into the lower area of the drywell is 1680 ft.^{3} This analysis includes the effect of the TIP station volume. The result is an accumulation of water less than 6" deep which will not come into contact with piping containing hot reactor coolant.

Any water which spills over the drywell wall will do so very gradually. The water will flow over the edge of the wall down the wall and accumulate in low points in the drywell.

It is not credible that water flowing into the drywell will strike hot essential equipment.

In the highly unlikely event that cool suppression pool water did strike high temperature reactor coolant pressure boundary piping, the resulting thermal stresses do not require evaluation. The stresses produced by the event are in a category (secondary & peak) that do not require evaluation except for normal and upset conditions. These peak stresses produced by the thermal shock are important only for fatigue, and fatigue usage for a few rare events is not required by the Code or by NRC rules.

If it were necessary to consider the fatigue usage due to this thermal shock, calculations show based on worst case conditions that significant fatigue usage would not result unless there were several hundred such cycles.

Under a worst case condition the potential damage to the piping could be slight distortion at the weld joints. The worst case condition is defined as the insulation being removed and a 450° temperature difference between the outside and inside of the recirculation pipe. In the event that suppression pool water immersed part of the recirculation piping, at the next shutdown the insulation of the piping be removed and the weld joints connecting the recirculation piping to the recirculation pump would be visually examined for deformation.

11. Operational Control of Drywell to Containment Differential Pressures

Mark III load definitions are based upon the levels in the suppression pool and the drywell weir annulus being the same. The GGNS technical specifications permit elevation differences between these pools. This may effect load definition for vent clearing.

Response

If the water level in the weir annulus is lower than the suppression pool, then the horizontal vents will clear sooner resulting in lower drywell pressures. The resultant increased level in the SRVDL in the suppression pool will have less than 0.1 psi effect on the pool boundary pressures and a small effect on peak internal SRVDL pressures.

If the water level in the weir annulus is higher than the suppression pool, the horizontal vents will take longer to clear during a DBA. However, there is significant margin between design pressure and the predicted peak drywell pressure to accommodate the pressure increase due to longer vent clearing time. In addition, peak pool swell velocity is relatively insensitive to driving pressure.

12. Suppression Pool Makeup LOCA Seal In

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

Response

This concern is not applicable to the GGNS plant. Once the timer for suppression pool dump has been initiated, only operator intervention can prevent upper pool dump.

13. Ninety Second Spray Delay

    The "B" loop of the containment sprays includes a 90 second timer to prevent simultaneous initiation of the redundant containment sprays. Because of instrument 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.

Response

The GGNS FSAR Section 6.2.1.1.4.2 contains an evaluation of a simultaneous actuation of both trains of containment spray following a line break (RWCU) in the containment. RWCU line break was selected as a bounding containment negative pressure case based on minimizing the initial containment air mass resulting from a credible accident. The low pressure calculated as a result of containment spray actuation was -0.7 psig, well within the -3.0 psig design pressure.

14. RHR Backflow Through Containment Spray

    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 spray.

Response

The RHR control logic does not specifically preclude the valve conditions postulated in this contention. However, the BWR/6 RHR design is considered fully acceptable because the sequence of events required to establish a reverse flow from the reactor to containment spray headers has an extremely low probability of occurrence on the order of 10^{-5}. Furthermore, the postulated sequence does not fall within the widely accepted interpretation of the number of equipment failures and operator errors that must be considered in the design of a nuclear power plant. For example, reverse flow of reactor vessel water in the approximately 20-second window when both containment spray and LPCI injection valves are simultaneously open requires the following:

A loss of coolant accident to initiate the LPCI system,

A failure of the drywell structure such that steam bypass yields containment pressures greater than 9 psig at a time when reactor pressure is still significant,

A failure of the LPCI injection line check valve that allows reverse flow.

Similarly, if it is postulated that at some time after an accident has occurred, plant operators elect to initiate containment sprays, reverse flow of reactor water to the spray headers requires the following:

A loss of coolant accident that permits spray actuation,

An operator error involving opening the containment spray valve before the LPCI injection valve is closed,

Failure of the LPCI injection line check valve.

For both automatic and manual realignment of the system, the above sets of failures and/or operator errors are not within the plant design bases.

15. Secondary Containment Vacuum Breaker Plenum Response

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.

Response

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

16. Effect of Suppression Pool Level on Temperature Measurement

Some of the suppression pool temperature sensors are located (by GE recommendation) 3" to 12" 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 required safety action could be delayed.

Response

The temperature sensors which are located 3" to 12" below the pool surface are used for monitoring operational transients such as SRV actuation. Numerous temperature sensors are located at approximately elevation 106' 6" to 107' 3" which is below the temperature sensors discussed above. The operator will have sufficient information regarding pool level available to him to resolve discrepancies between suppression pool temperature reading.

17. Emergency Procedure Guidelines

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.

Response

This is not a safety concern since vessel depressurization does not adversely effect any assumptions made with respect to containment response. The effect of increased suppression pool water level (up to approximately 5 feet) due to inadvertent dump could be up to 0.1 psi increase in the pool boundary loads and submerged structure loads. This assessment is based upon the use of the SRV load definition methodology contained in Appendix 6D of the FSAR (GESSAR II, Appendix 3B).

The effect of increased suppression pool water level could be up to a 5% increase in the maximum operating pressure in the discharge piping. The pressure stress is not one of the controlling loads for the piping design; dynamic valve discharge forced loads, and structural response loads are the controlling loads. A 5% increase in pressure is, therefore, inconsequential.

18. Effects of Insulation Debris

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.

Response

There are no gratings over the weir annulus at GGNS.

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.

Response

The metallic insulation used for the primary coolant system piping has a heavy outer stainless steel casing and rigid, thin inner stainless steel spacers. This insulation was used in lieu of calcium silicate or similar insulation in response to NRC concerns about potential clogging of the ECCS strainers in the suppression pool.

The concern raised assumed that a number of panels of the metallic insulation rupture catastrophically and the spacers become debris. The outer casing completely encloses the spacers and the spacers are spot welded to the casing. The physical constcuctruction of the assembly is such that the assembly is quite strong.

To achieve substantial blockage of the ECCS suction strainers, it must be assumed that a number of panels totally fail and that the spacers are evenly distributed around the drywell. In addition, it must be assumed that the spacers would all enter the weir annulus and be transported thru the horizontal vents into the suppression pool. The spacers must then be carried across the suppression pool and must wrap around the ECCS strainer, clogging it. It is excessively conservative and not reasonable to assume that all of these factors would occur during an accident.

Please note that each strainer can become 50% clogged and still perform its design function. Furthermore, the approach velocity of the water in the vicinity of the strainer is substantially less than 3.2 ft/sec. These design factor further reduce the potential for debris to adversely affect ECCS system performance.

19. Submergence Effects on Chugging Loads

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 effect chugging loads.

Response

In addition, chugging design loads conservatively bound all test data from the Mark III Test Program. Although submergence effects on chugging loads were not identified in the Mark III Program, the Mark II testing showed that vertical vent chugging decreased about 10% when submergence was decreased from 11 feet to 9. No effect was observed for deeper submergence.

This possible small parametric trend has been ignored because the effects of other parameters such as vent mass flux are stronger and in the opposite direction. Specifically, at the time of upper pool dump when submergence could be high, the vent mass flux will be well below the chugging threshhold and the net effect of these two parameters will be a reduced load.

20. Loads on Structures Piping and Equipment in the Drywell During Reflood

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.

Response

A bounding analysis which was performed by GE concluded that the largest horizontal loads which could be imposed on a structure above the weir would be no greater than the buoyant force that would occur, if the structure were submerged. A load of this magnitude is judged to be of no consequence for all significant structures.

21. Containment Makeup Air For Backup Purge

Regulation Guide 1.7 requires a backup purge H_2 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 (SGTS). 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 assure that the shield annulus volume contains a hydrogen lean mixture of air to be admitted to the containment via containment vacuum breakers.

Response

The concern is not applicable to the GGNS design because the backup purge compressor takes suction from outside the containment and pressurizes the containment slightly. The containment atmosphere is bled-off through a ventilation system directly to the environment.

22. Miscellaneous Emergency Procedure Guideline Concerns

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 EPG's to assure that they do not conflict with the expected course of the design basis accident.

Response

The Emergency Procedure Guidelines (EPG's) were not developed to deal exclusively with "degraded core accidents", but rather to deal both with emergencies and events which may deteriorate into emergencies. The guidelines specify actions appropriate for both, based on the symptoms present during an actual event. The spectrum of events considered in developing the guidelines ranges from simple anticipated occurrences, postulated accidents less severe than the design basis, postulated design basis accidents, and postulated accidents more severe than the design basis. The guidelines have been carefully reviewed by General Electric, the BWR Owners Group, and the NRC, to insure that they do not contain requirements conflicting with design basis accident requirements. It is clear, however, that no actual event at a plant will be identified to be the event postulated as a design basis for automatic safety systems. Thus at various points within the guidelines, operator actions are specified to be taken sooner, later, or in other ways than automatic systems would operate, according to what is best under the particular conditions at the plant. If such operator actions are not taken, the automatic safety systems will function as designed. Therefore the EPG's can be thought of as a supplement to the design basis of the plant, rather than as alternative requirements which may conflict with the design basis.