GULF STATES UTILITIES COMPANY

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U.S. Nuclear Regulatory Commission
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Gentlemen:

River Bend Station - Unit 1
Docket No. 50-458

Please find enclosed Gulf States Utilities Company's response to the NRC Station Blackout Safety Evaluation Report (SER) for River Bend Station dated January 16, 1992. This response specifically addresses the five recommendations described as requiring additional information. Additionally this response addresses several instances where GSU disagrees with the recommendations provided in the SER. Detailed justification is provided to support GSU's position for those instances. GSU requests the NRC reconsider those SER recommendations based on the justifications provided herein.

If you have any questions or desire further information, please contact Mr. L.L. Dietrich of my staff at (504) 381-4866.

Sincerely,

WEngland

for W.H. Odell
Manager - Oversight
River Bend Nuclear Group

MFS/LAE/JSM/JLB/JCM/kvm

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RIVER BEND STATION, UNIT 1
RESPONSE TO STATION BLACKOUT
SAFETY EVALUATION (TAC NO. M68593)

River Bend Station (RBS) personnel have reviewed the Safety Evaluation Report (SER) concerning our Station Blackout (SBO) Rule submittal. The supporting Technical Evaluation Report (TER) has also been reviewed. The following responses are submitted to the five SER recommendations for which additional information was required.

2.1 Station Blackout Duration

SER Recommendation: "...the licensee needs to change the EDG reliability target from 0.95 to 0.975 in order to remain a 4-hour SBO coping duration plant. The EDG target reliability change should be included in the documentation supporting the SBO submittals that is to be maintained by the licensee. Alternatively the licensee needs to change the coping duration to 8 hours and reevaluate the plant for an 8-hour coping duration."

RBS Response: River Bend does not concur with this recommendation. Our analyses indicate that a 4-hour coping duration with 0.95 as the emergency diesel generator (EDG) reliability target is appropriate for River Bend. RBS analyses met the guidance provided in NUMARC 87-00 (Ref. 1) for offsite power design, emergency AC power configuration, and EDG reliability.

The major factor driving this recommendation is the extremely severe weather (ESW) analysis performed by NRC's contractor (SAIC). To determine ESW wind recurrence probabilities, the contractor extrapolated 125 mph wind speeds using USAR data for wind speeds of 90 mph and below. The contractor then compared the result to NUMARC 87-00 data Table 3-2 which is not the most accurate data for the River Bend site. The contractor concluded in the TER that River Bend was an ESW Group 4 site, which results in a "P2" AC power design characteristic. The "P2" classification would require 0.975 as the EDG reliability target for RBS to be considered a 4-hour coping duration plant.

It is our contention that this ESW analysis method is inappropriate, as is the comparison to NUMARC 87-00 Table 3-2. Attachment 1 to this submittal provides a detailed evaluation of the ESW analyses performed for the TER and for River Bend's SBO submittal. From this evaluation, River Bend concludes that:

1) our application of extreme wind climatology is correct,

2) our use of RBS site-specific data is consistent with NUMARC 87-00 and Reg. Guide 1.155,

and

3) RBS should be classified as an ESW Group 1 site with a resulting AC power design characteristic of "P1".

Based on these conclusions, our original submittal was correct in stating that RBS is a 4-hour coping plant with and EDG reliability target of 0.95.

2.2 Station Blackout Coping Capability

SER Recommendation: "The licensee needs to conform to the 4-hour coping duration by increasing the EDG reliability target from 0.95 to 0.975. Otherwise, the licensee needs to reevaluate the plant for an 8-hour coping duration and the supporting analyses should be submitted for NRC review."

RBS Response: For the reasons provided in Response 2.1 above, River Bend does not concur with this recommendation.

2.2.2 Class 1E Battery Capacity

SER Recommendation: "The licensee needs to ensure that RCIC loads are consistent with or bound the expected load profile during an SBO event since any change in RCIC operation will directly impact the loading calculations and alter the battery capacity adequacy."

RBS Response: The pertinent battery capacity calculation (Ref. 3) assumed that:

1) RCIC initiates and sequences automatically in the first minute due to a low reacto: water level (Level 2). This is consistent with the RCIC system design (Ref. 4).

2) RCIC is aligned for full flow testing when the SBO occurs, so the DC motor-operated valves (MOVs) must close when the initiation signal is received. This provides a conservative load profile for the batteries.

3) RCIC is secured after AC power is restored. This is consistent with several cautions in Abnormal Operating Procedure (AOP)-0050, "Station Blackout", which warn operators to maintain RCIC in operation throughout the SBO (Ref. 4).

On the basis of this review, River Bend personnel have determined that the RCIC loads used in the Class 1E battery capacity calculations are consistent with RCIC system operation following a SBO.

2.2.4 Effects of Loss of Ventilation

SER Recommendations: "The licensee should: (1) provide additional information and/or technical justification for the initial conditions and assumptions used in the heat-up analysis for each area of concern, (2) provide detailed information to address the staff's concerns as discussed in the above evaluation with regard to the computer code, and (3) re-perform the heat-up analysis for each area of concern taking into account the non-conservatisms as identified in the SAIC TER."

RBS Response: Each of these items has been reviewed for this response. Attachment 2 evaluates these recommendations in detail. In summary, RBS used reasonable assumptions and initial conditions for the heat-up calculations which support our SBO analysis. The computer codes used in the heat-up calculations are appropriate for these purposes and have been accepted for use by NRC in other nuclear safety-related applications. The THREED and CONSBA programs are documented in the River Bend USAR. RBS personnel found no appreciable impact to calculation results when sensitivity cases were run to test the potential non-conservatisms discussed in the SAIC TER.

2.4 Proposed Modification

SER Recommendation: "The licensee needs to clarify whether the removal of control room ceiling tiles will be a permanent modification or an operator action covered by an appropriate SBO procedure."

RBS Response. RBS Operations Department has been advised (Ref. 5) of the need to incorporate this operator action into Abnormal Operating Procedure (AOP-)0050.

The data provided in Table 3-2 is to be used only if site data is not available or if the user does not desire to further refine the data. NUMARC 87-00 states that the data provided in Table 3-2 is from site-specific NOAA (National Oceanic and Atmospheric Administration) data. However, no specific reference is provided and GSU has been unable to obtain any such reference from NUMARC's investigator (Devonrue). Thus, GSU has been unable to establish the validity of this data. For this reason, River Bend decided to perform a site-specific ESW determination (Ref. 8), as allowed in NUMARC 87-00.

GSU Analysis of ESW

The GSU transmission system is designed to remain in service for winds of up to 90 mph and to sustain winds up to 110 mph without mechanical failure (Ref. 9). However, the extremely severe weather (ESW) estimate is concerned with wind speeds greater than or equal to 125 mph.

NUMARC 87-00, Section 3.2.1, Part 1.B states:

"USE METHOD "A" OR "B" BELOW TO DETERMINE THE ESTIMATED FREQUENCY OF LOSS OF OFF-SITE POWER DUE TO EXTREMELY SEVERE WEATHER AT THE SITE AND SELECT AN ESW GROUP:

"A. Site-specific data provides the most accurate source for calculating the annual frequency of storms with wind velocities greater that or equal to 125 mph, and can be used in calculating the estimated frequency of loss of off-site power due to extremely severe weather."

and

"B. If site data is not readily available to perform this calculation, the annual estimated frequency of loss of off-site power due to extremely severe weather may be derived from data recorded at local weather stations. Alternatively, a loss of off-site power frequency estimate for extremely severe weather may be based on data obtained from the National Oceanic and Atmospheric Administration (NOAA). Site-specific data is summarized in Table 3-2 along with the appropriate ESW Group."

NUMARC 87-00 and NRC Reg Guide 1.155 "Station Blackout," provide identical tables for translating the annual frequency of wind speeds in excess of 125 mph into ESW Groups. Reg Guide 1.155 (Ref. 2) does not provide plant-specific data on wind speed frequency, but notes that "The annual expectation of storms may be obtained from National Weather Service data from the weather station nearest to the plant or by interpolation, if appropriate, between nearby weather stations"

Rather than utilize Table 3-2, Gulf States Utilities based its evaluation on other plant-specific data. The expected frequency of loss of off-site power due to ESW was evaluated in GSU calculation G13.18.12.4*05 "SBO - Extremely Severe Weather" (Ref. 8). First, this calculation used NUREG/CR-2639 data for the New Orleans Weather Bureau Office, without correcting the data for the reduction of wind speed due to friction over land from New Orleans to the River Bend site (approximately 90 miles). This uncorrected data indicated that the annual expectation of storms at the River Bend site with winds in excess of 125 mph is 6.8×10^{-4}.

Adjustment of the New Orleans data for the reduction of wind speed due to friction over the land yields data which more closely represents the expected winds at the River Bend site. This correction results in a reduction in the annual expectation of 125 mph winds at the site to 4.866×10^{-5} (Ref. 8). This result compares favorably with an independent meteorological analysis of the NUREG data which also adjusted the New Orleans data to the River Bend site. That independent study calculated an annual expectation of 125 mph winds at River Bend as 6.5×10^{-5}. These site specific results are less than the minimum ESW Group criteria provided in NUMARC 87-00 (3.3×10^{-4}), therefore River Bend was classified as an ESW Group 1 site. Combined with a SW Group 1 classification, this results in an AC power design characteristic of "P1" for the plant.

EXTREMELY SEVERE WEATHER (ESW) EVALUATION

One of the key issues concerning station blackouts is the probability of losing offsite power due to extremely severe weather events (winds in excess of 125 mph). Winds of this magnitude would only be associated with great hurricanes or tornadoes. Since hurricanes of this size would effect a large area, the probability of having a significant grid disturbance is greater. Obviously tornadoes can also produce winds of this magnitude; however, due to their lesser extent there is a much lower probability of a total grid disturbance due to a tornado. Therefore, the evaluation of extremely severe weather is focused on the probability of hurricanes with winds above 125 mph. Investigation of the NRC Staff methodology and data support this assumption. The probability of tornadoes is included in the evaluation of severe weather along with all other storms which have winds less than 125 mph.

TER Analysis of ESW

In the Technical Evaluation Report (TER), SAIC stated:

"The licensee's estimate of the frequency of ESW conditions differs substantially from the NUMARC 87-00 estimation. In NUMARC 87-00 the site is classified an ESW group "4", while the licensee considers the site to be in ESW group "1". The licensee has provided an analysis of its ESW frequency calculation(14) in response to a request for information. However the licensee's calculations are not consistent with the ESW frequency results obtained when using information contained in the plant USAR (15). The site is located 70 miles inland and therefore considered to be a hurricane exposed plant. According to the USAR, Section 2.3.2, the site is expected to see a fastest-mile wind speed of 100 mph with a return period of 100 years. The USAR also gives a return period of 2, 10, 25 and 50 years for fastest-mile wind speeds of 50, 65, 70, and 90 mph respectively. We plotted the fastest-mile wind speed against return period and fit a curve through the data points. Our results show that a wind speed of 125 mph, or greater, will occur at the site with a return period of 150 years, or a frequency of 0.0065 per year. This estimate is almost identical to the estimated frequency given in NUMARC 87-00, Table 3.2, both of which place the site in ESW group "4" ".

The NRC's contractor (SAIC) estimated the frequency of wind speed of 125 mph using an extrapolation of the NUMARC 87-00 data. GSU believes:

1) that a simple data extrapolation is not an accurate method of calculating ESW and

2) that NUMARC 87-00 Table 3.2 is not the best data available for the River Bend site.

Selection of ESW Analysis Method

Devonrue, Ltd. was a principal investigator for NUMARC 87-00. GSU retained Devonrue to provide an independent assessment of our SBO analysis. Devonrue has also reviewed the TER prepared by SAIC. With regard to SAIC's ESW calculation, Devonrue determined that SAIC's method was "based on inappropriate or insufficient data to accurately estimate the return period of 125 mph winds" (Ref. 6). SAIC used 50-year (or less) data to estimate the frequency of tropical storms with winds of 125 mph. This type of rough extrapolation of data associated with lower speed winds can lead to much higher estimated frequencies than what is actually expected.

Maximum windspeed data for return periods shorter than 50 years is typically dominated by winds not associated with tropical storms, while 125 mph winds would be due almost exclusively to such storms (Ref. 7, p.108). In effect, the USAR data used by SAIC is not entirely indicative of ESW conditions, and use of solely this data to predict the frequency of 125 mph winds will significantly overestimate the expected frequency. Therefore, GSU conducted a more detailed meterological analysis using site-specific data as recommended by NUMARC 87-00.

NUMARC 87-00 Table 3-2 Evaluation

The NRC staff provided NUMARC with data which was included in NUMARC 87-00, Table 3-2 giving the annual expectation of wind speeds above 125 mph. NUMARC has not verified the accuracy of this data since the use of site-specific data is recommended (Ref. 1).

Validity of River Bend's ESW Analysis

To establish the validity of the ESW methodology used by GSU, two independent reviews of our calculation were performed. First, a certified meteorological consultant reviewed NUREG/CR-2639 data and applied accepted wind speed adjustments to the data to make it River Bend site specific. The results of this independent analysis agreed with GSU's ESW Group 1 determination (Ref. 8).

Next, Devonrue reviewed our calculation (Ref. 6) and found that the River Bend analysis "is based on accepted statistical treatment of extensive data that includes high winds due to tropical storms and other causes, each considered separately. For these reasons, we (Devonrue) agree with the GSU determination that River Bend is in ESW Group 1".

Conclusions

From the above information, GSU concludes:

1) SAIC's extrapolation of USAR data is an inappropriate way of determining the site's ESW category.

2) NUMARC 87-00 Table 3-2 does not provide appropriate site-specific ESW data for River Bend. In addition, River Bend has been unable to verify the validity of the numbers published in the table. No specific references are provided in NUMARC 87-00, and none could be obtained from NUMARC's principal investigator.

3) Both NUMARC 87-00 and NRC Reg. Guide 1.155 allow the development of site-specific data for use in ESW Group determination.

4) GSU correctly applied extreme wind climatology to determine an ESW Group 1 for the River Bend site.

EFFECTS OF LOSS OF VENTILATION EVALUATION

Initial Conditions and Assumptions

The SER requested that RBS provide adequate technical justification for selecting parameters used in room heatup calculations. These parameters are: initial room temperature, initial room humidity, concrete thermal conductivity, control room free air volume, and constant control room boundary temperature.

The SER recommendation requested additional information and/or technical justification for each area of concern. However, the TER requested justification of particular assumptions and initial conditions for specific areas of concern. This attachment addresses the specific information requested in the TER.

1) Relative Humidity

The TER states that the assumption of 100% initial relative humidity (RH) is non-conservative for maximizing SBO temperature response. The TER recommends that the response should be recalculated using 0% RH. To test this recommendation, a sensitivity case was run for the auxiliary building using a low value for RH (Ref. 10). This calculation demonstrates that the temperature response in the auxiliary building is not appreciable impacted by the assumption of 100% RH.

2) Initial Control Room Temperature

The TER stated that the initial control room temperature of 78°F is non-conservative. RBS disagrees with this assessment. A review of plant operating data from April 15, 1988 through January 20, 199[illegible] provides the following (Ref. 11):

Control Room Maximum Temperature (°F)	No. of Days
65	1
66	5
67	13
68	64
69	135
70	301
71	263
72	146
73	45
74	7
75	2
76	1
77	0
78	2
79	1
Total	986
Average Maximum Temperature	70.4°F

Based on this information, 78°F is a conservative initial control room temperature for River Bend Station.

In addition, a review of River Bend Operations procedures indicates that Alarm Response Procedure (ARP)-863-74 (Ref. 12) provides administrative controls on control room temperature. Specifically, alarm number 0377 (1H13*P863/74A/B04) annunciates at 78.8°F to indicate high discharge temperatures for control room air handling units. The ARP provides directions for operator response to this alarm to reduce temperature.

3) Outside Air Temperature

The TER states that the outside air temperature of 96°F, assumed in the control room heat-up calculation, is not consistent with the 110°F outside air temperature used in other heat-up calculations.

96°F is the outside air temperature used in River Bend HVAC sizing calculations performed by our architect/engineer (Stone & Webster) when the plant was designed. The source of the 96°F design value for River Bend was the 1972 Edition of the ASHRAE Handbook (Ref. 25, Table 1, page 673). This data is specific to Baton Rouge, and represents the 1% non-exceedence temperature. Therefore, outside air temperature should be 96°F or less 99% of the time. Based on this information, 96°F represents a realistic outside air temperature for the main control room heat-up calculation.

Recent room heat-up calculations used 110°F for conservatism to ensure that switchgear rooms, battery rooms, etc. did not exceed NUMARC 87-00 limits. 110°F represents a 14°F exceedence of 96°F. Based on the ASHRAE data above, outside air should reach this temperature much less than 1% of the time. As discussed below, sensitivity analyses (Ref. 13) indicate that if 110°F outside air temperature is used instead of 96°F, main control room temperature does not exceed 120°F after 4-hours.

4) Control Room Free Air Volume

The TER requested a justification for the assumption that the control room free air volume below the suspended ceiling was 90% of the gross volume. The control room heatup calculation (Ref. 13) used 90% of the gross volume below the ceiling as free volume. The 10% reduction in volume accounts for the solid material located in the control room. The constant pressure thermodynamic process occurring in the control room during heatup is not sensitive to small variations in the free volume and thus a rough estimate was used.

USAR Figures 1.2-24 and 1.2-27 show the control room arrangement. The control room space is occupied by electrical and control panels. The floor area covered by the panels is approximately 20% of the total floor area. The panels reach, on average approximately 80% of the floor to ceiling dimension. The panels are vented to the control room and each have approximately 50% free volume. Thus the solid volume occupied by the panels within the control room is less than 10% of the gross volume and the assumption presented in the calculation is justified.

Computer Code Validation

The SER recommended that RBS address the staff's concerns regarding computer codes used for the heat-up calculations for areas of concerns. Three (3) computer codes were used in the River Bend SBO analysis:

1) CONSBA for containment analysis,
2) THREED for the auxiliary building and control room, and
3) COMPARE for the battery rooms, switchgear rooms, and DC equipment rooms (all located in the control building).

Each of these computer codes is discussed below

1) CONSBA and THREED

The Stone and Webster Engineering Corporation (SWEC) propriety computer codes THREED and CONSBA have been used to provide auxiliary building and containment (including suppression pool) temperature response to the SBO event. These computer codes are controlled, documented, and qualified under the SWEC Engineering Assurance program (Ref. 14).

Local heat loads are produced from active piping and operating equipment. These active systems are assumed to be pumping water at the suppression pool temperature which continues to rise over the course of the analysis.

The piping heat release rate therefore increases over time as the temperature of the fluid being pumped increases over increasing heat load is directly reflected in the resulting temperature increase.

2) Switchgear Rooms

The results of GSU Calculation G13.18.12.4*14-0, "Maximum Temperature during Station Blackout, Switchgear Rooms A and B" (Ref. 19) indicate a small cyclical behavior of standby switchgear room temperatures. From peak to peak this variability is 0.7° F. The variation is small and results from the model chosen by the analyst rather than expected temperature variations or characteristics of the COMPARE computer code.

The model includes a flow junction between the node representing the switchgear room of interest and the node representing the remainder of the control building. This junction was defined by the analyst as 0.001 ft^2 to allow for equalization of pressures between the nodes which developed due to thermal expansion of air. The junction area was minimized to conservatively model the subcompartments as closed volumes, though ventilation ducting and other non-airtight penetrations actually are present in the control building. As defined, this junction area was insufficient to completely obviate pressure differences between the nodes in the first several hours of the analysis. Due to this small pressure buildup, temperature increases resulted in Node 1 (switchgear room) which were slightly greater than those from heat input alone (heat input from electrical equipment was relatively small for the standby switchgear rooms). For example, the output data for Switchgear Room A at time 2 hours indicates pressure in Node 1 of 14.91 psi, increased from an initial pressure of 14.7 psi. In reality, no real pressure differential would be established between control building subcompartments because of ventilation and other penetrations between subcompartments. As modeled, the pressure equalizes through the junctions over time, temperature decreases due to lower pressure and, subsequently, switchgear room temperature increases again due to the expected effect of the heat input from switchgear equipment. This cyclic effect is very small, a result of the model used, does not effect the longer term results, and does not alter the basic conclusion of the calculation.

A validation run was made with the junction area defined as 0.2 ft^2. No cyclic effect was observed, though slightly lower long term switchgear room temperatures were predicted due to mass interchange through the junctions.

Potential Non-conservatisms

The TER identified a number of potential non-conservatisms and asked for explanations or re-calculations using more conservative data. River Bend has analyzed each of these potential non-conservatives as follows:

1) Relative Humidity

The TER states that the assumption of 100% initial relative humidity (RH) is non-conservative for maximizing SBO temperature response. The TER recommends that the response should be recalculated using 0% RH. To test this recommendation, a sensitivity case was run for the auxiliary building using a low value for RH (Ref. 10).

The heat-up in the auxiliary building is essentially a thermodynamic constant-pressure process. The model consists of connected rooms with various heat sources and passive heat sinks. The temperature response in each room is determined by a change in the average enthalpy in the room. The enthalpy change is a reflection of the heat capacity of each room.

The heat capacity of the mixture in each room is determined from the air-steam mixture as determined from the initial temperature, pressure and relative humidity (RH). The table below presents unit-volume heat capacities for zero, 10 and 100 percent RH.

These codes have provided licensing basis analyses for River Bend Station (and other SWEC designed units) and results have been presented in the USAR (Ref. 15 and 16).

All temperature responses have been prepared and documented in calculation files prepared under appropriate quality assurance programs. The SWEC code, THREED, is used to prepare similar analyses including equipment qualification temperature profiles and leak detection setpoint determination. The CONSBA code is used to prepare small break and transient response calculations.

2) COMPARE

The COMPARE code was developed by the Los Alamos Scientific Laboratory in conjunction with and under contract to the U. S. Nuclear Regulatory Commission. LA-NUREG-6488, "COMPARE: A Computer Program for the Transient Calculation of a System of Volumes Connected by Flowing Vents" (Ref. 17), was published in September 1976 and described the COMPARE program for transient subcompartment response analysis for nuclear power plants. Published in 1980, NUREG/CR-1185, "COMPARE-MOD 1 Code Addendum" (Ref. 18) was developed by Los Alamos for NRC and documented the extension of the code to include additional technical capabilities and an ability to plot calculated results. Extensions of the capabilities of COMPARE have been accomplished by other users in the past. For example, Babcock and Wilcox developed COMPAR2, the B&W version of COMPARE-MOD 1, to increase the number of volumes and junctions which could be modeled.

The COMPARE code, and derivatives of COMPARE, have been widely used in the nuclear industry to calculate post-accident harsh environment conditions of pressure, temperature, and humidity. These analyses included consideration of mass and energy release in the subcompartments of interest. The GSU SBO temperature calculations employ a more simplified analytical model in which energy, but not mass, release occurs in the volumes of interest. The code has been qualified under many QA programs, including that of SCIENTECH, a GSU contractor. SCIENTECH QA for this use of the COMPARE code included validation calculations for the use of COMPARE with subcompartment energy release. COMPARE verification and validation was formally reviewed by GSU and submitted to NRC as a part of the calculations. Use of the COMPARE code for SBO subcompartment response is a very simple, but appropriate application of this code.

With regard to COMPARE, the TER also asked that GSU verify that an ENSA calculation using COMPARE has been reviewed. The GSU reviewer for Calculation G13.18.12.4*14-0, "Maximum Temperature during Station Blackout, Switchgear Rooms A and B" (Ref. 19), noted that data from a calculation, ENSA-100-11A-ADD (Ref. 20), needed to be confirmed. This reference was obtained from the contractor's QA files, necessary data was confirmed by the original GSU reviewing engineer, and the signature block for G13.18.12.4*14-0 "Data Confirmed" was completed on September 25, 1991.

Computer Code Behavior

The TER questioned computer program results in the auxiliary building and standby switchgear rooms. River Bend has reviewed these results and offers the following responses:

1) Auxiliary Building

As noted, the room temperature profiles in the auxiliary building have two distinct characteristic shapes (Ref. 10). The characteristic shapes are a direct result of the heat loads dominating the particular room throughout the analysis period. Each of these dominant heat loads are described below.

The asymptotic profiles are the expected result of a nearly constant heat load throughout the analysis. These heat loads are generally dominated by system piping that was in operation prior to the SBO event. Specifically the RHR system piping is conservatively assumed to be hot prior to the SBO. The heat load causes the air temperature to increase rapidly to an early steady-state value.

Temperature transients increasing linearly over the course of the analysis are the result of systems becoming active and producing an increasing heat load. Specifically RCIC and HPCS systems are considered to be initiated following the SBO.

Dry Bulb Temperature, °F	Heat Capacity, BTU/(cu-ft °F)		
	100%	10 % RH	zero % RH
122	0.0167	0.0164	0.0164

As can be observed there is a slight difference in the volumetric heat capacity. This is expected due to the ideal gas behavior of the steam and air mixture. The effect of the calculated temperature response is on the order of 1.8%. For a typical SBO result with a temperature rise of 23 °F, the difference would amount to less than 0.5 °F. In order to confirm the effect of choosing a low RH, the analysis was repeated using 10% RH (Ref. 10). Ten percent is lower than the minimum expected building RH and allows the computer model to operate efficiently. The resulting temperatures are presented below:

	RCIC Room Temperature after four hours	
Original Analysis	100 % RH	146 F
Revised Analysis	10 % RH	146 F

Therefore, temperature response is not appreciably impacted by the assumption of 100% relative humidity.

2) Initial Control Room Temperature

As discussed above, 78°F is a conservative initial control room temperature for RBS (average maximum temperature = 70.4°F). Use of this temperature meets NUMARC 87-00 guidance. Therefore, no additional sensitivity calculations were performed for initial control room temperature.

3) Outside Air Temperature

As discussed above, 96°F is the 1% non-exceedence temperature for Baton Rouge. Use of this temperature provides a realistic analysis of control room heat-up during a SBO.

The outside temperature of 96°F was used to establish the initial temperature profile through the outside concrete walls. The temperature also determines the initial heat addition from the walls to the control room. The wall acts as a heat source for as long as the control room temperature remains below the wall surface temperature. When the room temperature exceeds the wall surface temperature heat is absorbed into the wall, cooling the room.

Walls surrounding the control room consist of concrete two feet thick. These walls require a long time more than (24 hours) to reach a steady state condition following a change in external temperature. Thus the inside surface temperature of the walls are little affected by daily temperature variations. Using 96°F outside temperature establishes an expected wall temperature profile.

Raising the outside temperature to 110°F and holding it steady for 24 hours prior to the SBO has the effect of raising the internal wall surface temperature by less than 1°F (Ref. 13). In approximately 0.5 hours following the onset of the SBO, the control room temperature increases to a value greater than the wall surface temperature and the walls then become heat sinks. The temperature in the control room is affected by the heat sink behavior of the outside walls. Therefore the impact on the control room SBO temperature of raising the outside temperature to 110°F for a period of 24 hours remains small (less than 1°F).

4) Control Room Free Air Volume

As discussed above, 90% free air volume is reasonable for the control room volume below the ceiling.

5) Concrete Thermal Conductivity

GSU subcompartment temperature calculations - performed by GSU to determine the effects of loss of ventilation due to station blackout - used a value of 0.87 BTU/h.ft.°F (1.5 W/m.°K) for the thermal conductivity of the concrete interior walls, interior floors and ceilings, and exterior walls of the control building. Actual concrete thermal conductivity varies greatly depending on the type of concrete and the presence of imbedded reinforcing steel. One representative value was chosen for use in all of the calculations. This value has been used in previous nuclear plant analysis sponsored and reviewed by the NRC (Ref. 21, p. 68). To determine whether the subcompartment temperature analyses are sensitive to changes in the value used for thermal conductivity of concrete, the most limiting of the temperature analyses performed was rerun using a lower thermal conductivity. The lowest value for thermal conductivity of concrete found in the common reference manuals reviewed was 0.54 BTU/h.ft.°F (Ref. 22, p. 39.3) for stone concrete.

The most limiting subcompartment heatup was that of Battery Room A, which reached a temperature of 129° F four hours after station blackout and loss of ventilation. This case - Case 1 of GSU Calculation G13.18.12.4*15-0, "Maximum Temperature During Station Blackout: Battery Rooms A and B" (Ref.23) - was rerun using a thermal conductivity of 0.54 BTU/h.ft.°F to determine the sensitivity of the calculations to this constant. Calculation G13.18.12.4*21-0, "Sensitivity of Station Blackout Temperature Calculations to Change in Concrete Thermal Conductivity Value" (Ref. 24), demonstrates that the temperature calculation is relatively insensitive to concrete thermal conductivity -temperatures nearly identical to the original calculation result.

Though the thermal conductivity values used in the two calculations differ greatly, the difference between the resulting bulk air temperature profiles is small because heat transfer though concrete structures (walls, floors and ceilings) is extremely small for the periods of the events studied. Therefore a representative value of 0.87 BTU/h.ft.°F can be used for the thermal conductivity of concrete without significantly affecting the results of the analysis for coping with loss of ventilation in the control building following station blackout.

Conclusions

Based on the above information, GSU concludes that:

1) Initial conditions, parameters, and assumptions used in River Bend loss of ventilation calculations are reasonable and represent expected conditions at the site.

2) No potential non-conservatisms exist with regard to these initial conditions, parameters, or assumptions.

3) Computer programs used in this analysis are appropriate for this use, and have received through validations and verifications, as documented in River Bend's USAR and other references.

4) Loss of ventilation effects have been adequately addressed by River Bend as part of our SBO analysis.

REFERENCES

1) NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Rev. 1, August 1991.

2) NRC Regulatory Guide 1.155, "Station Blackout", August 1988

3) GSU Calculation G13.3E-143-7, Addendum C, "Standby Battery 1ENB*BAT01A Duty Cycle, Current Profile and Size Verification".

4) GSU Abnormal Operating Procedure (AOP)-0050, "Station Blackout", Rev. 3.

5) EA-PM-91-675, "Procedure Changes Required to Cope with Station Blackout (SBO)", GSU memorandum, May 22, 1991.

6) DMGSU 9202-01/JEM, "Station Blackout Extremely Severe Weather Group Determination for River Bend Station", Letter from Devonrue to GSU, February 5, 1992.

7) E. Simiu and R. Scanlan, Wind Effects on Structures, John Wiley & Sons, 1986.

8) GSU Calculation G13.18.12.4*05-1, "SBO - Extremely Severe Weather".

9) EA-RA-92-0001-M, "Conformance of River Bend Station with the Station Blackout Rule (10CFR50.63) and NUMARC 87-00", Rev. 0, GSU Proprietary Report, January 31, 1992.

10) GSU Calculation G13.18.12.4*01-2, "SBO Auxiliary Building Temperature Response."

11) EQ-92-0026, "Control Room Temperature", GSU memorandum, January 28, 1992.

12) GSU Alarm Response Procedure (ARP)-863-74, "P863-74 Alarm Response", Rev. 4

13) GSU Calculation G13.18.12.4*02-2, "Control Room Heatup Following SBO".

14) SWEC Engineering Assurance Procedure (EAP) 5.25, "Computer Program Documentation and Qualification", Rev. 1.

15) RBS Updated Safety Analysis Report (USAR) Appendix 6B, "THREED Subcompartment Analytical Model", August, 1990.

16) RBS USAR Appendix 3A.27, "Additional Programs Used in Stone & Webster Analysis", August, 1990.

17) LA-NUREG-6488, "COMPARE: A Computer Program for the Transient Calculation of a System of Volumes Connected by Flowing Vents," U.S. Nuclear Regulatory Commission. 1976.

18) NUREG/CR-1185, "COMPARE-MOD 1 Code Addendum," U.S. Nuclear Regulatory Commission. 1980.

19) GSU Calculation G13.18.12.4*14-0, "Maximum Temperature during Station Blackout, Switchgear Rooms A and B"

20) Calculation ENSA-100-11A-ADD, "Qualification of COMPARE-MOD1A Computer Code."

21) Theofanous, T. G., et. al. "The Probability of Liner Failure in a Mark-I Containment," NUREG/CR-5423, U. S. Nuclear Regulatory Commission, August 1991.

22) American Society of Heating, Refrigerating and Air-conditioning Engineers, (ASHRAE) Handbook of Fundamentals, 1985 Edition.

23) GSU Calculation G13.18.12.4*15-0, "Maximum Temperature During Station Blackout: Battery Rooms A and B"

REFERENCES (cont.)

24) GSU Calculation G13.18.12.4*21-0, "Sensitivity of Station Blackout Temperature Calculation to Change in Concrete Thermal Conductivity Value"

25) ASHRAE Handbook of Fundamentals, 1972 Edition