GULF STATES UTILITIES COMPANY
POST OFFICE BOX 2951 • BEAUMONT, TEXAS 77704
AREA CODE 409 838 6631

September 30, 1983
RBG-16,085
File Code G9.5

Mr. Thomas M. Novak
Assistant Director for Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Novak:

River Bend Station Units 1 & 2
Docket Nos. 50-458 and 50-459

This letter provides Gulf States Utilities Company's (GSU) final response to the Nuclear Regulatory Commission's (NRC) March 30, 1981 letter concerning "Ultimate Capacity Analysis Of Mark III Containments". GSU previously submitted a partial response on June 22, 1983 (RBG-15,321).

The partial information provided in the June 22, 1983 report has not changed and is included again herein for completeness. The enclosed amended report includes ultimate capacities of the containment equipment hatch and personnel airlock which were determined to be 56 psi and 72 psi respectively. The enclosed report completes GSU's response to the NRC's March 31, 1983 request.

Sincerely,

J E Booker

J. E. Booker
Manager-Engineering,
Nuclear Fuel & Licensing
River Bend Nuclear Group

JEB/LAE/MWH/kt

Attachment

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ENCLOSURE

ULTIMATE CAPACITY OF RIVER BEND STATION CONTAINMENT

1.0 ORIGINAL DESIGN PRESSURE

The original design pressure of the River Bend Station (RBS) steel containment is 15 psid, as stated in RBS-FSAR Section 6.2.1.1.1. The design pressure of the drywell is 25 psid internal and 20 psid external, as stated in RBS-FSAR Section 6.2.1.1.1.

2.0 CALCULATED STATIC PRESSURE-RETAINING CAPACITY

2.1 Overall Structural Capacity

The calculated static pressure-retaining capacity of the containment is summarized in Table 1. The calculated static pressure-retaining capacity of the drywell is greater than 80 psi.

3.0 CACULATED DYNAMIC PRESSURE CAPACITY

Since the rate of any pressure buildup resulting from a potential hydrogen burn is expected to be relatively slow, no dynamic evaluation of the containment is performed.

4.0 ASSOCIATED FAILURE MODES

4.1 Drywell

The failure mode of the drywell structure is defined as the stage when the reinforcing bars at the junction of the cylindrical wall with the top slab reach the yield stress and the compressive strain of the concrete reaches a value of 0.003.

4.2 Containment

The critical area of the containment is in the torus portion of the dome. The failure mode is a general yielding of the steel in this area. Table 1 defines the pressure that causes general yielding to occur.

5.0 CRITERIA

5.1 Drywell

The drywell concrete is designed to satisfy the ASME Code, Section III, Division 2 (1977 edition). The criterion used to establish failure is the condition at which the resulting forces and moments cause the reinforcing bars to reach the yield stress and the compressive strain in concrete to reach the value of 0.003.

5.2 Containment

The steel containment is designed in accordance with ASME, Section III, Division 1, Subsection NE (1974 edition, no addenda). In evaluating failure, the containment was studied for a number of cases. They are: pressure to exceed stress limits for the operating condition V, as defined in RBS-FSAR Table 3.8-1, pressure to cause first yielding, pressure to cause a general state of the yield at any section, and pressure to cause buckling. The actual failure criterion is the pressure that causes a general state of yield or the pressure to cause buckling, whichever occurs first. Since both of these events occur after initial yielding, linear analysis is used to conservatively approximate the actual failure pressure.

6.0 ANALYSIS DETAILS AND GENERAL RESULTS

In all cases, the analysis considered the pressure loads in combination with dead loads.

6.1 Drywell

The drywell is a 5-ft thick reinforced concrete cylinder with a circular 5-ft thick concrete slab at the top. There is a circular hole in the center of the top plate to which the drywell head is attached. The fuel pool walls stiffen the top slab. In the analysis, the structure is modeled as a cylindrical shell and circular plate, ignoring the effects of the fuel pools. Properties of the shell are modified to reflect the amount of cracking of the concrete. The drywell has a 3/8-in. thick steel liner on the inside.

The pressure is applied to the model, and a linear, elastic, axisymmetric shell analysis is performed using the finite difference program, SHELL 1 (see RBS-FSAR Appendix 3A). The resulting forces and moments are used to check the reinforced concrete section capacity at each elevation. The pressure at which the most heavily stressed section can no longer resist the resulting force and moment based on the yielding of the reinforcing bars and the maximum concrete compressive strain of 0.003 is considered as failure.

Failure of the drywell structure occurs at the junction of the top slab and cylinder. In reality, the fuel pool walls strengthen this area, so failure would occur at a higher pressure. Since a high capacity for the drywell has already been demonstrated, this additional capacity was not investigated.

6.2 Containment

The steel containment with the concrete fill at the base was analyzed using an axisymmetric linear elastic model (Figure 1). The steel was found to yield first at a pressure of 38 psi in the torus portion of the dome. The forces and moments were assumed to increase linearly with pressure, until the plastic capacity of the section was exceeded. This pressure is 56 psi and represents a lower bound, since the moment does not increase linearly with pressure after yielding. Based on Reference 2 below, the shell will buckle in this area at 63 psi. Therefore, the capacity is between the lower bound of 56 psi and the upper bound of 63 psi.

6.3 Containment Equipment Hatch, Containment Locks, Containment and Drywell Penetrations

The pressure capacity of the containment penetrations (CRD removal tube hatch, containment purge members, and the containment penetration bellows) is greater than 100 psi. The ultimate capacity of the drywell penetrations, including CRD removal tube hatch, is significantly greater than 100 psi.

The pressure retaining capabilities of the containment personnel airlocks and equipment hatch were analyzed using the finite element program, "ANSYS". Based on the actual material strengths, the ultimate pressure retaining capacity of the equipment hatch is 56 psi and is limited by stresses in the collar. The accompanying failure mode is a local area experiencing yield stresses. The ultimate pressure retaining capacity of the personnel airlocks was calculated in the same manner as the equipment hatch and also used actual material strengths. The ultimate pressure capacity of the personnel airlocks was determined to be 72 psi with the maximum stresses at the bulkhead plate reaching yield stress values.

The ultimate failure capacities of the containment equipment hatch and personnel airlock will be higher than the values given above and can be determined, if necessary, by considering elastic-plastic behavior.

7.0 REFERENCES

7.1 River Bend Station, Final Safety Analysis Report (FSAR).

7.2 "Elastic-Plastic Buckling of Internally Pressured Thin Torispherical Shells," G. D. Galletly and S. K. Radhamohan, ASME publication, Paper No. 79-PVP-52, June 1979.

7.3 SWEC Calculation No. 12210-219.710-FAE-1095, "Ultimate Pressure Capacity of Steel Containment Openings and Penetrations," for River Bend Station-Unit 1.

7.4 SWEC Calculation No. 12210-219.710-EBA-1102, "Ultimate Pressure Capacity of Containment", for River Bend Station - Unit 1.

TABLE 1

ULTIMATE CAPACITY BASED ON GENERAL YIELDING

Steel Containment	56 psi
Control Rod Removal Hatch	>100 psi
Containment Purge Members	>100 psi
Containment Penetration Bellows	>100 psi
Drywell Penetrations	>100 psi
Containment Equipment Hatch	56 psi
Containment Personnel Airlock	72 psi

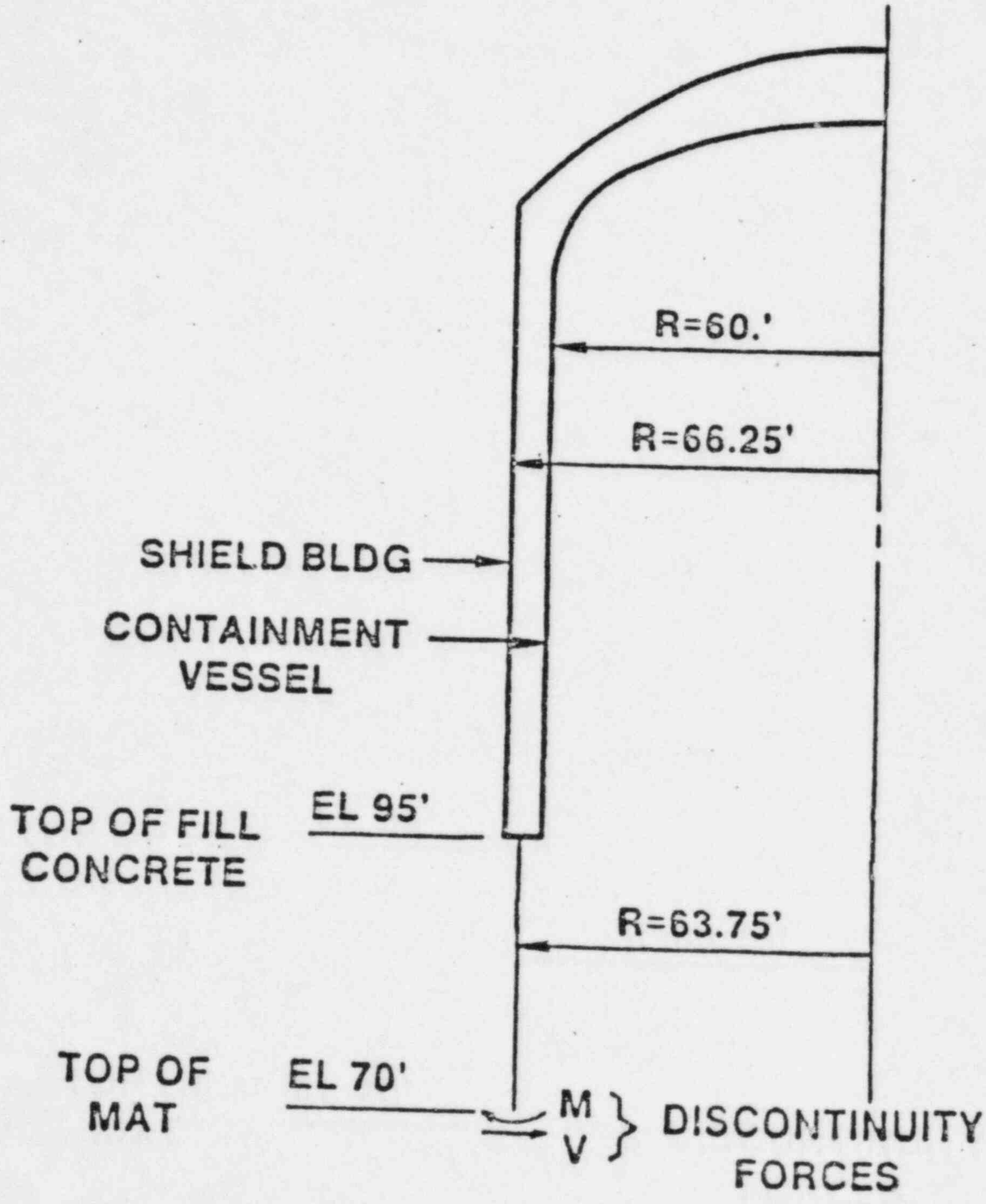

FIG. 1 SHELL MODEL