APPENDIX 5B

DESIGN PROGRAM FOR REACTOR BUILDING

1 DESIGN BASES

1.1 GENERAL

The Reactor Building is a steel lined concrete shell designed to contain all radioactive material which might be released from the core following a loss-of-coolant accident at a maximum leak rate of 0.2 per cent by weight of air per day at the design accident pressure. The concrete shell will be prestress to assure that the structure has an elastic response to all loads and that it strains within such limits so that the integrity of the liner is not prejudice The liner will be anchored so as to ensure composite action with the concrete shell.

1.2 DESIGN LOADS

The following loads will be used in the structural design:

a. Internal pressure - 55 psig

b. Test pressure - 63.3 psig

c. Live loads - Applicable loads including roof loads, pipe (penetratio reactions), and the polar crane

d. External pressure - 2.5 psig

e. Wind load - In accordance with ASCE paper No. 3269, "Wind Forces on Structures"

f. Internal temperature -

   1. Accident 281 F
   2. Operating 110 F

g. Seismic ground accelerations - 0.06 g horizontal and vertical

h. Dead loads

i. Pre-stressing loads

j. Tornado loads

The thermal loads on the Reactor Building and their variation with time will be determined from transient temperature gradients developed from the pressure time curve in Section 14.

The seismic loads are to be evaluated as outlined in Appendix 5A.

3 DESIGN STRESS CRITERIA

e design will be based upon limiting load factors which are used as the ratio which accident, earthquake, and wind loads will be multiplied for design rposes to ensure that the load deformation behavior of the structure is one elastic, low strain response. The loads utilized to determine the required miting capacity of any structural element on the Reactor Building are comted as follows:

a. $C = 0.95\ D + 1.5\ P + 1.0\ T$

b. $C = 0.95\ D + 1.25\ P + 1.0\ T' + 1.25\ E$

c. $C = 0.95\ D + 1.0\ P + 1.0\ \underline{T} + 1.0\ E'$

d. $C = 0.95\ D + 1.0\ W_t + 1.0\ P_t$

mbols used in the above equations are defined as follows:

C: Required load capacity of section

D: Dead load of structure

P: Accident pressure load

T: Thermal loads based upon temperature transient associated with 1.5 times accident pressure

T': Thermal loads based upon temperature transient associated with 1.25 accident pressure

$\underline{T}$: Thermal loads based upon temperature transient associated with accident pressure

E: Seismic load based on 0.06 g ground motion

E': Seismic load based on 0.12 g ground motion

W_t: Wind loads based on a 300 mph tornado

P_t: Pressure load based on an internal pressure of 3 psig difference between inside and outside of the Reactor Building

the required resisting capacity on any structural component resulting from wind load on any portion of the structure exceeds that resulting from the sign earthquake, the wind load "W" will be used in lieu of "E" in the second uation. The factor of 1.05 times dead load will be used should it control determining the required load capacity. All structural components will be signed to have a capacity, as defined hereafter, required by the most severe ading combination.

PRESTRESSED CONCRE

concrete shell will be prestressed sufficiently to eliminate tensile stresses to membrane forces form des n loads. Membrane tension due to factored loads l be permitted to the limits described in Appendix 5C. On those elements rrying primarily tensile membrane forces, any secondary tensile stresses due bending will be assumed to cause partial cracking. Mild steel reinforcing l be provided to control this cracking by limiting crack width, spacing, and th. The load capacity determined for tensile membrane stresses will be uced by a capacity reduction factor "Ø" of 0.95 which will provide for the sibility that small variations in material strengths, workmanship, dimensions, and control may combine to result in under capacity. The coefficient "Ø" foı flexure, shear, and compression will be in accordance with Section 1504 and ACE 318-63.

Tensile stresses in the concrete resulting from diagonal tension will be permitted. The nominal shear stresses as a measure of this diagonal tension wil be less than the maximum value stipulated in ACI 318.

3 PRESTRESSING ARRANGEMENT

The configuration of the tendons in the dome (Figure 5-1) is based on a three way tendon system consisting of three groups of tendons oriented at 120 degre with respect to each other. A large concrete ring girder is provided at the intersection of the dome and wall in order to develop sufficient horizontal restraint for the dome when subjected to all factored load combinations. The cylindrical wall is prestressed with a system of vertical and horizontal tend The horizontal system consists of a series of rings. Each ring is made up of three tendons, each subtending an angle of 120 degrees. Six buttresses are used as anchorages with the tendons staggered so that adjacent rings will not have tendons anchored at the same buttress. Each tendon will be stressed frc each end so as to reduce the friction losses. The vertical systems consist c vertical tendons anchored in the foundation slab and ring girder. For typica tendon arrangement, see Figures 5-1 and 5-3.

4 PRESTRESSED LOSSES

In accordance with the ACI 318-63, the design will make allowance for the following prestress losses:

a. Seating and anchorage

b. Elastic shortening of concrete

c. Creep of concrete

d. Shrinkage of concrete

e. Relaxation of steel stress

f. Frictional loss due to intended or unintended curvature in the tend

All of the above losses can be predicted within safe limits. The environment of the prestress system and concrete is not appreciably different in this case from that found in numerous bridge and building applications.

5 MILD STEEL REINFORCEMENT

The mild steel reinforcing will provide capacity in bending only and therefor will be designed in accordance with ACI 318-63. In addition a minimum amount of mild steel reinforcement (0.15 per cent of the wall section) will be place near the exposed surface of the concrete shell for crack control.

6 MATERIALS

6.1 POST TENSIONING SYSTEMS

The following post tensioning systems provide sufficiently large capacity units and are applicable for containment vessel construction:

DESIGNATION	TYPE TENDON	TYPE END ANCHORAGE
S.E.E.E.	1/2" Ø wire strand	swaged, threaded collar, and nut
BBRV	1/4" Ø wire	button head

The system used will be dependent upon the availability of materials. Experimental data on anchorage hardware will be or will have been developed to ensure that the end anchorages develop the ultimate capacity of the tendon and satisfactorily resist dynamic loads.

The wire strand will conform to "Specifications for Uncoated Seven-Wire-Stress-Relieved Strand for Prestressed Concrete," ASTM A-416 with a minimum ultimate strength of 250,000 psi or seven-wire 270 K strands with minimum ultimate strength of 270,000 psi. The wire will conform to "Specifications for Uncoated Stress-Relieved Wire for Prestressed Concrete," ASTM A-421, Type BA with a minimum ultimate strength of 240,000 psi.

6.2 REINFORCING STEEL

The mild steel reinforcing will be deformed bars conforming to one or more of the following:

Specifications for:

a. Billet-Steel Bars for Concrete Reinforcement (A15-64)

b. Special Large Size Deformed Billet-Steel Bars for Concrete Reinforcemer (A408-64T)

c. High Strength Deformed Billet-Steel Bars for Concrete Reinforcement wi' 75,000 psi Minimum Yield Strength (A431-64)

d. Deformed Billet-Steel Bars for Concrete Reinforcement with 60,000 psi Minimum Yield Strength (A432-64)

The type or types of steel to be used will be the highest strength material consistent with efficient use of material and economy.

6.3 CONCRETE

All structural concrete work will be performed in accordance with "Specification for Structural Concrete for Buildings," ACI 301-66, modified as necessary for the more exacting requirements of the reactor building. All concrete to be prestress will have a minimum compressive strength of 5,000 psi in 28 days. The base mat n consist of lower strength concrete.

Portland cement will conform to "Specifications for Portland Cement," ASTM C-150 Type II, modified for low heat of hydration.

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Concrete aggregates will conform to "Specifications for Concrete Aggregates," ASTM C-33 and applicable specifications of the Pennsylvania Department of Highways. The type and size of aggregate, slump, and additives will be established to minimize shrinkage and creep. Neither calcium chloride nor any admixture containing calcium chloride or other chlorides, sulphides, or nitrates will be used. Mixing water will be controlled so as not to contain more than 100 ppm of each of the above chemical constituents.

6.4 LINER PLATE

The Reactor Building will be lined with welded steel plate conforming either to ASTM A-36 or A-283, Grade C, to provide for a low leakage vessel.

7 BUILDING PENETRATIONS

Openings required for equipment and/or personnel access will be reinforced to withstand computed stress concentrations. The design of the opening reinforc will ensure approximate strain compatibility within the shell.

The openings requ for piping and electrical penetrations will be reinforc with mild steel reinforcement. The location of these penetrations will be su as to minimize tendon deflection and related stress concentrations.

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IMAGE EVALUATION
TEST TARGET (MT-3)

6"

MICROCOPY RESOLUTION TEST CHART