TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE
37401

TVA 40TH ANNIVERSARY OF PEOPLE IN PARTNERSHIP

November 21, 1973

Mr. John F. O'Leary, Director
Directorate of Licensing
Office of Regulation
United States Atomic Energy Commission
Washington, DC 20545

Dear Mr. O'Leary:

In the Matter of the Applications of) Docket Nos. 50-390
Tennessee Valley Authority) 50-391

In Amendment 19 to the Watts Bar Nuclear Plant Preliminary Safety Analysis Report (PSAR), we committed to design the Watts Bar containment in accordance with the criteria established on pages 3-7 and 3-8 of Supplement No. 1 to the staff's safety evaluation for the Watts Bar Nuclear Plant. Subsequently, your staff informally raised the question of how our Sequoyah Nuclear Plant containment design met these criteria. As a result of an informal evaluation of the various structural aspects of the Sequoyah divider barrier design, your staff concluded that a design using the load factor approach as given in the ACI-ASME (ACI-359) document, "Proposed Standard Code for Concrete Reactor Vessels and Containments," is acceptable for the interior concrete structure comprising the divider barrier. We were so advised informally in conversations with members of your staff on August 6 of this year. It is therefore our intention to use the same design approach for the Watts Bar Nuclear Plant.

It should be noted that the criteria for the steel containment vessel are the same as given in the PSAR, while the criteria for the divider barrier structure will differ from the PSAR, but will be the same criteria as agreed on by the AEC for the Sequoyah Nuclear Plant.

The specific design criteria for the Watts Bar Nuclear Plant reactor containment are discussed below and in the enclosed design criteria document.

The containment vessel is designed according to the criteria, load combinations, and allowable stresses as given in Section 5.1.2 of the PSAR. The design analysis is based on working stress concepts in

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which loads are coupled with appropriate yield stress criteria to ensure a quantitative design overload capacity for the vessel and to establish that structural integrity is maintained under loading extremes.

The pressure for the Design Basis Accident load is as described in Section 14.5 of the PSAR. The vessel is designed for the peak pressure (including 100 percent moisture entrainment) as calculated by the TMD Code plus an additional 20 percent with the pressure being symmetrically or unsymmetrically applied where it exists.

The design criteria for the interior concrete divider barrier are presented in the enclosed pages 7 through 15 of the Watts Bar concrete design criteria document. Pressure (P_a) as given in the criteria is the actual calculated pressure with a 40 percent margin already added. These criteria are the same as those discussed for our Sequoyah Nuclear Plant with your staff in February and March of this year. They are based on the edition of the Proposed Standard Code for Concrete Reactor Vessels and Containments prepared by the Joint ACI-ASME Committee (ACI-359) and issued for trial use and comment in the spring of 1973. Although in its present form this document does not specifically cover concrete interior structures, we have nevertheless used it as a guide. We reason that the divider barrier is a pressure retaining structure and rules for concrete containments should apply.

The PSAR will not be revised at this time to document the change in criteria for the interior concrete divider barrier. This letter serves to document that change from a working stress design approach to a load factor design approach as identified in the attached criteria document pages. The completed design will be presented in the FSAR. In the meantime, we are continuing with designs based on the criteria as given above.

If you so desire, we will be happy to meet with members of your staff to further discuss this matter.

Very truly yours,

J. E. Gilleland

J. E. Gilleland
Assistant to the Manager of Power

Enclosure

TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
CIVIL DESIGN BRANCH

WATTS BAR NUCLEAR PLANT

Design Criteria for Reactor Building Concrete Structure
WB-DC-20-2

August 10, 1972

Sponsor Engineer [signature]

Submitted [signature: Joseph W McReynolds]

Recommended [signature]

Approved [signature]

Approved Not required
(NSSS Vendor as Required)

Mechanical	Electrical	Civil	Architectural
LWK ELIBlyeck JJG PLK [initials]	HEMS MNLC	SK [initials] RCG [initials] OHR JWS	[initials] LKG WCA

Revisions

No. 2 Pages 7-15 Spon Engr AJ Subm [initials] Recom [initials] Appr RGD Date 7/16/73

Mechanical	Electrical	Civil	Architectural	NSSS Vendor
		RCG OHR		

5.0 Interior Concrete

5.1 General

All reinforced concrete walls, slabs, and columns inside the containment vessel are considered under this section. That portion of the interior concrete or steel structure or seals which separates the upper compartment of the containment from the lower compartment is defined as the Divider Barrier. Any wall, floor, seal, or other member, the failure of which would allow escaping steam from a pipe rupture to bypass the ice condenser and affect upper compartment design pressure, is considered part of the divider barrier. Only the concrete portion of this divider barrier is discussed here. Primary elements of interior concrete are listed below:

a. Fill slab on containment floor plate

b. Reactor Vessel Annulus Wall

c. Compartment above Reactor (Divider Barrier)

d. Refueling Cavity Wall and Floor (Divider Barrier)

e. Control Rod Drive Missile Shield and Storage Pool Gate (Divider Barrier)

f. Crane Wall *(Divider Barrier)

g. Steam Generator Compartments (Divider Barrier)

h. Pressurizer Compartment (Divider Barrier)

i. Floor at elevation 756.63 (Divider Barrier)

j. Ice Condenser Support Floor (Divider Barrier), Elevation 716 Floor and Support Columns

k. Miscellaneous Dead End Compartment Partitions

l. Concrete Foundations for Miscellaneous Equipment

*The crane wall is a Divider Barrier only for those portions which are between the steam generator and pressurizer compartments and the ice condenser. R2

5.2 Loads

D = Dead load of structure and any permanent load.

L = Live load, including normal pipe hanger loads.

P_a = Pressure from accident.

T_o = Effects from operational temperature.

T_a = Effects from accident temperature.

F_{eqo} = 1/2 Safe Shutdown Earthquake. R2

F_{eqs} = Safe Shutdown Earthquake.

Y_r = Pipe anchor force due to jet from pipe rupture.

Y_j = Jet force from pipe rupture.

Earthquake effects on various parts of the building shall be determined by using the shears, moments, deflections, and accelerations from the report, "Dynamic Earthquake Analysis of the Interior Concrete Structure and Response Spectra for Attached Equipment," prepared by TVA. Where earthquake loads are caused by major equipment supports, the design forces will be furnished by Westinghouse. Tangential shear due to earthquake in cylindrical walls is discussed in Section 1.8.4 of Design Criteria WB-DC-20-1, and all such walls will be designed by those provisions. All LOCA pressure loads are furnished by Westinghouse. These basic, calculated, LOCA pressure loads are increased by 40 percent to account for possible uncertainties in assumptions used in calculating these pressures. R2

R2

5.2.1 Load Combinations

The following load combinations shall be considered and stresses resulting from them shall not exceed the allowable stresses given in the proposed ACI-ASME (ACI 359) code.

Service Loads

Case	Combination
I	$D + L + T_o$
II	$D + L + T_o + F_{eqo}$

Factored Loads

III	$D + L + T_o + F_{eqs}$
IV	$D + L + 1.5\ P_a + T_a + Y_j$ / or Y_r
V	$D + L + 1.25\ P_a + T_a + 1.25\ F_{eqo} + Y_j$ / or Y_r
VI	$D + L + P_a + F_{eqs} + Y_r$ / or $Y_j + T_a$

R2

5.3 Fill Slab on Containment Floor Plate

This slab follows the contour of the bottom liner plate. It has a thickness of 3 feet. Shear keys are provided on its bottom face and are located under the crane wall to provide continuity for horizontal shear forces between internal concrete and the base slab. R2

The fill slab shall be designed to span between walls with hydrostatic uplift pressure on 100 percent of its bottom face from water table at elevation 710.

The vertical forces from the steam generators and the reactor coolant pumps are transferred directly into the base mat by continuous steel connections through the liner plate. The fill slab will be designed for the same deflections as occur in the base mat due to these forces. The slab will also be designed to carry large loads due to reactor coolant pipe supports.

R2

5.4 Reactor Vessel Annulus Wall

The reactor vessel is supported on this wall at about elevation 716. The wall is circular in shape and about 8 feet thick. Box-outs for neutron detectors reduce its effective thickness to 6 feet. In addition to internal pressure, which is furnished by Westinghouse, the vessel annulus wall is designed to carry the gravity and seismic loads from the reactor. The annulus wall is also designed to carry the horizontal seismic and/or LOCA forces due to a coolant pipe rupture which will be transmitted to the wall by the reactor coolant pump and steam generator struts. The loads on these horizontal struts will be furnished by Westinghouse, the supports designer. R2 R2

5.5 Compartment Above Reactor

This compartment is a part of the divider barrier. In applying the loading cases in 5.2.1 it should be noted that in the case of a LOCA no jet force is assumed. Furthermore, a LOCA is not assumed during refueling when water is in the compartment, but an earthquake is assumed at this time. R2

5.6 Refueling Cavity Walls and Floor

During refueling operations, the area within these walls is filled with water to elevation 749 feet 1-1/2 inches. The upper and lower internals of the reactor vessel are stored underwater in this area. R2

A Loss of Coolant Accident is not assumed during refueling, but an earthquake is. When water is in the pool, the Loss of Coolant Accident is eliminated from the load combinations shown in 5.2.1. R2

5.7 Control Rod Drive Missile Shield and Storage Pool Gate

This shield is the 3-foot 6-inch-thick precast concrete cover over the compartment above the reactor. It is precast in sections. These are bolted down to resist the assumed internal pressures within the compartment above the reactor. R2

The bottom face of the shield will have a 1-inch steel plate to resist penetration by missiles. The edges will have a 1/4-inch steel plate to prevent concrete chips falling into the reactor cavity and storage pool. R2

The storage pool gate is 2 feet 6 inches thick and is precast in sections. It is the vertical barrier, during normal operation, between the reactor vessel and the storage pool. All edges will have a steel plate to prevent concrete chips from falling into the reactor cavity and storage pool. During the refueling operation the shield and gate sections will be stored flat on top of the steam generator compartments. R2

Both the shield and the gate are part of the divider barrier between the containment upper and lower compartments. All connection details shall be more conservatively designed than the concrete members by a factor of 5 percent. R2

5.8 Crane Wall

The crane wall supports the polar crane rail and carries crane loads to the base slab.

Insulation and air ducts are attached to the outside face of the crane wall. At the elevation of the ice condenser doors the wall is supported on columns. Over the storage pool, the wall becomes a curved beam to carry the crane rail over the pool with a span of about 45 feet. At elevation 756.63 the crane wall supports the floor slab which spans to the top of the compartment above the reactor. The ice condenser floor is supported on the outside face of the crane wall immediately below the ice condenser inlet doors. Floors for compartments below the ice condenser floor are also supported on the outside face of the crane wall at elevation 716. R2

Large, concentrated loads will be imposed on the inside face of the crane wall by major equipment support struts. These loads will be furnished by Westinghouse, the equipment designer. Local areas of the crane wall in the lower compartment will be designed to withstand a jet force associated with a postulated rupture of the reactor coolant piping.

Where the crane wall becomes part of the pressurizer and steam generator enclosures it constitutes part of the divider barrier and must withstand the design pressures associated with these compartments. Other parts of the crane wall must carry smaller pressure differentials. The crane wall shall also be designed to withstand normal operating and LOCA temperature gradients through the wall. R2 R2

5.9 Steam Generator Compartments

Two double compartments in each reactor building house four steam generators.

The main design case is a pressure buildup due to a break in the main steam pipe within the compartment, accompanied by a jet force and restraint forces for the generators on the compartment walls. The pressure is determined from Westinghouse design curves, and is based on the downvent area between equipment and concrete wall plus a crossover opening between adjacent compartments which relieves the pressure buildup. Westinghouse will also furnish the equipment support loads. Jet forces will be based on formulae given in Westinghouse's proprietary document, "Protection Criteria Against Dynamic Effects Resulting From Pipe Rupture." R2 R2 R2

5.10 Pressurizer Compartment

This compartment houses the pressurizer. The main design case is the pressure resulting from the severence of the largest connecting pipe within the enclosure. Jet and restraint forces occurring with this pressure will also be taken into account. R2

5.11 Floor at Elevation 756.63

This floor represents the main divider barrier between the upper and lower compartments. It is supported at its outer edges by the crane, steam generator, and pressurizer walls. Support near the center of the building consists of the canal walls forming the refueling cavity and five short columns spaced around the upper reactor compartment. The floor contains several concrete hatches for equipment removal. The concrete covers on these hatches will be designed using the same allowable stresses as the floor. The floor shall be designed to resist the largest pressure and temperature buildup in the lower compartment following a LOCA. The pressure is determined from Westinghouse design R2 curves. In addition, the floor shall be designed to resist jet forces from assumed breaks in reactor coolant pipes, downward loads consisting of its dead weight, plus an applicable live load including concentrated loads from the reactor head set-down area.

For reactor pump motor removal, a temporary rail will be installed on this floor and will be supported by the floor and the circular hatch cover nearest the equipment door. R2

5.12 Ice Condenser Support Floor, Elevation 716 Floor and Support Columns

These floors are supported on their outer edges by columns beginning at the fill slab at elevation 702.78 and extending to the bottom of the ice condenser floor at about elevation 742.

The ice condenser floor is part of the divider barrier. Normal operating loads on this floor are mainly column loads from the ice support structure, and they R2 will be furnished by Westinghouse. A temperature gradient will also cause stresses in this floor.

Normal loads on the elevation 716 floor will consist of equipment loads and applicable live loads.

During a LOCA both floors will be subjected to pressure and temperature loads, which Westinghouse will furnish. R2

The support columns will be designed to resist the loads from both floors.

5.13 Miscellaneous Dead End Compartments

These compartments must be designed to withstand earthquake, thermal, and pressure loads resulting from a LOCA. R2

5.14 Concrete Foundations for Miscellaneous Equipment

These foundations are used to provide rigid supports under various pieces of equipment in the building. They shall be designed to carry equipment loads and limit deflections. They shall be securely anchored to floor slabs and/or walls. R2

5.15 Jet Forces

Jet forces from postulated pipe ruptures, both longitudinal and transverse, shall be assumed to load the interior concrete structure. The force applied on the structure is given by the formula:

$F = (1.2pA)k$ where:

F = Force on Structure

p = Pressure

A = Inside cross sectional area of pipe

k = Load factor

Two loading conditions will be assumed.

a. Effect of initial jet force alone on structure before the uniform compartment transient pressure has time to build up.

b. Effect of jet force using the saturation pressure at the rupture point in combination with the uniform compartment differential pressure.

A load factor k = 1.3 used with both conditions assumes localized yielding of the structural member and a ductility factor of 3.

The only jet force in the compartment above the reactor cavity will be from the control rod opening. This is due to a pressure of 2250 psi. The reactor coolant pipe will not produce a jet force in this area.

The ductility factor is defined as the ratio of the actual ultimate deflection of the structure to the deflection of the structure at the time of first yield in the reinforcing steel. (See ASCE Manual of Engineering Practice No. 42 - Design of Structures to Resist Nuclear Weapons Effects, 1961, pages 3-44.) R2