REVIEW OF THE

SAFETY RELATED STRUCTURAL ADEQUACY

OF THE

OCONEE NUCLEAR STATION

PRESTRESSED CONCRETE CONTAINMENT DESIGN

Containment and Component Technology Branch

Division of Reactor Licensing

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I. INFORMATION

The containment structures proposed for Duke Power Company's Nuclear Generating Units 1 and 2 are of the same basic design as the containments used for Turkey Point and Palisades. They are structural concrete containments prestressed across the dome and throughout the side walls and employing reinforced concrete containment for the base slab. Likewise, most structural details associated with the liner, liner anchorages, temperature steel and prestressing steel patterns around large openings are basically the same as in the Palisades/Turkey Point design. Since this high degree of similarity exists to previous units the containment review as documented herein devotes itself primarily to changes from features previously reported in the Preliminary Safety Analysis Reports for Palisades and Turkey Point.

II. PRINCIPAL DESIGN FEATURES

The reactor containment structure, which encloses the primary system, steam generators, and related auxiliaries, consists of a concrete shell in the form of a vertical right circular cylinder with a shallow spherical sector dome and flat slab base. A one-fourth inch welded mild steel (A-36) liner is attached to the inside face of the concrete shell as a provision to ensure leaktightness.

The base slab is of reinforced concrete construction using a high strength grade (60,000) mild steel. The cylinder walls are prestressed circumferentially against hoop stress by three staggered systems of prestressing tendons anchored at vertical buttresses. The cylinder walls are, likewise, prestressed vertically with a series of uniformily spaced tendons extending from the top of the ring girder (thickened section at cylinder-dome intersection) to the bottom of the base slab. Local base moment is carried by 14S and 18S reinforcing bars on approximately one foot centers cut off about ten feet from the base.

The dome is prestressed by a three way tendon system extending across the dome and anchored on a horizontal plane on the dome ring girder. A gird of supplemental reinforcement consisting of reinforcing bars on eighteen inch centers is provided on the exterior face of the cylinder and dome.

Additional supplemental reinforcement is provided on the interior face at the dome line and in the anchorage zones. Backing channels are provided at liner plate splices. Rigid shear "T" and "L" connectors are provided on the liner exterior face on, typically fifteen inch centers.

The prestressing tendon pattern is deflected around the major cylinder penetrations (personnel and equipment access hatches) and additional mild steel reinforcement is provided for local moment and shear. Base shear is carried by the concrete section, by radial stirrup reinforcing, by vertical mild steel reinforcing and by the mild steel liner participating through composite action.

III. LOADINGS

The major loadings considered by the applicant includes dead load, accident pressure, accident, temperature, seismic, and wind. He has also indicated consideration of external pressure, buoyant water force, tornado and missile loadings. The loadings considered and their manner of combination are the same as previously used for Turkey Point and Palisades. They include all loadings appropriate for the site with the possible exception of 225 mph for the design tornado wind speed. Selection of 225 mph was justified for Turkey Point on the basis of the large water areas. A 300 mph tornado wind is, in the absence of definitive information that such tornado wind velocity cannot exist at the site, considered a more appropriate value. Their manner of load combination is considered to realistically consider all significant load combinations and is acceptable.

IV. DESIGN DETAILS

The applicants overall design concept remains unchanged from his (Bechtel's) criteria for Turkey Point/Palisades. Several changes in details are noteworthy, however. At our suggestion, the designer has reviewed data relating to strength in shear under combined loading and, as the result, has revised his design criteria after consultation with his consultants. We consider that his rewritten criteria have clarified his design approach. We also consider that his usage of Mattock's equations in consideration of radial shear represents a rational and more conservative approach to design than reliance on ACI 318-63 provisions. His criteria in designing to cope with lateral shear remains the same as his previous final criteria for Turkey Point/Palisades.

POOR ORIGINAL

The applicant's base-to-cylinder detail has been improved over what has been previously proposed. In previous submittals a rather rigid transition was envisaged whereas the design detail for Duke has incorporated a flexible pipe transition section. It is a judgment that the present detail for this junction should perform considerably better than the previously proposed detail with respect to potential leakage under design basis accident loading. The penetration design is, also, considerably improved over previous designs. The Oconee design indicates use of sizeable rigid shear keys as additional assurance of adequate shear resistance at penetrations. It, also, indicates use of increased strength piping sections at penetrations to preclude a pipe failure from jeopardizing liner leakage integrity at the liner-penetration junction.

With respect to hatch dimensions and details, the equipment access hatch proposed by the applicant has grown considerably and has changed somewhat in structural detail. The hatch size is nineteen foot diameter for Oconee whereas for the sister containments for Point Beach, Turkey Point, and Palisades it is between eleven and fourteen feet. This represents a considerable increase in overall hatch size and, to an extent, increases the designer's problems with regard to tendon deflection around the opening and proper reinforcement for local stresses. However, an opening of nineteen foot diameter is not a major perturbation on a structure of this size. The method analysis that the applicant proposes to use to analyze his opening should not be invalidated by the increased size. In addition, extensive instrumentation has been proposed around the opening as a design check during structural acceptance testing.

Due to time limitations the applicant's response spectrum and dam stability analyses have not been analyzed in detail. It is to be pointed out, however, that the response spectrum are unusual and, as such, should be commented on in detail by the staff's consultants. Likewise, the applicant has not included earthquake effects in his "slip-slice" analysis. The review of the dam with regard to dynamic stability, therefore, hinges on acceptability of the Newmark "N" values which should be appropriately commented on by the consultants.

V. MATERIALS AND CONSTRUCTION

The materials of construction, i.e. the prestressing system, tendon protective grease, concrete, reinforcing steel, and liner plate materials, are essentially the same materials used for Turkey Point/Palisades. These are high quality, proven materials. Usage of a system for cathodic protection of the structure is indicated. Likewise, liberal cover allowances on reinforcing steel have been specified to provide assurance that deterioration of the structure during its operating life will not become significant.

The existence of a well established, experienced construction department in the Duke Power Company organization which will handle the construction lightens considerably the task of the quality control organization in ensuring that the plant is constructed in accord with the requirements of the design. User testing of the materials of construction is indicated. The construction quality control program provides a reasonable separation of construction and inspection functions, adequate authority for the quality control personnel to perform properly, and design group review of the construction progress.

VI. TESTING AND INSERVICE SURVEILLANCE

An extensive program of acceptance testing for both structural and leaktightness has been indicated. The program to establish structural acceptance will require extensive instrumentation around the large opening, at the discontinuities and on the liner to provide a high degree of assurance that anomalous structural behavior, if such occurs, will be capable of detection and correction, as warranted. Likewise, extensive pre-operational integrated leakage tests have been planned to establish the structure's leakage characteristics.

For inservice surveillance, detailed programs have not been established. However, an adequate capability to establish such a program is indicated. It is not deemed essential that either leakage or structural surveillance intervals or procedures be required at a construction permit review.

VII. CONCLUSIONS

The containment desi[illegible] as proposed for Duke's Oconee units has without question been present[illegible]n as much detail as any unit yet considered for licensing. The design details have evidenced a high degree of conservatism and [illegible]iate to a structure serving as the last barrier to fission pro[illegible]elease. It is concluded that the design, as presently proposed, and the construction, as indicated, will result in a structure adequate for its intended purpose.

POOR ORIGINAL