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THREE MILE ISLAND CONTAINMENT DESIGN, DOCKET NO. 50-289

C&CTB:DRL:FPS - RT-34

The containment system design for the Three Mile Island Nuclear Power Station has been reviewed on the basis of information presented in the PSAR (Preliminary Safety Analysis Report).

The containment structure is a typical structural concrete containment of right circular cylinder, elliptical dome, and flat slab base geometry. It is prestressed in the cylinder and dome regions and utilizes reinforced concrete construction in the base slab.

The design is quite similar in basic concept to the concept used for the Oconee containments. Since the detailed design is being undertaken by a different A-E than the one responsible for the Oconee containments, however, significant differences naturally exist in analytical procedures and design details. A list of questions relating to areas where further information is desirable is attached.

Attachment:
List of questions

cc: S. Levine, Asst. Dir. for Reactor Technology

Suppl
DRL Reading
ADRT Reading
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QUESTIONS RELATING TO: THREE MILE ISLAND CONTAINMENT DESIGN

I. Design Loadings and Factors

A. Provide scaled load plots as a function of containment height for moment, shear, deflection, longitudinal force, and hoop tension resulting individually from prestress, dead, pressure, design basis earthquake, wind, liner thermal (normal and accident), and concrete thermal (normal and accident) loadings.

B. Provide stress levels for significant areas in the containment structure which result from the chosen loading combinations.

C. Provide a load combination for tornado loading.

D. Provide the temperature gradients calculated to exist across the containment shell under operational and design basis accident conditions.

E. Describe in more detail the wind load parameters and pressure distribution assumed.

II. Design Criteria and Procedures

A. Seismic Analysis

1. Provide the analytical mode (including consideration of mass distribution, stiffness coefficients, and vibrational modes) and the analytical procedures used in arriving at a loading distribution on the structure.

2. Clarify the "algebraic" addition of vertical and horizontal seismic components.

3. Justify or revise the one-half factor for vertical acceleration for the maximum earthquake condition.

B. Large Openings

1. Provide criteria with regard to what size opening constitutes a large opening; hence, meriting special design consideration.

2. List the number and indicate the sizes of the large openings for the containment.

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3. Indicate the primary, secondary, and thermal loads that will be considered for design of these openings, including design combinations.

4. Provide more detail on the analytical methods that are being used in design of large openings.

C. Shell Analysis

1. The general shell analysis procedures are not provided in sufficient detail that a judgment may be made as to their adequacy. Provide a description of the analysis procedures for the structure to include a detailed description of the analytical technique used, information verifying the acceptability of the technique, sample calculations, the general geometry utilized to determine structural stresses and the consideration given to structural stiffness and discontinuity effects.

2. The analysis procedures for treating non-axisymmetric loadings such as earthquake and wind lateral loading are not clear. Provide a detailed explanation.

3. Describe the analysis procedures for the containment base slab design, particularly with respect to non-axisymmetric loadings.

D. Missile Protection

1. Provide the analytical procedures to be used in design of missile shields.

E. Penetrations

1. The adequacy of the piping penetration details as shown in assuring that pipe ruptures at the containment shell will not result in loss of containment leakage integrity is questioned. Provide analytical backup for the piping penetrations.

2. Provide the general criteria for and methods of reinforcing the concrete structure at and around penetrations.

3. The meaning of your "5.1.2.6.1 d criterion" is not understood. Provide further amplification.

4. The intent with regard to limitation of temperature in the concrete structure around hot piping penetrations is not clear. Indicate your criteria in this regard.

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F. Shear

1. Reliance on ultimate values of shear (used as a measure of beam

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strength in diagonal tension) does not seem particularly applicable to shell structures. Provide amplification and justification.

2. In view of the indicated non-conservatism of the ultimate strength provisions of ACI 318-63 for combined loading, your design criteria in this area must be more explicitly indicated.

G. Liner

1. Provide the types and combinations of loading considered with regard to liner buckling. Also, the safety criteria, with respect to buckling.

2. Provide the geometrical pattern, type and spacing of liner attachments and the analysis procedures, boundary conditions and results with respect to buckling under the loads cited in answer to "1" above.

3. Provide the stress and strain limits used for the liner, the bases for these limits, and the extent to which these limits relate to liner leakage.

4. Provide a discussion of the pressure/thermal load variations considered.

5. Provide the analytical procedures and technique to be used in liner anchorage design, including example calculations.

6. Provide the failure mode and failure propagation characteristics of anchorages. Discuss the extent to which these characteristics influence leak tightness integrity. What design provisions will be incorporated to prevent anchorage failures from jeopardizing leak-tight integrity?

7. Provide the anchorage design considerations given to and tolerances on liner plate out-of-roundness, liner plate fitup, liner plate thickness and liner yield strength variation and these bases.

8. Provide procedures for analysis of liner stresses around openings. Also provide the method of liner design to accommodate these stresses and the related stress limits.

9. Provide the design approach that will be used where loadings must be transferred through the liner such as at crane brackets or machinery equipment mounts. Also, provide typical design details.

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10. Provide the liner detail to be used at the base-cylinder liner juncture, the strain conditions imposed at the juncture, and an analysis of the capability of the chosen liner detail to absorb these strains under design basis accident conditions.

11. Provide a discussion of the extent to which containment vacuum can influence liner buckling and the capability of the chosen liner/attachment arrangement to resist possible vacuum loading.

H. Anchorage Zone Design

1. Provide a description of the analysis procedures used for anchorage zone analysis and typical analytical results.

2. Provide typical details of anchorage zone reinforcing.

3. Provide test data supporting the acceptability for your reinforcing method to resist the impaired anchorage loading (particularly under extended loading).

III. Materials

A. Reinforcing Steel

1. Considering the critical nature of the structure, a material specification on splicing in conformance with ACI 318-63 does not provide adequate assurance of structural ductility. Revise your material performance criteria in this regard and provide more explicit information with regard to the type of cadweld splicing intended.

2. Indicate the extent to which splice stagger will be achieved.

3. Indicate the location of and extent to which splicing or tacking of reinforcing steel will be made by welding.

B. Prestressing Materials

1. Provide a detailed description of the prestressing materials and hardware selected.

2. Justify the prestressing system selection. Include data with regard to ultimate tendon strength, elongation, anchorage strength, hardware dynamic performance, etc.

C. Liner and Penetrations

1. Provide the material selections for containment penetrations and indicate the NDTT considerations in their selection.

D. Corrosion Protection

1. Provide the concrete cover provisions for reinforcing steel and prestressing for the dome, base slab and cylinder. Include for comparison the minimum code requirements.

2. To what extent will a water proofing compound or membrane be used for the containment base slab and lower cylinder area?

IV. Construction

A. General

1. Indicate the codes of practice that will be followed in the containment construction.

2. Indicate where and to what extent ACI 301 standard practice for construction will be equaled, exceeded, or not followed.

3. Provide the general construction procedures and sequence that will be used in construction of the containment to include excavation ground water control, base slab construction, liner erection and testing, and concrete construction in cylinder and dome regions.

B. Concrete

1. Provide the concrete mixing, placing and curing procedures to be used.

2. Provide the procedures for bonding between lifts.

3. Indicate the manner in which concrete lifts will be placed and staggered.

4. Indicate the amount of user check testing of cement to be accomplished.

C. Reinforcing Steel

1. Indicate the amount of user check testing of reinforcing steel for strength and ductility to be accomplished. Include the statistical basis for the program and the basis for reinforcing steel shipment rejection.

2. Indicate the attention that will be given to cadweld splice quality control to include operator qualification and procedural requirements.

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3. Indicate the reinforcing bar welding procedures and quality control to be used in performing reinforcing bar strength welds. Include bar preparation, user check testing of reinforcing steel composition, maximum permissible alloy specifications, temperature control provisions, radiographic and strength testing requirements, and the basis for welded splice rejection and cut-out.

D. <u>Liner</u>

1. Provide the general sequence of liner construction and testing in relationship to the backing structural concrete construction.

2. Indicate the liner plate dimensional construction controls to be employed for liner plate out-of-roundness.

3. Indicate the extent of user check testing of liner NDT properties, liner thickness, ductility, weldability, etc.

4. Indicate the applicable ASME or API code sections that will be adhered to in liner construction.

5. Indicate the procedures and criteria for control of seam weld porosity.

6. Indicate the requirements for and the control that will be placed on seam weld ductility.

7. Provide the quality control procedures for liner angle and stud welding.

8. Provide your quality control procedures and standards for field welding of liner plate to include welder qualifications, welding procedures, post weld heat treatment, visual inspection, magnetic particle inspection, liquid penetrant inspection, radiographic inspection, and construction records.

E. <u>Prestressing System</u>

1. Indicate the basis for the wire/buttonhead factory quality control requirements imposed to insure production material meeting design requirements and specifications. Where a system other than BBRV is specified, provide these requirements.

2. Provide the corrosion protection provisions that will be given to wire/strand at the factory, through transportation, and in the structure prior to prestressing.

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3. Indicate the corrosion protection attention that will be given to the tendon ducting.

4. Provide a description of the prestressing sequence, procedures and tendon stress verification that will be employed.

5. Provide the grouting procedures and controls that assure proper tendon grouting.

F. Preoperational Testing

1. Provide, in detail, the manner and extent to which all valving will be tested for leaktightness both individually and during preoperational integrated leak testing.

2. Provide an analysis of crack size, spacing, and pattern expected during the containment preoperational structural test.

G. Inservice Surveillance

1. Describe the surveillance capabilities provided by the containment design to facilitate periodic inspection of the steel liner, and monitoring and/or periodic structural testing of the containment. Since leak-rate testing is intended to be performed at reduced pressure, provide an evaluation of the minimum level of such tests that would also serve to verify continued structural integrity. Consider in the evaluation structural response and installed surveillance instrumentation requirements.

2. Indicate the extent of long-term structural surveillance to be provided by test samples and in-place instrumentation of the containment.

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