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Docket No. 50-302

Florida Power Corporation
ATTN: Mr. J. T. Rodgers
Assistant Vice President
P. O. Box 14042
St. Petersburg, Florida 33733

Gentlemen:

This letter is a follow up to a telephone conversation held on July 7, 1976 between Mr. J. T. Rodgers (Florida Power Corporation) and Mr. L. Engle (NRC) regarding the NRC staff's review and evaluation of your interim report, "Reactor Building Dome Delamination", June 11, 1976. The staff's comments and request's for information concerning the above report were telecopied to you on the same day as the July 7, 1976 telephone call.

Enclosed you will find the staff's comments and requests for information as telecopied to you at that time.

In a telephone call on July 8, 1976 between Mr. J. T. Rodgers and Mr. L. Engle, it was agreed that your response to the staff's request for information concerning the interim report should be sent o the staff no later than August 6, 1976.

The many subsequent communications with you concerning your investigations and status of the corrective fix for the concrete separation on the reactor building dome now indicate you should amend your June 11, 1976 report regarding the staff's specific requests for information concerning this document.

50-302

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OFFICE ➤					
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Because of the constantly changing status on these matters, we request that you meet with the NRC staff as soon as possible in early August, 1976 to update the staff on your investigations, findings, and the present status of your corrective fix concerning the concrete separation in the Crystal River, Unit 3 reactor building dome. At that time, we can discuss your plans for a new interim report on this problem.

Please call us if you have any questions concerning these matters.

Sincerely,

Original Signed by
John F. Stolz

John F. Stolz, Chief
Light Water Reactors Branch No. 1
Division of Project Management

Enclosure:
Staff Comments and
Requests for Information

cc: Mr. S. A. Brandimore
Vice President and General Counsel
P. O. Box 14042
St. Petersburg, Florida 33733

OFFICE	LWR #1:DPM	LWR #1:DPM				
SURNAME	LBEngle/LM	JFStolz				
DATE	07/30/76	07/30/76				

ENCLOSURE 1

COMMENTS AND REQUESTS FOR INFORMATION

REACTOR BUILDING DOME DELAMINATION INTERIM REPORT

FLORIDA POWER CORPORATION

CRYSTAL RIVER, UNIT 3

DOCKET NO. 50-302

STRUCTURAL ENGINEERING BRANCH

COMMENTS ON CRYSTAL RIVER UNIT NO. 3 REACTOR BUILDING DOME DELAMINATION INTERIM REPORT

GENERAL

1. For easy reference, provide a list of tables and figures in the Table of Contents.

SECTION 1.2

1. The staff considers the establishment of the causes of the dome delamination to be important in assessing the adequacy of the repair program and in providing assurance that another crack will not occur again during the life of the structure. The potential contributing factors should, therefore, be identified indicating the magntiude of radial tensile stresses created in the concrete.

2. The use of radial anchors will enhance the capability of the dome to resist radial tension. However, they will not eliminate tension in concrete, and therefore small cracks may still exist. Provide an analysis to indicate that such cracks will not jeopardize the required structural integrity of the dome to resist all combinations of loadings for which it is designed.

SECTION 2.3 AND TABLE 2-2

1. Clarify the definition of tensile capacity of concrete. Explain how principal tension is related to shear and diagonal tension as indicated in Section 2.3.1, and what is the difference between the shear discusse in this section and that in the next section (2.3.2).

2. Provide and describe with examples of actual design, the conditions under which each of the criteria (a) and (b) in Section 2.3.1 is appliec

3. Since the stress/strain distribution is tri-axial, the limits of $3\sqrt{f'_c}$ and $6\sqrt{f'_c}$ may not be directly applicable to this problem and their use should be justified.

4. If $0.85f'_c$ as extreme compression in ultimate strength design is used, it may not be directly applicable for the same reason as in the above comment and should be justified.

5. The shear strength of concrete is influenced by stresses orthogonal to the axis of the element; therefore, this effect should be considered.

SECTION 2.4

1. In the paragraph in the middle of Page 2-4, you indicated that for structural integrity test and accident condition load combinations, stresses for sustained loads cannot be combined with those due to rapidly applied loads internally in the program and are combined externally. Provide an example of actual design to show how the stresses are combined externally and illustrate the combination on a stress-strain diagram.

2. On Page 2-5 under Item b. Creep, it is indicated that as a result of concrete creep there is a reduction in concrete stress and an increase in liner stress. Since the liner is relatively thin and may buckle under prestress, the liner should not be considered to contribute any strength to the containment vessel. However, in the design of the steel liner, strain due to creep of concrete should be considered to check its leaktightness integrity. Revise the concrete stresses in the report if they have been reduced.

3. Provide the procedure which you used in the design of the steel liner. In Table 2-2, you stated that no criteria on liner strains were used in the original design. Indicate the criteria you used for the steel liner design.

4. Discuss in detail the effects of creep, including the following consideration :

   Because of the different level of prestress in the wall in the vertical direction, the wall in the hoop direction, in the ring girder and in the dome the E_c' is different in all these directions and this effect should be considered in the analysis. The wall acts as an orthotropic element. The different parts of the structure have simultaneously different E_c' due to different specific creep.

5. In Table 2-3 add load combination equation for repairs. This equation should include the seismic load term.

SECTION 3.1

1. Discuss the reliability of direct tensile tests performed on cores. Since in the structure the radial tensile stress occurs simultaneously with two orthogonal compressions or with two orthogonal tensions, a more thorough investigation is required.

Section 3.3

1. In the list of factors which may have contributed to the delamination problem, add: creep and stress concentrations (at tendons) inherent in this type of structure.

2. In Sect on 3.3.2 it is indicated that by using SAP IV computer program an the model shown in Fig. 3-16, the effects of material properties on radial tension stresses are evaluated. Identify in the model:

   (1) the steel elements, such as reinforcing steel, and tendon conduits,

   (2) the manner in which the prestressing force is applied, indicating if the prestressing force component tangent to the dome curvature is considered.

3. Provide the hand calculation which you made to obtain the radial tension.

4. In Section 3.3.4, transient thermal gradients may generate shear stresses, and should be considered in the analysis. Similar effect exists for localized thermal gradients.

5. The solution for stress concentrations as shown in Fig. 3-17 & 3-18 is incomplete. It should be noted that compression exists also in the direction parallel to the conduit (σ_1). This stress generates additional stress concentration in the plane (σ_2; σ_3) orthogonal to the tendon, which should be added to the stresses shown in Fig. 3-18.

6. When the effect of tendon conduits is analyzed, it should be noted that this effect is different when evaluated in the direction parallel to the tendon and orthogonal to the tendon. In the direction parallel to the tendon a ¼" thick pipe (5"Ø) approximately replaces the removed concrete. But in the direction perpendicular to the tendon, the pipe introduces a flexible link which modifies the average properties of the concrete section.

SECTION 4.4

1. In Sections 4.4.1 and 4.4.2 you indicated that in order to consider the containment structure serviceable for the two loading conditions the shear capacity of the tendon conduit would have to be considered. Such consideration may not be possible, unless the bond stress between the conduit and concrete can be justified to be adequate.

SECTION 5.3

1. In releasing the prestressing force as a result of tendon detensioning, strain recovery will occur. However, most likely the strain recovery in concrete will be resisted by the steel reinforcing bars and steel liner, because of creep effects, and tension may result in the concrete. Provide an analysis to show that the resulting cracking in dome concrete will not jeopardize the structural integrity of the dome particularly in the region of the liner anchors.

2. The behavior of the detensioned dome is strongly influenced by the creep of the prestressed structure which has taken place after prestressing and up to this date. The detensioning of the dome will not return the structure to a previously unprestressed state, whatever the sequence of operations. It is therefore imperative to analyze the detensioned dome for the influence of creep. Present such an analysis and demonstrate that the integrity of the detensioned dome will not be impaired. The analysis should include the ring girder and the top of the cylindrical wall.

3. The figures 5-11 to 5-14 do not include a study on shears. Provide a detailed analysis of shear stresses in the detensioned dome and demonstrate that these shear stresses, acting simultaneously with normal stresses, do not endanger the stability of the dome. Special attention should be given to radial shears.

4. Either justify in detail the use of 24" for the dome thickness in the present analysis, or present a parametric study for different thicknesses; for instance 24"; 18"; 15".

5. Demonstrate that the detensioned dome and the steel liner can take the load applied during the repair operations.

6. Present a detailed discussion of the provision made to monitor the behavior of the dome, the ring girder, and the top part of the cylindrical wall during repair operations. Indicate:
   (a) the acceptance criteria for safety in such operations, and
   (b) the provisions made to safely stop the repair procedures if the acceptance criteria for safety are not met.

7. Describe in detail the methods, acceptance criteria and methods of inspection for the grouting of the cap on the dome, the radial anchors to be installed and the grouting of these anchors. Present the planned testing of these anchors.