



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

September 2, 1980

Docket No. 50-395

Mr. T. C. Nichols, Jr.
Vice President & Group Executive
Nuclear Operations
South Carolina Electric & Gas Company
Post Office Box 764
Columbia, South Carolina 29281

Dear Mr. Nichols:

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION - VIRGIL C. SUMMER
NUCLEAR STATION, UNIT NO. 1

Enclosed are requests for additional information concerning the effects of settlement of the pumphouse and service water intake structure. These requests numbered 362.15 thru 362.49 were developed by the Hydrologic and Geotechnical Review Branch.

Please provide your responses not later than September 26, 1980. If you cannot meet that schedule or require clarification of any of the requests, please contact the staff's assigned licensing project manager.

Sincerely,

A handwritten signature in cursive script, appearing to read "R. Tedesco".

Robert L. Tedesco, Assistant Director
for Licensing
Division of Licensing

Enclosure:
Request for Additional
Information

cc w/enc1:
See next page

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- 2 -

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REQUEST FOR ADDITIONAL INFORMATION
VIRGIL C. SUMMER
DOCKET NO. 50-395

- 362.15 As stated in Report No. 2, SWIS Settlement Effects and Related Work, soft/loose surficial soils were removed from beneath the pumphouse area. Figure 2, Section Profile of SWIS & PH, (Service Water Intake Structure and Pumphouse) indicated up to 11 feet soft soil was removed. However, Boring WE-2, showed that the loose sandy silt (classified as saprolite) extends to a depth of 17 feet. It appears that these loose saprolite were left in place. Discuss their significance on the settlement of the pumphouse.
- 362.16 The pre-construction subsurface profile of the West Embankment as shown in FSAR's Figure 2.5-102, indicated that the SWIS & PH are located in a valley with some soft/loose alluvium deposits and loose saprolite. Have those materials been removed during the construction of West Embankment and SWIS & PH? If they were removed, provide the documentation; otherwise, discuss the significance of them being left in place.
- 362.17 In FSAR, Section 2.5.4.5.2, six types of backfill materials were discussed; none was called as selected fill. Discuss the relationship.
- 362.18 Table 1 of Report No. 2, Inplace Density Tests of Selected Fill Materials below El. 390, seemed to indicate that seven (7) selected fill materials were used for West Embankment with the optimum moisture contents varied from 13.6 to 24.6 percent and the maximum dry density varied from 100 to 115 pcf. Explain how with so few moisture control tests performed in the field it can be assured that water contents of the placed fill were within the limits of +4 and -2 percentage of the optimum moisture contents.

- 362.19 Borings WE-6 & 7, drilled in Sept. 1977 (a few months prior to reservoir filling), showed that the water contents of the compacted fills varied from 19 to 34 percent. These seem to indicate that all fills were placed much wetter than originally proposed. Discuss their significance with regard to the predicted settlements.
- 362.20 Consolidation tests, as stated in FSAR Section 2.5.4.2.2, were performed in general accordance with ASTM D2435-70. However, from the information presented on Figures 2.5-114 it appeared that ASTM's standard procedure was not followed for those tests. Specifically, ASTM requires that readings should continue at least until the slope of the characteristic linear secondary portion of the thickness versus log of time plot is apparent. Later tests in conjunction with SWIS & PH investigation, similar non-conformance of ASTM procedure, as shown in Report No. 2, was also noticed. Provide the justification for making such a procedure change. Also discuss the significance of this procedure change affecting the preconsolidation pressure, the compression index, the rate of consolidation, and the overall settlement estimates.
- 362.21 Only two borings, WE-6 & 7, were drilled after the unexpected cracks were discovered in the intake structure. None was drilled along or adjacent to the intake structure. Construction records showed that several types of materials were used at the West Embankment. Provide construction records and field testing results which would enable an as-built section profile including soil properties to be established along the intake structure. If the available information is not sufficient, provide an investigation program which would provide the subsoil profile, type and thickness of

various fills, material characteristics, and consolidation characteristics of subsoil and fills.

- 362.22 Select fill materials excavated from borrow source F & G, as stated in FSAR Section 2.5.6.4.3.2, were used for most portions of the West Embankment and on-site borrow soils were used as fill below elevation 386.0'. The on-site borrow materials possess a relatively high compressibility as indicated on Figure 2.5-125. There were nine consolidation tests, but no compaction tests on these on-site borrow material. The consolidation test results shown in Figure 2.5-125 gave some indication that the behavior of those materials are rather complex. Without any compaction test data, explain, how the field placement control was achieved.
- 362.23 No consolidation test on borrow materials F & G can be found in FSAR. Without such tests, explain how the settlements of these materials were estimated.
- 362.24 Consolidation tests, performed in 1977 after the discovery of cracks in the intake structure, did not follow the ASTM procedure. These test results tend to over-estimate the preconsolidation pressures and underestimate the compression indices, therefore, the settlement estimates become non-conservative. The results presented in Appendix C of Report No. 2 show the trend of the compacted fills when they're subjected to different consolidation pressures. These results indicate that the compression indices increased significantly when the saturation pressures were increased. This implies that more settlements would be expected in the future. Discuss the significance of this observed behavior on anticipated future settlements; quantify your discussion.

- 362.25 It is not clear how the revised settlement estimate, as presented in Sec. 6.4 of Report No. 2, was obtained. Provide the calculation, and the soil profile and properties used for that estimate. Also, provide the settlement estimates and back-up data for the SW and NE corners of the pumphouse and the mid-point and east end of the intake structure. Discuss the significance of the estimated differential settlements, if they exist.
- 362.26 What are the anticipated future movements for the pumphouse and the intake structure. Identify and discuss their potential effects.
- 362.27 Borings WE-6 & 7 revealed that the moisture contents of the in-place fill were higher than the 4 percent above optimum limit prescribed in the specification. No rejection or concern was mentioned in the resident engineer's reports attached in Appendix B of Report No. 2. Document reports filed with NRC about this non-conformance in construction and how resolution was achieved.
- 362.28 The special testing, presented in Section 2.5.6.4.2.3 of FSAR, appears to be trying to justify the acceptability of the non-conformance mentioned above. However, the material tested at borrow source G, as shown in Table 2.5-59a, was not typical fill used. Materials from borrow source F and on-site soil were reportedly used to construct the West Embankment. The block samples UDS-21 & 22 were low plastic materials and do not represent the materials from source G, as presented in Figure 2.5-122. Provide additional background information related to the specification change and the special test: such as the date for requesting such a specification change and the date of performing the special test, why the test is necessary, why low plastic material was selected for the test, etc.

- 362.29 The summary of 43 gradation tests from the West Embankment, as shown in Fig. 2.5-142, revealed that select fill was not in conformance with the prescribed gradation limits. Discuss the significance of this, specifically, in the case where materials with more fines than specified were placed.
- 362.30 Many of the resident engineer's reports, presented in Appendix B of Report No. 2, stated that soft and organic materials were encountered during construction. However, none of the reports indicated that probing was carried out to determine the extent of the undesirable materials. Document the removal of these materials. Without such documentation, discuss the possibility of those materials being left in place, the effect of this error, and the significance to foundation behavior.
- 362.31 Ground surface elevations of Borings WE-1 through 5 were not compatible with the contours shown on Figure 1 "Location Plan, SWIS & PH" of Report No. 2. Clarify this with resolution and discussion and provide a sectional profile along the longitudinal axis of the SWIS & PH.
- 362.32 The intake structure, as stated in Report No. 2, was expected to undergo a linear differential settlement with some essentially rigid body rotation, based on the geometries of the underlying soils and on the overburden along its length. Hence, no significant bending of the tunnel in the longitudinal direction was anticipated and no longitudinal reinforcement was provided in the intake structure. However, our review of the boring information at the SWIS & PH area seems to indicate the boring information was not utilized for the design, because:

- a. Had information revealed by borings WE-1 through 5 been used in the design, the incompatibility of their surface elevations with what were shown on Fig. 1 "Location Plan - SWIS & PH" would have been detected and corrected.
- b. Assuming the boring locations shown on Fig. 1 were correct, the surface condition would indicate that differential settlements should be anticipated because the east end of the SWIS is founded on decomposed rock, the midpoint of SWIS on 20 feet of fill, the west end of SWIS and the east end of the PH on 15 feet of fill, 7 feet of loose soil, and 20 feet of saprolite, while the west end of PH would be on 25 feet of fill and 30 feet of saprolite. The load distribution due to the fill or structure along the axis of SWIS & PH varied from almost zero at the east end to as much as 70 feet of fill at the west end. A non-linear settlement along this axis should have been anticipated.

In addition to the boring evidence, the original settlement estimates indicate that 3 to 4 inches was expected at the PH and 1.5 to 2 inches was expected at the east end of the SWIS. With the PH sitting on top of the IS, it is difficult to understand why "no significant bending in the longitudinal direction was anticipated."

Provide the design criteria which were used for the SWIS & PH: including earth pressures under static and dynamic loading conditions and under limits of differential settlements.

362.33 ACI 318-71, Section 10.6 and the Code Commentary were cited to justify that the grouting of the cracks as wide as 0.125 inches is a precautionary

step. Section 10.6.4 stated this is not applicable for structure subjected to aggressive exposure or designed to be watertight. Discuss the applicability of this code to the SWIS.

- 362.34 Epoxy grout, as stated in Sec. 8.0 of Report No. 2, was used to fill the cracks. Fifteen test cores of the grouted cracks were reported taken in Sec. 8.0.F. What is the design strength of this grout? What were the confirmation test results? Provide those data.
- 362.35 The maximum crack width observed is stated to be about 1/8 of an inch. What was the maximum crack width at the upper face of the SWIS?
- 362.36 It appears from information in Sec. 8.0.D that the cracks were not sealed at the outer faces of the intake structure. If this is the case, what is the assurance that this grout is fully and evenly distributed along the cracks?
- 362.37 If the upper ends of the cracks were open, discuss the significance of those openings, especially the corrosion aspects of the exposed reinforcing bars. Should there be undetected and unfilled cracks through the SWIS, discuss the effects of the hydraulic gradient through the crack with regard to piping erosion of the SWIS foundation or cooling capacity and effects on pumping facilities.
- 362.38 Service water pump discharge lines, as reported in Sec. 5.4 of the Final Report, were discovered to have some misalignment requiring re-excavation in order to connect the pipes to the PH. Describe the nature of the misalignment: horizontal, vertical movement, or both and the amount of the movements. What was the condition of the pipelines already buried? Were they also misaligned? Describe the monitoring program performed along the service pipe lines?

- 362.39 Electrical duct banks were reported in Sec. 5.3 of the final report to have moved downward about 0.84 inches relative to the PH. It appears that no investigation or monitoring along the duct banks was performed. Discuss the possibility of differential settlement along the duct banks and its effects such as causing the duct bank to crack, the potential for corrosion, and water intrusion.
- 362.40 Analysis assuming a non-linear soil settlement along part of the structure was performed as indicated in Sec. 7.2 of Report No. 2.
- a) Provide the analytical model, assumptions, soil material properties used, and the results of the analysis.
 - b) If the settlement information presented in Table 3 was used in the analysis, provide the results corresponding to the state of the settlement.
 - c) Discuss the residual stresses in the concrete and the re-bars resulting from the excessive differential settlements. Discuss their effects on future performance.
 - d) If Table 3 information has not been used, provide your program to establish the stress conditions corresponding to various settlement conditions and discuss the residual settlement stress effects on the ability of the structure to also resist design loadings.
- 362.41 Horizontal movements were observed at the North and South Dams. Provide additional details, such as where, when, how much and direction of the movements; and discuss the possible causes and the effects of the horizontal movements.

- 362.42 Horizontal movements of the SWIS & PH and West Embankment were not mentioned in the documents reviewed. Sec. 2.5.6.8 of FSAR indicates that horizontal movements were measured at the North and South Dams. Justify your reasons for not making measurements of horizontal movement at the West Embankment.
- 362.43 Liquefaction potential, as stated in Sec. 2.5.4.8 of FSAR, was evaluated based on Seed's procedure. Discuss the applicability of that procedure to saprolites in light of the highly compressible nature of these materials as disclosed by laboratory test results.
- 362.44 Slope stability analysis was not performed for the West Embankment, as stated in Sec. 2.5.4.10.6.1 of FSAR, because the embankment height is lower than the north or south dam. Since the as-built conditions of the Embankment were different than those original proposed, justify the validity of not performing an analysis of the embankment. Describe the effects of the West Embankment loads on the SWIS & PH that tend to push the SWIS into the valley.
- 362.45 Dynamic analyses of typical dam sections of the north and south dams were performed based on some laboratory test results. The materials used in construction were quite different from those tested. Discuss the significance of the changed materials.
- 362.46 For the West Embankment, highly compressible materials were used. Discuss the dynamic behavior of these materials, especially seismic induced settlements.

- 362.47 For the SWIS & PH complex, discuss the potential differential ground movements resulting from SSE in a vertical and a critical oblique direction and provide the analytical results of the effects on this complex.
- 362.48 Describe the overall inspection program related to the reservoir including all dams, embankment, SWIS & PH, duct banks, SW pipeline, and the SW discharge. Since most conclusions presented in Sec. 11.0 of Report No. 2 need to be substantiated, what kind of additional monitoring program would be proposed?
Discuss how you will implement R.G. 1.127.
- 362.49 In reviewing the FSAR Sec. 2.5, some open items were noticed. For instance, on page 2.5-97, it is stated that soft and loose fill was encountered and this condition is being evaluated and appropriate corrective action will be taken as necessary. Provide the resolution and documentation back-up data for the corrective action taken.