ATTACHMENT F

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STUDIES OF CONCRETE AND COARSE AGGREGATE FROM THE DOME OF THE CRYSTAL RIVER UNIT #3 REACTOR

FOR

CONSTRUCTION ENGINEERING CONSULTANTS

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SUMMARY AND DISCUSSION

The aggregate was a crushed, fine-grained limestone. About one-half of the particles were dense and firm; the remaining one-half were fossiliferous, contained shell fragments, were generally porous, and had a chalky texture.

Dolomite was not detected. The acid insoluble residue content was 2.2 percent and consisted of clay as a major component and quartz as a minor component. The aggregate contained less than 0.1 percent clay lumps by weight.

Individual particles were generally equiaxial, and angular. All particles were dusty due to crusher fines that adhered to surface irregularities. The clay lumps will degrade during mixing.

The results of the chemical test for alkali-silica reactivity of the aggregate were negative. Thus the aggregate is classed as non-reactive.

The core represented air-entrained concrete, very well proportioned and fabricated, and made with physically and chemically sound aggregates.

On the end of the core that represented a delaminated face were secondary deposits of ettringite and calcite. The ettringite was present in voids located in a 3/16 inch thick zone at that end of the core. The secondary deposits demonstrate that the concrete at that end of the core had been exposed to moisture for prolonged periods. Because of the density of the paste (a result of the use of a low water-cement ratio) an exposure upwards of one year is probable.

In summary, the concrete was very well made and did not evidence any volume instability features due to chemical or physical changes of components. That was confirmed with respect to the coarse aggregate by separate studies of the coarse aggregate. One end of the concrete had been exposed to moisture for periods judged to be upwards of one year.

INTRODUCTION

Reported herein are the results of petrographic studies of a concrete core and a separate coarse aggregate specimen, and the chemical method for evaluating the potential alkali-silica reactivity of the aggregate specimen.

The studies were requested by J. Artuso of Construction Engineering Consultants in conjunction with concrete of the Florida Power Corporation Crystal River, Unit #3 Dome.

STUDIES

Specimens - Received for the studies were: (1) a core identified as No. 8B-3 and representing concrete near the apex of the dome (one end of the core was the surface of a delamination face); and (2) coarse aggregate used for the construction.

Petrographic Studies (Aggregate) - The studies were made in accordance with the procedures given in ASTM Designation: C295, "Petrographic Examination of Aggregates For Concrete" and Erlin, Hime Associates Quality Control Procedures For Nuclear Power Projects.

The aggregate was a gray-white, crushed, fine-grained, massive textured, fossiliferous limestone. The maximum nominal size was 3/4 inch. The aggregate contained clay lumps; however, the clay constituted less than 0.1 percent, by weight, of the total aggregate.

Approximately one-half of the limestone was fossiliferous. These particles were generally more porous and many contained small vugs. The remaining limestone was hard and dense. The clay lumps were soft and friable. Many contained shell fragments. These particles will probably degrade during mixing.

The calcite/dolomite ratio, determined by X-ray diffraction methods was 1:0 (dolomite was not detected.) The acid-insoluble residue content was 2.2 percent. The residue consisted of clay as a major component and quartz as a minor component. Opaline material was not detected.

Particles were generally equi-axial and angular. Broken edges were sharp, or frequently rounded due to attrition during processing. The aggregate was dusty due to crusher fines that adhered to surface irregularities. The aggregate should be washed prior to use.

Quick Chemical Test - The aggregate was tested for alkali-silica reactivity in accordance with the procedures in ASTM Designation: C289, "Potential Reactivity of Aggregates (Chemical Method)".

Test results are given below.

R_c 37 millimoles per liter.
S_c 19 millimoles per liter.

The test data indicates the aggregate to be innocuous.

Petrographic Studies (Concrete) - The core had a diameter of 3 5/8 inches and a length of 5½ inches.

The coarse aggregate of the core was as described in the section covering the petrographic examination of the aggregate. The fine aggregate was a siliceous sand constituted principally of quartz.

The aggregates were poorly graded as demonstrated by deficiencies of the finer sizes of the coarse aggregate and the coarse sizes of the sand.

There was no evidence that the aggregate had been either physically or chemically unsound. Not detected were alkali reactive materials such as chert and opal, or reaction products of chemically unstable aggregates.

Paste was medium dark gray, firm, and contained abundant residual and relict cement. The compositional and textural characteristics of the paste are indicative of a low water-cement ratio.

Air in the core occurred as small, discrete, spherical voids characteristic of air purposefully entrained, and as coarser non-spherical voids characteristic of entrapped air. The air content of the core is estimated to be 5½ percent and the parameters of the air-void system are judged to be effective for protecting critically saturated concrete exposed to cyclic freezing.

On one of the ends of the core, and in a 3/16 inch zone at that end, were secondary deposits of acicular ettringite ($3CaO{\cdot}Al_2O_3{\cdot}3CaSO_4{\cdot}31H_2O$) that lined samll surface areas on the end and some of the air voids in the 3/16 inch zone. Secondary calcite ($CaCO_3$) was associated with the ettringite on the end of the core. These secondary deposits demonstrate that the concrete portion associated with the ettringite had been exposed to moisture for prolonged periods.

June 25, 1976

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