EVALUATION REPORT REGARDING THE

CONCRETE STRENGTH OF THE

REACTOR BUILDING BASE MAT

WOLF CREEK GENERATING STATION

On December 12 and 13, 1977, the Wolf Creek reactor building base mat was placed as a monolithic pour of approximately 6600 cubic yards of concrete. At the end of the 90-day curing period, thirty-four out of a total of sixty-six sets of concrete cylinders tested exhibited strengths below the specified concrete strength of 5000 pounds per square inch. Thirty sets of the concrete cylinders tested at 90 days had strengths which were lower than the strengths previously determined for the same batch of concrete after 28 days. The 5000 pounds per square inch strength for the concrete was specified by Bechtel (architect-engineer for the plant), in conjunction with other design parameters (e.g., base mat thickness and rebar arrangement), in order to satisfy the design criteria specified in the Wolf Creek Preliminary Safety Analysis Report (PSAR). These criteria require that the base mat be able to withstand, without impairment of its structural integrity or its safety function, the specified design loads and loading combinations.

Subsequently, the applicant conducted several investigations to determine the possible causes of the anomaly and submitted the results of the investigations in a report, dated October 26, 1978. The applicant concluded in its report that the 90-day strength of the concrete in the reactor building base mat was above 5000 pounds per square inch and that the apparent low strength of a portion of the 90 day cylinders was attributed to errors in testing.

The matter was investigated by the NRC Office of Inspection and Enforcement (IE) with the help of an outside consultant. As a result of the investigation, IE determined that the conclusions made by the applicant in its report of October 26, 1978, were not sufficiently supported by the facts contained in the report. Detailed findings of the investigation performed by IE are described in a report, dated February 16, 1979. Subsequently, the applicant performed additional studies in order to resolve the issues and concerns expressed by the NRC staff. At our request the applicant also performed a reanalysis of the base mat, based on the concrete strength indicated by the results of the 90-day cylinder tests, to determine if the design stresses are within allowable limits and whether the base mat design satisfies all commitments made in the Wolf Creek PSAR.

Additional tests were performed by the Construction Technology Laboratories of the Portland Cement Association on 48 concrete cylinder remnants previously tested at 90 days and on 26 cylinder remnants previously tested at 28 days. Cement compression strength tests were also performed on four cement samples. The additional concrete tests consisted of compressive strength tests on two-inch cubes sawed from the cylinder remnants, and petrographic examination and chemical analysis of a selected group of cylinder remnants. All of these test results are described in detail in reports submitted by the applicant by letters, dated February 28, 1979 and May 3, 1979. In addition, the Structures Laboratory of the Corps of Engineers, USAE Waterways Experiment Station, Vicksburg, Mississippi, conducted a petrographic examination of concrete thin sections and documented its conclusions in a report, dated July 2, 1979.

We have completed our review of the results of the tests performed by the Portland Cement Association and the evaluation performed by the Corps of Engineers. Based on our review of the test data, we conclude that there is no evidence of degradation of concrete strength nor is there any sign of substandard or faulty cement. However, we cannot conclude that the low 90-day strengths obtained with the cylinder tests are attributed to testing machine factors or testing conditions as claimed by the applicant. We note that the 90-day cylinder strength test results correlate very well with the two-inch cube compressive strength test results. In fact if both sets of results are plotted, the two curves would almost be parallel. Because of this excellent correlation between the strengths of cubes and cylinders, we conclude that the 90-day cylinder test results should be considered as valid and that these results should be used in assessing the load carrying capacity of the base mat.

The applicant completed the requested reanalysis of the base mat and the results were submitted by letter, dated May 10, 1979. In order to perform the reanalysis, the applicant first determined a concrete strength for the mat based on the 90-day cylinder test results by utilizing the established acceptance criteria in Section 4.3 of American Concrete Institute (ACI) Standard 318-71. We concur with the applicant that the resultant strength is 4460 pounds per square inch.

The reanalysis of the base mat was then performed in accordance with the original design commitments of the Wolf Creek PSAR by using the calculated concrete strength of 4460 pounds per square inch. A seismic soil-structure interaction analysis was performed by using the computer code FLUSH based

on a finite element approach. Since the Wolf Creek plant is one of th
five SNUPPS standard plant units, the SNUPPS envelope design earthquak
motions of 0.20g for the safe shutdown earthquake (SSE) and 0.12g for t
operating basis earthquake (OBE) were used to generate the seismic desig
forces for the base mat. The SSE and OBE for the Wolf Creek site are 0.1
and 0.06g, respectively.

The seismic forces generated by the finite element approach were compared with those generated by another established method of analysis, the fixed base approach, to demonstrate that the seismic loads used in the reanalysis are conservative for the Wolf Creek plant. For the fixed base approach, the Wolf Creek site specific design earthquake ground motions of 0.12g for the SSE and 0.06g for the OBE were used as input motions.

The results of the reanalysis by both approaches indicate that the base mat meets the design criteria for the Wolf Creek facility and that the tensile stresses of the reinforcing steel are controlling. Thus, the base mat design is controlled by tension and the load carrying capacity of the mat is governed primarily by the amount of reinforcing bars provided in the base mat. Lowering the specific concrete design strength from 5000 to 4460 pounds per square inch has very little effect on the load carrying capacity of the base mat.

Based on our review of the test results and the results of the reanalysis, we conclude that the base mat concrete strength has not retrogressed, that the strength of the base mat meets the original design criteria

in the Wolf Creek PSAR, and that the mat will withstand the specified design loads and loading combinations without impairment of its structural integrity or its safety function.

Ms. Wanda Christy
515 N 1st Street
Burlington, KS 66839

Dear Ms. Christy:

William H. Ward, by petitions dated January 11 and June 29, 1979, on behalf of the Mid-America Coalition for Energy Alternatives (MCEA), Richard P. Pollack, by petition dated December 27, 1978, on behalf of the Critical Mass Energy Project, and other persons have requested that the Commission suspend or revoke Construction Permit No. CPPR-147 which authorizes construction of the Wolf Creek Generating Station Unit No. 1.

For the reasons stated in the enclosed decision, these petitions are denied.

A copy of the decision will be filed with the Secretary of the Commission for its review in accordance with 10 CFR 2.206(c) of the Commission's regulations. As also provided in 10 CFR 2.206(c), the decision will constitute the final action of the Commission twenty (20) days after the date of issuance, unless the Commission on its own motion institutes review of the decision within that time.

Sincerely,

Victor Stello, Jr.
Director
Office of Inspection
and Enforcement

Enclosure:
Director's Decision Under
10 CFR 2.206

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