NATHAN M. NEWMARK
CONSULTING ENGINEERING SERVICES

1114 CIVIL ENGINEERING BUILDING
URBANA, ILLINOIS 61801

4 November 1971

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Mail Section

Mr. Edson G. Case, Director
Division of Reactor Standards
U.S. Atomic Energy Commission
Washington, D.C. 20545

Re: Contract No. AT(49-5)-2667
Final Report
Surry Power Station Units 1 and 2
Virginia Electric and Power Company
AEC Docket Nos. 50-280 and 50-281

Dear Mr. Case:

We are transmitting herewith 8 signed copies of our Final Report concerning the Operating License Review for the Surry Power Station Units 1 and 2.

Sincerely yours,

W J Hall

W. J. Hall

pg
Enclosure

cc: N. M. Newmark

4859

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REPORT TO THE AEC REGULATORY STAFF

STRUCTURAL ADEQUACY

OF

SURRY POWER STATION UNITS 1 AND 2

Virginia Electric and Power Company

AEC Docket Nos. 50-280 and 50-281

by

N. M. Newmark

and

W. J. Hall

Urbana, Illinois

4 November 1971

REPORT TO THE AEC REGULATORY STAFF

STRUCTURAL ADEQUACY

OF

SURRY POWER STATION UNITS 1 AND 2

INTRODUCTION

This report is concerned with the structural adequacy of the containment structures, piping, equipment and other critical components for the Surry Power Station Units 1 and 2 for which application for a construction permit and an operating license has been made to the U.S. Atomic Energy Commission by the Virginia Electric and Power Company. The facility is located in Surry County, Virginia on the south side of the James River, approximately 30 miles NW of Norfolk, Virginia and 7 miles S of Williamsburg, Virginia.

This report is based on a review of the Final Safety Analysis Report and supplements (Ref. 1) and supplementary material (Ref. 2). The report also is based in part on discussions held with the applicant and his consultants at the time of a visit to the Surry Power Station Site on 20 October 1970 by W. J. Hall with D. Muller and R. Lee (DRL/AEC). A discussion of the adequacy of the structural criteria presented in the Preliminary Safety Analysis Report is contained in our report of March 1968 (Ref. 3), and unless otherwise noted no comment will be made in this report concerning points covered therein.

The design criteria for Class I components for this plant called for a design to withstand a Design Basis Earthquake of 0.15g maximum horizontal ground acceleration, coupled with other appropriate loadings to provide for containment and safe shutdown. The plant also was designed for an Operating Basis Earthquake of 0.07g maximum horizontal ground acceleration acting simultaneously with other appropriate loadings forming the basis of containment design.

COMMENTS ON ADEQUACY OF DESIGN

Foundations

The foundation conditions for the various Surry Power Station structures were considered in detail at the time of the PSAR review. At the time of the site visit it was ascertained that, with Unit 1 of the plant at approximately 80% completion, no unexpected motions of the foundations had been noted under the static loading imposed.

In the interim, since the PSAR review, two lateral load tests of piles were made to verify the computed deflections used in the design of the fuel building. The pile tests showed that the computed values were reasonable; the values of possible lateral motion used in design are presented in Table 2.4-5 for the piling. These values appear reasonable to us.

The calculated expected displacements for the various structures are presented in Table 2.4-5; the rattle space provided between buildings is presented on page 2.4.8-3, namely a space of 6 in. between the pile-supported fuel building and the auxiliary building and between the fuel building and the containment structures, and a clearance of 3 in. between other structures. The applicant indicates on page 15.2-17 that the clearance provided between structures is a minimum of 2 in. In any event, whether the clearance is 2 in. or the larger values as cited in Section 2 on page 2.4.8-3, we feel that these clearances are adequate.

The applicant advises in the answer to Question 2.14 that a check of the vertical motions has also been made, and that a further check has been made to insure that the pipe stresses of all Class I piping between structures is within acceptable limits. We concur in the approaches followed.

A discussion of the analyses that have been carried out for liquefaction potential of strata in the site area is presented in Section 2.4.5.1. The summary of the liquefaction studies indicates that with the depressed piezometric levels under the Surry structures, the potential for liquefaction is quite low. Additional information on the depressed piezometric levels is presented in the answer to Question 2.16, wherein it is noted that the piezometric levels are slightly lower in 1971 in comparison to the values for 1967. These data, covering piezometer readings over the plant area, help confirm the low probability of any difficulty with liquefaction. Also, the applicant states that the liquefaction analysis was based on surface accelerations of 0.15g. On the basis of the information provided, and other studies and judgments that we have made independently, we believe the design has been carried out in a manner which makes the probability of liquefaction negligible. We believe the design to be satisfactory in this regard.

Dynamic Analyses

a) Class I Structures

The procedures followed in the dynamic analysis of major Class I structures are described in Section 15.5.1.4 of the FSAR and in the answer to Question 5.21. It is noted that the structures were analyzed using a Stone and Webster proprietary computer program, "Container Vessel Seismic Analysis". It is indicated on pages 15.5.1.5-2 and -3, in the answers to Questions 5.12 and S5.12, and Ref. 2(c), that for the OBE a value of 5 percent of critical damping was used for the coupled soil-structure model, whereas for the Design Basis Earthquake a damping value of 10 percent of critical was used; these latter values, according to the applicant, include the effects of radiation damping and soil-structure interaction. For example, the high damping for Mode 2, as presented in the answer to Question S5.12-1, corresponds only to translational motion and is not applicable to other modes or to internal strains. On the basis of the information presented in the answer to Question 5.12, and the discussion in Section 15.5, and on the basis of additional clarifying material to be provided in Section 15.5 in a later amendment, we conclude that structural component damping of 5 percent was used for the DBE analysis. The total modal damping (by mode) tabulated in the answer to Question 5.12 appears reasonable for the Surry site. The system damping of 10 percent for the DBE, as discussed in Ref. 2(c), includes the energy losses from the coupled soil-structure model and appears reasonably conservative to us for this site.

b) Piping and Equipment

The seismic design approach for the nuclear steam supply system is outlined in Appendix B of the FSAR. It is indicated that the Westinghouse portions of the system are analyzed in accordance with Westinghouse Report WCAP-5890, Rev. 1, and we are in agreement with the approach adopted.

The applicant states in the answer to Question 5.12 that 0.5 percent damping was used in all the piping analyses for the OBE and 1.0 percent for the DBE; we have been advised that the 1.0 percent of critical value is correct, in contrast to the lower value stated on page 24 of Ref. 2(c). A general description of the analysis procedure employed by NSSS piping is presented in the answer to Question 4.12.

With respect to the dynamic piping analysis, the answer to Question 5.1 indicates that differential support motions for piping were included in the analyses. Where piping ran between buildings and the supports could move relative to one another, the differential motion also was taken into account in the analyses.

For piping and components supplied by Stone & Webster, the answer to Question 4.10 indicates that major equipment-supporting structures and piping systems were dynamically analyzed. Mechanical components (Class I) were procured with specified seismic coefficients corresponding to the peak acceleration values on the response spectrum curves. Additional information on these approaches, including typical stress summaries, is presented in Ref. 2(c). The procedures and results presented appear reasonable and satisfactory to us.

c) Vertical Earthquake Excitation and Critical Instrumentation and Controls

The answer to Question 4.23 describes the approach employed for the vertical excitation. For the containment structure and other rigid structures, the approach of using two-thirds of the horizontal acceleration is satisfactory. In the case of equipment, it is indicated that the acceleration magnitudes are included in the equipment specification. Subsequently later during plant design and construction, a seismic review was carried out as described in detail in Ref. 2(c). Floor response spectra were computed and adapted to design use. As noted on page 24 of Ref. 2(c), in Ref. 2(d) and in the answer to Question S5.16-1, many changes and alternations in equipment support and bracing were made. The margins reported in Table 4-1 are satisfactory.

The answer to Question 4.10 indicates that the vendor is required to validate component integrity under the specified seismic conditions. A general description of the approach adopted is presented in Sections 5.0 and 6.0 of Ref. 2(c) and is acceptable to us.

Reactor Internals

The answer to Question 4.13, dealing with reactor internals, makes reference to the H. B. Robinson response to Question 1.1B dated 5 November 1969. Topical Report WCAP #7332-L, covering the seismic analyses of reactor internals for pressurized water reactors, is applicable. The approach followed here appears acceptable to us.

Design Stresses

The discussion on page 15.2-17 of the FSAR indicates that for those structures subjected to the DBE loading and analyses, allowable stresses do not exceed 90 percent of the yield strength for structural steel or in the case of reinforcing steel and concrete, the capacity reduction factor times the specified yield strength for reinforcing steel or the specified strength for concrete. The answer to Question 5.8 indicates that the stresses cited are of the order of 50 percent of ultimate strength. On this basis there is reason to believe that the deformation associated with these design stresses are generally low although the amount of deformation that may be controlling under the maximum loading conditions between the various materials used may not be precisely similar. We must assume, for lack of other evidence, that where composite action is called for, the compatibility of the deformations in the various elements have been studied carefully and taken into account.

SUMMARY COMMENT

On the basis of our review of the FSAR and the answers to the questions given in the supplement, it appears to us that the design possesses a margin of safety which is adequate in terms of provision for safe shutdown for a Design Basis Earthquake of 0.15g maximum horizontal ground acceleration and to withstand otherwise the effects of an earthquake of half this amount.

REFERENCES

1. "Final Safety Analysis Report -- Vol. 1-5 (Part B), plus Supplement Vol. 1 and 2, and Amendments 14, 15, 17, 19, 20, 21, 22, 23, 24, 25", Surry Power Station Units 1 and 2, Virginia Electric and Power Company, AEC Docket Nos. 50-280 and 50-281, 1969.

2. Supplementary material:

   (a) "Surry Nuclear Power Station Preoperational Environmental Radiation Surveillance Program", Report, 1 May 1968 through 30 June 1970, Virginia Electric and Power Company.

   (b) "Lateral Load Pile Tests -- Surry Power Station -- Virginia Electric and Power Company", prepared by Stone & Webster Engineering Corporation, Boston, Massachusetts, July 1968.

W. J. Hall

(c) "Seismic Design Review, Equipment and Piping, Surry Power Station", Virginia Electric and Power Company, Revised 15 Sep. 1971.

(d) "Qualification Test of Prototype -- Vertical Induction Motor -- Containment Recirculation Spray Pump", by J. P. Waggener et al, Franklin Institute Research Laboratories, Final Report F-C2909, 1971.

3. "Adequacy of the Structural Criteria for the Surry Power Station Units 1 and 2, Virginia Electric and Power Company", AEC Docket Nos. 50-280 and 50-281, by N. M. Newmark, W. J. Hall, and A. J. Hendron, Jr., March 1968.