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November 28, 1969

Dr. Peter A. Morris, Director
Division of Reactor Licensing
U. S. Atomic Energy Commission
Washington D.C. 20343

Contract No. AT(49-5)-4011
Blume Project No. 2085504
Subject: Palisades Plant
Docket No. 50-255

Dear Dr. Morris:

We are transmitting herewith five copies of our report, "Review of the Seismic Design of the Palisades Plant." This report has been revised to include an evaluation of the data submitted by the applicant at a meeting on October 17, 1969, and the informal submittal, "Piping Systems Seismic Design Summary," Amendments 16 and 17, additional data recently received, and data gained during a tour of the facility on November 25.

You will note that there are several items the applicant has stated he will do. The principle item is the further analysis and subsequent installation of any corrective measures necessary to insure safety of Class I components in the Turbine and Auxiliary Buildings. Based on observations during our site visit we also suggested that the seismic design of the shutdown heat exchangers be reviewed. You will also note there are several follow-on items in our report.

Very truly yours,

JOHN A. BLUME & ASSOCIATES, ENGINEERS

Roland L. Sharpe
Executive Vice President

RLS:nlk

Enclosure

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REVIEW OF THE SEISMIC DESIGN

OF THE PALISADES PLANT

(Docket No. 50-255)

November 28, 1969

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San Francisco, California

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REVIEW OF THE SEISMIC DESIGN

OF THE PALISADES PLANT

(Docket No. 50-255)

INTRODUCTION

This report summarizes our review of the engineering factors pertinent to the seismic and structural adequacy of the Palisades Plant. The plant is located in Covert Township on the southwestern side of Van Buren County, Michigan, and is on the eastern shore of Lake Michigan approximately four-and-one-half miles south of the city limits of South Haven, Michigan. The design and construction of the plant were performed by Bechtel Corporation under the direction of the applicant, Consumers Power Company. The nuclear steam supply system was manufactured by Combustion Engineering, Inc. Application for an operating license has been made to the U. S. Atomic Energy Commission (AEC Docket No. 50-255) by Consumers Power Company. A Safety Analysis Report has been submitted in support of the application to show that the plant was designed and constructed in a manner which will provide for safe and reliable operation. Our review is based on the information presented in the Safety Analysis Report and information presented by the applicant at meetings and during a visit to the plant site. The review is directed specifically towards an evaluation of the seismic and structural design of Class I structures, systems and components. The list of reference documents upon which this review has been based is given at the end of this report.

DESCRIPTION OF FACILITY

The Palisades Plant site is located in an area of sand dunes which were removed for construction of the plant. Underlying these dunes are approximately 160 ft of glacial deposits of varying types. The upper layer of glacial deposits is approximately 45 ft thick and consists of compact

glacial lake deposits. The lower layer is approximately 115 ft thick and consists of a compact glacial till. These glacial deposits overlay a bedrock sequence of Mississippian Coldwater Shale. The top of the bedrock is approximately at elevation 430 ft and the bottom of the reactor structure is approximately at elevation 575 ft.

The Containment Structure is a prestressed concrete cylinder and dome which is supported on a reinforced concrete foundation slab. The interior of the structure is lined with a 1/4 inch thick welded steel plate to ensure leak tightness. The inside diameter of the Containment Structure is 116 ft and the inside height including the dome is 189 ft. The vertical wall thickness is 3-1/2 ft and the dome thickness is 3 ft. The foundation slab thickness varies from 8-1/2 to 13 ft. The dome and walls of the Containment Structure are post-tensioned. This post-tensioning system consists of three groups of 55 dome tendons oriented at 120° to each other and anchored at the vertical face of the dome ring girder; the walls are post-tensioned by 180 vertical tendons anchored at the top surface of the ring girder and at the bottom of the base slab. In addition, six groups of 87 hoop tendons enclosing 120° of arc are anchored at six vertical buttresses. The anchorage system used in the post-tensioning is the BBVR type, furnished by Inland-Ryerson Construction Products Company.

Reinforced concrete construction is used for the Auxiliary Building. A steel structure with metal siding encloses and supports the fuel handling crane over the spent fuel pool. The Turbine Building consists primarily of steel construction with concrete slabs and a massive concrete turbine support structure.

STRUCTURAL DESIGN CRITERIA AND LOADS

All structures, equipment, systems, and piping are classified according to function or consequence of failure as either Class 1, 2, or 3 as defined in Appendix A of the Safety Analysis Report. Class 1 structures,

systems, and equipment are those whose failure could cause uncontrolled release of radioactivity or are those essential for immediate and long-term operation following a loss of coolant accident. They are designed to withstand the appropriate seismic loads simultaneously with other applicable loads without loss of function. Class 2 structures, systems, and equipment are those where limited damage would not prevent safe shutdown or whose failure would not cause uncontrolled release of radioactivity. There are no structures considered to be Class 2; however, there are Class 2 systems and equipment. Class 3 structures, systems, and equipment are those whose failure would not result in a release of radioactivity and would not prevent reactor shutdown but may interrupt power generation.

The design loads for the Palisades Plant are divided into two basic categories. The first category includes normal operation (dead, live, and prestress loads) and the second category includes accident, wind and seismic conditions. Structure design loads are increased by load factors based on the probability and conservatism of the predicted design loads. In determining the capacities of the structures, yield capacity reduction factors are applied to the stresses allowed by the applicable building codes.

The Containment Structure has been designed for a design pressure of 55 psig and a test pressure of 63.3 psig. The maximum design temperature is 283°F. The Containment Structure is designed for a 40 psf snow or ice load on the roof, and no loads due to flooding are considered.

Wind loads were determined for a 90 mph wind using the methods outlined by the Task Committee of Wind Forces, ASCE paper No. 3269 "Wind Forces on Structures." The structure has been designed for tornado loading which corresponds to a design tornado with a 300 mph tangential velocity, a 60 mph forward velocity, and an atmospheric pressure drop of 3 psi. Tornado generated missiles considered in the design were a 12 ft long 4 x 12 plank at 300 mph and a 4000 lb automobile at 50 mph at a height less than 25 ft above grade.

A maximum potential earthquake was specified with a maximum horizontal ground acceleration of 0.2g and a smooth response spectrum as originally defined by Dr. G. W. Housner. The design earthquake has a maximum horizontal ground acceleration of 0.1g and a response spectrum similar to the maximum potential earthquake. Vertical ground accelerations are 2/3 of the horizontal ground accelerations for both earthquakes. These seismic criteria have been previously accepted by the AEC.

COMMENTS ON THE ADEQUACY OF THE SEISMIC DESIGN

We have reviewed the information presented by the applicant in the Final Safety Analysis Report, in Amendments No. 14 through 17, and an informal report "Piping Systems Seismic Design Summary." In addition, we have discussed the various aspects of the seismic design of the plant with the applicant and members of the staff of the Division of Reactor Licensing at a meeting on October 17, 1969 and during a site visit on November 25, 1969.

Based on the information presented by the applicant, we concur in general with the seismic design criteria and with the approach to seismic design of structures, piping, and equipment taken by the applicant. The analytical techniques used by the applicant are satisfactory and approximate techniques, where utilized, appear to result in a conservative design. We do, however, have several reservations about the design which have arisen either because the applicant has not submitted sufficient information or because he has not yet completed the design and/or construction of the item in question. These reservations are as follows.

The applicant has stated that Class I piping systems are currently being analyzed for seismic adequacy and that sufficient restraints and/or snubbers will be installed to insure that the Class I systems will not be overstressed when subjected to earthquake ground motions postulated for the site. The applicant has further stated that spacers or other means will

be used between adjacent pipe runs to prevent damage due to impact during maximum seismic conditions. Analyses are now being performed by the applicant to determine if additional restraints or other provisions are necessary to insure the seismic adequacy of motor-operated or piston-operated valves. Based on our observations during our site visit, we have suggested that the seismic design of the shutdown heat exchangers be reviewed.

With regard to the seismic adequacy of Class I electrical instrumentation, battery racks, power panels, and switch gear, the applicant has stated that these critical components have been or are being analyzed for maximum seismic conditions. Anchors to resist seismic shears and overturning moments have been designed and are or will be installed on all Class I electrical instrumentation, power panels, battery racks, and switch gear cabinets.

With regard to the adequacy of the Turbine Building under Class I seismic loads and its possible effect on the adjacent Auxiliary Building, the data presented by the applicant in Amendment 17 and during the site visit indicate that horizontal movement of the Turbine Building due to earthquake may damage a portion of the Auxiliary Building where the operating floor of the Turbine Building connects thereto. In addition, the description of the analysis submitted by the applicant for Class 3 on page 8-2 of Amendment 17 does not indicate whether the stresses in the Turbine Building and Turbine Pedestal due to impact of the building frame and pedestal have been analyzed. Impact stresses could be high and cause failure of the Turbine Building frame. We understand that the applicant is making further analyses of the effects on the Auxiliary Building and of the effects of impact. Presumably the applicant will make any corrections or additions to the structures necessary to insure safety of all Class I components under earthquake conditions.

We have also requested (and not yet received) additional information and justification of the properties of the foundation materials used in the

seismic analysis. The accurate definition of these properties is important because the properties significantly affect the modes of vibration of the structure, which in turn affect the peak accelerations for which the structure must be designed and the shape of the response spectra used for the design of equipment and piping.

We consider the results of the structural integrity tests as essential evidence of the adequacy of the design. We understand that these tests will be performed early next year and, at that time, we would like to review the testing program prior to the tests and the results of the tests.

The applicant has stated that a strong motion seismograph and three peak-reading accelerometers will be installed at the plant. We strongly recommend that the applicant make a careful study of the facility to insure proper location of these instruments and that procedures for utilizing the data obtained from the instruments in case of earthquake be developed within the near future.

CONCLUSIONS

On the basis of the information presented by the applicant in the Final Safety Analysis Report and Amendments and oral statements at the meeting and site visit, and provided the items mentioned above are satisfactorily resolved, it is our opinion that the Palisades Plant will have an adequate margin of safety to resist the earthquake conditions postulated for the site.

JOHN A. BLUME & ASSOCIATES, ENGINEERS

Roland L. Sharpe

Roland L. Sharpe

Garrison Kost

Garrison Kost

REFERENCES

Final Safety Analysis Report - Volume I

Final Safety Analysis Report - Volume II

Final Safety Analysis Report - Volume III

Amendments 11 through 17

"Piping Systems Seismic Design Summary"