REVIEW OF THE SEISMIC DESIGN CRITERIA

FOR THE BEAVER VALLEY POWER STATION

(Docket No. 50-334)

Revised April 10, 1970

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This report summarizes our review of the engineering factors pertinent to the seismic and structural adequacy of the Beaver Valley Power Station. The plant will be located in Shippingport Borough, Beaver County, Pennsylvania on the south bank of the Ohio River approximately one mile from Midland, Pennsylvania. Immediately west of the plant is the Shippingport Atomic Power Station. The design and construction of the plant will be performed by Stone & Webster Engineering Corporation under the direction of the applicant, the Duquesne Light Company. The nuclear steam supply systems will be supplied by Westinghouse. A Preliminary Safety Analysis Report has been submitted in support of the application to show that the plant will be designed and constructed in a manner which will provide for safe and reliable operation. Our review is based on the information presented in the Preliminary Safety Analysis Report and Amendments, and 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 Beaver Valley Plant site is located on gently sloping river terraces on the south bank of the Ohio River. The plant will be about 1000 ft southeast of the river; ground surface of the plant will be about 40 ft above normal river level. Steep bluffs which comprise the margins of the river valley rise to elevations several hundred feet above river level south and east of the site. The site is located in an area of river deposits which were removed for construction of the plant. Underlying these

sedimentary deposits is a terrace of well-consolidated alluvial gravels. These gravels have a maximum depth of about 100 feet and rest directly on the sandstone and shale bedrock of Pennsylvanian age. The bedrock is bedded horizontally and is essentially undeformed.

Foundation materials vary from gravelly soils to highly silty and clayey soils. Gravelly soils are predominant on the upper bench where the reactor structure will be located and relatively weak silty and clayey soils predominate near the rivers edge where the cooling water intake facilities will be located. In the area intermediate between the upper bench and the river where some major structural components will be placed the uppermost soils will be excavated and replaced with compacted fill.

The containment structure will be reinforced concrete cylinder and dome supported on a reinforced concrete foundation slab. The interior of the structure will be lined with a welded steel plate to ensure leak tightness. The inside diameter of the containment structure will be 126 ft. The vertical wall thickness will be 4½ ft and the dome thickness will be 2½ ft. The foundation slab thickness is 10 ft.

STRUCTURAL DESIGN CRITERIA AND LOADS

Class I structures, systems, and equipment are those whose failure could cause or increase the severity of a loss-of-coolant accident. They are designed to withstand the appropriate seismic loads simultaneously with other applicable loads without loss of function. Structure design loads are increased by load factors based on the probability and conservatism of the predicted design loads. 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 45 psig. The maximum design temperature is $280^{\circ}F$. The containment structure is designed for a 40 psf snow or ice load on the roof. Loads due to flooding are a factor only during construction of the containment building.

Wind loads are to be determined for an 80 mph wind using the methods outlined by the Task Committee on Wind Forces, ASCE Paper No. 3269 "Wind Forces on Structures". The structure will be 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 will be among others, a 35 ft long utility pole at 150 mph.

ADEQUACY OF THE SEISMIC DESIGN CRITERIA

We have reviewed the Preliminary Safety Analysis Report and Amendments No. 1 through 15. In addition, we have discussed the various aspects of the seismic design of the plant with the applicant and members of the staff of of the Division of Reactor Licensing at meetings on January 28, 1970 and March 18, 1970. We have the following comments regarding the adequacy of the seismic design criteria:

1. An analysis of settlements in the founding soils has been presented by the applicant and based upon this data the predicted settlements can be accomodated by suitable design procedures. In addition, the applicant has considered the possibility of densification of granular soils under vibratory loading due to earthquake and has indicated that suitable precautions will be taken to prevent vibratory densification.

2. One of the areas of concern is possibility of liquefaction in those soils which consist predominantly of sand. The applicant has shown that the natural in-place density and grading of the sand are not within the range characteristic of sands which have been found to be subject to liquefaction during earthquakes.

3. The applicant has presented slope stability analyses developed for saturated conditions and under earthquake loading. Based upon the

data which was submitted the slope design should be adequate with respect to safety and integrity of Class I structures. It should be noted that saturation of soils can be achieved under conditions of thawing snow or prolonged heavy rainfall without necessity of flooding. Therefore the assumption of saturated conditions is not overly conservative and combining this condition with the DBE is appropriate.

4. Geologic reports state that the sedimentary strata beneath the site are very gently folded which indicates that the region has probably not been subject to strong stresses for at least since the Pennsylvanian period, and is not considered tectonically active. The reports further indicate that no faults are known to exist at the site or in the surrounding region. The nearest fault is said to be located about 60 miles southeast of the plant site trending in a northeasterly direction.

5. Historically, no earthquake of epicentral intensity greater than V has occurred within 80 miles of the site. The nearest earthquake occurred at Sharon, Pa., about 40 miles north of the site, and had an epicentral intensity of MM III or IV. It is estimated that the New Madrid (1812) and Charleston (1886) earthquakes may have caused intensities of up to MM V at the site. The nearest areas of moderate seismicity are near Attica, N.Y. and Anna, Ohio, both about 200 miles from the site; earthquakes in these areas have had a maximum intensity of MM VIII, and apparently none of these has been perceptible at the site. It is estimated by the applicant that the maximum bedrock acceleration under DBE conditions would be 0.035g, which results in a peak ground surface acceleration of 0.125g for the Design Basis Earthquake (DBE). A peak ground acceleration of 0.06g has been selected for the Operating Basis Earthquake (OBE). We concur with the selection of these ground accelerations for the DBE and OBE. We also concur with the response spectra for the DBE and OBE and the method of application of these spectra as proposed by the applicant in Appendix B, Amendment 15.

6. The applicant has stated that he will use the response spectrum method of dynamic analysis for Class I structures, piping, and equipment, and that discrete-mass multiple-degree-of-freedom mathematical models will be developed for the structural system. Possible variations in foundation material properties will be considered in the seismic analyses. Structures will be analysed for response in both the horizontal and vertical directions, and horizontal and vertical response spectra will be developed at the points of support of piping and equipment. We concur in general with this approach. The analytical techniques proposed by the applicant are satisfactory and if properly implemented will result in a conservative design.

7. The applicant has proposed to use approximate techniques for the development of response spectra to be used in the design of Class I piping and equipment supported within structures. These methods are based on assumed motions at the support points of piping and equipment. We have at several times expressed concern about the conservativeness of the proposed method as compared to the more commonly accepted time-history method. The applicant has presented a comparison of the two methods in Amendment 15. In these comparisons, the applicant has introduced an "r" factor which was not in the method as originally proposed in the PSAR. The comparisons presented in Amendment 15 do not demonstrate that the proposed approximate method produces conservative results.

   The applicant has also stated in Amendment 15 that he will develop comparisons of response spectra computed by his proposed method and the time-history method for the Beaver Valley Plant. He has stated that these comparisons will be developed for the appropriate piping and equipment damping ratios and will utilize an input time-history that produces the closest match to the response spectra presented in the PSAR. The applicant has also implied, although it is not entirely clear, that the actual spectra utilized in the design will envelope the spectra produced by the proposed method and the time-history method. The applicant has not specifically stated what will be

done in this regard for Class I structures other than the containment structure; we feel this point should be clarified.

In summary, the applicant has not yet demonstrated that the proposed approximate method to develop response spectra at the support points of Class I piping and equipment is conservative. He has outlined a program to substantiate the validity of his approach as applied to the Beaver Valley Plant. Although certain details of this program are not entirely clear, we feel that the general over-all program is acceptable. We recommend that the applicant be required by the AEC to submit his demonstration of the validity of the proposed method to the AEC for review and approval prior to utilization of the response spectra curves in the final design.

CONCLUSIONS

On the basis of the information presented by the applicant in the Preliminary Safety Analysis Report and Amendments, it is our opinion that the seismic design criteria and approach to seismic design as outlined in the PSAR and Amendments 1 through 15, if properly implemented by the applicant, will result in a design that is adequate to resist the earthquake conditions postulated for the site.

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REFERENCES

BEAVER VALLEY POWER STATION

DUQUESNE LIGHT COMPANY

(Docket No. 50-344)

Preliminary Safety Analysis Report, Volumes 1 through 4

Amendments No. 1 through 15

Boring Logs