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CONSULTING ENGINEERING SERVICES

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URBANA, ILLINOIS 61801

29 June 1970

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
Wm. H. Zimmer Nuclear Power Station
The Cincinnati Gas and Electric Company, et al
AEC Dockets No. 50-358 and 50-359

Dear Mr. Case:

Dr. N. M. Newmark, Dr. A. J. Hendron and I have reviewed the Preliminary Safety Analysis Report for the William H. Zimmer Nuclear Power Station Units 1 and 2, and call attention below to certain items for which additional information is needed.

In reviewing the PSAR it is noted that the applicant has recommended that the seismic design be carried out for a Design Basis Earthquake characterized by a maximum ground acceleration of 0.10g to insure safe shutdown and containment, and that the plant be analyzed for an Operating Basis Earthquake of 0.05g maximum horizontal ground acceleration. It is our understanding that these seismic design levels are under review by representatives of the USGS and the USC&GS, and that a decision as to the acceptability of the applicant's criteria will be forthcoming in joint meetings between the aforementioned AEC representatives and ourselves at a later time. No further comment on this aspect of the criteria is made in this letter.

As a result of our review of the PSAR we should like additional information from the applicant on the following items:

1. A description of a number of possible foundation schemes for the facility structures are presented in Section 2.5.4.3.1. The proposed foundation elevations for the major buildings are summarized in Table 2.5-11. At such time as a decision is made as to the type of foundations to be employed, the applicant should submit the details in order that the foundations can be considered in evaluating the adequacy of the plant design to resist seismic effects. The information supplied should include a description of the structure supported, dimensions of the foundation element, including length of pile or caissons and the depth to which they are driven, or drilled, and any other pertinent features needed to describe the foundations.

2. In Section 2 of the PSAR there is presented a limited discussion of liquefaction potential at the site. It is indicated on page 2.5-64 "...that there may be a possibility of soil liquefaction during the design basis earthquake." It is indicated there also that further studies will be performed to develop the data required for a complete assessment of the liquefaction potential and corrective action at the plant site. The applicant should provide the details of these studies and findings as soon as possible for study and evaluation.

One of the most important variables in the liquefaction analysis is the assumed elevation of the water table. Since the normal pool elevation in the river is Elev. 455 and the maximum flood stage is Elev. 517, then it seems reasonable that for a significant length of time during the spring of the year that the river elevation would be significantly above Elev. 455; it would seem reasonable that some level above Elev. 455 should be used in evaluation of the liquefaction potential of the site. Prezometric data taken during recent years, if available, should be cited for evaluation purposes. The elevation of the water table used in the analysis by the applicant should be clearly noted and justified.

3. There is enough difference in elevation between the flood plain elevation and the Ohio River bottom (approx. 40-50 ft.) that liquefaction or partial liquefaction could result in large lateral earth movements. Thus, even if the foundations of Class I structures are treated or corrected the applicant should demonstrate the adequacy of building connections, or tunnels or pipes between buildings, intake structures and cooling towers, etc., to withstand the possible differential motions or horizontal motions arising from earthquake ground motions or partial liquefaction, or both.

4. In Section 2.5.4.6, there is described some of the problems concerned with river bank stability along the Ohio River. It is indicated there that analyses will be performed to evaluate the effects of earthquake loadings on bank stability. The applicant is requested to make available the details of these studies. If there are any other supporting embankments such as around lagoons, canals, or other cuts for which a failure or slippage can affect the integrity of the plant, analyses and/or details of corrective measures to prevent such movements should be described by the applicant.

5. The recommended response spectra for use in the plant design are shown in Figs. 2.5-19 and 2.5-20 for the OBE and DBE respectively. With the exception of the low frequency region, the spectra appear to be the same as the so-called "Housner" spectra.

The appropriate spectrum to be used for a particular earthquake hazard depends on the amount of damping employed in the analysis, and on the stress and deformation levels permitted. Thus, a comparison of spectra on a purely absolute basis is not entirely meaningful. As a general rule, we are willing to permit the use of the so-called Housner spectra for structures where the damping is assumed relatively conservatively and where the structural elements can deform slightly into the inelastic range without damage. However, unless the damping is conservatively chosen, we would not consider the Housner spectra as satisfactory and we would prefer one with higher amplification as the basic input ground motion. In general, for use of the Housner spectra we would not be willing to accept more than 5% damping for structures for any of the conditions described in the PSAR for the DBE and not more than a ½% damping for vital piping under similar conditions.

The damping values presented in Table 12.3-1 for the Operating Basis Earthquake and Design Basis Earthquake are in some cases significantly larger than those just noted. For example, bolted or riveted assemblies are shown as being designed for a 10% of critical damping. In Appendix A on page A.3-4 it is indicated that critical piping will be designed for damping values of either ½ percent, or 1 percent of critical when near yield stress. Unless these elements can go some distance into the inelastic range without difficulty and in fact do so, it is difficult to see how these high values of damping can occur physically. If such levels of damping are to be used with the spectra noted, then the applicant must present justification to demonstrate that the margin of safety is adequate and consistent with the design criteria. If the stresses arising from earthquake seismic excitation are relatively low in comparison with the total stresses, then this needs to be considered in the evaluation of the conservatism in the damping employed in the analyses.

6. It is indicated on page 2.5-57 that the analyses may be carried out with a time-history procedure. It is further stated there that "these time-histories will be adjusted if necessary to assure that no portion of the response of the structure will fall below the spectra values presented on Figs. 2.5-19 and 2.5-20." It is not at all clear how the "response of the structure," which may be quite complicated can be compared with spectra which are developed for single-degree-of-freedom linear oscillators. This statement requires clarification to remove the ambiguity as presently stated.

7. The general method of seismic analysis for structures is described for Section 12.3.1. The procedures for handling the seismic analysis of piping are described briefly in Appendix A, and particularly in Sections A.3.1.1.1 and A.3.1.1.2. Also, seismic analysis procedures are described in Section C.3.1 and C.3.2 for equipment. These descriptions are not sufficient to permit an evaluation of their adequacy. A more detailed description of the methods of analysis to be employed for different categories of structures, piping, equipment, etc., is required.

In order to be sure as to what is actually intended to be used, and on what basis, in the seismic analysis, it is requested that the applicant supply a table or chart for each major item or group of items of Class I structures and equipment to show the following: the method of analysis used (whether response spectra, time-history, peak seismic coefficient from response spectra, or other methods as applicable); the damping coefficient; stress or deformation levels applicable; margins of safety for the combined loading conditions considered; a description of the method by which the shears, moments and stresses and/or deflections and/or accelerations are computed for each mode as well as the combined total response; and any special comments or explanations necessary such as, for example, the specific procedure used in defining the response spectrum for items supported at different levels.

The above tabulation need be supplied only for the Design Basis Earthquake and the corresponding design conditions applicable for this earthquake; but, it should include both vertical and horizontal excitation, and the methods used for combining horizontal excitation in the various directions if this is done, and for combining horizontal and vertical excitations.

8. With regard to the discussion of floor response spectra and piping in Section A.3.1.1.1.1, it is indicated that the floor spectra will be used as horizontal excitation for a particular piping analysis; it is not clear how spectra can be used as an input, nor how a time dependent input would be generated therefrom. These matters require clarification.

Also the method by which the differential motions between the floors or piping support points will be determined or calculated should be presented, along with a discussion as to how these motions will be employed in the analyses.

9. The design criteria for vertical earthquake motion is mentioned at several places in the PSAR briefly with respect to the seismic design of structures, piping, and other items. The statement is generally made that the vertical acceleration will be taken equal to two-thirds of the horizontal acceleration. The applicant is requested to indicate how the vertical seismic excitation is to be handled in the design, and specifically whether this will involve the use of a constant acceleration coefficient, accelerations corresponding to amplified motions, or some other scheme.

10. Special supplementary methods for Class I equipment to be supplied by the General Electric Company are presented in Section C.3.2.2 of the PSAR.

No clarification is provided as to the manner in which the criteria are actually to be used and the margins of safety that are inherent in the design procedures employed. If these special supplemental methods are to be used as a sole basis for the design of certain specific elements or items, further information is needed as to the parameters governing variations in load combinations and distributions employed, and the probabilities as to whether or not the damage will occur in the extreme probability ranges. It is not clear from the material presented whether the probabilities of failure are sufficiently low under all combinations of circumstances as to make this technique acceptable for design in all cases.

In reviewing the equipment design criteria in Appendix C it appears that there may be a number of instrumentation and control items, which could be categorized as Class I equipment, but which cannot be analyzed precisely by the methods described in Appendix C. The applicant is asked to describe the criteria that are employed in these cases for either procurement or in subsequent analyses to insure their adequacy to resist seismic effects.

11. The matter of interconnected Class I and Class II structures is discussed in Section 12.2.1.1. The applicant is requested to describe the method of design employed to insure that the failure of a Class II structure will not impair the integrity of the Class I structure or its contents.

Also, the applicant is requested to indicate whether there are any Class I components located in Class II structures and if so the provisions that have been provided to insure that the Class I components cannot be damaged to the extent of preventing them from fulfilling their functions.

12. The design of reactor internals for seismic forces is discussed in Section 3.3.5.4. Therein, it is indicated that a 1.0g lateral force would be assumed in the design. The applicant is requested to describe the assumptions under which this design criteria is believed to be adequate and also to indicate whether the vertical seismic excitation would in any case, when combined with the lateral seismic excitation, lead to difficulties with the functioning of the reactor internals.

13. The stress levels proposed for the design of structures is summarized in Table 12.2-2. It is not clear from the material presented in this table that the same margin of safety will exist for a given load combination with regard tc concrete and steel members; the applicant is requested to provide further comment on this aspect of the design.

14. In connection with the material presented in Section 5 and Section 12 of the PSAR, the applicant is requested to provide the following information: (a) With regard to the support of the reactor vessel, the applicant is asked to provide a more detailed description of the manner in which this is supported both vertically and laterally. (b) It is indicated that the dividing floor between the drywell and the suppression chamber will be a conventionally reinforced concrete floor and will be supported by the center pedestal, on a series of concrete columns, and from the containment wall at the periphery of the slab. It is not clear from the description given whether there is a seal between the floor and the containment wall separating the two chambers, yet which will provide the required differential motion for thermal, seismic effects, etc. If there is such a seal the details should be described.

(c) In view of the fact that the drywell primary containment structure is prestressed, the applicant is requested to provide additional information about the details of the penetrations through this structure and particularly the methods of analysis employed in checking the adequacy of the penetrations.

Respectfully submitted,

W. J. Hall

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bjp

cc: N. M. Newmark
A. J. Hendron, Jr.