

April 2, 1997

Mr. Nicholas J. Liparulo, Manager
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Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, PA 15230

SUBJECT: STAFF REVIEW OF WESTINGHOUSE LETTERS DATED JANUARY 28, 1997, AND
FEBRUARY 10, 1997

Dear Mr. Liparulo:

The Nuclear Regulatory Commission (NRC) Civil Engineering and Geosciences Branch (ECGB) reviewed the Westinghouse letters dated January 28, 1997, and February 10, 1997, which were in response to the staff letters dated November 4, 1996, and January 31, 1997. The letters discussed two key AP600 issues, the nuclear island foundation mat adequacy and the site parameters for seismic design. On March 3, 1997, a senior management meeting was held to discuss these issues. In that meeting, the staff committed to formally respond to your letters. Enclosed is the staff evaluation of your response.

If you have any questions regarding this matter, you can contact me at (301) 415-8548.

Sincerely,

original signed by:

Diane T. Jackson, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosure: As stated

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Docket No. 52-003
AP600

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STAFF EVALUATION OF WESTINGHOUSE RESPONSE TO NRC POSITION LETTERS

References:

1. Letter from T. R. Quay, NRC to N. J. Liparulo, Westinghouse, "Three Major Issues Resulting from the Civil Engineering and Geosciences Branch (ECGB) Review of the Westinghouse AP600 Advanced Reactor Design," dated November 4, 1996.
2. Letter from T. T. Martin, NRC to N. J. Liparulo, Westinghouse, "AP600 Advanced Reactor Design site Parameters for Seismic Design and Nuclear Island Foundation Mat Adequacy," dated January 31, 1997.
3. Letter from B. A. McIntyre, Westinghouse to T. R. Quay, NRC, "Site Conditions - Shallow Soil Sites," dated January 28, 1997.
4. Letter from B. A. McIntyre, Westinghouse to T. T. Martin, NRC, "Structural Key Issues," dated February 10, 1997.

I. Site Conditions - Shallow Soil Sites

By its letters dated January 28, 1997, (Reference 3) and February 10, 1997, (Reference 4) Westinghouse responded to the staff's concerns regarding the inclusion of shallow soil sites in the design of AP600 nuclear island (the first issue addressed in the staff November 4, 1996, and January 31, 1997, letters, References 1 and 2). The staff's evaluations of Westinghouse's responses are as follows:

Background

For siting the AP600, Westinghouse chose four site conditions that envelope soil locations for the AP600 standard plant. These four site conditions are hard rock, soft rock, soft-to-medium soil, and upper bound of soft-to-medium soil. The staff clearly stated in the DSER that shallow soil sites are outside the envelope of these four site conditions. In a June 1995 meeting, Westinghouse agreed to exclude shallow soil sites from the AP600.

In order to allow the AP600 nuclear island to be founded on potential shallow sites, Westinghouse now proposes to allow the COL applicant to perform site-specific soil-structure interaction analysis based on the site-specific soil condition and site-specific safe shutdown earthquake, and demonstrate the design adequacy of the standard plant. In doing this, it would allow a deviation from the standard design. According to 10 CFR 52.47(a)(1)(i), the application for design certification must contain the technical information that is relevant to the design and is not site-specific. Also, 10 CFR 52.47(a)(1)(iii) requires that the application for design certification contain the site parameters postulated for the design, and an analysis and evaluation of the design in terms of such parameters. On this basis, the staff believes that Westinghouse has misinterpreted the requirements of the regulation.

Enclosure

General Comment

It appears that Westinghouse picked out specific sentences from our letter dated November 4, 1996, and commented on them. To fully understand the staff's concern, Westinghouse should focus on the letter as a whole. Westinghouse needs to demonstrate that the AP600 standard plant design is in compliance with the full range of site conditions based on its chosen site parameters. At this time, Westinghouse has not demonstrated that its seismic design of the nuclear island is valid for shallow soil sites. Therefore, Westinghouse should either exclude the shallow soil sites from the AP600 design, or consider the soil parameters corresponding to the shallow soil sites as a new set of design soil parameters and perform the necessary analysis to include them in the AP600 standard design. To consider the shallow soil sites as a COL issue and delay the seismic analysis review and approval does not meet the standard design rule of 10 CFR Part 52.47 and is not acceptable.

Specific Comments

1. The statement made in Westinghouse's response letter (Reference 3), that the AP600 design as documented in the SSAR satisfies the NRC staff position regarding establishing design capacity, is true only for those sites for which the soil parameters fall inside the range of design soil parameters identified in the SSAR. For these sites, Westinghouse defined the ground motion as shown in SSAR Figures 3.7.1-1 and 3.7.1-2, and used the ground motion as input to perform seismic analyses and to generate seismic responses (member forces and floor response spectrum envelopes) for the design of the AP600 nuclear island structures, systems and components. These seismic responses which have been reviewed and accepted by the staff were used for the seismic design, and are to be used by the COL applicants for qualifying site-specific safety related items. However, in the case of shallow soil sites, the AP600 design has not been demonstrated to be adequate for the standard seismic design ground motion as required by the regulation.
2. In its letter (Reference 3), Westinghouse quoted the staff position that "suitability of a future site would then have to be established by demonstrating that the seismic demand spectra for the site are lower than the capacity spectra." In response to this staff position, Westinghouse, in Reference 3, stated that: (1) the suitability of a future site, including any shallow soil site, is established by the COL applicant as described in SSAR Section 2.5, and (2) for sites where the soil characteristics are outside the range considered in Appendix 2A.2 and Appendix 2B.2, site-specific soil-structure interaction analyses may be performed by the COL applicant to demonstrate the acceptability by comparison of floor response spectra at specified key locations. Also in SSAR Section 2.5.4.5.5, Westinghouse stated that these analyses would use the site-specific soil conditions and site-specific safe shutdown earthquake. On this basis, Westinghouse concludes that they have complied exactly with the written staff position.

Westinghouse is correct in that a comparison of site-specific seismic demand must be enveloped by the standard seismic design capacity.

However, Westinghouse's response does not recognize that they are required to use the necessary and sufficient set of design response spectra which established the seismic capacity of the standard AP600 design. In this context, a set of sufficient response spectra is necessary in order to meet the provision of the regulation requiring a standard design parameter (modified Regulatory Guide 1.60 response spectra anchored to 0.3g) for the full range of design site parameters.

3. In response to the statement made in the staff's position letter dated November 4, 1996 (Reference 1), "as with other design acceptance criteria, the result will be non-standard seismic design for certain system (e.g. piping)," Reference 3 states that Westinghouse has established only a single set of in-structure response spectrum envelopes and has designed the systems, buildings, and equipment using this envelope. Therefore, site-specific piping design is not required when the response spectrum envelope is satisfied. Westinghouse is correct in that they do not intend to allow piping design using site-specific soil properties. However, Westinghouse does not meet the requirement that the standard seismic design capacity be established through response spectrum envelopes over a full range of site conditions.

As stated in the NRC draft safety evaluation report (DSER) issued in November 1994 (Open Item 3.7.2.4-3), the staff concluded, based on its review of the SSAR, related documents and confirmatory analysis results, that Westinghouse's design based on the site conditions committed in the SSAR is not adequate for shallow soil sites. Therefore, shallow soil sites should be excluded for the AP600 design. Also, during the June 12 through 16, 1995, meeting, Westinghouse agreed to exclude shallow soil sites from the AP600 design and to provide basis for excluding the "shallow soil sites" in the SSAR, because the design adequacy of the AP600 could not be demonstrated for these site conditions. From the discussion above, it is not clear that the piping design based on the single set of in-structure response spectrum envelopes specified in the SSAR will be adequate for the AP600 founded on a shallow soil site.

4. For the three options provided in its position letter (Reference 1), the staff's comments on Westinghouse's responses are as follows:
 - a. For sites other than shallow soil sites, the Westinghouse position is that the suitability of the future site would be established through a comparison of the site specific ground response spectrum and the AP600 design response spectra.

Westinghouse's proposal to compare the site specific seismic demand with the standard seismic capacity is acceptable only when the standard design parameter, which was established from a full range of site conditions, is met. Shallow soil sites are outside of the current range of design site conditions.
 - b. For the second option, Westinghouse responded that the AP600 has not been analyzed specifically for shallow soil sites. There are shallow soil sites where AP600 would not be acceptable. However,

there are shallow soil sites where the AP600 could be demonstrated acceptable by site specific analyses and comparison against the floor response spectra at four key locations.

As stated in (a) above, Westinghouse's approach is not acceptable. A necessary and sufficient set of response spectrum envelopes based on a full range of site conditions must be developed to establish the AP600 design capacity.

- c. The staff understands Westinghouse's reason for rejecting this option.

II. Design of Containment Foundation Mat

Background

As documented in the SSAR, Westinghouse chose a six foot thick mat foundation (117 ft wide and 256 ft long) in the auxiliary building area of the nuclear island. During its review meetings conducted in 1994, the staff identified design errors in the structural calculations. Consequently, Westinghouse incorporated shear reinforcements into the basemat to accommodate the design errors; whereas the original basemat detail had no shear reinforcements. The staff also identified the need to consider variation of soil stiffness across different parts of the basemat. It appears that Westinghouse did not fully investigate the constructability of such a thin and large basemat, and, as such, an enhanced geotechnical site investigation must be performed and strict adherence to a specific construction sequence must be maintained by the COL applicant.

Evaluation

Westinghouse responded to the staff's concern regarding the design adequacy of the AP600 nuclear island foundation mat (the second issue addressed in the November 4, 1996, and January 31, 1997, position letters, References 1 and 2) through its letter dated February 10, 1997, (Reference 4). In Reference 4, Westinghouse decided to choose the first option stated in the position letter dated November 4, 1996, (Reference 1) and tried to demonstrate the design adequacy of the six foot thick foundation mat. Westinghouse's approach is to either demonstrate the foundation mat design can accommodate the effects of soil stiffness variations of hard and soft spots underneath the basemat, or exclude sites with extreme soil variability by using site interface criteria during the COL stage.

The approach proposed by Westinghouse for the foundation design is not acceptable, because the design of the foundation is not completed based on a full range of site conditions (certain sites could be excluded as a result of the COL site investigation), and a significant amount of work needs to be done by the COL applicant. In demonstrating the completeness of the AP600 design, according to 10 CFR Part 52.47(b)(2)(i)(A)(4) that "the certification of a standard design which will be granted only if the scope of the design is complete except for site-specific elements such as the service water

intake structure and the ultimate heat sink," Westinghouse should complete the basemat design so that it can be located at sites with a full range of site condition of soil stiffness variability. On this basis, the staff concluded in its January 31, 1997, position letter (Reference 2) that the basemat thickness should be changed to demonstrate its acceptability over a full range of soil stiffness variability. Subsequent to the January 31, 1997, letter, Westinghouse proposed to establish geotechnical survey criteria and a construction sequence that will define the siting ability of the AP600 within the limitations of the basemat while retaining the ability to be sited on a large majority of U.S. sites. The staff will review this information and justification when provided.