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NSD-NRC-97-5109
DCP/NRC0847
Docket No.: STN-52-003

May 6, 1997

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: T. R. Quay

SUBJECT: Independent Review of AP600 Plant Basemat - Design Calculation 1010-CCC-001.

Dear Mr. Quay:

NRC letter dated August 16, 1995 included a summary of a review meeting conducted by the NRC staff and consultants with Westinghouse in the Bechtel offices during June 12-16, 1995. Item G.4 of that letter was a Westinghouse commitment to provide a summary of an independent review of the INITEC AP600 basemat calculation. This letter documents the background for this issue and the response by Westinghouse.

The U. S. Nuclear Regulatory Commission staff and its consultants performed an audit of the structural design of the AP600 at the Bechtel offices in San Francisco, on July 11 through 14, 1994. The summary of the design audit was transmitted to Westinghouse by the NRC letter of August 24, 1994.

In Revision "A" of the design calculation 1010-CCC-001, which was prepared by our sub-contractor Initec, the NRC staff noted an error related to basemat shear analysis. The staff asked Westinghouse to use simple calculations to check the results of complicated computer analysis results. The objective of this letter is to provide the NRC a written documentation of the technical corrective actions taken by Initec, Westinghouse and Bechtel related to the subject basemat calculation.

As stated in our letter NTD-NRC-94-4251 of August 2, 1994 to the NRC, Westinghouse had committed to the NRC staff the following:

- To perform an independent review of the analyses;
- To perform simplified analyses, as appropriate, to confirm the existing results;
- To provide the results of the independent review to the NRC.

These actions are all completed and are summarized below.

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Westinghouse took the following actions.

- Westinghouse letter NTD-NRC-94-4251 of August 2, 1994 to the NRC, committed to an independent review of the subject calculation by Dr. W. H. White of Bechtel Corporation.
- Westinghouse contracted the services of Dr. White for an independent review of Initec's analyses and design methodology.
- Westinghouse letter FOK/INI 0181 of August 3, 1994 asked Initec to respond to the NRC concern.

The process and the results of the independent review were presented to the NRC staff, and its consultants, in the following meetings:

- NRC/Westinghouse meeting at Bechtel's office in San Francisco on October 12/13, 1994. (NRC meeting minutes transmittal letter of Nov. 9, 1994 states that NRC staff "acknowledged that the depth and scope of the independent expert's review is reassuring").
- NRC/Westinghouse meeting at San Francisco on February 28, 1995 included a presentation of the summary of his evaluation by Dr. White. (NRC meeting summary transmitted with the letter of May 17, 1995)
- NRC/Westinghouse meeting at San Francisco, June 12-16, 1995 included a presentation by Initec on updated basemat design/analysis. The NRC staff and consultants suggested additional details to be incorporated in the calculations. (Item J in "Summary of AP600 Structural and Seismic Design Review" attached to NRC letter of August 16, 1995).
- NRC/Westinghouse meeting at San Francisco, June 17/20, 1996; Westinghouse provided the status of basemat analyses being performed in response to the independent design review comments by Dr. White (Summary of Meeting attached to the NRC letter of July 18, 1996) .
- NRC/Westinghouse meeting at New York, on July 11, 1996, resulted in additional input to the basemat design (Summary of meeting attached to NRC letter of July 26, 1996).

Westinghouse technical staff monitors the quality of design and analysis submittals from Initec. These are reviewed by Westinghouse, as well as Bechtel, engineers. All complex calculations from Initec, similar to the basemat calculation, are reviewed as draft calculations. The resulting comments are addressed in the issued version of the calculations.

On calculation 1010-CCC-001, Mr. Richard Orr, the Westinghouse Lead for AP600 structural design and analysis, devoted substantial effort in reviewing Initec work and providing comments and guidance. In July 1996, Mr. Orr spent time at Initec office reviewing basemat analysis and design. He also advised them on, and ensured, proper implementation of Dr. White's recommendations.

Independent Review:

Dr. White performed a detailed review, and independent calculations and analyses. He presented his approach and initial results to the NRC staff in October 12/13, 1994 meeting at San Francisco. His approach and review, as presented, were received favorably by the NRC. (Dr. White's presentation material was included in the summary of the meeting issued by the NRC on November 9, 1994.)

Dr. White issued to Westinghouse his report "Independent Review of AP600 Nuclear Island Basemat Design (Document No. 1010-GG-001, dated November 11, 1994)".

The report was available to the NRC staff during the next design review meeting at San Francisco on February 28 through March 3, 1995. Dr. White attended this meeting and provided a summary of his evaluations. (Summary of the meeting issued by the NRC on May 17, 1995.)

Dr. White's independent review findings and recommendations in the above report are given below:

- The global finite element model is adequate for representing the global deformation but may not be adequate to represent local deformation and provide direct design information.
- To develop adequate design information for the Auxiliary Building basemat, it is recommended to use the subgrade reaction from the global model in conjunction with supplemental models of sections of the basemat.
- The method for determining the subgrade modulus is appropriate. The subgrade modulus should be evaluated using the layers below the foundation, and when estimating the subgrade reaction for load combinations involving seismic load, the dynamic soil modulus should be used.
- The basis for the design in this calculation included one soil modulus. Parametric studies performed as part of this review suggest a hard rock site may cause considerable change in the distribution of the subgrade reactions. The significance of the hard rock site should be addressed.
- Modeling of the shear walls is adequate. The centroidal finite element forces were used to estimate the forces at critical sections. It should be demonstrated this approach is comparable to using nodal forces particularly in triangular elements.
- The horizontal restraints provide conservative estimates of the membrane forces in the basemat.
- The massive foundation of the shield building is modeled with shell elements that do not account for out-of-plane normal and shear deformation. A study should be performed to verify the modeling is adequate.

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A summary of these findings were included as attachment to the NRC letter of May 17, 1995.

Subsequently, Dr. White spent time at Initec for a detailed review of the basemat analyses and design. He assisted Initec, and ensured the implementation of the recommendations of his independent review.

Dr. White reviewed other design changes and enhancements in the revision 0 of the calculation, in November 1996, and documented his review of Initec design on December 6, 1996 (Letter Number BPC/FOK 0950). Dr. White summarized his conclusions as follows:

The review of the design and summary report included all sections and covered the general methodology, the applicability of the assumptions and the reasonableness of results. My comments were addressed to my satisfaction.

Initec:

Initec took actions to investigate the error and resolve other technical questions identified by the NRC, Westinghouse and Bechtel.

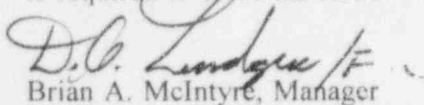
Initec letter INI/FOK 0175, dated February 15, 1995 provided to Westinghouse an explanation to address the root cause of the quality issue. Measures instituted by Initec to preclude the occurrence of similar situation in future were identified.

Westinghouse found the root cause and corrective action acceptable (Letter number FOK/INI-0898). Westinghouse plans to audit the corrective actions in the quality audit of Initec, scheduled for May 12/16, 1997.

Revision 0 of design calculation 1010-CCC-001 by Initec, plus Revision 0 of the new calculation 1010-CCC-005, rectified the error noted by the NRC staff, and further enhanced the calculation by addressing the recommendations of Dr. White. This was done to the satisfaction of Dr. White, Bechtel, and Westinghouse project personnel.

As summarized above, Westinghouse took the necessary technical actions, and provided the necessary technical oversight, to address the NRC staff comments. This information was provided to the Staff in several NRC/Westinghouse design review meetings. This letter provides written documentation that delineates the actions taken by Initec, Westinghouse and Bechtel to modify and justify the technical approach of the subject calculation.

The letters and calculation discussed above have been reviewed by NRC reviewers or have been available in subsequent review meetings. If necessary these documents can again be made available for NRC review. Please contact Donald A. Lindgren at (412) 373-4856 if any additional information is required to close the issue.


Brian A. McIntyre, Manager

Advanced Plant Safety and Licensing

jml

cc: D. Jackson, NRC
N. J. Liparulo, Westinghouse