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Gentlemen: ULNRC-3018

DOCKET NO. 30-483
CALLAWAY PLANT
STEAM GENERATOR HYDRAULIC SNUBBER ELIMINATION PROGRAM

Reference: Letter dated March 3, 1994, from W. D. Reckley and L. R. Wharton, NRC, to N. S. Carns, WCNOC, and D. F. Schnell, UEC

The attachment to this letter provides additional information requested in the reference concerning the planned elimination of steam generator hydraulic snubbers at the Wolf Creek Generating Station and Callaway Plant. Specifically, during a December 9, 1993, meeting several questions were raised regarding the design basis analyses associated with the replacement of the hydraulic snubbers. These questions were formally transmitted by the reference. As discussed between Mr. Bill Reckley, NRC, Mr. Steve Wideman, Wolf Creek Nuclear Operating Corporation, and Mr. Dave Shafer, Union Electric on April 21, 1994, no unreviewed safety question was determined for implementation of the modification. The results of the specific analyses associated with this modification are available for review at Westinghouse.

If you have any questions concerning this matter, please contact me at (314) 554-2650, or Mr. Dave Shafer at (314) 554-3104.

Very truly yours,

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RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Request:

Because the coupled building/loop model used in the analysis considers a fixed base, the staff questions the validity of applying the free field time-history input motions at the top of the foundation mat. In order to account for the effects of soil-structure interaction (SSI), the time-history response motions obtained at the top of the foundation mat, instead of the free-field motions, should be used as input motions to the building/loop mathematical model. Please provide a response to the above position which, if necessary, includes justification for the use of free field time-history input motions.

Response:

In the non-linear time-history transient analysis, the mathematical model used was a coupled building/loop model with a fixed base at the top of the foundation mat. The input motions for the analysis were at the top of the foundation mat and were obtained from the Wolf Creek Generating Station (WCGS) and Callaway Plant soil-structure interaction analyses. Therefore, the effect from the soil-structure interaction analysis was included. Free-field motions were not the inputs used in the analysis.

Request:

It was stated that the compression bumpers are modeled as gap elements in the analysis. The licensees should verify the capability of the computer code used for the analysis in its treatment of bumper impact when the bumpers are in the compression mode. If the analysis involves assigning a value of coefficient of restitution for the impact effects, the licensees should provide information regarding parametric studies for the effects of assumed coefficients of restitution on system responses and justification for the values assumed in the analysis.

Response:

(a) The computer code used in the analysis is the Westinghouse Proprietary Code WECAN. Element STIF37 was used for the modeling of the compression bumper in the time-history modal superposition analysis. In the mid-seventies (Reference 1) Westinghouse developed structural analysis computer codes with the capability to treat compression bumpers modeled as gap elements using modal superposition analysis technique with nonlinearities treated as pseudo forces. Direct integration of the equations of motion, typically by the Newmark Beta method, was also developed in the same time period. The nonlinear modal superposition technique employing pseudo forces in the WECAN code and other codes (Westdyn, EPIPE) has been verified and benchmarked extensively by comparison to direct integration (References 1, 2, and 3).

The modal superposition analysis technique for the gap element (STIF37) is described in WCAP-9389 (Reference 4). In this WCAP, Verification Problem No. 9 is the same application of the non-linear modal superposition method to the reactor coolant loop support system as is used for Wolf Creek Generating Station and Callaway Plant. Also in this WCAP, the theoretical formulation of the gap element, which includes the impact phenomena, is explained in Section 2.

Another direct application of the WECAN non-linear gap element STIF37 is in the San Onofre Nuclear Generating Station, Unit 1, seismic re-evaluation and modification. In that analysis, the STIF37 element was used in a similar manner for the gapped supports in the reactor coolant loop support system. This analysis was documented and sent to the NRC on Docket No. 50-208 (Reference 5).

Additionally, Westinghouse topical reports (WCAP-8252, Revision 1) entitled "Documentation of Selected Westinghouse Structural Analysis Computer Codes," and (WCAP-8928) entitled "Benchmark Problem Solution Employed for Verification of the WECAN Computer Program," which contain such compression bumper elements were submitted to and reviewed by the NRC (Reference 6). Another topical report (WCAP-9401-P), which also employs the same type of compression bumpers modeled as gap elements using the modal superposition technique for fuel assembly analysis, was accepted by the NRC (Reference 7).

In general, whenever an enhancement is made to the WECAN program, a set of problems identified in the WECAN User Manual, Table 5-2, Volume II, is used to further verify the capabilities of the computer code, as was done for the compression bumpers modeled as gap elements. This process was presented during the NRC's review and approval of a more advanced element "STIF77," which included both compression bumper gap aspects as in STIF37 and friction aspects.

Based on the above discussion, we believe the compression bumper type of gap element used in the Wolf Creek Generating Station/Callaway Plant analysis has been verified and benchmarked. Further, in several previous licensing applications, the NRC has reviewed and approved such an element.

(b) The analysis did involve the use of a conservative impact-damping which was 4 percent of critical damping, in the

WECAN impact element (STIF37). We believe that the 4 percent damping is very conservative by comparison to the overall reactor coolant loop system damping or 4 percent allowed by the NRC for the Westinghouse reactor coolant loop design. In addition, Westinghouse had used an 8 percent impact damping for a similar geometry in Reference 5, which was approved by the NRC.

Energy loss resulting from impact was represented by a dashpot acting as a viscous damper during impact (Reference 4). This damping is equivalent to a coefficient of restitution of 0.88 for impact between steel to steel surfaces. Calculation from a single degree of freedom system under sinusoidal motion provides correlation between the percent of damping and the coefficient of restitution (Reference 8).

The 4 percent damping (or 0.88 for coefficient of restitution) is believed to be a very conservative estimate since the range of coefficient of restitution between steel surfaces under impact is between 0.5 and 0.8 (Reference 9). Since the value used in the analysis (0.88) is higher than the upper bound value (0.8), it was determined that no parametric study was necessary. Any value below 0.88 will provide higher than 4 percent of critical damping. For comparison, the coefficient of restitution of 0.8 and 0.5 correspond to critical damping of 7.1 percent and 22 percent.

References:

(1) Molnar, Vashi and Gay, "Application of Normal Mode Theory and Pseudoforce Methods to Solve Problems with Nonlinearities," Journal of Pressure Vessel Technical, Volume 98, May, 1976.

(2) Shah, Bohm and Nahavandi, "Modal Superposition Method for Computationally Economical Nonlinear Structural Analysis," Journal of Pressure Vessel Technology, Volume 101, May, 1979.

(3) Prachuktam, Bezler and Hartzman, "Non-linear Dynamic Analysis of Piping Systems using the Pseudoforce Method," International Journal of Pressure Vessel and Piping, Volume 8, 1980.

(4) Westinghouse Proprietary Class 2 Report, WCAP-9389, "Non-Linear Model Superposition in WECAN," V. N. Shah, October, 1978.

(5) "San Onofre Nuclear Generating Station Unit 1, Seismic Reevaluation and Modification," April 29, 1977. NRC Docket

No. 50-206, Southern California Edison Company and San Diego Gas & Electric Company.

(6) NRC Letter from Tedesco to Anderson, "Acceptance for Referencing of Licensing Topical Report WCAP-8252, Rev. 1," April 7, 1981.

(7) NRC Letter from Tedesco to Anderson, "Acceptance for Referencing Topical Report WCAP-9401-P," May 7, 1983.

(8) Westinghouse letter from Kubancsek to Krieger, "NRC question related to Coefficient of Restitution," San Onofre Nuclear Generating Station, December 15, 1982.

(9) "Vector Mechanics for Engineers," edited by H. R. Nara, John Wiley & Sons, Inc., New York, London, 1963.