TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

(5)

80-004-03L
80-003-03L

October 14, 1980

1980 OCT 20 AM 11:00

NRR

Mr. James P. O'Reilly, Director
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Region II - Suite 3100
101 Marietta Street
Atlanta, Georgia 30303

Dear Mr. O'Reilly:

YELLOW CREEK NUCLEAR PLANT UNITS 1 AND 2 - IMPROPER DOCUMENTATION AND UTILIZATION OF COMPUTER PROGRAM "INERTIA" - NCR YCN CEB 8004 - FINAL REPORT

The subject deficiency was initially reported to NRC-OIE Inspector R. W. Wright on March 21, 1980, in accordance with 10 CFR 50.55(e). Interim reports were submitted on April 21, May 5, and August 1, 1980. Enclosed is our final report.

If you have any questions concerning this matter, please get in touch with D. L. Lambert at FTS 857-2851.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills, Manager
Nuclear Regulation and Safety

Enclosure
cc: Mr. Victor Stello, Jr., Director (Enclosure)
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, DC 20555

1/22/81 meeting with H. J. Wong (NRR I) this is more of a problem to insure that something is done to make sure the odd ball case, where results are not close, is taken care of. NRR has no hangups.

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ENCLOSURE
YELLOW CREEK NUCLEAR PLANT
IMPROPER DOCUMENTATION AND UTILIZATION
OF COMPUTER PROGRAM INERTIA
NCR YCN CEB 8004
10 CFR 50.55(e)
FINAL REPORT

References: 1. John A. Blume, Nathan M. Newmark, and Leo H. Corning, "Design of Multistory Reinforced Concrete Building for Earthquake Motions," Portland Cement Association, 1961.

2. N. C. Chokshi and J. P. Lee, "Shear Coefficients and Shear Force Distribution in Nuclear Power Plant Structures Due to Seismic Loadings," International Symposium on Earthquake Structural Engineering, St. Louis, Missouri, August 1976.

3. "Analysis of Small Reinforced Concrete Buildings for Earthquake Forces," Portland Cement Association, 1955.

Description of Deficiency

Improper documentation and utilization of the TVA computer program INERTIA could have resulted in incorrect shear-related cross sectional properties being used in seismic analyses. INERTIA documentation did not include verification of the program for structures with open cross sections (such as a channel section) with small height-to-width (aspect) ratios as found in some nuclear power plant structures. Structures with closed sections (cells) connected by a wall may also have response characteristics similar to an open section. The control building at Yellow Creek Nuclear Plant has cross sections of this latter type. Incorrect shear-related cross sectional properties will affect the natural frequencies of the structure and, consequently, the structural response and instructure response spectra.

In our investigation of the applicability of this problem to Watts Bar, Bellefonte, Hartsville, and Phipps Bend Nuclear Plants, it was discovered that INERTIA is used as a subroutine in a computer program known as BIGDYNA. BIGDYNA is a structural analysis program that calculates the modal frequencies and mode shapes of a structure and determines the structural response to dynamic loads by the modal superposition method.

Safety Implications

For closed sections, the computer program INERTIA is consistent with industry practice. In that no unsafe conditions resulted from the use of the rigidity method as used by TVA, NCR YCN CEB 8004 as reported on March 17, 1980, did not create a safety concern.

Corrective Action

The computer program INERTIA uses the "rigidity method" described in reference 1 to calculate shear-related properties for use in seismic analysis. Other methods are "beam theory" and "finite element methods." The latter is seldom used because of the cost and effort required for large complex structures. A literature study was made to determine the theoretical basis, relative merits, and standard industry practice of the three methods.

Beam theory and rigidity method give essentially the same results for closed sections. Comparison of the two methods do not agree as closely for all open sections and closed sections connected by a single wall, but each is preferred in certain applications. Theoretically, finite element methods give "correct" results and, therefore, were used in reference 2 to compare with the rigidity method and beam theory.

It was found (reference 2) for a structure with an open section and small height-to-width ratio that the rigidity method compares more favorably with the finite element method than does beam theory. Also, Portland Cement Association recommends the rigidity method for open structures (reference 3). In addition, a survey of utilities and architect engineers engaged in nuclear power plant construction showed that the rigidity method was in wide usage in seismic analysis of similar nuclear power plant structures.

The extent to which a model predicts how the shear forces are distributed across the cross section of the structure determines the accuracy of the natural frequencies, mode shapes, and, consequently, the structural responses. While both the rigidity method and beam theory are valid approaches, neither can fully account for the interactions (shear flow) between walls and walls and slabs in complex "open" structures. But until work now being done by TVA, NRC, and others to better define how shear forces from earthquakes are distributed is completed, open structures will be conservatively analyzed on a case-by-case basis using one or more of the three methods to calculate shear-related properties. The programs INERTIA and BIGDYNA will continue to be used for closed sections.

A check has been made of all other TVA nuclear plants, and it has been determined that INERTIA and BIGDYNA were properly utilized.

ITEM	FACILITY	NOTIFICATION	ITEM OR EVENT	REGIONAL ACTION
REACTOR CONSTRUCTION				
	Yellow Creek 1 and 2	Telecon	CDE - Improper Documentation and Utilization	Followup per
	DNS: 50-566, 567	3/21/80	of TVA Computer Program (INERTIA)	MC 2512.
		& 3/25/80	The program is specifically designed for use with closed wall sections, however, it was used for open wall sections also. Dynamic structural response calculations are unconversative to an unknown extent at this point in time when used for the above structural members and foundation anchor rod designs in the control buildings. A written report is due April 23, 1980.	

confirmed reportable by Jerry Price 3/27/80

NCR # YCN CEB 8004

This is prelim info. A PN will be issued if the problem is determined to be significant

GENERAL: