UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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MEMORANDUM FOR: Robert B. Minogue, Director
Office of Standards Development

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

FROM: Saul Levine, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER NO. 48
A TECTONIC OVERVIEW OF THE MIDCONTINENT

REFERENCES:
1. Letter, W. R. Stratton to Dixie Lee Ray dated May 16, 1973. Subject: Report on Seismic Research.
2. Title 10, Chapter 1, Part 100, CFR Appendix A - Seismic and Geologic Siting Criteria for Nuclear Power Plants.
3. Memo to R. J. Mattson dated July 15, 1975. Subject: U.S. Tectonic Province Map.

INTRODUCTION

Enclosed is NUREG-0382, "A Tectonic Overview of the Central Midcontinent." The research effort to produce this report was conducted by Purdue University, Department of Geosciences, in cooperation with the University of Texas and the University of Pittsburgh Geoscience Departments. This effort was conducted under the direction of Prof. W. J. Hinze of Purdue University as a part of the New Madrid Cooperative program.

The "Tectonic Overview" is especially significant because it is the most up-to-date synthesis of geologic knowledge of the earth's crust in the study area. It contains the most complete bibliography of the geodynamics of the area ever assembled. It is a significant block in the foundation of the seismic and geologic criteria which will aid in nuclear power plant licensing decisions.

BACKGROUND

In 1973 (ref. 1) the ACRS recommended that investigations be initiated to determine the reasons for, and source of, earthquakes in areas of the eastern U.S. where large shocks have occurred.

This recommendation also was in part brought about by Appendix A, 10 CFR Part 100 (ref. 2) which establishes requirements for seismic and geologic site investigations for nuclear power plants and associated nuclear

facilities necessary for evaluation of the site and for providing information needed for engineering designs. Paragraph (6), Section IV of Appendix A requires that, where possible, epicenters of historically reported earthquakes be correlated with tectonic structures, any part of which are within 200 miles of the site; and that epicenters or locations of highest intensity which cannot reasonably be correlated with tectonic structures should be identified with tectonic provinces, any part of which are within 200 miles of the site.

This part of the Regulation was developed to take into account the fact that tectonic settings of the eastern U.S. are significantly different from those of the western U.S. The Regulation does not provide guidance in the form of a map to establish seismotectonic provinces in the East. This has resulted in lengthy licensing delays because of the time needed to resolve controversies among applicants and the public and NRC regarding tectonic province boundary locations.

In 1974 the Office of Standards Development undertook an effort to develop an eastern U.S. Seismotectonic Province Map; however, when the map was completed, there was a consensus opinion that it was not adequate to clarify Appendix A to 10 CFR which requires the tectonic province approach. There remained specific information needs to be satisfied in order to develop a map which will be a useful regulatory tool. That is, more geologic data and seismologic input are needed to more accurately delineate eastern U.S. seismotectonic provinces. Consequently, the cooperative geologic and seismic programs were undertaken with state geological surveys and universities to gather regional data to: (1) help delineate tectonic provinces; (2) identify earthquake source mechanisms; (3) improve knowledge of regional geologic conditions; (4) provide data to confirm past licensing decisions; (5) expand the existing geologic and seismic data base; and, (6) to provide a consistent data base.

Approximately twenty-three state geological surveys and universities are cooperating under NRC funding to provide data needed to develop a data base for an eastern U.S. seismotectonic province map. The studies are being conducted in three phases: Phase I -- existing data compilation (complete), Phase II -- new data acquisition, and Phase III -- problem resolution or conclusions including a tectonic synthesis of the problem areas of the eastern U.S. and a seismotectonic provinces map. Many of these cooperative programs were funded initially by the Office of Standards Development (ref. 3). Later, the program responsibility was transferred to the Office of Nuclear Regulatory Research because of their long-term nature.

RESULTS

This report, NUREG-0382, summarizes the state of knowledge of the crust, including structural history, basement geology, and contemporary geodynamics of the central Midcontinent region. The tectonic models which have been suggested to explain the contemporary tectonism are reviewed. Modern tectonism is explained by three principal hypotheses: (1) resurgent tectonics, (2) thermal expansion and contractions, and (3) isostatic warping. The first of these hypotheses emphasizes crustal rifting and its relation to crustal boundaries, ancient zones of weakness, and location of basement inhomogeneities. The second hypothesis is based on the idea of that thermal variations, caused by igneous intrusions, local heat flow or mantle convection, produce regional tension and compression that result in deformation of the crust. The third model, isostatic warping, considers the effects of regional variations in crustal loading and unloading and the possible relationship to warping of the crust, faulting, and earthquake activity.

The present geologic and seimsic data base is insufficient to evaluate fully these hypotheses. It is apparent, however, that a satisfactory working tectonic model for the Midcontinent region should be based on the concepts of plate tectonics and must consider the lateral and vertical variations in composition and physical properties, fault zones and intraplate boundaries imposed by past deformational and thermal events. It is clear from the report that an understanding of the contemporary tectonism of this area requires definition of the tectonic history and sequence of events which have resulted in the present geologic setting in the interior of the North American Plate.

RECOMMENDATIONS

It is recommended that the information and hypotheses in NUREG-0382 be considered by the Office of Standards Development and the Office of Nuclear Reactor Regulation as input to the development of a tectonic province or seismic zoning map of the eastern U.S. and to provide a basis and guide for ongoing studies in the area.

Additionally, RES recommends that studies be continued in this area to attain the objectives previously stated, with redirection and modification of projects as deemed necessary by ongoing work.

Technical questions concerning NUREG-0382 results may be directed to Neil B. Steuer at 427-4370.

Saul Levine

Saul Levine, Director
Office of Nuclear Regulatory
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Enclosures:
1. NUREG-0382
2. Definitions