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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of )  
GEORGIA POWER CO. )  
et al. )  
(Vogtle Electric Generating Plant, )  
Units 1 and 2)

Docket Nos. 50-424  
50-425  
(OL)

NRC STAFF RESPONSE TO  
LICENSING BOARD LETTER OF JULY 12, 1984

In a letter to Staff counsel dated July 12, 1984, the Chairman of the Licensing Board asked the Staff to provide additional information concerning Joint Contention 5 which challenges the Vogtle facility's seismic design. The Staff herein responds to the Board Chairman's letter.

The Staff took the position in its earlier responses to Contention 5 (both at the prehearing and in our written response of May 14, 1984) that Intervenors had provided no substantial new information upon which to litigate a seismic contention. The Staff continues to believe that there is little information provided in the basis of Contention 5; almost all of the discussion there centers around a description of the Charleston earthquake rather than of the seismic design of the plant.

However, Staff counsel has learned that the Staff is in the process of reassessing the seismic design of many nuclear facilities, including

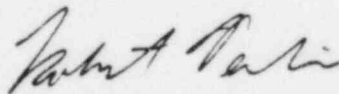
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Plant Vogtle. Attached to this response are two memos describing the nature of the Staff's current efforts in this area. In particular, the Staff is performing both a deterministic and a probabilistic study to determine whether the seismic design of Vogtle is adequate given the uncertainty of the location of the Charleston earthquake.

The Staff will discuss these studies and their impact on the design of Plant Vogtle in the Vogtle SER which is scheduled to be released in June of 1985. At the present time, the Staff still believes there is little reason to admit Contention 5 based on the information provided therein. The Staff suggests that ruling on this contention be deferred until the issuance of the Staff SER. If at that time Intervenors are dissatisfied with the results of the Staff's analysis, they should be given a reasonable amount of time to supply some factual support for their position.<sup>1/</sup> At that point, the Board would then be able to determine whether there are factual matters in dispute which are susceptible to litigation.

Respectfully submitted,



Robert G. Perlis  
Counsel for NRC Staff

Dated at Bethesda, Maryland  
this 23rd day of July, 1984

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<sup>1/</sup> If Intervenors do attempt to challenge the information contained in the SER, the other parties should be granted the opportunity to respond. Any such challenge filed at that time should be based on information contained in the SER and not on information currently available. See Duke Power Company (Catawba Station, Units 1 and 2), CLI-83-19, 17 NRC 1041, 1048 (1983).

November 19, 1982

FOR: The Commissioners

FROM: Executive Director for Operations

SUBJECT: CLARIFICATION OF U. S. GEOLOGICAL SURVEY POSITION RELATING TO SEISMIC DESIGN EARTHQUAKES IN THE EASTERN SEABOARD OF THE UNITED STATES

PURPOSE: To provide the Commissioners with information relating to the clarification of the U. S. Geological Survey Position with respect to the 1886 Charleston, S.C. Earthquake reoccurrence

DISCUSSION For the purpose of licensing of facilities in the Southeastern U. S., the NRC has taken a position, based primarily on the advice of the U.S. Geological Survey (USGS), that any reoccurrence of the 1886 Charleston, S.C. earthquake (Modified Mercalli Intensity (MMI) X, estimated Magnitude about 7) would be confined to the Charleston area. That is, the Charleston earthquake is assumed to be associated with a geologic structure in the Charleston area. Nuclear power plants in the region east of the Appalachian Mountains are, therefore, usually controlled in their seismic design, according to Appendix A to 10 CFR Part 100, by the maximum historical earthquake not associated with a geologic structure. This controlling earthquake is typically an MMI VII or VIII. Since 1974, the NRC has funded an extensive research project in the Charleston area to gain further information on the causative mechanism of this event.

On January 28 and 29, 1982 the Extreme External Phenomenona Subcommittee of the ACRS convened a meeting of expert professionals in the geosciences to obtain an overview of the state of knowledge and future NRC research needs in this area. During that meeting, we were informed by the USGS that it had formed a working group to reassess the validity of its position on the Charleston earthquake.

Contact:  
R. Vollmer, NRR  
492-7207

This information was conveyed to the Commissioners in a Commission Information Paper (SECY-82-53) on February 5, 1982. In that paper we indicated that any major modification of the former USGS position could have significant impact on many Eastern U.S. nuclear plant sites.

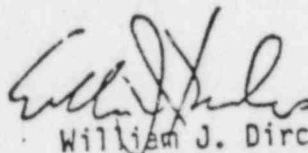
After many months of deliberation, the USGS has clarified its previous position relating to the 1886 Charleston, S.C. earthquake. The attached letter, James F. Devine, USGS, to Robert E. Jackson, NRC, November 18, 1982 provides the position and indicates that:

"Because the geologic and tectonic features of the Charleston region are similar to those in other regions of the eastern seaboard, we conclude that although there is no recent or historical evidence that other regions have experienced strong earthquakes, the historical record is not, of itself, sufficient grounds for ruling out the occurrence in these other regions of strong seismic ground motions similar to those experienced near Charleston in 1886. Although the probability of strong ground motion due to an earthquake in any given year at a particular location in the eastern seaboard may be very low, deterministic and probabilistic evaluations of the seismic hazard should be made for individual sites in the eastern seaboard to establish the seismic engineering parameters for critical facilities."

Based on our discussions with USGS senior personnel, this clarification is not intended to recommend that we categorically consider a Charleston-type event in the seismic design of all nuclear plants in the eastern seaboard of U.S. The USGS does believe, however, that an earthquake of this size should not be categorically ruled out at locations away from Charleston based solely on the statement in the December 30, 1980 USGS letter which states, "Consequently, earthquakes similar to the 1886 event should be considered as having the potential to occur in the vicinity of Charleston and seismic engineering parameters should be determined on that basis." Instead, this clarification provides guidance that indicates that such a conclusion should be reached only after deterministic and probabilistic evaluations of the seismic hazard for individual sites have been made.

Our evaluation of the significance of this clarification is underway. Currently, a two day review meeting between NRC (ORES and ONRR) and the USGS is planned for November 30, 1982 and December 1, 1982 to discuss both the status of geoscience knowledge in the Charleston region and future research efforts. The first day will be an open public meeting (noticed in the Federal Register) which will allow for comments and questions from interested parties and members of the public.

We have also attached our preliminary views on a plan to address this clarified USGS position. This plan includes elements which relate to both ongoing research and licensing efforts and possible requirements for new efforts (split approximately 75% and 25% respectively). This plan will be modified and completed after several meetings with the USGS take place in order that a more complete understanding of its clarified position can be obtained.



William J. Dircks  
Executive Director for Operations

Attachments:  
As stated

*TAC*

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# United States Department of the Interior

GEOLOGICAL SURVEY  
RESTON, VA. 22092

In Reply Refer To:  
Mail Stop 905

NOV 18 1982

Dr. Robert E. Jackson  
Chief, Geosciences Branch  
Division of Engineering  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Bob:

The purpose of this letter is to clarify our position on the seismic potential of certain regions of the Eastern United States. In our letter of December 30, 1980, on the same subject we expressed the view that "... the likelihood of a Charleston sized event in other parts of the Coastal Plain and Piedmont is very low."

As you are aware, after several years of intensive study in the Charleston region, no geologic structure or feature can be identified unequivocally as the source of the 1886 Charleston earthquake. However, as studies in the Charleston region and elsewhere along the Atlantic margin have progressed, it has become evident that the general geologic structure of the Charleston region can be found at other locales within the eastern seaboard (Appalachian Piedmont, Atlantic Coastal Plain, and Atlantic Continental Shelf).

Because the geologic and tectonic features of the Charleston region are similar to those in other regions of the eastern seaboard, we conclude that although there is no recent or historical evidence that other regions have experienced strong earthquakes, the historical record is not, of itself, sufficient grounds for ruling out the occurrence in these other regions of strong seismic ground motions similar to those experienced near Charleston in 1886. Although the probability of strong ground motion due to an earthquake in any given year at a particular location in the eastern seaboard may be very low, deterministic and probabilistic evaluations of the seismic hazard should be made for individual sites in the eastern seaboard to establish the seismic engineering parameters for critical facilities.

As stated in our letter of December 30, 1980, earthquakes similar to the 1886 Charleston, South Carolina, event should be considered as having the potential to occur in the vicinity of Charleston and seismic engineering parameters of critical facilities in that area should be determined on that basis.

Sincerely yours,

James F. Devine  
Assistant Director for  
Engineering Geology

Outline for Recommended Plan  
Eastern U. S. Earthquakes

Introduction

Based on our preliminary assessment of the U. S. Geological Survey's (USGS) clarification of position relating to a Charleston-type earthquake, we do not see a need for any immediate action for specific sites at this time. Instead, we foresee that this clarification can be addressed predominantly through existing ongoing programs at NRC with the possibility of additional requirements for work by the Utilities.

The USGS clarification indicates that deterministic and probabilistic evaluations should be made. Generally, for most existing sites, extensive deterministic studies have been undertaken and used in developing the existing seismic design basis. We therefore believe that this element of the clarification continue to be addressed through our long range research plan. Specific modifications to that plan can be made in order to address specific tectonic structures. If necessary, a few specific applicants or licensees may be required to investigate tectonic structures which may not have been previously identified during the licensing procedure.

As many of the current working deterministic hypotheses are not directly amenable to investigation in the short term, we believe that the clarification issue should be pursued in the short term principally through a probabilistic assessment of plants in the eastern seaboard. This probabilistic program can be coupled to the current ongoing NRC efforts in this area already underway. We also believe that utility-sponsored studies should be undertaken, preferably as a consolidated group, to assess the seismic hazard in the eastern seaboard.

Further specifics on this program will be provided after more extensive discussions with the USGS. Although the probability of strong

**PROBABILISTIC EVALUATION:**

In our view, the USGS clarification represents not so much a new understanding but rather a more explicit recognition of existing uncertainties with respect to the causative structure and mechanism of the 1886 Charleston earthquake. Many hypotheses have been proposed as to the locale in the eastern seaboard of future Charleston-size earthquakes. Some of these could be very restrictive in location while others would allow this earthquake to reoccur over very large areas. Presently, none of these hypotheses are definitive and all contain a strong element of speculation.

Traditional deterministic approaches are not generally designed to deal with this situation. Probabilistic methods which allow for the consideration of many hypotheses, their associated credibilities, and the explicit incorporation of uncertainty are much better equipped to provide rational frameworks for decision making. We believe that the

probabilistic approach described below, which takes into account the uncertainties, should be used to determine differences (if any) between seismic hazard levels associated with seismic design values in the eastern seaboard (i.e. as affected by the USGS clarified position on the Charleston Earthquake) and seismic hazard levels associated with seismic design values elsewhere in the central and eastern U. S.

#### Probabilistic Plan

1. Continue development of Lawrence Livermore National Laboratory (LLNL) study on seismic hazard (probability of exceedance) for nuclear power plants east of the Rocky Mtns. This study (Seismic Hazard Characterization of the Eastern United States) is presently underway.
2. Compare of LLNL study with existing probabilistic studies (for example USGS Open File Report 82-1033) and other ongoing NRC Research into probabilistic seismic estimation.
3. Sponsorship by the industry as a whole of a probabilistic estimation of hazard for all nuclear plants on the eastern seaboard, along with existing studies for individual plants.
4. Make comparisons between plants in the eastern seaboard and other parts of U.S. using the LLNL and other studies to determine significant differences (if any) in seismic hazard associated with seismic design.
5. Integration of above into Systematic Evaluation Program-type evaluation for possible engineering reanalysis.

#### DETERMINISTIC EVALUATION:

Deterministic studies in response to the USGS clarification should continue to be oriented toward determining the causal mechanisms of the earthquake under NRC's existing research program. These studies should involve systematic testing of the several hypotheses of the causative structure of the Charleston earthquake and investigations in areas of high seismicity and designated areas of potential seismicity for additional evidence of the cause. The type of studies most likely to lead to a better understanding of the causes of seismicity in the eastern seaboard of the United States are neotectonic investigations (recent crustal motions and seismicity) coupled with examination of crustal structure:

These deterministic studies are basically four types:

1. The continuation of seismological research through the operation of the existing micro-earthquake networks and the development of a strong motion data base.



2. The determination of the geometry of structure and tectonics of the earth's crust at depths where earthquakes are occurring (5-20 km) in the eastern seaboard using such techniques as seismic reflection profiling.
3. The continuation of subsurface neotectonic investigations of earthquake source areas to determine if uplift, subsidence or differential movement is occurring. Such studies may include among others:
  - A. Tectonic Geomorphology
  - B. Geodetic Measurements
  - C. Geologic Mapping
  - D. Remote Sensing



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

MAR 30 1984

MEMORANDUM FOR: James P. Knight, Assistant Director for  
Components & Structures Engineering, DE

FROM: Robert E. Jackson, Chief  
Geosciences Branch, DE

SUBJECT: REVISION 1 OF DIVISION OF ENGINEERING GEOSCIENCES PLAN  
TO ADDRESS USGS CLARIFICATION RELATING TO SEISMIC  
DESIGN EARTHQUAKES IN THE EASTERN SEABOARD OF THE  
UNITED STATES

Attached is our revised plan to address the U. S. Geological Survey's clarification of position relating to seismic design earthquakes in the Eastern Seaboard of the United States.

The revisions are generally changes of the dates of completion of specified tasks with minor revisions of the tasks themselves. Tasks which are completed or currently underway are also indicated.

We estimate that the preliminary hazard levels for the sites, along with our recommendations of which plants may need further evaluation should be completed early to mid-1985, instead of mid-1984 as originally planned. In addition, industry has undertaken an extensive parallel program to develop methodology for calculating hazard curves through the Electric Power Research Institute (EPRI) which is scheduled for completion early in 1985.

The deterministic portion of the program will be synthesized on or about January 1986. The delay from the original date of January 1985 is due to the time required to compete the necessary contracts through ORES.

In summary the probabilistic and deterministic parts of the programs are underway. There have been some delays of 6 months to 1 year. The present schedule is for completion of the probabilistic part of the plan during 1985, and the deterministic part early in 1986.

A handwritten signature in cursive script that reads "Robert E. Jackson".

Robert E. Jackson, Chief  
Geosciences Branch, DE

cc: See next page

MAR 30 1984

cc: H. Denton  
R. Vollmer  
- D. Eisenhut  
R. Arsenault  
L. Beratan  
A. Murphy  
T. Schmitt  
L. Reiter  
S. Brocoum  
GSB Staff



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

MAR 02 1983

MEMORANDUM FOR: Harold R. Denton, Director  
Office of Nuclear Reactor Regulation

FROM: Richard H. Vollmer, Director  
Division of Engineering

SUBJECT: DIVISION OF ENGINEERING GEOSCIENCE PLAN TO ADDRESS USGS  
CLARIFICATION RELATING TO SEISMIC DESIGN EARTHQUAKES IN  
THE EASTERN SEABOARD OF THE UNITED STATES

A plan for our proposed program to address the U. S. Geological Survey's clarification of position relating to seismic design earthquakes in the Eastern Seaboard of the United States is attached (enclosure 1). This plan elaborates on the outline provided as an attachment to a memorandum entitled, "Clarification of U. S. Geological Survey Position Relating to Seismic Design Earthquakes in the Eastern Seaboard of the United States", which was sent from the Executive Director of Operations to the Commissioners on November 19, 1982.

The plan is divided into two parts. Part one is a short term probabilistic assessment utilizing an extensive new seismic hazard study currently being developed by Lawrence Livermore National Laboratory. Part two is a longer term deterministic assessment based primarily on long range ORES research with the possible need for utility sponsored investigations at some locations after an assessment of the long term research results. Additionally, we recommend that an industry sponsored seismic hazard study be solicited.

We estimate that the effort to establish the seismic hazard level for the sites and make appropriate comparisons will take approximately three years to complete, utilizing staff resources of about 2.5-3.0 SY per year, and \$300K per year in technical assistance funds. Our preliminary recommendations on which plants, if any, may need further evaluation should be completed in mid-1984. Because of the required research effort, the deterministic element will not be synthesized until 1985.

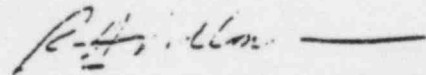
The proposed program will complement ongoing PRA reviews and the seismic hazard spectra which are developed can also be used for future SEP evaluations. This program, therefore, is basically a continuation, with modification, of our ongoing work. This program does not include resources to complete a reevaluation effort for plants for which design spectra may need to be reevaluated. We recommend that this contingency be considered and included in the operating plan for FY 84. This plan also presupposes that our interim position for licensing reviews (enclosure 2) is found to be acceptable by ACRS and ASLB while we implement this program.

There is evidence to support this assumption in the recent Appeal Board decision on Summer (ALAB-710).

We have also assessed our ability to implement this plan under the existing regulation, Appendix A to 10 CFR Part 100. We have concluded that, although Appendix A itself does not explicitly recognize the use of probabilistic methods, as a minimum they can be used to assist in reaching deterministic judgements (Seabrook Remand, CLI80-33). It is not clear whether they can be used as the primary tool in setting appropriate ground motion levels. Therefore, we recommend that we implement a limited modification or clarification of Appendix A as previously planned in conjunction with ORES as a parallel, yet independent effort, along with the Charleston plan. This modification has been recommended in SECY-79-300 and endorsed by the Siting Policy Task Force in NUREG-0625 and is necessary to reflect the current state of art. This modification will require an additional 1.0 SY per year for 2 years.

We recommend that you consider placing this effort equally under three resource areas - Operating Reactor Licensing Actions or Safety Technology, Systematic Evaluation Program for older operating plants, and Casework for ongoing OL review plants.

This plan has been developed as a result of extensive discussion within the Geosciences Branch, NRR; and discussions with the Earth Sciences Branch, ORES; and the U. S. Geological Survey.



Richard H. Vollmer, Director  
Division of Engineering

Enclosure:  
As stated

cc: w/enclosure  
E. Case  
D. Eisenhut  
R. Vollmer  
R. Mattson  
H. Thompson  
J. Knight  
R. Jackson  
L. Reiter  
S. Brocoum  
T. Sullivan  
L. Beratan  
R. Minogue  
F. Arsenault  
J. Scinto

A. Murphy  
T. Schmidt  
W. Russell  
R. Bernero  
GSB Staff  
Z. Rosztoczy  
P. Williams

Recommended Plan  
Eastern U. S. Earthquakes Revision 1

Introduction

On November 18, 1982, the U. S. Geological Survey (USGS) forwarded a letter to the Nuclear Regulatory Commission clarifying their past position with respect to the 1886 Charleston earthquake. The USGS letter states that:

"Because the geologic and tectonic features of the Charleston region are similar to those in other regions of the eastern seaboard, we conclude that although there is no recent or historical evidence that other regions have experienced strong earthquakes, the historical record is not, of itself, sufficient grounds for ruling out the occurrence in these other regions of strong seismic ground motions similar to those experienced near Charleston in 1886. Although the probability of strong ground motion due to an earthquake in any given year at a particular location in the eastern seaboard may be very low, deterministic and probabilistic evaluations of the seismic hazard should be made for individual sites in the eastern seaboard to establish the seismic engineering parameters for critical facilities."

We have evaluated the USGS clarification of position and have concluded that it can be addressed predominantly through existing programs at NRC with the possibility of additional requests for utility - sponsored work. We recommend that a two part program be implemented which will address both the deterministic and probabilistic elements mentioned by the USGS.

Part 1 of the proposed program is a short term probabilistic assessment of plants in the eastern seaboard. This part of the plan is necessary because many of the current tectonic working hypotheses are not amenable to investigation by deterministic methods in the short term.

Part 2 of the proposed program is a longer term deterministic assessment of the causes of large earthquakes, such as the Charleston earthquake, in the eastern seaboard. Specific areas of relatively high seismicity and tectonic structures are identified which we recommend be addressed through the ORES long range research plan.

Based on our evaluation of the research results, some applicants or licensees may be required to investigate tectonic structures which may not have been previously identified during the licensing procedure.

#### Part 1 - Probabilistic Assessment

##### Discussion

The November 18, 1982 letter from the USGS represents not so much a new understanding but rather a more explicit recognition of existing uncertainties with respect to the causative structure and mechanism of the 1886 Charleston earthquake. Many hypotheses have been proposed as to the locale in the eastern seaboard of future Charleston-size earthquakes. Some of these could be very restrictive in location while others would allow this earthquake to recur over very large areas. Presently, none of these hypotheses are definitive and all contain a strong element of speculation.

Traditional deterministic approaches such as that outlined in Section 2.5.2 of the Standard Review Plan are not generally designed to deal

with this situation. Probabilistic methods which allow for the consideration of many hypotheses, their associated credibilities, and the explicit incorporation of uncertainty are much better equipped to provide rational frameworks for decision making. The question that needs to be answered is:

Taking uncertainties into account, have licensing decisions for plants in the eastern seaboard (i.e., in the region affected by the USGS clarified position on the Charleston Earthquake) resulted in acceptable levels of assumed seismic hazard (exposure to earthquake ground motion) at the individual sites?

One means for answering the above question is a probabilistic assessment of seismic hazard at all nuclear power plant sites east of the Rocky Mountains. Since adequate or acceptable levels of seismic hazard have not been explicitly defined in probabilistic terms, it is assumed that the probability of seismic ground motion exceeding design levels implicitly associated with licensing decisions based upon traditional methods in other regions of the U. S. east of the Rocky Mountains is adequate; these other regions include areas such as the Central Stable Region and the Gulf Coastal Plain. The prime tool for carrying out this assessment is an updated and revised version of the Uniform Hazard Methodology developed for the Systematic Evaluation Program by Lawrence Livermore National Laboratory (LLNL) and its subcontractor TERA Corporation. This methodology relies upon the incorporation of diverse expert opinion with regard to the input parameters needed to make probabilistic estimates. As such, it does not rely upon single hypotheses which do not account for existing uncertainties but rather



attempts to incorporate the hypotheses and their uncertainties into the computations. Identification of plants (if any) in the eastern seaboard at which the probability of exceeding design-level ground motion is significantly greater than has been assumed at other locations may result in an integrated seismic evaluation and/or engineering reanalysis to assure the plant's ability to withstand a more severe earthquake. This study may also identify selected plants outside of the eastern seaboard whose design levels may be inappropriate, relative to other plants, with respect to the seismic hazard.

In addition [~~we are also initiating~~] through a technical assistance contract, a study to better estimate ground motion from a large earthquake the size of the 1886 Charleston event to gain a better understanding of how this ground motion should be represented [-]. has recently been completed.

#### Major Activities - Probabilistic Assessment

The probabilistic assessment portion of the proposed program is divided into the following elements.

1. January 1983 thru [~~April-1983~~] September, 1984 - Continue development of LLNL study including expert opinion surveys on seismic hazard east of the Rocky Mountains. This study (Seismic Hazard Characterization of the Eastern U.S.) is presently underway as a joint effort of NRR (FIN NO. A0428) and ORES. (FIN No. A0306).

[No] Additional resources above those [already] allocated [are] were needed because of cost overruns on this project (about 1.0 SY, \$157,500).

2. [~~May-1983~~] January, 1984 thru [~~December-1983~~] September, 1985 - Calculation of seismic hazard spectra by LLNL for all nuclear power plant sites (approximately 75) east of the Rocky Mountains will be completed by early to mid-1985. An estimation of the probability of seismic ground motion exceeding the design level at each site, taking into account specific site conditions, will be completed and provided as a report. [An-additional-2.0-SY-is-needed-for-LLNL-and 0.3-SY-for-NRC-effort-during-this-period]

[~~3-September---December-1983--~~] In addition, a comparison of LLNL study with existing probabilistic studies such as Algermissen and others (1982) will be completed. [An-additional-0.2-SY-is-needed for-LLNL-effort] An additional 3.0 SY is needed for LLNL (FIN No. A0448) and 0.3 SY for NRC effort during this period.

[4] 3. [~~March~~] December 1983 - [~~1983~~] March 1985 - Sponsorship by the utilities of a probabilistic estimation of seismic hazard for all nuclear power plants east of the Rocky Mountains. [This-study, while-not-a-requirement, is-strongly-recommended-so-as-to complement-the-LLNL-study-and-provide-another-independent assessment-of-seismic-hazard] An additional [0.1] 0.4 SY needed for LLNL FIN No. A0448 and 0.1 SY for NRC effort.

[5] 4. [~~December-1983-March-1984~~] February, 1985 - September, 1985 - Using LLNL and other studies, the NRC staff will integrate this information and make comparisons of the probability of seismic

ground motion exceeding design levels in the eastern seaboard with probabilities calculated at plants in the rest of the Eastern and Central U. S. Comparisons will be made in several ways including comparison by region alone and by region and plant vintage. Plants in the eastern seaboard (if any) that are associated with significantly greater hazard than those elsewhere will then be identified. Other comparisons may be needed, but will be decided upon after review of initial results. An additional 0.7 SY is needed for NRC effort.

[6-April-1984-September-1984---Assessment-of-initial-conclusions regarding-hazard-in-light-of-feedback-from-expert-opinion-on original-input---A-final-letter-report-will-be-issued-with-a-final recommendation-on-plants-which-need-reevaluation---An-additional-0.2 SY-needed-for-LENL-and-0.2-SY-for-NRC-effort.]

[7] 5. January 1983-December 1983 - Ground motion estimates at different distances and site conditions from a large Charleston type earthquake. Both theoretical and empirical estimates using data from recent earthquakes will be made. This study [is presently-being-initiated-through-a-technical-assistance-contract with-LENL---No-additional-resources-are-required.] has been recently completed.

Status summary reports of research into probabilistic estimates of seismic hazard funded by ORES will be needed by December 1983 so as to incorporate them into task number 5.

### Implementation of Probabilistic Assessment Results

The implementation of results is outlined above in [elements-5-and-6+] element 4.

### NRR Staff and Cost Requirements - Probabilistic Assessment

The additional effort required for this portion of the program will be [2+5] 4.4 SY for LLNL ([1+9] in FY 83, [0+6] 2.4 in FY 84) and 1.3 SY for NRC (0.3 in FY 83, 1.0 in FY 84). This staff effort can be accommodated with the currently available resources in the Geosciences Branch because this program complements ongoing staff activities and may replace other staff activities for individual sites. This program does not include resources to complete the seismic evaluation and/or engineering reanalysis which some plants may require as a result of the probabilistic elements.

### Utility-Sponsored Study in Conjunction with the Probabilistic Assessment

A recommended utility-sponsored study is outlined above in element [4+] 3.

### Schedule - Probabilistic Assessment

The proposed schedule for implementing this plan appears in Table 1.

## Part 2 - Deterministic Assessment

### Discussion

The deterministic portion of the proposed program is designed to better understand the causes of large earthquakes, such as the Charleston earthquake, in the eastern seaboard. This effort may require some expansion of immediate and long term ORES programs. Increased

understanding of the cause of seismicity in the eastern seaboard will allow a reduction in the uncertainty in estimating the seismic hazard for nuclear power plants. The primary problem with seismic hazard characterization in the eastern seaboard is that no causative mechanism for seismicity has been identified to date and no surface offsets due to earthquakes are known. Although there are literally thousands of crustal structures known in the eastern seaboard, which, if they were active, could produce strong earthquakes, none have been demonstrated to have been active during the Quaternary (the last two million years) or proved to be capable. The result is that, to date, there has been no generally accepted association between eastern seismicity and crustal structure.

The overall approach of the deterministic assessment is to study areas of relatively higher seismicity in the eastern seaboard to determine if tectonic features and processes responsible for the seismicity can be identified and correlated. This will be pursued by crustal studies at hypocentral depths to determine if there is any correlation between crustal structures at hypocentral depths and the earthquake hypocenters. The primary tool for determining crustal structure at hypocentral depths will be the use of multi-channel seismic reflection profiles. The primary tools for locating the hypocenters will be the continued monitoring and analysis of earthquakes from the existing microearthquake nets. These nets will have to be maintained and upgraded in order to improve depth locations of hypocenters if there is to be an improved ability to correlate between hypocenters and tectonic structures at depths of up to 25 kilometers.

This research will be contracted and monitored by ORES, and does not represent a radical departure from past programs. Increased coordination between NRR and ORES will be required, however, to better define the problems that are to be resolved in order to improve our understanding of eastern seismicity in the licensing context. This portion of the program is designed to improve our ability to assess the adequacy of the design of nuclear facilities on the eastern seaboard. The result, in part, will be summary reports which will represent the current status of research including a review and synthesis of available data. These results will be used to modify, if necessary, conclusions drawn from the probabilistic studies and identify individual features, if appropriate, for assessment by utilities.

#### Major Activities - Deterministic Assessment

The deterministic assessment portion of the proposed program is divided into the following elements appropriate to each region listed.

##### A. Charleston Region

Since the causative mechanism of the Charleston earthquake of 1886 continues to be one of the primary unresolved problems in evaluating seismicity in the eastern seaboard, research in the Charleston area should continue with the goal of testing the various hypotheses as to the cause of the earthquake. In particular, emphasis should be placed on determining if suggested features such as the Ashley River and Woodstock Fault zones constitute the source zones of the Charleston earthquakes.

1. May 1983 - "Workshop on the 1886 Charleston Earthquake and Its Implications for Today" - the U. S. Geological Survey and the scientific community [~~will present~~] presented a summary and evaluation of the tectonics and seismicity at Charleston.
2. [~~September-1983~~] April 1984 - ORES in consultation with the U. S. Geological Survey and the scientific community should have a program in place to test the most likely tectonic hypothesis for seismicity.
3. June [~~1984~~] 1985 - ORES presents the results of the program of testing the highest-weighted hypothesis. Interim results will be presented as available.
4. January [~~1985~~] 1986 - ORES presents summary report (perhaps a symposium) describing the results of the Charleston work testing the highest-weighted tectonic hypothesis.

#### B. Ramapo Fault Zone

The Ramapo Fault Zone, a Precambrian fault zone that was intermittently active until the Mesozoic, is the northwestern boundary of the Newark Triassic Basin. Low level seismicity occurs in the area and may be associated with the fault zone, however, the seismicity in the region forms a band 40 kilometers wide. Detailed field work and limited trenching and core drilling suggest that the Ramapo Fault has not been recently reactivated. The purpose of studying the fault is to establish whether there is a causal relationship between Mesozoic or older faults such as the Ramapo Fault and current seismicity in this area by determining the location and geometry of these faults at hypocentral depths.

1. April 1983 - ORES [~~initiates~~] initiated a new evaluation of the Ramapo Fault. The study [~~should include~~] includes multi-channel seismic reflection profiling and other geophysical techniques such as in-situ stress measurements and geodetic measurements to determine the current state of stress at hypocentral depths.
2. [~~January~~] February 1984 - ORES [~~presents~~] presented preliminary results of the program to date, and plans for the coming year.
3. [~~January~~] March 1985 - ORES presents summary report on this aspect of the Ramapo Fault Study including the identification and analysis of any seismic source zones.

#### C. Central Virginia Seismic Zone

Recent work by earth scientists at Virginia Polytechnic Institute have suggested that there may be a relationship between the seismicity in Central Virginia and the northeast trending thrust faults and decollement of the Piedmont crust of the Appalachian Orogenic Belt. The purpose of this part of the program is to continue evaluation of the relationship between the faults and the earthquakes.

1. April 1983 - ORES [~~presents~~] presented a plan for undertaking the seismic reflection profiling, and applying other geophysical techniques such as geodetic measurements and in-situ stress measurements.
2. [~~January~~] May 1984 - ORES presents the preliminary results or progress to date, and plans for the coming year.
3. January 1985 - ORES presents a summary report on the



the Central Virginia Study including the potential identification and analysis of any seismic source zones.

D. Giles County, Virginia

The Giles County Seismic Zone is a northeast trending linear zone of seismicity which apparently is located beneath the decollement and thrust faults associated with the Valley & Ridge Province of the Appalachian Orogenic Belt. It has been suggested that the seismic zone has occurred as a reactivated northeast trending normal fault associated with the opening of the Proto-Atlantic (called the Iapetus) in the late Proterozoic and early Paleozoic (800-500 million years ago).

1. April 1983 - ORES [initiates] initiated planning for the proposed research.
2. August 1983 - ORES [initiates] initiated study of the Giles County structure using seismic reflection profiling.
3. [April] May 1984 - ORES presents preliminary results and plans for the coming year.
4. April 1985 - ORES presents summary results of this phase of the research including the potential identification and analysis of any seismic source zones.

E. New England

The research in New England has been underway for several years and will be continued. Increased emphasis should be placed on evaluation of the source mechanism for the New Brunswick and Gaza, N.H. earthquakes, the neotectonics of seismically active areas, and the orientation and

magnitude of the stress field in the seismically active areas of the region. An in-situ stress measurement at hypocentral depths will be conducted at Moodus. Depending on the results of the seismic reflection studies described above, additional seismic reflection surveys may be conducted in seismically active areas of New England such as Moodus, Connecticut; New Hampshire; Massena, New York and New Brunswick, Canada.

1. April 1983 - ORES [~~completes~~] completed plans for stress measurement at Moodus.
2. [~~August~~] April 1983 - Conduct stress measurements at Moodus. Stress measurements will also be conducted in the Ramapo Fault area in May, 1984.
3. [~~April~~] July 1984 - ORES presents preliminary results of stress measurements and their relationship to the local seismicity and tectonics.
4. January 1985 - ORES presents summary results of stress measurements and other studies (including neotectonics) described above.

#### Implementation of Deterministic Assessment Results

As the results from the deterministic studies become available, they will be evaluated, and, the effect, if any, on operating plants and plants in the Operating License stage of review will be determined. The need for additional evaluations of particular structures by utilities will be assessed as the information becomes available. Two problems will be addressed by the deterministic portion of the program; (1) whether or not the deterministic findings warrant any reassessment of the

conclusions drawn from the probabilistic study; and (2) whether there are any particular tectonic structures which are associated with or similar to tectonic structures associated with seismicity which, because of their proximity to individual sites, should be analyzed by the utilities. The above effort will take about two to three years (early [~~1985~~ 1986] to complete. The impact of this research on nuclear power plants will be determined by the NRC staff with technical assistance contracts, if necessary.

NRR Staff and Cost Requirements - Deterministic Assessment

This effort will require continuous communication among NRR, ORES and the contractors. As research funds are limited and the amount of time is short, careful interaction will be necessary to obtain the information required to allow a resolution of eastern seismicity. It is estimated that one staff year per year for three years will be necessary for NRR to implement this deterministic part of the overall plan. The research effort will be funded by ORES and technical assistance contracts will be funded by NRR. It is estimated that for the deterministic assessment, \$200,000 may be required to implement the NRR technical assistance program to determine the impacts of the findings on the nuclear facilities in the eastern U. S.

Utility-Sponsored Studies as Result of the Deterministic Assessment

During FY 1983 no deterministic work by the utilities is currently recommended, beyond that necessary to pursue their normal efforts to continue to assess any hazards identified by them for their sites. After the results of the research are available and if any source zones are identified which have particular importance to specific sites or

have impact on the probabilistic program, some utilities may be required to investigate structures in the vicinity of their plants.

Schedule - Deterministic Assessment

The proposed schedule for implementing this plan follows as Table 1. Our ability to meet this proposed schedule may be somewhat optimistic and is contingent on implementing the appropriate contracts. We will be better able to assess this schedule when the work has been initiated.

Calendar Year Schedule for Probabilistic and Deterministic Seismic Hazard Program

	1983	1984	1985
<u>Part 1 Short Term</u>	Meet with ACRS to discuss Program	Meet with ACRS to discuss Preliminary Recommendations	
1. Update LLNL Seismic Hazard Methodology	[+Complete-Methodology]	+Complete Methodology	
2. Calculate Seismic Hazard Spectra for Eastern Sites	+ _____	[+Report-with-Spectra]	Report with Spectra ±
[3+] Compare with other available probability studies		+ _____	[+Report-with-Comparisons] Report with Comparisons ±
[4+] 3. Initiation of Industry-Sponsored Seismic Hazard Study	+ _____	[+Production-of-Study-Results]	Production of Study Results ±
		Letter Report with Recommendations	
5. 4. Comparison of Seismic Hazard at Sites		[Letter-Report-with Preliminary-Recommendations]	Final Recommendations ±
		+ _____ [+]	[+Final--Recommendations]
[6+ Assessment-of-Impact-of Expert-Feedback		Initiate-Feedback	Assess-impact-on Previous-Results ±
		+ _____	
[7+] 5. Charleston Ground Motion Study	Initiate Tac with LLNL	+Issue Report (issued Jan, 1984, NUREG June, 1984)	

Table 1

Calendar Year Schedule for Probabilistic and Deterministic Seismic Hazard Program

	1983	1984	1985
<u>Part 2 Long Term</u>	Meet with ACRS to discuss Program	Meet with ACRS to discuss Preliminary Recommendations	
1. Charleston Research	Workshop-Interim Synthesis x	Progress Report on Hypothesis Testing [x] x	Results of Testing [xx-----] x
2. Ramapo Fault Research	Initiate Study x	Preliminary Report x	Summary Report xx-----
3. Central Va. Research	Initiate Study x	Preliminary Results Report [x] x	Summary Report xx-----
4. Giles County, Va. Research	RFP x	Initiation of Study x	Preliminary Results x
			Summary Report xx-----
5. New England Seismotectonic Research	Stress Measurements Plan x	Conduct Measurements x	Preliminary Results x
			Summary Report -----xx
6. Assessment of Impact of Deterministic Studies on Sites		Preliminary Evaluation of Results of RES x	Summary of Source Zones x
			Summarize Review of Deterministic Work +

Table 1 (cont'd)

Interim Position on Charleston Earthquake  
for Licensing Proceeding

The NRR Staff position with respect to the Intensity X 1886 Charleston earthquake has been that, in the context of the tectonic province approach used for licensing nuclear power plants, this earthquake should be restricted to the Charleston vicinity. This position was based, in part, on information provided by the United States Geological Survey (USGS) in a letter dated December 30, 1980 from J. E. Devine to R. E. Jackson (see Summer Safety Evaluation Report). The USGS has been reassessing its position and issued a clarification on November 18, 1982 in a letter from J. E. Devine to R. E. Jackson. As a result of this letter, a preliminary evaluation and outline for NRC action was forwarded to the Commission in a memorandum from W. J. Dircks on November 19, 1982.

The USGS letter states that:

"Because the geologic and tectonic features of the Charleston region are similar to those in other regions of the eastern seaboard, we conclude that although there is no recent or historical evidence that other regions have experienced strong earthquakes, the historical record is not, of itself, sufficient grounds for ruling out the occurrence in these other regions of strong seismic ground motions similar to those experienced near Charleston in 1886. Although the probability of strong ground motion due to an earthquake in any given year at a particular location in the eastern seaboard may be very low, deterministic and probabilistic evaluations of the seismic hazard should be made for individual sites in the eastern seaboard to establish the seismic engineering parameters for critical facilities."

The USGS clarification represents not so much a new understanding but rather a more explicit recognition of existing uncertainties with respect to the causative structure and mechanism of the 1886 Charleston earthquake. Many hypotheses have been proposed as to the locale in the eastern seaboard of future Charleston-size earthquakes. Some of these

could be very restrictive in location while others would allow this earthquake to recur over very large areas. Presently, none of these hypotheses are definitive and all contain a strong element of speculation.

We are addressing this uncertainty in both longer-term deterministic and shorter-term probabilistic programs. The deterministic studies, funded primarily by the Office of Research of the NRC should reduce the uncertainty by better identifying (1) the causal mechanism of the Charleston earthquake and (2) the potential for the occurrence of large earthquakes throughout the eastern seaboard. The probabilistic studies, primarily that being conducted for NRC by Lawrence Livermore National Laboratory (LLNL) will take into account existing uncertainties. They will have as their aim to determine differences, if any, between the probabilities of seismic ground motion exceeding design levels in the eastern seaboard (i.e. as affected by the USGS clarified position on the Charleston earthquake) and the probabilities of seismic ground motion exceeding design levels elsewhere in the central and eastern U. S. Any plants where the probabilities of exceeding design level ground motions are significantly higher than those calculated for other plants in the Central and Eastern U. S. will be identified and evaluated for possible further engineering analysis.

Given the speculative nature of the hypotheses with respect to the recurrence of large Charleston-type earthquakes as a result of our limited scientific knowledge and the generalized low probability associated with such events, we do not see a need for any action for



UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of

GEORGIA POWER CO.  
et al.

(Vogtle Electric Generating Plant,  
Units 1 and 2)

Docket Nos. 50-424  
50-425  
(OL)

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF RESPONSE TO LICENSING BOARD LETTER OF JULY 12, 1984" in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class, or, as indicated by an asterisk, through deposit in the Nuclear Regulatory Commission's internal mail system, this 23rd day of July, 1984:

Morton B. Margulies, Esq., Chairman\*  
Administrative Judge  
Atomic Safety and Licensing Board  
Panel  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dr. Oscar H. Paris\*  
Administrative Judge  
Atomic Safety and Licensing Board  
Panel  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Carol A. Stangler  
425 Euclid Terrace, N.E.  
Atlanta, GA 30307

Ernest L. Blake, Jr. Esq.  
Shaw, Pittman, Potts & Trowbridge  
1800 M Street, N.W.  
Washington, D.C. 20036

Mr. Gustave A. Linenberger, Jr.\*  
Administrative Judge  
Atomic Safety and Licensing Board  
Panel  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Deppish Kirkland, III, Esq.  
Joel R. Dichter, Esq.  
Consumers Utility Counsel  
Suite 225  
William Oliver Building  
32 Peachtree Street, N.W.  
Atlanta, GA 30303

Douglas C. Teper  
1253 Lenox Circle  
Atlanta, GA 30306

Jeanne Shorthouse  
507 Atlanta Avenue  
Atlanta, GA 30315

Dan Feig  
1130 Atlanta Avenue  
Atlanta, GA 30307

Atomic Safety and Licensing  
Board Panel\*  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Docketing and Service Section\*  
Office of the Secretary  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

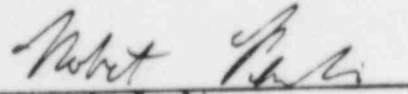
James E. Joiner, Esq.  
Troutman, Sanders, Lockerman,  
& Ashmore  
127 Peachtree Street, N.W.  
Atlanta, GA 30043

Tim Johnson  
Executive Director  
Educational Campaign for  
a Prosperous Georgia  
175 Trinity Avenue, S.W.  
Atlanta, GA 30303

Laurie Fowler, Esq.  
Legal Environmental Assistance  
Foundation  
1102 Healey Building  
57 Forsyth Street, N.W.  
Atlanta, GA 30303

Atomic Safety and Licensing  
Appeal Board Panel\*  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Ruble A. Thomas  
Southern Company Services, Inc.  
P.O. Box 2625  
Birmingham, AL 35202



Robert G. Perlis  
Counsel for NRC Staff