



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

APR 02 1982

MEMORANDUM FOR: Commissioner Ahearne

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: USGS EARTHQUAKE ANALYSES

As a result of my March 19, 1982 report to Chairman Palladino on a meeting with Dr. Dallas Peck, Director of the United States Geological Survey (USGS), you requested on March 23 clarification of the USGS position on the Charleston, S.C. earthquake and on eastern U. S. earthquakes in general. My purpose in meeting with Dr. Peck on March 1, 1982 was to discuss overall management aspects of our interagency agreement. We did discuss the Charleston earthquake issue and the USGS stated that they had not completed a reassessment of their previous position on the Charleston earthquake.

The USGS did indicate, however, based on the present stage of their deliberations, that the geologic features related to the Charleston earthquake may not be unique to the Charleston area. Although they have not completed their seismology analysis, they are attempting to formulate a position which appropriately expresses, most likely in a probabilistic manner, the likelihood of such an event occurring elsewhere in the eastern U. S. Our latest information is that this position may not be reached until late April.

I have attached several relevant documents that reflect the most recent USGS and staff licensing positions relating to the Charleston earthquake. The most recent letter we have from the USGS dealing with the Charleston earthquake is a December 30, 1980 letter from J. Devine, USGS, to R. Jackson, USNRC (Enclosure 1), which states:

"The problem regarding identification of specific tectonic structures capable of generating large earthquakes in the east is far from resolution. Local structures near Charleston are incompletely known at present and the larger structural element, the decollement, is as yet hypothetical. However, the concentration of seismicity in the Charleston earthquake epicenter both before and after the August 31, 1886, event and the lack of post Miocene faulting in the Coastal Plain or any evidence for localizing large earthquakes indicate that the likelihood of a Charleston sized event in other parts of the Coastal Plain and Piedmont is very low. 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."

CONTACT:
R. E. JACKSON, NRR
492-8063

8205280409 XA

After considerable interaction with the USGS and geoscience consultants to an applicant in South Carolina, the staff issued a recent Safety Evaluation Report (Enclosure 2) which states:

"Therefore, it is our position that the 1886 Charleston, Modified Mercalli Intensity IX-X earthquake, can be reasonably related to complex geologic structure unique to that region; and in consideration of recurrent seismicity in the Summerville area, should not, in developing the earthquake design basis for the facility, be assumed to occur at the site (of the nuclear facility)."

At the January 28, 1982 ACRS Subcommittee meeting on Extreme External Phenomena (Enclosure 3), Mr. R. Morris of the USGS stated:

"We are currently taking a very hard look and, I suspect, will end up with a revision of what would be a formal position on the Charleston earthquake. There is a committee within the Survey composed of various scientists working on the Charleston project as well as some of the others. Bob Hamilton and John Behrendt are the head of that and committee co-chairmen. We will issue a position for a revised statement, when Bob (Hamilton), in about a month?" (Sic.)

As I have indicated earlier, however, the USGS now estimates that the issue will not be resolved until late April.

Although we have not recently asked the USGS for a formal description on their position on eastern earthquakes in general, they have followed the tectonic or seismotectonic approach and use of the maximum historical earthquake in licensing recommendations. The USGS is, however, working diligently to develop and release an updated earthquake hazard map of the United States. This map is being developed by T. Algermissen and will be an improved version of the map issued by Algermissen and Perkins in 1976. In summary, it appears that the USGS assumes that earthquakes are associated with faults in the eastern U. S. but there remains an inability to demonstrate a direct correlation between earthquakes and individual faults with the possible exception of the New Madrid and Charleston areas. This may be due to the long return periods or slow rate of activity on faults in the eastern U. S. As a result, the USGS has assumed the possibility of so-called random events and has used a variety of methods to express this randomness; including both deterministic judgements and probability (hazard) maps.

Commissioner Ahearne

- 3 -

We will advise you of any new information on this subject which is made available to us by the USGS.

(Signed) William J. Dircks

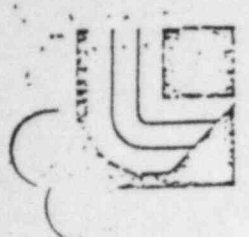
William J. Dircks
Executive Director for Operations

Attachments:

- (1) Ltr J. F. Devine, USGS to
R. E. Jackson, USNRC, 12/30/80
- (2) Staff position, Charleston earthquake,
V. C. Summer Safety Evaluation Report,
pp. 2-32 through 2-39, 1981
- (3) Partial transcript, ACRS Subcommittee
on Extreme External Phenomena, Jan. 29,
1982, pp. 341-352

cc:

Chairman Palladino
Commissioner Gilinsky
Commissioner Roberts
SECY
PE
GC



Lawrence Livermore National Laboratory

NUCLEAR SYSTEMS SAFETY PROGRAM

June 11, 1982
EG-82-26

Dr. Andrew J. Murphy
Earth Sciences Branch
Division of Health, Siting,
and Waste Management
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: Transmittal of NRC Form 189 Proposal for LLNL
Technical and Research Assistance to the Offices
of NRR and RES, NRC - "Seismic Hazard
Characterization of the Eastern United States,"
(FINS A0428 (NRR) and A0390 (RES)). DRAFT

REFERENCE: NRC Letter Arsenault to LaGrone, April 29, 1982.

Dear Dr. Murphy:

We are happy to submit the subject 189 proposal for FY 83.
This is in response to an NRC letter referenced above.

If you have any questions, please let us know.

Sincerely,

Don L. Bernreuter
Principal Co-Investigator

Dae H. Chung
Principal Co-Investigator

DLB:DHC/ca

Enclosure

cc: J. LaGrone, DOE/SAN
C. Poslusny, NRC/NRR/DE
J. M. Johnson, LLNL

82/11 920 69 XA

May 15, 1982



PROJECT AND BUDGET PROPOSAL FOR NRC WORK

☒ NEW☐ REVISION NO.

PROJECT TITLE

Seismic Hazard Characterization of the Eastern U.S.

FIN NUMBER

A0390

A0428

NRC S&R NUMBER

60-19-42

20-19-40-42-2

NRC OFFICE

Nuclear Regulatory Research

DOE CONTRACTOR

Lawrence Livermore National Laboratory (LLNL)

CONTRACTOR ACCOUNT NUMBER

DOE S&R NUMBER

SITE

Livermore, California 94550

COGNIZANT PERSONNEL	ORGANIZATION	FTS PHONE NUMBER	PERIOD OF PERFORMANCE
NRC PROJECT MANAGER L. Beratan	RSR	427-4370	STARTING DATE 10/1/82
OTHER NRC TECHNICAL STAFF A. J. Murphy	RSR	427-4615	COMPLETION DATE 5/30/84
DOE PROJECT MANAGER William J. Gallagher	DOE/SAN	536-7916	
CONTRACTOR-PROJECT MANAGER L. L. Cleland	LLNL	532-4948	
PRINCIPAL INVESTIGATOR(S) D. L. Bernreuter D. H. Chung J. M. Johnson, Resource Manager	LLNL LLNL LLNL	532-0305 532-0268 532-4949	

STAFF YEARS OF EFFORT (Round to nearest tenth of a year)	FY 82	FY 83	FY 84	FY	FY
Direct Scientific/Technical	1.1	1.7	0.6		
or Direct (Graded)	0.2	0.3	0.1		
TOTAL DIRECT STAFF YEARS	1.3	2.0	0.7		

COST PROPOSAL					
Direct Salaries		48	74	24	
Material and Services (Excluding ADP)		0	0	0	
ADP Support		10	20	5	
Subcontracts		80	110	30	
Travel Expenses	Foreign Domestic	2 8	10	10	
Indirect Labor Cost		43	70	23	
Other (Specify)		0	0	0	
General and Administrative (%)		13	21	8	
TOTAL OPERATING COST		205	305	100	
CAPITAL EQUIPMENT FIN CHARGED:		0			

TOTAL PROJECT COST		205	305	100		
MONTHLY FORECAST EXPENSE	OCTOBER	27	27	27	27	27
	APRIL	27	27	27	27	8

PROJECT AND BUDGET PROPOSAL FOR NRC WORK


DATE
May 15, 1982

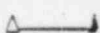
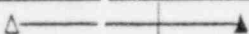
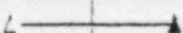


PROJECT TITLE

Seismic Hazard Characterization of the Eastern U.S.

DOE PROPOSING ORGANIZATION

Lawrence Livermore National Laboratory

FORECAST MILESTONE CHART: Scheduled to Start —  — Completed (Shown in Quarter Year)
PROVIDE ESTIMATED DOLLAR COST FOR EACH TASK FOR EACH FISCAL YEAR

TASK		FY 82				FY 83				FY 84				FY 85				FY 86			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1. Develop Initial Earthquake Occurrence Models	SCHEDULE																				
	COST	140K																			
2. Methodology Improvements	SCHEDULE																				
	COST	45K				75K															
3. Sensitivity Studies	SCHEDULE																				
	COST	20K				100K															
4. Stability of Results Feedback	SCHEDULE																				
	COST					15K															
Peer Review's Final Comments	SCHEDULE																				
	COST									10K				100K							
TOTAL ESTIMATED PROJECT COST		205K				305K				100K											

PROJECT DESCRIPTION: (Provide narrative descriptions of the following topics in the order listed. Attach on plain paper to this NRC Form 189. If an item is not applicable, so state.)

1. OBJECTIVE OF PROPOSED WORK
2. SUMMARY OF PRIOR EFFORTS
3. WORK TO BE PERFORMED AND EXPECTED RESULTS
4. DESCRIPTION OF ANY FOLLOW-ON EFFORTS
5. RELATIONSHIP TO OTHER PROJECTS
6. REPORTING SCHEDULE
7. SUBCONTRACTOR INFORMATION
8. LIST NEW CAPITAL EQUIPMENT REQUIRED
9. DESCRIBE SPECIAL FACILITIES REQUIRED
10. CONFLICT OF INTEREST INFORMATION

SEE NRC MANUAL CHAPTER 1102 FOR ADDITIONAL INFORMATION

APPROVAL AUTHORITY—SIGNATURE

DATE

1. OBJECTIVES OF PROPOSED WORK

Objective

The objective of this program is the development of a seismic hazard characterization methodology for the entire region of the United States east of the Rocky Mountains. Associated tasks are:

1. Develop the seismicity and ground motion parameters⁽¹⁾ for the entire U.S. region east of the Rocky Mountains. These parameters will be at such stage that they can be used to develop the seismic hazard in a form useful for PRA studies for any U.S. site east of the Rocky Mountains with relatively little additional effort.
2. Assist the NRC staff in addressing current NRC problem areas such as possible changes in the USGS position on the Charleston earthquake and the implications of recent eastern U.S. (EUS) earthquakes in New Brunswick and New Hampshire. This will be done through additional quality control, methodological improvements and ample sensitivity analysis.
3. Test the methodology at approximately eight sites east of the Rocky Mountains.

(1) The seismicity and ground motion parameters we will develop are characterized as follows:

- o Seismo-tectonic zonation.
- o Rate of earthquake occurrence
- o Distribution of earthquake magnitudes.
- o Largest earthquake with its associated uncertainty.
- o An identification of which available ground motion models, including uncertainty, should be used in site-specific studies.

Approach

Our approach to achieve this objective is to expand, improve, and apply methods developed in the SEP/SSMRP, including:

- o Use of expert panels.
- o Retention of multiplicity of expert models rather than looking for a consensus.
- o Use of sensitivity studies to identify key parameters.
- o Develop characterization of uncertainty about best estimates (or medians) of results.

2. SUMMARY OF PRIOR EFFORTS - BACKGROUND

This Project was initially formulated to meet the needs of a simplified methodology for routine probabilistic risk assessment. However, several larger EUS earthquakes occurred and at the January 28 & 29, 1982 meeting of the ACRS Subcommittee on Extreme External Phenomena, the USGS indicated that it might change its position in the Charleston earthquake putting NRR in the position of needing to assess the possible safety implications of the recent earthquakes and for any USGS change in position regarding the location of the Charleston earthquake.

In the proposed scope of work two sets of NRR needs are recognized. First, there is the need to perform seismic hazard analysis sensitivity studies at particular sites to provide the staff with sufficient information to assist them in making their safety assessments. The second need is to incorporate improvements into LLNL's approach to reduce the uncertainty in their results and provide rapid peer review of approach and results so that NRR can confidently use the results in their safety assessments and at hearings.

Specifically, the NRC has requested LLNL to assist the NRC in meeting the needs described above by expanding and improving the SEP/SSMRP methodology. This methodology was developed under the SEP project by LLNL with the TERA

Corporation as a subcontractor and then improved upon and extended under the SSMRP/Seismic Input (SI) Project. (In the following, we will refer to this methodology as the SEP/SSMRP study or seismic hazard analysis). As detailed later, LLNL was requested to expand the range of the EUS Seismicity Modeling Panel by adding expertise (specialists) in the southern portions of EUS; to improve the SEP/SSMRP questionnaire; to improve the EUS ground motion model; and to re-execute the SEP/SSMRP codes on the new data base.

3. WORK TO BE PERFORMED AND EXPECTED RESULTS

There are six (6) tasks as follows:

Task 1: Development of Initial Earthquake Occurrence Models

Task 2: Methodology Improvements

Task 3: Sensitivity Analysis

Task 4: Stability of Results

Task 5: Feedback and Development of Finalized Models

Task 6: Peer Review and Final Results

TASK 1 - Development of Initial Earthquake Occurrence Models

Background

The objective of this task is to develop and convene an EUS Seismicity Modeling Panel and obtain from them the necessary information (e.g. zonations, largest earthquakes, etc.) to develop for each panel member an overall earthquake occurrence model for the EUS in a form suitable for hazard analysis programs.

Subtask 1.1 - Select Panel Members

Interact with the geophysical community to select a panel with NRC concurrence that is representative of the diversity of opinion about the seismotectonics of the EUS. The main requirements for being a panel member are recognized expertise and willingness to put in the time required (estimated to be about 2 manweeks of effort per panel member including the feedback-loop). Initial attempt should be made to setup a single panel of

10-15 members to cover the entire EUS; however, 2-3 smaller regional panels may be considered, if a single panel is not practical.

Subtask 1.2 - Expand LLNL EUS Earthquake History Data Tape

Add Bollinger's catalog to our data tape, add results from the NRC support EUS network, and quality control the data tape.

Subtask 1.3 - Develop Improved Questionnaire

Review results from the past questionnaire developed under the SEP program and develop with close interaction with the NRC staff through the Project Manager and recommend a new questionnaire for the seismicity modeling panel. Incorporate results from Subtask 2.1.

Subtask 1.4 - Interaction with Panel and Obtaining Panel Responses

Interact with seismicity modeling panel members to explain program and use of their input. Provide, when requested, earthquake history for various zones defined by panel members.

TASK 2 - Methodology Improvements

Background

The approach used for the SEP/SSMRP seismic hazard analysis has been extensively reviewed. A number of improvements have been suggested particularly in the areas of expert opinion solicitation and use and in theoretical modeling to make probabilistic estimates of the seismic hazard at a site. Additional work is currently ongoing as part of the SSMRP to improve our ground motion modeling and correction for site factors. Subject this work to peer review and incorporate additional improvements in LLNL results. To account for the systematic error introduced by the ground motion model requires a large number of runs for each expert's earthquake occurrence model. This makes it difficult to come up with the final best estimate hazard results which includes all of the random and systematic uncertainty of both the earthquake occurrence and ground motion models. Under this task, approximate methods will be developed to handle this problem and still keep the amount of analysis and data management reasonable.

Subtask 2.1 - Solicitation and Use of Expert Opinion

Review the approach, results and recommendations of the Subjective Opinion Review Panel and other peer review comments and incorporate improvements into the approach used to solicit and use expert opinion. Use the results of Subtask 2.3 and develop an improved approach to develop a hazard curve.

Subtask 2.2 - Review of Ground Motion Models

Convene a panel of experts with the concurrence of the NRC Project Manager, to review Subtasks being carried out as part of the SSMRP effort to improve our ground motion modeling and site amplification effects. Incorporate recommendations as schedule and budget allow into methodology. This is the Ground Motion Modeling Panel.

Subtask 2.3 - Alternative Ways to Handle the Systematic Uncertainty of the Ground Motion Model

Develop approximate simplified methods to account for both the random and systematic uncertainty of the ground motion model. Sufficient sensitivity studies will be performed to verify if the developed approach is acceptable.

TASK 3 - Sensitivity Analysis

Background

The first objective of this task is to provide each expert sufficient information about the sensitivity of the computed hazard in different regions of the EUS for him to assess the physical reasonableness of their responses to the questionnaire and make adjustments to their model as required during the feedback-loop. The second objective is to provide NRC with an early preliminary assessment of implications of possible USGS changes in position regarding the Charleston earthquake and recent EUS earthquakes.

Subtask 3.1 - Encode Results of Questionnaire

Translate the responses to the questionnaire into a form suitable for input into hazard analysis program. Digitize boundaries of zones supplied by panel members. Interact with panel members as required to ensure proper interpretation of both the question and response.

Subtask 3.2 - Sensitivity Studies for Feedback Needs

Perform analysis using each panel member's model so that panel members can assess the physical reasonableness of their model.

Subtask 3.3 - Results at Specific Sites for NRC and Interim Report

Interact with and expand upon the sensitivity studies of Subtask 3.2 to address current NRR licensing needs using initial models. Experience from SEP suggests that feedback changes will not be significant except at a few isolated locations. Perform a "historical" hazard analysis for eight (8) selected sites for comparison. Write an interim report that provides the results of the analysis. Our interim report for this task is planned to be a report similar in format as Appendix B of Volume 4 of our SEP reports for NRR use. At this time, the scope of this subtask is uncertain. If additional work is required, we will prepare a proposal that outlines the work required, level of effort, costs, period of performance, etc., and submit it to the Director, Division of Health, Safety and Waste Management, RES and to the Director, Division of Engineering, NRR.

TASK 4 - Stability of Results

Background

The objective of this task is to establish the relative stability of our approach using a comparison of the seismic hazard results between the SEP/SSMRP study and this study. Recent EUS earthquakes will allow us to assess the impact of new information.

Subtask 4.1 - Analysis and Assessment

Perform additional analysis required using both the earthquake occurrence models developed in Task 3 and the SEP/SSMRP study. In particular, as the recent EUS earthquakes occurred in regions not analyzed as part of the SEP/SSMRP, LLNL will have to compute the seismic hazard in these regions using both the SEP/SSMRP models and the models developed as a result of this study. Compare results using both the synthesis hazard results from both this study

and the SEP/SSMRP study, and the individual results from seismicity modeling panel members who participated in both this study and the previous one. individual members that participated in both studies and the synthesis hazard results from both this study and the SEP/SSMRP study.

TASK 5 - Feedback and Development of Finalized Models

Background

The objectives of this task are to give the seismicity modeling panel members an opportunity to review the physical reasonableness of their inputs, review LLNL interpretation of their inputs and finally make any changes to their earthquake occurrence models that they feel is necessary to make their models physically reasonable. It will also provide the panel members a chance to discuss their views and possibly narrow the differences in opinion about key parameters.

Subtask 5.1 - Reconvene Panel and Develop Feedback Questionnaire

Put results of Task 3 and 4 in a form suitable for seismicity modeling panel members review. Hold a meeting with panel and discuss sensitivities, importance of various parameters, significance of difference between panel members. Allow panel members to discuss their differences and hopefully narrow the differences between panel members. However, SEP/SSMRP results suggest that there will be little movement towards consensus positions. Isolate the key items and develop a feedback questionnaire to address open items.

Subtask 5.2 - Make Changes to Models

Make changes to each expert's model as required using the responses obtained in Subtask 5.1.

TASK 6 - Peer Review and Final Results

Background

The objective of this task is to help maintain the scientific merit and credibility of this program by subjecting it to a formal peer review panel.

Subtask 6.1 - Assessment of Feedback

Analysis will be carried out to assess the implications of the feedback-loop on the results reported on in Subtask 3.3. We have only budgeted for a limited amount of assessment such as was performed for the SEP study. Develop an interim report on the assessment of the feedback-loop.

Subtask 6.2 - Convene Peer Review Panel

Select a peer review panel similar in make-up to the one used for the SEP. Meet with panel and provide them with an updated methodology report, results report from Task 3 and the feedback assessment reported from Subtask 6.1.

Subtask 6.3 - Assess Peer Review Recommendations

Perform sensitivity studies to assess the implication of Peer Review Panel recommendations in a manner similar to what was done for the SEP.

Establishment and Purpose of Model and Peer Review Panels

During the course of this project, it is necessary to convene three panels of experts:

1. Eastern U.S. Seismicity Modeling Panel, Task 1
2. Ground Motion Modeling Panel, Subtask 2.2
3. Overall Peer Review Panel, Subtask 5.1

Each of these panels is being convened by the contractor to obtain the expert opinion of each expert individually and not to obtain a consensus opinion of the panel. ~~Several of the panels are being brought together in~~ meetings to permit the free-flow of all available information that may contribute to the formulation of individual expert opinion. The contractor may, as part of the program effort, form its opinion of an average or consensus opinion of the panel's individual opinions.

Seismic Hazard Characterization of the Eastern U.S.
Milestones

<u>Milestone Task</u>	<u>Task</u>	<u>Target Date</u>
<u>Subtasks</u>		
1. Develop Initial Earthquake Occurrence Models		
	1. Complete selection of panel and development of first round questionnaire.	9/1/82
	2. Zonations developed from panel's responses.	10/15/82
	3. Panel members complete questionnaire.	12/1/82
2. Methodology Improvement		
	1. Start work on statistical improvements.	5/1/82
	2. Complete effort on improvements to solicitation of expert opinion.	9/1/82
	3. Convene Ground Motion Panel.	10/15/82*
	4. Complete work on statistical improvements on use of expert opinion and alternative approaches to handle systematic error in the ground motion model.	1/1/83
	5. Complete work on statistical improvements to feedback approach.	4/1/83

*Date approximate as it depends upon the schedule of Panel members.

<u>Milestone Task</u> <u>Subtasks</u>	<u>Task</u>	<u>Target Date</u>
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3. Sensitivity Analysis

1. Start encoding zonations.	9/15/82
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2. Complete sensitivity studies and provide NRR with initial assessments.	4/15/83
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4. Complete assessment of stability of results.	7/1/83
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5. Feedback Loop

1. Hold feedback meeting ^{(1)*} .	6/15/83
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2. Send out second round questionnaire ^{(2)*} .	8/1/83
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3. Results from second round questionnaire encoded.	11/1/83
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*Note: (1) This is approximate date as it depends upon the schedule of panel members. Our experience from the SEP study indicates that it was difficult to find a date to gather in one place at the same time sufficient number of the panel members.

(2) This date is approximate. The actual date is dependent upon when the feedback meeting was held.

6. Peer Review and Final Results

1. Complete assessment of implications of feedback.	1/1/84
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2. Hold Peer Review Panel meeting.	3/1/84
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3. Complete assessment of Peer Review.	6/1/84
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4. DESCRIPTION OF ANY FOLLOW-ON EFFORTS

Uncertain at this time.

5. RELATIONSHIP TO OTHER PROJECTS

The state-of-the-art findings from this project will assist two other projects in progress at LLNL. One is the SSMRP, Phase II studies (FIN No. A0126-2), and the other the Geoscience Case Review Project (FIN No. A0406-2).

6. REPORTING SCHEDULE

Upon completion of each task, LLNL will provide the NRC Project Manager with a draft letter report which includes a statement of the task, objectives, problems, solutions, products, results, and level of effort. After incorporation of NRC comments, provide a camera-ready copy and twenty copies of the final report to the Project Manager.

A monthly business letter report shall be submitted by the 15th of the month covering details of the preceding month to the cognizant NRC Project Manager with copies to B. L. Grenier, NRR, and W. Batson, RES. These reports shall contain:

- a. A listing of the amount of effort (staff months), broken down by task, expended during the reporting period;
- b. A listing of any efforts completed during the period; milestones reached, or if missed, an explanation provided;
- c. The amount of funds expended for staff, computer, subcontracting, and travel during the period and cumulative to date for each task;
- d. Any problems or delays encountered or anticipated, itemized by task and subtask; and
- e. A brief but thorough summary of progress during the reporting period.

An interim report will be issued upon completion of Task 3. This interim report for the Task 3 as we envision is a report similar in format as Appendix B of Volume 4 of our SEP reports for NRR use.

In our final report, we will provide a complete technical description of our effort and results of Task 3 along with the following products:

- a. Seismic data (zonation, occurrence rates, magnitude distributions, attenuation models, etc.) in sufficient detail to be applied in a seismic hazard analysis of any location in the Eastern United States (east of the Rocky Mountain). The forms of this data should be such that it can be directly input as a computer file into the SSMRP HAZARD Code, or be used in whole or part by the general public in performing other types of seismic hazard evaluations.
- b. Complete documentation, in the form of NUREGs, of the data and the procedures by which it was obtained.

NOTE: It is important both to this project and to the SSMRP that this report (in a draft form) be available on or about mid-June 1983. We expect by this time that the SSMRP will have access to our data and the results of our analysis from this project.

A draft version of the final report shall be submitted to the NRC for review and comment thirty (30) calendar days prior to the contract expiration, with fifteen (15) copies to the Project Manager. This report shall contain a comprehensive recapitulation of the entire contract effort and shall be documented, produced, and disseminated in accordance with NRC Manual Chapter 3202, "Publication of Regulatory and Technical Documents Prepared by NRC Contractors." The final report shall include, as a minimum, a summary of two to three pages written in clear, unambiguous language and fully substantiated in the body of the report. The summary shall be suitable for use as a press release. The contractor shall submit one (1) camera-ready copy and two copies of the Final Report to the Project Manager.

7. SUBCONTRACTOR INFORMATION

The TERA Corporation has been identified as our sole subcontractor for the project. The TERA Corporation was involved with the SEP and the SSMRP work, as a subcontractor to LLNL.

The TERA Corporation has performed all types of seismic hazard determinations--empirical, deterministic, and probabilistic. Many site-specific analyses have been performed under LLNL contracts. These include (1) nine eastern SEP sites and the Zion site; (2) six sites for NMSS as part of their licensing effort; and (3) 26 sites of DOE facilities. More recently, the TERA group has performed a variety of seismic hazard analyses for such sites as San Onofre, Diablo Canyon, and Humboldt Bay for other clients. In view of this, we are structuring our work under the subject project such that we remove TERA from a central role in the hazard analysis.

Regarding the principal project staff at TERA, we expect Lawrence H. Wight will provide all the necessary corporate direction; Drs. Ken Campbell, Charles Mortgat, and Mansour Niazi will provide task level technical direction, with support from other TERA staff as appropriate.

8. LIST NEW CAPITAL EQUIPMENT REQUIRED

None.

9. DESCRIBE SPECIAL FACILITIES REQUIRED

None.

10. CONFLICT OF INTEREST INFORMATION

None.

ATTACHMENT I
SEISMIC HAZARD CHARACTERIZATION OF THE EASTERN
U.S. - ESTIMATED BUDGET BREAKDOWN
(FIN No. A0390 and A0428)

TASK	RES			NRR		
	82	83	84	82	83	84
1. Develop Initial Eq Occurrence Models	100	20	0	15	5	0
2. Methodology Improvements						
2.1 Sol. & Use of Expert Opinion	0	0	0	30	10	
2.2 Ground Motion Panel	0	0	0	30	20	
2.3 Alternative Uncertainty Modeling	0	0	0	10	15	
3. Sensitivity Studies						
3.1 Encode Results	10	20	0	0	0	0
3.2 RES Sensitivity Studies	0	50	0	0	0	0
3.3 NRR Sensitivity Studies	0	0	0	10	30	0
4. Stability of Results	0	15	0	0	0	0
5. Feedback	0	100	0	0	10	0
6. Peer Review's Final Results						
6.1 Assess Feedback	0	0	0	0	10	30
6.2 Peer Review Panel	0	0	0	0	0	50
6.3 Assess Peer Review	0	0	0	0	0	20
	110	205	0	95	100	100



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

NOV 01 1982

MEMORANDUM FOR: R E Jackson
Geosciences Branch, DE

THRU: UK Leon Reiter, Leader
Seismology Section
Geosciences Branch, DE

FROM: Jeff Kimball, Seismologist
Seismology Section
Geosciences Branch, DE

SUBJECT: SEISMIC HAZARD CHARACTERIZATION PROGRAM IMPROVEMENTS

At the ACRS Extreme External Phenomena subcommittee meeting on Friday October 22, 1982 Dr. Okrent requested that the staff provide written comments on how the current seismic hazard characterization program differs from what was done in the past. These differences are listed below. In addition I have attached NRC Form 189 which outlines the statement of work that Lawrence Livermore National Labs is following.

Changes in Seismic Hazard Characterization Program to incorporate improvements and reduce uncertainty.

1. The maps that the experts will use to show seismic source zones will not be pre-zoned.
2. The experts will be given the opportunity to draw a variety of maps showing their belief in zone configurations and existence - non existence of zones. Weights will be placed on these zone alternatives by the experts. This will eliminate the need to evaluate background versus no background scenarios.
3. A more careful treatment of systematic and random errors will be completed.
4. Site effects will be better taken care of. A better understanding of deviations from generalized soil and rock profiles is expected.
5. The questionnaire will be written in such a way as to get a more careful description of maximum magnitude.
6. The attenuation panel will give more direct expert input. This aspect is still in the development stage although we anticipate improvement in this area.

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7. Other improvements include the expectation that the experts will provide more recurrence information than the last panel, and minor statistical changes which LLNL is completing.
8. By using additional experts (panel size has increased to 15) a greater geographical region can be evaluated (entire U.S. east of the Rocky Mountains).

The above information can be given to R. Savio of ACRS who can forward this information to Dr. Okrent.

Jeff Kimball, Seismologist
Seismology Section
Geosciences Branch
Division of Engineering

cc: L. Reiter
J. Kimball
A. K. Ibrahim
A. Murphy
D. Chung (LLNL)
D. Bernreuter (LLNL)



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

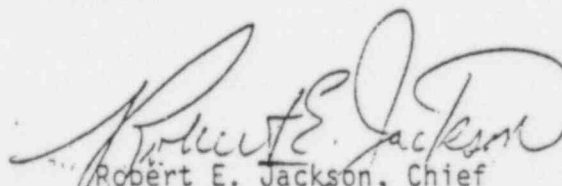
NOV 09 1982

MEMORANDUM FOR: Richard Savio
Advisory Committee on Reactor Safeguards

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

SUBJECT: SEISMIC HAZARD CHARACTERIZATION PROGRAM

At the Extreme External Phenomena Subcommittee in Santa Monica on October 22, 1982, I commented that the new seismic hazard program included a number of improvements. Dr. Okrent suggested that this information be conveyed to the subcommittee sometime later. Please find enclosed a short summary of program improvements along with the LLNL 189 proposal. Please forward this information to the subcommittee for their use.


Robert E. Jackson, Chief
Geosciences Branch
Division of Engineering

Attachment:
As stated

cc: J. Knight
L. Reiter
J. Kimball

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1P



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

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HOK

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.

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

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

8212020185
PDR (Purge)

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.

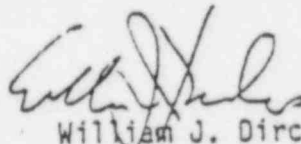
After many months of deliberation, the USGS has clarified its previous position relating to the 1886 Charleston, S.C. earthquake. The attached letter, James F. Devine, USGS, to Robert E. Jackson, NRC, November 18, 1982 provides the position and indicates that:

"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



United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

In Reply Refer To:
Mail Stop 905

NOV 18 1982

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

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