

**CNWRA WORK PLAN
TO ASSIST NRC IN THE DEVELOPMENT OF
PROBABILISTIC FAULT DISPLACEMENT AND
SEISMIC HAZARDS ANALYSIS CODES AND METHODS**

**Geologic Setting Element
Task 3.0
Subtask 3.3**

Prepared for

**Nuclear Regulatory Commission
Contract NRC-02-88-005**

Prepared by

Renner B. Hofmann

**Center for Nuclear Waste Regulatory Analyses
San Antonio, Texas**

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I. BACKGROUND

Fault displacements and seismic hazards are concerns for potential repository sites and site regions. Effective assessment of preclosure hazards due to fault displacement and earthquake seismicity is associated with validation of tectonic models. Displacements on faults and effects of seismic activity in general may have significant influence on repository design and performance, site performance, determination of site suitability, and containment and isolation of waste material. Computational and graphical analyses, using existing computer codes when feasible, and developing conceptual models and numerical methods when necessary, will be required to evaluate the technical validity and viability of potential Department of Energy (DOE) compliance demonstration methods.

The proposed work will support Systematic Regulatory Analysis (SRA) in Task 2 by providing the necessary technical foundation for development of Compliance Determination Methods (CDMs) and refinement of Technical Review Components (TRCs). Iterative Performance Assessment (IPA) is directly supported by providing information for identification of pertinent processes and conditions, development of scenarios, and potentially by providing methods and computer codes for critical evaluation of the effects of fault displacement and seismic activity on postclosure performance of the repository engineered and natural barriers.

Work performed in this task will provide Nuclear Regulatory Commission (NRC) and Center for Nuclear Waste Regulatory Analyses (CNWRA) staff with essential capabilities to review and evaluate model results, analyses, and interpretive conclusions presented by a license applicant in the probabilistic fault displacement and seismic hazards analysis (PFD&SHA) technical area. The necessary technical computing capabilities will be obtained to quickly and interactively test conclusions drawn by the DOE on these issues. Output from a probabilistic seismic hazard analysis (PSHA) code, e.g. SEISM 1, are necessary to couple seismic and faulting information with tectonic processes, and groundwater flow and transport calculations, in a probabilistic manner.

II. SUBTASK DESCRIPTION

Assistance in the development of analysis codes and methods for fault displacement and seismic hazards is identified as Subtask 3.3 in the Geologic Setting Element section of the CNWRA FY91-92 Operations Plans for the Division of High-Level Waste Management (DHLWM) (Change 2, September, 1991).

The NRC staff will require the capability to comprehensively review and evaluate complex probabilistic fault displacement and seismic hazard models of the site and geologic setting of a proposed repository for high-level waste. The CNWRA staff will support NRC in the attainment and maintenance of this capability by acquisition of the computer hardware and software systems, identification and integration of existing methods, and development and documentation of specially tailored methods for computer-assisted analysis of probabilistic fault displacement and seismic hazard models. The CNWRA staff will develop techniques, by incorporating certain types of new and existing models, that can be used by NRC staff in the probabilistic assessment of natural hazards due to earthquakes and faulting and in the assessment of associated or coupled processes (e.g., fracture and fault control of groundwater flow, deformation and stress changes on the scale of the repository block associated with faulting).

A. SUBTASK ORGANIZATION

The activities to be performed in accomplishment of this subtask are subdivided into five separate activities as follows:

ACTIVITY 1: Obtain Lawrence Livermore National Laboratory (LLNL's) Seismic Hazard Model (SEISM 1) Code.

ACTIVITY 2: Select Alternative Acceleration Attenuation Functions for the Basin and Range

ACTIVITY 3: Assess Requirements for Exercising the SEISM 1 Code on Computer Systems Available at, or accessible to, the Center.

ACTIVITY 4: Assess Level of Effort to Convert SEISM 1 for use in Modeling Yucca Mountain Data with Computer Systems Available at, or accessible to, the Center.

ACTIVITY 5: Document Assessment of Performing SEISM 1 Code Analyses and Develop Work Plan for Continuing Subtask Activities.

B. SUBTASK ACTIVITIES AND DELIVERABLES

ACTIVITY 1: Obtain LLNL's Seismic Hazard Model SEISM 1 Code.

Work proposed for this activity was to contact the National Laboratories charged with developing or disseminating codes applicable to the High Level Nuclear Waste program to obtain the (LLNL) SEISM 1 PSHA source code. The responsibility of disseminating codes has been transferred to Oak Ridge National Laboratory, but it was necessary to contact the LLNL to obtain source code for SUN and CRAY systems. *Note that this task has been completed as of February 11, 1992.*

Results of this activity will be reported in Administrative Milestone 3702-003-400-001.

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ACTIVITY 2: **Select Alternative Acceleration Attenuation Functions for the Basin and Range.**

The work activities proposed for this activity are a review of literature concerning attenuation functions recommended for the Basin and Range. Much of this effort has been completed as part of the Task 2 activities for FY91 (Hofmann, 1991). New literature will be reviewed as applicable and a rationale developed for selection of appropriate functions.

Results of this activity will be reported in Administrative Milestone 3702-003-400-002.

ACTIVITY 3: **Assess Requirements for Exercising the SEISM 1 Code on Computer Systems Available at, or accessible to, the Center.**

Work proposed for this activity is loading the SEISM 1 source code and executables, if available, on appropriate CNWRA computers and testing the functionality of the code. In the process, a determination will be made concerning whether machine-specific libraries used in the LLNL coding are available and useable on CNWRA computers. If they are not available, appropriate libraries will be ordered. *Note that the code has been loaded on a CNWRA SUN SS2 workstation and libraries appear to be available that are compatible with this computer as of February 1992.*

Results of this activity will be reported in Administrative Milestone 3702-003-400-003.

ACTIVITY 4: **Assess Level of Effort to Convert SEISM 1 for use in Modeling Yucca Mountain Data with Computer Systems Available at, or accessible to, the Center.**

Work proposed for this activity is to examine the LLNL FORTRAN code for SEISM 1 and estimate the level of effort required to program an appropriate attenuation function into the code, recompile, debug, and run the program with test files. *Note that a cursory examination of the SEISM 1 PSHA Code suggests that the level of effort required is within the budgeted funds available and this has been communicated to NRC staff as of February 1992.* Materials used in the examination are Davis (1991) and FORTRAN source files of the SEISM 1 PSHA code.

Results of this activity will be reported in Administrative Milestone 3702-003-400-004.

ACTIVITY 5: **Document Assessment of Performing SEISM 1 Code Analyses and Develop Work Plan for Continuing Subtask Activities.**

Work proposed for this activity is to summarize input requirements of the code and document the types of data and expert opinions required for its operation for a proposed Yucca Mountain site. The possibility of using published expert opinions concerning Basin and Range tectonics will be addressed as will requirements for expert opinion from CNWRA, NRC and other technical staff regarding tectonic and seismic inputs to the code. Means of obtaining printed and graphical output will

be considered. These elements will be developed in the form of a work plan for continued subtask activities.

Results of this activity will be reported in Intermediate Milestone 3702-003-400-005.

ADMINISTRATIVE MILESTONES

WORK ITEM	COMPONENT	TITLE	DATE
400-001	Activity 1	Obtain LLNL's Seismic Hazard Model SEISM 1 Code	Feb. 11, 1992
400-002	Activity 2	Select Alternative Acceleration Attenuation Functions for the Basin and Range	Mar. 30, 1992
400-003	Activity 3	Assess Requirements for Exercising the SEISM 1 Code on Computer Systems Available at, or accessible from, the Center	Apr. 15, 1992
400-004	Activity 4	Assess Level of Effort to Convert SEISM 1 for use in Modeling Yucca Mountain Data with Computer Systems Available at, or Accessible from, the Center	Apr. 30, 1992

INTERMEDIATE MILESTONE

WORK ITEM	COMPONENT	TITLE	DATE
400-005	Activity 5	Document Assessment of Performing SEISM 1 Code Analyses and Develop Work Plan for Continuing Subtask Activities	May 25, 1993

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III. ESTIMATED LEVEL OF EFFORT

Cost and general scope of the work plan are included in Task 3.0, Subtask 3.3 in the Geologic Setting Element section of the CNWRA FY91-92 Operations Plans for the DHLWM (Change 2, September, 1991). This Work Plan increases the level of detail of the material given in Geologic Setting Element Subtask 3.3 in the Operations Plans.

IV. SCHEDULE/MILESTONES

The following schedule is dependent on several factors. The duration of review periods for deliverables and the scope of the required response to address comments may affect revisions of the schedule. Priority reactive work requiring the same staff and expertise may necessitate schedule revisions. Timely acquisition of required hardware and software systems will be necessary to hold to the schedule.

V. TECHNICAL CONTACTS

NRC:	Phil Justus	(301) 504-3460
NRC:	Buck Ibrahim	(301) 504-0523
NRC Manager:	William Ford	(301) 504-2506
CNWRA Principal Investigator:	Renner Hofmann	(512) 522-5308
CNWRA Manager:	John L. Russell	(512) 522-5183

VI. REFERENCES

Davis, B. C. 1991. *SHC software and data base*. NUREG/CR-XXX draft report. Livermore, California: Lawrence Livermore National Laboratory (LLNL).

Hofmann, R. B. 1991. *Probabilistic fault displacement and seismic hazard analysis literature review*. CNWRA 91-013. San Antonio, Texas: Center for Nuclear Waste Regulatory Analyses (CNWRA).