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ADJUDICATIONS STAFF

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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| In the Matter of: | ) | Docket No. 72-22-ISFSI |
| PRIVATE FUEL STORAGE, LLC (Independent Spent Fuel Storage Installation) | ) | ASLBP No. 97-732-02-ISFSI |
| | ) | April 19, 2000 |

## STATE OF UTAH'S REQUEST FOR ADMISSION OF LATE-FILED UTAH CONTENTION JJ (Co-seismic Fault Rupture)

Pursuant to 10 CFR § 2.714, the State of Utah hereby seeks the admission of late-filed Utah Contention JJ which challenges the adequacy and scope of the Applicant's analysis of a possible co-seismic rupture of the Stansbury fault with the East and or/West faults. The Applicant has inaccurately computed the seismic hazard implications of possible co-seismic fault rupture for 2,000-year return period ground motions and, more significantly, has not performed such an analysis for a 10,000 year return period. Furthermore, simple calculations suggest that the combined rupture of the faults would result in extremely high vibratory ground motions at the site, with an estimated 84th percentile deterministic peak ground acceleration of 1.0 g. The Applicant's inadequate and incomplete analysis has important safety implications because of the potential for under-estimating ground motions which systems, structures, and components ("SSCs") at the independent spent fuel storage installation ("ISFSI") site must be designed to withstand.

The State meets the late-filed factors and, for the reasons stated below, the State requests the Board to admit Utah Contention JJ. This contention is supported by the

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Declaration of Dr. James Pechmann, attached hereto as Exhibit 1.

BACKGROUND

Contention JJ is related to Utah Contention L, which asserts: "The Applicant has not demonstrated the suitability of the proposed ISFSI site because the License Application and SAR do not adequately address site and subsurface investigations necessary to determine geologic conditions, potential seismicity, ground motion, soil stability and foundation loading." State of Utah's Contentions on the Construction and Operating License Application by Private Fuel Storage LLC for An Independent Spent Fuel Storage Facility (November 23, 1997) ("State's Contentions") at 80.[1] Contention L and its bases are founded on 10 CFR Part 72, including cross reference to 10 CFR Part 100, App. A requiring analysis of seismicity using a deterministic methodology.[2]

In 1997, the NRC amended Part 100 with a new section 100.23 to allow the option of using a probabilistic seismic-hazard methodology. On June 4, 1998, NRC issued "Rulemaking Plan: Geological and Seismological Characteristics for Siting and Design of Dry Cask Independent Spent Fuel Storage Installations, 10 CFR Part 72," U.S. NRC SECY-98-126 (hereinafter "Rulemaking Plan"). The purpose of the rulemaking is to make a conforming change to 10 CFR 72.102 by allowing the use of a probabilistic seismic hazard

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[1] Contention L (Geotechnical), and its bases were admitted in their entirety by the Licensing Board in LBP-98-7, 47 NRC 142, 191, 253, *aff'd on other grounds*, CLI-98-13, 48 NRC 26 (1998).

[2] Section 72.102(b) of Part 72 requires ISFSI sites "[w]est of the Rocky Mountain Front . . . will be evaluated by the techniques of appendix A of part 100 of this chapter." Appendix A requires a deterministic approach based on a site-specific investigation of the largest credible earthquake likely to affect a site. 10 CFR Part 100, App. A, V(a)(1)(i).

assessment; the plan requires that systems, structures, and components must be designed to withstand either a Frequency-Category-1 design basis ground motion (1,000 year recurrence interval) or a Frequency-Category-2 design basis ground motion (10,000 year recurrence interval). Rulemaking Plan at 5.

On April 2, 1999, the Applicant requested an exemption from the requirements of 10 CFR § 72.102(f)(1) and requested approval to conduct a probabilistic seismic hazard analysis instead of a deterministic analysis as currently required by Part 72.[3] In response to the Applicant's exemption request, the State, on April 30, 1999, filed a Motion Requiring Applicant to Apply for Rule Waiver Under 10 CFR § 2.758(b) or in the Alternative Amendment to Utah Contention L. The Board denied the State's motion to require the Applicant to apply to the Board for a rule waiver and denied, without prejudice, the State's request to amend Contention L. LBP-99-21 at 11-12 (May 26, 1999).

In its original exemption request, the Applicant submitted its design basis ground motion based on a 1,000 year recurrence interval. Exemption Request at 2. However, on August 24, 1999, the Applicant substituted a 2,000 year recurrence interval for the 1,000 year recurrence interval in the initial exemption request.[4] For all intents and purposes, the Staff has granted the Applicant's exemption request to use a probabilistic analysis ("PSHA")

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[3] "Request for Exemption to 10 CFR 72.102(f)(1), Seismic Design Requirement, Docket No. 72-22/Tac No. L22462, Private Fuel Storage, Private Fuel Storage L.L.C," addressed to Mark Delligatti at NRC's Spent Fuel Project Office.

[4] "Request for Exemption to 10 CFR 72.102(f)(1), Seismic Design Requirement, Docket No. 72-33/Tac No. L22462, Private Fuel Storage Facility, Private Fuel Storage L.L.C," addressed to U.S. Nuclear Regulatory Commission, Document Control Desk.

based on a 2,000 year return period. Safety Evaluation Report ("SER") for the PFS facility, dated December 15, 1999, at 45.[5]

On January 26, 2000 the State filed Request for Modification to Basis 2 of Utah Contention L, alleging that the Applicant had not followed the Commission's Rulemaking Plan, which requires a 10,000 year return period, nor had the Applicant followed the existing Part 72 regulations requiring a deterministic analysis. All pleadings have been filed and the modified contention is pending before the Board.

On August 31, 1999 the State filed a Supplemental Response to Applicant's Interrogatories No. 3 and No. 4 relating to the Geomatrix "Fault Evaluation Study and Seismic Hazard Assessment" (February 1999) and the Geomatrix "Update of Deterministic Ground Motion Assessments" (April 1999). The State advised the Applicant that the Geomatrix seismic hazard analyses do not include the possibility of synchronous coseismic rupture of the Stansbury fault with the East and/or West faults – a scenario that could lead to larger ground motions than for independent rupture of the individual faults.

In a February 11, 2000 conversation between the Staff and the Applicant, the Staff requested the Applicant to evaluate the likelihood that the Stansbury fault could rupture co-seismically with the East Fault, West fault, or East-West combined faults and also request the Applicant to advise the Staff whether such a possibility would alter the Applicant's

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[5] "[T]he staff concludes that additional analyses are needed to assess ground vibrations of the Facility and to approve the applicant's request for an exemption to 10 CFR 72.102(f)(1). The staff agrees that the use of the PSHA methodology is acceptable, however, the SAR analyses need to be revised to consider a 2,000-year return period, rather than a 1,000-year return period." SER at 2-45.

seismic hazard analysis. The Applicant responded to the Staff in Commitment Resolution Letter # 26 (Tac No. L22462), dated February 23, 2000. The State received a copy of this letter on February 28, 2000.

As part of Amendment 10 to the license application, the Applicant added to the SAR Appendix 2G, Additional Seismic Evaluations. The State received a copy of Amendment 10 on March 20, 2000. Contention JJ is based on the information relating to co-seismic rupture contained in Appendix 2G.[6]

**CONTENTION JJ. Co-seismic Fault Rupture**

> The Applicant's failure to comply with 10 CFR § 72.102 places undue risk on the public health, safety, and the environment because the Applicant's effort to assess the seismic hazard implications of possible co-seismic rupture of the Stansbury Fault with the East and/or West Fault is erroneous and incomplete.

**BASIS:**

The Applicant's analysis of the co-seismic rupture of the Stansbury fault with the East fault does not comply with any regulation or proposed regulation. This is due, in part, to the Staff's ad hoc approach underlying the probabilistic seismic hazard analysis of the PFS ISFSI site, in which the Staff permits the Applicant to use a PSHA with a 2,000-year return period. As a result of this relaxed standard, the design values to which SSCs at the PFS

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[6] Appendix 2G is not paginated. The co-seismic information consists of six pages and commences on the second page of Appendix 2G. The State will refer to the Appendix as if it were paginated.

ISFSI site must be designed to withstand will be inadequate to protect public health, safety and the environment.

The Applicant has made errors and omissions in analyzing the seismic hazard implications of possible simultaneous rupture of the Stansbury fault with the East and/or West faults. As described below, there is an error in the Applicant's computations relating to the 2,000 year return period ground motions in the SAR, App 2G. Moreover, the Applicant has omitted computation of the effects of such a co-seismic rupture based on the requirements of the current regulations (*i.e.* a deterministic hazard analysis) or as required by the Commission's Rulemaking Plan (*i.e.* a 10,000-year return period).

The Applicant's error in Appendix 2G is in the use of the numbers in the table entitled "Adjustment Factors for Multiple Rupture on Two Faults Developed by Yucca Mountain Project Expert Panel For Horizontal Peak Ground Acceleration (from Tables 6-3 through 6-9 of CRWMS M&O, 1998)" (hereafter "Yucca Mountain Table"). The Yucca Mountain Table gives adjustment factors recommended by a group of ground motion experts for a specific two-fault rupture scenario considered in the seismic hazard analysis of the proposed nuclear waste repository at Yucca Mountain, Nevada: two ruptures, each apparently of M ~ 6.5, on parallel faults separated by 2-3 km. The Applicant averages the adjustment factors recommended by the seven experts to determine average adjustment factors of 1.22 for the median horizontal peak ground acceleration and 1.10 for the standard error of the natural log of the peak ground acceleration. The Applicant then proceeds to apply these factors to the peak ground acceleration estimates for the maximum earthquake

on the closest of the two faults. For example, the Applicant states: "Thus, if it is assumed that the maximum magnitude earthquakes occurred simultaneously on the East and Stansbury faults, the estimated median peak ground acceleration would be a factor of 1.22 times the median value obtained for the maximum magnitude event on the East fault alone..." SAR, App 2G at 4. The Applicant gives the median peak ground acceleration for a maximum magnitude event of M 6.5 on the East fault, 0.9 km from the site, as 0.44 g. Id. at 6. The Applicant therefore estimates the median peak ground acceleration at the site resulting from simultaneous occurrence of maximum magnitude earthquakes on the East fault and the Stansbury fault to be 1.22*0.44 g = 0.537 g.

There are several shortcomings in the Applicant's analysis. First, it is not apparent that the adjustment factors determined by the Yucca Mountain ground motion experts can be transferred wholesale to other two-fault rupture scenarios such as the one discussed in Appendix 2G: an M 6.5 earthquake on a fault at 0.9 km distance (the East fault) and an M 7.0 earthquake on a fault at 9 km distance (the Stansbury fault). In addition to this shortcoming, it is clear from the original reference for these adjustment factors that the way in which the Applicant has applied these adjustment factors is incorrect. The Yucca Mountain Table gives factors by which peak ground acceleration are increased relative to empirical predictions using the distance to the closest fault and an earthquake magnitude calculated by combining the seismic moments from both simultaneous ruptures. In contrast to the Yucca Mountain analysis, and as the following illustrates, the Applicant has incorrectly used only the magnitude from the closest of the two ruptures in its analysis.

The simultaneous occurrence of an M 6.5 earthquake and an M 7.0 earthquake

results in an earthquake of M 7.047 (rounded off to 7.0). The Applicant should have applied the scaling factor of 1.22 to the peak ground acceleration from an M 7.0 earthquake at 0.9 km distance – not the peak ground acceleration from an M 6.5 earthquake at 0.9 km distance – to obtain the estimated peak ground acceleration at the site resulting from the simultaneous occurrence of an M 6.5 earthquake on the East fault and an M 7.0 earthquake on the Stansbury fault. From Figure 6-9 of the February 1999 Geomatrix report, the median peak ground acceleration from an earthquake of M 7.0 at 1 km distance appears to be ~0.5 g. The correct peak ground acceleration for the co-seismic rupture case, based on the Yucca Mountain Table, is therefore ~1.22*0.5 g = ~0.61 g.

As a check on the foregoing computed peak ground acceleration, the State applied a simple method used by certain Yucca Mountain ground motion experts to calculate peak ground accelerations for multiple fault ruptures. In this method, the peak ground acceleration is computed as the square root of the sum of the squares of the peak ground accelerations from the individual faults. This method assumes that the motions from each fault overlap in time at the site, and that the motions from each fault are uncorrelated. The median peak ground accelerations at the PFS site for an M 6.5 on the East fault and an M 7.0 on the Stansbury fault are 0.44 g and 0.43 g, respectively. SAR, App. 2G at 6. The square root of the sum of the squares of these two numbers is 0.62 g. This peak ground acceleration is in excellent agreement with the value of ~0.61 g obtained above.

Applying the same method to the 84$^{th}$ percentile peak ground accelerations found in the revised deterministic seismic hazard analysis – 0.72 g and 0.70 g for the East and

Stansbury faults, respectively – the 84th percentile deterministic peak ground acceleration for the combined rupture is 1.0 g. Such a value is unacceptably high and almost twice the current 0.53 g design peak ground acceleration of the PFS proposed ISFSI. SAR (Rev. 9) at 2.6-107.

On the last two pages of Appendix 2G, the Applicant assesses the effect of considering the simultaneous rupture of the East and Stansbury faults on the 2,000-year-return period ground motions by performing two simplified calculations. In one calculation, the two faults are assumed to always rupture simultaneously. In the other calculation, it is assumed that every third rupture on each fault is a co-seismic rupture of both faults. The results of these calculations formed the basis for the Applicant's conclusion that accounting for co-seismic ruptures of the Stansbury with the East and West faults in the PSHA would result in a slight decrease in the 2,000-year return period ground motions. The State re-computed these calculations using a peak ground acceleration of 0.62 g for the combined rupture instead of the incorrect value of 0.537 g used by the Applicant and concluded that the amount of decrease in the 2,000-year return period ground motions is much smaller. The Applicant should be required to perform the same analyses, using 0.62 g peak ground acceleration for the co-seismic rupture, to assess possible effects on the 10,000 year-return-period peak ground acceleration of 0.78 g. *See* Figure 6-12 of the Geomatrix "Fault Evaluation Study and Seismic Hazard Assessment" (February 1999). Notably, 0.78 g is already significantly higher than the current design value of 0.53 g peak ground acceleration for the 2000 year return period.

The effects of the Applicant's computational error would be significant (~ 15%) for

deterministic estimates of the ground motions from a simultaneous rupture of the Stansbury and the East and/or West faults, and may also be significant for such an analysis of 10,000-year return period probabilistic ground motions.

In summary, the Applicant erred in the way it analyzed the seismic hazard implications of possible simultaneous rupture of the Stansbury fault with the East fault. The implications of its error are arguably not too significant if the NRC allows the design ground motions to be based on probabilistic 2000-year return period ground motions. But the Applicant's erroneous methodology would significantly underestimate deterministic ground motions and may underestimate probabilistic 10,000 year return period ground motions. The deterministic analysis remains germane either as a valid baseline for comparison to probabilistic design ground motions, or as governing ground motions for design. The 10,000 year return period probabilistic analysis is also germane to design basis ground motions – a design basis that the PFS facility may not be able to meet.

LATE FILED FACTORS

The State meets the 10 CFR § 2.714(a) late filed factors for amending its contention.

**Good Cause:** The State has good cause for late filing Contention JJ. First, the State raised co-seismic rupture in its discovery response to the Applicant as one of many inadequacies in the Applicant's seismic hazard analysis. This appears to have prompted the Staff to require the Applicant to undertake the co-seismic rupture analysis. Second, the State has filed this contention within 30 days of receiving License Application Amendment No. 10 containing the Applicant's analysis of co-seismic rupture. The Applicant and the Staff may argue that the State should have attempted to file Contention JJ after the Applicant

submitted its Commitment Resolution Letter No. 26. The State strongly disagrees with this proposition. The Applicant frequently uses responses to the Staff's requests for additional information or commitment resolution letters as a prelude to amending its license application. It is only when the Staff has no apparent complaints with the Applicant's responses that the Applicant formally amends its license application. Thus, in the highly technical areas of PSHA, notably in the computation of ground motions and their resultant effects on SSCs, it is unrealistic to expect an intervenor to undertake a full scale analysis and computations every time the Applicant submits some information to the Staff. Furthermore, Contention JJ contains very detailed and specific information. It points out why the Yucca Mountain Table may not be appropriate in this case. It also uses specific calculations to show that the Applicant's analysis is wrong and that if co-seismic rupture of the East and Stansbury faults were used in a deterministic seismic hazard analysis, as the regulations currently require, the estimated 84$^{th}$ percentile peak ground acceleration could be an extraordinary 1.0 g. Furthermore, the safety implications of SSCs at the PFS facility not being designed to withstand ground motions based on a 10,000 year return period probabilistic analysis weighs in favor of the good cause factor for admitting Contention JJ.

**Development of a Sound Record:** The State is prepared to present testimony by Dr. James C. Pechmann on Contention JJ. Rather than the narrow perspective offered by the Applicant, testimony by Dr. Pechmann will give the Board a broad perspective on the safety implications of a co-seismic fault rupture as it relates to the design of SSCs. Therefore, the State's participation will assist in developing a sound record.

Dr. Pechmann is a recognized expert in the field of earthquake hazard evaluation

and has extensive experience with seismic hazard analysis. He is a Research Associate Professor of Geology and Geophysics at the University of Utah in Salt Lake City, Utah with 23 years of experience in geophysical research, primarily in the field of earthquake seismology. Most of his research has been related, either directly or indirectly, to earthquake hazard analysis. During the last 17 years he has also been involved in the operation of the University of Utah regional seismic network, and has done occasional teaching and consulting in the areas of earthquake seismology and hazard analysis. His curriculum vitae, attached to his accompanying Declaration, provides greater detail about his professional qualifications, experience and publications. As the foregoing shows, Dr. Pechmann has the expertise and experience to present testimony explaining the Applicant's incorrect use of the Yucca Mountain Table and, as described in the Basis above, the errors and omissions in the Applicant's co-seismic analysis.

As a complement to Dr. Pechmann's expertise, the State may also offer testimony by Dr. Walter Arabasz, whose expertise and qualifications are described in the State's Request for Modification to Basis 2 of Contention L.

**Availability of Other Means for Protecting The State's Interests:** The State has no alternative means, other than this proceeding, for protecting its interest. The State's interest in the design basis for the PFS facility are significant. If such a facility is to be located in the State of Utah it is imperative that the State be permitted to litigate whether the facility will be designed to safely withstand seismic events.

**Representation by Another Party:** The State's position will not be represented by any other party, as there is no other party in this proceeding who has an admitted contention

relating to seismic hazards.

**Broadening of Issues or Delay of the Proceeding:** The admission of Late-filed Utah Contention JJ will not unduly broaden or delay the proceeding as this contention could proceed along the same track as Contention L.

CONCLUSION

For the foregoing reasons, Utah Contention JJ meets the Commission's standard for late filed contentions and, thus, should be admitted.

DATED this 19th day of April, 2000.

Respectfully submitted,

Denise Chancellor, Assistant Attorney General
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Laura Lockhart, Assistant Attorney General
Diane Curran, Special Assistant Attorney General
Connie Nakahara, Special Assistant Attorney General
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CERTIFICATE OF SERVICE



I hereby certify that a copy of STATE OF UTAH'S REQUEST FOR ADMISSION OF LATE-FILED UTAH CONTENTION JJ (Co-seismic Fault Rupture) was served on the persons listed below by electronic mail (unless otherwise noted) with conforming copies by United States mail first class, this 19th day of April 2000:

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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| In the Matter of: | ) | Docket No. 72-22-ISFSI |
| | ) | |
| PRIVATE FUEL STORAGE, LLC | ) | ASLBP No. 97-732-02-ISFSI |
| (Independent Spent Fuel | ) | |
| Storage Installation) | | April 19, 2000 |

**DECLARATION OF DR. JAMES C. PECHMANN IN SUPPORT OF STATE OF UTAH'S REQUEST FOR ADMISSION OF LATE-FILED UTAH CONTENTION JJ (Co-seismic fault rupture)**

I, Dr. James C. Pechmann, declare under penalty of perjury that:

1. I am a Research Associate Professor of Geology and Geophysics at the University of Utah in Salt Lake City, Utah. I have had 23 years of experience in geophysical research, primarily in the field of earthquake seismology. Most of my research has been related, either directly or indirectly, to earthquake hazard analysis. During the last 17 years I have also been involved in the operation of the University of Utah regional seismic network, and have done occasional teaching and consulting in the areas of earthquake seismology and hazard analysis. My curriculum vitae, attached hereto, provides greater detail about my professional qualifications, experience and publications.

2. I am familiar with the aspects of Private Fuel Storage's license application and Safety Analysis Report which are relevant to this contention, and other information submitted by the Applicant in this proceeding with respect to earthquake hazards. I am also familiar with NRC regulations and guidance documents relevant to this contention, the NRC Rulemaking Plan to amend Part 72, and current methodologies for earthquake hazard evaluation.

3. I assisted in the preparation of State of Utah's Request for Admission of Late-Filed Contention JJ (Co-seismic fault rupture), filed on April 19, 2000 ("Utah Contention JJ"), and statements and conclusions therein are true to the best of my knowledge, information and belief.

4. If Utah Contention JJ is admitted, I am prepared to provide expert testimony regarding these matters. I expect that my testimony would follow the general statements and conclusions in Utah Contention JJ.

James C. Pechmann

Dr. James C. Pechmann

April 19, 2000

# JAMES C. PECHMANN

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**BORN:** July 22, 1954; Binghamton, New York

**EDUCATION:**

B.A. 1976 Hamilton College, Clinton, NY (Summa Cum Laude, with Departmental Honors in Geology)

M.S. 1979 California Institute of Technology, Pasadena, CA (Geophysics)

Ph.D. 1983 California Institute of Technology, Pasadena, CA (Geophysics)

**THESIS TITLE:** The Relationship of Small Earthquakes to Strain Accumulation Along Major Faults in Southern California (Thesis Advisor, Dr. Hiroo Kanamori)

**PROFESSIONAL EXPERIENCE:**

1. Research Faculty, University of Utah, Department of Geology and Geophysics:
Research Associate Professor, July 1989-present,
Research Assistant Professor, April 1984-June 1989,
Research Seismologist, April 1983-March 1984.
Studies of seismotectonics, earthquake hazards, earthquake source properties, attenuation and site amplification of seismic waves, and crustal structure in the eastern Basin and Range Province using data from the University of Utah regional seismic network, portable seismographs, and seismic reflection equipment. Supervision of graduate student research. Management of Seismograph Stations computer facilities and computer support personnel. Assistance with ongoing development and operation of the Utah seismic network, hiring and training of network staff, and 24-hour response to felt earthquakes.
Part-time teaching:
Earthquake Seismology, Winter Quarter, 1985;
Aspects and Methods of Earthquake Hazard Evaluation (with W.J. Arabasz), Spring Quarters, 1987, 1988, and 1991.

2. Graduate Research Assistant, Seismological Laboratory, California Institute of Technology, Sept. 1976-March 1983.
Studies of mechanisms, waveforms, and spectra of small earthquakes in Southern California. Aftershock monitoring with portable seismic arrays. Photogeologic and

theoretical analysis of large-scale polygonal troughs on Mars. Repeat gravity measurements along the San Andreas fault.

3. Teaching Assistant, California Institute of Technology:
   Physics of Earthquakes, Fall Quarter, 1978
   Introductory Geology, Spring Quarter, 1979

4. Internship with Viking Mars Project, Jet Propulsion Laboratory, California Institute of Technology, Aug.-Sept. 1976.
   Viking landing site safety analysis. Coordination of orbiter science experiments.

5. Field Assistant, St. Joe Minerals Corp., June-Aug. 1975.
   Geochemical exploration for zinc, northeastern U.S.

6. Research Assistant for Dr. Donald B. Potter, Hamilton College, July-Aug. 1974
   Field studies of the relationship between morphology and age of volcanic cinder cones near Flagstaff, Arizona.

7. Laboratory Assistant, Department of Chemistry, Hamilton College, 1973-1976.

**CONSULTING:**

1. Rollins, Brown, and Gunnell, Inc., Dec. 1986 - Jan. 1987.
   Determination of earthquake design criteria for the proposed Inter-Island Diking Project, Great Salt Lake, Utah.

2. Kennecott Utah Copper Corporation, Feb.-Aug. 1991, Jan.-Sept. 1994.
   Consultant for a seismic hazard analysis of a proposed expansion of Kennecott's tailings impoundment in Magna, Utah.

3. Rutherford and Chekene, Inc., May-June 1995
   Consultant for a seismic hazard analysis of the site for Micron Corporation's planned computer chip manufacturing plant in Lehi, Utah.

4. Solvay Minerals, Inc., Oct. 1995.
   Review of studies of the 1995 partial collapse of Solvay's trona mine near Green River, Wyoming.

5. Utah Department of Transportation, Dec. 1995 - Sept. 1996
   Assistance (under a University of Utah contract) with a seismic hazard analysis for the renovation of Interstate Highway 15 in the Salt Lake Valley, Utah.

6. Utah Department of Environmental Quality, Dec. 1998 - present.
   Review (under a University of Utah contract) of a seismic hazard analysis for a proposed high-level nuclear waste storage facility in Skull Valley, Utah.

## SCIENCE AND PROFESSIONAL SERVICE COMMITTEES:

1. Southern California Earthquake Safety Policy Advisory Board, 1980-1982

2 Proposal Review Panel, U.S. Geological Survey Earthquake Hazards Reduction Program, 1993

3. Utah Strong-Motion Instrumentation Advisory Committee, 1993

4. Earth Sciences Standing Committee, Utah Earthquake Advisory Board, 1993-1994

5. Geoscience Standing Committee, Utah Seismic Safety Commission, 1995-present

6. Technical Advisory Committee, Utah Department of Transportation Deterministic Seismic Acceleration Map Project, 1998-present

7. Seismological Society of America Board of Directors Nominating Committee, 1998 and 1999

## UNIVERSITY COMMITTEES:

1. Department Executive Committee, 1988-1991, 1996-1997

2. College Computer Committee, 1988-1991

3. Department Research Faculty Merit Review Committee, 1993, 1994, and 1997

4. Organizer, Department Distinguished Lecture Series, Fall Quarter 1994

**HONORS:** Valedictorian of the Class of 1976, Hamilton College
Root Fellowship in Science, 1976
Rogers Prize in Geology, 1976
Oren Root Prize Scholarship in Mathematics, 1974
Brockway Prize, 1973
Fayerweather Prize Scholarship, 1973
New York State Regents Scholarship, 1972-1976

## SOCIETY AFFILIATIONS:

American Geophysical Union
Seismological Society of America
Sigma Xi
Phi Beta Kappa

## PUBLICATIONS

McNally, K.C., H. Kanamori, J.C. Pechmann, and G. Fuis (1978). Earthquake swarm along the San Andreas fault near Palmdale, southern California, 1976 to 1977, *Science **201,*** 814-817.

Pechmann, J.C. (1980). The origin of polygonal troughs on the northern plains of Mars, *Icarus **42,*** 185-210.

Hill, R.L., J.C. Pechmann, J.A. Treiman, J.R. McMillan, J.W. Given, and J.E. Ebel (1980). Geologic study of the Homestead Valley earthquake swarm of March 15, 1979, *California Geology **33,*** 60-67.

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