

Jean B. SAVY

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SUMMARY

Engineer scientist, director and vice-president with more than 30 years experience performing and overseeing research, development and validation of analytical and experts' consensus methods in the areas of natural and man-made catastrophe hazards, risk and mitigation decision making.

Specific experience in the following areas:

- Management of research and development projects
- Probabilistic Seismic Hazard Analysis for critical facilities (PSHA)
- Probabilistic Hazard analysis for flood, wind and terrorism.
- Probabilistic Risk Analysis (PRA) and mitigation
- Elicitation and integration of multiple experts' scientific interpretation of data

EDUCATION

PhD Stanford University, Civil Engineering, Natural hazards, Earthquake engineering, statistical methods
Engineer Stanford University, Civil Engineering: Soil Mechanics
M.S. Stanford University, Civil Engineering, Nuclear Civil
Ingénieur des Travaux Publics, Paris, France

EMPLOYMENT HISTORY

Savy Risk Consulting (SRC, Sole Proprietorship), Oakland, CA

Created 2009

Owner

- Provided technical support in areas of natural and manmade hazards and risks to private companies, National Laboratories, and government agencies, including:
 - Lawrence Berkeley National Laboratory (LBNL), USA *
 - Lawrence Livermore National Laboratory (LLNL), USA
 - Nuclear Regulatory Commission (NRC), USA
 - Office of Nuclear Regulation, (ONR), UK *
 - Fugro, USA
 - Jensen Hughes, USA *
 - ENGIE/Tractebel, Belgium *
 - Electricity de France (EDF), France *
 - GEOTER/Fugro, France
 - SEISTER, France *

* **Current**

Risk Management Solutions Inc. (RMS, Inc.), Newark, CA**2006-2009*****Vice –President***

- Researched a new generation of methods to model the consequences of disintegration of urban infrastructure and socio-economic systems after a major catastrophe, such as earthquakes, hurricane, or terrorism. These methods are used in future products for the estimation of losses to large insurance portfolios. They improved the understanding of the spatial distribution of losses, what types of losses, how they are correlated, and it reduced the uncertainty in their estimations, and provided better information to insurance companies in the decision-making.
- Specifically, these included models of scale-free networks of urban infrastructure, electricity outage, and a network model of offshore platforms and pipelines in the Gulf of Mexico to estimate financial losses from loss of oil production (business interruptions) after damaging hurricanes.

Lawrence Livermore National Laboratory, Livermore, CA**1982-2006*****Senior Fellow***, Center for Global Security Research (CGSR), 2002-2006

Concurrently, fellow at the International Institute for Strategic Studies (IISS), London, UK

- Investigated new methods for predicting socio-economic consequences of terrorism, including probabilistic models of occurrences and estimation of losses.
- This research included the organization of several workshops to get multidisciplinary members of organizations responsible for emergency management and high-level public policy making, together with academics and members of the federal laboratories to discuss new analytical methods of predicting consequences of terrorism and other destabilizing actions in the area of homeland security.

Co-Director, Hazard Mitigation Center (HMC), 1994-2002

- Led and managed the HMC center to provide seismic analysis support to the Nuclear Regulatory Commission (NRC) and other federal agencies.
- Performed PSHAs for all DOE sites of nuclear facilities in the US, as part of the agency long term facilities update program to provide the design parameters of the facilities to resist earthquakes.
- Was commissioned by the California Mineral Management Services (MMS) to produce the results of a PSHA for the Santa Barbara Channel. These results were the input used in the development of the current seismic design standards for the docking and port facilities in California.
- Managed the Senior Seismic Hazard Analysis Committee (SSHAC) for NRC, and contributed sections in the final document (NUREG-CR/6372), which is one of the most consulted document for performing elicitation of experts knowledge in probabilistic seismic risk studies.
- Led the development of the DOE probabilistic model for wind hazard analysis, which is presently used as the basis for wind loading in DOE standards.
- Chaired the American Nuclear Society (ANS) Committee on Probabilistic Seismic Hazard for Nuclear Facilities resulting in Standard ANS 2.29 published, as ANSI/ANS2.29 in Nov. 2008.

Engineer, 1982-1994

- Contributed to the development of the PSHA methodology adopted by the NRC for the characterization of US nuclear plant sites, and created key portions of the software.

Massachusetts Institute of Technology, Cambridge, MA**1979-1982*****Research professor***, Department of Constructed facilities

- Supervised PhD theses and developed a model of generation of artificial earthquakes for PSHA

EDS Nuclear, San-Francisco, CA and Paris, France**1974-1978*****Principal engineer***, Advanced Analysis Division

- Performed the dynamic analysis of a floating nuclear plant during an earthquake
- Performed the soil-structure-interaction study for the Creys-Malville nuclear plant, in France.

CONSULTING EXPERIENCE

- GEOTER/Fugro, France** 2017
- Performed the review of the PSHA study for the Mochovce site, Slovakia.
- ENGIE/Tractebel, Belgium** 2013-2017
- Project of nuclear power plant at SINOP site, Turkey. Lead of the PPRP (Participatory Peer Review Panel), for the PSHA study.
- Construtora Norberto Odebrecht Engenharia de Mexico** 2012-2013
- Project Etileno XXI, Coatzacoalcos, State of Veracruz, Mexico. Provide advice on site specific evaluation of ground-motion for foundation design.
- Health and Safety Executive – Office for Nuclear Regulations (ONR), UK** 2011-present
- Member of reviewer on the Expert Panel on Seismic Hazard and Climate Change.
- Electricité De France (EDF), Paris, France** 2009-2018
- Consultant for a PSHA and seismic risk research and development of 5-year research and development project SIGMA on seismic ground motion characterization for design and operation of nuclear power plants (2009-2016). Review of PSHA update (2018).
- Lawrence Livermore National Laboratory (LLNL), Livermore, CA.** 2000-2006
- Principal investigator for the PSHA of the Caucasus region (Azerbaijan, Armenia, Georgia)
 - Principal investigator for the PSHA of Central Asia (Tajikistan, Kyrgyzstan, and part of Russia)
 - Consultant on modeling seismicity induced earthquakes from CO₂ sequestration injection.
- Lawrence Berkeley National Laboratory, Berkeley, California** 2009-present
- Consultant, to perform reviews of the COL licensing applications of nuclear reactor siting, for the Nuclear Regulatory Commission (NRC)
 - Consultant on modeling seismicity induced earthquakes from enhanced geothermal systems (EGS). Work on the development of a DOE Protocol of recommendations for planning, design and operation of Enhanced Geothermal Systems (EGS), and a Best-Practices guide for following the Protocol.
 - Design and develop computer software for calculation of hazard and nuisance-risk due to induced seismicity from EGS operations, and for CO₂ sequestration operations.
- GEORISK, Yerevan, Armenia** 2008-2009
- Provide support in the performance of a PSHA for the design of a nuclear power plant. Give guidance on new PSHA methods and software, and perform expert's elicitation for seismic source characterization and for the selection of ground motion attenuation models.
- GEOTER, Montpellier, France** 1999-present
- Member of a committee of 3 international experts to help GEOTER develop their own PSHA method and software for the seismic hazard characterization of France
 - Consultant senior review committee for the PSHA of SINOP Nuclear Power Plant in Turkey

International Atomic Energy Agency (IAEA), Vienna, Austria. 1999

- As IAEA mission expert, participated in the review of the licensing application for the siting of a planned nuclear power plant near Essaouira, Morocco.

IAEA, Vienna, Austria 1998

- Perform a review of the safety upgrades proposed for the Armenian nuclear power plants.

Other consulting, in the area of seismic hazard, and loss estimation

- RMS, for the development of HAZUS, 1992
- Korean Advanced Energy Research Institute (KAERI), 1987
Principal Investigator for assessment of the seismic hazard in the South Korean Peninsula.
- Also consulted for WESTON Geophysical, TERA Corporation, and Engineering Decision Analysis Co. (EDAC)

TEACHING EXPERIENCE

Teaching Assistant in soil mechanics, Stanford University.	1971-1972
Teaching duties in the French Army.	1973-1974
Teaching Assistant in Earthquake Engineering, Stanford University.	Spring 1977
Teaching classes in random vibrations, Stanford University.	Winter 1978

HONORS AND SCHOLARSHIPS

Fulbright Travel Scholarship, 1969.
 French Government Scholarship for a one-year period of studies at Stanford University, 1969-1970.
 Research Assistantship in Soil Mechanics. Supported by NSF Grant GK 24355, "Application of Probability, Statistics and Decision Theory in Soil Engineering", 1971-1972
 Research Assistantship in Civil Engineering (Stanford), 1976-1979.

SOCIETIES AND COMMITTEES

Member, Seismological Society of America (SSA)
 Member, American Geophysical Union (AGU)
 Member, Earthquake Engineering Research Institute (EERI)
 Licensed as Professional Civil Engineer for the State of California, (License#C28232)
 Chair of the ANS 2.29 committee on Probabilistic Seismic Hazard for Nuclear Facilities.
 Chair ISO working group on Natural Hazards Design standard, 1994-2000.
 Chair, 1994-2003, Site Evaluation Committee of ANS/Nuclear Facilities Standards
 Member, 1986-1987, Committee on Earthquake Losses, National Academy of Science
 Member ANS Committee (NFSC, Formerly NUPPSCO/ANS-2) 2002-2012
 Member, Nat. Acad. of Sciences Panel of Earthquake Loss Estimation Methodology, 1986-1987.

PUBLICATIONS

1. Books

Contributing author to "Estimating Losses from Future Earthquakes: Panel Report," National Academy of Science, National Academy Press, 1989.

2. Papers in Refereed Journals

Stepp, J. Carl, Ivan Wong, John Whitney, Richard Quittmeyer, Norman Abrahamson, Gabriel Toro, Robert Young, Kevin Coppersmith, Jean Savy, and Tim Sullivan: "Probabilistic Seismic Hazard Analyses for Ground Motion and Fault Displacement at Yucca Mountain, Nevada", *Earthquake Spectra*, Volume 17, No. 1, February 2001.

Savy, J., Shah, H., and Boore, D., "Non-Stationary Risk Model with Geophysical Input," *ASCE Journal of the Structural Division*, Proc. Vol. 106, No. ST1, January 1980, pp. 145-164.

Savy, J., Bernreuter, D., and Mensing, R., "Seismic Hazard Characterization for the Eastern United States." Nuclear Safety Division of the *American Nuclear Society Journal*. Vol. 27, No.4.

Savy, J., Bernreuter, D., and Mensing, R., "Probabilistic Assessment of the Seismic Hazard for Eastern United States Nuclear Power Plants". *Nuclear Engineering on Design* 123 (1990), 99-109, North Holland, and presented at the 2nd Symposium Current Issues Related to NPP Structures, equipt with emphasis on Resolution of Seismic Issues in Low Seismicity Regions, December 7-9, Orlando, Florida.

3. Proceedings in Refereed Conferences

Savy, J., "Improving Support for Risk-Based Terrorism and Policy Decision-Making", presented at the 6th Biennial Tri-Laboratory Engineering Conference, Monterey, CA ,September 12-15, 2005

Savy, J., "An approach to integrating non-normative information in terrorism policy decisions", Presented at the SRA Europe Annual Meeting 2004, and at the Probabilistic Safety Analysis, PSA05 International Topical Meeting, Sir Francis Drake Hotel, San Francisco, California, September 11-15, 2005

Lawrence Hutchings, Eleni Ioannidou, William Foxall, Nicholas Voulgaris, Jean Savy, Ioannis Kalogeras, Laura Scognamiglio, and George Stavrakakis. "A Physically-Based Strong Ground Motion Prediction Methodology; application to the 7 September 1999, Mw=6.0 Athens Earthquake", Athens Greece, September 30, 2005,.

Lawrence Hutchings, J. Savy, C. Bachman, O. Heidbach, M.Miah, N.Lindsey, A. Singh, and R. Laboso. "Examination of a Site-Specific, Physics-based Seismic Hazard Analysis, Applied to Surrounding Communities of The Geysers Geothermal Development Area", *Proceedings Geothermal Resources Council*, Reno, Nevada, 2015.

Foxall, W., J. Savy, and N. Abrahamson, Probabilistic seismic hazard analysis for the Santa Barbara Channel, California, *Seismol. Res. Let.*, 67, 38, 1996.

Savy, J., "Estimating the Average Patch Size in Earthquake Ruptures for a Strong Motion Model with Engineering Use," presented at the Structural Mechanics in Reactor Technology Conference, Paris, France, August 17-21, 1981.

Savy, J. and Cornell, C.A., "A Theoretical Earthquake Model to Complement Empirical Studies of Strong Motion Attenuation," Seventh World Conference on Earthquake Engineering, Vol. 2, Istanbul, Turkey, September 8-13, 1980, pp. 593600.

Savy, J., "Determination of Seismic Design Parameters: A Stochastic Approach," European Conference on Earthquake Engineering, Dubrovnik, Yugoslavia, September 1978. Also, ASCE EMD Specialty Conference, Tuscon, Arizona, 1974, and Second National Conference on Earthquake Engineering, Stanford University, August 1979, pp. 723-732.

Gurpinar, A., Shah, H., and Savy, J., "Attenuation Relationships for California Strong Motion Earthquakes," Second Annual ASCE Engineering Mechanics Division Specialty Conference, North Carolina, May 1977.

4. Proceedings in Non-Refereed Conferences

Lawrence Hutchings, R. Budnitz, D. McCallen, b. Foxall, S. Larsen and J. Savy. "Uncertainties in Physically-based Probabilistic Seismic Hazard and Risk". Spring AGU, Montreal, Canada, 2008.

Savy, J.B., Bernreuter, D.L., Chen J.C., "Site Effects: A Generic Method for Modeling Site Effects In Seismic Hazard Analyses." UCRL-94089, January 1986 and proceedings of the USGS Workshop on Probabilistic Earthquake Hazards, November 25-27, 1985. Also presented at the 3rd International Conference on Soil Dynamics and Earthquake Engineering. Princeton University, June 22-24, 1987. (Proceedings).

Bernreuter, D. L. Savy, J. B., Mensing, R. W., "Seismic Hazard Characterization of the Eastern United States, SMIRT 89 Proceedings, August 1989.

Savy, J.S., Bernreuter, D.L., Mensing, R.W., "Uncertainties in Seismic Hazard Analysis Using Expert Opinion for the Eastern U.S." UCRL-92190. Presented at the . International ANSIENS Topical Meeting on Probabilistic Safety Methods Febuary 24 March 1, 1985.

Savy, J., "Ground Motion Simulation for Risk Analysis," for the meeting of the Seismological Society of America, Golden, Colorado, May 1979.

5 . Internal Reports NRC, NUREG, LLNL, LBNL and UCRL

Hossain, Q., R. Mensing, J. Savy, and K. Kimball: Probabilistic tornado wind hazard model for the continental United States. UCRL-JC-133566, 1999.

Majer, E., Nelson, J., Robertson, A., Savy, J. and Y. Wong: "Protocol for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems ". USDOE Energy Efficiency & Renewable Energy, Geothermal Technologies Program, January 2012, DOE/EE-0662

Majer, E., Nelson, J., Robertson, A., Savy, J. and Y. Wong: "Best Practices for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems (EGS)". LBNL Paper LBNL-6532E, 04-21-2014. PermaLink: <http://escholarship.org/uc/item/3446g9cf>

Savy, J. and B. Foxall: Probabilistic Seismic Hazard for Southern California Coastal Facilities. UCRL-TR-204215, 2003.

Savy, J.B. Lawrence Livermore National Laboratory Probabilistic Seismic Hazard Codes Validation, UCRL-ID-155282, 2003.

Savy, J. and Foxall, B.: Lawrence Livermore National Laboratory Site Seismic Safety Program: Summary of Findings, UCRL-53674 rev. 2, 2002.

Savy, J. and D. Bernreuter: Comparison of the PSHA results of the 1993-EUS- update and the 1998-TIP studies for Watts Bar. UCRL-ID-142039, 2001.

Savy, J. and B. Foxall: Probabilistic seismic hazard characterization and design parameters for the sites of the nuclear power plants of Ukraine. UCRL-ID-137370, 2000.

Savy, J.B., B. Foxall, N. Abrahamson, and D. Bernreuter: "Guidance for Performing Probabilistic Seismic Hazard Analysis for a Nuclear Plant Site: Example Application to the Southeastern United States." NUREG/CR-6607, UCRL-ID 133494, U.S. Nuclear Regulatory Commission (1998).

Savy, J., B. Foxall, and D. Bernreuter: Probabilistic seismic hazard characterization and design parameters for the Pantex plant. UCRL-CR-132282, 1998.

Savy, J.: Seismic hazard characterization at the DOE Savannah River Site (SRS), status report. UCRL-ID-117452, 1993.

Savy, J., Boissonnade, A., Mensing, R. and Short, S. "Eastern U.S. Seismic Characterization Update." UCRL-ID-115111. Lawrence Livermore National Laboratory: Livermore, CA. June 1993.

Savy, J.B., Bernreuter, D.L., Chen, J.C., Davis, B.C., Ueng, J., and Short, C., "Seismic Hazard Characterization of the DOE New Production Reactor Sites," Volumes 1,2, and 3.1992.

Savy, J.: Comparison of NUREG/CR-0098 0.3g spectra to plant design basis spectra. UCID-21922, 1990.

Savy, J.: Seismic hazard characterization of the BNL-HFBR site (Upton, New York). UCID-105148, 1990.

Savy, J.B., Princeton Plasma Physics Laboratory (PPPL): Seismic Hazard Analysis," UCID-21829, October 1990.

Bernreuter, D.L., Savy, J.B., Mensing, R.W., Chen, J.C., "Seismic Hazard characterization of 69 Nuclear Plant Sites East of the Rocky Mountains," Vol. 1 through 8, NUREG/CR-5250, UCID-21517, 1989.

Bernreuter, D. L., J. B. Savy, R. W. Mensing, and J. C. Chen. 1989. Seismic Hazard Characterization of 69 Nuclear Plant Sites East of the Rocky Mountains. Report NUREG/CR-5250, vols. 1-8, prepared by Lawrence Livermore National Laboratory for the U.S. Nuclear Regulatory Commission.

Savy, J.B., "Seismic Hazard Characterization of the Savannah River Plant Site (SRP), UCID-21596, November 1988.

Savy, J.B., Murray, R.C., "Natural Phenomena Hazard Modeling Project: Flood Hazard Models for Department of Energy Sites", UCRL-53851, May 1988.

Savy, J.: Seismic Hazard Analysis of Western Venezuela Methodology and Data Collection Process. UCID-21454, 1988.

Savy, J., D. Bernreuter, and R. Mensing: Probabilistic Assessment of the Seismic Hazard for Eastern United States Nuclear Power Plants. UCID-21541, 1988.

Bernreuter, D.L., Savy, J.B., Mensing, R.W., "Comparison of Seismic Hazard Estimates Obtained by Using Alternative Seismic Hazard Methodologies". UCRL 96147, 1987.

Savy, J., D. Bernreuter, and J.C. Chen: Methodology To Correct For Effect Of The Local Site Characteristics In Seismic Hazard. UCID-96148, 1987.

Bernreuter, D.L., Savy, J.B., Mensing, R.W., "The LLNL Approach to Seismic Hazard Estimation In An Environment of Uncertainty, UCRL 94088, January 1986.

Prassinis, P.G., Ravindra, M.K., and Savy, J.B., "Recommendations to the Nuclear Regulatory Commission on Trial Guidelines for Seismic Margin Reviews of Nuclear Power Plants", NUREG/CR-4482 and UCID-20579. March 1986.

Savy, J., D. Bernreuter, and R. Mensing: Uncertainties In Seismic Hazard Analysis Using Expert Opinion For The Eastern United States. UCRL-92190.

Bernreuter, D.L., Savy, J.B., Mensing, R.W., Chen, J.C., and Davis, B.C., "Seismic Hazard Characterization of the Eastern United States," Vol. 1 and 2, UCID20421, April 1985.

Bernreuter, D., Savy, J., Mensing, R., Chen, J.C., and B. Davies: Seismic Hazard Characterization Of The Eastern United States. Volume 2, Questionnaires. UCID-20421, 1985.

Bernreuter, D.L., Savy, J.B., Mensing, R.W., and Chung, D.H., "Seismic Hazard Characterization of the Eastern United States: Methodology and Interim Results for Ten Sites," NUREG/CR-3756, April 1984.

Savy, J., "Use of an Artificial Catalog of Earthquake Data in a Study of the Attenuation and Component Statistics of the Strong Ground Motion Acceleration," M.I.T. Research Report 82-02, 1982.

Savy, J., "A Geophysical Model of Strong Motion for Large Ensemble Generation," Massachusetts Institute of Technology, Report R81-6, Author No. 693, 1981.

Savy, J. and Boore, D., "Study of Ground Motion Attenuation laws Using Geophysical Modeling," for TERA Corporation, consultants, 1979.

Savy, J., "Determination of Seismic Risk Parameters: A Stochastic Approach," the John A. Blume Earthquake Engineering Center, Stanford University, Report No. 34, 215 pages, December 1978.