Fault Line Forum
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Utah's Earthquake Information Needs — New Technologies and Solutions

by Walter J. Arabasz
University of Utah Seismograph Stations

An earthquake strikes. Within tens of seconds, crisis managers receive automated pager messages giving them the epicenter and magnitude of the shock. Within minutes, maps appear on their computer screens showing the center, severity, and geographic distribution of strong ground shaking. The information immediately enables decisions for effective emergency response and estimates of likely casualties and damage.

Futuristic? Not for California, Japan, Mexico, or Taiwan, where real-time earthquake information systems already exist in various forms. The Pacific Northwest and the state of Nevada are actively investing in these capabilities.

Northridge, California, 1994: Key earthquake engineering questions can only be answered by local recordings of strong ground shaking.

Earthquake Information is Vital

My point in this article, which I contribute as a personal opinion, is that information is vital for coping with earthquake dangers - before, during, and after an earthquake. And in any urbanized earthquake-prone area, essential information for emergency management, earthquake engineering, and science now depends on having suitable sensors, digital processors, computer networks, and communications systems in place. New technologies have become just as vital for managing earthquake dangers as Doppler radar now is for weather forecasting.

Current and projected growth and development in Utah, especially along the Wasatch Front, mean that the absence of earthquake information - when and where it's critically needed - increasingly will have great human and financial consequences. Given this growth, Utah inevitably must invest in a multipurpose, real-time earthquake information system to cope effectively with its vulnerability to earthquakes. Must we

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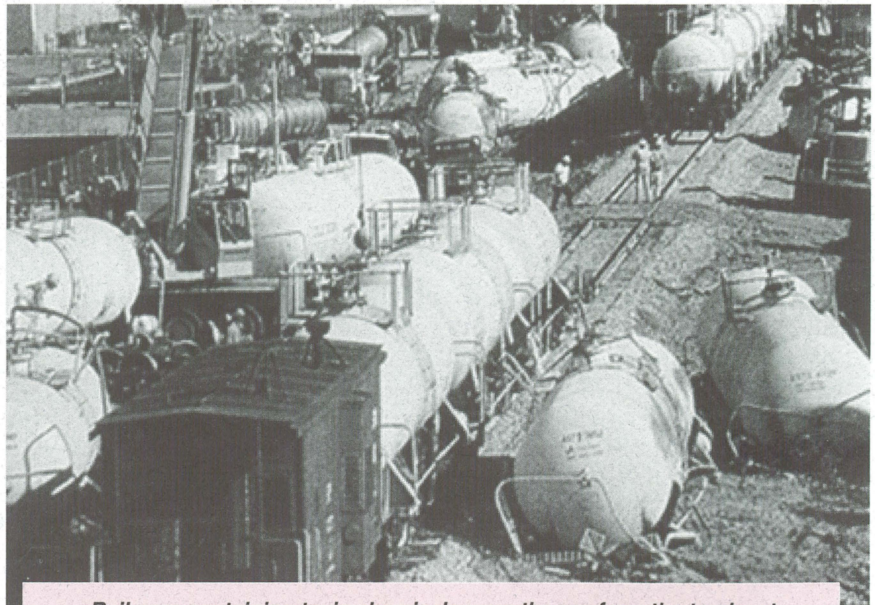
have a disastrous earthquake first? Do we host the 2002 Olympics in "earthquake country" without capabilities for rapidly delivering information if any significant local earthquake occurs during the Games?



Rail cars containing toxic chemicals were thrown from the tracks at Northridge. Crisis managers need earthquake information immediately.

Real-time Earthquake Information Systems

Real-time earthquake information systems are powerful applications of advances in information technology. Importantly, they offer a practical framework for unifying earthquake data, information, and knowledge in a way that the overlapping needs of emergency management, engineering, and science can be served cost-effectively. For example, distributed sensors essential for rapid ground-shaking maps are also fundamental for strong-motion engineering. And continuous recording of earth deformation using Global Positioning System (GPS) technology will give key information for science, hazard assessment, and civil engineering. All instrumental data from the system will contribute importantly to improving our understanding of earthquake behavior in Utah, and much of the information can be used in novel ways in public education.

A modern earthquake information system includes real-time elements for (1) acquiring and processing data in a unified way from varied ground-deformation sensors (strong-motion, short-period, broadband, GPS) and (2) broadcasting and otherwise distributing data and information to a host of users using a dynamic database, client/server computing, and interfaces with Geographic Information Systems (GIS). Preliminary cost estimates indicate that an effective earthquake information system in Utah, chiefly focused on the Wasatch Front, can be built for less than $10 million, with cost factors depending on the type, number, and geographic distribution of instruments for information gathering.

> "Utah is the third fastest growing state in the nation, with more than three-quarters of its population and economy concentrated in the Wasatch Front area astride the active Wasatch fault. Population in this urban corridor is projected to grow dramatically from its 1995 base of 1.6 million to 2.7 million by 2020 and to 5 million by 2050."

Costs and Benefits

What value is there in investing in an earthquake information system? Without timely and detailed earthquake information, potentially costly failures in emergency response include (1) delayed attention to people needing urgent help (as happened in the Loma Prieta and Kobe earthquakes, or as might happen in a nighttime winter earthquake in Utah) and (2) delayed response to a damaged lifeline, structure, or facility, which can have multi-million-dollar consequences. Rapid information to crisis managers - such as public safety officials and operators of utilities, hospitals, dams, and other critical facilities and lifelines - will aid many decisions for response and recovery. Many of the benefits from this timely decision-making can be measured in dollars.

In crisis management, time counts. Recent experience in California shows that cost savings up to hundreds of thousands of dollars after even a moderate-size magnitude 5 to 6 earthquake can result from properly-focused, post-earthquake field inspections or, in some cases, from informed decisions signaling no need to respond or assurance that interrupted costly operations can safely be resumed. In the event of a large magnitude 7 earthquake in the Wasatch Front metropolis, for which projected losses exceed $10 billion, the economics and politics of disaster relief and recovery will clearly involve large dollar amounts. Rapid estimates of damage, losses, and population impacts based on real-time ground-shaking information has become important to meet requirements for a formal Presidential Declaration of disaster. This information can also directly expedite federal recovery assistance to individuals and communities.

In the realm of earthquake engineering, compelling needs for instrumental recordings of strong ground shaking relate to (1) anticipating correctly the character and severity of ground shaking for safe, cost-effective seismic design and (2) being able to quantify, after the impact of an earthquake, the forces to which a specific damaged structure (or locale) was subjected. Under-designing and over-designing for earthquakes each can have enormous financial consequences. During the next dew decades, tens of billions of dollars will be spent on engineered structures and facilities in the Wasatch Front area,

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> Planned Olympic venues in the Wasatch Front valleys are chiefly at risk from strong ground shaking accompanying a moderate-to-large earthquake (magnitude 5 or greater). However, the most likely earthquake danger during the 2002 Winter Olympics will be posed by a small-to-moderate earthquake (magnitude 4 or larger) threatening one or more of the alpine venues (and access roads) with avalanches and landslides.

and hundreds of millions of dollars will hang in the balance as decisions are made on what level of seismic strengthening is appropriate for new construction and whether or not existing critical structures need to be retrofitted to avoid unacceptable failure.

It is important to understand that setting the design factors for earthquake safety is evolutionary and that refinements are inevitably made based on experience and data from actual earthquakes. There is good news in that methods are now available to use high-quality recordings of ground shaking in small to moderate earthquakes to quantitatively model ground motions during future large earthquakes in the same area. Is there bad news? Yes, if a damaging earthquake occurs and there are inadequate instrumental recordings of the ground shaking, engineers have to use speculative judgment in reconstruction and remedial engineering, and the spectre of dangerous underdesign versus costly overdesign looms large once again.

Because of sparse data, there currently is major uncertainty and debate about whether, for the same size earthquake, faults in geologic regions of extensional deformation such as Utah produce systematically lower ground motions than faults in regions of different deformation such as California. Because design decisions in Utah now rely heavily on California strong-motion data, not investing to collect local data in Utah could, by default, lead to spending billions of dollars in overdesign in the long term.

Another important uncertainty in predicting earthquake ground motions relates to geologic site response throughout the populated valleys of the Wasatch Front. In order to reliably characterize expectable earthquake ground motions for specific sites and geologic conditions in Utah, we must make a serious investment in the necessary instrumentation to record, with high fidelity, the ground motions from local earthquakes ranging widely in size.

> More than $20 million is now being invested for a real-time earthquake information system in southern California, where an elaborate infrastructure of earthquake instrumentation was already in place, and more than $50 million is estimated to be needed for the San Francisco region.

Opportunity and Challenges

A real-time earthquake information system for Utah offers a new opportunity and two major challenges. The opportunity is to bring modern information technology to bear on Utah's earthquake information needs in a coherent way. The first challenge is to persuade emergency managers, engineers, earth scientists, and public officials to work together for an information system that serves Utah's entire earthquake safety program - and which will benefit all. The second challenge is securing the funding. One mind-set, which has to be overcome, contends that spending dollars for "instruments" is not really going to change the outcome in future earthquakes. The facts show otherwise. Moreover, Utah's growth and the economics of earthquake engineering alone make this mind-set a "penny-wise, pound-foolish" position.

Where are the dollars going to come from? One scenario is that Utah first must have a catastrophic earthquake, and then federal funds will become available to mitigate effects of the next one. More sensibly, our state and congressional representatives should be persuaded to help find funding now. This is particularly timely in the present climate of congressional attention to reducing losses from natural disasters and to preparations for the 2002 Winter Olympics.

Key elements in successfully funding a real-time earthquake information system for Utah will likely be: (1) capital funding for a major part of the infrastructure of the system from one or more federal sources, (2) state funding for a

In the aftermath of the Northridge quake, time meant lives

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minor part, together with a firm commitment to providing at least part of the system's long-term operational support, and (3) private-sector involvement, particularly in extending the geographic distribution of sensors and perhaps in sharing resources for digital communications.

To meet Utah's many needs for earthquake information, an investment must be made. If not now, when?

For More Information:

1. The Web site, http://www-socal.wr.usgs.gov/pga.html, gives a view of near-real-time ground-shaking maps now routinely produced in southern California. Maps show peak ground acceleration, peak ground velocity, and intensity.

2. For an excellent overview of real-time seismic information systems, see: Kanamori, H., Hauksson, E., and Heaton, T., 1997, Real-time seismology and earthquake hazard mitigation: Nature, v. 340, no. 4, p. 461-464.

3. For perspective on the importance of rapid loss-estimation for emergency management, see: Eguchi, T.E., Goltz, J.D. Seligson, H.A., Flores, P.J., Blais, N.C., Heaton, T.H., and Bortugno, E., 1997, Real-time loss estimation as an emergency response decision support system: The Early Post-Earthquake Damage Assessment Tool (EPEDAT): Earthquake Spectra, v. 13, no. 4, p. 815-832.

4. The 1994 Northridge, California, earthquake provided many timely lessons for dealing with contemporary urban earthquakes. These lessons are well described and illustrated in U.S. Geological Survey Open-File Report 96-263, USGS Response to an Urban Earthquake, Northridge '94 (now available on the Web at http://geohazards.cr.usgs.gov.northridge; see also http://www-socal.wr.usgs/gov/north).

5. Regarding the issue of whether ground shaking in geologic regions of extensional deformation is lower than in other regions, see, for example: Becker, A.M., and Abrahamson, N., 1998, Stress drops in extensional regimes: Seismological Research Letters, v. 69, no. 2, p. 172; and Spudich, P., Joyner, W.B., Boore, D.M., and Lindh, A.G., 1998, SEA98, an updated predictive relation for earthquake ground motions in extensional tectonic regimes: ibid. p. 142.

USSC Hosts Box Elder, Cache, and Weber County Officials; Citizens, Local Officials Confident of Emergency-Response Plans

by Janine L. Jarva
Utah Geological Survey

The April 8, 1998 meeting of the Utah Seismic Safety Commission (USSC) was held in Brigham City, Utah. This is the first time the USSC has conducted a quarterly meeting outside of Salt Lake City. The idea was suggested by Utah State Representative Peter Knudson, a USSC member from Brigham City. It was an excellent opportunity for the USSC to meet with the public and local and state officials from Box Elder, Cache, and Weber Counties to discuss how we can take responsible actions to promote earthquake safety, both statewide and, in particular, in this area where a large earthquake along the Wasatch fault is considered likely to strike next. The meeting was attended by more than 30 local officials and other interested parties.

A Look to the Future

Chairman Arabasz opened the meeting and gave a brief history of the USSC and its purpose and membership. He explained that the biggest challenge facing the USSC in achieving its mission is to determine how we can motivate people to take actions that will make a real difference long-term. What can we do today? What sensible actions can be taken and implemented now by elected officials, especially with respect to the built environment? Gary Christenson, Utah Geological Survey, then presented the geologic record of large, catastrophic earthquakes (magnitude 6.5-7.5) along the Brigham City segment of the Wasatch fault and the implications for the future. Chairman Arabasz followed with a discussion of the threat of moderate-size (magnitude 5.5-6.5) but more frequent earthquakes, based on historical seismicity. He pointed out that there is an average recurrence interval for such earthquakes in the region surrounding Brigham City of 20-30 years and it has been 23 years since the last one in 1975. So there is a high likelihood that public officials in this region will have to deal with one of these earthquakes in the next decade. And such an earthquake has a high damage potential if it occurs under a populated area.

Strategies Identified

Chairman Arabasz then summarized a brainstorming session he held with the Chairs of all the USSC Standing Committees in February. Its purpose was to identify strategies for USSC action in 1998, especially those relating to growth and development issues. Actions with strong advocates included: (1) earthquake safety in schools; (2) the dangers of locating utility lines, water mains, pipelines, telephone lines, and other lifelines along the same corridors; (3) up-to-date earthquake instrumentation; (4) real-estate disclosure; (5) use of older, high-occupancy, unreinforced masonry buildings without seismic retrofit; and (6) a general campaign for earthquake awareness and education for all citizens.

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Preparing Our Schools

Deedee O'Brien (a member of the Awareness and Education Standing Committee) presented the draft of a "Plan for a Prepared School" campaign for the USSC's consideration and endorsement. Her subcommittee plans to send an emergency preparedness survey to all public and private school principals in Utah. The USSC agreed to consider the definition of a "prepared school" at their next full meeting. Commissioner Arabasz reported that he, Larry Newton (Utah Office of Education), and Ron Dunn (Chair of the Engineering and Architecture Standing Committee) would meet in May with Scott Bean, Superintendent of Public Instruction, to discuss the Engineering and Architecture Standing Committee's proposal for ensuring good seismic review in new school construction. Commissioner Lorayne Frank asked to make a presentation on "Project Impact" at the USSC's next meeting. She would like the USSC to sponsor and support a pilot project using this FEMA initiative in a local community, like Brigham City. The pilot project could then be used as a model for other local Utah communities.

> ***"... there is a high likelihood that public officials in this region will have to deal with one of these earthquakes in the next decade ..."***

Defensive Actions Discussed

The remainder of the meeting was an open discussion between the USSC and local officials, asking what defensive actions could be taken to advance earthquake safety in northern Utah and how the USSC could help them achieve that goal. Chairman Arabasz wanted their perspective on the political and economic problems they faced in implementing prudent, defensive actions and what they needed in the way of help that the USSC could provide or facilitate. Local officials repeatedly emphasized the need for timely information and updated maps reflecting the most recent consensus of knowledge about earthquakes and associated hazards. They believe they are doing a good job of planning for emergency response, especially in the first hours and days after an event. There was far less satisfaction with their ability to reduce their exposure to the hazard in advance of the event. They sensed that citizen awareness was coming mostly from the schools and local PTAs. They said that the local resistance makes it hard to promote land-use planning as a tool for increasing earthquake safety long-term. A discussion followed on problems associated with enforcement of non-buildable areas and whether or not building codes were adequate. Local officials believed they are already doing a good job of plan review checks and quality control on contractors.

Information Fair

Following a luncheon with invited public officials, the USSC sponsored an earthquake information fair for the general public. This was well advertised in advance by the local press and was well-attended. The USSC considered the entire endeavor a significant success and will consider holding such meetings in other regions of the state in the future.

Next Meeting

The next meeting of the USSC will be Friday, July 17, 1998, in the State Office Building in Salt Lake City, from 9 a.m to 11 a.m. For further details please contact Janine Jarva, Utah Geological Survey, (801) 537-3386, fax: (801) 537-3400, e-mail: nrugs.jjarva@state.ut.us.

Fault Line Forum Editor Bea Mayes Retires

Bea Mayes, editor of the Fault Line Forum for the past two years beginning with v. 12, no. 2, retired from the Utah Geological Survey (UGS) on June 1, 1998. Characteristic of Bea's style and dedication to the Forum, she helped put this issue together as her final act before leaving for Europe for the summer. During her tenure as editor, she brought a change in format to the Forum, and was judicious in maintaining a tight publication schedule. She also made substantial written contributions, particularly her comprehensive summaries of the 1996 and 1997 Utah Seismic Safety Commission Earthquake Conferences. We wish her the best in her retirement and European adventures.

Tim Madden, UGS Public Affairs Officer, takes over the editorship with this issue. Tim is in the UGS Geologic Extension Service, which works with all UGS Programs to deliver usable, understandable information to our targeted audiences. Tim has been at the UGS for 18 months, and has taken over many responsibilities for conference planning, media relations, and "translation" of our technical publications. We welcome him to the **Fault Line Forum** *and to Utah's earthquake community, and look forward to seeing some format and content changes reflecting his new perspective.*

FEMA Introduces Earthquake Loss Estimation Methodology

By Bob Carey
EPICenter Manager

Over the years, the Federal Emergency Management Agency (FEMA) has struggled to compare different states' risk assessments. Each state had its own methods of determining its vulnerability for any given hazard. Some states had more resources available to complete this assessment than others. In the end, there was a hodgepodge of studies that could not be readily compared. FEMA needed to create some way to standardize these studies.

History

In the early 1990s, FEMA approached the Applied Technology Council (ATC) to pilot a project, ATC-36, to develop a software program that uses mathematical formulas, information about building stock, local geology, the location and size of potential earthquakes, economic data, and other information to estimate losses from potential earthquakes for the counties of Salt Lake, Weber, Davis, Utah, and Tooele. ATC completed about 75 percent of the project before exhausting its funding, and FEMA elected not to continue to fund it. However, ATC acquired alternative sources of funding to complete the project, and it is currently being used by Salt Lake County.

> **"HAZUS supplies the user with all the information needed to produce a rough estimate of losses."**

Program Development and Features

FEMA approached the National Institute of Building Standards to pilot a project known as HAZUS. Using Portland, Oregon, as the project study area, HAZUS uses an approach similar to that used in ATC-36. But while ATC-36 focuses on earthquakes, HAZUS can be expanded into a multi-hazard methodology by initiating development of nationally applicable standardized modules for estimating potential losses for wind and flood. The software program uses a geographic information system to map and display ground shaking, the pattern of building damage, and demographic information about individual communities. Once the program knows the location and size of a hypothetical earthquake, HAZUS estimates the amount of ground shaking, the number of casualties and buildings damaged, the impact on transportation systems, the extent of disruption to the electrical and water utilities, the number of people displaced from their homes, and the estimated cost of repairing projected damage and other effects.

The products of the earthquake loss estimation methodology have several pre-earthquake and post-earthquake applications; in addition, the program estimates the scale and extent of damage and disruption.

Pre-earthquake Applications

- Development of earthquake hazard mitigation strategies as a countermeasure to earthquake losses and disruption indicated in the initial loss estimation study.
- Development of preparedness (contingency) planning measures.
- Anticipation of the nature and scope of response and recovery efforts.

Post-earthquake Applications

- Projection of immediate economic impact assessments for state and federal resource allocation and support.
- Activation of immediate emergency recovery efforts.
- Application of long-term reconstruction plans.

The HAZUS level of accuracy depends upon the quality of the databases. The software provides for three different levels of estimated losses. HAZUS supplies the user with all the information needed to produce a rough estimate of losses. The default data comes from national databases which will provide a general view of regional geology, building inventory, and economic structure. The default data provide a **Level One** estimate of losses.

To produce a more accurate estimate of losses, **Level Two,** more detailed information about each community is needed. This information would include local geology, local building inventory, and data about utilities and transportation systems. More detailed information requires a substantial amount of effort, not only in acquiring the databases, but in convincing the different agencies to release the needed information. In some cases, the information may be proprietary, so agencies will need to understand the uses of the data before releasing it.

The most accurate estimate of losses, **Level Three,** requires detailed engineering and geotechnical input to customize the methodology to the specific conditions of each community.

Beneficial Outcomes

HAZUS provides local emergency management and planning staffs with a pre-earthquake tool that illustrates potential areas of damage to building and infrastructure, provides insight into numbers of casualties, assists in the possible location of shelters, and supplies indirect economic impacts. For a risk assessment to be useful, planners need to work closely with public works, utilities, transportation agencies, county assessors, and the geotechnical community. Coordinating with these agencies provides planners with the best available data to achieved the most accurate results.

RECENT PUBLICATIONS

Earthquake Engineering Research Institute, 1997, *Earthquake Spectra*, v. 13, no. 4 (November 1997) devoted to loss estimation and its application to emergency response, risk management, and hazard mitigation. Annual subscriptions: $100.00, individuals $150.00 institutions. To subscribe, contact the Editor, *Earthquake Spectra*, Earthquake Engineering Research Institute, 499 14th Street, Suite 320, Oakland, CA 94612-1934, e-mail: eeri@eeri.org; WWW: http://www.eeri.org

-----1997, Proceedings-Fifth United States/Japan workshop on urban earthquake hazard reduction: Recovery and reconstruction from earthquakes, Publication No. 97-A: Oakland, California, Earthquake Engineering Research Institute, 455 p. $25.00, plus $5.00 shipping. Purchase from Earthquake Engineering Research Institute, 499 14th Street, Suite 320, Oakland, CA 94612-1934, (510) 451-0905; fax (510) 451-5411, e-mail: eeri@eeri.org; WWW: http://www.eeri.org. California residents add 8.25% sales tax.

-----1997, Construction quality and earthquake damage (slide set): Oakland, California, Earthquake Engineering Research Institute, 46 slides. $70.00, members; $80.00 nonmembers. Order from Earthquake Engineering Research Institute, 499 14th Street, Suite 320, Oakland, CA 94612-1934, (510) 451-0905; fax (510) 451-5411, e-mail: eeri@eeri.org; WWW: http://www.eeri.org. Orders must be prepaid, and California residents must add 8.25% sales tax.

Kiremidjian, A.S., and others, 1997, Methodologies for evaluating the socio-economic consequences of large earthquakes, Technical Report No. 126: John A. Blume Earthquake Engineering Center, Stanford, California, 247 p. $40.00. To purchase, contact John A. Blume Earthquake Engineering Center, Department of Civil Engineering, Stanford University, Stanford, CA 94305-4020; (415) 723-4150; fax: (415) 725-9755; e-mail: earthquake@ce.stanford.edu

Lizundria, Bret, and Greene, Marjorie, editors, 1998, Ethical issues and earthquake risk reduction: Oakland, California, Earthquake Engineering Research Institute, 70 p. Order from Earthquake Engineering Research Institute, 499 14th Street, Suite 320, Oakland, CA 94612-1934, (510) 451-0905; fax (510) 451-5411, e-mail: eeri@eeri.org; WWW: http://www.eeri.org

Perkins, Jeanne, Chuaqui, Ben, and Wyatt, Edward, 1997, Riding out future quakes: Pre-earthquake planning for post-earthquake transportation system recovery in the San Francisco Bay region, Publication No. P97002EQK: Association of Bay Area Governments, Oakland, California, 198 p. $25.00 plus $5.00 shipping. California residents include 8.25% sales tax. Order from Association of Bay Area Governments, P.O. Box 2050, Oakland, CA 94604-2050; (510) 464-7900; fax: (510) 464-7979; e-mail:shaky@abag.ca.gov

MEETINGS AND CONFERENCES

July 26 - 31, 1998, **"Gender in Disaster Research: Are the Experiences of Women Really Different?" XIV World Congress of Sociology--Session of the Research Committee on Disasters, International Sociological Association,** Montreal, Canada. For information contact Joseph Scanlon, 117 Aylmer Avenue, Ottawa, Ontario, Canada KIS 2X8; (613) 730-9239; fax (613) 730-1696; e-mail: jscanlon@ccs.carleton.ca

August 3 - 6, 1998, **ASCE Geotechnical Earthquake Engineering and Soil Dynamics Conference,** Seattle. For information contact ASCE, (800) 548-2723 or (703) 295-6029; fax (703) 295-6144; e-mail: conf@asce.org

September 15 - 18, 1998, **Western States Seismic Policy Council (WSSPC) 20th Annual Conference**, Pasadena. For information contact WSSPC, 121 Second Street, 4th Floor, San Francisco, CA 94105; (415) 974-6435; fax: (415) 974-1747, e-mail: wsspc@wsspc.org

September 21 - 25, 1998, **8th Congress of the International Association of Engineering Geology**, Vancouver, British Columbia. Contact: Kim Meida, Secretariat, 8th Congress IAEG, (604) 528-2421, fax (604) 528-2558, e-mail: kim.meidal@bchydro.bc.ca; WWW: http://ewu.bchydro.bc.ca/IAEG/IAEG98.html

September 20 - October 3, 1998, **AEG's 41st Annual Meeting**, Seattle, Washington. Information: Bill Clevenger, (425) 861-8672 (clevenger1@aol.com) or Julie Keaton (520) 204-1553 (aegjuliek@aol.com) or WWW: http://www.aegweb.org

October 7 - 9, 1998, **Risk '98: First International Conference on Computer Simulation in Risk Analysis and Hazard Mitigation**, Valencia, Spain. Organizers: Wessex Institute of Technology and Universitat Jaume 1. Palau de Pineda. For information, contact C.A. Brebbia, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, U.K.; tel: 44 (0)1703 293223; fax 44 (0)1703 292853; e-mail: wit@wessex.ac.uk.

October 11 - 14, 1998, **Dam Safety '98**, Las Vegas. Sponsored by the Association of State Dam Safety Officials. Information: (606) 257-5140; fax: (606) 323-1958; e-mail: damsafety@aol.com

June 13 - 16, 1999, **Eighth Canadian Conference on Earthquake Engineering,** Vancouver, British Columbia, Canada. Information: 8th CCEE Conference Secretariat, c/o Department of Civil Engineering, University of British Columbia, 2324 Main Mall, Vancouver, B.C., Canada V6T 1Z4; fax (604) 822-6901; e-mail 8ccee@civil.ubc.ca; WWW: http://www.civil.ubc.ca./home/eq/conferences/

May 17 - 19, 1999, **SEE-3, Third International Conference on Seismology and Earthquake Engineering,** Tehran, I.R., Iran. Information: International Institute of Earthquake Engineering and Seismology, P.O. Box 19395/3913, Tehran, I.R., Iran; tel: (98 21) 229 5085, fax: (98 21) 229 9479; e-mail SEE3@DENA.IIEES.AC.IR

January 29 - February 5, 2000, **12th World Conference on Earthquake Engineering, (12WCEE)**, Auckland, New Zealand. Information: Conference Secretariat, 12WCEE Organising Committee, c/o Convention Management, P.O. Box 2009, Auckland, New Zealand; (649) 529-4414; fax: (649) 520-0718; e-mail: 12wcee@cmsl.co.nz; WWW: http://www.cmsl.co.nz/12wcee; also see http://www.eeri.org/Meetings/12WCEE.html

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EARTHQUAKES: MEAN BUSINESS

Earthquake Symposium '98

September 22, 1998

Marriott University Park Hotel, Salt Lake City

Symposium '98 will feature keynote addresses by experts in the fields of business, business survival, and community involvement. There will be two separate afternoon breakout sessions following a luncheon. The breakouts will be keyed to one of three tracks:

How to Plan - the ABCs of basic earthquake contingency planning
Plan Validation - testing your plan in small-group table-top demonstrations
All Hazards Preparedness - a broad-scope workshop on all manner of perils that can affect a community

This symposium is co-sponsored by the Association of Contingency Planners and the Utah Seismic Saftety Commission. For more information contact Mike Stever, (801) 535-6030, e-mail: **mike.stever@ci.slc.ut.us**

ASSOCIATION OF CONTINGENCY PLANNERS

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