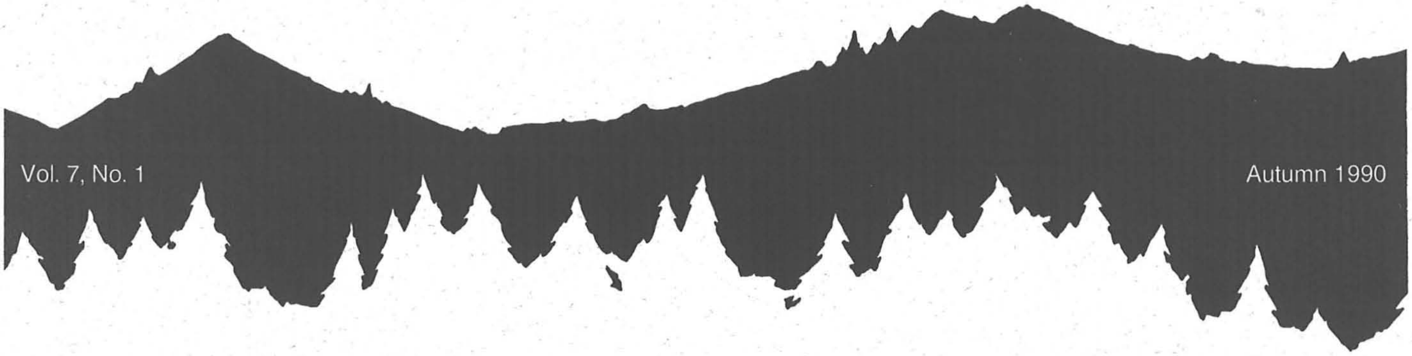
# WASATCH FRONT FORUM



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## EARTHQUAKE HAZARDS PROGRAM

The Wasatch Front Forum is published quarterly by the Utah Geological and Mineral Survey. Information, contributions, questions, and suggestions, concerning future issues may be sent to the Editor at the address listed below:

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### DEADLINES FOR FUTURE ISSUES

| | |
|---|---|
| WINTER 1990 | JANUARY 15, 1991 |
| SPRING 1991 | APRIL 15, 1991 |
| SUMMER 1991 | JULY 15, 1991 |

## DON'T FORGET! 1991 EERI ANNUAL MEETING

February 14-16, 1991 - Salt Lake City, Utah

This year's meeting is expected to attract hundreds of engineers, geoscientists, social scientists, policy makers, architects, and planners to Utah for discussions of the latest policy, practice, and research in the earthquake hazard field.

Sessions will focus on: current code developments; bridge evaluation and retrofit; earthquake insurance; lifelines evaluations; and seismic rehabilitation of hazardous buildings.

A field trip will bring participants to the City and County Building and the historic Hotel Utah to view innovative seismic strengthening.

Highlighting the meeting will be presentations on the Iran and Philippines earthquakes, and the International Decade for Natural Disaster Reduction, as well as a special session designed to bring together Loma Prieta earthquake researchers with practicing members of the professional community.

The pre-registration deadline is January 25, 1991. EERI has directly mailed all Forum readers program and registration information by this time. If you did not receive information about registration, hotel reservations, student paper competition, or poster session, write or call EERI at 6431 Fairmount Avenue, El Cerrito, CA 94530, (415) 525-3668, fax 415-525-1815.

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## EARTHQUAKE LEGISLATION UPDATE

Gary E. Christenson
Utah Geological and Mineral Survey

The State and Local Affairs Interim Committee has now written and filed a bill establishing a commission to oversee the state's earthquake program. They have expanded the scope of the commission to include more than just earthquakes, and have termed it the "Natural Disaster Commission." The bill has been filed (HB 11) and will be sponsored by Representatives Donald LeBaron and Ray Nielsen.

The ACIR (Advisory Council for Intergovernmental Relations) Earthquake Task Force met with the ACIR on December 7, 1990, to discuss the Natural Disaster Commission bill and possible additional legislation for 1991. Both the Task Force and the ACIR had comments on HB 11, and these were received by Richard North (State and Local Affairs Interim Committee) and Representative Nielsen. If any changes to the bill become necessary, it will probably be amended in committee during the legislative session. The ACIR enthusiastically supported the bill and passed a motion endorsing it, in concept.

Senator Craig Peterson and Representative Donald LeBaron intend to sponsor another earthquake instrumentation bill this session. It has not yet been filed, but the ACIR voted to support that bill, in concept, also.

The Task Force prepared a "short list" of top priority bills that it thought should be considered in the 1991 session. The two bills discussed above were at the top of the list, and the others included:

1) Require that **fees collected** by local governments **for building plan checks be used for that purpose** to more effectively implement the Uniform Building Code structural/seismic provisions.
2) **Assess seismic vulnerability of schools** and **fire stations.**
3) **Increase public awareness** and **improve** personal and family **preparedness.**
4) **Train for disaster preparedness** and **urban search and rescue.**

The ACIR passed a motion recommending this legislation, and asked the Task Force to look for sponsors.

It appears that earthquake legislation may receive broader support in this session that it did last year. We are particularly encouraged because of the Interim Committee support for earthquake issues, particularly the sponsorship of the "Natural Disaster Commission" bill by the State and Local Affairs Interim Committee. We would like to encourage all Forum readers to support earthquake issues and contribute in any way they can to a successful legislative session.

# Earthquake Activity in the Utah Region

## July 1 — September 30, 1990

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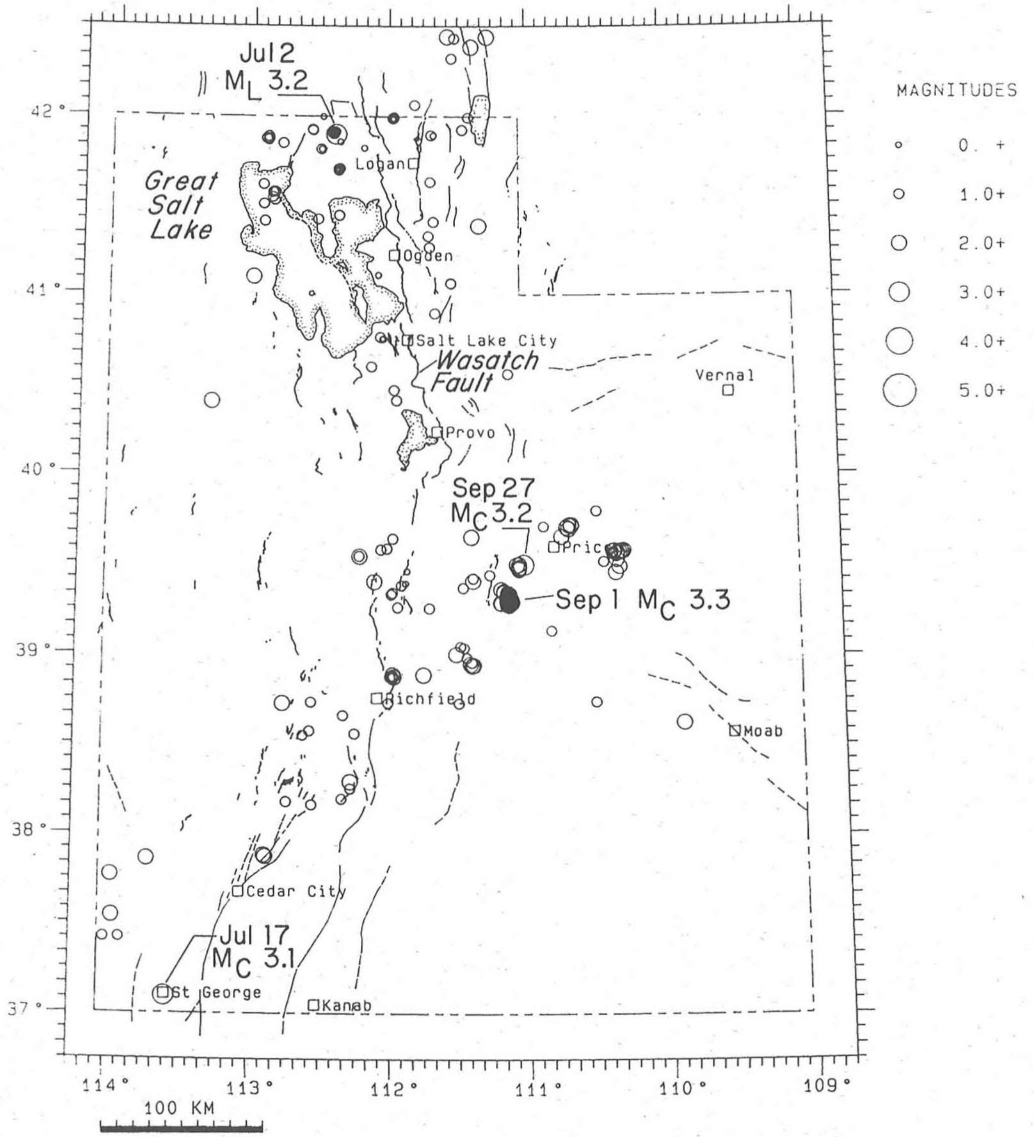

During the three-month period July 1 through September 30, 1990, the University of Utah Seismograph Stations located 277 earthquakes within the Utah region (see accompanying epicenter map). Of these earthquakes, 118 had a magnitude (either local magnitude, $M_L$, or coda magnitude, $M_C$) of 2.0 or greater, and none were reported felt. There were four earthquakes of magnitude 3.0 or greater during this report period; their epicenters are specifically labeled on the epicenter map. (Note: All times indicated here are local time, which was Mountain Daylight Time during this period).

Four earthquakes of magnitude 3.0 and greater occurred in the Utah region during the report period: an $M_L$ 3.2 event on July 2 at 9:05 p.m., located 13 km east of Howell; an $M_C$ 3.1 event on July 17 at 7:33 p.m., located 1 km east of St. George; an $M_C$ 3.3 event on September 1 at 12:12 p.m., located 11 km east of Orangeville; and an $M_C$ 3.2 event on September 27 at 9:05 a.m., located 2 km east of Hiawatha.

Several clusters of earthquakes in the vicinity of Price appear on the epicenter map. The most dominant cluster, located 40 km to the southwest of Price, contains 85 shocks ranging in magnitude from 1.5 to 3.3. Earthquake activity in the areas to the east and southwest of Price is coal-mining related seismicity, as observed for many years.

Additional information on earthquakes within the Utah region is available from the University of Utah Seismograph Stations.

## STATE EARTHQUAKE EXERCISE PLANNED FOR APRIL, 1991

By John Rokich
Utah Division of Comprehensive Emergency Management

The Utah Division of Comprehensive Emergency Management is planning to conduct a functional exercise in April, 1991 to test the overall State planning and response capabilities under a catastrophic earthquake scenario. This exercise is the next step in the joint Federal/State catastrophic disaster response planning effort and is designed to focus on the problems and issues identified during the Response 90 Federal exercise conducted this past July (see WFF, v. 6, no. 3-4, p. 8).

The purpose of the exercise is to test all 22 State agencies that have emergency response assignments under the State Natural Disaster Plan, implement the 11 Emergency Support Functions tasked under the State Catastrophic Earthquake Plan, and evaluate the status of each agency's standard operating procedures.

The State Emergency Operations Center (EOC) will be fully activated and messages will be sent and received just as in a real disaster event.

## UCBC CONSIDERED FOR ADOPTION

By Carl R. Eriksson
Salt Lake County Inspection Services

The Uniform Building Code Commission of the State of Utah has directed its structural advisory committee to consider the feasibility of the State adopting the Uniform Code for Building Conservation (UCBC). This code, first promulgated by the International Conference of Building Officials (ICBO) in 1987, "establishes life-safety requirements for all existing buildings that undergo alteration of a change in use. Its provisions offer alternative methods of achieving safety so that the inventory of existing buildings can be preserved" (Preface, UCBC).

The intent of the code is to require a building, when it is remodeled, altered, or undergoes a change of occupancy, to be brought into compliance with this code. Minor remodeling would logically not require a complete retrofit of a building, but the question of what constitutes major remodeling - the so-called "trigger mechanism" - will be a difficult one to answer.

The actual code, only 19 pages long, has a strong emphasis on exiting and fire safety, and has only two small sections on structural safety. However, one of the four appendices included with the code is entitled "Earthquake Hazard Reduction in Existing Unreinforced Masonry Buildings". The latest revision of this appendix, due off the presses in January, has significant changes which incorporate some of the so-called ABK methodology.

The bulk of the book consists of "UCBC Guidelines" developed as a part of the HUD Rehabilitation Guidelines Program. One of these guidelines is entitled "Allowable Stresses for Archaic Material", and will be of special interest to the structural engineer.

## SEISMIC RETROFITTING OF DOMESTIC WATER HEATERS

By Peter W. McDonough
Mountain Fuel Supply Company

Mountain Fuel Supply Company has begun offering a water heater seismic retrofit service to its natural gas customers in Utah, Wyoming, and Idaho. This service consists of the installation of a newly designed floor-mounted water heater brace and flexible gas connector between the water heater and adjacent piping. Customers will pay a nominal charge for the service.

Movement or toppling of water heaters is a common cause of damage within residential structures during even moderate earthquakes. This type of damage can be anticipated at Modified Mercalli shaking intensities as low as VII. It can occur in new, as well as older, structures, independent of other damage to the building. Significantly, there have been at least eleven earthquakes which caused this, or greater, shaking intensities within Utah since 1850. These include events in Salt Lake City (May 1910) and Ogden (May 1914) (Stover and others, 1986).

In the spring of 1990, a local entrepreneur approached Mountain Fuel with the prototype of a seismic resistant water heater brace. The initial design of this device consisted of vertical and horizontal steel legs made of flat bar stock, supported by two diagonal steel members, one rigidly fixed, the other hinged (Fig. 1). The installation procedure called for the brace to be bolted to a floor with expansion bolts and the water heater strapped to the brace at two points using steel banding. The Company agreed to evaluate this product for possible use on domestic water heaters.

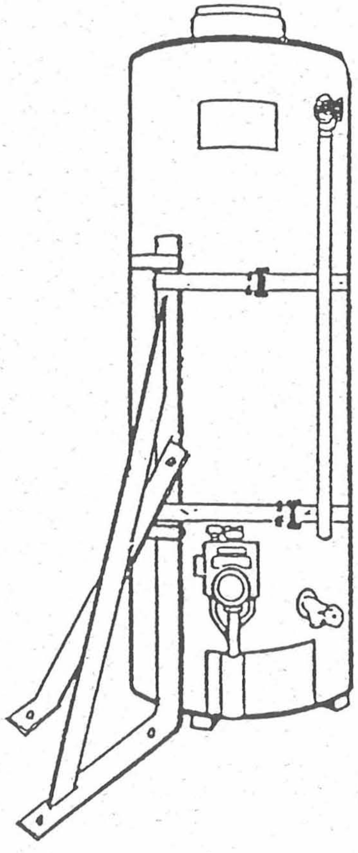

**Figure 1.** *Prototype Water Heater Brace*

It was decided that the evaluation criteria would be severe, due to the fact that our knowledge of local ground response to earthquakes is far from complete.

The proposed test called for applying a 700-pound force against the brace at four positions, 90 degrees from each other. Thus, each structural member would experience both tension and compression. Additionally, the force would be rapidly applied 50 times at each point to approximate sinusoidal motion. This would be roughly equivalent to 10 seconds of strong motion with a frequency of 5 Hertz, which, in turn, is similar to that experienced during the 1983 Borah Peak, Idaho, earthquake (Jackson and Boatwright, 1985).

The 700-pound force was based on a water heater weight of 470 pounds, which approximates the weight of a full, 40-gallon, domestic heater. The water heater was assumed to be acted upon by a 1.5 g horizontal acceleration. This value, based on U.S. Geological Survey data presented in 1987, is one estimate of the maximum acceleration anticipated during a near field magnitude 7.5 Utah earthquake, and takes into account fault type, site amplification and anelastic attenuation effects (Campbell, 1987). While this value is higher than that usually discussed regarding Wasatch fault earthquakes, accelerations approaching 1 g are not uncommon for earthquakes smaller than magnitude 7.5. Note, by way of general comparison, the 1.74 g (vertical) and 0.81 g (horizontal) accelerations recorded during the magnitude ($M_s$) 6.8 Imperial County earthquake in 1979 (Leeds, 1980). It is also believed that the 1988 Armenia ($M_s = 6.8$) may have generated PGA's of greater than 0.8 g (Wyllie and Filson, 1989).

The 700-pound force was over four times greater than the minimum design lateral force calculated using UBC formula 12-10 (lateral force on elements of structures and nonstructural components supported by structures) (International Conference of Building Officials, 1988).

The final submitted design successfully withstood the entire testing process with only elastic movement to the various components. On this model, diagonal members consisted of 1" x 1" x 1/8" thick, square, steel tubing. The 4-foot-high vertical member was made of 1-1/2" x 1/8" channel with a 1/2" lip. The horizontal member was made of 1-1/2" x 3/16" flat, steel stock.

The load was then increased to 1045 pounds, which approximated the force a 60-gallon water heater would exert when subjected to 1.5 g acceleration. The force was repeated in four directions, as described above. While slight plastic deformation occurred in the vertical member, it was not great enough to cause failure. Note that 50 gallons is considered the maximum size of a domestic water heater.

Concurrent with the brace evaluation, tensile tests were made on samples of the 3/4" x 1/32" steel banding provided with the prototypes. The banding was found to have a minimum tensile strength of 696 pounds, at the clasp. This would provide an approximated factor of safety of two when used with a 40-gallon water heater, given that two bands are used with the brace. The factor of safety fell to 1.3 with the 60-gallon water heater loading.

Mountain Fuel Supply is confident that the product, when properly installed together with a flexible gas connector, will significantly reduce the possibility of damage due to movement or toppling of a typical domestic water heater subject to the earthquake forces expected within our service area.

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# REDUCING EARTHQUAKE HAZARDS IN UTAH: THE CRUCIAL CONNECTION BETWEEN RESEARCHERS AND PRACTITIONERS

By William J. Kockelman
U.S. Geological Survey

[This is the third excerpt from the publication entitled "Reducing Earthquake Hazards in Utah: The Crucial Connection Between Researchers and Practitioners" to be reprinted in the Forum (see WFF, v. 6, no. 1-2, p. 16-25, 1990 and v. 6, no. 3-4, p. 9-17, 1990). Although the full paper will be included in the USGS Professional Paper "Assessment of Regional Earthquake Hazards and Risk Along the Wasatch Front, Utah" currently in press, the editors feel the information to be timely and relevant enough to reprint herein. This information is available now as USGS Open-File Report 90-217. Questions can be directed to Bill Kockelman at (415) 329-5158. Ed.]

## TRANSLATION FOR PRACTITIONERS

The objective of translating hazard information for practitioners is to: make them aware that a hazard exists which may affect them or their interests; provide them with information that they can easily present to their superiors, clients, or constituents; and provide them with materials that can be directly used in a reduction technique (List 2). The Utah work plan is quite specific as to what is expected of translated information:

- ... users will have easy access to data in media, scales, and formats, that will be most useful to them.

- ... selection of standard base maps and mapping scales ....
- ... interpreted information derived from basic scientific data.
- ... make it easy for local government, engineers, architects, planners, ... and emergency responders to use the technical information ....
- ... information in a format and language suitable for use by engineers, planners, and decisionmakers.

## Definition

Much has been said about the need for and objectives of translation. No clear concise definition or criterion has been offered, nor can it be found in the literature except by inference or by an analysis of what is actually used by practitioners. However, various researchers, translators, and users of earthquake research information are specific about what is needed by nontechnical users. They range from Steinbrugge (1982, p. 13) "Knowledge of the distribution of earthquakes in time, locations, and size is essential for insurance ratings and underwriting purposes," to Keaton and others (1987, p. 73) "Successful translation of science must 1) show hazard locations on maps at suitable scales, 2) provide some sense of the damage likely to result from occurrence of a hazardous event, and 3) provide some sense of when a hazardous event is likely to occur."

## Three Elements

My experience with reducing potential natural hazards (primarily atmospheric, floods, soils, landslides, and earthquakes) indicates that hazard information successfully used by nontechnical users has the following three elements in one form or another:

1. Likelihood of the occurrence of an event that will cause human casualties, property damage, or socioeconomic disruption.
2. Location of the effects of the event on the ground.
3. Estimated severity of the effects on the ground, structure, or equipment.

These elements are needed because usually engineers, planners, and decisionmakers will not be concerned with a potential hazard if its likelihood is rare, its location is unknown, or its severity is slight.

However, concern varies widely with the individual user, the cost of hazard reduction, and who or what might be affected. For example, a pedestrian might prepare for a fifty-percent probability of rainfall tomorrow by carrying an umbrella; a lender might require flood insurance if the mortgaged property is within a 100-year-recurrence-interval flood zone; and a regulatory agency might curtail construction if a critical facility is being located near a fault that has moved in the last 100,000 years. The reader will note that both location (areal, zonal, or specific) and likelihood of occurrence are conveyed in these three examples; severity is provided in a much different way -- personal experience, documented damage, or fear of a disaster and possible liability.

Unfortunately, these three elements come in different forms and with different names, some quantitative and precise, others qualitative and general. Several examples follow for each element. In all cases, for a product to be defined as "translated" hazard information, the nontechnical user must be able to perceive likelihood, location, and severity of the hazard so that he or she becomes aware, can convey it to others, and can use it directly in selecting and adopting a hazard reduction technique.

## Likelihood of Occurrence

This element can be conveyed for a selected size and location of damaging earthquake by the use of various concepts -- probability, return period, frequency of occurrence, or estimated, average, or composite recurrence interval. Sometimes a specific event is chosen -- design earthquake, hypothetical earthquake, characteristic earthquake, or postulated earthquake. Each of these terms has a specific definition which is beyond the scope of this report. In all cases, each event chosen must be credible; that is, have some likelihood of occurring.

In some cases, an engineering parameter is used for a specific ground failure: "the probability that the critical acceleration would be exceeded in 100 years" for liquefaction by Anderson and others (1986, p. 39) or for landslides by Keaton and others (1987). Algermissen and others (1982) use a map showing probabilistic bedrock peak horizontal ground acceleration that has a 90-percent probability or likelihood of not being exceeded in a 50-year period. In another case, the term "opportunity for liquefaction" was used where "a return period of about 30 to 50 years is anticipated for ground motions sufficient to exceed the liquefaction threshold at a given susceptible site" (Tinsley and others, 1985, p. 315). The period of 30 to 50 years is selected because it embraces the economic or functional life of most buildings.

No matter what term is used, it must convey a likelihood of occurrence that is important to the users. This likelihood varies widely, depending upon its use. For example, the National Research Council (1986, p. 5) notes that "various public agencies define an active fault as having had displacements (a) in 10,000 yr, (b) in 35,000 yr, (c) in 150,000 yr, or (d) twice in 500,000 yr." The interest of an engineer, planner, or decisionmaker in likelihood of occurrence also varies widely, for example:

| | |
|---|---|
| Insuring agent | Premium period (1 yr) |
| Elected official | Term of office (2-6 yr) |
| Lending officer | Amortization schedule (10-30 yr) |
| Bridge designer | Structure's life (50-100 yr) |
| Waste manager | Hazard's life (1,000-10,000 yr) |
| Pyramid builder | Next world (10,000-10,000,000 yr) |

## Location and Extent

Once users are convinced of the likelihood of a damaging event, they want to know if their interests might be affected. This information is conveyed by showing the location and extent of ground effects or geologic materials susceptible to failure. These are usually shown on a planimetric map having sufficient geographic reference information to orient the user to the location and extent of the hazard. Topographic maps showing geographic information, such as streams, highways, railroads, and place names, are very helpful. Some maps show streets; others show property boundaries. The scales of such maps vary widely; examples from Utah vary from 1:36,000 (1 in. equals 3,000 ft) to 1:1,200,000 (1 in. equals approximately 3 mi.). Compare figures 3 and 4 in next section.

The scale selected depends on the detail and amount of information to be shown, as well as the users' needs. For example, the seismic zone map of the United States adopted by the International Conference of Building Officials (1988, p. 178) and incorporated into the widely used Uniform Building Code is at a scale of 1:30,000,000; it is based on Algermissen and others (1982) national map which is at a scale of 1:7,500,000. Some building site hazards have been shown at scales of 1:1,200 (1 in. equals 100 ft) or larger. Most hazard maps are a compromise between scale, detail, reliability, difficulty and cost of preparation, and the purpose for which they were designed. There are no "best" scales, only more convenient ones.

## Estimated Severity

After the users recognize the likelihood of an event which may affect their interests, their next question is: how severe will be its effects? In other words, is the hazard something that should be avoided, designed for, or should preparations be made to respond during, and recover, repair, and reconstruct after a damaging event. Severity of anticipated effects is best expressed by use of measurable engineering parameters for the various hazards, for example:

- vertical horizontal displacements for surface fault ruptures.
- peak acceleration, peak velocity, peak displacement, frequency, and duration for ground shaking.
- velocity and volume for landslides.
- extensional and vertical displacement for liquefaction.
- vertical displacement for tectonic subsidence.
- run-up height for tsunamis.

Modified Mercalli or Rossi-Forel intensity scales of observed or estimated damage also show severity. They are used primarily for ground shaking but can include the effects of surface fault rupture, landsliding, and liquefaction. These scales also include some of the observed or anticipated effects on structures, their occupants, and their contents.

## Format

These three elements -- likelihood, location, and severity -- have been combined into various formats, some easy for the nontechnical user, and others requiring additional information or an experienced user to appreciated, adapt, and use in a reduction technique. Sometimes all of the elements are placed on a single map. At other times, information in the report or volume must be combined, or outside supplemental information must be obtained. Sometimes one of the elements (likelihood of occurrence) is one of public knowledge or experience. Sometimes the elements are only available or combined for a demonstration area. When adequate research information is available for other areas, additional translation work can be done. Otherwise new research must be undertaken to cover the user's area of jurisdiction or interest.

At other times, the format is a "seismic-hazards zone" (sometimes called "seismic zonation") showing the location and severity of all the effects from one postulated event. Qualitative terms are often used to show relative susceptibility (high, moderate, low, and very low) of geologic or other units to landslides or liquefaction, or to show relative severity (very violent, very strong, strong, and weak) of shaking. Examples of some of these formats follow:

Wesson and others (1975) and Ziony and Yerkes (1985) show location of faults that have, or may generate, damaging earthquakes or surface-fault rupture on index-scale maps. Maps at much larger scales (1:24,000) for surface-fault traces are readily available. Likelihood of occurrence (estimate of recurrence intervals) and severity (maximum surface displacement) are conveyed by discussions, tables, and graphs in the text accompanying the index maps. Both reports are in a volume that illustrates surface faulting as part of the predicted effects of a postulated earthquake (magnitude 6.5) for a selected fault.

Algermissen and others (1982) show location and severity (in terms of peak velocity and acceleration) by areas on a map for the ground-shaking hazard. Likelihood of occurrence is conveyed by probability (percent) of not being exceeded for various exposure times (10, 50, and 250 yr) in the map caption.

Rogers and others (1985) show location of a demonstration site and severity (mean amplification factor compared with level of shaking at site on rock) by areas on maps for predicted relative ground response. Individual maps are used to show predicted relative ground response in three period-bands having significance to buildings of specific heights (2-5, 5-30, and 30 or more stories). Likelihood of occurrence is conveyed by other papers in the same volume.

Wieczorek and others (1985) show location and extent (levels of susceptibility), and percentage of area likely to fail on a map for slope stability during earthquakes. Likelihood of occurrence is conveyed by a discussion of a lower-bound hypothetical (or "design") earthquake large enough to trigger landslides (Richter magnitude 6 or 7, depending on location of the earthquake). Severity is conveyed by a discussion on the map by noting that "structures generally cannot withstand more than 10 to 30 cm of movement without damage ...." and then by selecting 5 cm (2 in.) as a conservative design threshold.

Tinsley and others (1985) show location and extent (levels of relative susceptibility) of liquefaction on a map. Likelihood of occurrence (return period of liquefaction opportunity) for magnitude 5 or larger earthquakes is shown by contours on a separate map. Severity is partially conveyed by photographs showing liquefaction damage to three critical facilities -- causeway, juvenile hall, and an earth-filled dam. Their report is in a volume that illustrates liquefaction-related ground failure as part of the predicted effects of a postulated earthquake for a selected fault; the text also conveys severity.

Agnew and others (1988) show conditional probability of large earthquakes on a map for selected segments. Probabilities are based on expected recurrence times, and calculated for the likelihood of occurrence during the next 30 years. Severity is generally conveyed by the expected magnitude of major earthquake, which is provided for each segment.

In some cases, the use of lists of damaging events, photographs of damage, or diagrams of effects on ground or buildings for similar events are used to convey severity. Examples include Youd and Hoose (1978) for ground failure, Ziony (1985) and Borcherdt (1975) for earthquake hazards, and Hays (1981) for several geologic hydrogeologic hazards.

This type of information is an important part of the researcher's observations, but when used in translated information becomes an effective transfer technique, namely, communicating possible effects -- casualties, damage, and socioeconomic interruptions. Sometimes this can be misleading because of differences in the user's environment and that depicted -- earthquake location and size, ground conditions, structure's vulnerability, people exposed, and reduction techniques already implemented.

### Successful Translation

One of the best ways to confirm that these elements -- likelihood, location, and severity -- are needed is to look at information that has been prepared for, and successfully used by, engineers, planners, and decisionmakers to reduce earthquake hazards.

Many examples of the use of translated (and of course transferred) earthquake research information for specific reduction techniques can be cited. In others words, the connection between research and its use in hazard reduction techniques is being made. Selected examples follow:

- Shaking intensity maps for major fault systems (Everenden and others, 1981) used for anticipating damage and interruptions to critical facilities and preparing for emergencies by utilities and local, multicounty, and state government agencies (Davis and others, 1982; Steinbrugge and others, 1987).
- Fault-rupture zone maps by various federal, state, university, and consultant researchers (Brown and Wolfe, 1972; Sarna-Wojcicki and others, 1976) used for statewide legislation, city and county regulations, and real-estate seller disclosures (Hart, 1988).
- Fault-rupture, tsunami, liquefaction, shaking, and landslide hazard information combined by computer and used for county seismic safety plans (Santa Barbara County Planning Department, 1979).
- Maximum credible ground acceleration on bedrock map (Greensfelder, 1972) used to assign priorities and to design for strengthening of highway overpasses by a state transportation agency (Mancarti, 1981).
- Maximum earthquake intensity map (Borcherdt and others, 1975) used for estimating cumulative damage potential for different building types by a multicounty agency (Perkins, 1987).
- Numerous studies of ground shaking acceleration, losses, and predicted intensities used as a basis for inventorying unreinforced masonry buildings and requiring the strengthening or demolishing of unsafe ones (Los Angeles County Council, 1981).
- Probabilistic intensity (Algermissen and others, 1982) and local site amplification (Hays and others, 1978) maps used to estimate loss and replacement cost for various building types in Salt Lake City (Algermissen and Steinbrugge, 1984, p. 12-22).
- Continuous monitoring and analysis of earthquake precursor information for a specific fault segment used to warn local governments, the public, and the press via a governor's office of emergency services (Bakun and others, 1986).

Discussions and illustrations of some of these and other examples can be found in Blair and Spangle (1979), Kockelman and Brabb (1979), Brown and Kockelman (1983), Kockelman (1985, 1986), Jochim and others (1988), Mader and Blair-Tyler (1988), and Blair-Tyler and Gregory (1988).

### Comment

These examples of translation vary as to scale, area covered, format, postulated or probable occurrence, single- or multiple-hazards, limitations, and supplemental information required. What they all have in common is that they convey the likelihood of the occurrence of a damaging event, show location and extent of the hazard on a map. and provide some indication of severity of effects on the ground.

Some of these examples have gone, or can easily be taken, a step further to show potential response of structures, occupants, and equipment. This next step is actually using translated information in a reduction technique (List 2); for example, development regulations, loss estimates, overpass retrofits, preparedness scenarios, and warning systems as seen in the above examples. The next step requires the collection, analysis, and use of new information -- type, age, and condition of vulnerable structures, characteristics of exposed populations, sensitivity of equipment, and importance of the socioeconomic systems at risk.

Numerous benefits are derived from translating earthquake-hazard research for nontechnical users; for example:

- Reports and maps designed for one common user group -- intelligent and interest citizens -- provide a common basis for discussion during public meetings.
- Researchers are relieved from repetitive requests for translation.
- Numerous nontechnical transfer agents are available to transfer nontechnical information.
- Transfer and use occur more rapidly and more correct and appropriate use is made of the research.
- Researchers become more sympathetic to users and their needs, and users become more appreciative and supportive of the researchers.

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## MEETINGS AND CONFERENCES

**February 14-16, 1991, EERI 1991 Annual Meeting** at the Little America Hotel in Salt Lake City, Utah, Del Ward, Annual Meeting Chairman and Larry Reaveley, Program Chairman. Please see article, this issue. EERI has mailed all Forum readers Meeting and Registration information by this time. The pre-registration deadline is January 25, 1991. If you need further information, call EERI at (415) 525-3668, fax (415) 525-1815.

**March, 11-15, 1991, Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics,** held at the Sheraton St. Louis Hotel, Convention Plaza, in St. Louis, Missouri. In recognition of the International Decade for Natural Hazard Reduction and as part of a continuing effort to provide a forum for geotechnical, structural and civil engineers, seismologists, geologists, and teachers of engineering schools, the University of Missouri-Rolla presents this conference. The participants will have the opportunity to discuss recent advances in the thematic areas including: static and dynamic engineering soil parameters and constitutive relations of soils; model testing in cyclic loading; deformation and liquefaction of sands, silts, gravels, and clays; dynamic earth pressures and seismic design of earth retaining structures; soil structure interaction under dynamic loading; earthquake geotechnology in offshore structures; stability of slopes and earth dams under earthquakes; soil amplification during earthquakes and microzonation; seismology; predicting strong ground motion for design; wave propagation in soils; and dynamic characteristics of vibration sources other than earthquakes. For technical or exhibition information, contact Shamsher Prakash, Conference Chairman, Department of Civil Engineering, University of Missouri-Rolla, Rolla, MO, 65401-0249, (314) 341-4489 or -4461, fax (314) 341-4729. For registration information, contact Norma R. Fleming, Conference Coordinator, University of Missouri-Rolla, Rolla, MO 65401-0249, 1-800-752-5057 or (314) 341-4200, fax (314) 341-4992. The final program will be sent to those who ask for it.

**March 25-27, 1991, 87th Cordilleran Section, GSA, and Seismological Society of America Joint Meeting,** sponsored by San Francisco State University Department of Geosciences, will be held at the Cathedral Hill Hotel in San Francisco, CA. Joint GSA-SSA Symposia include: Neotectonic framework and seismic hazards of the San Andreas transform boundary-Hollister to Cape Mendocino; Tectonics of the west coast of North America: geological and geophysical constraints; Volcanic hazards and Cenozoic volcanism in the Cordillera. Preregistration deadline is February 22, 1991. For further information, call the GSA Registration Coordinator at (303) 447-2020.

**April 10-12, 1991, 27th Annual Symposium on Engineering Geology and Geotechnical Engineering,** sponsored by Utah State University, Idaho State University, University of Idaho, Boise State University, and University of Nevada-Reno, held in Logan, Utah. The Symposium invites presentations on all aspects of engineering geology and geotechnical engineering with emphasis on the western U.S. One page abstracts are due December 21, 1990, with camera-ready copy of manuscripts (20-page limit) due March 1, 1991. A short course "Techniques in paleoseismology" will be held April 9, and a field trip to the Jordanelle damsite is scheduled for April 13. For more information contact James McCalpin, Department of Geology, Utah State University, Logan, UT 84322-4505, (801) 750-1220.

**April 21-24, 1991, 44th Rocky Mountain and 25th South-Central Sections, GSA, Annual Meeting,** sponsored by the University of New Mexico Department of Geology and Institute of Meteoritics, the New Mexico Bureau of Mines and Mineral Resources, and the University of Texas at El Paso Department of Geological Sciences, will be held in Albuquerque, New Mexico. Papers are invited for technical sessions, symposia, and poster presentations. Abstracts for symposia should be submitted directly to the appropriate convener. Abstracts are limited to 250 words and must be submitted camera-ready on the official 1991 GSA abstracts form, available from Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020. Send one original and five copies of abstracts to be considered for technical sessions and poster sessions to: Michael Campana or Lee A. Woodward, GSA Technical Program Co-Chairs, Department of Geology, University of New Mexico, Albuquerque, NM 87131, (505) 277-3269 (Campana), 277-5309 (Woodward); Kathleen Marsaglia, Department of Geological Sciences, University of Texas, El Paso, TX 79968, (915) 747-5968. Abstracts deadline is December 20, 1990. For further information concerning registration, etc., contact the General Co-Chairs: John W. Geissman, Wolfgang E. Elston, Department of Geology, University of New Mexico, Albuquerque, NM 87131, (505) 277-3433 (Geissman), 277-5339 (Elston), fax (505) 277-8843; G. Randy Keller, Department of Geological Sciences, University of Texas, El Paso, TX 79968, (915) 747-5501, fax (915) 747-5111.

**June 12-14, 1991, Sixth Canadian Conference on Earthquake Engineering,** organized by the Department of Civil Engineering, University of Toronto, held in Toronto, Ontario, Canada. The purposes of this conference are to present new developments in earthquake engineering and earthquake hazard mitigation, focus attention on earthquake engineering problems in Canada, and bring together practicing engineers, researchers and scientists from Canada and other countries who are actively involved in earthquake engineering and related fields. Conference topics will include: ground motion and seismicity; seismic risk and hazard; lifelines; seismic analysis of structures; design of structures and components; experimental methods and testing; soil-structure interaction, soil stability, and foundations; observations of behavior during earthquakes; characteristics and impact of earthquakes in eastern North America; seismic code provisions; planning of emergency response; and repair and retrofitting of structures. For more information contact, the Organizing Secretary, 6CCEE, University of Toronto, Department of Civil Engineering, Toronto, Ontario, Canada, M5S 1A4, (416) 978-5960.

**July 10-12, 1991, UCLA International Conference: Impact of Natural Disasters,** to be held in Los Angeles, California. The conference aims at a cross fertilization of ideas from many disciplines and types of natural disasters and at providing a comprehensive approach to the important impacts of disasters, at a local, national, regional and international level. The disasters to be addressed cover a wide spectrum, including earthquakes. The conference aims at bringing together an interdisciplinary group of academic, governmental, and private industry experts, to present results of research and past experience and to discuss the agenda for the future in terms of needed research, mitigation actions and appropriate policies. An abstract of about 1,000 words, together with a short curriculum vitae, is due by December 15, 1990. Major themes will include: impact of natural disasters dealing with economic, environmental, legal, medical and health, physical and technological, political, and social issues; insurance aspects of natural disasters; and future international interdisciplinary cooperation. Send abstracts to, and get further information from, Professor Samuel Aroni, Conference Chair, GSAUP, UCLA, Los Angeles, CA 90024, (213) 825-7430, fax (213) 206-5566.

**August 22-23, 1991, Third U.S. Conference on Lifeline Earthquake Engineering**, sponsored by the American Society of Civil Engineers, Technical Council on Lifeline Earthquake Engineering and the Los Angeles Section, ASCE, held in Los Angeles, California. The conference is presented in cooperation with EERI's Fourth International Conference on Seismic Zonation. The conference will present recent advances in lifeline earthquake engineering, address engineering practice and policy for mitigating earthquake effects on an infrastructure, and contribute to the development of new knowledge and improved performance of lifelines which may be subject to earthquakes. Subject areas include: seismic hazard; risk and reliability; dynamic analysis; experimental projects; design/strengthening/retrofit; vulnerability assessment; planning for mitigation; performance and behavior; socio-economic/insurance impacts; policies for loss reduction and mitigation; implementation strategies; and lifeline experience during earthquakes. Issues resulting from the Loma Prieta earthquake of 1989 will be included.

**August 26-28, 1991, Fourth International Conference on Seismic Zonation for Safer Construction and Reduction of Life and Property Losses from Future Earthquakes**, sponsored by the Earthquake Engineering Research Institute, will be held at Stanford University in Palo Alto, California. The purpose of the conference is to review and evaluate zonation-related advances over the last decade in earth sciences, engineering, urban planning, social sciences, and public policy to reduce earthquake hazards at local, regional and national scales. The Conference is intended to be a major event for the International Decade for Natural Disaster Reduction. The format has been designed to ensure that multidisciplinary earthquake hazard mitigation efforts in major seismic regions of the world are represented in depth. Recent results from the 1989 earthquake near San Francisco pertinent to seismic zonation will be emphasized during one day of the program. For further information, contact the Earthquake Engineering Research Institute, 6431 Fairmount Avenue, Suite 7, El Cerrito, CA 94530-3624, (415) 525-3668.

**July 19-25, 1992, Tenth World Conference on Earthquake Engineering**, held in Madrid, Spain, one week prior to the 1992 Olympics in Barcelona, Spain. The official language of the conference will be English. Abstract deadline is April, 1991 and the deadline to receive papers is May, 1992. Individuals wishing to receive the first, and subsequent, announcement circulars should request them from 10WCEE, Steering Committee, c/o Tilesa, Londres 39 - 1 B, 28028 Madrid, Spain.

## RECENT PUBLICATIONS

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