WASATCH FRONT FORUM

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EARTHQUAKE HAZARDS PROGRAM

1993

QUAKE MONITORING OUTSIDE THE WASATCH FRONT AREA IN JEOPARDY

Whether or not earthquake monitoring in Utah outside the Wasatch Front by the University of Utah Seismograph Stations (UUSS) can continue is the subject of urgent deliberations by University and state officials (figure 1). Background information and the status of progress toward finding a solution to the problem, at the time of this writing, are as follows.

Walter J. Arabasz and Robert B. Smith, Director and Associate Director, respectively, of the UUSS, formally notified University President Arthur K. Smith in late May 1993 that, because of inadequate funding, they would be forced to end earthquake recording throughout major parts of southwestern, central, and eastern Utah after July 1, 1993. The proposed cuts follow well-publicized alerts that the UUSS would be unable to continue statewide earthquake surveillance. (Editorials in both the Salt Lake Tribune and the Deseret News in December, 1992, urged the State Legislature to continue statewide earthquake monitoring.) No supplemental funds were appropriated by the 1993 Legislature. On July 1, the seismologists gave a 30-day notice to state agencies and other users about scheduled station shutdowns outside the Wasatch Front area. According to Arabasz, areas notably affected would be "the seismically hazardous regions of Richfield, Beaver, Cedar City, St. George, Kanab, and the entire region of coal mining-induced seismicity in Carbon and Emery Counties." Available funds, including federal support targeted for Utah's densely populated urban corridor, will allow continued earthquake monitoring and research along the Wasatch Front.

According to Arabasz, a crisis of "benign neglect" was forcing UUSS to refocus on strategic research for which they have stable funding, and to reduce existing network operations and public service in order to achieve a balanced budget for the partial support provided by the state. A state line-item appropriation now provides about one-fourth of the Seismograph Stations' annual funding for earthquake recording and research, including a little more than one-third of the costs of seismographic operations, exclusive of research, in the Utah region. Arabasz described three factors that brought UUSS to a decision-making crossroads:

> First, despite many requests, the UUSS has not received any base-budget increase (separate from ordinary salary adjustments) in its state line-item appropriation since 1978. Second, non-payroll categories in the line-item appropriation have not received any inflationary adjustment since 1985. One major problem is that our costs for seismic data transmission using the state microwave system have risen sharply by 85 percent—due in effect to legislative mandate. Third, the state provides no funding to the UUSS for any permanent equipment, placing the burden for an equipment-intensive operation fully on the shoulders of UUSS researchers.

On July 19, 1993, M. Lee Allison, State Geologist and Director of the Utah Geological Survey, formally asked the UUSS to postpone the announced station shutdown "for at least one month while possible long-term solutions for continued funding are sought" by state officials. The UGS and Department of Natural Resources then convened high-level meetings of various state-government and University of Utah officials that led to a two-stage plan to address (1) a long-term solution and (2) a short-term "fix" for the current state fiscal year.

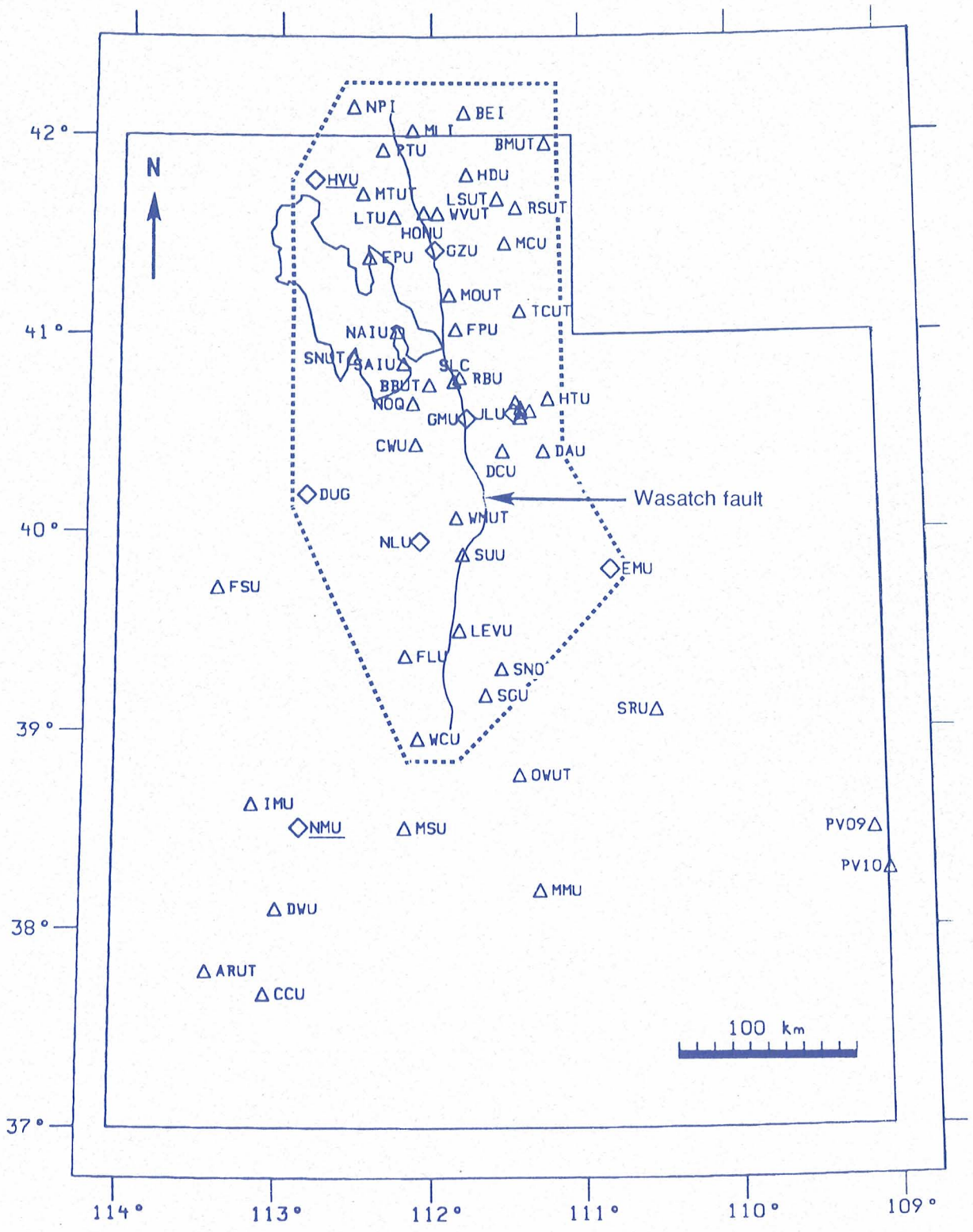

Figure 1. In jeopardy is the transmission of seismic data to the University of Utah campus from seismograph stations located outside the delineated area.

Prospects for a long-term solution currently hinge on a multi-agency budget-increase request being put forward to the Governor's Office of Planning and Budget for fiscal year 1994-95. The departments of Natural Resources, Public Safety, Transportation, and Environmental Quality have signaled their intent to jointly support such a request. Funds in the amount of $75,000 annually are being requested specifically to enable UUSS to continue--and to improve--seismic monitoring and emergency earthquake response in Utah outside the Wasatch Front area.

The budget-increase request has four principal desired outcomes:

1. Continuation and expansion of existing seismographic coverage of seismically hazardous parts of southwestern, central, and eastern Utah for continous collection of vital earthquake data.

2. Rapid alert to emergency-management officials of the size and location of potentially dangerous earthquakes anywhere in the Utah region.

3. Availability and distribution of reliable, up-to-date earthquake information, on a statewide basis, to state and local government officials and to the general public through electronic media and through personal outreach.

4. An improved understanding of the patterns of earthquake occurrence and factors relevant to the engineering design of safe structures throughout all of Utah.

Coincidentally, the UUSS is moving rapidly toward developing a real-time earthquake-monitoring system, which will automatically provide earthquake information within minutes of a sizable earthquake. (Currently, earthquake information is not generally processed and available before 30 minutes to an hour after an earthquake occurs.) Such information for emergency response will not be available for earthquakes outside the Wasatch Front area if the network infrastructure there is dismantled.

For a short-term "fix," M. Lee Allison and Walter Arabasz are pursuing a "30-30 strategy" by which the University of Utah administration and state government will each provide $30,000 to ensure continued earthquake monitoring on a statewide basis through June 1994. The University's half of the funding is now committed--contingent on state agencies funding the other $30,000. At this writing, two-thirds of the state part has been secured.

The next critical development will be (1) whether the Governor's Office of Planning and Budget gives reasonable priority to the UUSS budget-increase request as part of the Governor's 1994-95 budget and (2) whether an appropriation is indeed made by the 1994 Legislature. Without the funding supplement, the UUSS will have no choice other than to discontinue earthquake monitoring outside the Wasatch Front.

"The closing of our seismographic stations outside the Wasatch Front area would unquestionably have a regrettable impact on the availability of earthquake information for emergency response," according to Arabasz. He added:

> The National Earthquake Information Center [NEIC] in Golden, Colorado, will maintain a capability to provide emergency information on moderate to large earthquakes. However, NEIC relies on key stations of the UUSS seismic network for its basic surveillance. NEIC acknowledges that its ability to detect and reliably locate earthquakes throughout southern and central Utah below about magnitude 4.5 will be seriously degraded by the closure of UUSS stations in southern and central Utah.

(During 1992, the UUSS located 1,425 earthquakes in the Utah region—including several hundred outside the Wasatch Front area; all but two had magnitudes below 4.5. Also noteworthy is that Utah has about 220 moderate- to high-hazard dams outside the Wasatch Front area.)

Whatever the outcome, Arabasz says, "the University of Utah Seismograph Stations has a fundamental, longstanding commitment to helping the people of Utah deal with the statewide threat of earthquakes. Despite the setbacks we now face, we will do all we can to motivate state policy-makers to attend to Utah's growing, long-term needs for earthquake information—for emergency management, earthquake engineering, and earthquake science."

If you have any questions regarding the process or have ideas (or money) to contribute, call Lee Allison (UGS, (801) 467-7970) or Walter Arabasz (UUSS, (801) 581-6274).

UUSS OFFERS NEW PUBLIC SERVICE

The University of Utah Seismograph Stations (UUSS) has recently implemented online access to recent earthquake information via Internet. Internet is a world-wide computer network which electronically links universities, government agencies, and subscribing private companies. In order to access recent earthquake information, you must first have an Internet connection. Consult your data-processing system administrator for information on how to do this within your organization. Internet can also be accessed through popular computer bulletin-board services such as CompuServe. Once you have established an Internet connection, type:

finger recent@eqinfo.seis.utah.edu

This will produce a listing of recent world, Utah region, and Yellowstone National Park region earthquakes, which is output to your computer screen. The earthquake listings are automatically updated on a daily basis (at 2:00 a.m. MDT). Special updates are made following significant earthquakes. Sample output follows:

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UNIVERSITY OF UTAH SEISMOGRAPH STATIONS EARTHQUAKE SUMMARY

The following information on recent earthquake activity is reported for public use. These data are preliminary, may include blasts, and are subject to change. Seismic activity in east-central Utah (39.20-39.83N, 110.25-111.25W) includes frequent seismic events related to underground coal mining. Please email comments an suggestions to recent@eqinfo.seis.utah.edu

DATE-(UTC)-TIME is the origin time of the earthquake reported in Universal Coordinated Time (Mountain Standard Time = UTC + 7hours; Mountain Daylight Time = UTC + 6hours). LAT, LONG are in decimal degrees for the world list and LAT-N, LONG-W are in degrees and minutes for the Utah/Yellowstone lists. DEPTH is in kilometers. * indicates a fixed depth. Depths of Utah/Yellowstone earthquakes may be in error by several kilometers. MAG is the magnitude of the earthquake.

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RECENT WORLD-WIDE EARTHQUAKES REPORTED BY THE NAT. EARTHQUAKE INFORMATION CENTER

DATE-(UTC)-TIME	LAT	LONG	DEPTH	MAG	LOCATION
09/11/93 06:14	4.7S	76.3W	120	5.7(mb)	NORTHERN PERU
09/11/93 19:29	14.0N	92.2W	33*	5.6(mb)	NEAR COAST OF CHIAPAS, MEXICO
09/12/93 08:22	29.3S	177.3W	33*	5.7(ms)	KERMADEC ISLANDS, NEW ZEALAND
09/12/93 03:22	13.2N	90.3W	70	5.8(mb)	NEAR COAST OF GUATEMALA
09/13/93 12:37	29.1S	177.4W	33*	6.0(ms)	KERMADEC ISLANDS, NEW ZEALAND
09/13/33 12:37	29.1S	177.4W	33*	6.0(ms)	KERMADEC ISLANDS, NEW ZEALAND
09/13/93 22:58	10.5N	86.2W	33*	5.5(ms)	OFF COAST OF COSTA RICA
09/14/93 01:23	29.0S	177.5W	33*	5.7(ms)	KERMADEC ISLANDS, NEW ZEALAND
09/13/93 22:58	10.5N	86.2W	33*	5.5(ms)	OFF COAST OF COSTA RICA
09/16/93 00:59	44.5N	149.1W	33*	5.6(mb)	KURIL ISLANDS

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RECENT UTAH REGION EARTHQUAKES LOCATED BY THE UNIVERSITY OF UTAH

DATE-(UTC)-TIME	LAT-N	LONG-W	DEP	MAG	LOCATION
09/14/93 23:22	39 28.73	111 13.18	6.3	2.0	13.4 mi E of Mount Pleasant, UT
09/15/93 03:00	39 26.73	111 12.41	1.5	2.2	15.0 mi ESE of Mount Pleasant, UT
09/15/93 03:25	39 29.19	111 12.14	1.0	1.9	14.1 mi E of Mount Pleasant, UT
09/15/93 03:45	41 43.28	112 49.46	7.3	1.2	34.1 mi W of Tremonton, UT
09/15/93 11:37	39 28.34	111 12.50	7.9	1.9	14.1 mi E of Mount Pleasant, UT
09/15/93 11:54	39 41.45	111 15.72	1.6	2.1	10.4 mi NE of Fairview, UT
09/15/93 12:30	39 30.14	111 6.53	7.3	1.7	14.4 mi NW of Huntington, UT
09/15/93 22:32	39 32.00	112 12.62	0.9	2.2	14.5 mi W of Juab, UT
09/16/93 02:20	39 28.33	111 12.53	7.9	2.1	14.1 mi E of Mount Pleasant, UT
09/16/93 03:38	39 42.04	111 16.05	6.4	2.0	10.5 mi NE of Fairview, UT
09/16/93 03:47	38 57.52	111 23.05	4.1	2.1	7.7 mi W of Emery, UT
09/16/93 04:40	39 19.18	111 8.66	1.4	2.3	8.1 mi NW of Orangeville, UT

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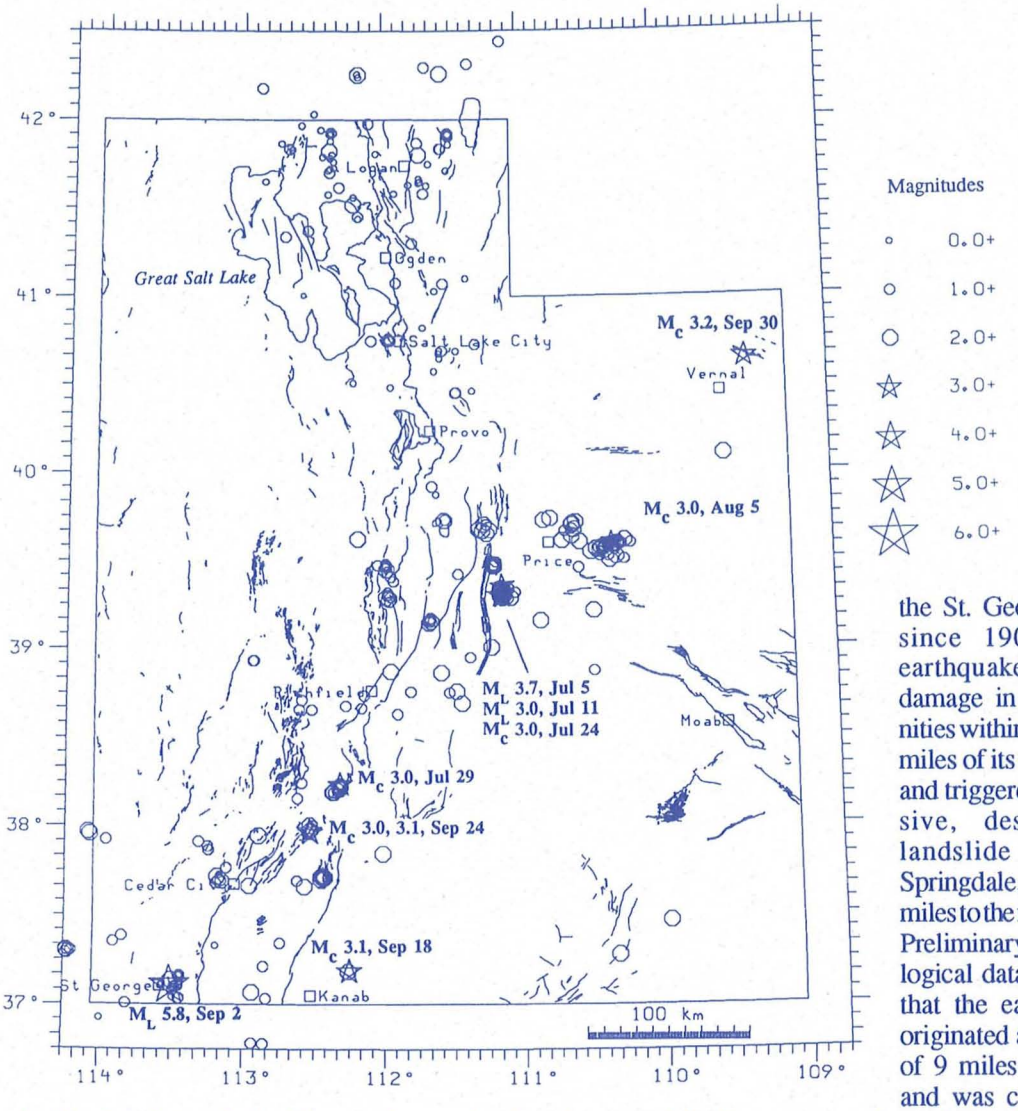
RECENT YELLOWSTONE NATIONAL PARK REGION EARTHQUAKES LOCATED BY THE UNIVERSITY OF UTAH

DATE-(UTC)-TIME	LAT-N	LONG-W	DEP	MAG	LOCATION
08/05/93 18:04	44 46.58	110 59.21	6.0	2.6	9.8 mi NNE of W. Yellowstone, MT
08/05/93 19:56	44 46.53	110 59.20	5.7	3.2	9.7 mi NNE of W. Yellowstone, MT
08/05/93 19:56	44 46.64	110 59.17	5.5	2.6	9.8 mi NNE of W. Yellowstone, MT
08/05/93 20:18	44 46.42	110 59.34	5.6	2.5	9.5 mi NNE of W. Yellowstone, MT
08/05/93 20:18	44 46.35	110 59.20	5.5	2.4	9.5 mi NNE of W. Yellowstone, MT
08/19/93 19:43	44 45.80	110 54.17	6.4	4.2	8.4 mi NNW of Madison Junction, WY
08/19/93 23:07	44 45.44	110 53.63	1.0	2.4	7.9 mi NNW of Madison Junction, WY

Utah Earthquake Activity — July 1 - September 30, 1992

by
Susan J. Nava, University of Utah Seismograph Stations
Department of Geology and Geophysics, University of Utah

Additional information on earthquakes within the Utah region is available from the University of Utah Seismograph Stations. (801) 581-6274



During the three-month period July 1 through September 30, 1992, the University of Utah Seismograph Stations located 357 earthquakes in the Utah region with one in the magnitude 5 range, nine in the magnitude 3 range, and 135 in the magnitude 2 range. Earthquakes of 3.0 or larger are plotted as stars and specifically labeled on the epicenter map. Magnitude indicated here is either local magnitude, M_L, or coda magnitude, M_C. All times are local time, which was Mountain Daylight Time.

St. George: A damaging earthquake (M_L 5.8) occurred 5 miles southeast of St. George, Utah, on September 2, 1992. The earthquake was felt throughout most of southwestern Utah, northwestern Arizona, and southeastern Nevada. The shock was the largest in the Utah region since 1975 and the largest in the St. George area since 1902. The earthquake caused damage in communities within about 35 miles of its epicenter and triggered a massive, destructive landslide near Springdale, Utah, 30 miles to the northeast. Preliminary seismological data indicate that the earthquake originated at a depth of 9 miles (15 km) and was caused by dominantly normal faulting on a north-south-trending fault, possibly a subsurface extension of the Hurricane fault. The main shock was followed by remarkably few aftershocks (only 16 locatable) during the report period. Additional information is available in "The St. George (Washington County), Utah, Earthquake of September 2, 1992," Preliminary Earthquake Report, University of Utah Seismograph Stations, 1992. A detailed summary will be published by the Utah Geological Survey during 1993.

Significant shocks:

M_L 5.8	September 2	4:26 a.m.	5 miles SE of St. George; widely felt (see above)
M_C 2.7	September 10	12:42 a.m.	4 miles NE of Washington; felt in St. George
Mc 1.0	September 23	11:19 p.m.	1 mile NE of Washington; felt in St. George

Book Cliffs/Price (coal-mining related):

M_L 3.7	July 5	6:22 p.m.	9 miles NW of Orangeville
M_L 3.0	July 11	7:23 a.m.	8 miles NW of Orangeville
M_C 3.0	July 24	9:01 a.m.	10 miles W of Huntington

General vicinity of Cedar City:

M_C 3.0	July 29	7:54 p.m.	5 miles NW of Circleville
M_C 3.0	September 24	4:02 a.m.	11 miles NW of Panguitch
M_C 3.1	September 24	8:35 a.m.	12 miles NW of Panguitch

Northeast of Kanab:

M_C 3.1	September 18	8:54 p.m.	18 miles NE of Kanab

Northeast of Vernal:

M_C 3.2	September 30	9:35 a.m.	16 miles NNE of Vernal

EARTHQUAKE ACTIVITY IN THE UTAH REGION
October 1 - December 31, 1992

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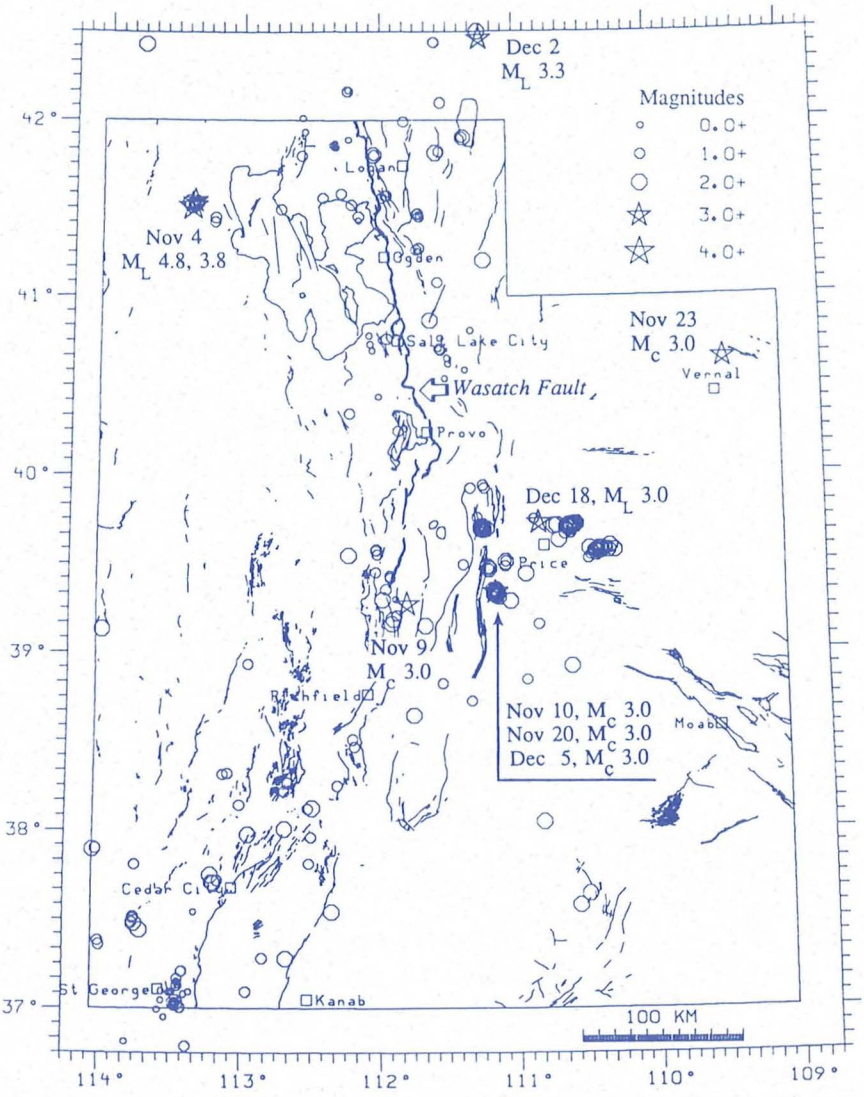
During the period October 1 through December 31, 1993 the University of Utah Seismograph Stations located 347 earthquakes within the Utah region. The total includes one earthquake in the magnitude 4 range, eight in the magnitude 3 range, and 146 in the magnitude 2 range. Magnitudes of 3.0 or larger are plotted as stars and specifically labeled on the epicenter map. There were six earthquakes reported felt during this period. (Magnitude indicated here is either local magnitude, M_L, or coda magnitude, M_C. All times are local time, which was Mountain Daylight Time from October 1 to 24, and Mountain Standard Time for the remainder).

St. George: Aftershocks continued to occur in the vicinity of the September 2, 1992, St. George (M_L 5.8) earthquake. Thirty-three aftershocks, ranging in magnitude from 0.3 to 2.2, were located.

Book Cliffs/Price (coal-mining related): Five clusters of earthquakes (magnitude 1.3 to 3.3) make up 50% of the shocks occurring in Utah during this period. These clusters are located: (a) near Sunnyside and East Carbon (southeast of Price); (b) in the vicinity of Soldier Canyon (northeast of Price); (c) northwest of Orangeville (southwest of Price); (d) near Hiawatha (southwest of Price); and (e) southwest of Scofield (northwest of Price).



Terrace Mountain, West Desert: An M_L 4.8 earthquake occurred November 4 under the Great Salt Lake Desert, south of Terrace Mountain and 29 miles east-northeast of Lucin. The shock was felt throughout northern Utah, eastern Nevada, and southeastern Idaho; no locatable foreshocks. Nine locatable aftershocks occurred during the 101 minutes following the main shock. The largest was M_L 3.8 located 31 miles east-northeast of Lucin. Prior earthquakes in this general region include a magnitude 4.8 shock in 1987, 25 miles to the southeast of the Terrace Mountain earthquake, and a magnitude 4.7 shock in 1970, located 26 miles to the northwest of the Terrace Mountain earthquake.

• M_L 3.0	November 23	11:36 a.m.	14 miles NNE of Vernal
• M_L 2.6	November 28	11:01 p.m.	13 miles SSE of Morgan; Felt in Bountiful, eastern Salt Lake Valley, Emigration Canyon
• M_L 2.7	December 21	10:34 p.m.	12 miles ENE of North Logan; Felt in Cache County
• M_L 2.5	October 12	5:04 a.m.	4 miles E of Fielding; Felt in Fielding
• M_L 3.0	November 9	11:11 a.m.	4 miles NNE of Fayette
• M_L 3.3	December 2	5:59 p.m.	6 miles NNE of Bennington, ID

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

WHAT STRONG-MOTION PROGRAM?

by Gary E. Christenson
Utah Geological Survey

Beginning July 1992, the Utah Geological Survey (UGS) was granted an appropriation of $75,000/year to begin an earthquake strong-motion instrumentation program (see *WFF* v. 8, no. 1, p. 4-5). To implement the program, a plan was prepared, a memorandum of understanding was entered into with the University of Utah Seismograph Stations formally establishing the Utah Strong-Motion Instrumentation Program (USMIP), and the Utah Strong-Motion Instrumentation Advisory Committee (SMIAC) was empaneled by the Utah Earthquake Advisory Board. The SMIAC met in January 1993 to review the proposed plan developed by the UGS. Based on their comments, the plan was then revised and finalized. The plan has subsequently been published as UGS Open-File Report 302 by S.S. Olig and G.E. Christenson (see Recent Publications, this issue).

The UGS planned to begin purchasing and installing instruments in March 1993. However, because of declining revenues from mineral-lease funds in the UGS budget, on-going funds for the USMIP were lost for FY 1993-1994 and beyond. A stable source of on-going revenue is needed to ensure instrument maintenance, so the USMIP has been postponed pending identification of stable on-going funding. In addition, the Applied Geology Program, which was contributing staff to run the USMIP, has lost (at least temporarily) one staff position, and no longer has sufficient staff to start this new program. Therefore, at this point the program is indefinitely postponed.

RESPONSE 93 POSTSCRIPT

by Bob Carey
Earthquake Preparedness Information Center
Utah Comprehensive Emergency Management

If you have not experienced a full-scale emergency-response exercise, you have not lived. It is a time of stress and information overload. It is a time to see years of planning come together to control the response meltdown that follows any major disaster, especially an earthquake. It is also a time to see the local, state, and federal jurisdictions pool their resources to provide for the needs of the citizenry. This was Response 93 (see *WFF*, v. 8, no. 4, p. 12-16).

With the exercise behind us, we can now look back and evaluate just how well we did. The first criterion of a successful exercise is to see if any of the participants checked into the State Mental Hospital. To date, no one has, to the best of my knowledge. The second criterion of a successful exercise is that a variety of problems arise that are not anticipated. A too well-orchestrated exercise does not allow for failure of the system being exercised. Failure is good. Failure can be fixed; that is why we exercise.

One of the highlights of the exercise included the participation of the Civil Air Patrol (CAP). CAP inclusion in Response 93 added a much-needed resource to the State. CAP's primary mission was to assist in damage assessment. Several missions were flown to evaluate the accuracy of aerial reconnaissance, with very good results. CAP was also used to transport search and rescue dogs, blood, and personnel throughout the disaster area. CEM is looking forward to working with the CAP in future exercises.

On the second day of the exercise, the State relocated its Emergency Operation Center to the Disaster Field Office at Camp Williams where FEMA had opened their response operations. This was a real challenge for CEM and the other State agencies, and was accomplished with only a few problems. (However, it is doubtful that during a real earthquake the State operations would move unless our building was unsafe for occupancy.)

FEMA and the Army Corps of Engineers brought in their computer systems to assist in their response efforts. This system proved to be invaluable for producing maps of the disaster area. These included maps projecting inundation areas for potential dam breaks and hazardous material plumes, and maps showing areas of significant property damage and water, sewer, natural gas, and other lifeline breaks. I think one can see the potential value for response and response planning with a tool like this.

As a personal observation, State agency participation in Response 93 was exceptional. The value of the exercise for each agency became very apparent as the exercise play continued. Most of

the feedback after play had finished was very positive and the agencies were interested in continuing the training process.

UTAH EARTHQUAKE ADVISORY BOARD NEWS

by Janine L. Jarva
Utah Geological Survey

One of the major goals of the Utah Earthquake Advisory Board (UEAB) has been to create a long-term risk-reduction plan for improving earthquake safety in Utah. On May 10, 1993, the UEAB held a workshop to begin the development of such a document. Given the concern that a comprehensive, integrated, and sustained effort be made to reduce earthquake hazards in Utah, the UEAB agreed that the document needed to be written for both Utah's citizens and its decisionmakers (including the legislature), and that it should represent a community consensus resulting from community participation in formulating the document.

Patterned after *California at Risk,* the California Seismic Safety Commission's hazard-reduction plan, the heart of the Utah plan is the development and implementation of initiatives to significantly improve Utah's earthquake safety by the year 2000. Board members reviewed the initiatives submitted for the first draft document presented at this meeting. They will modify and expand these initiatives as well as propose additional ones to be included in a subsequent draft. Once initiatives are developed, they will be evaluated and prioritized based on the following criteria: (1) the potential to save lives and prevent injuries, (2) the potential to avoid property and economic losses, (3) the potential to reduce social and economic disruption, (4) the relative ease with which the action can be implemented, (5) the degree to which each action supports or complements other actions, and (6) the cost associated with the action.

Initiatives will be divided into categories reflecting the different areas in which actions are needed to prepare for an earthquake, such as emergency planning and response, structural safety, awareness, and earth-science information. Within each category, actions to increase life safety and speed recovery will both be addressed. Recognizing that the overall goals will be long term, the document should nonetheless establish a time-table with interim milestones for the implementation of specific objectives, detailing lead and supporting agencies, resources, current status, and needed actions.

The UEAB also proposed the following Standing Committees to broaden involvement in the planning process and help develop various parts of the document: Engineering and Architecture, Earth Sciences, Emergency Planning, Intergovernmental Relations, and Earthquake Awareness. The UEAB will continue review and development of the document, and hopes to have a draft completed in time for the 1994 legislative session.

ATC UNDERTAKES COMPREHENSIVE EARTHQUAKE LOSS-ESTIMATE STUDY IN UTAH

The Federal Emergency Management Agency (FEMA) is funding the Applied Technology Council (ATC), a non-profit corporation based in California serving the structural engineering profession, to develop loss relationships and compile current, updatable computer and GIS databases to estimate losses for a large (magnitude 7.5) earthquake on the Wasatch Front. The project is termed ATC-36, and is scheduled for completion in January 1994.

During the last decade FEMA has begun developing systems to estimate the effects of disasters using GIS, hazard-effect models, structural-inventory information, structure vulnerability-functions, and economic and industrial models. These systems are intended to enable FEMA to:

1) plan pre-disaster mitigation and emergency management efforts,
2) quickly assess the emergency situation, its major impacts, and the emergency-response needs during the first hours to days after an emergency, and
3) plan and execute post-disaster recovery efforts.

To do this, FEMA is simultaneously funding General Research Corporation (GRC), a Virginia-based software-development company, to develop an IBM-compatible personal computer-based system known as the FEMAS Earthquake Impacts

Projection Model (PC-EQUIP) that can be used for making earthquake damage and loss assessments.

In 1985, ATC completed a study of earthquake losses for all types of existing industrial, commercial, residential, utility, and transportation facilities in California. Several elements of this study, "Earthquake Damage Evaluation Data for California," ATC-13 (1985), have already been integrated into PC-EQUIP, including:

1) a scenario-designation module for assigning intensity levels to geographic areas,
2) systems to give structure-type designations to businesses identified by type in California,
3) earthquake-damage functions for structures (buildings, lifelines, and equipment) located in California, and
4) estimates of losses of business production and sales arising from earthquake ground shaking.

The purpose of the ATC-36 study in Utah is to develop structural engineering and collateral hazards databases and methods for estimating earthquake damage and losses to be integrated into a FEMAS PC-EQUIP version for FEMA Region VIII and to focus these capabilities on Utah. The engineering data and methods developed will be easily generalized to support earthquake damage and loss assessments in other FEMA regions and for the rest of the U.S. The ATC-36 study will use GIS databases with building-by-building structural information, and ground-shaking and collateral-hazards maps, to provide methods to estimate:

1) damage from ground shaking (as projected by a ground-shaking intensity model included in PC-EQUIP) and the following collateral hazards: fault rupture, liquefaction, inundation, landslides, and fires,
2) replacement costs for damaged facilities,
3) time to restore damaged facilities to pre-earthquake usability, and
4) deaths and injuries.

GRC will incorporate this methodology and data into the Utah PC-EQUIP model to make earthquake loss estimates. The scenario earthquake for ATC-36 is the same one used in Response 93, the full-scale FEMA earthquake exercise held in June in Salt Lake City (see this issue, p. 7). This was a magnitude 7.5 earthquake on the Salt Lake City segment of the Wasatch fault, with the epicenter in Midvale. However, the methods will be applicable to any Wasatch Front earthquake and can be applied anywhere sufficient data (building structural information and hazards maps) are available in GIS formats.

The ATC-36 project is using Utah and California consultants to identify and compile databases, and is guided by an advisory Project Engineering Panel consisting of leading structural engineers and earth scientists from Utah and California. We will include a project summary and listing of report availability in the *Wasatch Front Forum* when ATC-36 is completed. For further information, contact Chris Rojahn or Patty Christopherson at ATC (415) 595-1542, and/or Barbara Skiffington at GRC (703) 506-5829.

USGS PROFESSIONAL PAPER 1519 NOW AVAILABLE

The report *Applications of Research from the U.S. Geological Survey Program, Assessment of Regional Earthquake Hazards and Risk Along the Wasatch Front, Utah* (U.S. Geological Survey Professional Paper 1519), edited by Paula Gori, is now available.

In 1983, the U.S. Geological Survey (USGS) targeted the Wasatch Front for a multi-year program that focused on earthquake research and hazards reduction. An earlier report, USGS Professional Paper 1500-A-J, *Assessment of Regional Earthquake Hazards and Risk Along the Wasatch Front, Utah,* contained the results of much of the scientific research undertaken from 1983 to 1988.

This new report explains and gives examples of how information about earthquake hazards has been applied at the local level in Utah. It includes information developed at the local level to reduce the earthquake hazards of surface-fault rupture, landslides and debris flows, liquefaction, and tectonic subsidence. The report also contains discussions of methods followed to encourage application of scientific information. The authors who have contributed to this report represent the many disciplines and levels of government that participated in the multidisciplinary cooperative program.

To order Professional Paper 1519, send a

check for $12.00 to USGS, Box 25286, Denver Federal Center, Denver, Colorado 80225. Checks should be made payable to the Department of Interior/USGS. Copies are also available at the Earthquake Science Information Center in Salt Lake City at 8105 Federal Building, 125 South State, Salt Lake City, (801) 524-5652.

(Summaries reprinted from FEMA documents)

nehrp

National Earthquake Hazards Reduction Program

FEDERAL EMERGENCY MANAGEMENT AGENCY

RECENT PUBLICATIONS

Building for the Future - NEHRP Fiscal Years 1991-1992 Report to Congress

The Federal Emergency Management Agency (FEMA) has recently published the National Earthquake Hazards Reduction Program Biennial Report to Congress for Fiscal Years 1991-1992. Entitled *Building For the Future, NEHRP Fiscal Years 1991-1992 Report to Congress,* the report summarizes the earthquake risk reduction activities of the NEHRP principal (FEMA, USGS, NSF, and NIST) and contributing agencies.

Seismic Rehabilitation of Buildings - Phase 1: Issues Identification and Resolution (FEMA Publication 237)

In September 1989, FEMA awarded the Applied Technology Council (ATC) a three-year contract to identify and resolve issues that will affect the development of guidelines for seismic rehabilitation of existing buildings. The project has been identified by FEMA as Phase I of a two-phase effort, with the guidelines themselves being developed under a separate contract in Phase II. The guidelines are expected to become the nationally accepted basis for seismic rehabilitation and are intended for use by the design professions, building codes and standards writers and administrators, researchers, and educators.

The two-phase strategy of FEMA is based on the recognition that the writing of the detailed Guidelines will be greatly facilitated by this preparatory study of technical and societal issues. Both of these phases build upon earlier work on existing buildings funded by FEMA as part of the National Earthquake Hazards Reduction Program (NEHRP).

FEMA's program to mitigate the hazards posed by existing buildings started in 1984 after the completion of a set of application materials on the seismic safety of new buildings. The first project undertaken was a Plan of Action and companion Workshop Proceedings on the existing building topic by a joint venture consisting of the Applied Technology Council (ATC), Building Seismic Safety Council (BSSC), and Earthquake Engineering Research Institute (EERI). The Plan (FEMA Publication 91) is being used as a "road map" by FEMA to develop a coherent, cohesive, carefully selected and planned set of documents enjoying a broad consensus and designed for national applicability. These publications provide guidance on existing buildings primarily to local elected and appointed officials and design professionals on how to deal not only with engineering problems, but also with public policy issues and societal dislocations.

Completed to date are:

- a handbook on how to conduct a rapid visual screening of buildings potentially hazardous in an earthquake (FEMA Publications 154 and 155).
- a handbook on consensus-backed and nationally applicable methods to evaluate in detail the seismic risk posed by existing buildings of different characteristics (FEMA Publication 178)
- an identification of consensus-backed and nationally applicable techniques for the seismic rehabilitation of buildings of different characteristics (FEMA Publication 172).
- a collection of data on costs incurred in seismic rehabilitation of buildings of different occupancy, construction, and other characteristics, based on a sample of about 600 projects, now being updated and expanded (FEMA publications 156 and 157).
- a handbook on how to set priorities for the seismic rehabilitation of buildings—

an interdisciplinary examination of the complex public policy-societal impacts of rehabilitation activities at the local level (FEMA Publications 173 and 174).

- an identification of potential financial incentives in the public and private sectors derived with the assistance of a user group and disseminated through workshops in seven selected localities cooperating in the effort (FEMA Publications 198, 199, and 216).
- a benefit/cost model to evaluate the direct costs of seismic rehabilitation to owners and occupants (FEMA Publications 227 and 228).

In the now completed Phase I document, published as FEMA 237, the goal of analyzing and suggesting solutions for the issues involved in seismic strengthening can be compared to the process of designing a building. This project is analogous to preliminary design steps: developing an architectural program to ensure the building spaces will be designed to meet the client's needs and budget and devising a schematic site plan and structural scheme to ensure that the design concept is feasible. Analogous to the role of a preliminary approval by the client of a design concept for a building is the extensive set of measures in the present project whereby a broad range of "clients" has been involved. Building on this logical first phase of work in this project, the Guidelines writers can then proceed to enter their second phase of work, which is analogous in the building design case to production of construction drawings and specifications.

A secondary purpose that has a more immediate application is to provide the final version of this Issues Identification and Resolution document as an information resource for communities, design professionals, building owners, and others on the complex issues surrounding this subject.

Seismic Safety of Federal and Federally Assisted, Leased, or Regulated New Building Construction, A Progress Report on Federal Agencies' Execution of Executive Order 12699

FEMA recently submitted to the President the first assessment report on Federal agency progress in executing Executive Order 12699. The two-volume report, *Seismic Safety of Federal and Federally Assisted, Leased, or Regulated New Building Construction, A Progress Report on Federal Agencies' Execution of Executive Order 12699*, covers the activities of Federal agencies during Fiscal Year 1991 and 1992 in establishing effective seismic safety programs required by the Executive Order.

The purposes of the Executive Order are to reduce earthquake risks to the lives of occupants of buildings owned by the Federal Government; to improve the capability of essential Federal buildings to function during or after an earthquake; and to reduce losses of public buildings in a cost-effective manner. The assessment of agency progress by FEMA indicates that real progress has been made. For example, most of the 27 affected agencies have issued procedures or regulations to implement the requirements of the Order and have adopted the minimum standards for seismic safety recommended by the Interagency Committee on Seismic Safety in Construction. However, the assessment also indicates that much more can be done to meet the requirements of the Order, primarily by those agencies providing financial assistance for new building construction. According to the report, the principal concern is the slow progress by many agencies toward the final regulations or procedures required for compliance with the Order before February 1993.

Volume 1 of *Seismic Safety of Federal and Federally Assisted, Leased, or Regulated New Building Construction, A Progress Report on Federal Agencies' Execution of Executive Order 12699* includes a summary assessment of agency progress, as reported in the biennial report to the Congress on the National Earthquake Hazards Reduction Program (NEHRP). A more detailed assessment of agency progress is provided in Volume 2 of the report. The second volume also contains the Executive Order, individual agency progress reports, the format for reporting to FEMA, and the progress assessment criteria.

Funding Post-Earthquake Investigations - A Report to Congress
From the Executive Summary:

On November 16, 1990, Congress enacted Public Law 101-614, the National Earthquake Hazards Reduction Program (NEHRP)

Reauthorization Act. Section 11(b) of this law requires the Director of the Federal Emergency Management Agency (FEMA), in consultation with other NEHRP agencies, to report to Congress within 1 year on possible options for funding a program of post-earthquake investigations.

It is clear that Congress has recognized, as have the NEHRP agencies and all others involved in earthquake-hazard reduction, that actual earthquakes provide a natural, unique laboratory for collecting critical time-sensitive data and for conducting longer-term post-earthquake investigations. These investigations are fundamental to the goals of NEHRP because they further knowledge of the processes of earthquakes and of the appropriate measures to reduce loss of life and property from earthquakes.

It is important to recognize that post-earthquake investigations are not limited to immediate investigations designed to capture perishable data, but also include longer-term studies that require additional reconnaissance and detailed analysis of data. Post-earthquake investigations may range from the immediate response needed to evaluate causes of death and injury, to longer-term studies to evaluate the performance of buildings and lifelines, to even longer-term studies that might evaluate the economic impact of an earthquake on a community. In fact, much of the cost of post-earthquake studies is not in the immediate collection of data but in the longer-term comprehensive data and analysis. This report recognizes that post-earthquake investigations span a very wide range of topics and time. However, the report concentrates more on identification of options for funding immediate and shorter-term investigations than on the full range of post-earthquake studies.

This report addresses each of the requirements of Section 11(b), and is intended to fulfill Congress' request to investigate potential sources of funding for post-earthquake investigations.

Improving Earthquake Mitigation - Report to Congress

EXECUTIVE SUMMARY

The NEHRP Reauthorization Act of 1977, as amended in 1990 (the Act), directed the Federal Emergency Management Agency (FEMA) to convene a panel of experts to study the adequacy of mitigation capabilities with respect to a catastrophic earthquake, and to provide to Congress a report on that study (mitigation study). The 1990 amendments to the Act (P.L. 95-124) reflect, in part, congressional concern about the lack of progress throughout the United States in implementing earthquake hazards mitigation measures as contemplated by the 1977 Act.

An essential conclusion of the mitigation study is that the degree of nationwide earthquake hazard mitigation envisioned by the 1977 Act has not been achieved. There are many reasons why the program has fallen short of its goals, but one of the most important is that implementation of the mitigation techniques that are most likely to reduce the hazard is voluntary. NEHRP, in encouraging the adoption and enforcement of mitigation measures, must devise a new national strategy. This strategy should tie seismic mitigation to all federal financing programs available to state and local governments. The strategy should include: (1) expanding Executive Order 12699 for new construction to include both direct and indirect federal financing; (2) incorporating mitigation into federal rehabilitation financing programs; (3) linking receipt of federal disaster assistance to mitigation actions; and (4) identifying appropriate incentives to stimulate mitigation actions, particularly for the existing built environment.

The study panel concluded that the 1977 Act promoted real gains in knowledge about the earthquake hazard and about the techniques that need to be applied to reduce earthquake losses. Implementation of loss-reduction measures, however, has not kept pace with advances in knowledge. The panelists agreed that, despite clear confirmation of the losses caused by earthquakes, and despite heightened attention to the consequences of earthquakes in the last few years, most state and local governments are unlikely to launch significant efforts to improve mitigation in the absence of stronger federal requirements, guidance, and incentives.

Some states and local jurisdictions have made important advances in earthquake hazard mitigation. Many areas of significant earthquake risk, however, have done little or nothing to address the problem. The lack of

mitigation activity could be explained by the inability of communities to accurately assess risks, the perception that mitigation costs are excessively high, and the expectation that the government will provide federal disaster assistance after an earthquake. Among the most prominent impediments to mitigation identified by the study team are:

1. The low priority given to the earthquake hazard by the many state and local governments, many private-sector entities, and the public at large;
2. the absence of incentives, particularly financial, for the adoption of earthquake mitigation policy; and
3. limited leadership, coordination, and direction at the federal level, particularly with respect to mitigation activities it can impact through existing programs.

To begin to overcome these impediments, a new national strategy for earthquake hazard mitigation must be devised that includes, at a minimum, a program requirement that seismic considerations be applied in all new construction to any structure that receives either direct federal support, a federal guarantee of financing, or federal insurance for that financing. A second phase to the new strategy must provide concrete incentives to those who undertake earthquake-mitigation actions to address the existing built environment.

Although increasing the seismic resistance of existing construction is, in many ways, more important and difficult than improving the resistance of new construction, pragmatic considerations suggest that the greatest gains can be made by focusing, at least initially, on new structures. Fourteen years after passage of the 1977 Act, the three most dominant model building-code groups in the United States have incorporated basic seismic-safety provisions for new construction that are substantially equivalent to those of the *NEHRP Recommended Provisions* (the Provisions). Although the panel welcomed this major success of NEHRP, its view is that the mere existence of building codes does not assure implementation of earthquake-mitigation measures. The Provisions accomplish less than they should because: (1) in adopting model codes, localities often delete the seismic provisions; (2) even where codes are adopted, enforcement is not given a high priority and needed expertise is lacking in many jurisdictions; and (3) the model seismic codes are directed primarily at preserving life safety. Costly property damage will still occur unless stronger measures are adopted.

The panel points out that uniform, visible progress has not been achieved nationally because, despite the risk of destruction from earthquakes, mitigation requires restraints on the freedom to build structures at the lowest possible cost and in the locations deemed most desirable. Until the balance between the relatively unfettered exercise of this freedom and the risk of loss of life and property is changed to give more emphasis to avoiding such losses, mitigation on a broad, nationwide basis will not occur.

Economic interests predominate when seismic building codes are considered. Unless the Federal Government is willing to demonstrate its support for mitigation by requiring that states and localities exercise their authority to ensure that action is taken; and unless the Federal Government is prepared to place conditions on the disbursement of public funds for the prevention of losses in earthquakes, or to provide incentives to encourage local action, it is wishful thinking to expect subfederal governments to improve their mitigation performance.

Governmental authority already has been exercised to a limited degree in Executive Order 12699, which requires that appropriate seismic design and construction standards and practices be adopted for any new construction of buildings owned, leased, constructed, assisted, or regulated by the Federal Government. Although the Executive Order does not apply to existing buildings or to lifelines such as bridges, highways, and utility systems, it is a good start in the view of the expert panel.

Active enforcement of the Executive Order by appropriate federal agencies is, of course, basic to its success. Even with adequate enforcement, much of the nation's new construction will not be covered by the Executive Order. The panel believes that, for the Executive Order to be truly effective, federal "assistance" as defined by the Order should include structures covered by conventional mortgages issued by institutions insured by agencies of the Federal Government

such as the Federal Deposit Insurance Corporation.

Model codes for new construction do not address the very serious problems posed by existing hazardous buildings and by other potentially vulnerable elements in the built environment such as bridges, highways, and utility lifelines. As noted earlier, even if the Executive Order were implemented to its full potential, it still would not cover existing structures or lifelines. As was dramatically evident in the collapse of the Cypress structure after the Loma Prieta earthquake, this critical problem cannot be ignored. On the other hand, costs for the retrofit of structures can be significant, and the gaps in our knowledge about cost-effective retrofitting strategies and standards for many types of structures must be recognized and remedied.

The panel agreed that, particularly in this context, a properly structured program of incentives could effect significant improvement in the seismic safety of existing structures. An effective incentive program could be tied to the availability of disaster assistance, to federal programs that provide funds to state and local governments for housing construction or infrastructure improvements (both before and after an event), to any insurance program that receives federal support; or could be connected more closely to the nation's tax structure.

One approach could be to use negative incentives, such as prohibitions against the issuance of conventional mortgages by a federally insured lender to households or businesses in an earthquake-prone area if state or local governments fail to adopt or enforce appropriate seismic-mitigation standards for new and existing construction. This type of negative incentive authority was exercised by the Federal Government in the 1973 Flood Disaster Protection Act and was the sole reason that the number of communities adopting flood mitigation measures increased from fewer than 3,000 in 1973, to almost 18,000 less than 5 years later.

The panel of experts made clear to FEMA that the need to develop a national strategy to mitigate earthquake hazards is beyond dispute. Voluntary measures have not worked. The national strategy, therefore, needs to incorporate at least three basic components: (1) it should capitalize on the large number of Federal Government programs that support construction and grants by requiring that seismic safety be incorporated into these programs; (2) it should explore how federal disaster assistance can be used to enhance mitigation; and (3) it should identify appropriate incentives to mitigate (particularly the existing environment). To continue using approaches that have proved to be ineffective would be to acquiesce in future earthquake losses that could otherwise be avoided.

Copies of all the reports detailed above are available free of charge from FEMA publications by writing Federal Emergency Management Agency, PO Box 70274, Washington, D.C. 20024. For further information regarding the documents, contact the Federal Emergency Management Agency, Earthquake Programs, 500 "C" Street, S.W., Washington, D.C. 20472, (202) 646-2810.

(Reprinted from a September 15, 1993, EERI News Release)

NEHRP REAUTHORIZATION HEARING

On September 14, 1993, the Earthquake Engineering Research Institute (EERI) Secretary/ Treasurer Chris Poland represented the EERI in testimony before the Subcommittee on Science of the Science, Space, and Technology Committee of the House of Representatives in support of the reauthorization of the National Earthquake Hazards Reduction Program.

Other witnesses included: George Bernstein, Esq., Chairman of the NEHRP Advisory Committee; Tom Durham, Executive Director, CUSEC; and Klaus Jacob, Lamont-Doherty Observatory, Columbia University.

Witnesses were asked to recommend ways to strengthen the management of NEHRP, accelerate implementation of earthquake risk reduction activities, ways to improve the coordination of research, and to comment on accomplishments of NEHRP and the President's '94 Budget Request.

Poland referred the Committee to the EERI Response to the NEHRP Advisory Committee Report (see April '93 EERI Newsletter), in voicing EERI's concern that an alternative management structure is needed to identify targets, set priorities

and schedules and allocate resources. "The current structure has contributed to an inability to define program and budgetary priorities and achieve realistic, well-coordinated goals."

He went on to recommend that t significant component of the program must continue to focus on the development and updating of design guidelines and building codes. EERI endorses the need to identify incentives to encourage local government to adopt ordinances and to cause owners to bring older buildings up to acceptable standards.

EERI recommends that in reauthorizing the NEHRP Program Congress consider creating a technical assistance program that would pair experienced professionals with their counterparts in states and communities in areas of moderate or infrequent seismic activity, to assist in the adoption of seismic building codes and to develop mitigation programs. In areas of highest earthquake risk there is a need for incentives to encourage states to adopt greater levels of mitigation activity; to identify critical facilities and upgrade them as necessary; to encourage the adoption of standards that go beyond "life safety" for sustained function of facilities critical to the regional economy.

Recognizing that a great deal has been accomplished by each of the NEHRP agencies, EERI remains concerned that much is yet to be done, if mitigation programs are to be successfully expanded. Increased funds must be provided for state and local government mitigation programs, either through increased appropriations, or by making the adoption of mitigation programs a condition of continued eligibility for federally backed financing, or through greater use of funds available under other federal programs.

Poland reminded the Committee that an orderly and balanced earthquake research program must include basic research, problem focused research, development of state-of-the-art design guidelines, and development of new building code provisions and better procedures for strengthening existing buildings. Poland concluded his remarks by calling for stronger partnerships between the research community, design professionals, industry, and local, state, and federal government agencies.

A copy of the full testimony is available from the EERI office by writing to 499 14th Street, Suite 320, Oakland, CA 94612-1902 or calling (510) 451-0905, FAX (510) 451-5411.

MEETINGS AND CONFERENCES

October 25-28, 1993, Geological Society of America Annual Meeting, held in Boston, Massachusetts. The main focus of the meeting will be "Geology and Health," underscoring the centrality of geological knowledge and education to discussions of human interactions with global and local environments. For further information about the conference, contact GSA Meetings Department, 3300 Penrose Place, Boulder, CO 80301, (303) 447-2020.

December 6-10, 1993, American Geophysical Union Fall Meeting, held in San Francisco, California. Abstract deadline is September 9, 1993. For information, contact AGU-Meetings Department, 2000 Florida Avenue, N.W., Washington, DC 20009, (202) 462-6900, fax (202) 328-0566.

July 10-14, 1994, Fifth U.S. National Conference on Earthquake Engineering, organized by the Earthquake Engineering Research Institute and held at the Marriott Downtown Hotel in Chicago, Illinois, will have as its theme "Earthquake Awareness and Mitigation Across the Nation." The conference will provide an opportunity for both researchers and practitioners to share the latest knowledge and techniques for understanding and mitigating the effects of earthquakes. This quadrennial conference will bring together, and enhance dialogue among, professionals from the broad range of disciplines committed to reducing the impact of earthquakes on the built and natural environment: geology, seismology, geophysics, geotechnical engineering, soils and foundation engineering, structural engineering, architecture, social response, regional planning, emergency response planning, and regulation. For further information, contact the Earthquake Engineering Research Institute, 499 14th Street, Suite 320, Oakland, CA 94612-1902, (510) 451-0905, fax (510) 451-5411.

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