U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROCEEDINGS OF THE WORKING GROUP MEETING ON

NORTHEAST UNITED STATES EARTHQUAKE PROBABILITY

APRIL 28-29, 1993
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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NEW ENGLAND STATES EARTHQUAKE CONSORTIUM

U.S. GEOLOGICAL SURVEY

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NORTHEAST EARTHQUAKE PROBABILITY WORKING GROUP MEETING
APRIL 28, 1993 - 9:30 am - 4:30 pm
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Northeast Earthquake Probability Working Group
Day I - Experts' Session
April 28, 1993, 9:30 am - 4:30 pm

KEY POINTS/ISSUES

John Ebel, Boston College/Weston Observatory, Weston, Massachusetts.

There have been many reports in the press with various probabilities for earthquakes in the Northeast. For example, by the year 2000 there's an 85% chance there will be a major earthquake in the Northeast, according to newspaper accounts. This prompted us to get together and reach a consensus, using this meeting as a springboard to future scientific and mitigation work.

Nafi Toksoz and others at MIT published the first probability figures for earthquakes in the Northeast. He generously agreed to host this meeting.

Stuart Nishenko, U.S. Geological Survey, Golden, Colorado.

In the late 80's and early 90's, Gil Bollinger and I wrote a paper on forecasting damaging earthquakes east of the Rocky Mountains. That process was initiated by a series of newspaper articles stating very high probabilities for earthquake occurrence in the Central and Eastern Northeast. We published the **Science** article to provide a credible statement about earthquake hazards and to provide some consistency for what is said to the media, as well as local officials. Tomorrow some of those state, federal, and local officials are going to be here to discuss their problems and needs with us. Tomorrow we will try to put our results together with their needs. This working group is the first step in a longer process. We have an agreement with FEMA to put together a workshop some time in the Fall or Winter (1993/94) for the larger user group. All of this is aimed at stimulating a little more activity in the Northeast.

Nafi Toksoz, Earth Resources Laboratory, Mass. Institute of Technology.

I would like to welcome you to the Earth Resources Laboratory. We are part of the Department of Earth and Planetary Sciences. Due to growth, we are now in several buildings. We are involved in research seismic wave propagation, seismology, and tectonics, along with other colleagues in the department. Nina Buckingham and Sue Turbak will help with logistics, word processors, etc. These can be made available. Please ask us for assistance if you need any. I will have to leave this afternoon to fly to the West Coast. Professor Daniele Veneziano will be the local MIT host.

Randy Updike, National Coordinator for the Earthquake Hazards Program, U.S. Geological Survey, Reston, Virginia.

I guess I know about half the people in the room, and I look forward to meeting the rest.

I would like to mention three aspects of this meeting and what is going on the NEHRP program that has relevancy to the timing of this meeting. First, and foremost, everybody's interested in money. Throughout the 1980's the Earthquake Hazards Program at the USGS was about 35 million dollars. As a result of the Loma Prieta earthquake, we got an add-on from Congress of about 12 million, which put us up to the 50 million dollar mark. This year we are at the President's budget of about 50 million. We are anticipating a cut of one million next year. That sounds like a lot of money, but when you put in the projections of increasing costs, we are right now at about the same level of funding that we were in 1978. Related to that, we have a much larger infrastructure we are trying to support--both inside and outside the USGS.

It is kind of tough now to envision new research with the size of the budget we have. Currently we are placing substantial emphasis in four regions: Southern California, Northern California, Pacific Northwest/Alaska, and the Central United States. When it gets down to real dollars, our support in each of these regions is shrinking.

One effective way to expand the Program is by a regional emphasis and by adding regions when appropriate funds are provided as budget increases. We have written an initiative for new money in the amount of 12 million dollars for FY 95, that would include the Northeastern United States for 4 million dollars. This is a major step. Four million is equivalent to our commitment for the Pacific Northwest.The 12 million dollars also would provide for new work in Hawaii, Alaska, and an extension on the Atlantic seaboard in South Carolina and the Caribbean. We are trying to reach out to those areas that have either moderate seismicity or historic evidence of major damaging earthquakes. It's non-productive for us today or over the next two months to debate whether the USGS is spending enough money in the Northeast; this would be an academic debate that would get us nowhere. There are people in other areas who would argue for their area. I would hope that we can be on a productive, positive note, so that we are giving better identification of the problem, and that will give me the tools to go after the money to support the research.

Secondly, within the Earthquake Hazards Program at the USGS we have gone through some restructuring. Formerly there was a "semi-permeable membrane" between the external research program and the USGS. There was some flow back and forth through the membrane, but there was almost a purposeful separation of the two. One-third of the earthquake program goes to the external program. We have made an effort to dissolve that membrane and get more collaboration and

efforts in transferring data and technology between the two.

You'll see this change in the next year or two. It is remarkable to see the increase in cooperative/collaborative research going on between USGS and university researchers. Another part of the restructuring is that there has been one position identified as the earthquake hazards national coordinator, who will have oversight of the total program. For right now, that's me.

In addition to myself, I have the following regional coordinators: Craig Weaver in Seattle, Bill Bakun in San Francisco/Menlo Park, Jim Mori in Southern California and Buddy Schweig for the Central U.S. Just yesterday the advertisement went out for the next external program coordinator to replace Elaine Padovani, and that will form the nucleus of this current NEHRP management team. As we add new regions, as in the Northeast, we would hope to establish a presence both in terms of a coordinator up here, and I'll mention Mary Ellen in a minute, but also make visibility for the Northeast on the national scale. I am very excited about this opportunity. This kicks off the opportunity for something that could grow rapidly, and you all would be the leaders.

Mary Ellen joined our staff about six months ago (in October 1992). She is doing a sensational job of sort of clearing the underbrush and figuring out where the knowledge lies, and how we can really make this effort work. I guess many of you have talked to her and she is working with me, so she is my point person out here.

The restructuring that's gone on within the USGS will give us a more streamlined, efficient, and focussed effort for you. If it doesn't look like it's working, call me up and yell at me.

Finally, I've been in a series of dialogues with FEMA about what kind of interface they would like to see in various regions between the scientific community and the user community. We need to try to strive to find these consumers of our information and putting it into a consistency that they are going to be able to consume. Some have teeth and others are using a straw. We have been working together and there are several efforts that FEMA is underwriting. One is Earthquake Hazards in Rural Areas of the United States. It is an area that has been neglected. Over the past ten years we haven't seen a major earthquake, but we have seen a series of earthquakes that have chipped away at our infrastructure and had major impact on the rural areas. We have one workshop for Southern California this Fall looking forward from Landers and what do we do next as far as a research focus in Southern California, and there are others. I mention this because there is a healthy new relationship between FEMA and the USGS. We want things that are not just show and tell, workshops or symposiums, but genuine efforts to get communication going. That's why today is science and tomorrow we have to listen to the consumers.

Klaus Jacob, Lamont-Doherty Earth Observatory, Palisades, NY.

There is a question about including New York and New Jersey in the term Northeast. Will there be representation from FEMA Region II? When we talk with people tomorrow, will there be Region II people there? No. FEMA/Washington? Yes. Region I is a much more active area. Need to activate Region II, in particularly with New York City, and maybe the Caribbean, even if our mandate is really Region I right now. We need to address this somehow.

Louis Klotz, New England States Earthquake Consortium.

NESEC is really a New England entity. It is very new. The thought of taking on New York State is rather horrifying. Taking the CUSEC route, there may be an associate membership in time. Maybe in 1995 there will be more funding available for staff. We need to grow internally. There is no program manager in Maine or Connecticut at this point. It would be nice to have another office in Connecticut to handle that state and New York. But that is blue sky at this point.

Jacob.

Scientifically it is the right thing to all sit together, but it may not work with FEMA.

Updike.

CUSEC encompasses three regions.

There is a an issue before Congress right now about creating an independent entity that will decide how NEHRP operates. If that recommendation is followed I think we would see a dramatic decline in earth science-type science in the earthquake program. I don't want to dwell on things that might happen. There is an optimism brought about by Babbitt's selection as Secretary of the Interior. We will also be getting a new Director of the USGS within 6 months.

The earthquake program is the single largest program in the USGS. It is 10% of the SIR Congressional budget for the USGS. It is high visibility. The Vice-President was key in getting us from 35 to 50 million, and he continues to have an interest in hazards. Congressmen are going to have to help in order to make substantial change. Next month are hearings on the reauthorization of NEHRP. Every three years they reexamine it to see what redirections need to be made. In the 1980's there were tiny changes, but the last time around there was a very vigorous review, particularly the role of FEMA. These hearings set the levels of funding for each of the four agencies (NIST, FEMA, NSF, USGS). They can change the balance. The total (slightly under 100 million dollars) I think will stay pretty well fixed. They can take money away from one agency and give it to another, or they can add another agency.

John Adams, Geological Survey of Canada.

Canada has similar problems. Historical earthquakes are not considered as important as more recent ones. We are continually reevaluating the magnitudes of historic earthquakes because it is hard to believe the reported earthquake epicenters and sizes. They don't think they have seen the largest earthquake in Canada. They may even be considerable larger than New Madrid (M 7 to 7 1/2).

Jacob.

In the Northeast, where it was glaciated, you have only 10,000 years at the most to work with. The recurrence time may be half of that for the largest events, we really don't have many options. It might very well be that the first 3,000 years of the 10,000 was seismically behaving entirely differently because of the history of that time creating a stress pulse. This is all speculation. If you look at Scandanavia where they have humongous faults and there is very little evidence to show that these are as active as they were. Therefore, what was true 10,000 years ago may not be true now. The paleoseismic record becomes proportionately more important.

Recurrence is very important societal issue--very important because it effects critical structures (bridges, etc.) The money for these studies comes in the form of special studies.

Ebel.

The agenda calls for a Consensus Probability Statement for the Northeastern U.S. There is an abstract by Nishenko, Ebel, and Perkins on New England Earthquake Hazards Estimates (see Appendix 1). We need to gather your thinking and put it into some sort of format. There are some questions that we need to come to grips with.

1. What is the probability of significant earthquakes that we would put out in a public statement? That's both probability and error statements.

2. What size earthquakes do we want to report those probabilities for?

3. What methods do we want to use? Region-wide? Sub-regions?

Some of the latest work to come out have been the Nishenko and Bollinger paper published in **Science** in 1990. I put out a paper in 1984 where I took seven years of network monitoring. What recurrence curves and probability does this give us based on this and then I compared it to the historic record. It was those numbers that has been used by Lou Klotz in some of the statements he's been making publicly. There was some work done by EPRI (Electric Power Research Institute) on issues related to this. The

Canadians and John Armsbruster have looked at the catalog. Nafi Toksoz published a paper on the randomness of the historic catalog.

John Armbruster, Lamont Doherty, Palisades, New York.

Exactly what study did the recurrence records come from? The .08 in 10 years agrees with the numbers by Nishenko and Bollinger and is referenced to the recurrence relationship in the Sterling Forest volume published by NCEER (National Center for Earthquake Engineering Research). Looking at that paper do I correctly interpret that this is for New England, plus New York, Pennsylvania, and New Jersey?

Ebel.

I took the network catalog for geopolitical New England. (Discussion of catalogs.)

Jacob.

The most important thing is to look at the risk, even if the probability is not high. You cannot afford to jeopardize the nerve centers of the United States.

Klotz.

Have you seen the ATC 25 Lifelines impact studies? Five percent of all the medical facilities in Massachusetts would be still standing after a Mag. 7. This is a study of Cape Ann, as one of the four areas in the country. They ended up with a 25 billion dollar loss. People still want to know what is the likelihood of a damaging earthquake occurring.

Ebel.

MOTION: that the study area of this working group consist of the six New England states, New York, and New Jersey. Unanimously accepted by the working group.

Nishenko.

Displayed and discussed Susan Goter's shaded relief maps of earthquake locations for California and the conterminous U.S. Plates are being prepared so that we can plot earthquake catalog information for New England this summer. This would be available for the workshop in Fall/Winter 1993-94.

This is a product that we put together fairly inexpensively, in a relatively short period of time, and I think FEMA will be willing to fund it. It can be circulated to every high school and increase the awareness that earthquakes do exist. It will change the

misperceptions. (John Adams showed the Canadian map of seismicity.)

Rus Wheeler. (Displayed and described maps in preparation for the Central U.S.) These maps are examples of the sorts of products that could be made for the Northeast. We are making the maps for the New Madrid seismic zone, centered in the Missouri bootheel, and for the surrounding region in the central U.S., together with representations of the seismic hazard. The map shows spatial relations that can help anticipate the likely effects of large New Madrid earthquakes. These maps are still in draft form, but they've already been in demand by people in the emergency-response community. Second, these other maps are aimed at scientists. They are called seismotectonic maps, and they show geologic and geophysical information in the area of most intense seismicity around New Madrid. The idea here is to show many kinds of information together on the same map or maps, so people can look for spatial relations that might suggest possible causal associations.

Klotz. I would like to look at earthquakes smaller than Magnitude (Mag.) 6. I am referring to Long Beach 1933, and the Newcastle Earthquake; we are talking about 5.4, and 5.5. NEHRP refers to 5.0, and we can relate very easily to New England. We need to define damaging.

Jacob. Mag. 5 and larger would be considered damaging. But you need to take into consideration whether it is near a large urban area. THERE WAS A CONSENSUS. To define damaging earthquakes as those with magnitude (mb) greater than or equal to 5.0.

We should make a list of questions that are most commonly asked for which we need a consensus answer.

1. Where is the nearest fault?

2. How often do damaging earthquakes occur?

    a. When was the last damaging earthquake?

    b. When will the next one be? (I don't want to be here.)

    c. What is largest earthquake that I can expect here.

3. How much damage will there be? What is the effect of a damaging earthquake?

4. How will society be affected by these earthquakes?

5. How does all this relate to California?

6. Why do we have earthquakes?

7. How does my little piece of God's Earth react to an earthquake?

8. Should I buy earthquake insurance? Do you have it?

9. Why should I worry about earthquakes in New England?

Klotz. When the public asks a question about an earthquake, they are not asking about a damaging earthquake. When the Mag. 3.4 occurred in Franklin and I confirmed it and an aftershock, they said "Oh, really?" Anything that is felt is potentially damaging. Anything that gets recorded, actually. They want to know when was the last one. Baltimore is an example of the public getting excited.

Ebel. We need a consensus on what we are going to tell the people tomorrow. How are we going to do this? We have studies that have been put into the literature. I don't see how we can do an extensive analysis from the catalog. We have one product -- the map which would reflect our work. Now we need to find out exactly what we want to present and how are we going to present it.

Alan Kafka. Boston College, Weston Observatory. What if we took the return time, and take John Armbruster's numbers, and see what we can come up for the Northeast.

TABLE 1

Earthquake Recurrence Time Estimates

Magnitude	**>5**	**>6**	**>7**	**Time Interval**
Ebel (1984)	21 yrs	147 yrs	1,018 yrs	1975-1982
Ebel (1987)	76	617	5,010	1938-1986
Armbruster (a)	94	1,035	11,000	1725-1985
Armbruster (b)	75	550	4,500	EPRI-EUS catalog
Adams (MRBC +NAZW)	25	210		1860/1700-1990
(Ecan)	60	450		1900-1992

This is the EPRI catalog before the NCEER catalog came along. Took a recurrence for the entire EPRI catalog from the Rockies, but excluding the Canadian events.

Ebel New England - Magnitude at or above 5.0 since 1727 - 4-6 events; return times 67-44 years.

Reiterating:

Ebel. The top line is seven years of data, instrumental data. The second line is part of the calculations from my Sterling Forest paper. I took all of my instrumental magnitudes for New England and did a linear fit to the New England data and extrapolated it up to larger magnitudes. What I published in the Sterling Forest paper was the entire Northeastern U.S. for a longer time period, 1975-1986. Also there are numbers for 1938 to 1986.

Armbruster. Mine is a combination of the rates indicated by your (Ebel's) network data for that 7-year period for the magnitude between 2 and 3, pasted on to the NCEER catalog from magnitude 3 on up. This is all for the Northeast.

Adams. The Canadian data are very good, though the conversion to the rates expected for the New England sub-area is a bit rough. The first rate is from earthquakes passing completeness in two geological zones encompassing New England, the Appalachian and the Mesozoic Rifted Basin Core (MRBC) zones. The total rates have been reduced to correspond with the fraction of the zone's area that is New England. The second method takes this century's seismicity for all of Canada (and adjacent offshore) east of the Rockies (Ecan). The total rates have again been reduced to correspond with the fraction of the area that is New England. The magnitudes are mostly mbLg, expected to give the best match to damage potential; they may be conservative with respect to moment magnitudes (i.e., for most events mbLg > Mw).

Ebel. Here are the earthquakes at or above 5.0 magnitude:

1727 - one
1755 - one
1940 - two
1903 - one
1869 - ? could be above Magnitude 5

This is somewhere between 4 and 6 events over the 260 years. These are clearly above Mag. 5 except that the last is probably above 5.

Daniele Veneziano, MIT. It seems to me that if you want to have some number, one should do it in a more direct way. Some of these numbers are good for comparison but not for quotation. I like the artistic side of it, but... I might suggest you agree on a couple of procedures and then make those calculations to get your estimates. This data only goes up to 1985; it should be updated.

Updike. If you can come up with something that is understandable such as the following: We've reviewed the data and the closest we can come at this point in time without further detail is one event every 75 years, Mag. 5. We would like to between now and the workshop refine these numbers. Two steps - current state and what you are going to do.

Nishenko. To clarify those recurrence times on the right hand board. Ebel's numbers are correct. Jacob's are correct. Based on Mag. 5 or larger for a 20 year exposure, the Poisson probabilities range from 19-28%, using the 76, 94, 75, 60 return times in Table I. For the purposes of having the longest base line as possible to introduce stability in the calculation, I threw out the return time estimate based on the 7 years of network data (top entry in Table I). If we just use the number of events larger than Mag. 5 in the last 260 years, 4 events in 260 years gives a 20-year probability of 26%, and a 50-year probability of 54%. If you use six events in 260 years, the Poisson probability for 20 years is 37%, and for 50 years it jumps up to 68%. These estimates are summarized in Table 2. For the larger NEUS region, including New York and New Jersey, the probabilities are about twice the estimates in Table 2.

TABLE 2

New England Earthquake Probability Estimates

A] Frequency-Magnitude Extrapolations

Magnitude	>5	>6	>7
Return Times (years)	60-94	447-1035	4,500-11,000
Probability			
P10	0.10-0.15	0.01-0.02	<0.01
P20	0.19-0.28	0.02-0.04	<0.01
P50	0.41-0.56	0.05-0.11	0.01

B] Direct Rate Estimates

4 to 5 events > M 5 in 266 years

P10	0.14-0.17
P20	0.26-0.31
P50	0.53-0.61

P10, P20, and P50 are Poisson probabilities for 10, 20, and 50 year exposure windows.

Earthquake Catalogs: Ebel (1987) 1938-1986
Armbruster (1993) a.1725-1985; b-EPRI-EUS
Adams (1993) 1725-1985

Klotz. So does this mean that New York and New Jersey have about the same probability as New England, roughly? Yes. Then combining them doesn't make any difference.

Veneziano. You have half the return period and you shouldn't worry about area. You haven't worried so far so why should you worry when you add New York.

Consensus. For the northeastern U.S. region (Maine, Vermont, New Hampshire, Connecticut, Rhode Island, Massachusetts, New York, and New Jersey), the preliminary probabilities of a potentially damaging earthquake, i.e., Mag. 5 or greater, is about 40% within the next 20 years and about 75% in the next 50 years.

If an earthquake of this magnitude were to occur in a heavily populated area of the region, substantial damage (millions to billions of dollars loss), injuries, and perhaps, loss of life would result.

An improved, uniform catalog of earthquakes in the northeastern region needs to be created, which will be used to produce an updated earthquake forecast (i.e., probability estimate) as well as a new earthquake map of the entire region.

NORTHEAST U.S. EARTHQUAKE PROBABILITY WORKING GROUP MEETING
PRACTITIONERS' SESSION
APRIL 29, 1993: 9:30 a.m. - 12:30 p.m.
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Northeast Earthquake Probability Working Group
Day II-Practitioners' Session
April 29, 1993, 9:30 am - 12:30 pm

KEY POINTS/ISSUES

Kevin Merli, FEMA Region I, Acting Chief, Natural and Technical Hazards.

Ten years ago there was a regional meeting at MIT to form a regional organization. Now we have one -- NESEC. It started with risk in New England, to determine vulnerability, analyzing hazards. This was done by local academicians. Then seismic mapping of Eastern Massachusetts was completed, and then the Boston loss study. NESEC provides structure.

I would like a good report (a consensus) so FEMA can use the data to explain the significance of the hazards. Without this consensus, the public awareness end of the program breaks down.

I would like to do hazard mitigation-convincing the states and communities to adopt building codes that have good seismic design. We can't do this without making people aware of the real hazards. This (meeting) is a giant step in doing this.

Randy Updike, National Coordinator for the EQ Hazards Program. U.S. Geological Survey, Reston, VA.

FEMA and the USGS have recognized the concern that exists here and the difficulty in determining how we can relate to user communities. This first event is to kick off what we hope will be a long-term effort/commitment and a growing effort. This room is the nucleus. There is a hazard in New England, clearly--maybe not like the San Francisco Bay area, but significant. The built environment makes the risk extreme. We are far back on the learning curve in the Northeast.

One of the problems we have in the Northeast is that the earthquakes are more diverse and we can't tie them into specific geological features. In California you can stand on the source. In the Northeast, earthquakes occur in different areas, making it more difficult for scientists to pin down cause. The earthquakes are more diffuse, not as frequent, and the geology is far more complicated than in California or the Pacific Northwest.

Another problem here is resources. First, there are a handful of institutions (e.g., MIT, Columbia, Boston College), where there are superb scientists but a small number of them. Secondly, not much earthquake money is going to the Northeast. Secondly, Federal, State, and local governments are facing very austere budgets.

We scientists can give you information, but we need input on what needs to be done. We need two-way communication.

Ted Litty, FEMA/Washington, DC

There is a need to define the hazard and present it to the public.

Stuart Nishenko, USGS, Golden, Colorado

Yesterday's session dealt with the question: What is the probability for damaging earthquakes to occur in the Northeast (which includes the expanded area-New York and New Jersey)? A draft statement was prepared, based on a one-day review of the data for the NEUS. This is a first step. (See Table 2.)

Societal consequences depend on location. If an earthquake occurred in Boston the effects would be devastating; in a rural area they would not. The group looked at 5-6 different earthquake catalogs to come up with the basic seismological parameters. (See Table 1.)

Proposal - Catalogs - add information from Canada, New York, New Jersey.

Purposes:

1. Get a better estimate on probability for entire Northeast.
2. Put information on a map where earthquakes have occurred. Susan Goter's map shown. This was done for Utah, Hawaii, CA, Northwest, and Alaska and distributed to high schools for public awareness. Large scale maps, e.g., the entire U.S., don't get point across. A map just of the Northeast would be more meaningful for the public--an effective tool to promote education and awareness.

Question: **(Walter Anderson, State Geologist, Maine).** Is this going to be prepared in a digital format? Nishenko replied that catalogs are digital. Catalog will be prepared by John Ebel, John Armbruster, and John Adams.

Maps. Have ready for the workshop-end of 1993-94. Showed the Central U.S. maps of earthquake faulting, summarizing different parameters, as examples of what might be done. The second map showed distribution of lifelines, giving an idea about the risk, infrastructure (dams, nuclear facilities). These are some of the products that could be developed. We need your input. What are your concerns?

Anderson. Are you going to use GIS?

Nishenko. Yes. We can develop the GIS data base. The GIS approach was used in the Central U.S. It's a long-term program.

Merli. Would a Northeast earthquake more likely occur in the Cape Ann area?

Nishenko. We can create planning earthquakes. If a Magnitude (Mag.) 5.5 earthquake occurred off-shore you can identify where the vulnerable places are.

Updike. An example - Oregon - Portland hasn't had any substantial historic earthquakes. Last month they had a Mag. 5.2, 35 miles south of Portland. This was an estimated 58 million dollar loss, fortunately with no loss of life. Oregon is going ahead with the idea that 5.0-6.0 could possibly occur in populated areas. If this 5.2 caused this much damage, then they are assuming that an urban epicenter earthquake of this magnitude will impact the larger metropolitan areas.

Klaus Jacob, Lamont-Doherty Earth Observatory, Palisades, NY.

Take the three areas of Portland, Boston, New York City. You can make scenarios or you can take the probabilistic approach. At a given point you map out all earthquakes that are probable to occur based on past experience. While this is more representative, it is harder to convey to the public. The USGS has published these maps with 10% probability in 50 years.(Map: New York to Boston.) The map represents the hazard but not the loss figure (millions of dollars).

If an earthquake does occur, which areas are more at risk? Jacob showed a map of NYC (soil categorization map: hard rock-stiff soil-soft soil). If a structure is on soft soil, where lifelines cross, you are at considerably higher risk regardless of where the earthquake occurs. Softer soils indicate higher risk.

Robert O'Brien, EQ Program Mgr.,Rhode Island Emergency Mgmt.Agency.

Needs soils maps for each city and town - schools, chemical tanks. University of Rhode Island (URI) is doing soil studies and how they would react--Cape Ann, Providence, RI, and Naragansett Bay. Real estate people have soils maps. Further research is being done by URI on the existing soils maps.

Nishenko.

Soil response and ground response should be workshop topics.

O'Brien.

Wants technical resources; existing body of work. Bibliography?

John Smith, EQ Prog. Mgr., MA Emergency Mgmt Agency (MEMA).

There is apathy in Massachusetts about earthquakes. The general public feels that earthquakes do not happen here--earthquakes

happen in California. Before we can get the public to take mitigation steps, they need to become aware of the risk in their specific area. The more local data as a resource the more effective each program manager can be. Much is available on mitigation. There is a need to get the public to listen. What happens in California and Memphis doesn't impress the local people. Smith likes the idea of soil maps.

O'Brien. We are vulnerable. People want facts.

Gregg Champlin, EQ Prog. Mgr.,New Hampshire Off. of Emerg. Mgmt.

There are so many facts. But it is going to happen.

Jacob. Example of the lottery. Winning the lottery is 1,000 times less likely than experiencing an earthquake in your lifetime. People bet on winning money, but never on losing money. Instead of playing the lottery, people should spend the money fixing up their houses for earthquakes.

O'Brien. They'll love that one.

Peter Nielsen, Dept.of Geology, Keene State Coll., New Hampshire.

What about plotting historical earthquakes? John Armbruster has done this. How accessible? He needs on-line information on little quakes.

Nishenko. You can get that information from NEIC (Mag.3-4).

Champlin. We talk to the press about Mag. 1.5 earthquakes because it keeps up the public awareness.

Anderson. The network. I hope it will be adequate to do research. Micro earthquakes are very important. What is the future of the network? Where is the research? Not in the USGS! Is there any move for more research? The USGS has to make a commitment.

Chuck Doll, MIT Earth Resources Lab.

There are changes going to be made in the network.

Anderson. But as far as research, it is lacking in the Northeast. There is $300,000 in new instrumentation, but will it help research in the Northeast?

Doll. There is a fundamental limit on what seismology can do.

Jacob. Networks in the Northeast have been funded in the past by the Nuclear Regulatory Commission. Now there is no support from them. It has been transferred to local networks and the USGS--and this takes away from researchers. The USGS can't sustain this

effort either. Money for instrumentation can't be used for operating expenses and salaries. FEMA needs to take the lead. NEIC reports only Mag. 3 and above. We have not been supported. We need to go to Congress to change this.

Doll. It is fundamentally important to maintain an ongoing earthquake catalog in order to continue research. Without the network and people you can't do it. The smaller earthquakes are studied to understand larger ones. Without them you have lost this research effort.

Anderson. Rad Waste. People buy maps with faults and are upset that rad waste sites are put there is a potential for earthquakes. To this point there is no correlation between plotted epicenters and structure. The small events, therefore, might give us more information on this correlation. A map of small epicenters would help.

Jacob. As of October 1993, solid waste facilities in every community have to apply EPA standards: 1. they cannot be within 200 ft. of a Holocene active fault. What is that in Maine, a glaciated area?, 2. If you are in a seismic zone you have to build according to seismic regulation (a 10% probability of exceeding in 250 years 10 G). There are not too many places where you don't exceed. You have to build for that acceleration level. (Upstate New York: .4 G). 3. You have to prevent instability on the site, or adjacent to it, where it may effect the site. Very few consulting engineers know how to deal with it. In Massachusetts they are capping all landfills. In October 1996, this is going to apply to existing landfills.

Nishenko. One of the recommendations of working group -- fold in analogs from other stable areas and look for similarities. Because of low-level activity, you can't get better than "back of the envelope" calculations. We would have more confidence in the numbers and evidence from geologically similar areas.

Suggestion for workshop: Make a bibliography on research on earthquakes, engineering, soil conditions.

Champlin. Needs information for third graders. This can also be used for adults. They don't want complicated answers.

Jacob. Kathy Ross at the National Center of Earthquake Engineering Research, SUNY Buffalo has a report on all resources - K-12 that are available - texts, videos.

Champlin. She doesn't have hands-on material.

Louis Klotz, Exec. Dir., New England States Earthquake Consortium.

We need a moderator with input for the workshop agenda.

Nishenko. The workshop should be a two-day meeting in FY 94 with four major half-day sessions:

1. Earthquake catalogs, probability, answers to questions about research.
2. Site effects - ground response, soil profiles, work done other places and locally, who to talk to, etc.
3. Societal response - building codes, response, solutions
4. Future - where do we go from here when we get NEHRP funds.

Merli. This approach sounds good. The meeting should be 3 days, starting at noon the first day, with a full day for the second day, and a half day for the third. (Days 1 and 3 for travel.)

Updike. The question is how to format the meeting so it is participatory and everyone has input. It shouldn't be a dog and pony show hearing only three new things. Should be a responsive-sub-working group.

Klotz. Will send out meeting document which shows various formats. (He explained one that he liked). Klotz later said that an executive group would organize the workshop. Kevin Merli wants NESEC to take lead.

Anderson. Oct. 25-28, 1993 - National Meeting for GSA in Boston. Might Babbitt and Peck attend? Should the workshop be before GSA? Could Father Skehan arrange a session? John Ebel said he would have trouble finding physical space. The Eastern Section of the Seismological Society of America is October 13-15,1993.

Jacob. Invite congressional staff from Northeast states to workshop. Get Shirley Mattingly's videotape. (She is Earthquake Response manager for Los Angeles.) They went to officials as if an earthquake had occurred (a hypothetical exercise). "You have just had a Mag. 5 earthquake - What do you say to the public?" This proved to be an incredible public awareness tool.

Anderson. Needs soil maps that are more than 3-4 meters deep, which is what the soils office has. In Maine they have done an aggregate study (digital format, sand and gravel reserves) derived from surficial geologic maps. They are delivering a report to the Governor's conference on aggregate resources and distribution of sediment types. This could be expanded to clays, tills, and bedrock in New England. Since this is in digital format, it can be an exchange of information.

Merli. Could have session on data exchange. What maps we have--what do you have, etc. Public outreach and education.

Klotz. Introductory courses for non-experts.

Merli. Have flip charts -- not just tapes. Charts help reach consensus-a visual generates more thought.Subsessions on specific

problems-to focus on the best way to deal with individual situations.The Northeast GSA will be in Binghamton, New York in March 1994. Would give us more time, get funding, etc. Randy thinks this is more realistic timing.

Jacob. Preparatory efforts - not mentioned. Are we not going to deal with this? This is the TECHNICAL PART OF AWARENESS. Need a realistic scenario from earth science community for earthquake simulations. Would like to ensure that experts work with the people arranging the simulation.

Have an earthquake scenario? Maybe should be part of a future workshop? Already there. It's another breakout? The right people might not be there.

Nishenko. A lot of the data bases may not be available to do a realistic job-but maybe in a year from now.

Champlin. In September 1993 there will be a civilian exercise with a hypothetical earthquake for central Massachusetts of Mag. 6.0.

Jacob. Who provides the scenario? Need experts to be part of it.

Smith. Will follow up on including someone from the scientific community in this earthquake simulation. This will be a smaller exercise than the one next year.

Litty. Workshop Number 2 would be worthwhile, but FEMA can't commit to a workshop for preparedness. Needs to get to mitigation.

Nishenko. Who is going to do this? I want to send out ideas to participants, get contributions of ideas and draft versions for the workshop.

Merli. November is better than December, January, or February for the workshop. Wants it well before March 1994. This is a NESEC function, combined with USGS and FEMA.

Mary Ellen Williams, USGS/Woods Hole, MA.

I will send out request for suggestions from participants. We are talking about 150-200 (maximum) including the following: geophysicists, geologists, engineers, emergency managers, state geologists, congressional reps, experts in NE research, one or two reps from hospitals, insurance, engineering groups, ASCE/Boston, NCPI, associations, educational institutions, police, public safety. NESEC and Dan Catlett, FEMA, Region I Boston will coordinate the list. I would like to thank Dr. Toksoz and his staff for so ably hosting this event at MIT. It has been most worthwhile to have this interaction between scientists and practitioners, and to be able to arrive at a consensus on earthquake probability in the Northeast. Thank you all for attending this meeting.