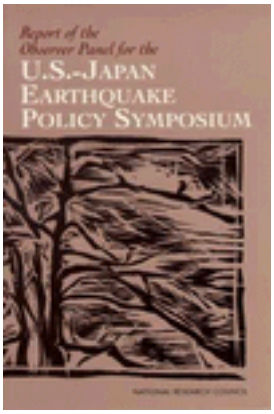

Report of the Observer Panel for the U.S.-Japan Earthquake Policy Symposium

U.S.-Japan Earthquake Policy Symposium Observer Panel, National Research Council

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REPORT OF THE OBSERVER PANEL FOR THE U.S.-JAPAN EARTHQUAKE POLICY SYMPOSIUM

U.S.-Japan Earthquake Policy Symposium Observer Panel
Board on Natural Disasters
Commission on Geosciences, Environment, and Resources
National Research Council

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the panel responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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Contents

Executive Summary

From September 16–18, 1996, a U.S.-Japan Earthquake Policy Symposium was held at the National Academy of Sciences in Washington, DC. Hosted by the Federal Emergency Management Agency (FEMA), the meeting involved high-level representatives from both the United States and Japanese governments as part of a new bilateral initiative for cooperation on policy and research to reduce earthquake losses. To help FEMA as it plans and implements this new program, this report by a panel of the Board on Natural Disasters of the National Research Council was charged to (1) "assess the outcomes of the Symposium" and (2) "identify important opportunities for future scientific and policy exchanges between the two countries."

Based on its review, the U.S.-Japan Earthquake Policy Symposium Observer Panel concludes that there were a number of important achievements from the Symposium. The most important of these was the initiation of a new era of earthquake policy cooperation based on agreements at the cabinet level of the United States and Japanese governments. In its review of the Symposium presentations and discussions, the panel identifies specific opportunities for policy and research collaboration on real-time seismic monitoring; seismological studies; probabilistic seismic hazard analysis; loss estimation studies; disaster situation assessments; performance-based design methodologies; large-scale dynamic testing and simulation; and emergency preparedness, response, and mitigation efforts. To enhance the opportunities for collaboration, the panel makes recommendations to FEMA on a range of topics. These include:

- there is a need for policy leadership to define the topics for U.S.-Japan collaboration,
- strategic planning is needed to define specific cooperative activities,

- there should be an effort to measure the success of the policy collaboration with Japan,
- there should be an emphasis on expanding the dialogue between the United States and Japan on earthquake issues,
- cooperative activities should involve policy makers and researchers with comparable roles and responsibilities,
- a single liaison office should be established in the United States to coordinate the cooperative activities, and
- to be a full partner with Japan in the collaboration, there is a need for increased funding for United States earthquake programs.

1—

Introduction

In response to devastating earthquakes over the past century, the United States and Japan have developed broad programs of research, engineering, and emergency management to mitigate the damage and disruption from seismic hazards. For the past 20 years, this effort has significantly improved the understanding of earthquakes, the seismic-resistance of buildings and infrastructure, and the assistance provided to communities following a disaster. Given financial commitments by the United States and Japanese governments, and the long history of cooperation between the two nations on scientific and technical issues, this effort has fostered world-renowned research programs in earthquake science and engineering at many university and government laboratories.

In this setting the Northridge, California (1994), and Hyogo-ken Nanbu (1995) earthquakes were painful reminders that the United States and Japan remain vulnerable to seismic hazards, despite the important contributions of their national programs. Spaced one year apart to the day, and occurring in the two countries with the most advanced mitigation efforts, these earthquakes resulted in huge economic losses and significant casualties (in the case of the Hyogo-ken Nanbu disaster, hundreds of billions of dollars in losses and thousands of deaths). In the wake of these events, there has been increased recognition of the severity of urban earthquakes and great interest in improving policy and research to address this problem. Indeed, in the past year both the United States and Japan have begun to restructure their national programs for reducing the impacts of seismic hazards.

In response to these concerns, then Prime Minister Murayama proposed an effort to President Clinton to increase United States - Japan cooperation on reducing earthquake impacts. The leaders discussed these issues at the G7 meeting in Halifax, five months after the Kobe disaster. Following the summit, President Clinton and now Prime Minister Hashimoto agreed that the United States would host a high-

level government-to-government symposium on earthquake policy and research and that collaboration on seismic hazards would be added to the existing bilateral agreement for cooperation on policy and technical issues (the "Common Agenda," see below). The U.S. Department of State asked the Federal Emergency Management Agency (FEMA) to take the lead in planning and hosting the earthquake symposium in the United States and in coordinating the federal, state, and local agencies that would be involved. This request and the response by FEMA's director appear in Appendix A.

Originating from the G7 discussions and the agreement between President Clinton and Prime Minister Hashimoto, the U.S.-Japan Earthquake Policy Symposium was held on September 16–18, 1996, at the National Academy of Sciences in Washington, D.C. Hosted by FEMA, the meeting was attended by FEMA Director James Lee Witt and Kazumi Suzuki, Minister of State for the National Land Agency of Japan. One hundred participants, spanning all levels of government, were invited from the United States and Japan, with additional representation from universities and private industry (see Appendix B). The purpose of the meeting was to initiate a new era of earthquake policy collaboration between the United States and Japan guided by the best available science and technology. To achieve this goal, discussions were to focus on critical policy decisions and the supporting research to reduce earthquake losses. Plenary speakers emphasized that cooperation should include all areas of policy, from mitigation to emergency response, and that it should be based on a broad range of cooperative exchanges, including partnerships with the private sector. The agenda for the meeting is included in Appendix C.

The Symposium was organized around the following four theme areas, each with formal presentations and a general policy discussion:

1. Earthquake Forecasting, Warning, and Hazard Zonation
2. Earthquake Risk Assessment and Loss Estimation
3. Earthquake-Resistant Design Construction, Rehabilitation, and Repair Standards
4. Earthquake Preparation, Response, Recovery, and Mitigation

Presentations were based on previously submitted papers that contained proposals for United States-Japan collaborations and discussions of

policy decisions for reducing earthquake losses. These papers will be published by FEMA at the end of 1996 as part of the Symposium proceedings.

During the Symposium, a bilateral interagency Working Group met separately to integrate the presentations and discussions into a formal statement of conclusions and agreements. This document, which is reproduced in Appendix D, was approved by the American and Japanese participants at the end of the meeting on September 18, 1996. The Joint Statement is the formal outcome of the meeting, and it will serve as the reference for future United States-Japan cooperation on earthquake policy under the Common Agenda.

As part of the Symposium, FEMA also invited the National Research Council's Board on Natural Disasters to convene a panel to observe the presentations and policy discussions. The panel was charged to (1) "assess the outcomes of the Symposium" and (2) "identify important opportunities for future scientific and policy exchanges between the two countries." It is intended that this report will be helpful to FEMA in planning and implementing cooperative activities resulting from the Symposium.

To this end, the present report reviews the outcomes of the Symposium in the context of existing bilateral programs. Considering the Joint Statement and the Symposium presentations, potential areas for research and policy collaboration to reduce earthquake losses in the United States and Japan are discussed. As part of this discussion, the panel distinguishes between technical issues and policy decisions. The report concludes with the panel's view of the Symposium's achievements together with recommendations for strengthening future scientific and policy exchanges on earthquake hazard reduction.

2—

Bilateral Programs

This chapter describes the outcome from the September 1996 Earthquake Policy Symposium in the context of existing bilateral agreements between the United States and Japan for reducing earthquake losses. These programs have emphasized collaboration on scientific and technical issues and have largely involved personnel from government research agencies. Some have been in existence for more than 30 years. They have been complemented by long-standing cooperative research efforts involving the United States and Japan and other countries that are vulnerable to seismic hazards (e.g., Mexico, China).

As described below, and summarized in Box 1, the United States-Japan cooperation falls under three broad initiatives: the U.S.-Japan Cooperative Science Program, the Japan-U.S. Science and Technology Agreement, and the Common Agenda. Following the discussion of these programs, the new agreements from the Policy Symposium are described.

EXISTING AGREEMENTS

U.S.-Japan Cooperative Science Program

Within the U.S.-Japan Cooperative Science Program, the U.S.-Japan Program on Natural Resources (UJNR) is the oldest mechanism for scientific and technical cooperation between the United States and Japan on earthquakes. The UJNR has sponsored three ongoing intergovernmental panels related to seismic hazards operating through 19 federal agencies: the Panel on Wind and Seismic Effects, the Panel on Fire Research and Safety, and the Panel on Earthquake Prediction Technology. Through their activities, these panels have sponsored a

range of international forums with published proceedings, programs for exchange of guest researchers, joint research projects, and technical data exchanges.

BOX 1 U.S.-JAPAN COLLABORATIVE MECHANISM FOR NATURAL DISASTER REDUCTION

FORMAL BILATERAL MECHANISMS

1. U.S.-Japan Cooperative Science Program (1961)

- U.S.-Japan Cooperative Program in Natural Resources
  - Panel on Wind and Seismic Effects
  - Panel on Fire Research and Safety
  - Panel on Earthquake Prediction Technology

2. Japan-U.S. Science and Technology Agreement (1988)

- Workshops on Natural Disaster Reduction
- Highway Science and Technology Program

3. U.S.-Japan Framework for New Economic Partnership: Common Agenda (1993)

- Research Cooperation in Construction Technology
  - Natural Disaster Reduction
  - Pan-Pacific Disaster Watch Network
  - Earthquake Disaster Mitigation Partnership
  - U.S.-Japan Earthquake Policy Symposiums

INFORMAL MECHANISMS

1. International Professional Societies
2. Academia
3. Industry and Regional Consortia
4. Sister Cities Program

Japan-United States Science and Technology Agreement (JUST)

Initiated in 1988, and renewed in 1993, JUST is a wide-ranging program for promoting cooperation to address problems related to natural resources, energy, space and ocean development, biotechnology, and environmental protection. Within JUST there are two natural disaster initiatives:

1. *Workshops on Natural Disaster Reduction*. These meetings have been sponsored by the National Science and Technology Council (U.S.) and the National Research Institute for Earth Science and Disaster Prevention (Japan). They have focused on opportunities for cooperative research, and they have generated Internet-accessible databases of research results, abstracts, and references on disaster reduction.
2. *Highway Science and Technology Program*. This agreement between the Federal Highway Administration (U.S.) and the Ministry of Construction's Public Works Research Institute (Japan) provides a foundation for exchanging scientific information and technology related to the construction of highway structures and surfaces.

U.S.-Japan Common Agenda for Cooperation in Global Perspective ("Common Agenda")

Initiated by President Clinton and then Prime Minister Murayama in 1993, the Common Agenda is a broad framework for partnership and collaboration between the United States and Japan. Within the Common Agenda, there are two initiatives related to seismic hazards:

1. *Research Cooperation in Construction Technology*. Coordinated by the National Science Foundation (U.S.) and the Ministry of Construction's Building Research Institute (Japan), this initiative supports collaborative research and

exchange programs on advanced engineering technology to reduce the impact of seismic hazards.

2. *Natural Disaster Reduction*. This initiative has three components:

- A Pan-Pacific Natural Disaster Watch Network is to provide a comprehensive system for surveillance and prediction of disasters in the Pacific region (e.g., volcanoes, earthquakes, tsunamis, and severe weather).
- The U.S.-Japan Earthquake Disaster Mitigation Partnership involves collaboration between the Science and Technology Agency (Japan) and a United States interagency group to focus on scientific and technical issues of seismic hazard mitigation. Within the partnership, research will be focused on:

a) Quantifying future earthquake potential
b) Strengthening loss estimation methods
c) Testing basic theories of the earthquake source
d) Understanding near-source motions, geologic effects, and structural response
e) Reducing the risks posed by steel buildings
f) Strengthening evaluation and retrofit of existing buildings and infrastructure
g) Developing performance-based design methods
h) Improved real-time seismic information systems
i) Controlling post-earthquake fires

Recently, a U.S.-Japan Universities Coalition for Earthquake Research has been proposed as a separate component of the Disaster Mitigation Partnership. Sponsored by the Ministry of Education (Japan) and the National Science Foundation (U.S.), it would focus on greater collaboration between universities in fundamental research and improved training of earthquake scientists and engineers.

- The Natural Disaster Reduction Initiative called for two high-level U.S.-Japan Earthquake Policy Symposiums, one

in the United States and one in Japan. The first of these meetings, held September 16–18, 1996, in Washington D.C., is the subject of this report.

In addition to these agreements, informal cooperative activities occur through professional societies, academia, private industry, and local governments.

NEW COOPERATIVE MECHANISMS FROM THE EARTHQUAKE POLICY SYMPOSIUM

The Joint Statement of Conclusions and Recommendations from the Earthquake Policy Symposium (Appendix D) establishes a new mechanism for bilateral cooperation between the United States and Japan in reducing earthquake losses. Specifically, items 6 and 7 of the conclusions state:

> The participants acknowledging the achievements of this Symposium, concluded that:
>
> a) a second Earthquake Policy Symposium will be held.
> b) a "U.S.-Japan High Level Forum for Earthquake Emergency Management Policy Cooperation" will be established acknowledging the importance of continuing cooperation after the second Symposium.
> c) a working group will be formed, to be formed, to be co-chaired by FEMA [Federal Emergency Management Agency] and NLA [National Land Agency], to provide a mechanism to promote and encourage implementation of the conclusions and recommendations of the this Symposium.
>
> The working group led by FEMA/NLA will:
>
> a) monitor and coordinate activities coming out of this Symposium and report on their status at the second Symposium
> b) promote and develop proposal for cooperative projects to be presented for consideration at [the] second symposium

c) develop and report the modality, terms of reference, and other details of the high-Level Forum at the Second Symposium

Compared to existing cooperative agreements between the United States and Japan on earthquake issues, this proposal contains two important new features:

1. For the first time, a High-Level forum will provide a basis for cabinet-level discussions of earthquake issues between the two countries.
2. A Working Group will be formed to facilitate collaboration on policy issues related to earthquake mitigation, response, and recovery.

CONCLUSIONS

The panel observes that there are many opportunities for collaborative work between the United States and Japan to reduce earthquake losses. Comparing the outcomes of the Symposium with existing agreements, the panel strongly endorses the initiative for collaboration on policy decisions. The panel believes that this represents an important new approach with opportunities to integrate the efforts of existing scientific and technical programs into a comprehensive framework in support of new policies for mitigating seismic hazards.

3—

Topics for Policy and Research Collaboration

The presentations and discussions at the September 1996 Symposium identified a wide range of topics for United States-Japan collaboration to reduce earthquake losses. These were described in the Joint Statement as follows:

> The Participants proposed the following areas for further cooperation:
>
> a. Develop and exchange information on:
>
> - improved earthquake warning, earthquake emergency response, recovery and mitigation policies, programs, and procedures.
> - use of urban planning and development policies and procedures and practices to achieve earthquake hazard reduction.
> - methods for the accurate assessment of the severity of the disaster that will enable proper and quick response.
> - advanced search and rescue and fire fighting techniques.
> - improved programs to assist communities in their recovery from disaster and exchange of this new knowledge.
> - improved seismic vulnerability assessment and strengthening technologies for buildings, structures, and lifeline systems, including use of new materials and large-scale testing, and development of recommendations for design guidelines, standards, and practices.
> - effective means to exchange policy and technical personnel and data following earthquakes.
> - risk assessment and emergency management for mega-cities.
>
> b. Improve:
>
> - real-time earthquake monitoring and warning, probabilistic forecasting, and earthquake hazard mapping.

- techniques for hazard, damage, and risk assessments for buildings, structure and lifeline systems.
- earthquake loss estimation models to stimulate preparedness and mitigation actions and facilitate emergency response following earthquakes.
- public policies and mechanisms to assess critical facilities, public works, and utilities for earthquake vulnerability and to strengthen their seismic resistance.

The panel agrees that these are important areas for collaboration between the United States and Japan; however, it notes that there is a need for detailed strategic planning to identify specific cooperative issues, to prioritize different topics, to provide a framework for assessing the progress and success of these efforts, and to devise methods to transfer the results to risk reduction efforts carried out by governments, private-sector organizations, and citizens. For this program to be successful, FEMA and the Working Group need to define the particular policy decisions that could be improved and advanced through cooperation with Japan. To assist in this process, this chapter outlines important issues drawn from the Symposium, focusing on the topics with the greatest potential for rewarding, cooperative work and that have the greatest implications for reducing losses and increasing public safety. The discussions are grouped according to the agenda categories from the Symposium.

In general, the panel strongly endorses efforts to broaden participation in cooperative programs to include state and local governments and the private sector. In the panel's view, United States - Japan collaboration could take place through a wide range of mechanisms including, but not limited to, High-Level and Working Group meetings, workshops, visits by researchers and policy officials, joint research projects, exchanges of data, dissemination of translated materials, and publication of the results from cooperative work. With this approach, collaboration could engage a diverse group of participants, including policymakers, program officials, representatives of private industry and state and local governments, academic and government researchers, and other stakeholders. To this end, the panel suggests that the proposed U.S.-Japan Universities Coalition for Earthquake Research also would complement the outcome of the Policy Symposium.

EARTHQUAKE FORECASTING, WARNING, AND HAZARD ZONATION

Real-Time Monitoring and Seismic Warning Systems

Real-time seismology provides rapid determinations of earthquake parameters such as epicenter, magnitude, and distribution of ground shaking for use in emergency response and warning activities. Using automated retrieval and analysis of data from seismic networks, these systems issue alerts up to tens of seconds before the start of ground shaking when a fault is distant from a community (~100 km). The operating principle of real-time seismic systems is that seismic waves travel at velocities that are much lower than the speed of electronic data communications. Such early-warning capabilities could benefit urban areas at risk from earthquakes on distant faults, such as Los Angeles (from the San Andreas fault) and many urban areas of Japan (from offshore subduction zones). Indeed, real-time warning systems are successfully operating in Mexico City because of its distant location from seismically active faults (greater than 100 km). Applications for real-time seismic systems include warnings to shut down lifelines and sensitive manufacturing processes before shaking begins and monitoring data during an earthquake to locate the extent of strongest ground shaking for public and private emergency response personnel.

Presentations at the Symposium indicated that there are significant differences between the United States and Japan in the level of financial commitment for real-time seismic systems. In the United States, systems are largely evolving from existing networks of weak and strong-motion sensors (with notable new installations in some areas), while Japan is installing large, dense, dedicated networks for real-time applications. Prototype systems have been demonstrated in both countries over limited regions. Developing these into operational systems will require focused efforts to

- site, install, and operate seismic monitoring stations;
- construct high-speed data collection and distribution networks;
- develop software for reliable and automatic analysis of seismic data; and

- establish coordination between the operators of real-time systems and user groups.

For this effort it will be valuable for the United States and Japan to share their experience designing seismic networks to identify the trade-offs among performance, station density, and configuration. Similar collaboration on high-speed communication systems will help to improve the reliability of communication during seismic events. As part of this effort, it would also be an excellent opportunity to implement tsunami warning systems, similar to operating systems in Japan, along the coasts of Hawaii and the western United States.

In panel's view, the greatest opportunities for scientific and technical collaboration are in the area of software development for automated data retrieval, analysis, and broadcasting. There are three reasons for this assessment. First, the principal problems of software development for real-time systems are independent of the details of network size and density and communications protocols. Hence, this is an area of commonality between the two countries. Second, collaboration on software development and benchmarking is relatively easy compared to large-scale experimental programs because of Internet communications. Finally, and most important, software development focuses on the key technical issue for operational real-time systems--the reliable identification and location of earthquakes and the rapid transmission of data to end users. Ultimately, the reliability of these systems will be established through benchmarking exercises in different tectonic and seismic settings, using a range of software for automated analysis.

In addition to these technical issues, there are a number of important policy concerns that would benefit from collaboration between the United States and Japan. Of these, the most important will be to identify the particular data products and delivery schedules (e.g., before or after an earthquake) that are most useful to stakeholders for real-time systems. Resolving these issues will have important implications for the design, cost, and performance of the operational systems. For example, if end users place a high value on receiving earthquake information before the start of ground shaking, systems that operate at the highest levels of performance will be required. Additional policy issues include establishing goals for the reliability of warnings, defining policies for the use of real-time data (e.g., liability, mandatory

or voluntary response to warnings), and educating stakeholders about the use of this information. The panel suggests that workshops with policymakers, seismologists, and end-users of real-time data would contribute to the resolution of these policy issues.

Seismological Studies

Source Studies

By analyzing seismic recordings, many of the details of an earthquake source can be resolved such as the history and spatial distribution of rupture and the radiated pattern of seismic energy. These research results describe the physical processes that control the origin of earthquakes and the relationship between the source and subsequent ground shaking. As described in presentations and discussions at the Symposium, these results are important baseline information for real-time seismic monitoring and warning systems, probabilistic seismic hazard analysis, loss estimation methods, and performance-based approaches to building design. (Collaborative projects for the last three issues are discussed below.) Given its importance, the panel notes that formal presentations on seismic source characterization were conspicuously absent from the Symposium.

Because the understanding of earthquakes is incomplete, scientific studies of seismic sources are valuable, regardless of where an earthquake occurs. For this reason and because of the high costs of seismic instrumentation, there would be significant rewards from continued and expanded programs to exchange primary seismic data between researchers in the United States and Japan.

Policy issues for source studies focus on the relationship between basic seismological research and practical mitigation technologies. Historically, this coupling has been weak because of limited exchanges among the scientific, engineering, and policy communities. The Northridge and Kobe earthquakes revealed the severe implications of this policy issue: the large damaging ground motions during these events were not surprising to seismologists because of knowledge gained from source studies over the past decade. Unfortunately, the implications of these results had not been fully recognized by earthquake engineers and policymakers. To address this

problem, it would be valuable to hold workshops on new applications for seismic source studies and to facilitate the transfer of knowledge from the scientific to the policy community.

Earthquake Prediction

Except for one technical talk from a Japanese delegate (Masakazu Ohtake), discussions of earthquake prediction were also conspicuously absent from the Symposium. In the panel's view, this was notable since short-term earthquake prediction is one of the legislatively mandated goals of Japan's earthquake program, and it has been the focus for much of Japan's research, mitigation, and preparedness efforts related to earthquakes. This de-emphasis may reflect the fact that Japan is reevaluating its prediction efforts following the Kobe disaster and that prediction programs in the United States are small by comparison.

At this juncture, the panel believes there are new and important opportunities for cooperation in ongoing research related to earthquake prediction. Utilizing scientific and policy expertise, there is a need to assess whether earthquakes (or properties of earthquakes) are predictable and if so, whether such information could be utilized for reducing earthquake losses. If research shows that earthquakes are not predictable, this will have important policy implications that should be explored. On a technical level, collaborations could continue through the UJNR Panel on Earthquake Prediction Technology. On a policy level, it would be useful to convene workshops on earthquake prediction, involving policymakers and scientists from government, universities, and industry.

Probabilistic Seismic Hazard Analysis

In recent years, geologists, seismologists, and engineers have developed methods to quantify the probability of seismic hazards at different locations. Often the results are stated as a probability that shaking at a particular intensity (e.g., 0.4 g) will be exceeded over a specific time interval (e.g., 50 years). Depending on the scope and accuracy of the input data, such models have been developed with high spatial resolutions to identify regions with comparatively high seismic

risks. Such information plays a critical role in the development of performance-based guidelines for buildings and in the development of building codes by seismic hazard zonation.

Symposium presentations described recent efforts in the United States and Japan to carry out probabilistic seismic hazard analysis on a national scale using a broad range of data sources. In the United States this analysis is incorporating new data on active faults slip and the geographic distribution of historical earthquakes. The panel suggests that it may be valuable to incorporate further information regarding the intensity of ground shaking close to the seismic source and the effects of resonance in sedimentary basins.

To support this mapping effort, the panel suggests the following areas of important research:

1. Exchanges of data on the nature of ground shaking and building response close to the seismic sources would be valuable for developing a comprehensive description of earthquake effects to utilize in probabilistic analyses.
2. There is a need for cooperative research to identify the characteristics of the seismic hazard that are most important for risk assessment (the details of the ground shaking that are the greatest predictors of damage to buildings, lifelines, etc.). Currently, most hazard maps are based on ground acceleration, but other measures may be more meaningful (e.g., duration of shaking, ground velocities, displacement).

In the panel's view the presentation by Kenzo Toki raised important policy questions for probabilistic seismic hazard analysis that should be considered in future discussions. Describing the history of hazard analysis in Japan, Dr. Toki noted that there has been a great effort to assess the possibility of large interplate subduction zone earthquakes because these were believed to be the greatest risk to Japanese cities. In the analysis the possibility of relatively infrequent and smaller intraplate events (such as the Hyogo-ken Nanbu earthquake) were not fully considered.

In the aftermath of the Kobe disaster (and the Northridge earthquake that occurred on a previously unknown fault), policymakers have raised fundamental questions regarding the value and application of probabilistic seismic hazard mapping. If the models are incomplete,

hence limiting the accuracy, can probabilistic seismic hazard mapping serve as a useful incentive for mitigation? Given the state of the art, what are the best uses of seismic hazard analysis for mitigation? Notably, there these issues were not discussed by policy officials at the Symposium, suggesting that the potential of the technology for reducing earthquake losses may not be well understood. For this reason there is a need for workshops with scientists, engineers, and policymakers to examine the capabilities of hazard mapping and the value of the mapping results (e.g., the above questions).

EARTHQUAKE RISK ASSESSMENT AND LOSS ESTIMATION

Loss Estimation

Seismic loss estimation models are used to calculate the broad range of damage, casualties, and economic costs associated with destruction of buildings, inventory, and infrastructure during an earthquake. A seismic hazard model is used as input and the resulting damage is estimated from the assumed ground shaking and the vulnerability of buildings and lifelines. Because of the complexity of urban environments and their response to earthquakes, loss estimation models require large amounts of site-specific input data to produce accurate results.

Presentations at the Symposium described applications for loss estimation studies over three different time scales:

1. before an earthquake to identify the most vulnerable regions and structures and to guide mitigation efforts;
2. immediately following an earthquake, using inputs of real-time seismic data, where possible, to guide the allocation of outside resources for emergency response operations; and
3. in the time period after an earthquake to guide recovery and reconstruction efforts.

Currently, both the American and the Japanese governments are focusing considerable effort and resources on the development of loss estimation models, although the applications are different. (A computer model, named HAZUS, has been developed by FEMA for use in the

United States. The Early Damage Estimation System has been developed by the National Land Agency for use in Japan.) Much of the Japanese effort involves the collection of input data on a national scale for emergency response activities following an earthquake. By comparison, loss estimation methods in the United States may be used as a tool to guide communities in prioritizing mitigation measures. Proprietary loss estimation models and data sets are also used by the insurance industry and private investors in both countries.

In practice, the accuracy of loss estimation calculations will be limited by uncertainties in both the hazard (including strong ground motion) and the vulnerability of a particular urban region. The accuracy of loss estimation calculations could be greatly increased if the uncertainties could be decreased. Because of these uncertainties and the complexity of the calculations, the panel believes that there would be benefit to increased collaboration between the United States and Japan on improving the methodology for estimating seismic losses. Such efforts would involve sharing a wide range of data on strong motions during earthquakes, building and lifeline inventories, and damage during past earthquakes to address the following questions:

1. How can loss estimation models be extrapolated to large scales to calculate the impacts on mega-cities?
2. How can loss estimation models be updated using information on near-real-time ground shaking and structural response?
3. How can probabilistic estimates of earthquake recurrence be used in loss estimation to develop improved measures of the risks associated with seismic hazards?
4. How can accurate estimates be constructed from incomplete baseline data?

Because of the central role of loss estimation as an incentive for mitigation and a guide for emergency response, there are a number of important policy issues that could be addressed through workshops on the application of this methodology. These include:

1. How can response, recovery, reconstruction, and mitigation efforts be strengthened through the use of loss estimation methodologies?

2. What has been the experience and influence of loss estimation calculations? For example, have past estimates been accurate and have they influenced communities to implement mitigation measures?
3. What are the tradeoffs between the accuracy and costs for developing loss estimation models, and what level of accuracy is needed for these estimates to be useful?
4. What are the ethical issues involved in providing loss information to potentially vulnerable communities?

Disaster Situation Assessments

Within 12 to 24 hours of an earthquake there is a need to assess the extent and severity of damage to guide emergency management agencies in the deployment of resources for response and recovery activities. The technology for disaster assessment includes remote sensing data from satellites and airplanes, readings from the Global Positioning System (GPS) and seismic sensors on buildings and infrastructure elements, and on-the-ground assessment teams using mobile communication equipment, all coupled with Geographic Information Systems (GIS). The primary challenge for successful disaster assessments is to develop policies and organizational structures that can respond quickly and decisively and provide continuous updates of the situation in the confused and chaotic state following an earthquake when lifelines and communication systems may not be functioning. Inaccurate assessments during this initial phase can have severe implications. For example, in the first few hours after the Hyogo-ken Nanbu earthquake, Japanese officials downgraded their assessment of the disaster based on incomplete instrument measurements of seismic intensity. Recordings from the severely affected zone, which would have signaled the disaster, were not available because of interruptions in communications.

Because accurate disaster assessment relies on quick action across many levels of government, success is contingent on prior planning and preparation, the development of automated decision-making mechanisms, and the deployment of adequate resources for accurate and reliable data gathering. Presentations at the Symposium demonstrated that there are significant differences in the policies for

disaster assessments between the United States and Japan. Prior to the Hyogo-ken Nanbu earthquake, Japan had used a centralized system for disaster assessment, coordinated at the national level. By comparison, United States communities rely on the coordinated assessments of local, state, and federal officials-in that order. Policy discussions at the Symposium focused on the roles and responsibilities in this coordinated effort, interest in strengthening the capabilities of local response mechanisms, and differences between the policies for emergency response in the United States and Japan. Recognizing that successful disaster assessments are contingent on both the technological and organizational infrastructure, the panel suggests the following areas for collaboration between the United States and Japan:

1. *Research on New Technologies.* Accurate assessments require reliable data-gathering technologies that will function in the hours following an earthquake. For this reason there may be great rewards from the use of current space-based technology and the development and application of new remote sensing techniques such as Synthetic Aperture Radar. It will also be important to identify strategies to limit system overloads so that communications remain operational following an earthquake. The use of real-time monitoring systems to delineate damaged regions, also should be explored. Finally, it would be valuable to develop real-time loss estimation capabilities, using measured ground shaking and building response, to focus disaster assessments on the most severely affected regions.
2. *Assessment of Organizational Infrastructure.* Often there are significant differences in disaster assessments between nominally similar organizations responding to the same disaster using the same policies and procedures (e.g., between two counties following an earthquake). These differences emphasize the importance of the organizational infrastructures in the success of disaster assessment and emergency response in the United States and Japan. By comparing the experience from previous earthquakes in the United States and Japan, there are opportunities to evaluate these organizational infrastructure and to identify "best

practices" for disaster assessment policies. Such cooperation would focus on the planning and organizational practices prior to an event, and the criteria for decision making and response that would be implemented following an earthquake.

EARTHQUAKE-RESISTANT DESIGN CONSTRUCTION, REHABILITATION, AND REPAIR STANDARDS

The design and construction of earthquake-resistant structures is a key component of strategies to mitigate earthquake losses. In the past 10 years there have been great advances in earthquake engineering; however, the Hyogo-ken Nanbu and Northridge earthquakes revealed that there are still some fundamental uncertainties. Steel moment resisting frame buildings, which were thought to be seismically reinforced, exhibited widespread failures during these two events. The precise cause of the problem has not been identified. This emphasizes the need for a broader understanding of structural performance during earthquakes.

The Symposium presentations and discussions showed that previous agreements between the United States and Japan have led to extensive collaboration between the two countries on improved design and construction practices. Looking to the future, the panel believes there are further opportunities for valuable scientific, technical, and policy collaboration in the areas of performance-based design methodologies (the design of structures to meet specific performance objectives under specified ground shaking) and large-scale testing and simulation.

Performance-Based Design

Historically, the United States has implemented building codes with the goal of preventing casualties during the largest expected earthquakes for a particular region. These standards are targeted to life safety, and have significantly reduced the number of fatalities from seismic hazards. From an economic perspective, however, the standards are minimal because buildings can be total economic losses after an

earthquake even if collapse is prevented. To address this problem and to reduce the costs associated with earthquakes, there has been an effort to develop performance-based approaches to design that consider a range of possible "damage states" that might result from an earthquake. Assuming one has reliable information about the probability of earthquakes of different magnitudes and the response of structures to different intensities of ground shaking, in principle it is possible to design for a range of performance objectives for a given seismic event. The Symposium presentations indicated a significant interest in developing such performance-based approaches to building design in both the United States and Japan, although it is important to note that there are differences in the definitions of performance being discussed in the two countries. In the panel's view, the following are important areas for collaboration:

1. To develop reliable, performance-based design methodologies, there is a need for comprehensive cooperative studies to establish the relationship between ground motions and all levels of damage to structures. This effort will rely on regional assessments of damage during recent earthquakes in the United States and Japan and on measurements of ground shaking during those events. It should also account for the important factors of aging and construction quality in determining structural response. The overall goal will be to establish a gradational set of performance objectives for different types of structures that can be correlated with a wide range of ground-shaking intensities. For policy decisions there is a need for collaboration on the process of establishing performance guidelines for different types of structures and assessing the reliability of performance-based design methodologies.
2. There is a need to understand the response of lifelines to seismic shaking and to develop associated performance-based standards. Lifelines include transportation systems (bridges, highways, railroads, airports), water and sewerage, electric power, communication systems, gas and liquid fuel pipelines, and critical facilities (hospitals, fire and police stations). Except for a few of these components (notably bridges and large buildings), most lifelines are

constructed without any special codes or guidelines for seismic resistance.

Large-Scale Dynamic Testing and Simulation

Shake tables can subject models of buildings and building elements to shaking that is similar to a real earthquake. Shake table testing has made significant contributions to the design of seismically resistant structures. In the United States much of the effort has focused on reduced-scale models of buildings owing to limitations in the size and load capacity of the available shake tables. Recently, there has been renewed interest in the development of "large-scale" shake table facilities to allow tests of full-scale, complex structures and buildings. The costs of these facilities would be significant. Plans to construct a large-scale shake table facility in Japan, costing $800 million, were described at the Symposium. (Note that these costs do not include the significant operational expenses of such a facility.) The possibility of building a comparable facility in the United States in the immediate future is unlikely.

Because large-scale testing facilities require a large financial commitment to a centralized research facility, they raise several important policy issues. As discussed at the Symposium, these include the possibility of collaboration between the United States and Japan on the construction and maintenance of a testing facility and the development of alternative (and possibly cheaper) technologies such as computer simulation. Both of these topics were discussed by the Symposium participants without resolution. In the view of the panel, both are important areas for future policy cooperation. If the two nations could collaborate on large-scale testing, it would enhance testing research in both countries at a significant cost savings. Likewise, it may be worthwhile to develop computer simulation techniques; however, this would require a coordinated effort to develop the expertise and infrastructure to support such techniques.

EARTHQUAKE PREPARATION, RESPONSE, RECOVERY, AND MITIGATION

In the period following an earthquake, the policies and practices governing emergency response and preparedness play a critical role in reducing loss of life and property and in speeding economic recovery in the community. This is an area that is predominantly driven by policy decisions and social science research rather than by science or engineering. It is also an area where there has been little collaboration between the United States and Japan because of the emphasis of prior bilateral programs. For these reasons it is also an area of great opportunity for collaboration.

In the view of the panel, it would be valuable to establish cooperation between emergency response managers in the United States and Japan. Such collaboration would focus on comparing emergency response plans, command and control structures, communication capabilities and protocols, and information management systems for all levels of government. Through such cooperation, it would be important to assess the performance of these systems during past disasters.

There is also a need to focus on the process of recovery following large earthquakes. Discussions at the symposium indicated that the challenge of rebuilding Kobe and addressing the housing needs of thousands of displaced residents (especially the aged) has proved to be more problematic than the original emergency response activities.

Such cooperation should involve officials at equivalent levels of government, representatives of nonprofit emergency services groups, and university public policy researchers. The goals for this collaboration would be to identify programs and information that successfully encourage individuals, households, and organizations to prepare for disasters. The cooperation could also be broadened to include strategies for post-earthquake psychological support.

CONCLUSIONS

This chapter provides an overview of the most promising areas for cooperation between the United States and Japan, with a focus on specific activities related to technical and policy advances. Consistent with the Joint Statement and with discussions at the Symposium, the

panel observes that there are many topics for fruitful policy collaboration between the United States and Japan. As discussed above, many of the policy concerns for reducing earthquake losses have strong connections to technical questions. For this reason the panel emphasizes that it will be important to integrate the activities of the Working Group and the High-Level Forum with the results of ongoing bilateral initiatives addressed to scientific and engineering research.

4—

CONCLUSIONS AND RECOMMENDATIONS

In the panel's view, there were a number of important accomplishments from the Earthquake Policy Symposium, as follows:

- Based on agreements at the cabinet level of government, the Symposium provided the foundation for a new era of earthquake policy cooperation between the United States and Japan.
- The Symposium brought together a unique mix of policymakers, scientists, engineers, and private-sector representatives, providing a rare opportunity to integrate technical discussions with the policy concerns of reducing earthquake losses.
- By bringing national, state, and local administrators together, the Symposium fostered new avenues of internal collaboration within the United States and Japan. This has important implications for strengthening policies for emergency response.
- The Symposium identified a promising list of topics for cooperation.
- The Symposium prompted high-level support from FEMA Director Witt and Minister Suzuki for expanded research and cooperation in the United States and Japan.
- The outcome of the Symposium provides a mechanism to bring together a wide range of bilateral programs into a common strategic framework.

Based on its observation of the Symposium and its own deliberations, the panel offers the following recommendations to FEMA and the Working Group to assist in the planning and implementation of future cooperative efforts between the United States and Japan on earthquake policy.

POLICY LEADERSHIP

The panel appreciates the considerable effort that resulted in the Joint Statement. The document is an important first step in collaboration. However, there is a need for a more detailed statement of the relevant policy issues and their relationship to supporting research efforts. Such a document should be prepared by the newly established Working Group. It will provide a foundation for future bilateral collaboration and high-level exchanges under the Natural Disaster Reduction initiative of the Common Agenda. The panel suggests that the Symposium papers, together with the discussion in this report, could serve as a starting point for that effort.

STRATEGIC PLANNING

After relevant policy issues are identified, specific measurable goals need to be established for all aspects of collaboration between the United States and Japan, including the transfer of research results to practical applications. A strategic plan should then be developed to achieve these goals. The plan should be formulated in the context of bilateral cooperation and should address technical issues and policy decisions together so that work can be coordinated with other United States - Japan initiatives (e.g., UJNR, JUST, Earthquake Disaster Mitigation Partnership, U.S.-Japan Universities Coalition for Earthquake Research). Part of this effort should focus on mechanisms to apply the results from individual projects to policy decisions for risk reduction. Where possible, there should also be an effort to integrate collaboration into a multihazard context. The panel notes that the cooperation with the Pan-Pacific Disaster Watch Network, described in the Joint Statement, offers excellent opportunities in this area.

MEASURING SUCCESS

As part of the strategic planning effort, new metrics should be developed for assessing the progress and success of collaborative risk reduction programs. These measures should be tailored to the goals from the strategic planning exercise described above. Having a consistent framework to measure progress should be given priority because it will lead to better policy and management decisions by government agencies and private corporations in both countries.

EXPANDED DIALOGUE

The United States-Japan Earthquake Policy Symposium was valuable because it provided an opportunity for open communication among a wide range of professionals. Building on the exchanges made during the Symposium, there is a need to promote an expanded dialogue between the technical and policy communities from the United States and Japan. In the panel's view, this is one of the primary responsibilities of the Working Group that was established at the Symposium. Increased translations of primary reference materials into English and Japanese would also contribute to improved communications. Examples of productive topics for this dialogue include developing performance-based design methodologies and utilizing loss estimation methods and probabilistic seismic hazard analysis for risk reduction. The panel notes that the long-standing relationships between members of the technical community, established through other U.S.-Japan programs, will help to bring a sense of continuity to these efforts.

FUNCTION-TO-FUNCTION COLLABORATION

While there was great value in the professional diversity of the participants in the policy Symposium, the smaller, collaborative projects should be well-matched in expertise to facilitate a productive working relationship. For this goal, collaborations should involve comparable researchers and agency officials (i.e., matching function to function in

the collaboration). Because of apparent differences in governmental function and authority between the Japanese national government and the prefectures, and the U.S. federal government and the states, efforts to match functions must be done deliberately. A better understanding of governmental organization, responsibilities, policy making, and administrative decision making in Japan will allow better matching of individuals. Strategic planning will also play an important role in integrating these smaller-scale efforts into the broader goals of the Common Agenda.

LIAISON CONTACT

To coordinate collaboration across the private sector, federal, state, and local agencies, and university researchers, there is a need for a United States liaison to serve as a single point of contact to facilitate the exchange of people, information, and resources. This liaison would also play an important role in minimizing the cultural and language barriers that can be an impediment to collaborative projects between the United States and Japan. The panel believes that FEMA, the State Department, or the Office of Science and Technology Policy could be responsible for these liaison functions in the United States. It will be important to establish a parallel liaison office in Japan.

FUNDING

To be a full partner with Japan in the effort to reduce earthquake losses, the United States should increase its financial commitments to the full range of research, mitigation, and preparedness activities related to seismic hazards. At present, there are significant differences between the two countries in expenditures for earthquake programs. For example, the combined 1995 budget for earthquake activities across seven Japanese Ministries and Agencies[1] was greater

[1] The seven Ministries and Agencies are National Land Agency, Science and Technology Agency, Ministry of Education, Ministry of Commerce, Ministry of Transportation, Ministry of Communication, and Ministry of Construction.

than $770 million. Notably, these funds include a special augmentation following the Kobe earthquake, although they do not include salaries. (This figure may decrease in later years.) By comparison, approximately $95.1 million was appropriated for the United States National Earthquake Hazards Reduction Program (NEHRP) for fiscal year 1996. Direct comparisons between budget levels with Japan are difficult because the great majority of United States funds (60 to 90 per cent) are for salaries and the Japanese budget provides a more comprehensive description of that government's activities related to earthquakes. Nonetheless, on this basis it appears that the difference between the United States and Japan in expenditures for infrastructure, instrumentation, and nonsalary expenses is between one and two orders of magnitude. Japanese presentations at the symposium supported this conclusion as speakers described extensive new seismic networks for real-time systems and plans for an $800 million large-scale testing facility. In the current United States budget environment, comparable facilities are not feasible. With such disparities, it will be difficult for the United States to work as an equal partner in the effort to reduce earthquake losses. The panel notes that this may require new funding mechanisms for earthquake programs in the United States. To this end, there should be consideration of a proposal made by Congressman George Brown in one of the plenary sessions of the Symposium: that United States earthquake programs could be funded from a trust fund created by a levy on earthquake insurance policies.

Appendix A—

CORRESPONDENCE

August 8, 1995

Mr. James Lee Witt
Director,
Federal Emergency Management Agency
500 C Street, SW Washington, DC 20472

Dear Director Witt:

At their June 15 meeting in Halifax, Japanese Prime Minister Murayama proposed to President Clinton that the U.S. and Japan host a natural disaster experts symposium as part of the U.S.-Japan Common Agenda, to which the President agreed. Due to the success of FEMA's assistance to Japan in the aftermath of the Kobe Earthquake, as well as FEMA's unrivaled expertise in disaster management, I believe your agency is ideally suited to coordinate within the U.S. government our participation in the symposium.

If FEMA is willing to engage in this effort, I would suggest that FEMA take the lead in coordinating the various USG agencies that would be involved. The natural disaster symposium offers an excellent opportunity to exchange experiences and solidify ties created during your much-appreciated trip to Japan. If you or your staff have additional questions on this proposal, please do not hesitate to contact me or the

State Department's Japan Desk. I look forward to working with you on this important new venture.

With best wishes,

Sincerely yours,
/s/Timothy E. Wirth
Under Secretary of State for Global Affairs United States Department of State
Washington, D.C.

Mr. Timothy E. Wirth
Under Secretary of State for Global Affairs Department of State
Washington, DC 20520-7250

Dear Secretary Wirth:

Thank you for your letter of August 8, 1995, requesting that the Federal Emergency Management Agency (FEMA) take the lead role in coordinating with other Federal agencies to carry out a joint U.S.-Japanese earthquake symposium. Since we have an established relationship with the relevant Federal agencies and the requisite expertise in disaster management that is of interest to the Japanese, we are pleased to accept this role.

Although FEMA has little authorization and limited resources to support international disaster activities, we appreciate your confidence in our capabilities and expertise. My staff will be working closely with the Japan Desk with respect to policy guidance and in making arrangements for the symposium. I have asked Kay C. Goss, FEMA Associate Director for the Preparedness, Training and Exercises Directorate, to manage the contract and the conference. I have asked Richard T. Moore, FEMA Associate Director for Mitigation, to take the lead on the technical and substantive components of the program. Further, we have contracted with the National Academy of Sciences for organizing assistance from their Board on Natural Disasters. I understand that the Japanese are agreeable to holding the symposium in Washington, D.C. during April–May 1996.

Currently, FEMA is also involved with the Japanese in several other natural disaster prevention activities. Most notable is a U.S.-Japan Panel on Wind and Seismic Effects, formed under a cooperative program in 1964. That group will be meeting in Washington, D.C. during May. While this Panel has more of a scientific focus, some of the same U.S. and Japanese officials may be involved in the proposed

symposium. FEMA is also participating in the disaster prevention activities of the Asia-Pacific Economic Cooperation.

I mention these activities so that you are aware of FEMA's increasing international role in the all hazards mission and capabilities. I need your assistance to help prioritize and integrate these outreach activities so as to mesh closely with your overall foreign policy objectives.

I look forward to working closely with you on these matters.

Sincerely yours,
/s/James L. Witt
Director
Federal Emergency Management Agency
Washington, D.C.

Appendix B—

American and Japanese Symposium Invitees

American Invitees

James Lee Witt
Director
Federal Emergency
Management Agency

(Alphabetical Order)

William Anderson
Section Head
Hazard Mitigation
National Science Foundation

Richard Andrews
President
National Emergency
Management Association

Joseph Barbera
Director
Disaster Medicine
The George Washington
University Hospital

Hal Bernson
Councilman, 12th District
Los Angeles, California

George E. Brown, Jr.
U. S . House of Representatives

Michael Bruinooge
Administrator
Disaster and Volunteer Services
Christian Reformed World
Relief Committee

Riley Chung
Building and Fire Research
Laboratory
National Institute of Standards
and Technology

Eileen Claussen
Assistant Secretary for Oceans,
Environment, and Sciences
U.S. Department of State

James F. Davis
State Geologist
California Division of Mines
and Geology

Gordon P. Eaton
Director
U. S . Geological Survey

John H. Gibbons
Assistant to the President for
Science and Technology

Mary L. Good
Under Secretary for
Technology Administration
U.S. Department of Commerce

Kay Goss
Associate Director
Preparedness, Training and
Exercises Directorate
Federal Emergency
Management Agency

Sherman G. Greer
Director
Indiana Emergency
Management Agency
Evansville/Vanderburgh County

Edward 0. Groff
President-Elect
American Society of Civil
Engineers

William Hall
Professor Emeritus of Civil
Engineering
University of Illinois at Urbana-
Champaign

Gerald J. Hane
Special Assistant to the
Associate Director
for Policy and Planning
Office of Science and
Technology Policy

Robert D. Hanson
University of Michigan

Walter H. Hays
Research Applications
U. S . Geological Survey

George Housner
California Institute of
Technology

Wilfred D. Iwan
Director, Earthquake
Engineering Research
Laboratory
California Institute of
Technology

Gerald H. Jones
National Institute of Building
Sciences

Lucile M. Jones
Seismologist
U. S . Geological Survey

Richard W. Krimm
Acting Associate Director
Mitigation Directorate
Federal Emergency
Management Agency

E. V. Leyendecker
U.S. Geological Society
Golden, Colorado

Catherine H. Light
Deputy Associate Director for Response
Response and Recovery Directorate
Federal Emergency Management Agency

Michael Matera
Japan Desk
U.S. Department of State

Charles Meade
Board on Natural Disasters
National Research Council

James I. Mori
Southern California Regional Director
Earthquake Hazards Reduction Program
U. S . Geological Survey

Joanne M. Nigg
Disaster Research Center
University of Delaware

Lee O'Donnell
Japan Desk
U.S. Department of State

Elaine Padovani
Office of Science and Technology Policy
Executive Office of the President

Robert Page
Earthquake Hazards Program Coordinator
U. S . Geological Survey

David Paulison
International Association of Fire Chiefs
Metro-Dade County, Florida Fire and Rescue

Mary Ellen Presgraves
Office of the Director
Federal Emergency Management Agency

Frank Press
Cecil and Ida Green Senior Fellow
The Carnegie Institution of Washington

Noel J. Raufaste
Head, Cooperative Research Programs
National Institute for Standards and Technology

Richard B. Rennick
Chairman
Franchise Emergency Action Team

James Roberts
California State Department of Transportation
Engineering Services Division

A. David Rodham
Assistant Secretary for Public Safety
Commonwealth of Massachusetts

Christopher Rojahn
Executive Director
Applied Technology Council

Harvey G. Ryland
President and Chief Executive Officer
Insurance Institute for Property Loss Reduction

William U. Savage
Pacific Gas & Electric Company

Mark Schaefer
Deputy Assistant Secretary of Water and Science
U. S . Department of Interior

Stephanie H. Masaki-Schatz
Manager, Corporate Safety and Emergency Planning
ARC0

Rodney E. Slater
Administrator
Federal Highway Administration
U .S . Department of Transportation

Paul Somerville
Senior Associate
Woodward-Clyde Consultants

John Stanford
Superintendent
City of Seattle Public Schools

William C . Tidball
Associate Director
Response and Recovery Directorate
Federal Emergency Management Agency

L. Thomas Tobin
Principal
Tobin and Associates

Robert H. Volland
Program Director
National Earthquake Loss Reduction Program
Federal Emergency Management Agency

Robert V. Whitman
Professor of Civil Engineering
Massachusetts Institute of Technology

Timothy E. Wirth
Under Secretary for Global Affairs
U.S. Department of State

Richard N. Wright
Director, Building and Fire
Research Laboratory
National Institute of Standards
and Technology

Arthur J. Zeizel
Policy Manager
Mitigation Directorate
Federal Emergency
Management Agency

Japanese Invitees

Kazumi Suzuki
Minister of State
National Land Agency

Yukio Takeuchi
Envoy Extraordinary and Minister Plenipotentiary
Charge d'affaires Interim
Embassy of Japan

(Alphabetical Order)

Yutaka Aoki
Assistant Director
First North America Division
North America Affairs Bureau
Ministry of Foreign Affairs

Seij i Baba
First Secretary
Embassy of Japan

Takayoshi Eto
Special Assistant to the Director
Technology and Safety Division
Transport Policy Bureau
Ministry of Transport

Akihiro Fujita
Counsellor
Embassy of Japan

Naoshi Hirose
First Secretary
Embassy of Japan

Yoshimori Honkura
Professor, Tokyo Institute of Technology
Member, Policy Committee
Headquarters of Earthquake Research Promotion

Kazuo Ikawa
Director
Citizens' Disaster Prevention Department
Citizens' Service Bureau
City of Kobe

Haruji Inoue
Director
Disaster Countermeasures Office
Security Bureau
National Police Agency

Masaharu Kanayama
General Manager (System Engineering)
Office of Power System Engineering and Operation
The Kansai Electric Power Company, Inc.

Tsuneo Katayama
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National Research Institute for Earth Science and Disaster Prevention
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Shuji Kato
Counsellor to the Minister's Secretariat
National Land Agency

Takashi Kato
Chief of Research Section
Earthquake Disaster Management Division
National Land Agency

Yuzo Kato
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Electric Power Technology Division
Public Utilities Department
Agency of Natural Resources and Energy
Ministry of International Trade and Industry

Nobumasa Kawabata
Guest Researcher
Disaster Prevention and Information Center
Shizuoka Prefecture

Tsuyoshi Kurokawa
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General Affairs Division
Minister's Secretariat
National Land Agency

Daisuke Machida
Deputy Director
International Scientific Affairs Division
Science and International Affairs Bureau
Ministry of Education, Science and Culture

Satoshi Maeda
First Secretary
Embassy of Japan

Noriyuki Matsukawa
First Secretary
Embassy of Japan

Takuo Mori
Official
Operations Division
Bureau of Defense Policy
Japan Defense Agency

Fumio Mukai
Director-General
Hanshin Expressway Public Corporation

Kiyofumi Murano
First Secretary
Embassy of Japan

Ichiro Nagao
Specialist for Earthquake Disaster Management
Earthquake Disaster Management Division
Japan Fire and Disaster Management Agency

Masaaki Nakada
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Office of Power System Engineering and Operation
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Masakazu Ohtake
Professor
Tohoku University

Keiichi Ohtani
Director
Disaster Prevention Research Division
National Research Institute for Earth Science and Disaster Prevention
Science and Technology Agency

Shotaro Oshima
Minister
Embassy of Japan

Shigeyuki Otake
Senior Planning Officer for Disaster Prevention
Disaster Prevention Bureau
National Land Agency

Takahiro Shibata
Director-General
Urban and Housing Department
Hyogo Prefecture

Toichiro Suzuki
Director of Engineering Affairs
Management Division
Minister's Secretariat
Ministry of Construction

Kunihiro Takahashi
General Manager
Technology Development Department
The Japan Gas Association

Shinji Takazawa
Deputy Director of Disaster Management and Investigation Division
River Bureau
Ministry of Construction

Akihiko Tamura
First Secretary
Embassy of Japan

Kenzo Toki
Professor
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Yoshihisa Toyoda
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Masahiro Uehara
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Building Research Institute
Ministry of Construction

Koichi Yokoyama
Director
Earthquake Disaster Prevention Research Center
Public Works Research Institute
Ministry of Construction

Naomasa Yoshida
First Secretary
Embassy of Japan

Appendix C—

Agenda U.S./Japan Earthquake Policy Symposium

National Academy of Sciences
Washington, D.C.

September 16-18, 1996

Monday, September 16

8:00 a.m.	**Organization Meeting/Continental Breakfast**
Lecture Room	
9:00	**Opening Ceremony**
	Welcome: Dr. Frank Press, The Carnegie Institution of Washington
	Welcome: Mr. James Lee Witt, Director, Federal Emergency Management Agency
	Response: Mr. Kazumi Suzuki, Minister of State for the National Land Agency
	Remarks: Minister Yukio Takeuchi, Charge d'affaires, Embassy of Japan
	Introduction of the Japanese delegates
	Introduction of the American delegates
10:00-10:35	**Break**
10:35	**Opening Plenary Session**
	Dr. Frank Press, Chair. The national policy framework for earthquake loss reduction in the United States and Japan. An overview of laws and

	other national policy guiding earthquake hazard reduction problems.
	Representative George E. Brown, Jr. U. S. House of Representatives
	Mr. James Lee Witt, Director, FEMA: An overview of American earthquake policy.
	Mr. Masaaki Nakada, Deputy Director-General, Disaster Prevention Bureau, NLA: An overview of Japanese earthquake policy.
	Agenda Overview/Symposium Outcomes Dr. Frank Press
11:45	**Group Photo**
12:00-1:30 p.m.	***Working Lunch - Dr. John H. Gibbons, Assistant to the President for Science and Technology-Speaker***
Lecture Room	**Earthquake Forecasting, Warning and Hazard Zonation**
1:30-5:00	
	Dr. Gordon P. Eaton, Director, United States Geological Survey, Chair
1:30-2:25	**Probabilistic forecasting, real time monitoring and warning systems**
	An overview of the social, technical, and policy issues associated with the provision and use of real time or near real time information to the gas and electric utility industry and the public sector.
	Dr. James J. Mori, Southern California Coordinator, U.S. Geological Survey
	Dr. William U. Savage, Senior Seismologist, Pacific Gas and Electric Company

	Mr. Masahiro Yamamoto, Deputy Director, Administration Division, Seismological and Volcanological Department, Japan Meteorological Agency
	Dr. Masakazu Ohtake, Professor of Tohoku University
	Dr. Yoshimori Honkura, Professor of Tokyo Institute of Technology
Meeting Room 150	
2:25-3:05	**Small Conferences, Exhibits, Break**
Lecture Room	
3:05-3:30	**Policy Discussion**
3:30-4:00	**Seismic hazard zonation mapping at the national and regional scale**
	An overview of the social, technical and policy issues associated with the construction and use of hazard maps in national model building codes and seismic zonation in the State of California.
	Dr. E.V. Leyendecker, Golden, Colorado, U.S. Geological Survey
	Dr. James F. Davis, California State Geologist
	Mr. Nobumasa Kawabata, Guest Researcher, Disaster Prevention and Information Center, Shizouka Prefecture
Meeting Room 150	
4:00-4:35	**Small Conferences, Exhibits, Break**
Lecture Room	
4:35-5:00	**Policy Discussion**
5:00	***Working Dinner-Mr. Kazuo Ikawa, Director, Citizens' Disaster Prevention Department Citizens' Service Bureau, City of Kobe - Speaker***

Tuesday, September 17

Lecture Room	***Working Breakfast-Presentation on the Franchise Emergency Action Team Mr. Richard B. Rennick***
7:45 a.m.	
8:30-12:00 p.m.	**Earthquake Risk Assessment and Loss Estimation**
	Dr. William A. Anderson, Section Head, Hazard Mitigation, National Science Foundation, Chair
8:30-9:15	**Earthquake loss estimation methods, models and GIS**
	An overview of processes, models and methods for estimating the potential impact of an earthquake on a specific area in terms of deaths, injuries, damage to structures and lifelines, and direct and indirect economic losses.
	Dr. Robert V. Whitman, Professor of Engineering, Massachusetts Institute of Technology
	Dr. Tsuneo Katayama, Director-General, National Research Institute for Earth Science and Disaster Prevention, Science and Technology Agency
	Dr. Kenzo Toki, Professor, Kyoto University
Meeting Room 150	
9:15-9:50	**Small Conferences, Exhibits, Break**
Lecture Room	
9:50-10:20	**Policy Discussion**
10:20-11:00	**Disaster Situation Assessments**
	An overview of methods and processes for quickly determining the nature, areal extent, and

	magnitude of damage after an earthquake and for identifying those areas most severely affected.
	Catherine H. Light, Deputy Associate Director for Response, Response and Recovery Directorate, FEMA
	Mr. Ichiro Nagao, Specialist for Earthquake Disaster Management, Earthquake Disaster Management Division, Japan Fire and Disaster Management Agency
***Meeting Room* 150**	
11:00-11:30	**Small Conferences, Exhibits, Break**
Lecture Room	
11:30-12:00	**Policy Discussion**
12:00-1:00 p.m.	***Working Lunch - Mr. Timothy E. Wirth, Under Secretary for Global Affairs, U. S. Department of State, Speaker***
Lecture Room	**Earthquake Resistant Design, Construction, Rehabilitation and Repair Standards**
1:00-5:00	
	Dr. Richard N. Wright, Director, Building and Fire Research Laboratory, National Institute of Standards and Technology Chair
1:00-1:45	**Performance based standards and steel frame buildings**
	An overview of efforts underway to develop performance criteria for life safety, damage reduction and maintenance of function, with emphasis on steel moment-frame buildings and use of large and full-scale testing.
	Dr. Robert D. Hanson, University of Michigan
	Dr. Keiichi Ohtani, Director, Disaster Prevention Research Division, National Research Institute

	for Earth Science and Disaster Prevention, Science and Technology Agency
	Dr. Hiroyuki Yamanouchi, Supervisor, Structural Engineering Department, Building Research Institute, Ministry of Construction
***Meeting Room* 150**	
1:45-2:25	**Small Conferences, Exhibits, Break**
Lecture Room	
2:25-2:55	**Policy Discussion**
2:55-3:55	**Assessment, repair and rehabilitation, lifelines, community planning for post-earthquake fire reduction**
	New activities in the assessment and rehabilitation of existing buildings and lifelines and in fire safety. Focus on the roles of government and the private sector.
	Dr. Richard N. Wright, Director, Building and Fire Research Laboratory
	Mr. Christopher Rojahn, Executive Director, Applied Technology Council
	Mr. Masaharu Kanayama, General Manager (System Engineering), Kansai Electric Power Company, Inc.
	Mr. Kunihiro Takahashi, General Manager, Technology Development Department, The Japan Gas Association
	Mr. Koichi Yokoyama, Director, Earthquake Disaster Prevention Research Center, Public Works Research Institute, MOC

***Meeting Room* 150**	
3:55-4:25	**Small Conferences, Exhibits, Break**
Lecture Room	
4:25-5:00	**Policy Discussion**
5:00	***Working Dinner-Mr. Takahiro Shibata Director-General Urban and Housing Department, Hyogo Prefecture Speaker***
Wednesday, September 18	
Lecture Room	
7:45 a.m.	***Working Breakfast-Presentation on Volunteer Organizations Active in Disasters Mr. Michael Bruinooge***
8:30-noon	**Earthquake Preparation, Response, Recovery and Mitigation** Mr. Richard W. Krimm, Acting Associate Director, Mitigation Directorate, FEMA, Chair
8:30-9:05	**Earthquake Response** A discussion of governmental policies and operations for providing immediate post-disaster assistance to the affected areas. Mr. William C. Tidball, Associate Director, Response and Recovery Directorate, FEMA Mr. Shigeyuki Otake, Senior Planning Officer for Disaster Prevention, Disaster Prevention Bureau, NLA
***Meeting Room* 150**	
9:05-9:50	**Small Conferences, Exhibits, Break**

Lecture Room	
9:50-10:10	**Policy Discussion**
10:10-10:50	**Post-disaster mitigation**
	Barriers to implementation of governmental actions to reduce future earthquake losses during the post-disaster period.
	Dr. Joanne M. Nigg, Co-Director, Disaster Research Center, University of Delaware
	Mr. Takahiro Shibata, Director-General, Urban and Housing Department, Hyogo Prefecture
***Meeting Room* 150**	
10:50-11:30	**Small Conferences, Exhibits, Break**
Lecture Room	
11:30-noon	**Policy Discussion**
12:00-1:00	***Working Lunch-Mr. Rodney E. Slater, Administrator, Federal Highway Administration-Speaker***
Lecture Room	
1:30-3:10	**U.S./Japan Cooperative Arrangements**
1:30-2:30	**Discussion and Adoption of the State of Conclusions and Recommendations**
	Mr. Harvey G. Ryland, President and Chief Executive Officer, Insurance Institute for Property Loss Reduction, former FEMA Deputy Director
	Mr. Masaaki Nakada, Deputy Director-General, Disaster Prevention Bureau, NLA

2:30-2:50	**Presentation of the Statement of Conclusions and Recommendations to Director Witt and Minister Suzuki**
	Dr. Frank Press
2:50-3:10	**Closing Remarks**
	Minister Suzuki Director Witt

Appendix D—

JOINT STATEMENT OF THE CONCLUSIONS AND RECOMMENDATIONS FROM THE FIRST U.S.-JAPAN EARTHQUAKE POLICY SYMPOSIUM

National Academy of Sciences
Washington, D.C.
September 16–18, 1996

1. This U.S.-Japan Earthquake Policy Symposium is one of the first thrusts under the Natural Disaster Reduction Initiative added by President Clinton and Prime Minister Hashimoto to the U.S.-Japan Common Agenda for Cooperation in the Global Perspective in April, 1996.
2. The First U.S.-Japan Earthquake Policy Symposium provided the forum to exchange valuable policy and technical information that is beneficial to both countries. The Symposium is an outgrowth from the discussions between then-Prime Minister Murayama and President Clinton held in June 1995. Twenty-five senior level persons from each country discussed methods to better exchange knowledge about earthquake emergency management (mitigation, preparedness, response, and recovery) and research and development. The Federal Emergency Management Agency (FEMA) is the U.S. chair and the National Land Agency (NLA) is the Japan chair. FEMA and NLA will take the lead in future earthquake policy discussions between the two countries.
3. This Symposium provided a foundation for the exchange of views on public policies and private activities and programs and the supporting science and engineering technologies related to earthquake emergency management. The participating organizations will continue to promote and enhance public safety and community

welfare by fostering improved public policies and programs and their supporting research and development.

4. Participants discussed a wide range of topical areas where significant advances have been made by both countries, cooperative activities that could improve each country's earthquake emergency management policies and programs, and applications of research and technology. Examples include:

a. Improving governmental policies and programs and private sector activities for providing emergency response, immediate post-disaster assistance to the affected population, and development of effective earthquake hazard mitigation strategies.
b. Performing joint post-disaster investigations to identify mitigation opportunities to avoid future losses.
c. Developing scientific knowledge and engineering technologies leading to such mitigation measures as improved land use and construction practices in new and existing buildings and lifelines to improve earthquake resistance.
d. Performing joint risk assessments and quick evaluation of damage following earthquakes.
e. Sharing information on topics such as earthquake forecasting and warning, and hazard zonation mapping.
f. Improving emergency communication systems for information exchange that will remain functional during disasters.
g. Establishing a quick decision-making and integrated response system to disaster situations.
h. Developing inter- and intra-governmental and non-governmental information systems that will contribute timely and effective assistance to disaster victims.

The participants recognized the importance of expanding the collaboration between the two countries in these and other related areas in order to achieve significant reduction in future earthquake losses.

5. The participants proposed the following areas for further cooperation:

a. Develop and exchange information on:

- improved earthquake warning, earthquake emergency response, recovery and mitigation policies, programs, and procedures.
- use of urban planning and development policies and practices to achieve earthquake hazard reduction.
- methods for the accurate assessment of the severity of the disaster that will enable proper and quick response.
- advanced search and rescue and fire fighting techniques.
- improved programs to assist communities in their recovery from disasters and exchange of this new knowledge.
- improved seismic vulnerability assessment and strengthening technologies for buildings, structures, and lifeline systems, including use of new materials and large-scale testing, and development of recommendations for design guidelines, standards, and practices.
- effective means to exchange policy and technical personnel and data following earthquakes.

- risk assessment and emergency management for mega-cities.

b. Improve:

- real-time earthquake monitoring and warning, probabilistic forecasting, and earthquake hazard mapping.
- techniques for hazard, damage, and risk assessments for buildings, structures, and lifeline systems.
- earthquake loss estimation models to stimulate preparedness and mitigation actions and facilitate emergency response following earthquakes.
- public policies and mechanisms to assess critical facilities, public works, and utilities for earthquake vulnerability and to strengthen their seismic resistance.

6. The participants, acknowledging the achievements of this Symposium, concluded that:

a. a second Earthquake Policy Symposium will be held.
b. a "U.S.-Japan High Level Forum for Earthquake Emergency Management Policy Cooperation" will be established, acknowledging the importance of continuing cooperation after the second Symposium.
c. a working group will be formed, to be co-chaired by FEMA and NLA, to provide a mechanism to promote and encourage implementation of the conclusions and recommendations of this Symposium.

7. The working group led by FEMA/NLA will:

a. monitor and coordinate activities coming out of this Symposium, and report on their status at the second Symposium.
b. promote and develop proposals for cooperative projects to be presented for consideration at second symposium.
c. develop and report the modality, terms of reference, and other details of the High-Level Forum at the Second Symposium.

8. The participants concluded that they will explore implementation of collaborative efforts resulting from this Symposium in cooperation with the new U.S./Japan Earthquake Disaster Mitigation Partnership, the Pan-Pacific Natural Disaster Watch Network, and other natural disaster programs.
9. The participants will explore the possibility of pursuing wider cooperation through several means, including, but not limited to, conduct of joint workshops on topics of mutual interest; exchange of policy-level officials and technical experts on a short-term basis; perform joint research to improve knowledge; exchange of scientific and engineering equipment to perform experiments; and exchange of policy, program and technical information that will bring into realization improved earthquake preparedness, response, recovery, and mitigation.
10. Information and data derived from the cooperative activities will be made available to the public. Dissemination of the information and data will be executed through media including but not limited to publications, talks, electronic means such as E-mail and the World Wide Web, and other information processes customarily used by the participating organizations.
11. The Symposium participants will continue to contribute to the International Decade for Natural Disaster Reduction (IDNDR) by such means as exchanging relevant proceedings of joint

meetings with their respective National Committees for the IDNDR. Consistent with the objectives of the Common Agenda, it is important that the report of and achievements resulting from the Symposium be shared with all countries vulnerable to earthquakes.

12. The Second U.S.-Japan Earthquake Policy Symposium will be held in Japan in 1997. The specific program and itinerary will be proposed by the Japan-side Chair with concurrence of the U.S.-side Chair.