

THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

June 22, 1978

Executive Office of the President
Washington, D. C. 20500

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THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

INTRODUCTION

The purpose of the National Earthquake Hazards Reduction Program - in accordance with the Earthquake Hazards Reduction Act of 1977 - is to reduce the risks of life and property from future earthquakes in the United States.

The Act (Public Law 95-124) directs the President "to establish and maintain an effective earthquake hazards reduction program." To implement such a program, the President is to develop a plan, which shall "set year-by-year targets through at least 1980, and shall specify the roles for Federal agencies and recommended appropriate roles for State and local units of government, individuals, and private organizations."

Earthquakes pose perhaps the greatest single-event natural hazard faced by the Nation. An earthquake can affect hundreds of thousands of square miles, can cause damage to property measured in the tens of billions of dollars, can cause loss of life and injury to tens of thousands of persons, and can disrupt the social and economic functioning of the affected area. During this century, earthquakes, because of their infrequency, have caused less damage in the United States than have hurricanes, tornadoes, or floods. Major earthquakes in other parts of the world, however, have shown the destruction and disruption they can cause, and the potential for disaster has multiplied here in recent years with the rapid development of the most seismically prone portions of the country.

While earthquakes in the United States occur most frequently in States west of the Rocky Mountains, 39 states are known to have the potential to experience moderate and severe earthquakes. During the history of this country, devastating earthquakes have occurred in the West, Midwest, and East, and are expected to occur again. Recent developments in earth science have lessened the mysterious nature of earthquakes, and offer promise in understanding their nature and effects. Scientific earthquake prediction is a real possibility, and in fact has already saved lives in other parts of the world. At the same time, much progress has been made in understanding the response of buildings and other structures to shaking from earthquakes, enabling us to build more resistant structures. Much remains to be learned in both the earth science and engineering aspects of earthquake problems. But, armed with the existing and merging knowledge about earthquakes, their effects and how to reduce their consequences, we can develop a strategy for a National Earthquake Hazards Reduction Program. As more is learned the strategy can be modified, but we can begin now.

Each year the United States spends hundreds of millions of dollars on relief to victims of natural disasters and on the reconstruction of damaged communities. Much, but certainly not all, of this post-disaster expense could be saved if mitigating actions were taken before the events

occur. The Nation must strive to find the proper balance – a balance that is both compassionate and cost effective – between efforts to mitigate the impacts of disaster and efforts to provide relief to victims. The National Earthquake Hazards Reduction Program addresses measures to mitigate this one particular kind of natural disaster – an earthquake – that can cause widespread economic disruption and personal tragedy.

Although we can make some plans for future uncertainties, most people tend to avoid thinking about the possibility that a disaster may personally befall them. This tendency is reinforced by the fact that most individuals have not recently experienced a disaster and so appropriately think that the odds against the occurrence of a disaster at any given time are **overwhelmingly in their** favor. Differences in perception of risks also blunt recognition of the need to undertake hazards reduction and disaster preparedness measures. Hazards reduction actions based primarily on the initiative of individuals or small groups have generally failed because they failed to recognize the human tendency to deny existence of danger and to assure that everything is all right until events clearly prove otherwise. Also, plans and other actions must often be undertaken on a large and coordinated scale, beyond the capacity of individuals or small groups. Leadership is required to encourage the appropriate consideration of seismic risk in making decisions that affect the ability of a community – and indeed the Nation – to resist the impact of earthquakes.

To accomplish the overall goal of reducing the risks to life and property from future earthquakes, the National Earthquake Hazards Reduction Program will emphasize:

- o Leadership – Actions to reduce earthquake hazards involve numerous Federal agencies, State and local governments, a variety of institutions in the private sector, and the public. Consequently, a mechanism for leadership and coordination is essential.
- o Partnership – Actions taken by the Federal government alone will have little effect. State and local governments and the private sector have principal responsibilities for action. For success, the planning, execution, and review of the Program must involve non-Federal participation, including State and local government, business, industry, the design professions, the research community, and the public.
- o Implementation – A National Program responsive to the legislation of the Congress must contain actions aimed at the following objectives:
 - Develop measures to prepare for earthquakes, to evaluate earthquake predictions, to warn residents of an impending earthquake if possible, and to ensure that a comprehensive response will be made after the occurrence of an earthquake;

- Develop ways for governmental units, industry, and the public to use existing and developing knowledge about regional and local variations of seismic risk in making their land use decisions;
 - Develop and promulgate specifications? building standards design criteria, and construction practices that will provide appropriate earthquake resistance for new and existing structures at reasonable cost;
 - Consider the reduction of earthquake hazards through alternative provisions and requirements for Federal and Federally-financed construction, loans, loan guarantees, grants, and licenses;
 - Determine the appropriate roles for insurance? loan programs, and public and private relief efforts in moderating the impact of earthquakes;
 - Provide researchers, the design professions, the construction industry, and the public with data and information to achieve the purpose of the Program.
- o Research - Improved techniques for hazards reduction over the low run require research into the basic causes of earthquakes, the means to try to predict and perhaps control them, the development and regional application of methods to evaluate and delineate their potential effects and seismic risk, the development of methods for increasing seismic resistance in manmade works, the exploration of impacts on the community of earthquakes and the consequences of alternative mitigation policies, and the utilization of foreign experience.

GUIDING PRINCIPLES FOR A NATIONAL PROGRAM

The National Earthquake Hazards Reduction Program is comprehensive in scope, establishing a balanced program of hazards reduction measures. The program breaks new ground in attempting to achieve, with a realistic expenditure of resources, an effective state of preparedness for, and protection from, a disaster characterized by a low probability of occurrence but with a high potential for destruction, damage, and disruption. The task is made even more difficult by the large number of groups in both the private and public sectors - often with conflicting objectives and interests - that need to be mobilized in support of the effort.

Decisions affecting earthquake safety must be made at virtually every level of society - individual, family, community, and national. Most of these decisions are made in the private sector, often subject to some

governmental constraints and incentives. The achievement of a safe seismic environment is therefore basically a responsibility shared by all levels of the public and private sectors. This National Program can be successful only if both governmental and private leaders recognize the need for active participation in planning and management at all levels. They must all take responsibility for stimulating and supporting hazards mitigation actions by the private sector.

The numerous groups that will be involved in implementing this Program include not only Federal, State, and local government officials, but also representatives from industry, business, volunteer associations, professional groups, research and academic institutions, and the public. Within the context of the diverse roles played by these groups, the program identifies those actions that the Federal, State, and local governments and private individuals can appropriately undertake. The Federal government can play a significant, but not dominant, role. The Federal government must set an example for others to emulate by its own actions, including the institution of more effective hazards mitigation measures in its own facilities. Existing Federal government resources for providing technical assistance and the acquisition and dissemination of data and information will be amplified and used to assist State and local governments and the private sector. Appropriate State and local governmental actions, and those that groups in the private sector may undertake, are also indicated within the framework of a coherent national effort.

This Program has been formulated with, and its implementation will be governed by, the following guiding principles:

- o The priorities of hazards reduction are to & based on relative risk; that is, the probability of significant loss of life and property, considering the population exposed, the nature and magnitude of the hazards posed by manmade structures to the population, and the likelihood and character of significant earthquakes. Regional differences in the nature and magnitude of the risk and of the perception of the risk require a flexible approach.
- o While the Federal government can take a strong, exemplary position with regard to its own facilities and develop guidelines and standards for Federally-assisted or licensed critical facilities, the effort to improve local land use and building codes --as a basis for all private construction, including Federally-assisted, noncritical construction -- must be accomplished by persuasion and encouragement, particularly through working with professional organizations and State and local officials.
- o Earthquake hazards reduction must not only take into account the direct natural hazards from faulting and vibration, but also the indirect natural hazards from tsunamis, seiches, landslides, floods, soil consolidation, soil failure, and slumping. Damage to **works** of man by these natural hazards leads to both primary hazards such as

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structural failure, and secondary hazards such as fire? flood, and the escape of contained toxic or hazardous fuels and materials "

- o Experience both in the United States and abroad has proved that buildings and other structures can be designed so as to protect life safety during very strong ground shaking from major earthquakes. For some buildings and structures the additional cost of earthquake resistance is quite small; in other cases the costs would be very significant.

- o Prediction cannot, in the near future, be relied upon as an effective tool to reduce earthquake casualties (for example, to avoid the problem posed by existing hazardous buildings). However, since scientific breakthroughs could come at any time, we must prepare to cope with different levels of Predictive capability.

- o Hazards reduction procedures, whenever and wherever possible, need to be incorporated into existing organizations? institutions, legislation, regulations, rules, building codes, relief procedures, and loan requirements, so that they are part of established activities rather than being superimposed as separate and additional. As the local building codes improve through time as a result of persuasion and encouragement, it may be appropriate to increase gradually the seismic provisions in requirements for Federal assistance.

- o Outside assistance to the local community must be planned for quick identification of needs that cannot be handled locally, and for provision of aid to supplement, rather than replace local efforts. Our society has a great resilience and recuperative power when called upon to respond to sudden disaster.

- o Special attention must be given to persons who are particularly vulnerable to earthquake hazards (the poor, the aged, the handicapped, the children) to provide them equal protection and ensure that they do not suffer disproportionately.

- o To be acceptable in regions characterized by lower, but significant, seismic risk, earthquake hazards mitigation activities should lead to the reduction of risks from hazards other than earthquakes and be coordinated with efforts to protect people and property from other potential hazards and disasters.

- o International cooperation on earthquake hazards research should be fostered as essential to ensure opportunities for mutual learning. Studies of foreign experience and exchange of information are therefore a fundamental part of this Program.

- o Continuing evaluation is needed to assess the strengths and weaknesses and the successes and failures of the Program. An annual report to Congress will reflect the progress and evaluate the effectiveness of the Program.

PRIORITIES FOR IMMEDIATE ACTION

Some actions for earthquake hazards reduction can begin immediately while others must await research results or the commitment of financial resources. Of the tasks outlined in this plan, the highest priorities for immediate action are:

- The establishment of a focus— a lead agency — to provide national leadership and to guide and inordinate Federal activities;

- o The determination of the interest of States for the development of State and local strategies and capabilities for earthquake hazards reduction.

- o The completion of Federal, State, and local contingency plans for responding to earthquake disasters in the densely populated areas of highest seismic risk.

- o The development of seismic resistant design and instruction standards for application in Federal construction and encouragement for the adoption of improved seismic provisions in State and local building codes.

- o The estimation of the hazard posed to life by possible damage to existing Federal facilities from future earthquakes.

- o The maintenance of a comprehensive program of research and development for earthquake prediction and hazards mitigation.

The tasks required to initiate these actions to achieve the long-term objectives of the National Earthquake Hazards Reduction Plan follow.

MOVING TOWARD A NATIONAL PROGRAM

Providing National Leadership

A central focus is needed to stimulate and inordinate earthquake hazards reduction activities within the Federal government and throughout the Nation. Pending the recommendations of the president's Reorganization Project and within the 300 days from enactment of Public Law 95-124, a lead agency will be rimed to assume this role, providing leadership in coordinating earthquake hazards reduction activities in the appropriate Federal agencies and in assisting State and local governments in planning and implementing their own programs. In carrying out these responsibilities, the lead agency will consider regional differences in the nature and perception of the earthquake threat and encourage flexible programs embodying earthquake hazards reduction in efforts to mitigate other natural hazards where feasible and appropriate. The lead agency will have primary responsibility for maintaining an overview of the National Program and identifying opportunities and needs.

The lead agency will be responsible for the development of guidelines to assist Federal agencies involved in construction in implementing earthquake hazards reduction elements in their ongoing programs. To develop these guidelines for consideration, by October 1978, the lead agency will organize and lead an Interagency Committee on Seismic Safety in Construction. This committee will be composed of representatives of all Federal agencies significantly engaged in construction, the financing of construction, or related activities. Following the appropriate review, the guidelines will be implanted by Executive Order as required.

By July 1979, the lead agency will complete a detailed work plan for its continuing role, including procedures for monitoring the assignments of responsibility contained in this Program and for participation in programmatic review and assistance in budgetary review. In addition, the work plan will describe the mechanisms that will be used to identify additional areas for hazards reduction activity through consultation with other Federal agencies, State and local governments, and private relief groups, including the establishment of any advisory groups or interagency committees that may be required. The work plan will address procedures for developing earthquake hazards guidelines for Federal agencies to include in their ongoing programs, and the development of guidelines for reconstructing damaged communities to make them more resistant to future earthquakes. Each year the lead agency will summarize progress toward the goals of the Program in a report submitted to the President for transmittal to Congress.

Improving Contingency Planning and Emergency Response

Following a destructive earthquake, all levels of government and the private sector should join to the extent necessary in providing assistance to the victims. This assistance will be most timely and effective if based on a set of coordinated Federal, State, local, and private contingency plans.

General disaster planning would probably not be adequate to cope with the unique aspects of a destructive earthquake in or near a heavily populated region.

The Federal Disaster Assistance Administration will develop a schedule, covering the areas of high seismic risk throughout the country, for the completion of Federal contingency plans and for assistance to State and local governments in completing their response plans. This schedule will reflect 1) an evaluation of the contingency planning completed to date, 2) priorities accorded to the level of seismic hazards and interest of the affected communities, and 3) the recognition that contingency plans **must be** preceded by estimates of potential damage and casualties. These plans should consider the developing capability for predicting earthquakes and **their** effects. If a reliable capability develops, opportunities should be identified to utilize governmental and private resources **for** post-disaster action before the occurrence of an earthquake. This schedule will be completed in time to be considered for the budget for Fiscal Year 1980.

The Federal Disaster Assistance Administration will bear a continuing responsibility for overseeing the revision of Federal earthquake contingency plans and for stimulating the revision of State and local contingency plans as new information on earthquake hazards is developed and as the perception of this threat in affected communities increases. Guided by these plans, State and local governments can assess the potential impact of earthquakes on safety to life and on essential community facilities and can take steps to reduce the loss of life and to ensure the maintenance of vital services.

Evaluating Earthquake Predictions

The development of a reliable capability to predict earthquakes is a fundamental research objective. As we move toward the goal of making scientifically credible earthquake predictions, information may develop that - although insufficient at the time for issuing an earthquake prediction - may heighten scientific concern about the imminence of a destructive earthquake. This information must be evaluated and communicated to responsible public officials in much the same way that scientifically credible earthquake predictions will be evaluated and communicated.

The responsibility for evaluating and communicating earthquake predictions and other information of this type will rest with the Director of the U.S. Geological Survey. To resolve questions of liability, additional legislation may be proposed. The Director **will be assisted** in this task by the National Earthquake Prediction Evaluation Council, a Council to be composed of scientists from inside and outside **government**.

This Council will be established in 1978. **The** responsibility for warning the people about the imminent danger from a natural hazard and to advise or direct them on how to respond is principally a function of State and local government. As a basis for determining their own actions in response to earthquake predictions, State governments in highly seismic regions may decide to establish their own advisory mechanisms. Scientific societies such as the Seismological Society of America, the Geological Society of America, and the American Geophysical Union are urged to develop ethical and scientific guidelines to be followed by individual scientists and scientific institutions in issuing earthquake prediction.

The current tsunami warning system of the National Oceanic and Atmospheric Administration will be continued. Advances made in earthquake prediction will be incorporated into this system to improve its overall effectiveness and efficiency.

Much remains to be learned but the social and economic effects of an earthquake prediction and about how officials can respond so as to minimize both potential losses and possible negative impacts. The National Science Foundation will continue its program of *research to* provide background information for these policy decisions.

Preparing National Seismic Risk Assessments

An assessment of the relative frequency and characteristics of earthquakes in the United States is needed. National maps are needed showing the degree of seismic risk and providing information necessary for engineering design of structures. - These maps are needed to establish national priorities for earthquake hazards reduction activities, for model building codes, and as a basis for incorporating earthquake hazards reduction provisions - where appropriate - in a wide variety of Federal programs, including those that observe requirements of locally adopted model codes. These maps are not intended for local zoning or the evaluation of specific sites but for showing the broad variation of seismic risk throughout the Nation. Under the recently augmented program of the U.S. Geological Survey, high priority will be given to the production of such seismic risk maps. However, fundamental scientific problems must be solved before fully satisfactory maps can be instructed, and it is not realistic to expect that one "final" map or series of maps can be produced in the near future. Instead, while researchers address the fundamental problems, a series of maps will be produced to meet immediate and growing needs. These will be revised as new information becomes available.

By July 1979, the Geological Survey will complete a review - in consultation with the Interagency Committee on Seismic Safety in Construction, professional organizations and model code groups - of the priorities and types of information to be shown on national seismic risk maps. A new draft national seismic risk map (or maps) will be available for **review by** interested agencies and groups by July 1980, and a completed map (or maps) will be published by July 1981. Maps will then be revised and updated as required.

In addition to the need for national-scale assessment, information is needed on a regional scale but the nature and distribution of earthquake hazards for use in making State and local decisions about construction and the use of land. The program of the Geological Survey emphasizes the development of new techniques for identifying and evaluating earthquake hazards, such as active faults and the ground conditions that affect the distribution of damage. The program also emphasizes the application of existing and developing techniques to the evaluation and regional delineation of earthquake hazards, particularly in the regions of highest risk. By January 1979, the Geological Survey will complete a priority schedule for the regional evaluation and delineation of earthquake hazards for the next five years, taking into account the views of State and **local** governments, hazards **evaluation** programs of the Nuclear Regulatory Commission and other agencies, differences in the nature **of the** hazards in each region, and the current state **of knowledge in** each. As these studies proceed, particular attention will be given to the timely publication of hazards information in a form readily understood by nonspecialists.

Although this regional information will provide a significant and necessary framework, it will rarely be sufficiently detailed to be used in making decisions about local construction, local land use planning, or the evaluation of specific sites. State and local governments may find it desirable to build on the Federal program in developing detailed information on which to base their decisions affecting instruction and land use. Planning new construction to avoid especially hazardous zones, where possible, is an extremely effective mitigation measure. Agencies and firms planning special or critical facilities appropriately bear the incremental cost of information required for their detailed analysis of specific sites to comply with the guidelines and requirements of States, local communities, or the Federal government.

Making Decisions for Federal Lands

Wise decisions about the use of land are - in the long run - among the most effective means to mitigate the hazards of earthquakes. Most of the decisions are made by local governments and in the private sector. The Federal government must set an example by carefully considering earthquake hazards in managing the lands it owns. The planning for these largely undeveloped lands, with a few exceptions, represents the sum of many decisions made by various departments and agencies. Most of the lands are in the western half of the Nation where the hazards from earthquakes are generally greater than elsewhere. Currently, in some areas, more consideration is given to earthquake hazards in making decisions for private lands than for adjacent Federal lands. Henceforth, in developing these Federal lands, decisions about the siting and construction of facilities affecting the safety and welfare of the public or providing vital services must reflect consideration of seismic hazards. Therefore, the lead agency will work with the principal land-management agencies in the Departments of Interior, Agriculture, Defense, and Energy, and others to develop guidelines, by 1980, indicating when and how earthquake hazards should be taken into account.

Improving Codes and Construction Standards and Practices

Criteria for the earthquake-resistant design of new construction used in many current Federal, State, and local building codes, standards and practices, do not reflect the current state of the art and should be updated. These codes and standards and the professional practices underlying them should not only represent our best knowledge, but be adaptable to different areas of the United States according to differing seismic risks and the costs and benefits they entail. The agencies involved in construction, working through the Interagency Committee on Seismic Safety in Construction, will develop seismic design standards for Federal building construction. The target date for completion of these standards and the initiation of their testing by Federal construction agencies is 1980. Implementation of the standards will be considered following testing and analysis of costs, and will utilize an Executive Order if required. These standards should reflect regional differences in the earthquake hazards placing emphasis on providing life safety, and should build upon existing model codes where feasible.

The vast majority of the construction in this country is undertaken by the private sector and regulated by local government. To assist State and local governments, industry, and the public in developing construction standards, criteria, and practices, the National Bureau of Standards will work with the Department of Housing and Urban Development, other Federal agencies (particularly those performing research), the National Institute of Building Sciences, professional organizations, model code groups, and State and local building departments. The Bureau will assist and cooperate with these groups in continuing the development, evaluation, and improvement of model seismic design provisions suitable for incorporation into local codes and practices. Incorporation of these seismic design provisions into local codes is, of course, voluntary, but the provisions must be flexible and give consideration to regional variation of seismic hazard, and adaptation to local conditions. They must also be adequately tested. This will be a continuing responsibility of the Bureau.

Reducing Hazards From Existing Buildings and Other Facilities

Most deaths and injuries in earthquakes have been caused by collapsing buildings - generally older buildings and often those made of unreinforced masonry, although some modern buildings are also vulnerable. The public's vulnerability to earthquakes **over the** coming years will be dominated by these existing hazardous structures. Most of these buildings are privately owned, but many are owned by Federal, State, and local governments. Almost all are expensive to upgrade, and thus present a very difficult problem of public policy for all levels of government. Over the long term, the potential to predict, reliably, damaging earthquakes may present an economically attractive alternative to upgrading substandard structures. However, the reliable prediction of earthquakes is likely to be many years away. In the mean time, it is important that hazards be reduced from those structures presenting the greatest risk in terms of occupancy and potential secondary impacts.

Special attention must be given to those structures that provide vital community services or pose unacceptable risks because of high occupancy. Some buildings, poorly designed or constructed from the point of view of seismic resistance, may not warrant reinforcement or replacement either because the collapse of the structure would not cause loss of life, injury, significant damage to contents, or loss of critical function, or because the structure is of great historical interest, has a low occupancy, would be impractical to reinforce or replace and for which the community is prepared to accept the risk. In some cases it may be most cost effective to achieve an increment of improved seismic resistance, but not require upgrading to meet the criteria for new construction.

Because of the astronomical costs of retrofitting whole classes of **hazardous** buildings, it is essential to reach a realistic and cost effective solution to this problem. The Federal government must set an example. agencies of the Federal government own or lease hundreds of thousands of buildings and other structures - examples include warehouses and hospitals, office buildings and defense installations. The cost of even a detailed field assessment of the seismic resistance of these structures would be very high. Therefore, the lead agency will develop - working closely with, and drawing on the expertise of the General Services Administration, the Department of Defense, Veterans Administration, the Department of Housing and Urban Development, and other Federal **agencies owning** buildings and other structures - a targeted strategy to identify the Federally-owned structures that present unacceptable risks - considering their use, occupancy, vulnerability to earthquakes, and the magnitude of the earthquake hazard. Several methodologies to approach this problem are under development by Federal agencies and by the State of California Seismic Safety Commission. The strategy should be outlined by the first half of 1979 to allow the General Services Administration and the Department of Defense to test and improve the strategy in Fiscal Year 1981. When the strategy is developed adequately for widespread application at reasonable cost, the agencies can request additional funds for implementation.

As structures that present unacceptable risks are identified, each agency will include corrections of seismic deficiencies along with other necessary improvements to maintain a balanced annual construction program within its available resources and consistent with its other systemwide priorities. Possible corrections may include retrofitting, replacement, modification of use or occupancy, or simply removal from service. Corrective measures must consider other factors than earthquake safety alone and must be undertaken in a reasoned way. The strategy for identifying hazardous buildings will be coordinated with the Federal Energy Management Program of the Department of Energy where feasible and appropriate.

Two programs provide examples of what can be done. Since the 1971 San Fernando earthquake the Veterans Administration has achieved significant progress in reducing the seismic vulnerability of hospitals. The Department of Defense has begun the upgrading of existing barracks-type buildings in high seismic areas to improve life safety as part of

their modernization and is accomplishing seismic strengthening of existing hospitals in high seismic areas in conjunction with upgrading their mechanical, electrical, and safety systems.

In addition to identifying Federally-owned structures that present unacceptable risks, the General Services Administration will prepare guidelines, by January 1980, for evaluating seismic hazard in leasing of buildings. By applying standards for seismic resistance to prospective leased buildings, the Federal government will encourage the gradual reduction of hazard from existing privately-owned hazardous structures.

State and local governments wishing to explore approaches to the problem posed by existing hazardous buildings within their jurisdictions may obtain Federal assistance through existing planning grant programs. Some Federal assistance for actually implementing a reduction in the hazards posed by existing buildings is already available through a variety of existing Federal programs such as the Community Development Block Grant Program of the Department of Housing and Urban Development.

Ensuring the Safety of Critical Facilities

Facilities such as dams and hydraulic structures, nuclear reactors, liquid natural gas plants, and storage facilities for explosive and hazardous materials, have the potential for significantly increasing the destructive impact of an earthquake, should they fail, particularly near a populated region. Lifelines, such as transportation routes and facilities, energy transmission facilities, water supply systems, sewage disposal systems, and communication systems, are all critical to the vitality and resilience of a community. Therefore, special attention must be given to the earthquake resistance of these critical facilities. Most of them are owned by the private sector or State or local governments. The Federal government also owns many critical facilities, including dams and storage facilities for hazardous materials; it also supplies funds for construction for such facilities as transportation and sewage systems; and it licenses some private facilities including nuclear power plants. Currently, earthquake hazards normally receive substantial attention when siting and constructing these critical facilities.

Owing to the limits of our present understanding of earthquakes and their effects, however, geologists, seismologists, and engineers commonly must attach large uncertainties to their quantitative estimates of earthquake hazards. Reservoirs and fluid injection wells pose special problems because, in some instances not yet fully understood, they seem to induce earthquakes. Although it is usually possible to design and construct facilities with an appropriate degree of safety for the use intended, the quantitative uncertainties sometimes virtually immobilize the process of decision making. Delay is often excessive as arguments are made about the appropriate level of conservatism in design and construction. New information developed through research and through the regional evaluation and delineation of earthquake hazards will help to reduce these **uncertainties**. In other cases the delay is caused as successive organizations conduct

their safety and technical reviews. The economic **cost** of such a delay can equal the cost of a very substantial increment of the conservatism in design. At the same time, requirements for public safety and the satisfaction of potentially affected communities give rise to the need for independent review and public participation in the planning process.

Several activities are already underway within the Federal government to address significant problems relating to critical facilities that are of particular relevance here. The Administration is proposing legislation to revise the procedures for licensing nuclear **power** plants. This legislation aims both to increase the participation of State governments in the decision process and to reduce the time required to get new power plants on line. It encourages early identification of geological conditions at prospective power plant sites and the banking of sites for future use. Earthquake-related issues are among the most difficult faced by the Nuclear Regulatory Commission in the licensing process and the Commission supports a research program aimed at their generic solution. In addition, the President recently established, under the leadership of the Secretary of energy, an Inter-agency Nuclear Waste Management Task Force to formulate recommendations for establishment of an Administration policy with respect to long-term management of nuclear wastes and supporting programs to implement this policy. Among other considerations, attention will be given to the geologic and seismologic aspects of this problem.

In November 1977, the Federal agencies responsible for dam construction completed a report maintaining draft guidelines for the safety of Federal dams. These guidelines contain provisions regarding earthquake resistance and independent review. Upon completion of a review of these guidelines now being conducted by the Office of Science and Technology Policy, they will be implemented by all Federal agencies. Further, both the Corps of Engineers and the Bureau of Reclamation and other agencies involved in dam construction have established requirements to include seismic design considerations - in accordance with the latest state of the art - for new dams and appurtenant structures. There are requirements providing for reevaluation of existing dams to determine their earthquake resistance in accordance with the latest standards. In addition, the Corps of Engineers has begun the inspection of approximately 9,000 nonfederal dams that could be the cause of substantial loss of life and property in the event failure. Among other considerations, the Corps will make an assessment of the potential vulnerability of these dams to seismic events and will recommend additional seismic investigation of these dams where required. Results will be made available to States to encourage them to initiate effective non-Federal dam safety programs.

Special attention must be given to facilities that will be vitally needed following a destructive earthquake. Hospitals, fire and police stations, communication and administration centers, water and fuel storage facilities, and transportation facilities and other lifelines, will be needed as much or more after an earthquake than before. The Federal

agencies involved, working through the Interagency Committee on Seismic Safety in Construction, will develop special guidelines for ensuring the serviceability of these facilities after a destructive earthquake. These guidelines will then be considered for new facilities of this type constructed or financed by the Federal government.

To illustrate this point, the grant and Federal-aid programs of the Department of Transportation rely upon existing national or local codes for design requirements to provide resistance to seismic forces. The fact that these codes do not provide adequate consideration for some of the special types of structures used in transportation structures has been recognized. The Federal Highway administration, for example, has been working actively with the State of California and the American Association of State Highway and Transportation Officials to develop improved seismic requirements for bridges and tunnels, and has sponsored research on these matters to provide an adequate technological base. This work has been coordinated with the National Science Foundation and other Federal agencies engaged in such research.

Reducing Risks Through Public Information and Participation

Exchange of information is the single most important element and will be the catalyst, in motivating the vast array of individuals who must take actions - mostly voluntary - to effect reduction of earthquake hazards. Information must flow in many directions among the public, professionals, research workers, and public officials. Leaders of business and industry must be aware of risks; research workers must be aware of needs, and professionals must be aware of new developments. The public must be kept informed in order to support local action, and public officials must be kept informed in order to take leadership. No single administrative mechanism or agency can provide all the necessary channels for disseminating information on earthquake hazards. There are many existing capabilities that can be used for transmitting earthquake information; the extensive information and education programs of the Department of Agriculture are but one example. Examples of existing mechanisms for transmitting technical data and information include the National Technical Information **Service** and Environment Data Service of the Department of Commerce and the publication program of the U.S. Geological Survey.

All Federal agencies implementing actions or supporting research must communicate with those affected of their actions and the results of their work. It will be the role of the lead agency to monitor, and stimulate as needed, the flow of information among research workers, planners and designers, the construction industry, public officials, and the public. Communication with key groups in the society, particularly engineers architects, planners, and building and emergency **preparedness** officials is important: the development of earthquake hazards reduction training programs for these groups would be especially fruitful. Free flow of data and ideas among research workers is crucial to the success of the research program. The lead agency will seek to identify areas where communication among these groups can be strengthened and to effect it.

In carrying out its many functions the lead agency must be aware of new research results, the success or failure of various mitigation programs, and the status of all the earthquake hazard reduction actions throughout the Nation. To achieve this end it must develop mechanisms to allow for participation in and periodic review of its program by appropriate representatives of State and local governments, the public, and the professional and research communities. These mechanisms and other procedures for the dissemination of information will be included in the work plan to be prepared by the lead agency.

Expanding Understanding Through International Cooperation •

The United States has neither the greatest nor the least exposure to earthquake hazards among the nations of the world. The frequent occurrence of destructive earthquakes around the world presents a two-fold humanitarian responsibility for the American people, first to assist in times of tragedy, and second to share information useful for mitigating the hazard. Lessons can be learned from earthquakes, foreign and domestic, that can be of value in mitigating hazards from future earthquakes. Several nations have earthquake research and hazard mitigation programs that are in some ways more advanced than those of the United States. Through continual and broadened cooperation with these nations we can learn much.

The Agency for International Development has a continuing responsibility to provide other nations and peoples with information that may help them moderate the impacts of earthquakes and to provide and coordinate Federal assistance when destructive earthquakes occur abroad. Several private professional organizations and Federal agencies have programs to study damaging earthquakes, both foreign and domestic. If gaps exist in the present programs, then the lead agency should identify them and assist in providing a means to fill them.

IMPROVING OUR KNOWLEDGE AND CAPABILITIES

In Fiscal Year 1978, the Nation embarked on a substantially increased program of research for earthquake prediction and hazards mitigation. This program, carried out by the U.S. Geological Survey and the National Science Foundation, is aimed at improving our fundamental capabilities to mitigate earthquake hazards. The full value of this program can be obtained only if it is continued at its present level of effort for several years, at least through Fiscal Year 1983. The main elements of the program are:

- o Fundamental studies - research into the basic causes and mechanisms of earthquakes.
- o Prediction - forecasting the time, place, magnitude and effects of an earthquake.

- o Induced Seismicity - prevention or modification of an inadvertently induced or natural earthquake.
- o Hazard Assessment - identification and analysis of the potential for earthquakes *within* a region, their frequency and their effects.
- o Engineering - design and construction of structures for acceptable performance during and after an earthquake.
- o Policy research - impacts of earthquakes on the community and options for dealing with them.

The technological base for mitigating earthquake hazards is far from complete. Some techniques, such as earthquake prediction and control, are still at an embryonic stage. In contrast, some techniques for earthquake hazard evaluation and engineering design have already been developed to a high degree but have not yet been applied to my hazard-prone regions. The delineation of active faults, for example, is a partially developed technique, the results of which are already being used as a basis for planning decisions. Because these techniques are in various stages of development, the results from research on earthquake prediction and hazards mitigation will become available on a variety of time scales.

Several other Federal agencies have ongoing research or service programs which, in addition to the programs aimed at the application of results discussed below, contribute to an understanding of the fundamental problems related to earthquakes. Examples include the geodetic survey and data service programs of the National Oceanic and Atmospheric Administration, the space geodesy program of the National Aeronautics and Space Administration, seismology programs of the Department of Defense, and programs of the Nuclear Regulatory Commission and the Department of Energy, among **others**.

Effective application of the emerging results from the research programs of the Geological Survey, the National Science Foundation and other Federal agencies will require development of capabilities through applied research and development in a number of mission agencies. Opportunities for improving capabilities for utilization in these agencies must be identified and considered, and programs of applied research selectively reinforced to ensure the effectiveness of the actions for earthquake hazards reduction taken by the respective agencies. Examples of the kind of applied research required may include the improvement, development, and testing of earthquake design provisions for complex structures other than buildings, such as bridges, dams, tunnels, reactors, and other facilities. The lead agency will play a key role in working with the agencies to identify these opportunities and in developing an overview of the entire program. In addition, the research program will be periodically reviewed by the Office of Science and Technology Policy.

ECONOMIC, FINANCIAL, AND BUDGETARY CONSIDERATIONS

The objectives of the National Earthquake Hazards Reduction Program and the tasks developed to achieve them provide a basis for actions that will reduce loss of life and maintain the functioning of the economy in the event of an earthquake. The challenge before us is to foster policies that rationally and equitably assess the importance of earthquake impacts in relation to the benefits of carpeting economic and social allocations of resources. The incremental costs in future construction to accommodate the appropriate seismic resistant requirements is very small in comparison with the cost of correcting *past* deficiencies. As mentioned above, the cost of retrofitting even Federal buildings alone – not to mention others – would be astronomical. Through the coming decades many hazardous buildings will be replaced in the natural course of events by buildings built to modern earthquake resistant standards, **because the** older buildings have finished their useful lives. These two considerations – astronomical costs of retrofitting whole classes of buildings, *on the one hand*, and the normal, gradual replacement of hazardous buildings, *on the other* – illustrate the need for an evolutionary strategy based on the identification and the mitigation of the highest risks – those risks judged to be unacceptable. The unacceptable risk concerns the functioning of the economy. There must be no question that the economic and financial system will survive a catastrophic earthquake. But in our definition of 'unacceptable risk' the overall budgetary picture must be kept sharply in focus.

The program set out here attempts throughout to balance overall economic priorities. We, **as** a Nation, currently face substantial loss of life and property should a large earthquake occur today. The Program described here will not reduce the risk overnight. That cost would be unacceptable. Instead the Program attempts to identify those risks that are simply unacceptable, to eliminate those, and to work gradually through time to achieve a National posture in which we are less and less susceptible to the threat of earthquakes. This Federal program is best approached on a time scale of decades at a reasoned level, rather than at a high rest, crash effort out of proportion with the extent and immediacy of the problem. Several difficult financial problems about earthquake hazards and their reduction remain unsolved. The lead agency will undertake studies to examine these problems, including:

- o Develop means to ensure a viable financial system in the event of a truly catastrophic earthquake. Preparations are currently made to ensure the viability of the financial system in the face of disasters such as nuclear attack. If a catastrophic earthquake would present different problems, these must be identified and appropriate preparations must be made.

- o Understand the impact of an earthquake prediction on financial institutions and private investment. A credible earthquake

prediction made several ninths or more in advance of the predicted event might lead to severe stresses in the financial and investment systems. The nature of these stresses must be identified so that remedies can be devised in advance.

- 0 Explore the utilization of financial mechanisms within the public and private sectors, including Federal loan, loan-guarantee and grant programs, to effect earthquake hazards reduction. Although significant leverage for mitigation actions exist through these mechanisms, a potential for *serious* dislocation also exists. Consequently, a cautious, studied approach is required.

Assisting the lead agency in these studies will be the Federal Preparedness Agency and the Department Of the Treasury. Assistance will also be requested from the Federal Reserve Board, Federal Home Loan Bank Board, Federal Deposit Insurance Corporation, Farmer's Home Administration, Federal Insurance Administration, the HUD Office of Housing, and the Small Business Administration. The result of these studies will be available by March 1980.

The role of insurance as a means to compensate victims and encourage earthquake mitigation is potentially great. While residential and commercial earthquake insurance is currently available, it is not widely purchased. Serious questions exist about the capacity of the insurance industry alone to absorb the cost of a catastrophic earthquake if such insurance were widely purchased. The Federal Insurance Administration, in cooperation with the lead agency and other appropriate agencies, will undertake a study of earthquake insurance.

Federal expenditures for earthquake hazards reduction must be weighed carefully and balanced against competing national needs. The highest priority tasks, defined by their ability to effect a reduction in the problem areas that present the greatest risk, will receive the principal budgetary attention.

The lead agency will assist the Office Of Management and Budget in reviewing budgets for earthquake related matters. Coordinative mechanism to accomplish this effort will be identified in the work plan that will be prepared. In general, however, the allocation of the resources to undertake efforts in the earthquake hazards reduction field that fall within the mission responsibilities of each agency will be considered along with that agency's budget. The Office will be concerned primarily with questions of overall balance, prevention of duplication, and filling of gaps. The Federal program will be balanced and strive to allocate neither too little nor too much to earthquake hazards reduction and

will adapt to developments in research and experience. The first task in this regard will be to address the Fiscal 1980 budgetary requirements for priority actions established in this plan.

RESPONSIBILITIES FOR IMPLEMENTING THE PROGRAM

Responsibilities for implementing the Earthquake Hazards Reduction Program are shared among Federal, State, and local government and diverse groups within the private sector. The Program identifies the roles and responsibilities for Federal agencies and recommends the appropriate roles for State and local government and the private sector as follows:

Federal Responsibilities

A central focus for leading and coordinating the National Earthquake Hazards Reduction program is needed. Currently the President's Reorganization Project is considering options for the organization of the Federal activities in disaster mitigation and response. Pending decisions resulting from this study, a lead agency will be named. This will be accomplished within 300 days from the date of enactment of the Earthquake Hazards Reduction Act of 1977.

The principal roles and responsibilities of the lead agency include:

- o Stimulate and coordinate actions to reduce earthquake hazards within the Federal Government and throughout the Nation.
- o Provide leadership of the Federal Interagency Committee on Seismic Safety in Construction to:
 - develop seismic design and construction standards for Federal projects;
 - develop guidelines to ensure serviceability following an earthquake of vital facilities constructed or financed by the Federal government;
 - develop guidelines that provide for independent and State and local review of seismic considerations in the construction of critical facilities constructed and financed by the Federal government, where appropriate

- o Develop guidelines for the inclusion of earthquake hazards reduction activities in ongoing Federal programs.
- o Develop a strategy to identify existing Federal buildings and other structures that pose unacceptable earthquake related risks.
- o Coordinate the development of guidelines for the consideration of seismic risk in the development of Federal lands.
- o Maintain liaison on earthquake-related matters with regulatory agencies such as the Nuclear Regulatory Commission and the Federal Energy Regulatory Commission.
- o Develop mechanisms for the participation in and periodic review of the National program by appropriate representatives of State and local governments, the public, and professional and research communities.
- o **Review and update periodically the research and implementation plans** to assure that they reflect the latest developments and objectives.
- o Prepare and submit an annual report on the National Earthquake Hazards Reduction program to the president for transmittal to Congress.

The principal roles and responsibilities for the Federal agencies as they relate to this program include:

Office of Science and Technology Policy

- o Review periodically the research program.

Department of Agriculture

- o Participate through the Federal Interagency Committee on Seismic Safety in instruction to develop seismic design and construction standards for Federal projects and related guidelines.
- o Work with professional organizations, model code groups, and State and local officials to establish appropriate local seismic requirements to be followed in Federal aid, grant, and loan programs.
- o participate in the development of guidelines for the consideration of seismic risk in the development of Federal lands.
- o Assist in the dissemination of information about earthquake hazards reduction activities through existing channels within the agencies of the Department.

Department of Commerce

- o National Bureau of Standards
 - Assist and cooperate with the Department of Housing and Urban Development, other Federal agencies (particularly those involved in research), National Institute of Building Sciences, professional organizations, model code groups, and State and local building departments, in continuing the development, testing, and improvement of model seismic design and construction provisions suitable for incorporation in local codes, standards, and practices.
 - Research on performance criteria and supporting measurement technology for earthquake resistant construction.
- o National Oceanic and Atmospheric Administration
 - Operate the tsunami warning network and issue tsunami warnings.
 - Conduct geodetic surveys through the National Geodetic Survey.
 - Provide data to researchers and the public through the Environmental Data Service.

Department of Defense

- o Participate in the Federal Interagency Committee on Seismic Safety in Construction to develop seismic design and construction standards for Federal projects and related guidelines.
- o Work with the lead agency and other Federal agencies in developing and testing a strategy to identify Federal structures that pose unacceptable seismic risks.
- o Initiate corrective action where existing agency facilities pose unacceptable seismic risks.
- o Corps of Engineers
 - Participate in the Federal Interagency Committee on Seismic Safety in Construction to develop seismic design and construction standards for Federal projects and related guidelines.
 - Assess potential vulnerability of selected non-Federal dams to earthquakes and develop recommendations for additional seismic investigations as required.
 - Participate in the development of guidelines for the consideration of seismic risk in the development of Federal lands.

Department of Energy

- o Participate in the Federal Interagency Committee on Seismic Safety in Construction to develop seismic design and construction standards for Federal projects and related guidelines.
- o participate in the development of guidelines for the consideration of seismic risk in the development of Federal lands.

Department of Housing and Urban Development

- o Participate in the Federal Interagency Committee on Seismic Safety in Construction to develop seismic design and instruction standards for Federal projects and related guidelines.
- 0 Work with Federal research activities, professional organizations, model code groups, and State, and local officials and planners to establish appropriate local seismic requirement guidelines to be follow in Federal aid, grant, and loan programs.
- 0 Cooperate with other Federal agencies, State and local governments, and private sector agencies in the conduct of appropriate research to improve building codes and other mitigation measures.
- 0 Federal Disaster Assistance" Administration
 - Prepare Federal; earthquake contingency plans and assist State and local governments in the preparation of their **plans.**
- o Federal Insurance Administration
 - Undertake a study of the appropriate role of insurance in mitigating the impactS of earthquakes.

Department of Interior

- o Participate in the development of guidelines for the consideration of seismic risk in the development of Federal lands.
- o Bureau of Reclamation
 - Participate in the Federal Interagency Committee on Seismic Safety in instruction to develop seismic design and construction standards for Federal projects and related guidelines.

o Geological Survey

Conduct research on the nature of earthquakes, earthquake prediction, hazards evaluation and delineation, and induced seismicity.

Evaluate, with the advice of National Earthquake Prediction Evaluation Council, earthquake predictions.

Prepare national seismic risk maps.

Evaluate and delineate earthquake hazards on a regional basis.

Provide data and information on earthquake occurrences and hazards.

Department of State

• Agency for International Development

– Coordinate *assistance to* other nations stricken by earthquake disaster.

– Coordinate assistance to other nations in developing strategies for mitigating earthquake hazards.

Department of Transportation

o Participate through the Federal Interagency Committee on Seismic Safety in Construction to develop seismic design and construction standards for Federal projects and related guidelines.

o Work with the lead agency and other Federal agencies in developing a strategy to identify Federal structures that pose unacceptable *seismic risks*.

o Initiate corrective action where existing agency facilities pose unacceptable seismic risks.

o Work with professional associations, model code groups, and State and local officials to establish appropriate local seismic requirements to be followed in Federal aid and grant programs.

o Cooperate with other Federal, State, and private agencies in the conduct of appropriate research to provide an adequate technological base for standards for projects, such as bridges and tunnels, not covered by common building codes.

Independent Agencies

General Services Administration

- o Participate in the Federal Interagency Committee on Seismic Safety in Construction to develop seismic design and construction standards for Federal projects and related guidelines.
- 0 Work with the lead agency and other Federal agencies in developing a strategy to identify Federal structures that pose unacceptable seismic risks.
- 0 Test and improve the strategy for identifying potentially hazardous Federal structures.
- 0 Initiate corrective action where existing agency facilities pose unacceptable seismic risks.
- 0 Develop guidelines for consideration of seismic hazard in the leasing of buildings.
- 0 Federal Preparedness Agency
 - Assist in the studies of financial problems related to earthquakes.

National Science Foundation

- o Support fundamental research studies on earthquakes, and basic and applied research on earthquake engineering and policy.

Veterans Administration

- o Participate in the Federal Interagency Committee on Seismic Safety in Construction to develop design and instruction standards.
- 0 Work with the lead agency and other Federal agencies in developing a strategy to identify Federal structures that pose unacceptable seismic risks.

The discharge of these responsibilities by the above principal agencies will require the participation, assistance, and cooperation of many agencies and units of the Federal Government: among these are:

Small Business Administration
Nuclear Regulatory Commission
Environmental Protection Agency
Department of Health, Education and Welfare
National Aeronautics and Space Administration
Department of Treasury

These agencies and others as identified by the lead agency will assist it and the agencies with principal responsibilities to achieve the purpose of this plan.

Under existing authority, many Federal agencies have important responsibilities for design and construction or for emergency preparedness, response, and relief. These responsibilities will continue undiminished. Where deficiencies are identified, steps will be taken to remedy them. Most Federal responsibilities described under this program can be carried out under existing legislative authority or by executive assignment. Should specific needs for additional legislation to implement this Program be identified, these needs will be communicated to the Congress.

State and Local Responsibilities

State and local governments bear the responsibilities for preparedness, response, warning, regulating construction, and regulating the use of land. The National Earthquake Hazards Reduction Program must, to be successful, include the development of State and local strategies for defining and meeting their responsibilities in earthquake hazards mitigation.

The most severely threatened States need to analyze their own problems **and** find their own solutions. This process should include the modification of decision making processes to include considerations of earthquake hazards where appropriate. Many sources of funds are available to States, local governments, and the private sector through Federal aid, grant, loan, and loan guarantee programs. Most of these Federal programs base their requirements for earthquake considerations on local codes and regulations. Rather than impose universal standards on local governments, it is more appropriate for the Federal agencies supplying the aid, grants, loans, and loan guarantees to work with professional organizations and State and local officials to encourage the development and adoption of appropriate seismic provisions in local codes. States need to assess their current posture and to identify opportunities to reduce their exposure to hazards through modification of existing procedures or regulations. Under existing authority and regulations there are several Federal aid programs that can be used, at the option of the recipient, to mitigate earthquake hazards. The example is the Community Development Block Grant Program, which can be used for a variety of mitigation measures, in many instances, including the acquisition of lands or facilities in seismic hazard zones, identification and mapping of local hazard zones for land use planning, and retrofitting, razing or relocation of structures.

One area of particular concern to State and local government is how, in the future, to respond to an earthquake prediction. Effective utilization of a scientifically credible earthquake prediction for the good of the public will depend on the kinds and extent of defensive action taken in response to the prediction. The responsibilities to warn the people about imminent danger from a nature hazard and to direct them on how to take defensive action are principally State and local government functions, assisted as appropriate by the Federal

government. The responsibility for the declaration of an "emergency" after an earthquake prediction rests with the Governor of a potentially affected State. He may also request the declaration of an "emergency" or a major disaster" by the President, according to the provisions of the "Disaster Relief Act of 1974" (P.L. 93-288). If the President accedes to this request, Federal agencies will then initiate appropriate actions under this Act. The States should review existing legislation defining the responsibility and liability of Governors other officials in regard to the evaluation of predictions and issuance of warnings, and take steps to remedy any existing deficiencies. In some cases this is already underway.

The opportunity exists for State and local governments to mandate, through legislation, including the adoption of building codes and zoning ordinances, earthquake hazards reduction actions on private property. *Much* has already been said about the importance of State and local codes and standards for the construction of buildings resistant to earthquakes. In the rapidly urbanizing areas of the country susceptible to earthquakes, regulation of land use through building codes or local zoning is the most effective way to avoid some earthquake hazards. The people of California, through the adoption of a variety of State and local regulations, have provided outstanding, if not universally applicable examples of what can be done. The State Planning Law requires a "Seismic Safety Element" as a part of the General Plan of each city and county. The Alquist-Priola Geologic Hazards Zones Act requires the State Geologist to delineate zones along active faults in which special geologic studies must be carried out prior to development. The Field Act, passed following the collapse of **several** schools during the 1933 Long Beach earthquake, has been extremely successful in improving the design and instruction of schools to resist earthquakes, as most recently demonstrated by the performance of school buildings during the 1971 San Fernando earthquake.

In California local communities have also played a strong role. The seismic provisions in the building codes in some California communities provide examples for other parts of the country with high seismic risk. The ordinances enacted by some local communities to reduce the hazards from parapets, a major life hazard should debris from parapets fall onto a crowded street below, demonstrate what can be done by communities who face their earthquake problems squarely. But appropriate application of the California experience in other seismically active parts of the country cannot be mandated by Federal fiat. State and local action is required. The identification of opportunities for State and local governments to mandate hazards reduction and the decision to act on these opportunities requires the leadership of State and local officials and the resolve of the citizenry.

The local, State, and Federal roles in earthquake hazards reduction are strongly interrelated. The Federal government has important roles in supporting State and local efforts through the provision of information, the development of guidelines and standards for some facilities, encouragement, and financial support as described earlier. To achieve overall earthquake hazards reduction the State and local governments must identify and address their own local earthquake problems.

Private Responsibilities

As can be seen by many **key** points in this Program, the success of a national effort to mitigate losses and suffering from earthquakes rests largely in private hands. The role of the Federal government is limited as are the roles of State and local governments.

Business, industry, and the services sector play the lead roles in constructing new buildings and in developing land. Seismic design provisions in local codes, be they modern or outdated, are minimum standards. Thoughtful businessmen interested in providing a safe environment for their consumers and employees, and in protecting their capital investment will want to give careful consideration to earthquake hazards in planning, constructing and maintaining their facilities. The *success* of much of this program requires the leadership of these elements of the private sector. The interest of business and industry must be maintained in order to accomplish our objectives. In some instances short-term profits may be *reduced* to increase the long-term benefits of saving lives, reducing property damage, and maintaining the functioning of the economy in the face of a major earthquake. Private financial institutions, including lending agencies and insurance companies, must continue their important role. These institutions **may** identify opportunities to effect hazards reduction that can be beneficial to all concerned.

Voluntary organizations have traditionally played a major part in providing specialized assistance to victims of disasters. The Nation places continuing reliance on the efforts of these citizens. Opportunities exist for these same organizations to provide even greater public service by initiating actions to mitigate losses before the disaster, particularly through the dissemination of information. This capacity will be even more important as the ability to predict earthquakes develops. Money and people do not add up to capability. What is required is the development of interest, experience and expertise.

Individuals and organizations from the research and professional communities, especially practicing professionals, have developed the degree of awareness of earthquake hazards that we have today. Government must work to assist, rather than replace, these efforts. Professional organizations have a continuing and vital role to play. The improvement of model codes, their testing, and their adoption by State and local governments require the vigorous participation of the professional community. Of course any code is only as good as the practice used to carry it out. High quality workmanship and improving practice are responsibilities shared by all elements of the construction industry and local building officials.

The professional organizations also have a particularly important part in communication the the exchange of information. Opportunities for training programs focused on techniques for earthquake hazards reduction should be identified and carried out through these organizations.

Ultimately the success or failure of the National Earthquake Hazards Reduction Program will depend on the resolve of the American people, particularly in the private sector. The expenditure of dollars does not make a successful program. The enthusiasm, the expertise, the willingness to work, and the perseverance of the **people** are required to make the program effective.

CONCLUSION

A reduction of the earthquake hazards faced by the Nation cannot be achieved overnight - or even in a few years. It will require continuing effort on the part of many individuals and institutions in government, and the private sector. Many actions can be taken today. Other actions must await the outcome of research. The reduction of earthquake hazards has an important place among our national priorities, and we must begin now. The National Program for Earthquake Hazards Reduction outlines an aggressive program to reduce these hazards - a program that is balanced against *our* other national needs and is responsive to the intent of Congress.