While the Field Guides are of international utility, another important set of documents is local in nature. Each city will have particular buildings, dams, pipelines, and emergency service facilities whose response to a strong quake will be of special interest locally or perhaps nationally, e.g., structures designed in accordance with recent code changes, structures selected as typical for the locality, and prevailing hazardous landslide conditions. Information on local geological and soil characteristics will also be of extreme interest. *Data banks* containing maps, plans, and other basic information should be maintained for all participating localities for prompt access by field investigators. The basic responsibility for maintaining these data banks should reside with local government.

These procedures and tools will be to no avail without the rapid post-earthquake promulgation of findings, following professional study and analysis. The new findings need to be assimilated rapidly into the state-of-the-art. Report publication, symposia, and short courses should be planned as integral steps in post-quake research in order to maximize the learning.

Finally, there is a clear need for coordination among the organizations that stand to gain the most from and to contribute the most to earthquake research. Investigations of damaging earthquakes in the United States have varied from routine qualitative inspections to detailed studies involving numerous individuals and government and private agencies. When large numbers of people and agencies have been involved, their effectiveness has suffered from a lack of overall coordination. For example, following the 1971 San Fernando, California, earthquake, there was excessive duplication of effort on survey reports. Also, energy and money were expended on work whose chief product was the relearning of old lessons. On the other hand, a number of critical investigational areas either were overlooked or were not covered in sufficient detail. EERI served a coordinative role following the San Fernando, Managua, and Guatemala earthquakes and is set up to do so in the future, using the philosophy of "Learning from Earthquakes."

The Concerned Professions

In the *building engineering* field, the first investigations which involved detailed analyses of the structural behavior of earthquake-resistive construction followed the two 1952 Kern County, California, earthquakes. This was the first time that significant numbers of earthquake-resistive buildings were tested, because California building regulations requiring earthquake-resistive design were not widely adopted until after the Long Beach earthquake of 1933. The 1952 Kern County, 1964 Alaska, and 1971 San Fernando shocks have been the sites of field testing of modern U.S. earthquake-resistive design methodology.

Essentially, earthquake-resistive design is a procedure wherein changes in criteria and methodology are made based on analyses of building behavior in actual earthquakes and on the results of research done between earthquakes. In several areas of the country, some older buildings have been modified and strengthened to resist earthquake forces, and the behavior of these older buildings in future earthquakes is of interest. However, the greatest opportunities to advance the state-of-the-art of building earthquake engineering have come from real earthquake tests of those structures in which the latest concepts of lateral-force design have been incorporated.

Due to the emphasis on structural behavior in past investigations, the state-of-the-art of the *structural* aspects of building earthquake engineering is far ahead of that of other aspects such as mechanical, electrical, and architectural. However, following the 1964 Alaska and the 1971 San Fernando earthquakes, data on the behavior of some of these nonstructural building systems were gathered and analyzed. There is a need for a much greater investigative effort on these aspects, as the overall behavior of these nonstructural systems has been poor and the associated hazards great.

In the *lifeline earthquake engineering* field, which includes research on the earthquake behavior of public utilities, transportation, waste disposal, flood control, and communication systems, relatively little earthquake investigative effort was made in the United States prior to the 1971 San Fernando earthquake. The state-of-the-art in earthquake engineering for lifelines is therefore generally less advanced than that for buildings. However, there are exceptions to this statement in the larger California utilities. Significant progress was made following the 1971 San Fernando earthquake and a Technical Council on Lifeline Earthquake Engineering has been formed by the American Society of Civil Engineers (ASCE) to encourage further research and progress in this area.

Geoscience investigations are concerned with obtaining new insights and new data on the nature of the earth and on the character of earthquakes by means of geologic, seismologic, and geodetic investigations. The geologist is interested in the earth's near surface as it both influences and is influenced by earthquakes; the seismologist is concerned primarily with quantification and understanding of the earth's geophysical processes; the geodesist is concerned with the changes in position of points on the earth's surface.

Interfaces of geosciences with engineering investigations occur in studies of strong-motion records, permanent ground deformations, estimation of shaking intensities, and aftershocks. Unfortunately, there often has been a considerable time lag of several months between the occurrence of an earthquake and the availability of some of the scientific information needed by the engineers; there is a need for speeding up this process.

Earthquake investigations in the *social science* fields have developed slowly, often on an ad hoc basis as resources have permitted. Such efforts have been largely unsystematic and inadequately integrated into other field investigations. There has been a growing interest in the social impact of earthquakes due to extensions of general research on natural hazards, mounting losses, and the perceived consequences of damaging earthquakes in large urban areas.

Early investigations in the social sciences consisted mainly of reports on the operations of emergency services. Later efforts, particularly those made in response to the 1964 Alaska earthquake, attempted to deal with more fundamental factors. Further research on the 1971 San Fernando and 1972 Managua quakes has produced new information of relevance to the social and managerial sciences. General areas of concern include the following:

1. Emergency responses by individuals, groups, and organizations
2. Secondary economic effects, such as unemployment, disruption of financial and marketing systems, insurance problems, and changes in property values
3. Problems of social control, such as evacuation, looting, relocation, and related measures
4. Analyses of casualties to help determine under what conditions deaths and injuries occurred
5. Assessments of impacts on the social structure, such as population mobility, psychological problems, and the various economic losses

LEARNING FROM EARTHQUAKES

Planning

Both pre- and post-earthquake planning actions are necessary for *all* organizations interested in earthquake investigations. The main planning steps are listed below and are covered in detail in the Summary of EERI Earthquake Response Procedures in Appendix I-B. The complete procedures may be obtained from the EERI Secretary.

Pre-Earthquake Planning Actions:

1. Develop and adopt response and coordination procedures
2. Establish locations for field headquarters (Clearinghouse) or communications centers and provide necessary equipment and supplies
3. Train staffs and investigators
4. Fix responsibilities for investigations (Coordination Plan)
5. Establish and maintain data banks of the following information:
   a. Geological and surface soils data maps
   b. Locations of seismographic stations and sources of data
   c. Lists and location maps of instrumented structures
   d. Lists and location maps of structures (such as buildings, dams, nuclear plants, bridges) deserving of detailed analysis. For each of these structures, assemble or note location of construction drawings, specifications, design calculations, foundation and geological reports, and names of architects and engineers
   e. Maps and brief descriptions of the major lifeline systems and names of chief engineers and their telephone numbers
   f. Street maps and U.S. Geological Survey (USGS) topographic quadrangles

   All of the above material should be assembled and stored at the locations pre-designated as Clearinghouses or Field Headquarters. Periodic checking and updating of this information are needed.

Post-Earthquake Planning Actions:

1. Activate response and coordination procedures
2. Establish Field Headquarters (Clearinghouse)
3. Conduct preliminary reconnaissance surveys to determine overall scope of damage and to identify subjects and areas deserving additional investigation
4. Provide on-the-spot training for local investigators
5. Hold preliminary coordination meetings to (a) discuss the results of the reconnaissance and other preliminary surveys, (b) decide on additional investigations which should be made, and (c) fix responsibilities for these investigations
6. Conduct investigations with research teams representing the organizations accepting responsibilities in advance and at the coordination meeting
7. Analyze research data and prepare reports
8. Rapidly disseminate to the concerned professions critically needed information, including the results of the reconnaissance survey
9. Hold national or international conferences, if justified, to present the results of the research studies

APPENDIX I-A: STAFF AND ADVISORS FOR "LEARNING FROM EARTHQUAKES"

The work leading to the publication of the Field Guides was done by a small staff and a large group of advisors serving on three advisory panels. Together, these people supplied varied technical backgrounds and extensive field investigation experience. The individuals are listed below. Locations are in California, except as otherwise noted.

Staff

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National Science Foundation Representatives

Charles C. Thiel

John Scalzi

Charles G. Culver (with National Bureau of Standards)

APPENDIX I-B: SUMMARY OF EERI EARTHQUAKE RESPONSE PROCEDURES

INTRODUCTION

The EERI Earthquake Response Procedures have been developed as part of the "Learning from Earthquakes" project. These procedures are based on experiences in past investigations, and they provide checklists and frameworks for an effective response. However, each earthquake will have unique features, and mature judgments by experienced professionals will be required to adapt the procedures to actual events. Modifications of these procedures will be made based on experience and further progress in the "Learning from Earthquakes" project.

The general EERI Earthquake Response Procedures apply to earthquakes occurring anywhere in the world, and include *all* aspects of investigations. The *special plans for California* earthquakes are in cooperation with the California Division of Mines and Geology (CDMG) EERI has engineering responsibilities and CDMG has geoscience responsibilities in these procedures.

Modifications and expansion of these special California procedures for earthquakes in other states and countries will be accomplished during the implementation phase of the "Learning from Earthquakes" project.

GENERAL EERI EARTHQUAKE RESPONSE PROCEDURES

The general EERI Earthquake Response Procedures apply to destructive earthquakes which occur anywhere in the world. EERI responsibilities under these procedures include scientific, engineering, and socioeconomic aspects. Significant aspects of the general plan are as follows:

1. Various points where decisions must be made by EERI officers regarding the scope of the responses and investigations.
2. Designation of the Earthquake Investigation Coordinator (EIC) and the Reconnaissance Team (RT).
3. Establishment of a field investigation headquarters by the EIC (or the Clearinghouse, in the case of a California earthquake).
4. While the primary mission of EERI is the investigation of the effects of the earthquake, it is recognized that there is sometimes an urgent need to determine the safety of buildings. In the past, when requested by local authorities, EERI has suggested procedures to assist the local building officials in determining the safety of buildings. The liability of those making safety inspections is recognized. It has been the practice of local communities to deputize inspectors.
5. Early holding of a preliminary coordination meeting to exchange information, discuss important aspects of the earthquake, and make tentative commitments regarding areas of responsibility for subsequent investigations (Engineering Coordination Plan for California earthquakes).

Table I-3 summarizes these procedures and provides a checklist of actions to be taken. It also lists those responsible for taking the actions indicated.

Table I-3: EERI Actions and Responsibilities Following a Destructive Earthquake

Action	*Responsibility (of)*
A. Destructive earthquake occurs anywhere in the world	
B. Obtain preliminary information from: 1. USGS National Earthquake Information Center (303) 234-3994 2. California Institute of Technology, Seismological Laboratory (213) 795-8806, x. 2295 3. University of California, Berkeley, Seismological Laboratory (415) 642-2160 4. Television and radio	1. Chairman of EERI Committee on Planning Earthquake Investigations: D. F. Moran (805) 642-7461 2. Alternate #1: F. E. McClure Office: (415) 642-1253 Home: (415) 254-8231 3. Alternate #2: J. F. Meehan Office: (916) 445-8730 Home: (916) 487-6235
C-1. Advise EERI officers 1. President: H.J. Degenkolb Office: (415) 392-6952 Home: (415) 564-7592 2. Alternate #1, Vice President, Anestis Veletsos Office: (713) 528-4141, x. 718 Home: (713) 729-4348 3. Alternate #2, Secretary, F. E. McClure Office: (415) 642-1253 Home: (415) 254-8231	Same as above
C-2. For California earthquake, staff Clearinghouse for engineering information in appropriate office of California Division of Mines and Geology (CDMG) or in alternate location	EERI Clearinghouse regional coordinators; response and staffing to be automatic according to procedure following
D. Make decisions on level of EERI initial response	1. President (Degenkolb) 2. Alternate #1, Vice President (Veletsos) 3. Alternate #2, Secretary (McClure) (with necessary Board concurrence)
E. Appoint EERI Earthquake Investigation Coordinator (EIC) and Reconnaissance Team (RT)	Same as above
F. Establish EERI Field Headquarters (for non-California earthquake); coordinate activities of the RT and other investigators, through the Clearinghouse	EIC
G. Suggest procedures to aid local building officials in determining building safety as requested and required	EIC

Table I-3 (continued)

Action	*Responsibility (of)*
H. Investigation by RT	EIC
I. Training and briefing of local investigators	EIC
J. Preliminary coordination meeting:	
1. For California earthquakes, to be held on first or second evening with CDMG meeting; Clearinghouse will advise on meeting time and place	CDMG representatives for California earthquakes
2. For non-California earthquakes, EIC will call the meeting at earliest time depending on progress of reconnaissance investigators; Field Headquarters to advise regarding time and place	EIC
K. Oral reports by RT	EIC and RT
L. Field investigations	Coordination by EIC; individuals, agencies, and organizations accepting responsibility
M. Prepare preliminary reports	Same as above
N. Prepare and publish reconnaissance report	EIC and RT
O. Additional coordination meetings (as required)	EIC
P. Additional investigations (if required)	Coordination by EIC; individuals, agencies, and organizations accepting responsibility
Q. Prepare additional reports (as required)	Same as above
R. Conference (national or international) on earthquake	Conference committee to be established by EERI President

SPECIAL PROCEDURES OF ENGINEERING CLEARINGHOUSE FOR CALIFORNIA EARTHQUAKES

Introduction

The concept of establishing an information Clearinghouse following damaging earthquakes in California was contained in recommendations in the First Report of the California Governor's Earthquake Council dated November 21, 1972. The principal functions of the Clearinghouse are to serve as a center for receiving information regarding damage reports and ongoing field investigations, and for releasing such information to those concerned. The Clearinghouse operation is intended to handle damage information in broad terms of damage to various buildings and utility types, and in various geographic areas. It is not intended to handle the individual building information necessary in order to determine structural safety, which is a function of the local regulatory agency. Clearinghouse responsibilities are divided between the California Division of Mines and Geology (CDMG) and

EERI. The CDMG is responsible for the seismological and geological aspects, and the EERI is responsible for the engineering aspects of the effort, including structures, utilities, transportation, communications, and soils. EERI has accepted the offer of CDMG to share their facilities for the Clearinghouse operations.

EERI response to Clearinghouse operations is planned to be automatic.

For earthquakes outside of California, a Field Headquarters will be established by the EIC. This Field Headquarters will serve essentially the same function as the California Clearinghouse, except that the CDMG will not be involved, and EERI's responsibilities will include all involved disciplines.

SPECIAL PLAN FOR THE COORDINATION OF ENGINEERING INVESTIGATIONS OF CALIFORNIA EARTHQUAKES

The need for coordination of early post-earthquake engineering inspections and studies for California earthquakes has been advocated by EERI and was contained in the First Report of the Governor's Earthquake Council. EERI was offered and has accepted the responsibility of the leading role in the implementation of the engineering aspects of this recommendation.

The CDMG has responsibility in California for the coordination of early post-earthquake geologic and seismologic investigations.

The purpose of the coordination plan is to maximize the learning from destructive California earthquakes by coordinating the efforts of the many individuals and organizations who will be making engineering investigations. This coordination plan is not intended to be restrictive but rather to avoid needless overlapping as well as the possibility of some areas not being properly investigated.

This coordination plan applies to investigations of the effects of destructive *California* earthquakes. However, a similar plan will apply for earthquakes in other states.

No attempt has been made to identify all of the numerous specific local jurisdictions such as building, fire, and police departments; sanitation districts; and water and power departments that will become involved. It is anticipated that these agencies will be identified and contacted immediately following the earthquake. The investigation responsibility assignments provide a prearranged framework for the coordination of early preliminary surveys and subsequent detailed investigations. Organizations which are listed first are considered to have the prime responsibility. Additional organizations in California and other states will be contacted as part of the implementation phase of the "Learning from Earthquakes" project. The EERI California Clearinghouse will serve as a message and information center for ongoing preliminary engineering investigations All investigators should maintain contact with the EERI Clearinghouse representative and keep him informed as to the type and scope of the investigations being made. In turn, the EERI Clearinghouse representative can advise those in the field and other interested parties regarding ongoing investigations, including preliminary results.

A preliminary coordination of subsequent detailed investigations will be accomplished at the preliminary *coordination meeting.* This meeting will be the first formal meeting of those involved or interested in the earthquake investigation and will be held on the first or second evening following the earthquake. Time and location of the meeting may be obtained from the Clearinghouse. Those who should attend the coordination meeting include the EERI Earthquake Investigation Coordinator (EIC), members of the EERI Reconnaissance Team (RT), persons staffing the EERI Clearinghouse, individuals and representatives of organizations which have made preliminary surveys, and those interested in further investigations. This meeting will be used to discuss the results of the preliminary investigations and to reach agreement on subjects deserving further detailed investigation. Responsibilities for further investigations will be discussed and agreed upon. This preliminary coordination meeting will be held in conjunction with the CDMG and will be chaired by their representative.

For earthquakes outside of California, the preliminary coordination meeting will be called and chaired by the EIC. Details of the meeting may be obtained from the EERI Field Headquarters.

Tables I-4 and I-5 are lists of participating organizations and investigation responsibility assignments primarily for California earthquakes. Similar lists for other states will be developed as part of the implementation phase of the "Learning from Earthquakes" project.

Table I-4: List of Organizations Participating In Engineering Investigations of California Earthquakes

Professional

- American Institute of Architects (California Council) (CAIA)
- American Society of Civil Engineers (ASCE)
  - ASCE Technical Council on Lifeline Earthquake Engineering (TCLEE)
- Association of Engineering Geologists (AEG)
- Consulting Engineers Association of California (CEAC)
- Structural Engineers Association of California (SEAOC)

Academic

- Earthquake Engineering Research Laboratory (EERL)—California Institute of Technology
- Massachusetts Institute of Technology (MIT)
- Stanford University (SU)
- Universities Council for Earthquake Engineering Research (UCEER)
- University of California, Berkeley (UCB)
- University of California, Los Angeles (UCLA)
- University of California, San Diego (UCSD)
- University of Illinois (UI)

Government and Military

Federal

- Federal Disaster Assistance Administration (FDAA)
- Federal Highway Administration (FHA)
- National Bureau of Standards (NBS)
- National Oceanic and Atmospheric Administration (NOAA)
- Nuclear Regulatory Commission (NRC)
- U.S. Army Corps of Engineers (COE)
- U.S. Geological Survey (USGS)

Table I-4 (continued)

California

- Department of Aeronautics (DA)
- Department of Housing and Community Development (CHCD)
- Department of Transportation (CT)
- Department of Water Resources (CDWR)
- Division of Mines and Geology (CDMG)
- Division of Oil and Gas (CDOG)
- Energy Resources Conservation and Development Commission (ERCDC)
- Office of Architecture and Construction (OAC)
- Office of Emergency Services (OES)
- Public Utilities Commission (PUC)
- Seismic Safety Commission (SSC)

Utilities

- East Bay Municipal Utility District (EBMUD)
- General Telephone (GTE)
- Los Angeles Department of Water and Power (LADWP)
- Metropolitan Water District (MWD)
- Pacific Gas & Electric (PG&E)
- Pacific Telephone & Telegraph (PTT)
- San Diego Gas & Electric (SDGE)
- Southern California Edison (SCE)
- Southern California Gas (SCG)

Associations and Institutes

- American Iron and Steel Institute (AISI)
- Insurance Services Office (ISO)
- International Conference of Building Officials (ICBO)
- Masonry Institute of America (MIA)
- Portland Cement Association (PCA)
- Western Oil and Gas Association (WOGA)

Table I-5: Investigation Responsibility Assignments for California Earthquakes

Area of Investigation	*Responsibility of*
Buildings—General	
Structural—General	SEAOC, NBS, IOC, OAC, EERI, ICBO
Masonry	MIA and above
Concrete	PCA and above
Steel	AISI and above
Non-Structural	SEAOC, NBS, ISO, OAC, EERI, ICBO, CAIA
Equipment	CEAC, SEAOC
Statistical loss data	ISO, SEAOC, NBS, MIT
Fire	ISO, ICBO
Buildings—Occupancy	
Dwellings and apartments	SEAOC, NBS, ISO, HUD, CHCD
Mobile homes	ISO
Hospitals	SEAOC, OAC, NBS, VA
Schools	SEAOC, OAC
Military	COE, Navy and Air Force
Nuclear	NRC, Owners
Special Structures	
Tanks (water, sewage, and petroleum)	TCLEE, EERI, ISO, Owners
Towers (radio, television, transmission)	SEAOC, Owners
Soils and Foundations	
Dams and reservoirs	CDWR, USGS, COE, Owners
Ground movements	CDMG, USGS, FHA, COE, CDWR, CT
Foundation soils	USGS, SEAOC, NBS, EERI, COE, ASCE
Soils-structure interaction	USGS, UCLA, EERI, SEAOC
Site amplification	USGS, CDMG, UCLA, EERI
Energy Systems	
Electric power	TCLEE, Utilities
Natural gas	TCLEE, Utilities
Oil	TCLEE, WOGA, Owners

Table I-5 (continued)

Area of Investigation	*Responsibility of*
Water Systems	
Potable water (including dams)	CDWR, TCLEE, USGS, COE, Utilities
Water for firefighting	ISO, Utilities
Storm drainage (including dams)	TCLEE, CDWR, USGS, COE, Local Districts
Sewage	TCLEE, Local Districts
Transportation Systems	
Railroads (including bridges)	TCLEE, Owners
Highways and roads (including bridges)	TCLEE, CDH, FHA, Local Districts
Mass public transportation	TCLEE, Owners
Airports	TCLEE, DA, Owners
Harbors	TCLEE, COE, Owners
Communication Systems	
Telephone	TCLEE, Utilities
Radio and television	Owners
Newspapers and magazines	Owners

The following sections, beyond the EERI California engineering co-ordination, may be useful for investigations in other areas.

Geoscience	
Geology	USGS, CDMG, Universities, Private Sector
Seismology	USGS, CIT, UCB, Other Universities
Geodesy	NOAA

APPENDIX I-C: REFERENCES TO REPORTS ON EARTHQUAKE INVESTIGATIONS

1. Agadir, Morocco, earthquake, 1960:
   The Agadir, Morocco, earthquake, February 29, 1960: American Iron and Steel Institute, New York, 1962.
2. Alaska earthquake, 1964:
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3. Caracas, Venezuela, earthquake, 1967:
   Hanson, R. D., and Degenkolb, H. J., 1969, The Venezuela earthquake, July 29, 1967: American Iron and Steel Institute, New York, 176 p.
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   Dutton, C. E., 1887-1888, The Charleston Earthquake of August 31, 1886: U.S. Geological Survey Ninth Annual Report.
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   a. Rosenblueth, E., 1961, Chilean Earthquakes of May, 1960: Their Effects on Engineering Structures: Revista Ingenieria, Mexico.
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10. Imperial Valley, California, earthquakes, 1940:
    Ulrich, F. P., 1941, The Imperial Valley earthquakes of 1940: Bulletin, Seismological Society of America, v. 31, p. 13-31.
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120, p. 1280-1294.
b. Oakeshott, G. B., editor, 1955, Earthquakes in Kern County, California, during 1952: California Division of Mines, Bulletin 171.
c. Steinbrugge, K. V., and Moran, D. F., 1954, An engineering study of the Southern California earthquake of July 21, 1952, and its aftershocks: Bulletin, Seismological Society of America, v. 44, 2B, p. 199-462.

12. Long Beach, California, earthquake, 1933:
Binder, R. W., 1952, Engineering aspects of the 1933 Long Beach earthquake: Proceedings of Symposium on Earthquake and Blast Effects on Structures, p. 186-211.

13. Managua, Nicaragua, earthquake, 1972:
a. Earthquake Engineering Research Institute, 1973, Managua, Nicaragua, Earthquake of December 23, 1972, Conference Proceedings, San Francisco, p. 528.
b. Earthquake Engineering Research Institute, 1973, Managua, Nicaragua, Earthquake of December 23, 1972, Reconnaissance Report.
c. Wright, R. N., and Kramer, S., 1973, Building Performance in 1972 Managua Earthquake: National Bureau of Standards Technical Note 897.

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