A MODEL "LIFELINES" APPROACH TO EARTHQUAKE PREPAREDNESS

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SUMMARY

This paper presents a case study of institutional coordination at the horizontal and vertical levels in lifelines planning for seismic disasters in San Bernardino County in Southern California. This is put in a systems framework for operations planning in earthquake contingencies of different magnitude. This "soft" approach is done in conjunction with earthquake mitigation strategies to decrease calculated risk through land-use planning and engineering solutions. The object is to increase acceptable, risk through emergency response measures by planning and effective implementation of operations for earthquake contingencies.

The great earthquake anticipated on the Southern San Andreas Fault presents an extraordinary threat to San Bernardino County. In addition to potential destruction of buildings the utilities and transportation systems are also at risk. These "lifelines" represent large capital investments which can be replaced only at great expense. More importantly, their destruction may cause loss of life through secondary disasters. Because of many factors, San Bernardino County approached the earthquake threat to their communities in a unique way. An experimental Project created by State and Federal initiatives (Southern California Preparedness Project) joined with the county in developing an earthquake preparedness plan, which is described in this paper (Ref. 1,2).

The approach used in this unique partnership was particularly comprehensive. The planning went beyond those public agencies over which the county government had jurisdiction to include "special districts" and private companies and associations. Another aspect of this process was planning for contingencies never before considered.

The lifelines committee and the transportation committee were formed in such a fashion as to be representative of the local utilities and transportation agencies rather than exhaustive. The result is action plans coordinated "vertically" within larger companies like Southern California Gas Company and Southern California Edison. At the local level the plans are coordinated between the utilities and transportation agencies. This can be symbolized as integration in a horizontal dimension. Finally, the plans are coordinated in a temporal (time) dimension.

Each "actor" faces specific earthquake challenges, vastly different resource bases they can call upon and unique roles in the local social and economic communities. The San Bernardino plan is offered as a model for others to adapt to their needs.

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INTRODUCTION

The need for effective emergency planning and implementation for utility, transportation and emergency facilities lifelines is a serious one and has to be done in conjunction with technical aspects of lifeline earthquake engineering for mitigating the disastrous effects of earthquakes. The area of lifeline earthquake engineering has made swift progress with the start of the "Technical Committee on Lifeline Earthquake Engineering by American Society of Civil Engineers (ASCE-TCLEE" on July 15, 1974 (Ref. 3,4). ASCE-TCLEE has identified the research needs in 1979 (Ref. 5). The subject of Transportation and Lifelines as well as Energy Generation and Storage Facilities was dealt in two sessions at the International Earthquake Convention at Los Angeles in February, 1983 (Ref. 6). Recently, in April/May, 1983, U.S. Federal Emergency Management Agency through its National Emergency Training Center has training courses on "Earthquake Hazard Mitigation for Utility Lifeline Systems" covering technical aspects of mitigation programs. The need for complementing this with action oriented planning for lifeline earthquake emergencies has been increasing felt by many cities, counties and regions of U.S.A. San Bernardino County in Southern California took the lead in forming a unique planning partnership with the Southern California Earthquake Preparedness Project of California Seismic Safety Commission and Federal Emergency Management Agency. This paper gives an overview of this process in a systems framework.

The problems of public policy formulation and implementation for mitigation and preparedness measures for natural hazards have been pointed by Petak and Atkisson (Ref. 9). Research conducted by Olson and Nilson of the Center for Public Affairs at Arizona State University indicates that political conflict increases rapidly by a factor as we go from Type 1 to Type 2, and again from Type 2 to Type 3, Type 3 to Type 4 in terms of the "Policy" typology of earthquake politics.

Type 1: Financial incentives for Rehabilitation of existing structures/ new structures for increased seismic safety...*Reward, Prospective Type*

Type 2: Disaster Relief Programs...*Reward, Retroactive Type of Policy*

Type 3: Proposing, Adopting and Implementing major code changes to increase seismic safety...*Penalty, Prospective Type*

Type 4: Existing Hazardous Structures Problem with no incentives and with requirement that existing lifeline structures which met the code standards (when they were built) to new codes for increasing seismic safety...*Penalty, Retroactive Type of Policy*

Emergency Management and Preparedness Agencies have a broad approach to reduce the threat of extended business interruption from the impact of a disastrous earthquake, in developing preparedness and response plans. In order that these plans are effective these must be coordinated between the utility companies and the local governmental agencies because of the regional nature. It is unfortunate that in the past the utility industry has often isolated itself from the disaster contingency planning efforts (against earthquake, floods, floods, major fire, tornadoes, etc.) on the part of the local governmental emergency planners. The need for autonomous control during relatively moderate disasters such as fire, explosion, toxic spill, civil disorders is understandable.because of the potential availability of the assistance from mutual

aid partners for support of local agency emergency forces. However, when there is a catastrophic earthquake, all regional resources will be committed and after a careful analysis, a priority system needs to be developed a priori for responding to earthquake damages. The case study of San Bernardino County presented in this paper shows the model "lifelines" approach to earthquake preparedness and response operations.

CONCEPT OF OPERATIONS FOR FOUR EARTHQUAKE CONTINGENCIES FOR LIFELINE FACILITIES

The phases of Seismic Emergency Management as shown in Fig.1 shows the complementariness of technical and emergency response measures. Mitigation, Preparedness, Response and Recovery are considered to be the four areas of emergency management. The following response and recovery functions are appropriate to a large, damaging earthquake or a prediction of such an earthquake. (See Fig. 2).

1. Long-Term Earthquake Prediction Response Function (LT-PRF)
2. Short-Term (Earthquake) Prediction Response Function (ST-PRF)
3. Emergency Response Functions (ERF)
4. Short-Term Recovery Function (ST-RF)
5. Reconstruction and Long-Term Disaster Recovery (LT-DR)

Fig. 3 and 4 show detail the first two functions for lifelines seismic disaster preparedness plan. These actvities are anticipated to encompass a full range of hazard mitigation, preparedness and response to be carried out by governmental (federal, state, county, local), utility agencies, private and neighborhood organizations and by households. In preparing the final draft report in August 1983 (Ref. 2) in the Southern California Earthquake Preparedness Project (SCEPP) in August in terms of County Prototype Planning;

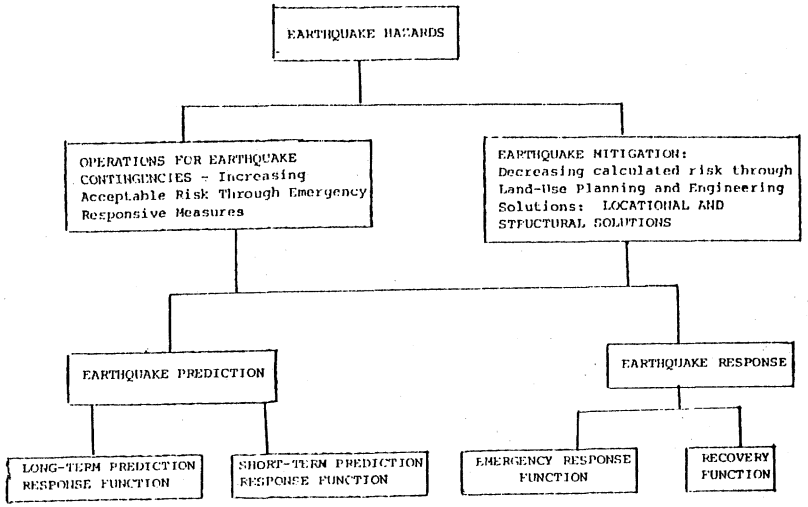
a the long-term prediction response element deals with actions to be taken a few years to a few decades before the earthquake occurs.

b (11 functions have been identified by SCEPP out of which the earthquake preparedness function is one) short-term prediction response actions to be taken a few days to a few weeks before the earthquake occurs. (12 functions including transportation function have been identified.)

c the emergency response element deals with actions to be taken during the first 72 hours (in reality it could be more especially with lifeline ruptures /failures/ secondary disasters) to a few weeks after the earthquake occurs. (About 16 functions including Utilitities/Lifeline Repairs, Transportation have been identified.)

d. the short-term recovery element involving the actions to be taken within one-two months after the earthquake occurs. (8 functions have been identified by SCEPP, including re-establishment of utilities.)

These recommended actions represent an adjunct to the more usual emergency procedures of utilities and transportation functions. In fact, these companies and agencies are well prepared for moderate localized disasters and need only recognize in their institutional structure the regional catastrophic nature of the event.



KINDS OF ASSOCIATED DISASTERS

LIFELINES SYSTEMS EARTHQUAKE PLANNING AND ENGINEERING

1. Los of service of the utility
2. Direct financial loss
3. Suspension of human activity e.g., employment, business
4. Inability to cope with secondary disasters such as fire, famines, and epidemics
5. Failure of a nature such that a lifeline itself becomes a hazard to life and property. Although earthquake hazard potential is great in the past, loss of life to schools due to earthquake and resultant fires may be greater.

OTHER NATURAL AND MAN-MADE DISASTERS

Winds, tornadoes, hurricanes
Fire (post earthquake), Mudslides, Landslides, Floods
Tsunami
Famines, epidemics
Lightening
Nuclear radiation
dam collapse, leakage

Figure 1. Contingency Planning in Lifeline Systems for Earthquake Hazards

OPERATIONAL CONCEPT FOR EARTHQUAKE CONTINGENCIES

Long Term Prediction Response	Short Term Prediction Response	Emergency Response	Recovery Response
· Structural Hazard Mitigation	· Transportation	· Transportation	· Route Recovery
· Nonstructural Hazard Mitigation (locational, Land-use Planning, Implementation, Micro-zoning	· Communication	· Communication	· Hazard Abatement
· Public Information Awareness	· Structural Engr.	· Debris Clearance for Lifesaving	· Disaster Assistance
· Earthquake Preparedness	· Logistical Support	· Firefighting	· Redevelopment, reinvestment
· Seismic Safety Planning	· Emergency Shelter	· Road, Bridge Repair	· Reestablish govt services
· School safety	· Hazard Material Mgmt	· Inspection, demolition, strengthening lifeline structure policy, medical schools, bridges, telephone	· Reestablish govt utilities
· Disaster Assistantance	· Resource allocation	· Logistical support	· Disaster accounting (resources of fishes, banks, insurance, business
· Emergency Shelter	· Evacuation	· Emergency Medical	· Public information
· Incentives	· Public Information	· Search and rescue	
· Mutual Aid	· Emergency Medical and Health Supplies	· Indentification and mortuary	
· Disaster Mngt.	· Response Readiness	· Publication information	
Insurance		· Medical supplies	
Loans for recovery		· Food Distribution	
Resource allocation		· Consumables distribution	
Infrastructure for post-recovery construction		· Shelter (temp)	
		· Damage Assessment Utilities	
		· Lifeline repair	

Figure 2. Major Contingency Functions and its Subfunctions

CASE-STUDY OF SEISMIC DISASTER PLANNING APPROACH FOR LIFELINES IN SAN BERNARDINO COUNTY

Duke, in 1981, suggested in his paper on an earthquake hazard plan for lifelines..."Still to be established are the responsibilities to be carried by existing and new institutions. The elucidation of these questions and the acceptance of suggested appropriate responsibilities for these institutions should lead to a set of guidelines with which to implement earthquake hazard reduction for lifelines" (Ref. 7). The geological and geographical aspects of an earthquake planning scenario for a magnitude 8.3 earthquake in Southern California formed the technical basis for the model institutional coordination by Southern California Earthquake Preparedness Project, County and local agencies,various utility companies (Ref. 8). As suggested by Duke (Ref. 7) the combination of a professional solution and a governmental solution to the life, lines earthquake disaster system problem was tried through committee structure with both horizontal and vertical integration. The principal actors in this model planning process are: (Ref. 1). (The final objective was to develop prototype plans which serves as a prototype for SCEPP (Ref. 1,2)).

A. Primary Emergency Action County Departments including 8 agencies such as:
   - Emergency Services Department of General Services Administration (GSA)
   - Communications Department
   - Public Information Office
   - Sherriff's Department
   - Transportation Department
   - Forestry and Fire Warden, EPWA
   - Flood Control District (in case of rupture of dams, waterways, canals)

B. Support Emergency Action Departments including 50 departments/offices such as:
   - Air Pollution Control District
   - Administrative Office
   - Airports Division, EPWA
   - Community Development, Office of
   - Economic Development
   - Solid Waste Management, EPWA
   - Risk Management Division, GSA
   - Public Social Services

C. Non-County Utility Agencies
   - AT & SF Railroad
   - CALTRANS (District 8)
   - Southern California Edison Co.
   - Southern California Gas Co.
   - General Telephone Co.
   - Omnitrans
   - Yucaipa Valley County Water District with many privately owned/ governmental ground/surface water units.

D. Voluntary Organizations including neighborhood watch programs, small businesses.

Public Utility networks and emergency facilities are lifelines which can be considered in a network form. In general, each public utility is a network within which there are sources, major transmission lines, storage, and a distribution or collection system. Each may have a terminus outside the city and an extensive matrix of contact or distribution points inside. Detailing for

seismic structural safety is important. For example, consider the problem of liquefaction of soils during earthquake, flexible couplings for water lifelines are useful. For lifeline/utility industry we need to consider: The design and operating agency, regulating authority, enforced codes/standards, professional or industry organizations, Special Vulnerability and Urgent Investigation Needs for Earthquake concerns. Various reliability levels for lifelines within different earthquake intensity levels (moderate intensity ground motion to high intensity ground motion with possibility of surface faulting) needs to be designated for different functions in terms of operations, life safety/endangerment for different storage, treatment facilities, distribution or for fire fighting (for example: In a Water Supply System). The following process of planning was used with SCEPP in conjunction with County local and utilities:

UTILITIES EARTHQUAKE EMERGENCY PLANNING FOR SAN BERNARDINO COUNTY

A. Preplanning Phase: Subcommittee Formation and Literature search.
   Task 1. Identify Membership and form subcommittees for the County Prototype Plan Task Force created by State and Federal initiatives joining with the county in developing an earthquake preparedness plan. The lifelines committee and the transportation committees' were formed.
   2. Survey of Existing Materials including Seismic Safety Element of San Bernardino County Disaster Plans and those disaster plans of Southern California Edison Co., Southern California Gas Co., General Telephone. This was tied with Transportation Subcommittee and Hazardous Structures (including Bridges) Subcommittee as well as with those of Water District.
   3. Initiate Planning Process including scope and deadlines for all plans.

B. Planning Process
   Task 4. Goals
   5. Objectives
   6. Assess Planning Information
   7. Formulate a strategy to meet needs.
   8. Develop a strategy and write the plan best on the best available information, concepts/skills, and the value system to meet the needs so as to maximize objectives, draft the action plans for utilities.

C. Coordination Process
   9. Report on Subcommittee Progress to the project coordinator.
   10. Participation of Subcommittee on coordinating task force.
   11. Development of Mutual Support - Mutual assistance, information sharing and other help from and between utilities subcommittees will be initiated in the coordinating task force.
   12. Design and Format of the Plan

   Note the integration is horizontal dimension because at the local levels the plans are coordination between the utilities and transportation agencies. Also, the lifelines committee and the transportation committee were formed in such a fashion as to be representative of the local utilities and transportation agencies rather than an exhaustive. These action plans are coordinated "vertically" within larger companies like S.C. Gas Co., and S.C. Edison Co. Integration of division plan with headquarter plans and with other local utilities or governmental agencies was also planned.

D. Implementation Process
   Task 13. Inclusion of utility plans in county plan.

Task 14. Endorsement by Utility: Each utility plan was submitted to its board of directors for endorsement as policy.

Task 15. Implementation and Action: The plans proposed policies, programs, actions, demonstration projects and further studies.

Each county agency or utility prepares emergency response plan-action forms for the 4 contingencies identified in the paper. For each contingency, the check-list includes consideration of People, Structures, Critical Resources, Communications Systems, Transportation Systems, Utility Systems, Hazardous Facilities (Ref. 1,2). Action statements are general and assume more detailed data, check lists, rosters, references, etc. are maintained separately in support of the plans through suitable procedures.

By developing phasing which conforms to the five phases preceeding and following a catastrophic earthquake the plans will achieve integration in the temporal dimension. At least approximate uniformity will promote comparison and coordination in the geographic sense when urgency will require proactive behavior rather than reactive crisis management.

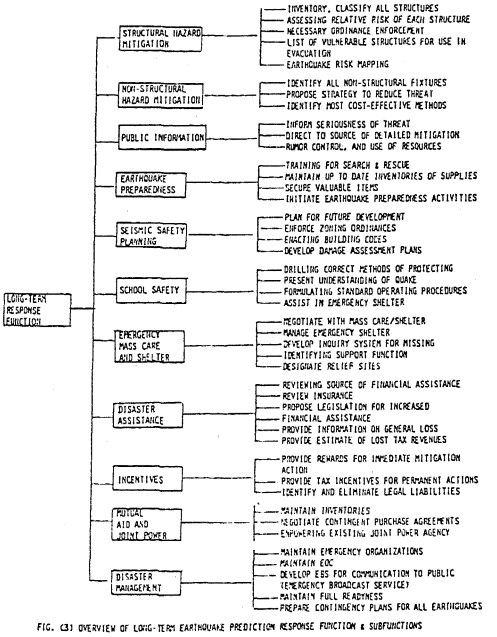


FIG. (3) OVERVIEW OF LONG-TERM EARTHQUAKE PREDICTION RESPONSE FUNCTION & SUBFUNCTIONS

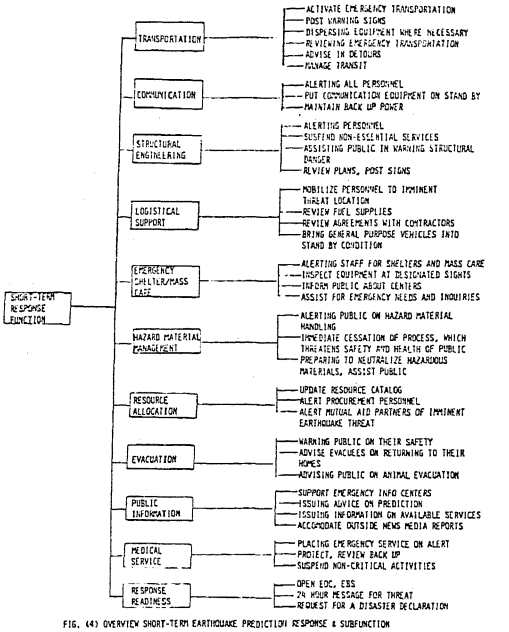


FIG. (4) OVERVIEW SHORT-TERM EARTHQUAKE PREDICTION RESPONSE & SUBFUNCTION

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