

CALIFORNIA INSTITUTE OF TECHNOLOGY

CENTER FOR RESEARCH ON
THE PREVENTION OF NATURAL DISASTERS

EARTHQUAKE ENGINEERING RESEARCH LABORATORY

EARTHQUAKES AND INSURANCE

DRC-73-02

Pasadena, California

July 1973

EARTHQUAKES AND INSURANCE

ERA CONFERENCE

2-3 April 1973

*

*

*

DRC - 73-02

*

*

*

Published by

The Center for Research on the Prevention of Natural Disasters

Division of Engineering and Applied Science

California Institute of Technology

Pasadena, California

1973



Burned area in San Francisco after the 1906 Earthquake.

page ii is blank

FOREWORD

The annual conference of the Earthquake Research Affiliates, California Institute of Technology, was held on 2-3 April 1973 on the campus of the California Institute of Technology. Some of the papers presented at the conference dealt with earthquake hazards and insurance, and it was decided to publish these papers to make them more widely available. In addition, other papers dealing with the 1906 San Francisco earthquake and the 1971 San Fernando earthquake were discussed at the conference, and these papers have also been included in this publication to make them more available.

The papers "Earthquakes and Fire Protection" and "Analysis for Earthquake Insurance" were presented by J. C. Fulton and D. G. Friedman who are participating members of the Earthquake Research Affiliates program. The papers "Insurance Losses in the San Fernando Earthquake" and "Earthquake Design Criteria" were presented by G. W. Housner and P. C. Jennings, staff members of the California Institute of Technology. The paper by L. C. Baker, Jr. was originally presented at the Conference on Earthquake Risk, September 22, 1971 that was sponsored by the Joint Committee on Seismic Safety of the California Legislature; it is reproduced here, with his permission, to make it available to ERA members. The other four papers are relatively scarce items that deal with the 1906 San Francisco earthquake; copies are in the document collection of the Earthquake Engineering Research Library at Caltech.

TABLE OF CONTENTS

	<u>Page</u>
Frontispiece	i
Foreword	iii
<hr/>	
Insurance Losses in the San Fernando Earthquake, by G. W. Housner	1
Availability and Desirability of Earthquake Insurance, by Lawrence C. Baker, Jr.	9
Earthquake Design Criteria, by P. C. Jennings, R. B. Fallgren and J. L. Smith	17
Analysis for Earthquake Insurance, by Don G. Friedman	34
Earthquakes and Fire Protection, by J. C. Fulton	73
The Story of the San Francisco Fire as Viewed from an Adjuster's Standpoint, by W. A. Bament	87
The California Insurance Company — 1906, by George W. Brooks	107
Dynamiting the San Francisco Fire	137
San Francisco Hotels and Reconstruction	141

*

*

*

INSURANCE LOSSES
IN THE
SAN FERNANDO EARTHQUAKE

by G. W. Housner

The San Fernando, California earthquake of 9 February 1971 provided a good opportunity to examine the earthquake insurance situation in California. The metropolitan Los Angeles area is known to be highly seismic, having experienced the destructive Long Beach earthquake on 10 March 1933, the strong shaking generated by the Tehachapi earthquake of 21 July 1952, and almost every year having experienced slight shakings which are premonitory of a future destructive shock. The inhabitants are certainly aware that strong earthquake shaking can be expected. It was, therefore, rather surprising to find that earthquake insurance was not widely carried, especially among homeowners.

Earthquake insurance is carried by some industrial and commercial concerns and some have programs of self-insurance. It has been reported, for example, that in 1964 a total premium of approximately \$8 million for earthquake insurance was written in the United States. Very few houses, however, were covered by this insurance. The annual rates for earthquake insurance coverage in the Los Angeles area range from about \$1.10 to \$3.00 per \$1000 of insurance, with 2% to 10% deductible. The spread in the rates results from various assessments of the degree of seismic risk in an area, as well as different pricing policies of insurance companies. The situation with respect to earthquake insurance seems to have been not much different from that described fifty years ago by John R. Freeman in his book Earthquake Damage and Earthquake Insurance, McGraw-Hill, 1932:

"At present, adequate earthquake insurance is difficult to obtain in California and is unsatisfactory in coverage in many cases. Most insurance companies hesitate to write California earthquake insurance in other than relatively small amounts, and this chiefly upon preferred risks at high rates of premium, with limitations in the policies which are often unsatisfactory to the property owner.

Even at the present high rates it is said to be difficult in many cases for property owners to obtain sufficient earthquake insurance; and when one succeeds in obtaining a policy at a high rate he may find it so drafted as to protect the banker or mortgagee and the underwriter much more fully than it protects the owner of the equity in the building."

Freeman suggested that earthquake insurance should be a clause in the fire insurance policy. If done this way, the cost to a homeowner could be much reduced for the cost of writing the policy and other paper work is a substantial fraction of the total premiums. Some insurance companies have indicated that a broader base is needed, and that this could be provided by having a disaster clause in the fire insurance policies throughout the United States to cover earthquakes, floods, tornadoes, etc. The insurance companies also point out that their reserves limit the amount of risk that can be assumed, and the government rules for insurance business make it difficult to build up reserves for an increased writing of earthquake insurance, and they naturally worry of being exposed to excessive risk in the event of a great disaster.

The total damage done by the San Fernando earthquake to ordinary houses built since 1933 in the northern San Fernando Valley was remarkably small considering how intense was the ground shaking there. It is estimated that the earthquake damage was less than 2% of the valuation of the houses that were subjected to ground shaking of 20%g or greater (roughly within

ten miles of the center of the earthquake).

Insurance Losses in the San Fernando Earthquake.

The total earthquake losses from the San Fernando earthquake, resulting from damage to buildings, bridges, public utilities, etc., have been estimated at about \$500 million (1971 dollars). It is difficult to assess the accuracy of this damage loss figure; in fact, there are different ways of defining damage losses which can lead to significantly different overall values.

The California Department of Insurance has issued the breakdown of losses reported to it, as given in Table 1.

TABLE 1

<u>Line</u>	<u>No. of Claims</u>	<u>Amount</u>
Fire	74	\$ 1,383,494
Extended Coverage	85	1,346,767
Other Allied Lines	54	1,213,129
Homeowners Multiple Peril	4,134	1,725,186
Commercial Multiple Peril	289	3,063,110
Earthquake	1,634	11,952,575
Inland Marine	571	9,501,659
Auto Physical Damage	1,218	417,243
Glass	952	482,651
Burglary and Theft	3	3,000
Boiler and Machinery	11	47,500
All Other	73	438,138
Policy on Pacific Intertie	<u>1</u>	<u>15,000,000±</u>
	9,099	\$ 46,574,452

The losses listed in Table 1 represent the money actually paid out by insurance companies. The last item in Table 1 represents the policy on the Pacific Intertie Station, which was the southern terminus of the high-voltage

electrical transmission line which brought electrical power to Los Angeles from Oregon. This policy was underwritten by an insurance firm in Sweden, and there was considerable delay in arriving at a final settlement. The exact value of the insurance loss paid on this policy could not be determined, however, the word is that it was in the neighborhood of \$15 million.

It can be seen from the foregoing that approximately one-tenth of the damage losses from the earthquake were actually covered by insurance. Apparently, only a small fraction of the total insurance losses was for damage to single-family dwellings.

Companies Writing Insurance in California.

Given below is a list of companies that wrote earthquake insurance in California in 1969. The list is abstracted from the annual reports submitted to the California Insurance Department.

Stock Companies

Aetna Casualty & Surety Co.
Aetna Insurance Co.
Affiliated F M Ins. Co.
Agricultural Ins. Co.
Allstate Ins. Co.
American & Foreign Ins. Co.
American Automobile Ins. Co.
American Casualty Co. of Reading, Pennsylvania
American Druggists Ins. Co.
American Empire Ins. Co. of South Dakota
American Employers' Ins. Co.
American Guarantee & Liability Ins. Co.
American Home Assurance Co.
American Ins. Co.
American Motorists Ins. Co.
American National Fire Ins. Co.
American Star Ins. Co.
American States Ins. Co.
Appalachian Ins. Co. of Providence
Associated Indemnity Corp.
Atlantic Insurance Co.
Atlas Assurance Co., Ltd.
Bankers & Shippers Ins. Co. of New York
Boston Old Colony Ins. Co.

Cal-Farm Ins. Co.
California Compensation & Fire Co.
Cascade Ins. Co.
Centennial Ins. Co.
Century Ins. Co.
Charter Oak Fire Ins. Co.
Chicago Ins. Co.
Civil Service Employees Ins. Co.
Commerce & Industry Ins. Co.
Commercial Ins. Co. of Newark, New Jersey
Connecticut Indemnity Co.
Consolidated American Ins. Co.
Continental Casualty Co.
Continental Ins. Co.
Countrywide Ins. Co.

Eagle Star Ins. Co.
Empire Ins. Co.
Employers Casualty Co.
Employers Commercial Union Ins. Co. of America
Employers' Fire Ins. Co.
Employers' Liability Assurance Corp. Ltd.
Equitable Fire & Marine Ins. Co.

Federal Ins. Co.
Fidelity & Casualty Co. of New York
Fire & Casualty Ins. Co. of Connecticut
Fireman's Fund Ins. Co.
Firemen's Ins. Co. of Newark, New Jersey
First National Ins. Co. of America

General Accident Fire & Life Assurance Corp. Ltd.
General Ins. Co. of America
General Ins. Corp.
Glens Falls Ins. Co.
Globe Indemnity Co.
Government Employees Ins. Co.
Great American Ins. Co.
Gulf Ins. Co.

Hanover Ins. Co.
Harbor Ins. Co.
Hartford Fire Ins. Co.
Hartford Steam Boiler *Inspection & Ins. Co.*
Hawaiian Ins. & Guaranty Co. Ltd.
Highlands Ins. Co.
Home Ins. Co.
Houston Fire & Casualty Ins. Co.

Industrial Indemnity Co.
Insurance Co. of North America
Ins. Co. of the State of Pennsylvania
International Ins. Co.

John Deere Ins. Co.

Kansas City Fire & Marine Ins. Co.

Liverpool & London & Globe Ins. Co., Ltd.
London & Lancashire Ins. Co., Ltd.
London Guarantee & Accident Co., Ltd.

Maryland Casualty Co.
Massachusetts Bay Ins. Co.
Members Ins. Co.
Mid-Century Ins. Co.
Millers National Ins. Co.
Monarch Ins. Co. of Ohio

National American Ins. Co.
National American Ins. Co. of California
National Automobile & Casualty Co.
National Fire Ins. Co. of Hartford
National Surety Corp.
National Union Fire Ins. Co. of Pittsburg, Pennsylvania
New York Underwriters Ins. Co.
Newark Ins. Co.
North River Ins. Co.
Northern Assurance Co. of America
Northern Ins. Co. of New York
Northwestern National Casualty Co.
Northwestern National Ins. Co. of Milwaukee, Wisconsin

Ohio Casualty Ins. Co.
Ohio Farmers Ins. Co.
Olympic Ins. Co.

Pacific Employers Ins. Co.
Pacific Indemnity Co.
Pacific Ins. Co.
Pennsylvania Ins. Co.
Phoenix Assurance Co. of New York
Phoenix Ins. Co.
Planet Ins. Co.
Potomac Ins. Co.
Premier Ins. Co.
Providence Washington Ins. Co.

Queen Ins. Co. of America
Reinsurance Corp. of New York
Reliance Ins. Co.
Republic Ins. Co.
Royal Indemnity Co.
Royal Ins. Co., Ltd.

Safeguard Ins. Co.
St. Paul Fire & Marine Ins. Co.
St. Paul Mercury Ins. Co.
Security Ins. Co. of Hartford
Security National Ins. Co.
Select Ins. Co.
Sequoia Ins. Co.
Signal Ins. Co.
South Carolina Ins. Co.
Southern General Ins. Co.

Standard Fire Ins. Co.
State Farm Fire & Casualty Co.
State Farm General Ins. Co.
Stuyvesant Ins. Co.
Superior Risk Ins. Co.
"Switzerland" General Ins. Co.

Tokio Marine & Fire Ins. Co., Ltd.
Transamerica Insurance Co.
Transport Indemnity Co.
Travelers Indemnity Co.
Trinity Universal Ins. Co.
Twin City Fire Ins. Co.

Underwriters Ins. Co.
Unigard Ins. Co.
Union Ins. Society of Canton, Ltd.
United Pacific Ins. Co.
United States Fidelity & Guaranty Co.
United States Fire Ins. Co.
Universal Underwriters Ins. Co.
Utah Home Fire Ins. Co.

Vanguard Ins. Co.
Vigilant Ins. Co.

West American Ins. Co.
Westchester Fire Ins. Co.
Western Fire Ins. Co.
Western Pacific Ins. Co.

Zurich Ins. Co.

Mutual Companies

American Hardware Mutual Ins. Co.
American Manufacturers Mutual Ins. Co.
Atlantic Mutual Ins. Co.

California Mutual Ins. Co.
Central Mutual Ins. Co.

Employers Mutual Fire Ins. Co.

Farmers Home Mutual Ins. Co.
Farmers Mutual Ins. Co.
Federal Mutual Ins. Co.

Grain Dealers Mutual Ins. Co.
Hardware Dealers Mutual Fire Ins. Co.
Hardware Mutual Casualty Co.

Liberty Mutual Fire Ins. Co.
Liberty Mutual Ins. Co.
Lumbermens Mutual Casualty Co.
Lumbermens Mutual Ins. Co.

Michigan Millers Mutual Ins. Co.
Millers National Ins. Co.
Mutual Service Casualty Ins. Co.
Northwestern Mutual Ins. Co.
Oregon Mutual Ins. Co.
Pennsylvania Lumbermens Mutual Ins. Co.
Pennsylvania Millers Mutual Ins. Co.
Utica Mutual Ins. Co.

Reciprocals

Canners Exchange Subscribers at Warner Inter-Insurance Bureau
Farmers Insurance Exchange
Fire Insurance Exchange
Truck Insurance Exchange
United Services Automobile Association
Warner Reciprocal Insurers

Acknowledgments

The foregoing data were provided by Mr. James Taney of the
Insurance Information Institute, Pacific Coast Regional Office in
San Francisco.

AVAILABILITY AND DESIRABILITY

OF EARTHQUAKE INSURANCE

by Lawrence C. Baker, Jr. *

The February 9, 1971 earthquake at San Fernando illustrated, rather dramatically, that in spite of the ever present danger of earthquakes in this state, a comparatively few residents purchased the coverage. Out of a total loss that is estimated at somewhere between \$600 million and \$1 billion, only about \$46 million of insured earthquake loss was incurred. In the aftermath it has become quite popular to assume that the insurance industry does not make the coverage widely available.

In fact, this is not the case when it comes to residential properties. We find that in surveying the companies that write the majority of coverage for homeowners in this state, that they universally make coverage for earthquakes available for nearly all of the risks that are otherwise eligible for homeowners policies. The exceptions would be buildings that are built of brick or adobe or hollow concrete block, risks that are located in known landslide or subsidence areas, very old dwellings, and risks that are located within a mile or so of known major fault lines, such as the San Andreas fault. Even for these risks, though, it is possible to purchase earthquake coverage if a diligent search of the market is made. There is also a very wide assumption that earthquake coverage is prohibitively expensive. Certainly when it comes to adobe and hollow concrete-block risks, the cost of the coverage is quite high. For this type of construction, the annual rate per \$100 of coverage would be \$2.50 and a deductible of 15% of the actual cash value of the risk at the time of the loss would apply. The rates drop down

* Mr. Baker is the Chief Deputy Insurance Commissioner, State of California, Los Angeles, California. He presented this paper at the Earthquake Risk Conference, September 22-24, 1971, sponsored by the Joint Committee on Seismic Safety of the California Legislature. Mr. Baker's paper is reproduced here, with his permission, to make it available to ERA members. It is a cogent statement from the regulatory end of the insurance business.

dramatically, though, when better construction is used. For brick construction, which is still quite susceptible, a rate of \$0.75 per \$100 with a deductible of 10% applies. When it comes to the rate for the predominating construction for individual residences in California, frame stucco, the rate is \$0.15 per \$100, and a deductible of 5% is applicable. This rate applies when a 70% co-insurance clause is used. When the risk is written without co-insurance, which is the normal case in dwellings, the rate becomes \$0.20 per \$100.

I have often been asked whether or not I consider these rates affordable. This question is not answerable in absolute terms; all I can say is that these rates compare quite favorably with the price of the balance of the coverages afforded in the normal homeowners contract. For a dwelling that is insured for \$20,000, which would exclude land value, and with contents insured for \$10,000, a typical homeowners policy premium might be around \$150.00 annually. To add earthquake damage assumption would cost an additional \$40.00. Is this too high? Many people, including myself, when I have to pay my premiums, think that all insurance is "too high". But I think on a relative basis, it is fair to say that the cost of earthquake insurance for the typical homeowner is not prohibitively expensive.

Thus far, I have alluded to residences in my appraisal of the situation. Commercial risks carry somewhat higher rates, and often the coverage is difficult to find. This is due principally to the fact that a much larger proportion of commercial risks are of a type of construction that is more susceptible to earthquake damage, and the fact that the values of individual risks tend to be higher, consequently the underwriters' exposure is more concentrated.

Getting back to the residential situation though, the question quite naturally arises as to why more coverage is not carried by homeowners, if it is readily available at reasonable premiums. A part of the answer, I think, lies in the widespread misunderstanding of availability and the price of the coverage, as I have just recited. At the same time, the insurance industry has made no effort to aggressively solicit the business or to even make its availability known. It has largely been a situation that if the customer asks for it, the company will generally sell it, but the underwriters hope that not too many people ask for it. At the same time, those agents that have made a conscientious effort to inform their customers of the availability of coverage and the premiums have had very little success in selling the coverage to their personal lines clientele. In one instance that I know about, an agent solicited his entire personal lines book of business for earthquake coverage, both before and after the San Fernando earthquake. Most of his customers were located in the San Francisco Bay region. Less than 6% of this particular agent's customers were interested in the coverage.

From an economic standpoint it would seem to be much more orderly and probably less expensive in the long run to alleviate the effects of disaster caused by earthquakes through widespread carrying of the coverage in the private insurance sector, rather than applying a system of grants and low-interest loans through disaster-relief agencies. Pre-establishment of a mutually agreed basis of adjustment through the insurance contract, as well as the private insurance industry's ability to respond to disastrous situations by pooling personnel and transferring both adjusters and arranging transfer of repair contracting facilities to a disaster site, seem to me to be desirable alternatives to current Federal disaster relief programs, when it comes to providing permanent repair and rehabilitation of damage.

We seem to be faced with a dichotomy. On the one hand, we have a reluctant insurance buyer and a reluctant insurance seller. On the other hand, we have a potential earthquake disaster ever present in California with insurance appearing to be a desirable solution to one aspect of coping with earthquake disaster, mainly, long-term property rehabilitation. Before forcing a marriage of the permanently reluctant partners of the insurance transaction, though, let's look a little deeper into what would happen if every homeowner in the state decided to buy the coverage.

In spite of the fact that loss ratios on earthquake insurance have been quite low over a long period of time, most underwriters are quite skeptical of selling large amounts of coverage. Insurance is a forward-looking business, and even though the past may be used to evaluate what the future may bring, when one speaks of infrequent, random occurrences, such as major earthquakes, past experience has very little bearing on evaluation of future possible occurrences. Natural-hazard simulation is probably the best method for the evaluation of earthquake risk. A mathematical representation can be constructed using a continuous index paralleling the Modified Mercalli Scale to estimate earth-shock intensity. The model for generating geographical patterns of earthquake intensity can be obtained by incorporating effects of the various influencing factors. This includes the magnitude of the earthquake, the distance from the center of the earthquake, orientation of the locality relative to the faultline, depth of the earthquake shock, duration of the earth shock, geology of the intervening area, and local ground conditions. Severity is converted into a measure of loss experience using a loss function filter and a hypothesized insurance coverage filter. Through computer techniques, output is synthetic loss experience in terms of the number of dwellings affected and the expected total damage for the affected area. Dr. Daniel G. Friedman has conducted such a simulation for both the San Francisco and Los Angeles

areas. While such actuarial prognostication can help the underwriter establish a proper rate to be used over a long period of time, it does very little to alleviate his fears that he may be unlucky in having a major earthquake very shortly after expanding his book of business.

A number of factors influence the underwriters in resisting material additions to their earthquake exposure. Among them are:

1. Predictions by geophysicists and geologists that Los Angeles is in imminent danger of a recurrence of the 1857 "Gorman" quake.
2. During the years when there are no earthquakes, Federal income tax provisions apply, so that premiums which should be conserved in a catastrophe reserve are siphoned off as taxable profit, and are thus depleted by 50%.
3. Most importantly, there is an absolute limit to the amount of earthquake protection that the private insurance business can prudently afford to risk. Insurance capacity is determined by the amount of surplus funds that the insurance companies have to pay large losses, and by the reinsurance capacity that is available to them. The total policy-holder surplus of all casualty property insurers in the United States amounts to about \$20 billion at the present time. Most states, including California, have a law that an insurance company cannot carry an amount more than 10% of its surplus on any one "risk" for the fire and marine-type of lines. Prudent management would normally limit the amount they carried on a single risk to even less than 10%. Even assuming that every carrier would carry 10% of its surplus on what it considered a single risk, it can easily be seen that \$2 billion is the theoretical maximum capacity of all domestic casualty property insurers in the United States. In considering this amount of capacity against the potential damage that could be caused by a great earthquake

along the southern portion of the San Andreas fault, it can be easily seen that there is an insufficiency of considerable proportions. In fact, our projections indicate that absolute capacity limits would be reached if about two and one-half times the present amount of coverage were written. This would mean that the annual earthquake premiums in California would rise to about \$12 million to \$15 million annually from the present \$5 million to \$6 million annually. If the San Fernando earthquake is representative, it would mean that the proportion of insured loss would increase from about 5% to $12\frac{1}{2}\%$. Again, from an economic point of view, this incidence of carrying coverage would probably not yield satisfactory results.

I believe, though, that a solution to the capacity problem and any potential availability problem is available within the framework of existing structures and interrelationships between the private and the public sectors. Similar capacity problems caused near paralysis of the inner city insurance marketing mechanisms in 1967 and 1968. In answer to the potential of catastrophic losses caused by riot, the insurance industry, State regulatory officials, and the Federal Government devised the National Insurance Development Program. This program provided for an offering of reinsurance to private insurance carriers by the Federal Government. The reinsurance was contracted on a state-by-state and line-by-line basis to afford coverage when losses exceeded a stated percentage of premium during a given year from the riot peril. A premium was charged for the coverage, which created a reinsurance fund. In addition, the Department of Housing and Urban Development, who had jurisdiction over the program, obtained borrowing authority from the Treasury. The states assumed a proportion of the reinsurance made available; however, most of the states found a means to pass this liability back to the insurance industry.

In consideration of the reinsurance afforded, the insurance industry, in cooperation with the states, guaranteed the availability of essential coverages through the formation of FAIR plans. In general, this cooperative effort by the industry, states, and Federal Government has worked quite satisfactorily. An availability crisis was averted, the catastrophe reinsurance pool of more than \$60 million has been created, and a minimum of additional regulations and bureaucracy has developed.

I would like to propose that the National Insurance Development Act be expanded to provide provisions for earthquake coverage. In addition, I think that this Act could be used as a means to solve other catastrophe insurance problems, such as hurricanes. Usage of the structures already developed would offer a number of advantages. A new bureaucracy and a new body of law would be unnecessary. Existing reinsurance contracts could be expanded, and the lines of communications already in existence would be utilized. A pool of reinsurance funds is readily available; FAIR plans are already established in most states and are now beginning to function relatively smoothly. Hence, new marketing mechanisms to assure availability of the coverage would not be needed. In the condition, the usage of the Federal Government facility to provide reinsurance assures that the premiums allocated are not depleted by Federal income tax, since these reinsurance programs are tax deductible. At the same time, reinsurance capacity would be available to reinforce private capacity, so that solvency of the insurance industry would remain unimpaired. This reinsurance capacity would probably also minimize the apprehension of underwriters, so that the existing voluntary writings could be expanded considerably.

To assure success of the program, it would probably be necessary to considerably expand the existing borrowing authority of HUD to meet the

potential of losses from a major earthquake. Considerable research would probably be necessary to determine an adequate amount; however, I personally believe that at least \$6 billion should be contemplated as a maximum payout in a single year.

All the foregoing assumes that earthquake insurance may be more widely purchased. This could probably be assured by requiring that all Federally-backed loans secured by real property require earthquake coverage on the real property. While this might be desirable from the standpoint of the economics of the situation, I do not personally favor such a solution, as it entails yet another coercion of individuals to provide security that they might not want in the first place. I do think that there are several things that can be done short of this kind of requirement. As a condition of purchasing reinsurance private industry could be required to offer the coverage whenever other kinds of transactions on property policies occur. Additional public education programs could be conducted, and a few more showings of the telecast "The City That Waits to Die" could be arranged.

In any event, it seems to me that the development of this type of coherent program for long-term rehabilitation of the effects of disaster is preferable over the existing patchwork system, and would go a long way toward reducing the anxiety of our citizenry, insurance industry officials, and public officials about the consequences of earthquakes on our society and our economy.

EARTHQUAKE DESIGN CRITERIA*

by P. C. Jennings, R. B. Fallgren and J. L. Smith

INTRODUCTION

The earthquake-resistant design of electrical generation and transmission facilities is not necessarily achieved using the static loading criteria contained in existing building codes and practice. While many conventional steel and concrete structures may be adequately designed using code or increased-code seismic forces, most electrical equipment is lightly damped and does not possess the ductility of most building structures. It was amply demonstrated in the San Fernando earthquake of February, 1971 that more realistic design criteria are required to assess the effect of earthquake motions on the vibration of electrical equipment and supporting structures.

Aseismic design criteria for major electrical facilities are customarily developed from detailed investigations of specific sites. Currently, criteria for nuclear power plants are acceptable only with a site-oriented approach. Although this approach may also be technically desirable for many types of non-nuclear facilities, it is not practically feasible where design information in a large region is needed well in advance of site designation. Moreover, it is necessary to design some manufactured equipment so that it will accommodate vibration at any site within a utility system, even if moved to different sites one or more times during its life. The most practical approach in this case is to establish conservative regional

*The talk presented at the Earthquake Research Affiliates Conference by Professor P. C. Jennings was based largely on this paper which appeared as a preprint for the American Society of Civil Engineers Conference in San Francisco April 9-13, 1973. The title of preprint 2014 was "Aseismic Design Criteria for Electrical Facilities."

guidelines which, while necessarily general and somewhat arbitrary, are nevertheless useful for design of many facilities and for preliminary design studies of major facilities.

This paper presents one approach to establishing regional aseismic design criteria for non-nuclear electrical facilities. The approach was applied to the distribution system of the Southern California Edison Company, whose service area is shown in Figure 1. The degree of earthquake hazard in the service area was judged on the basis of historic seismicity and the evidence for faulting within late Quaternary geologic time. This degree of hazard was then expressed, for purposes of design, in terms of design spectra and appropriately scaled accelerograms corresponding to the "average maximum earthquake."

SEISMIC ZONING

Faults and Seismicity

Three sources of data were used in evaluating the seismicity of the service area. These included fault maps, earthquake epicenter maps, and isoseismal intensity maps.

The fault map, shown in Figure 2, indicates the locations of major faults within and adjacent to the service area known or suspected to have displaced the ground surface during late Quaternary time. Prepared on this basis, the fault map provides an indication of the probable location of seismic activity within approximately the last 500,000 years.

An epicenter map indicating the distribution of recorded earthquakes in the service area is shown in Figure 3. The map indicates the distribution of earthquake epicenters equal to or greater than Richter magnitude 4 during the years 1933 through 1971⁽²⁾. Although Figure 3 is very useful, it must be interpreted cautiously, as the 39-year period is too short to be a single reliable indicator of future seismicity. Historic seismicity may, in some instances have an inverse relationship with future seismicity over a short period of time.

Isoseismal maps indicating intensity of ground shaking have been prepared for most of the moderate-to-large earthquakes in California's history. Two of the largest earthquakes for which isoseismal maps are available, the 1872 Owens Valley⁽¹⁾ and 1952 Kern County⁽⁶⁾ earthquakes, were centered within the service area. A third, the 1906 San Francisco⁽⁵⁾ earthquake was centered outside the area, but originated on the San Andreas fault which traverses the service area. These earthquakes occurred on major fault systems, and the isoseismal maps provided the basis for an estimate of the areal distribution of the moderate-to-high severity of shaking associated with such shocks. Smaller, but still major shocks accompanied by strong ground shaking, have occurred on these same fault systems and on other faults in the region^(4, 8). These include the 1918 San Jacinto, 1940 Imperial Valley, 1948 Desert Hot Springs, 1925 Santa Barbara, 1933 Long Beach, 1947 Manix, and 1971 San Fernando earthquakes.

Preparation of Seismic Zone Map

A comparison of the maps of epicenters and faults reveals that earthquakes of various magnitude continue to occur in the regions traversed by the major fault systems, and that there is geologic evidence that ground displacements have occurred along the fault systems several times in late Quaternary time. From this observation, it is reasonable to expect damaging earthquakes in these regions in the future.

As a start to seismic zoning, the distribution of moderate-to-high severity of shaking for some of the larger historic shocks was studied. The 1952 Kern County and 1971 San Fernando earthquakes were particularly useful since data in terms of Modified Mercalli intensities are supplemented by strong-motion instrument data and by descriptions of damage to electrical facilities^(4, 6, 7). For both the San Fernando and Kern County earthquakes,

the most severe shaking and damage to electrical facilities took place within about five miles of the epicenter of the earthquake or of the associated fault trace (within the area of MM intensity VIII-XI). Moderately severe shaking and damage occurred out to about ten to fifteen miles (MM intensity VII). Within these distances and intensities, there was a great range of maximum recorded acceleration (0.12g to 0.39g), which precludes for this application any useful correlation of this parameter with intensity or with ground conditions.

These findings suggested that two levels of severe shaking can be selected which are generally associated with either intensity VII or with intensity VIII and greater, thus providing a means for reviewing other historic earthquakes where intensity distribution has been mapped. Caution must be used, however, in evaluating reported intensities relative to characteristically short-period electrical facilities, since the rating of intensities and isoseismal zones after an earthquake reflect the maximum observed effects in the designated zone. In the range of intensity VII and greater these effects can include landslides, cracks, subsidence in soft ground, and other phenomena that are not necessarily representative of the severity of shaking in the frequency range pertinent to electrical facilities. Accordingly, zones depicting the relative severity of shaking for electrical facilities may not necessarily correspond directly with mapped distributions of intensity.

Examination of available isoseismal maps indicated that earthquakes of at least three sizes needed to be considered in the preparation of a seismic zone map for the region. These included:

- (1) moderate-sized earthquakes from about magnitude 5 to 6.5 which include, for example, the San Fernando earthquake;

- (2) large earthquakes, in the approximate magnitude range of 6.5 to 7.5, such as occurred in Kern County in 1952 and in El Centro in 1940; and
- (3) great earthquakes such as the 1872 Owens Valley and the 1906 and 1857 earthquakes on the San Andreas fault.

The distribution of severe and moderately-severe shaking, as previously defined, was determined by examination of the isoseismal maps for earthquakes in these three general categories. From this examination, a selection was made of distances from the ruptured section of the fault judged to be adequate for each earthquake size so that boundaries of the zones of most-severe and less-severe shaking could be drawn.

These distributions were extended hypothetically to faults judged capable of producing the sizes of earthquakes described. The earthquake-producing capability of a fault was evaluated taking into account fault length and type, continuity, topographic expression, and seismic activity. Twenty and 45-mile distributions for most-severe and less-severe shaking, respectively, were applied to the Owens Valley fault. Ten and thirty-mile distributions were applied to the San Andreas fault and its main members south of San Bernardino, and to the Garlock and Death Valley faults. Six and twelve-mile zones, representing the distributions for moderate-sized earthquakes, were drawn along a number of other faults including the White Wolf, Helendale, Blackwater, Palos Verdes, Norwalk, Sierra Madre, and Santa Rosa faults. The abundance and close spacing of such faults in most parts of the service area resulted in considerable overlap of zones of most-severe shaking.

After several trial plots were drawn, and considering also the distribution of historic earthquake epicenters and tectonic history of the region, the seismic zone map of Figure 4 was developed. This map is judged to represent

a reasonable distribution of the severity of shaking in the region which should be accommodated in design. Three zones are indicated which, qualitatively speaking, represent areas in which most-severe, less-severe, and moderate shaking is anticipated. The resulting zonation is in terms of capability of shaking, rather than in terms of probability or relative potential for earthquakes of one magnitude or another. The map is intended only to indicate the areas in which the design spectra discussed in the following section are to apply.

DESIGN SPECTRA AND TIME HISTORIES

The Design Spectrum

The effect of earthquake motions on structures may be conveniently assessed by means of design spectra. The design spectrum is a plot specifying the peak response of a single-degree-of-freedom oscillator as a function of period and damping. When appropriate damping factors and allowable design stresses are established, these values may be used in combination with the design spectrum to determine the earthquake forces to be used in design of a structure.

The design spectra discussed in this paper are smooth spectra representing the average spectra of earthquake motions of a maximum reasonable strength appropriate to each of the three seismic zones. Such spectra are termed average maximum spectra, as distinct from enveloped spectra which are smooth curves enveloping peaks of individual spectra. When using average maximum spectra the appropriate allowable stresses are elastic or working-level stresses, rather than ultimate stresses. In this approach to design, the factor of safety will be determined by the margin between the specified allowable or working stresses and the actual ultimate deflections or stresses which correspond to failure. The factor of safety for electrical equipment, defined

in this manner, will normally be greater than about 3 for conventional structures designed to the stresses allowed by codes.

Recommended Design Spectra and Zone Factors

The design spectra resulting from this study are shown in Figure 5. The curves are scaled to the most-severe seismic zone (Zone A). The design spectra are intended to reflect the severity of ground shaking generated by the average maximum earthquake, taking into account the average effects of distance to earthquake sources, travel path effects, and ground conditions as they affect the frequency content of strong ground shaking.

The shape was determined by examination of the spectra of individual acceleraograms, primarily accelerograms recorded within the service area, and by making smoothed versions of the individual spectra. The shapes of the spectra are generally similar to those of other design spectra with the exception that the curves for various values of damping are closer together in the middle frequency range and farther apart for higher frequencies. These differences are due primarily to the importance given the frequency band from $T = 0.04$ seconds to $T = 1.0$ second; this band was emphasized because of characteristics of the electrical equipment considered in the study.

The amplitude of the design spectra reflect an estimate of the level of average maximum earthquake motion in the most-severe seismic zone (Zone A). A comparison of the design spectra with strong earthquake ground motion records indicates, for example, that the design spectra are approximately 2.3 times the average strength of the record obtained at Taft, 25 miles from the center of energy release of the 1952 Kern County earthquake. A comparison with the El Centro record, obtained approximately 4 miles from the causative fault in the Imperial Valley earthquake of 1940, indicates the design spectra to be about 10 percent stronger. With margins of this

order over recorded motions, it seems reasonable to conclude that facilities located in the area of strongest shaking during these earthquakes could have survived without failure if they had been designed using the design spectra. Comparisons like these are limited in their application, of course, but they do support the conclusion that the recommended spectra for the average maximum earthquake are reasonable and conservative estimates for such motion, and that the use of the spectra, coupled with a factor of safety of about three, would be sufficient to prevent failure of electrical equipment in all but the most highly improbable circumstances. If occasional failure of a small fraction of equipment can be accepted, a factor of safety of two would be adequate.

For the less-severe seismic zones, similar comparisons were made, but with motions recorded in the epicentral areas of moderate-sized earthquakes (Mag. 5 and 6+). These comparisons indicate that the design spectra times $2/3$ and $1/3$ are reasonably conservative estimates of the average maximum ground motion expected in the less hazardous Zone B and Zone C, respectively.

Accelerograms and Response Spectra.

The design spectra are directly applicable to equipment idealized as single-degree-of-freedom oscillators. To analyze nonlinear response, however, or to see how the modes of more complicated linear structures combine in the response, a set of eight scaled accelerograms and their associated response spectra was assembled for use in digital computer studies.

Some of the properties of the accelerograms are given in Table I. Both the accelerations in the accelerograms and the ordinates of the spectra were scaled by the factors indicated to correspond to the strength of motion

of the average maximum spectra shown in Figure 5. The scaling of the accelerograms was determined by comparing their spectra to the design spectra, concentrating on the frequency band between $T = 0.1$ seconds and $T = 1.0$ second and with primary emphasis on the 2% damped curves. Because of the random nature of ground accelerations and differences in source mechanisms, size of earthquake, recording distance, travel path effects, and local geology, no single earthquake accelerogram gives spectra that fit the design spectra well over the entire plotted range.

The choice of records to use in studies of the response of equipment to strong ground motion depends on the particular application; for example, the type of strong shaking judged most likely to occur. In studies where the intent is to use time-histories in lieu of the recommended average maximum spectra, the response to several of the scaled accelerograms should be investigated. Considering, for example, the average of the response to the scaled versions of El Centro 1940, N-S; Olympia 1949 S 10° E; Helena 1935, E-W; and Pacoima Dam 1971, S 16° E, would be adequate to determine the peak response in a broad frequency range.

SUMMARY AND CONCLUSIONS

The service area has been divided into three zones on the basis of historic seismicity and on geologic evidence for seismic activity within late Quaternary time. The zones represent, qualitatively speaking, areas in which facilities should be designed to accommodate most-severe, less-severe, and moderate earthquake shaking. The earthquake motions to be considered in design are represented by the design spectra. The design spectra, in terms of the average maximum earthquake, are based on the characteristics of recorded earthquake motions. Both the design spectra and the set of scaled accelerograms and response spectra are directly applicable to the most-severe seismic zone. Factors of $2/3$ and $1/3$ were found to be

appropriate for the less-severe and moderate seismic zones, respectively.

The application of the design spectra is expected to provide a uniform and conservative level of earthquake resistance for non-nuclear, electrical facilities located within the service area. Using code-level allowable stresses and realistic damping values, the design spectra will normally provide a factor of safety greater than three between design and failure. Other levels of protection can be achieved by specifying other allowable stress levels and damping values.

The seismic criteria presented can be used to evaluate directly the seismic design input for many types of equipment located at typical facilities in the service area. For some facilities, however, the criteria presented would be used with caution and only as a general guide to indicate the extent of further investigation necessary. The siting and design of a major power generating facility, for example, would require detailed and thorough site investigations. Seismic design criteria based on the results of such detailed investigations might be significantly different from that found by use of the general approach presented in this study.

The criteria presented here should be supplemented by detailed site investigations to evaluate possible hazards from fault displacement, from any special vibrational effects of very soft soils, and from gross soil movements such as landslides. In addition, because the design criteria are necessarily based in large part upon measured and historic seismicity, it is anticipated that modifications may be required to take into account the results of future site investigations or of strong-motion records of future earthquakes. Finally, it should be emphasized that for facilities with dynamic characteristics

different from those considered in this study, different seismic zones might be established, different frequency ranges and damping might be emphasized, and consequently different design spectra might be appropriate.

APPENDIX - REFERENCES

1. Greensfelder, R.W., "Isoseismal Map of Owens Valley Earthquake of 1872," California Geology, California Division of Mines and Geology, Vol. 25, No. 3, March, 1972, p.60.
2. Hileman, J.A., unpublished thesis material, California Institute of Technology, 1972.
3. Jennings, P.C., Housner, G.W., and Tsai, N.C., "Simulated Earthquake Motions," Earthquake Engineering Research Laboratory, California Institute of Technology, Pasadena, California, 1968.
4. Jennings, Paul C., Ed., "Engineering Features of the San Fernando Earthquake of February 9, 1971," Earthquake Engineering Research Laboratory Report EERL 72-01, California Institute of Technology, Pasadena, April, 1972.
5. Lawson, A.C., et al., The California Earthquake of April 18, 1906, Report of the State Earthquake Investigation Commission, Carnegie Institution of Washington, Vol. 1, 1908, with atlas. Map No. 23.
6. Oakeshott, Gordon B., Earthquakes in Kern County, California During 1952, California Division of Mines and Geology Bulletin 171, November, 1955, p.208.
7. Pereboom, E.G., "Earthquake Considerations in Substation Design," Panel Presentation, IEEE Summer Power Meeting, July, 1971.
8. Richter, C.F., "Seismic Regionalization," Bulletin of the Seismological Society of America, Vol. 49, No. 2, April, 1959, pp.123-162.

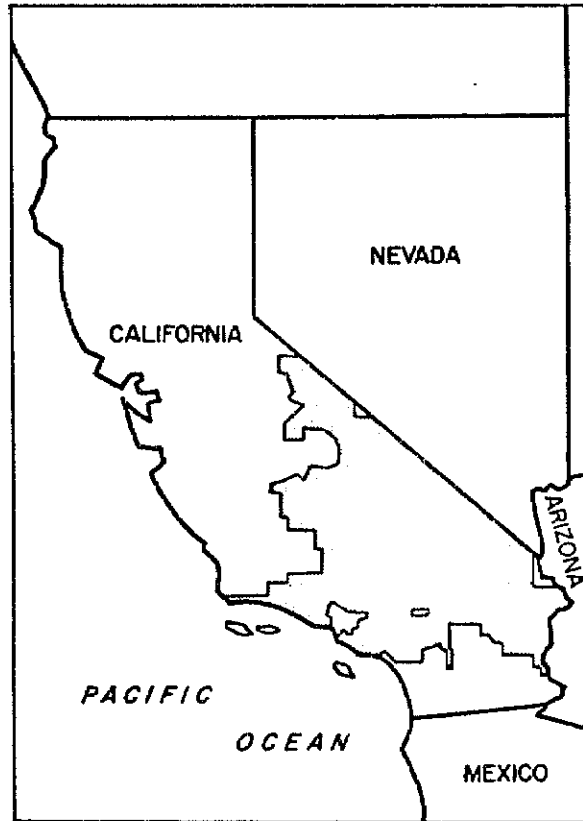


FIGURE 1 - SOUTHERN CALIFORNIA
EDISON SERVICE TERRITORY

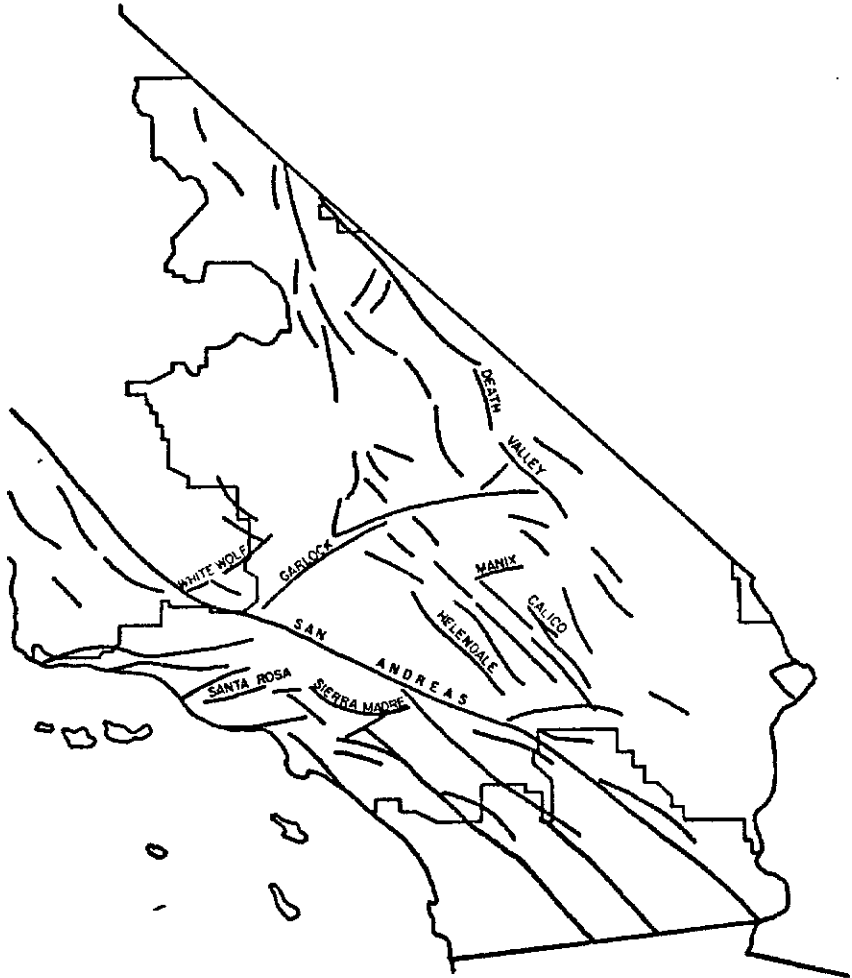


FIGURE 2 - FAULT MAP

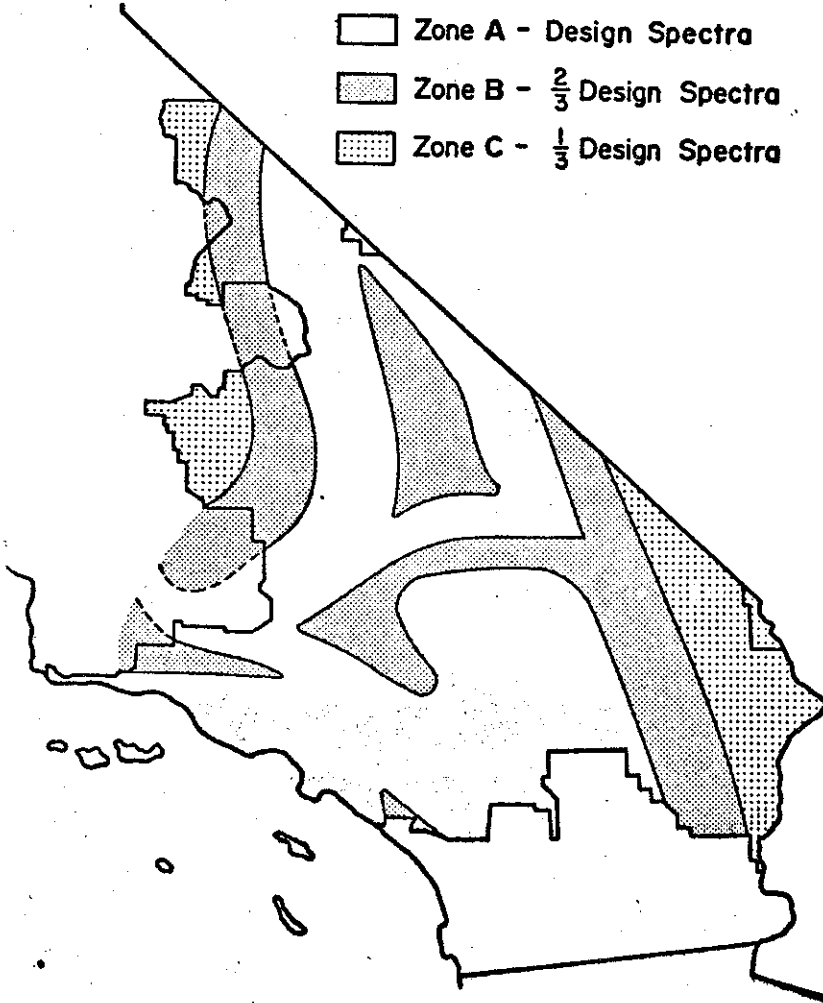


FIGURE 4 - SEISMIC ZONE MAP

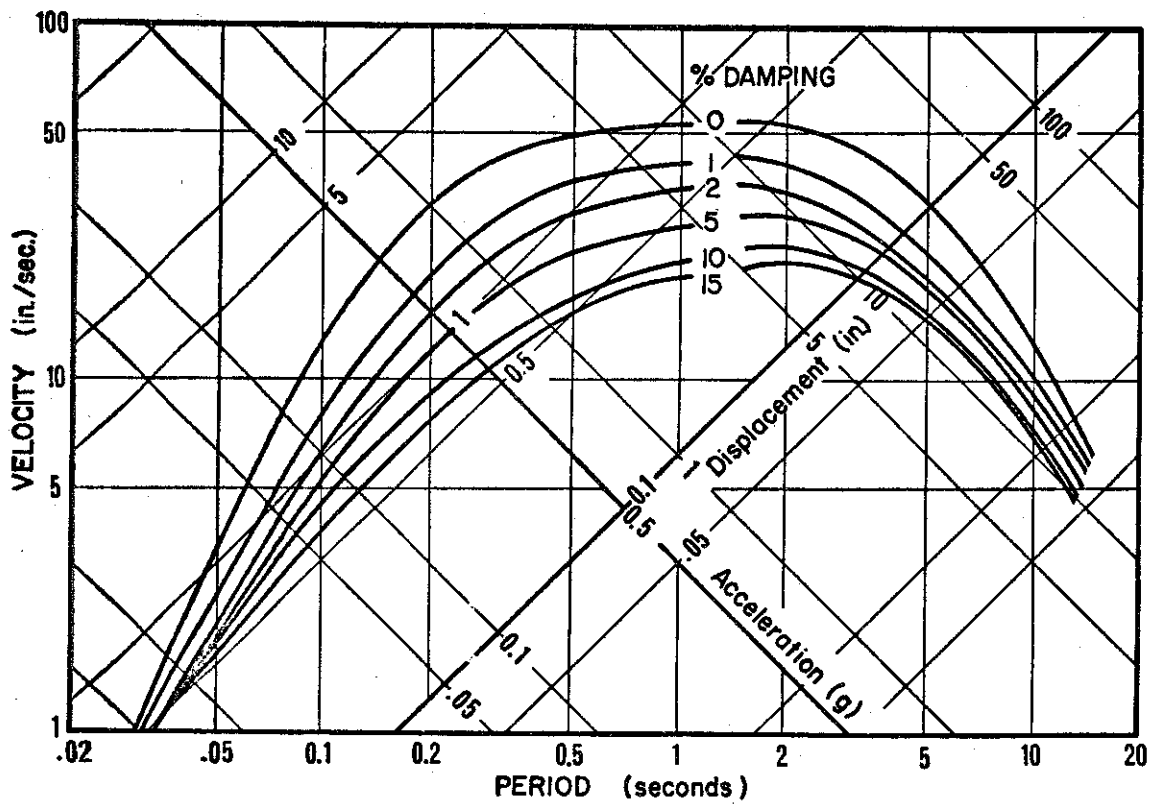


FIGURE 5 - DESIGN SPECTRA

Accelerograms	Earthquake Magnitude	H (miles)	D (miles)	Relative Strength	Scale Factor
EL CENTRO, 1940, N-S	7.0	4	15	0.89	1.12
TAFT, 1952, S69°E	7.7	25	15	0.43	2.33
OLYMPIA, WASH., 1949, S10°E	7.3	10	45	0.51	1.96
ARTIFICIAL EARTHQUAKE B-2	-	-	-	0.97	1.03
HELENA, MONT., 1935, E-W	6.0	5	25	0.33	3.03
VERNON, MAR. 10, 1933, S82°E	6.3	10	15	0.27	3.71
GOLDEN GATE PARK, 1957, S80°E	5.3	8	7	0.33	3.03
PACOIMA DAM, 1971, S16°E	6.6	0	4	2.17	0.46

H = Estimated horizontal distance to slipped fault.

D = Estimated depth of center of slipped fault.

TABLE I - PROPERTIES OF SELECTED
ACCELEROGRAMS

ANALYSIS FOR EARTHQUAKE INSURANCE

by Don G. Friedman*

Introduction

One's view of the character of the earthquake hazard depends upon the application. A structural engineer concerned with the earthquake hazard as it affects a particular building at a given site has specific information needs about the character of the hazard as it applies to his activity. An insurer covering the hazard on a number of buildings ranging in condition, type and size upward from one-family dwellings to high rise buildings and which are spread in an irregular fashion over a wide area of varying seismic activity such as in coastal sections of California necessarily has a different set of information requirements.

This presentation will discuss earthquakes as one of the natural hazards viewed from standpoint of an insurer. Information needs of an insurance operation required to cover the hazard will be outlined. Much of the earthquake hazard information that an insurer ideally would need to assist in making decisions about an insurance coverage of a geographical array of buildings is not yet available. Results of current research activities in structural engineering and seismology hopefully will provide this information in the future. In the meantime, the insurer must continue to make decisions even though much of the desired information is still lacking.

Another purpose of this presentation is to outline an application to the earthquake hazard of an approach that we have found to be useful in attempting to tie together and utilize the meagre bits and pieces of pertinent information on other natural hazards for an insurance operation. Information derived from this approach can possibly assist in making insurance decisions while we wait for more complete knowledge of the earthquake hazard to be developed.

Characteristics of earthquake "risk" as applied to an insurance operation are needed to answer the following questions that the actuary must ask:

1. How much premium is needed to cover the average annual expected loss on each insured building?
2. How much of a cash reserve do we need in order to cover possible catastrophic losses on this particular book of business?
3. Is it advisable to reduce our risk of catastrophic losses by reinsuring some of the excess loss potential?

Earthquake risk in this insurance context is dependent upon unique features of the natural hazards (floods, hurricanes, tornadoes, hailstorms, winter windstorms) that distinguish them from other insured hazards such as fire. These unique features make it necessary to find other means of estimating future risk rather than using the traditional method of evaluating the magnitude of a hazard solely using past loss experience. A dominant characteristic of these hazards is that a large percentage of associated damage results from a few severe events called natural disasters. A natural disaster occurs when many losses result from a single geophysical event -- flood, hurricane, earthquake.

* Associate Director of Research, The Travelers Insurance Company.
This paper was presented at the ERA meeting.

In the United States, frequency and cost of natural disasters is up each year even though there is no indication that storms and earthquakes are more severe now than in past years. However, property density, value, cost of repair are increasing rapidly:

1. Average annual loss is about 700 million dollars.
2. In 1965, the year of hurricane Betsy, property damages reached 2.7 billion dollars.
3. The 1971 San Fernando and 1964 Alaska earthquakes each cost 1/2 billion dollars.

Measures of risk.

Insurance is one means of protection against these hazards. To cover the hazard to fixed property such as buildings, two measures of risk are needed:

1. Average annual loss per structure -- pure premium. This is a measure of expected value (The actuary's first question).
2. Catastrophe potential -- many losses resulting from same event. This is a measure of variability (The actuary's second and third questions).

Relative importance of the measure of average annual loss as compared with the catastrophe potential is different for each type of hazard. For the fire hazard to dwellings, the average annual loss is dominant and catastrophe potential is of lesser significance. An extreme case, at other end of scale, would be a hazard for which all losses occur as a result of a single event which occurs on the average of, say, once every 25 years. In this case, catastrophe potential is dominant and average annual expected loss is a less meaningful measure. The various natural hazards lie somewhere between these two extremes. Catastrophe potential is an important measure for earthquakes.

For the natural hazards, the average annual expected loss and the measure of catastrophe potential are not directly related. Knowledge of one measure does not imply the magnitude of the other. Each must be estimated separately. To estimate average annual expected loss, ideally three measures are needed at each building site:

1. Physical character of the hazard (frequency, magnitude).
2. Property characteristics (type, value).
3. Susceptibility of structure to damage for a given severity (loss function).

The estimated average annual loss per dwelling due to the thunderstorm hazard in Midwest is given in Exhibit 1. Note that severe storms are most frequent in Texas, Oklahoma and Kansas in Exhibit 1a. A plot of the location of catastrophes causing at least one million dollars in insured damage is given in Exhibit 1b. The pattern of these points is displaced to the east of the area of severe storms because natural disasters are caused by the interaction of the geographical pattern of the severity of the geophysical event with the geographical pattern of the exposed structures. Even though severe storms are

less frequent in the Great Lakes region, when they do occur, the catastrophe potential is great. A severe storm is not a damaging storm unless properties susceptible to damage are in the storm area.

To measure catastrophe potential, the overlapping and interaction of the geographical severity pattern of the event with the density pattern of structures must be evaluated. Two measures are needed:

1. Frequency and magnitude of geographical patterns of severity associated with geophysical events.
2. Geographical array of exposed properties. Exhibit 2 represents population density and is a proxy measure of exposed properties.

There are usually a great many possible combinations of pattern interactions; a few lead to production of a natural disaster. This usually occurs when a severe geophysical event occurs near a populated area. If the severity pattern (earthshock intensity) of the 1971 San Fernando earthquake had been displaced northward a few miles away from the concentration of exposed structures, the resulting damage would have been much less than 500 million dollars. However, if the epicenter had been nearer Los Angeles, the resulting losses would have been much greater than 500 million dollars even though the earthshock intensity pattern did not change in size, shape, or gradient.

Methods of estimating risk

Conventional use of loss experience is not an adequate means of obtaining measures of future risk for the natural hazards. Loss experience measured over a short period of years is greatly biased by occurrence or non-occurrence of a geophysical event during the period. Extrapolation of loss experience into the future implies holding the natural hazard mechanism constant, using those events that happened to have occurred in the sample period. Actually a long record of occurrences is needed. Property characteristics rapidly change with time. Number, geographical distribution and susceptibility to damage change, because of time related differences in design, building codes, materials and changing insurance coverage or deductibles. Consequently, a dilemma exists. If the length of the sample period is increased, the effect of changing property characteristics is amplified. On the other hand, if the length of the sample period is decreased there is less chance of getting a non-biased estimate of frequency and magnitude of the natural hazard.

Loss experience is a result of a number of factors not easily dissected for use in estimating future risk. In addition, loss experience is not available for earlier years. Exhibit 3 is a block diagram of the process indicating the major factors that affect loss experience. This process is not reversible. Insurance operation and loss function are filters. To provide a measure of future risk, an alternative to loss experience is needed:

	Loss Statistics	Alternate Approach
Natural hazard	Constant	Variable
Property characteristics	Variable	Constant
Loss function	Variable	Constant

An alternative approach to the sole use of loss experience for evaluating the magnitude of the natural hazards is to construct a mathematical model of the process. A mathematical approximation of the natural hazard mechanism can then be used to artificially produce geophysical events and attendant severity patterns that mathematically interact with a given array of properties and produce synthetic loss experience. Both measures of risk can be examined using this type of analysis -- annual expected loss (a single structure in Exhibit 3) and catastrophe potential (a geographical array of structures in Exhibit 3). We are not as interested in what the 1857 Fort Tejon earthquake cost, as we are in the cost of a comparable earthquake occurring today and affecting the present geographical distribution, type and value of properties.

Natural hazard simulation

An approach which we call "natural hazard simulation" ties together additional information not available in the sole use of past loss experience such as:

1. Geophysical hazard information from the physical sciences.
2. Property information from the insurance company's book of business.
3. Loss functions from claim records or engineering studies.

Natural hazard simulation provides a measure of the effect of a recurrence of past geophysical events or simulated future events upon present or hypothetical future geographical arrays of property. Occasionally, a simulated "natural disaster" is produced (Reference 1).

A computer is needed to perform the great number of calculations involved. An IBM 370 computer is used. High speed analysis provides a means of obtaining many possible pattern interactions, which because of his short lifetime, man cannot afford to wait for nature to produce. Results of the analysis are needed to make insurance decisions about the riskiness of a particular book of business.

We are painfully aware of inherent deficiencies of mathematical and statistical modelling used in attempting to approximate real world mechanisms. There is always the danger that the required limiting assumptions will yield misleading results unless interpreted properly. "A little information based on a computer printout may be worse than no information" is very often a true statement. Recognition of these limitations in the interpretation of the results of the simulation analysis will be discussed later.

Method of analysis

The geographical array of exposed properties in the model is based upon a grid system. Size of the grid areas depends upon the purpose of the study. To make a micro-analysis of the earthquake hazard in the San Francisco Bay region, we have used areas of one-third square mile. For general use with the various natural hazards in the United States, grid areas of about 35 square miles are used (one-tenth of a degree latitude by one-tenth of a degree longitude squares). Convergence of the Meridians is accounted for in the analysis.

Approximately 85,000 of these grid areas are needed to represent the land area of the contiguous United States. Number, type and characteristics of property to be "exposed" are input to the appropriate grid area. Currently, contents of this grid system is being updated using 1970 Census information. Population-at-risk of 202,000,000 persons and property-at-risk of 47,000,000 single housing units are being allocated to the 85,000 grid areas.

The effect on population and dwellings of occurrences of various natural hazards (such as hurricanes, local severe storms, earthquakes or wide-spread winter storms) in any part of the United States can be simulated using this grid system. Examples of sections of the grid map that may be subjected to natural hazards are coastal sections of the South Atlantic States (Exhibit 4); the Great Lakes region (Exhibit 5) and Southern California (Exhibit 6).

Severity patterns associated with various natural hazard events are expressed in units which are directly related to damage-producing potential. For dwellings, the unit of severity is as follows:

1. Flood; depth of water.
2. Hurricane; maximum wind speed.
3. Hail; hailstone size, duration of storm and if wind driven.
4. Earthquake; earthshock intensity.

Mathematical models have been incorporated in the computer program which generate geographical patterns of severity. Size, shape and gradient of these patterns as determined by the magnitude, location and other characteristics of the geophysical event (earthquake, hurricane, hailstorm). Whenever a grid area lies within the area covered by the severity pattern, expected number of structures damaged and amount of damage is computed. These statistics summed by intensity category and grid area provide a measure of catastrophe potential. For population-at-risk, the number of persons exposed to each level of hazard severity is also tabulated.

Applications

An example of a computed severity pattern is shown in Exhibit 7 which represents the geographical pattern of maximum wind speeds (miles per hour times 10) experienced during the inland passage of a hurricane across the Southeast coastal area. Shape, size and gradient of the severity pattern of wind speed is determined by direction and curvature of storm path, storm speed, storm size, storm intensity (central barometric pressure) and landfall location. Effect of dissipation of wind with distance inland and degree of exposure are built into model. Computer-derived patterns are good representations of observed wind patterns. Exhibit 8 illustrates the actual and computed wind patterns of Hurricane Audrey. Interaction between wind pattern and property array in producing a high level of catastrophe potential and a possible "natural disaster" can be shown by holding characteristics of the storm constant and varying the landfall position relative to areas of high population concentration. The catastrophe potential of hurricane wind and tidal surge along the Gulf and East coasts will be simulated as soon as updating of the grid data is completed.

Exhibit 9 represents a simplistic representation of local severe storm patterns in the Midwest. Mathematical models, which hopefully will produce realistic thunderstorm wind, hailstorm and tornado severity patterns are being constructed.

To provide a framework for discussing results of our attempts to estimate catastrophe potential of the earthquake hazard, some background information is necessary. We applied natural hazard simulation, as consultants to the U.S. Department of Housing and Urban Development, during development of the now operative National Flood Insurance Program. The purpose of the work was:

1. To estimate the character and magnitude of the inland and coastal flood hazard to the 50 million dwelling structures in the United States.
2. To simulate the fiscal operation of a joint insurance industry -- Federal Government Flood Insurance Program.

The Southeast Hurricane Disaster Relief Act of 1965 also authorized a study of the possible need for federal government involvement in insurance coverage of the earthquake hazard. In 1968 upon completion of our work on the flood program for HUD, we participated in the planning stages of a study to be conducted by HUD on estimating the magnitude of the earthquake hazard to dwelling properties in California. We were scheduled to estimate the second component of risk -- the catastrophe potential for these properties using the computer simulation techniques used on the flood study. A subsequent cutback in funds on the project made it necessary to concentrate the research effort on only the first component of risk, that is, the average annual expected loss. As a result we did not participate on the project (Reference 2). Rather than abandoning the idea of developing a procedure for estimating earthquake catastrophe potential to a geographical array of buildings, it was decided to carry out a very modest long-term study at The Travelers as a part of our work on the various natural hazards and their impact upon an insurance operation.

The purpose of this test application was to determine if currently available information from seismology and engineering could be synthesized and translated into a form that would provide a better understanding of the earthquake hazard from an insurance point-of-view. Previously the use of computer simulation had yielded useful information on the catastrophe potential of the flood and hurricane hazard.

To make this pilot study, several types of information were needed. Of primary importance were the following tasks:

1. Definition of a measure of earthshock intensity that could be used to specify the level of damage to single unit dwellings.
2. Development of a realistic loss function which quantitatively related level of earthshock severity to resulting number of dwellings damaged and amount of loss per damaged dwelling.
3. Development of a method of specifying the geographical pattern of this measure of earthshock severity given a minimum amount of information about the physical characteristics of the earthquake event -- magnitude, location, depth.

4. Development of a method of simulating a series of possible future sequences of earthquake occurrences during the next fifty years in California.

Initial results of this application were reported at an OEP Conference on "Geologic Hazards and Public Problems" in San Francisco early in 1969 (Reference 3). Tentative conclusions were as follows:

1. If Modified Mercalli intensity units are used as the measure of earthshock severity for dwellings, reasonable estimates of damage potential to dwelling-type structures can be made using loss functions relating damage to Modified Mercalli intensity. In a paper at the recent Microzonation Conference in Seattle, Algermissen, Rinehart and Stepp showed in an independent study that damage estimates using the loss function approach produce realistic results (Reference 4).
2. A simple mathematical model can be constructed which generates realistic isoseismal patterns based on:
 - (a) Magnitude of the earthquake, length of faulting
 - (b) Depth
 - (c) Location
 - (d) Local ground conditions

An independent check of the approach by Evernden, Hibbard and Schneider was also reported at the Microzonation Conference. The authors conclude that the model produces realistic isoseismal patterns (Reference 5).

Earthquake hazard application

Construction of the model for generating isoseismal patterns was performed in two steps:

- (1) An isoseismal pattern of earthshock intensity expected on basement rock was developed.
- (2) The isoseismal pattern when the effect of local ground conditions is superimposed.

Local ground conditions can modify ground motion calculated for solid rock. In the model the amount of amplification has been made a function of type of ground condition and relative position of the locality in the earthquake isoseismal pattern. An index of local ground condition has been assigned to the equally spaced grid areas (1/10 degree latitude and longitude squares) over the State of California. Increments of earthshock severity vary from a zero additional increment for basement rock conditions to a maximum additional increment assumed for moist filled land. On solid rock the intensity contours are elliptical in shape and follow the course and length of faulting. When the effects of local ground conditions are added, the pattern becomes irregular in shape and simulate actual patterns.

For purposes of an analysis of the general interaction of isoseismal patterns with a geographical array of exposed properties, calculated patterns are adequate approximations of actual isoseismal patterns. For other uses, such as an engineering application at a specific site involving a non-dwelling type building, a more refined measure of earthshock intensity would be required. Information needs for buildings other than single family dwellings will be discussed later. Examples of actual and calculated isoseismal patterns of recent moderate earthquakes in Southern California are given in Exhibits 10-13:

<u>Earthquake</u>	<u>Calculated</u>	<u>Actual</u>
Borrego Mountain (9 April 1968)	Exhibit 10	Exhibit 11
San Fernando (9 February 1971)	Exhibit 12	Exhibit 13

An index of local ground conditions has not been input for locations in Nevada, Arizona and Mexico. Consequently, calculated isoseismal patterns extend only to the California border in Exhibits 10 and 12. Note also that the calculated severity units represent earthshock intensity only and do not include the effect of surface faulting. This could be one reason why the small area of Modified Mercalli VIII-IX near San Fernando on the actual pattern (Exhibit 13) does not exist on the calculated pattern (Exhibit 12) for the February 9, 1971 earthquake. Scale, gradient and shape of the calculated patterns can easily be adjusted in the computer model.

The effect of the overlapping of the isoseismal pattern with the geographical array of population and properties is expressed in a measure of catastrophe potential. Exhibit 14 provides a graphical illustration of the geographical distribution of population and property at risk in California. An estimate of catastrophe potential has been obtained assuming a recurrence of all earthquakes, estimated to have had an equivalent of Richter Magnitude 6 or greater, which occurred since 1800 in California using 36 square mile grid areas. The geographical array of the 3,000,000 dwellings in California was used. Catastrophe potential was also calculated for 110,000 dwellings in the City of San Francisco using 1/3 of a square mile grid areas and assuming a recurrence of the sequence of earthquakes that happened since 1800 and affected San Francisco. For the City of San Francisco, a comparison was possible between observed and simulated intensities for 60 of the 80 earthquakes that affected the city in the past 170 years. Refer to Exhibit 15. There is close agreement for high and moderate intensity occurrences.

An estimate of the first measure of risk -- average annual expected damage or pure premium -- varied considerably depending upon the 20-year period taken during the past 160 years (Exhibit 16). The importance of catastrophe potential of the earthquake hazard is emphasized by the estimated multiples of average annual damage needed to cover the rate for highly damaging major earthquakes that occurred near San Francisco (Exhibit 17).

Preliminary results of the type given in Exhibits 16 and 17 suggest that information useful to an insurance operation can be derived from a very simple modeling of the earthquake hazard -- property array mechanism. The set of

assumptions regarding the definition of a measure of earthshock intensity, the construction of a loss function, and the development of a simple model for producing the geographical pattern of earthshock intensity appear to be adequate representations. These items are used to develop a simulation method for analyzing the characteristics of an insurance operation needed to cope with the catastrophe-producing potential of the earthquake hazard (items 1-3 on page 6).

Our current interest is in item 4 listed at the top of page 7, namely, the development of a means of producing a large number of possible sequences of earthquake occurrences during future years in California. A recurrence of past earthquakes has been used as a means of testing the simulation procedures. The chance that this particular sequence of earthquake events will repeat, in the same order, in the future is very small. In general, the simple use of past recurrences does not provide much information about the characteristics of an insurance program needed to cover the earthquake hazard. A number of possible sequences of earthquake occurrences in a series of, say, 50-year periods are needed to examine the character and flexibility of an insurance mechanism.

The need for a similar type of "event" generator arose during development of the National Flood Insurance Program by HUD. Development of this new insurance program permitted the use of new procedures including the computer simulation approach in modeling the joint insurance industry - federal government program within constraints imposed by Congress. Thousands of "years" of synthetic loss experience for 1.5 million dwellings in 1010 inland urban areas and 1.6 million dwellings exposed to coastal flooding were obtained. Coastal flooding is usually caused by the storm surge of a hurricane along the Gulf and East coastlines. The order of events by magnitude in each 50-year sequence is important for reserving and reinsurance considerations. In the simulated insurance operation, account was taken of the effect of deductibles (type and size), market growth, flood plain zoning, and mixture of coastal and inland exposures. Size of the initial fund, reserve fund and level of reinsurance for alternative programs was examined relative to the various sequences of possible future flood occurrences. Results of these simulations were used by the Congress to help determine the government's liability for flood losses, treasury authority and insurance authorization. Reinsurance arrangements between the industry and government were also based upon results of these studies (Reference 2).

The generation of 50-year sequences of possible flood events of various magnitudes was much simpler than the generation of 50-year sequences of earthquake events in California because flood occurrences from one year to the next could be considered to be independent of one another. The earthquake generating mechanism is of greater complexity.

Generation of simulated future earthquakes

The earthquake generation mechanism in California probably has a memory both in space and time. The degree of memory appears to be related to the magnitude of the earthquake. We are currently attempting to construct a

simple mathematical model which will incorporate the effect of this memory and provide a means of generating realistic sequences of possible future earthquake occurrences which could be used as a basis for: (1) developing appropriate isoseismal patterns; (2) overlapping of these patterns with the geographical array of exposed properties resulting in synthetic damages; (3) the sequencing of these damages in the time series help to establish relationships between market share and spatial spread, initial fund, reserve fund and reinsurance level. To develop this model for generating "earthquake occurrences", we are trying to incorporate currently accepted knowledge about the character of the earthquake mechanism in California. Professor Clarence Allen in an abstract of his talk at the conference on the San Fernando earthquake stated that "we cannot as yet delineate, in detail, areas of markedly different seismic risk, and that for purposes of public policy in zoning and building codes, all of coastal California must be assumed to share a relatively high earthquake hazard."

Within the high risk area of coastal California there probably are sections where the likelihood of a major or extreme earthquake occurrence is greater than in other parts of the coastal strip, if the relationship between horizontal length of faulting and earthquake magnitude holds. Five earthquake source regions have been roughly assigned to California and Nevada based on this assumption (Exhibit 18). The area of greatest likelihood of a major or extreme earthquake is assumed to be in the immediate San Andreas Fault Zone and the zone along the eastern edge of the Sierra Nevada Mountains. The likelihood of a major earthquake is assumed to decrease with distance from these fault zones.

Each source region is assumed to represent a level of seismicity consistent with the accepted semi-logarithmic relationship between number of earthquakes per year per unit area and magnitude of the earthquake. The area of each source region is used to weight the number of earthquakes from each region. The overall long-term total per year from all regions is consistent with the annual totals for California and Nevada.

Probability surface

For purposes of illustration, it is assumed that an elastic surface covers these source regions. The height of the surface represents the probability of occurrence of a major or extreme earthquake. An east-west cross section through Southern California would show that this "probability surface" is highest in the vicinity of the San Andreas Fault Zone. The height falls off gradually to the east and west (Exhibit 19). The northwest-to-southeast cross section along the San Andreas Fault Zone shown in Exhibit 19, would represent the highest level of the probability surface. The probability level would be constant along the fault zone if the source region concept is followed.

It is probably more realistic to assume that the probability surface along the fault zone is not at a fixed level but varies in height as a function of the location and magnitude of major and extreme earthquakes that have occurred in the past along the fault zone, that is, there is an inherent memory in the earthquake generating system. In our simple model of this earthquake generating mechanism, it is assumed that the occurrence of a large earthquake depresses the probability surface in the vicinity of the epicenter

and along the length of fault movement (Exhibit 20). The effect of the aftershock pattern following a large earthquake would be to change the shape of the depressed area into an ellipse along the section with fault movement. A circular depression of less extent associated with only minor faulting is assumed for moderate earthquakes.

The amount of the surface depression in the model depends upon the magnitude of the earthquake. A Richter magnitude 8 occurrence would depress the probability surface the greatest amount indicating that the probability of a major earthquake along the faulted section is much less than before the occurrence of the earthquake after the adjustment period due to aftershock occurrences. Smaller magnitude earthquakes would have proportionally less effect on the probability surface. A Richter magnitude 5 earthquake would depress the probability surface only slightly indicating little change in the probability of future large earthquakes in the vicinity of the epicenter. Exhibit 21 represents computer derived patterns of depressions in the probability surface due to simulated earthquake occurrences.

To balance the effect of depressing the probability surface in the vicinity of an earthquake occurrence, a differential growth in the overall height of the probability surface would be assumed to occur. The greatest amount of growth would occur near and over the major fault zone. The least amount would occur in the source regions of lower seismic activity to the east and west of the major fault zone. In years following the occurrence of a major earthquake, a decaying growth rate in the level of the probability surface is assumed. At the end of a specified number of years, if there were no additional occurrences in the area, the depressed surface would return to its original level.

If earthquake activity in the area continued to be low, the level of the probability surface in the vicinity would continue to increase resulting in an elevated area -- a hill -- indicating an increased likelihood of the occurrence of major or severe earthquakes in the area. An example of this situation could be the area northwest of Los Angeles in the San Andreas Fault Zone in which the 1857 earthquake depressed the probability surface at the time. Over the years, with very little seismic activity, the depressed surface has probably returned to its original level or may, in fact, be elevated above its position in 1856 suggesting an increased probability of a large earthquake in this sector relative to other sections of the San Andreas fault system.

Fluctuating levels of probability surface

The inclusion of memory in the earthquake generating model has the effect of superimposing an irregular pattern of hills and valleys upon the general level defined by the source region seismic activity. This superimposed pattern of deviations would have the greatest impact in the vicinity of the major fault zones. In the less active source regions to the east and west, these deviations would be of minor importance (Exhibit 22). In the less active source areas, the maximum magnitude earthquake expected would be, say, Richter 5. It is assumed, it has little effect upon future earthquake probabilities, that is, there is very little memory associated with the lesser magnitude earthquake. There is considerable memory associated with the extreme earthquake-Richter Magnitude 7.50 or more.

The probability surface, under these assumptions, would be in a continual state of flux depending upon the recent past history of earthquake occurrences of various magnitudes by area and time. Exhibit 23 represents the possible effect of memory upon the probability proposed in Exhibit 18. Two calculations would be required; first, the return period of the next earthquake; and secondly, the location and magnitude of this earthquake which would be obtained from the normalized probabilities at a grid of locations. The probability of an earthquake of Richter magnitude 5 or more at these grid locations defines the level and shape of the probability surface. A feedback mechanism would modify the return period equation depending upon the magnitude of the simulated earthquake. A number of major earthquakes that happened to occur within a short period of years would depress the general level of the probability surface which, in turn, would lessen the potential seismicity of the area and increase the probable number of years to the next major occurrence. The lack of major or extreme earthquakes in a period of years would increase the potential seismicity and tend to shorten the period to the next occurrence. Using this earthquake generating model over simulated periods of, say, fifty years, a large number of possible sequences of events by location and magnitude could be obtained. Exhibit 24 represents a possible set of simulated epicenters.

Initial condition of the probability surface is important in determining the sequence of future occurrences. One method of arriving at an initial probability surface would be to "run" the system from the start of historical records on major or severe earthquakes, say, for the past 150 years to insure the inclusion of as many of these large quakes as possible. A map of strain release roughly estimated for this long period might also be useful.

The purpose of devoting so much time and going into so much detail on a possible earthquake generating model is to illustrate the complexity of the actual mechanism we must attempt to approximate. The set of assumptions upon which this generator is constructed can be of considerable influence on the implied character of an insurance operation needed to cover the earthquake hazard. It also illustrates the point made earlier that "a little information obtained from a computer printout may be worst than no information" if these assumptions are not realistic.

Choice of earthquake source generator

The next step in our analysis of the catastrophe potential of the earthquake hazard is to attempt to determine the effect on the character of an insurance operation of the following assumptions regarding the actual earthquake generating mechanism in California and Nevada. These assumptions range in complexity from the oversimplified model to the complicated version with a memory which has just been described:

1. One source region covering all of California and Nevada -- random occurrence of earthquakes of any magnitude -- no memory.
2. Several source regions of different seismic activity -- random occurrence of earthquakes of any magnitude -- no memory.
3. A number of source regions of different seismic activity -- occurrence of earthquakes is dependent upon past occurrences of various magnitudes in both space and time -- memory in space and time.

After the most "realistic" model is obtained and earthquake occurrences in a series of 50-year periods are generated using the model, isoseismal patterns can be applied for each simulated earthquake and the expected damage to the geographical array of exposed properties can be estimated. Analysis of a series of these 50-year time sequences of damages will provide information on characteristics of an insurance program needed to cover the hazard such as the required level of reserve, the need for reinsurance, and the required amount of pure premium.

Applicability of natural hazard simulation to the earthquake hazard

What can we say about our knowledge of the catastrophe potential of the earthquake hazard to a given geographical array of buildings using natural hazard simulation? Results obtained up to this time indicate that simple mathematical models can be constructed based upon presently accepted knowledge in the fields of structural engineering and seismology. Tying these models together apparently can provide useful information needed to answer the actuary's questions about the earthquake hazard.

One means of improving the output of the simulation approach would be to improve the input information. Items of greatest need are:

1. Ability to specify the geographical pattern of earthshock severity in terms of an engineering measure which includes the pertinent effects of acceleration, velocity, displacement, period and duration. This measure would replace the presently used, but widely disclaimed Modified Mercalli intensity unit and be applicable to non-dwelling type structures.
2. Specification of a method of quantifying the geographical distribution of local ground conditions as it affects earthshock characteristics. It will probably not be possible to provide a detailed measure because ground conditions in many areas are highly variable over very short distances. However, a meaningful general index possibly can be constructed which would be better than completely ignoring the effect of this apparently important factor.
3. A means of relating expected structural and non-structural damage of buildings other than single unit dwellings to the measure of earthshock intensity. This would probably involve obtaining measures of earthshock period, duration, and perhaps, velocity for each type of building.
4. These above mentioned measures are needed for a specification of earthquake hazard to presently constructed structures. Hopefully the engineering research results also will be applied to the establishment of more realistic seismic codes for structures that will be constructed in the future.

Future work

During the development of stages of this application to the earthquake hazard, the single family dwelling has been used as the unit of exposed property. A reason for using dwellings is that a geographical inventory can

be readily obtained from U.S. Census information of dwellings. A second reason is initial emphasis on dwellings in some of our earlier work associated with the HUD studies.

Currently, as consultants to a National Science Foundation study on "Assessment of Research on the Natural Hazards" directed by Gilbert White and Eugene Haas at the University of Colorado, we are applying natural hazard simulation as one means of evaluating the effect of various adjustments to the natural hazards as a means of reducing the social and economic impact of future natural disasters. Earthquakes are one of these hazards. It is hoped that during this study we will be able to examine the catastrophe potential of other types of buildings by tying together pertinent information that is available. There is nothing in the approach that ties it to dwellings. However, to use other types of buildings the necessary input information on type, character, and damage susceptibility may require individual on-site engineering inspections. For dwellings, we were able to assume general relationships for that class of structure. Also a measure of earthshock intensity more appropriate than the Modified Mercalli intensity unit is needed. However, if this information on other types of buildings is available, it can be input to the appropriate grid area in the computer and the effects of simulated earthquake occurrences can be analyzed for that particular geographical array of buildings.

To summarize, the effective application of insurance as one means of protection of buildings against some of the damaging effects of the earthquake hazard is dependent upon information needs from many study areas. The most important sources of needed information are seismology and earthquake engineering.

REFERENCES

1. Friedman, D.G. (1972) "Insurance and the Natural Hazards" 9th ASTIN Colloquium, International Congress of Actuaries, Randers, Denmark, International Journal for Actuarial Studies in Non-Life Insurance and Risk Theory, Amsterdam, The Netherlands, Vol. VII, Part 1, December , pages 4-58.
2. Kaplan, M. (1972), "Actuarial Aspects of Flood and Earthquake Insurance" The Proceedings of the Conference of Actuaries in Public Practice, Vol. XXI, 1971-72, pages 474-511.
3. Friedman, D.G. (1969) "Computer Simulation of the Earthquake Hazard" Geologic Hazards and Public Problems Conference Proceedings, May 27-28, 1969, San Francisco, Office of Emergency Preparedness, Region Seven, Superintendent of Documents, Washington, D.C. pages 153-181.
4. Algermissen, S.T., Rinehart, W. A. and Stepp, J.C. (1972) "A Technique for Seismic Zoning; Economic Considerations" The International Conference on Microzonation for Safer Construction - Research and Application, Sponsored by the National Science Foundation and Others, Seattle, Washington, October 30 - November 3, Proceedings, pages 943-956.
5. Evernden, J.F., Hibbard, R.R. and Schneider, J.F. (1972) "Interpretation of Seismic Intensity Data", The International Conference on Microzonation for Safer Construction - Research and Application, Sponsored by The National Science Foundation and others, Seattle, Washington, October 30 - November 3, Proceedings, pages 363-378.

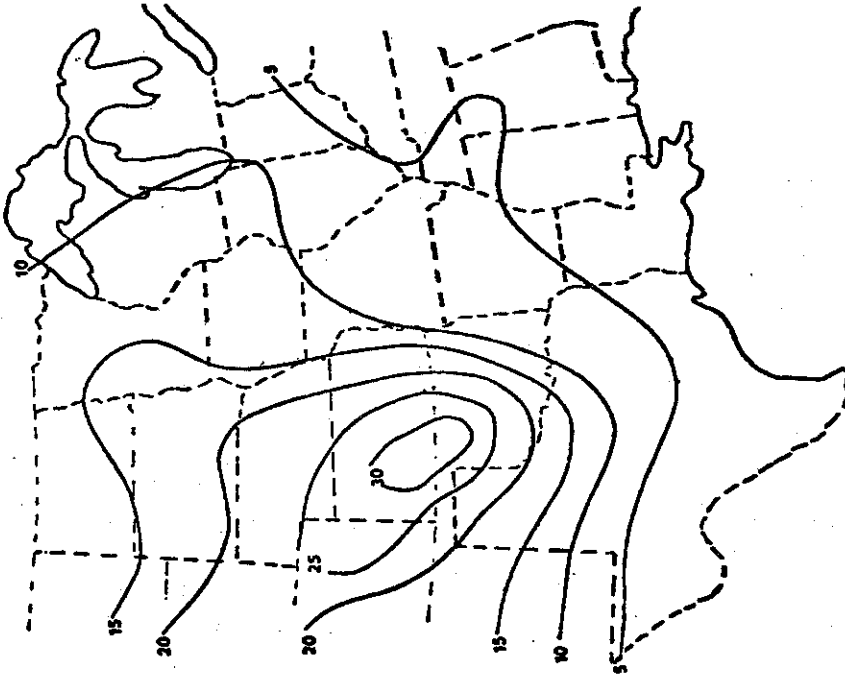


Exhibit 1a. Estimate of pure premium rate needed to cover the first component of natural hazard risk: expected average annual loss per dwelling based on Natural Hazard Simulation. Hazards include tornado, hail, thunderstorm wind, winter and spring (non-thunderstorm) windstorms.

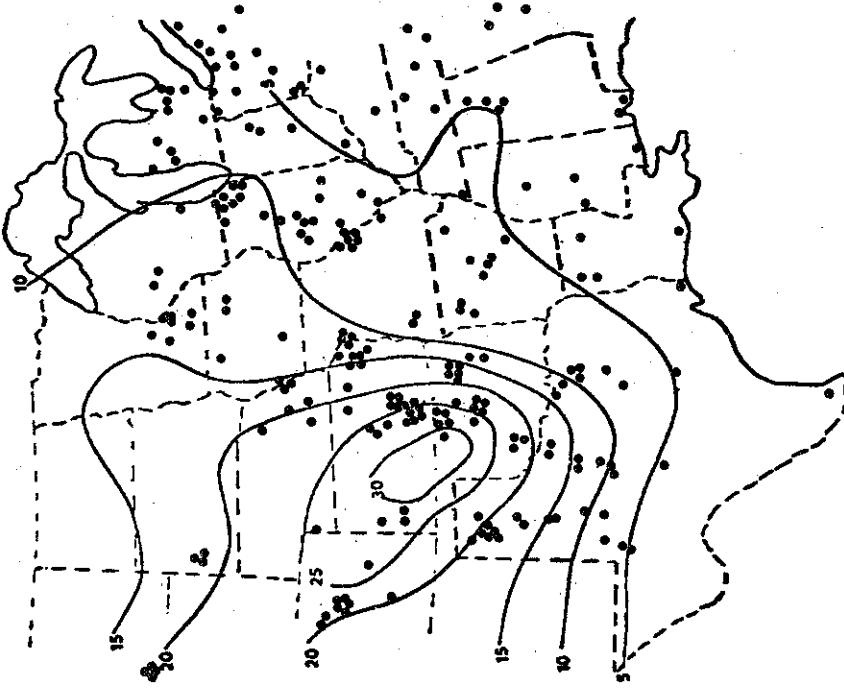


Exhibit 1b. Location of catastrophes caused by natural hazards during past twenty years plotted on the premium pattern given in Exhibit 1a. Losses exceeding one million dollars caused by a single geophysical event have been coded as a catastrophe by the National Board of Fire Underwriters and more recently by the National Insurance Actuarial and Statistical Association. The U.S. Department of Commerce publication "Storm Data" was used to pinpoint location of severest damage.

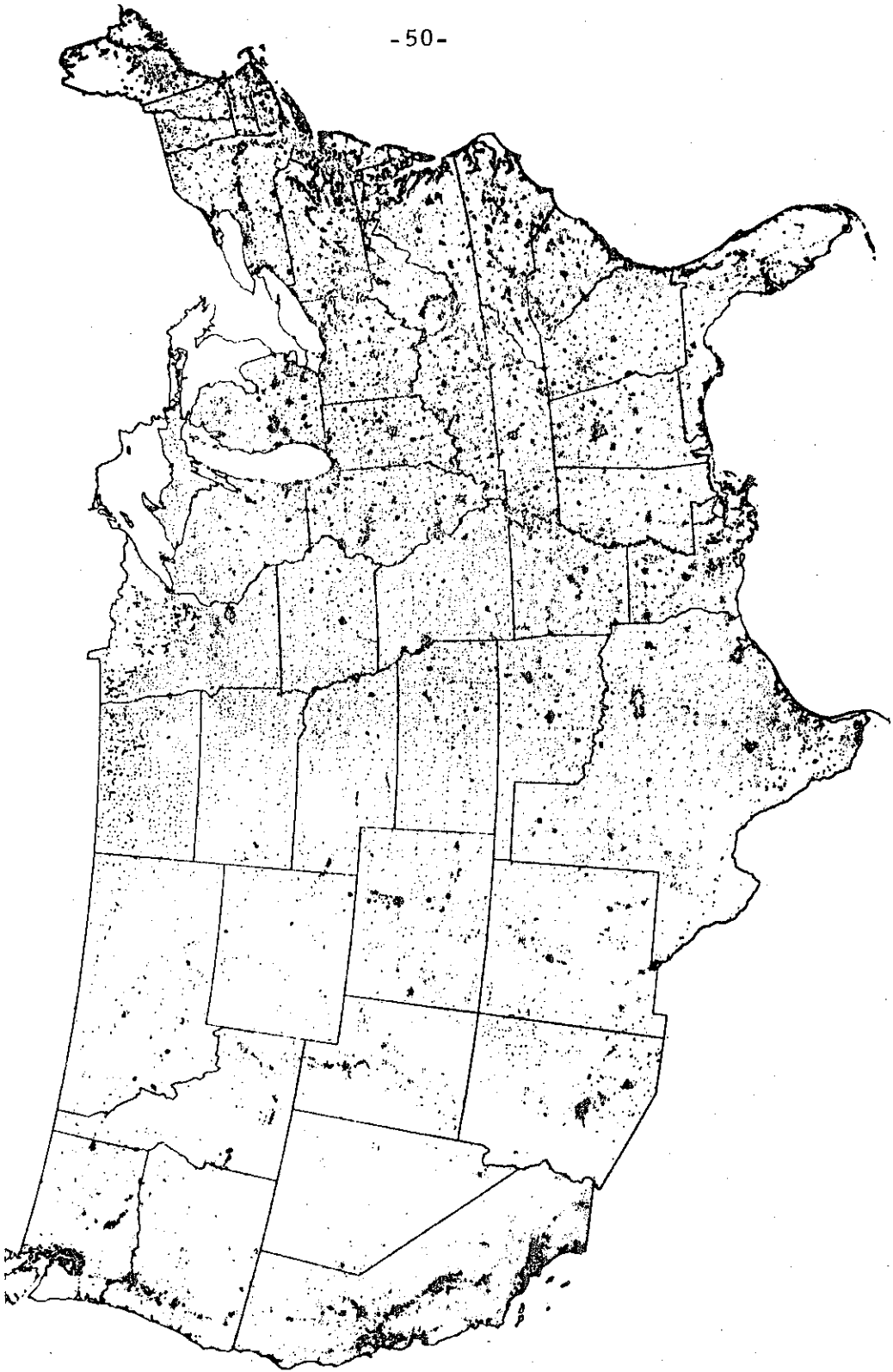


Exhibit 2. Population density.

Exhibit 3a. Actual (but unknown) system by which natural hazards become damage producers to fixed property.

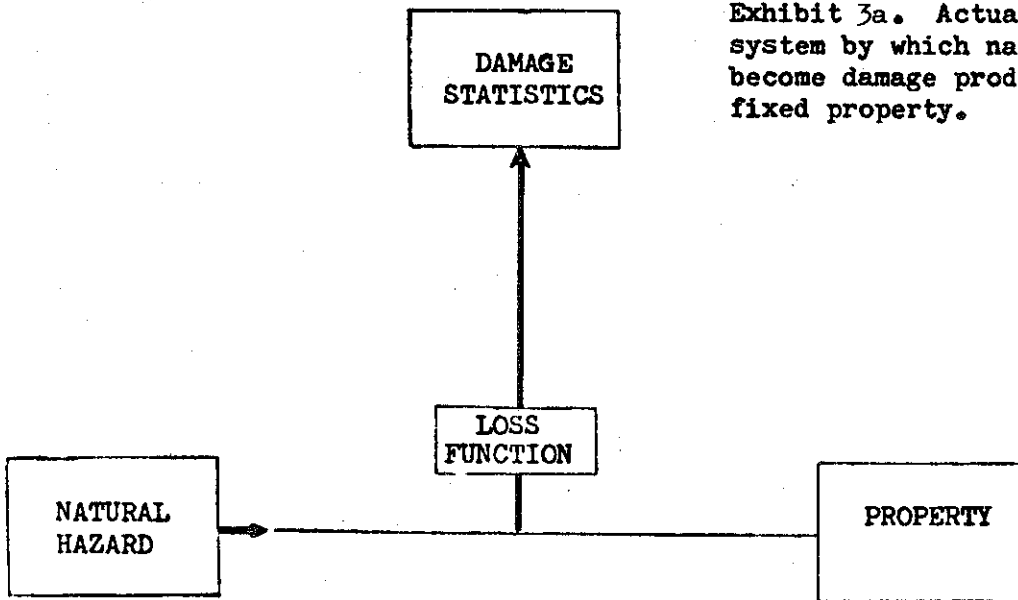


Exhibit 3b. Mathematical approximation of the actual system (Exhibit 3a) which is constructed to estimate the first component of risk -- potential loss per individual structure.

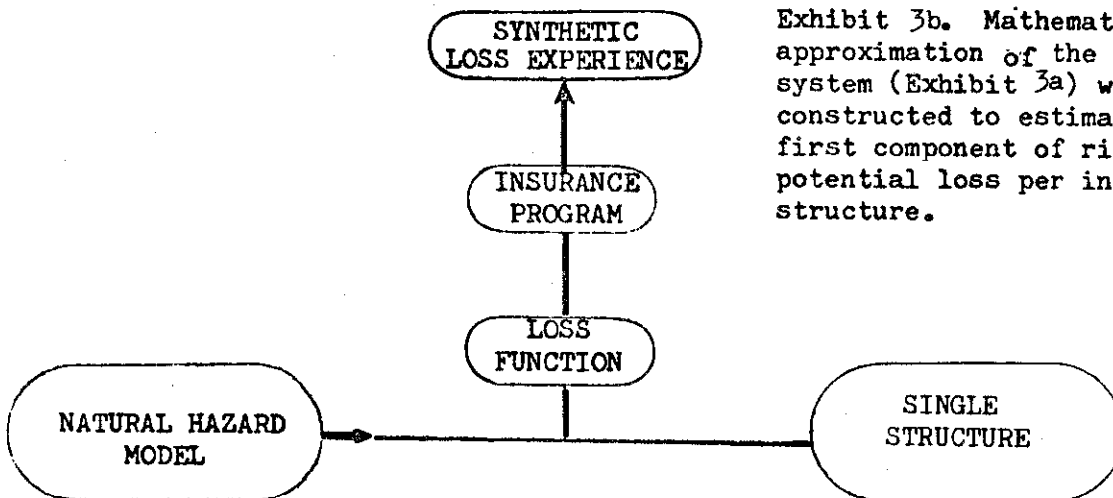
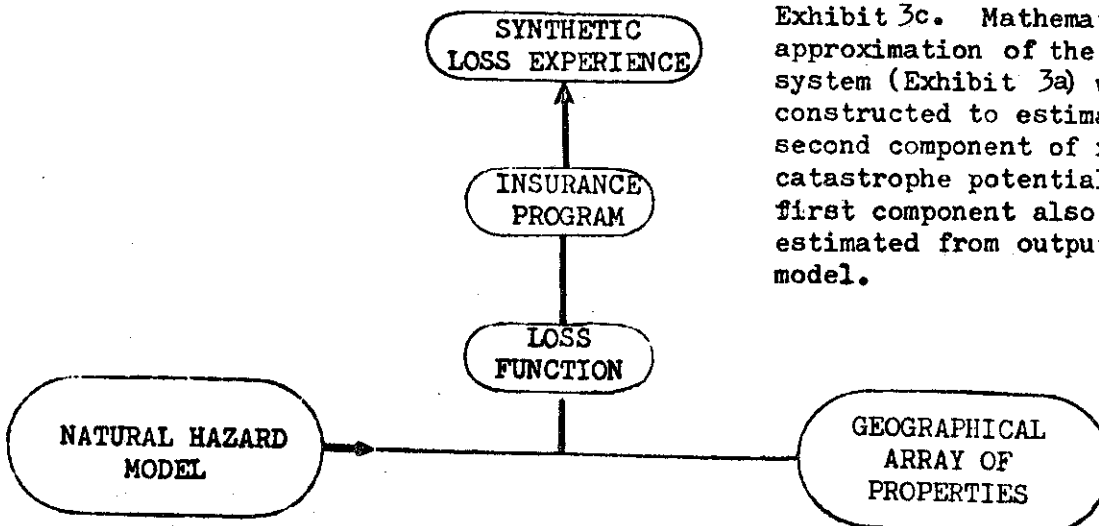


Exhibit 3c. Mathematical approximation of the actual system (Exhibit 3a) which is constructed to estimate the second component of risk -- catastrophe potential. The first component also can be estimated from output of this model.



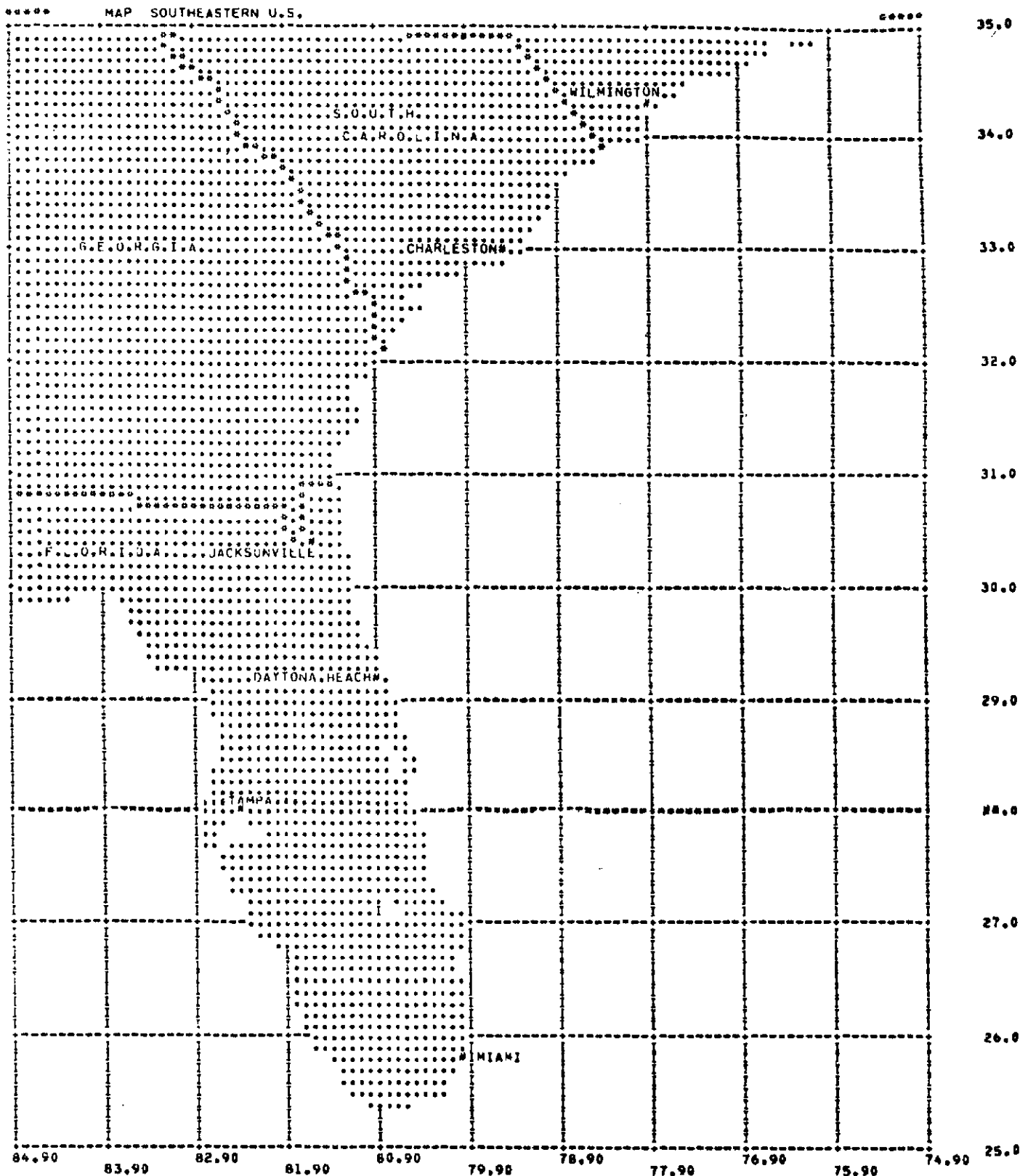


Exhibit 4. Graphical representation of southeastern coastal portion of grid system. Characteristics of population-at-risk and property-at-risk to be "exposed" to simulated occurrences of the various natural hazards are assigned to the appropriate one-tenth of a degree latitude by one-tenth of a degree longitude grid area. These areas are represented by dots on this map.

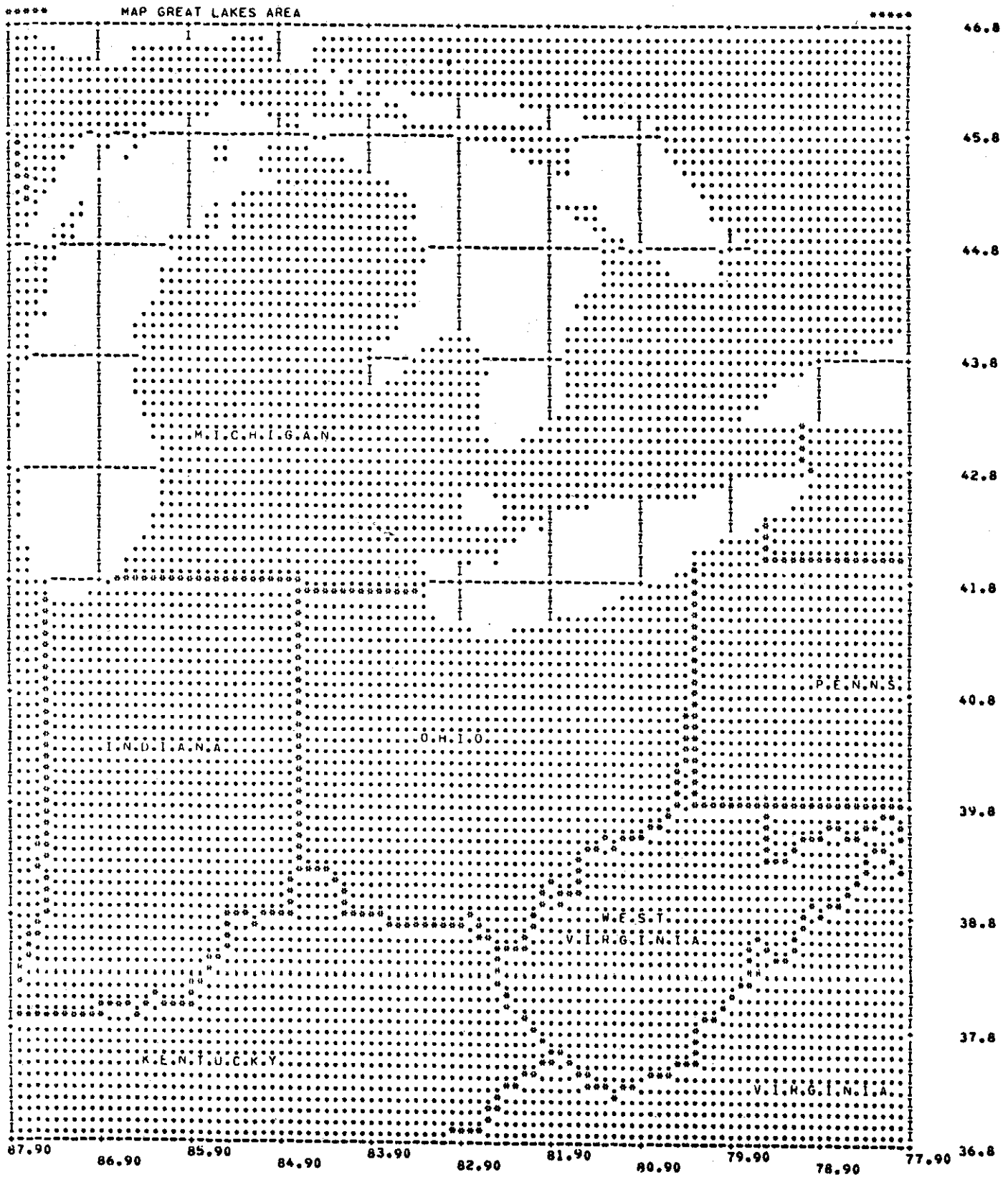


Exhibit 5. Graphical representation of Great Lakes portion of grid system.

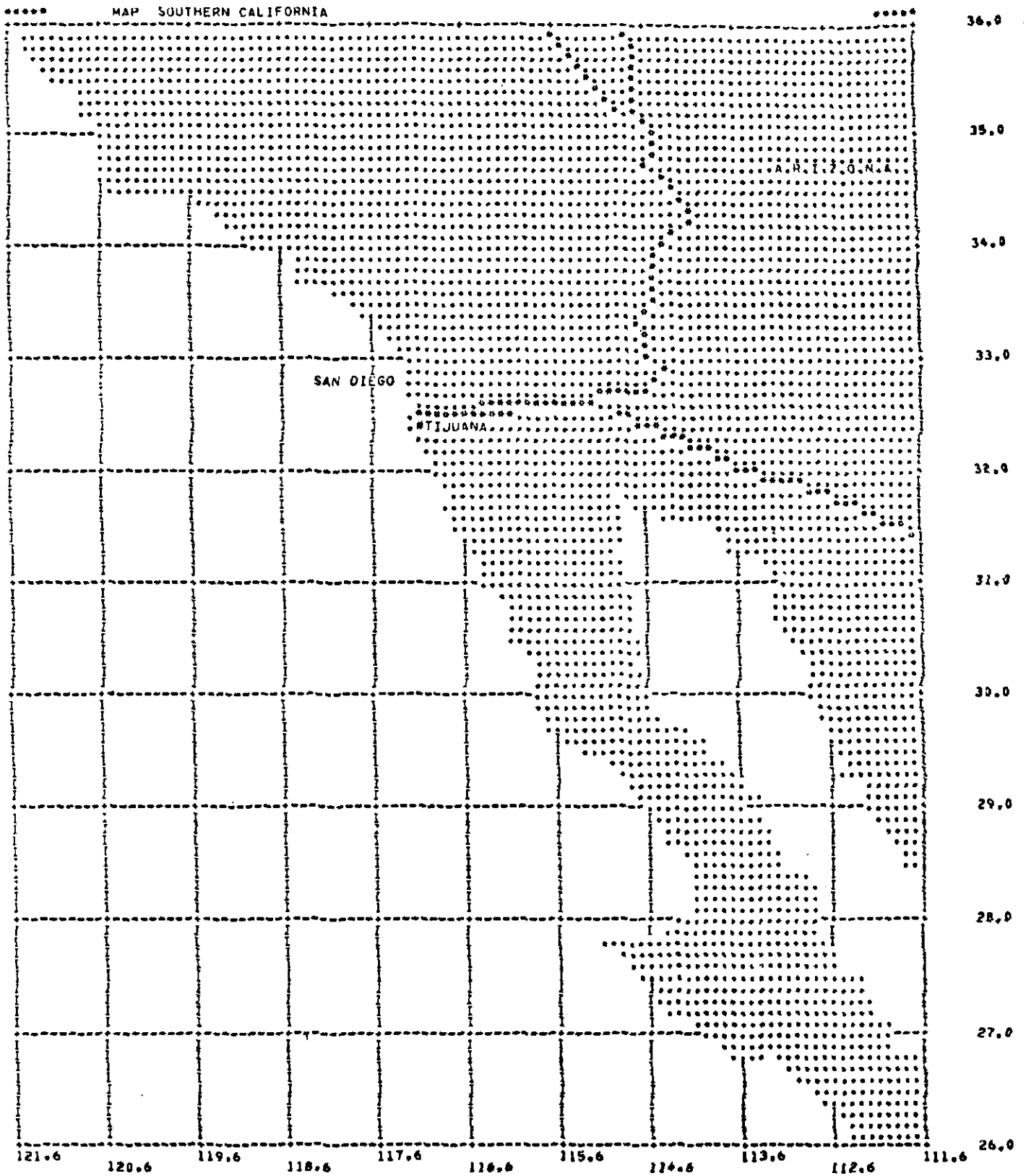


Exhibit 6. Graphical representation of southwestern coastal sections of grid system.

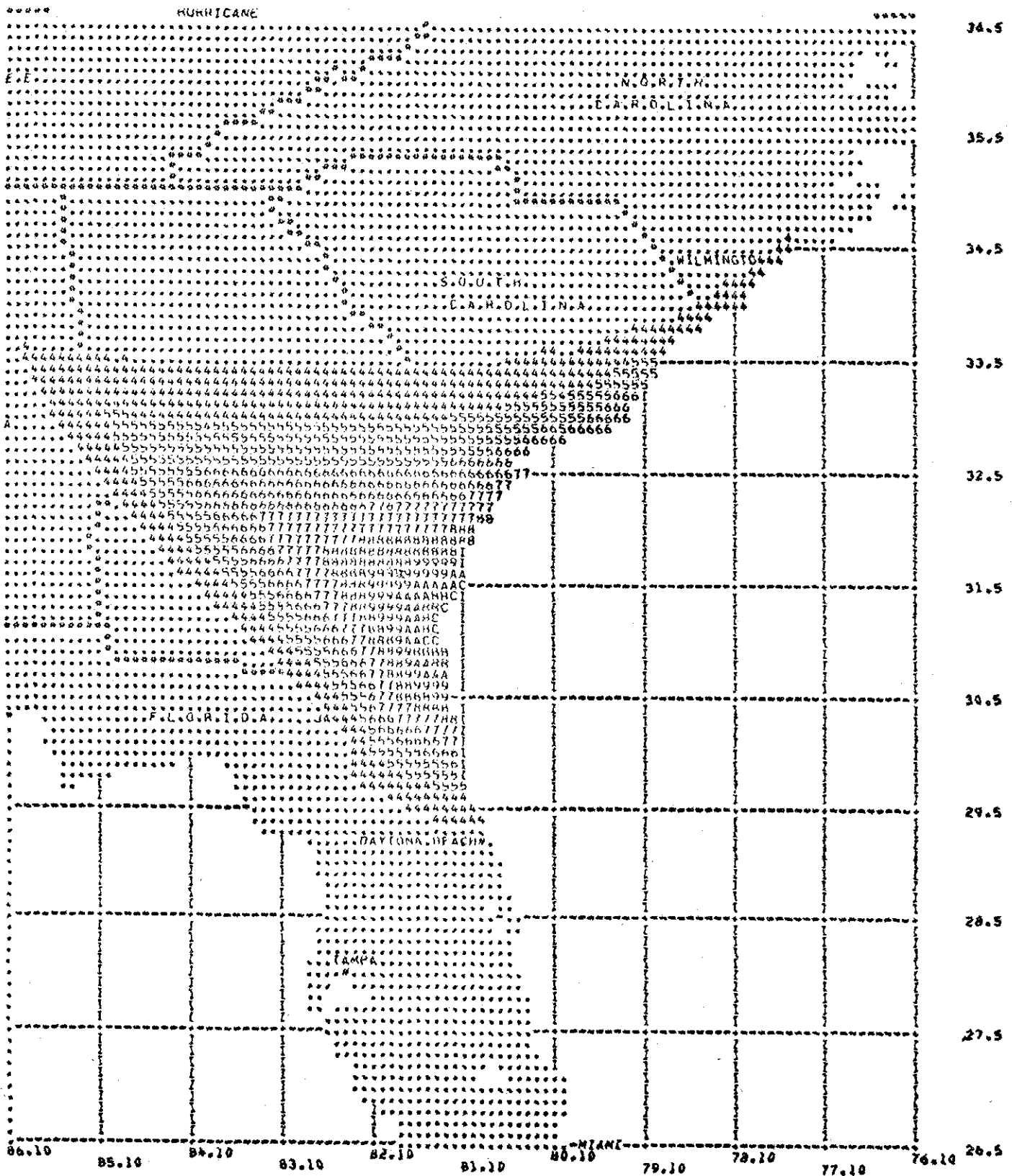


Exhibit 7. Example of the calculated pattern of maximum wind speeds associated with the passage of a hurricane across the southeast coastline. Loss functions are used to estimate the effect of calculated wind speed upon property-at-risk in each grid area.

Exhibit 8. Observed and calculated geographical pattern of highest wind associated with passage of Hurricane Audrey across the Gulf Coastline in 1957.

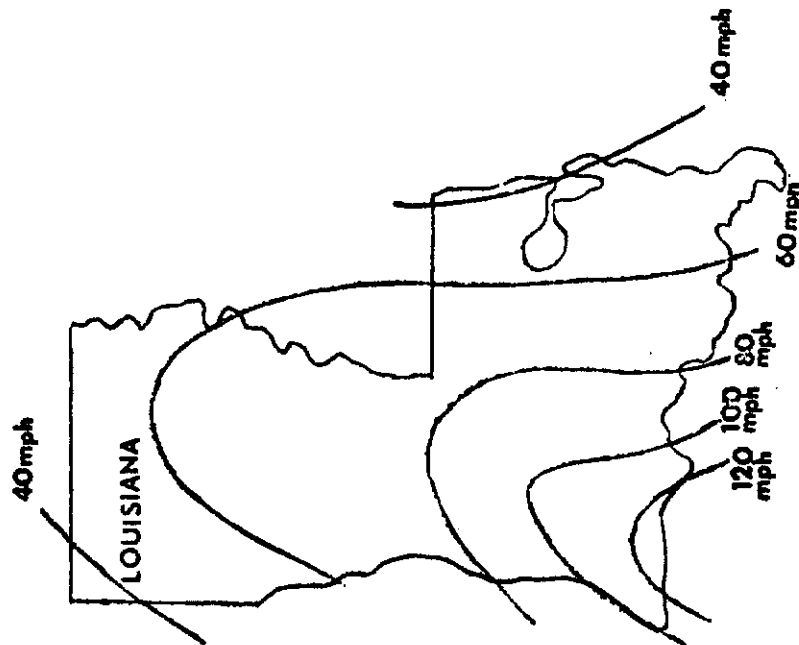


Exhibit 8a. Observed pattern of peak wind gust based upon observations tabulated in the U.S. Department of Commerce publication Climatological Data Annual Issue - 1957 (Vol. 8, No. 13) Superintendent of Documents, Washington, D.C.

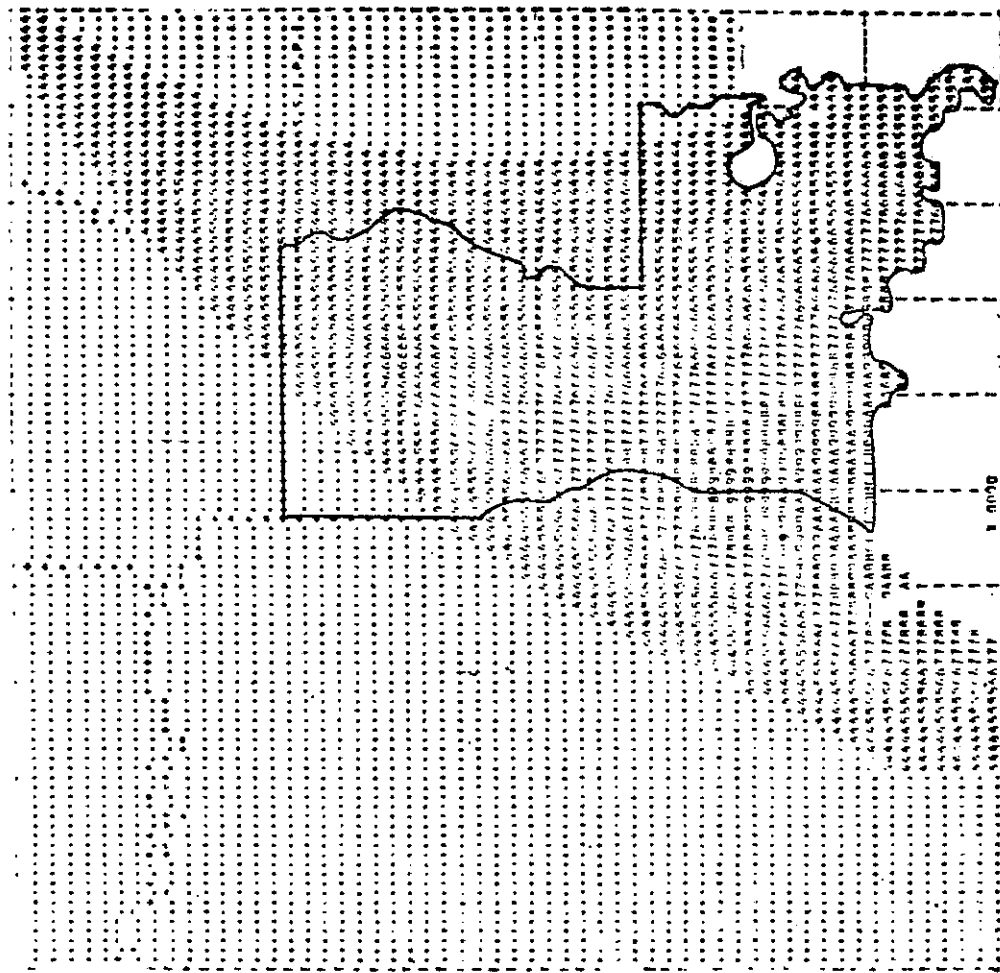
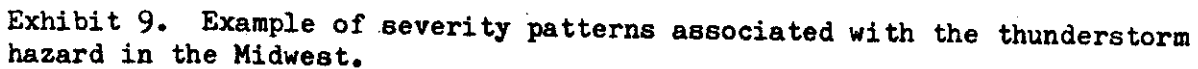


Exhibit 8b. Computed pattern of highest wind. The digit given at each grid point in the affected area represents a wind speed interval. For instance, the digit 5 denotes a wind speed between 50 and 59 miles per hour. For speed intervals above 100 miles per hour, an alphabetic designation is used. The letter A represents the interval from 100 to 109 miles per hour. The State of Louisiana has been outlined on the printout.



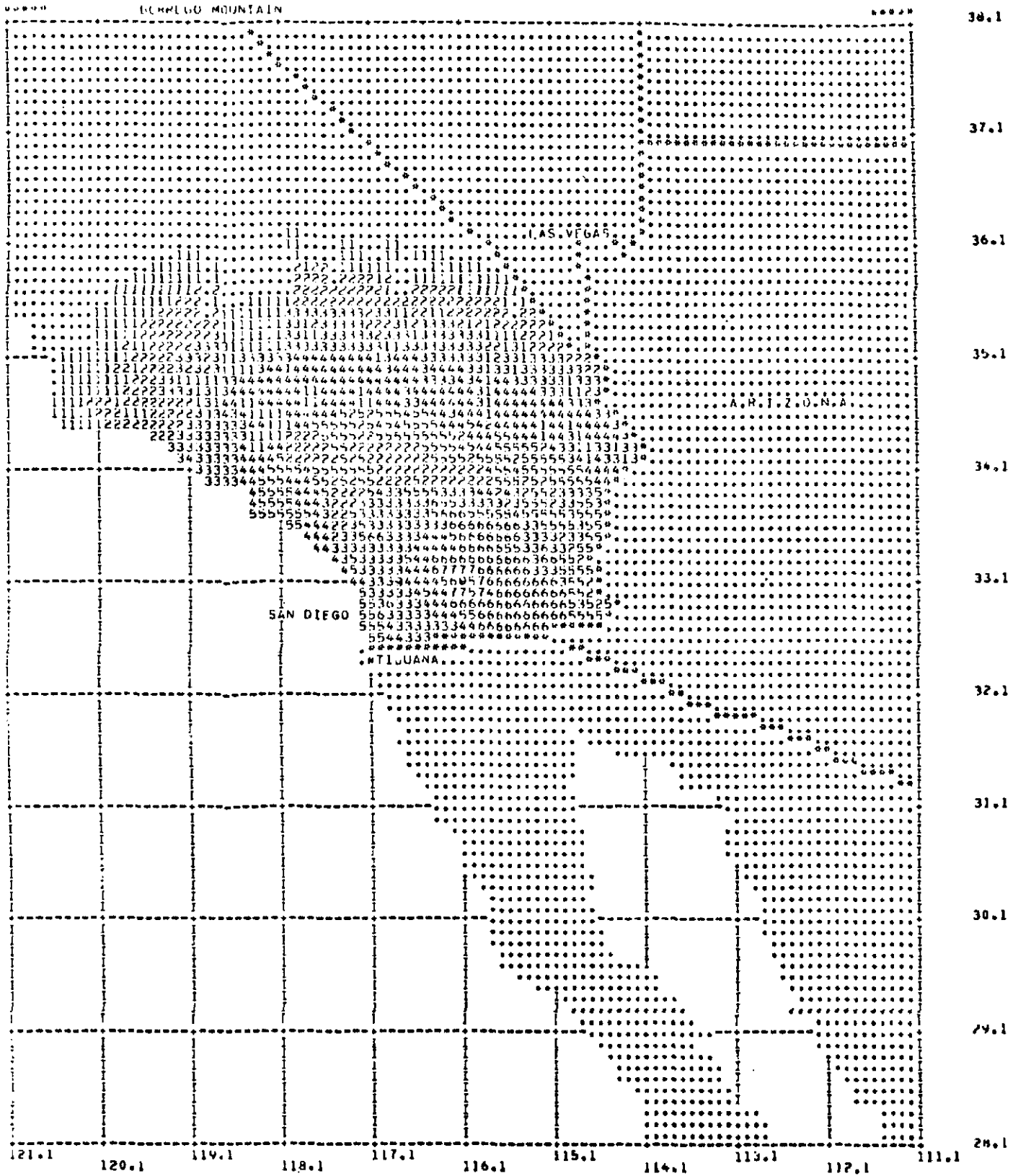


Exhibit 10. Computed pattern of earthshock intensity (Modified Mercalli units) based on magnitude, location and depth of the Borrego Mountain earthquake of April 9, 1968.

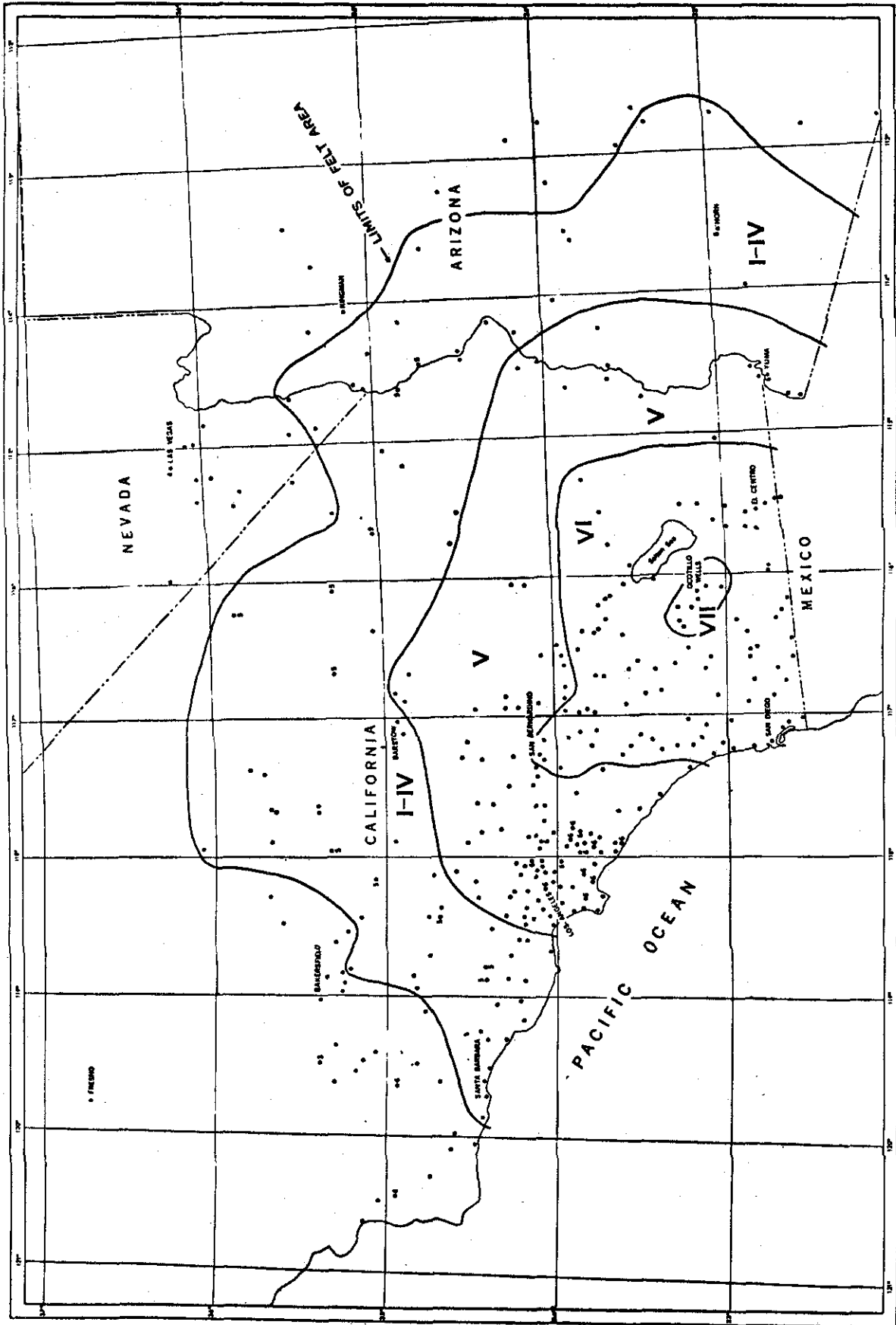


Exhibit 11. Actual isoseismal pattern resulting from the Borrego Mountain Earthquake, April 9, 1968 based on Figure 4 of "Strong-motion Instrumental Data on the Borrego Mountain Earthquake of 9 April 1968", August 1968.

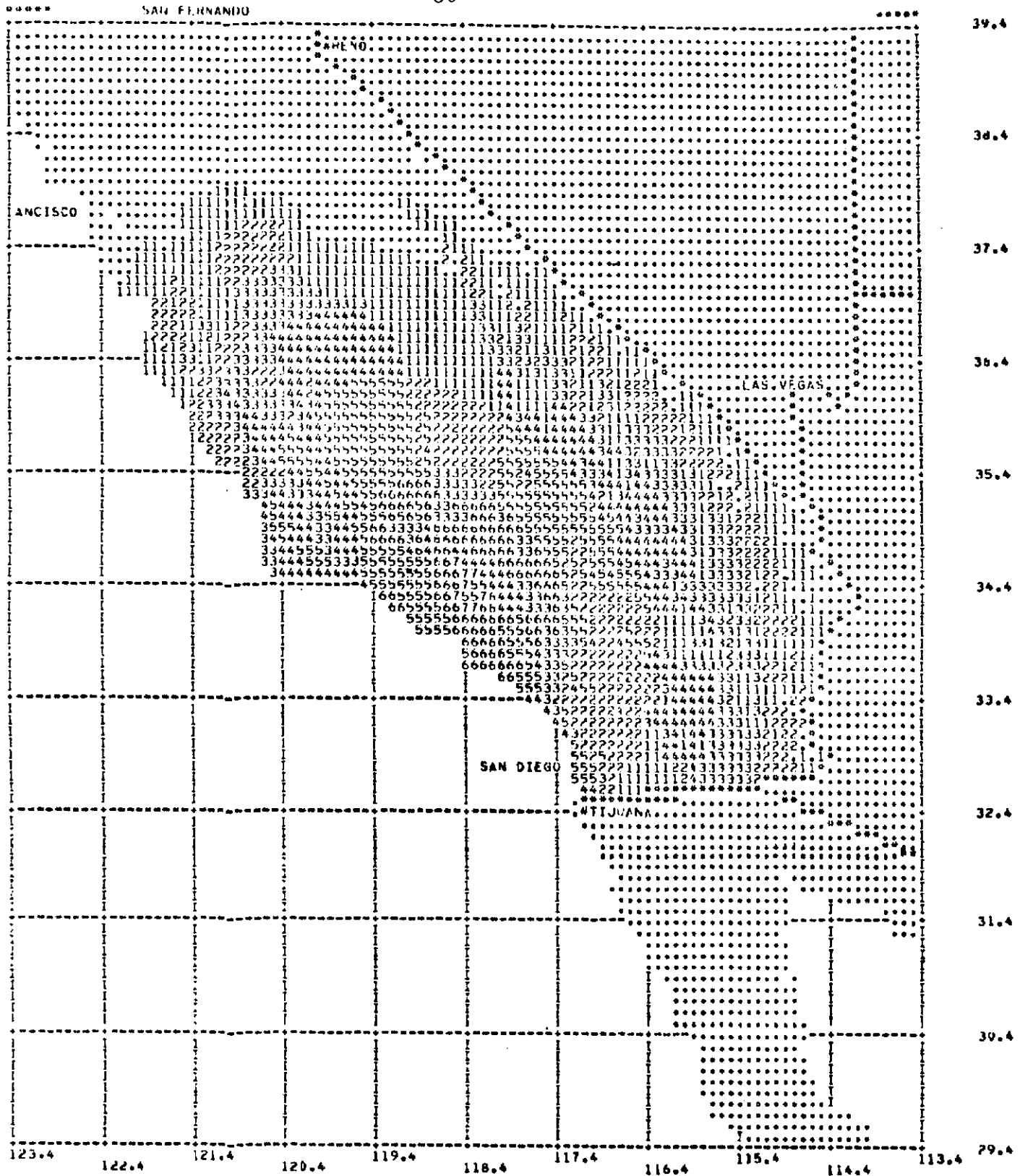


Exhibit 12. Computed pattern of earthquake intensity (Modified Mercalli units) based on magnitude, location and depth of the San Fernando earthquake of February 9, 1971

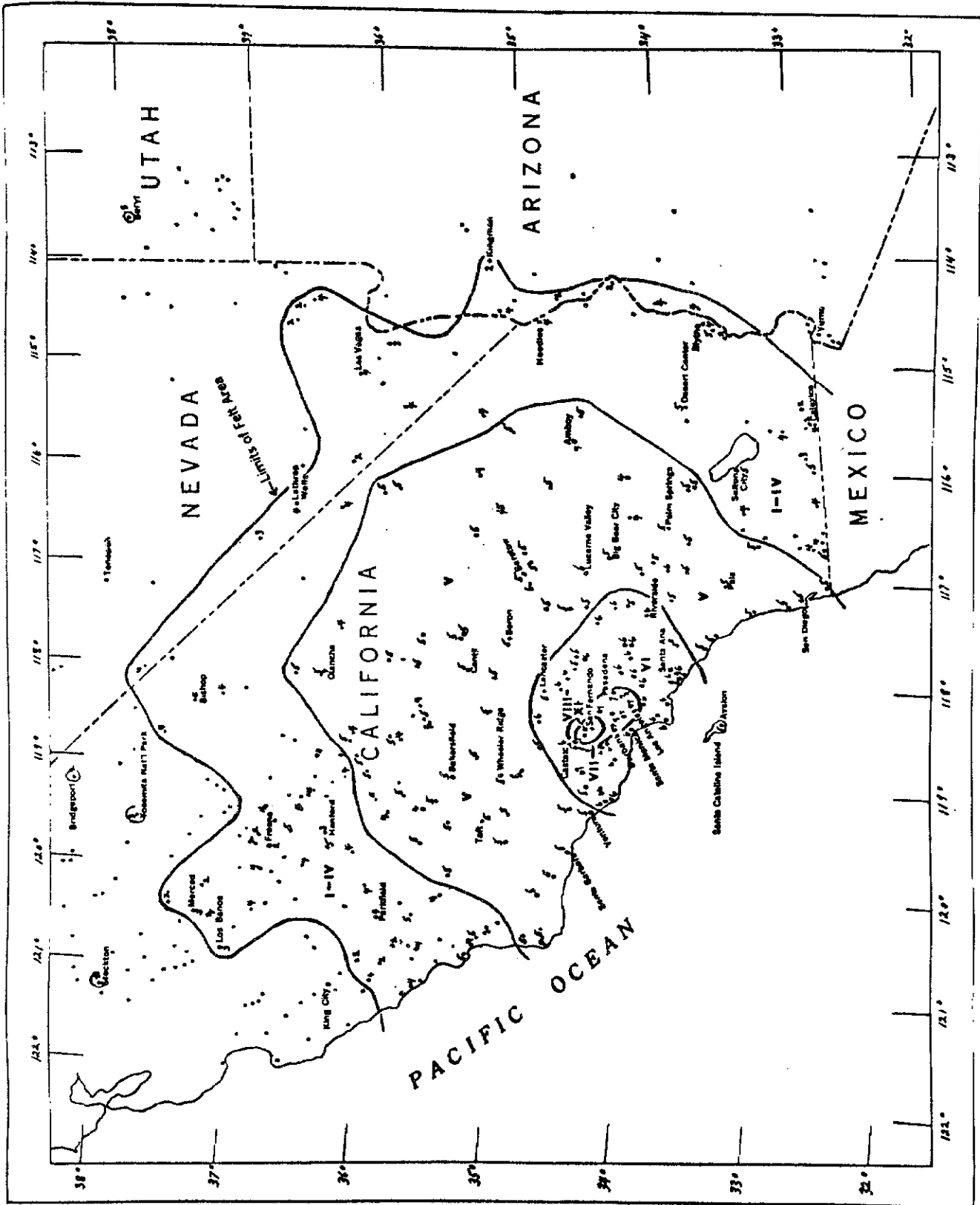


Exhibit 13. Actual isoseismal pattern resulting from the San Fernando Earthquake of February 9, 1971 based on a figure in Geological Survey Professional Paper 733.

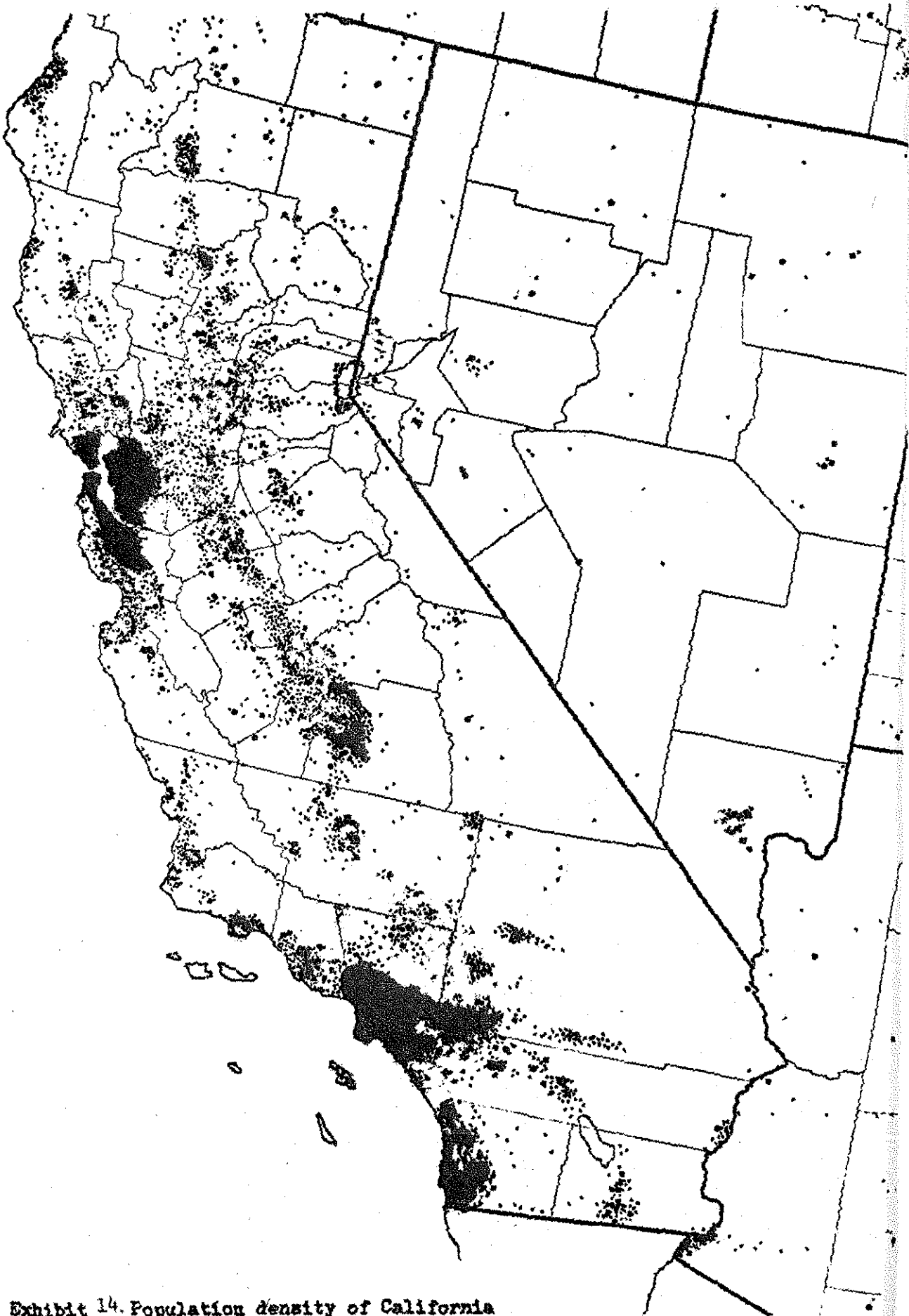


Exhibit 14. Population density of California

Figure 15. Number of times reported intensity was within range of simulated intensities in the City of San Francisco based upon 60 earthquakes that (1) occurred between 1800 and 1969; (2) had an epicenter intensity (Modified Mercalli) of VI or greater and (3) was close enough to affect the City of San Francisco.

<u>Reported Intensity in San Francisco (Modified Mercalli)</u>	<u>Number of earthquakes</u>	<u>Number of times reported intensity was within range of simulated intensities</u>	<u>Percentage</u>
VII or greater	6	6	100%
VI	8	7	88
V	18	14	78
IV	18	14	78
III or less	10	5	50
Total	60	46	77%

Exhibit 16. Average annual damage-per-dwelling to the 1960 distribution and value of dwelling properties. These averages are based on simulated losses associated with a recurrence of earthquakes that originally occurred in each 20-year period.

<u>20-year period</u>	Average annual damage- per-dwelling in the <u>City of San Francisco</u>
1948-1967	\$ 4.20
1928-1947	.30
1908-1927	1.60
1888-1907	79.90
1868-1887	19.00
1848-1867	10.20
1828-1847	48.70
1808-1827	.60
168-year period	\$19.70

Exhibit 17. Total simulated damage-per-dwelling resulting from recurrence of a single catastrophic earthquake, expressed as a multiple of the average annual damage-per-dwelling in San Francisco needed to cover losses caused by a single event.

<u>Recurrence of a comparable earthquake</u>	<u>Multiple of average annual damage-per- dwelling based on past 168 years</u>	<u>Multiple of average annual damage-per- dwelling based on most recent 20-year period</u>
1906 earthquake	73 times	339 times
1838 earthquake	40 times	184 times
1868 earthquake	19 times	90 times
1836 earthquake	10 times	45 times

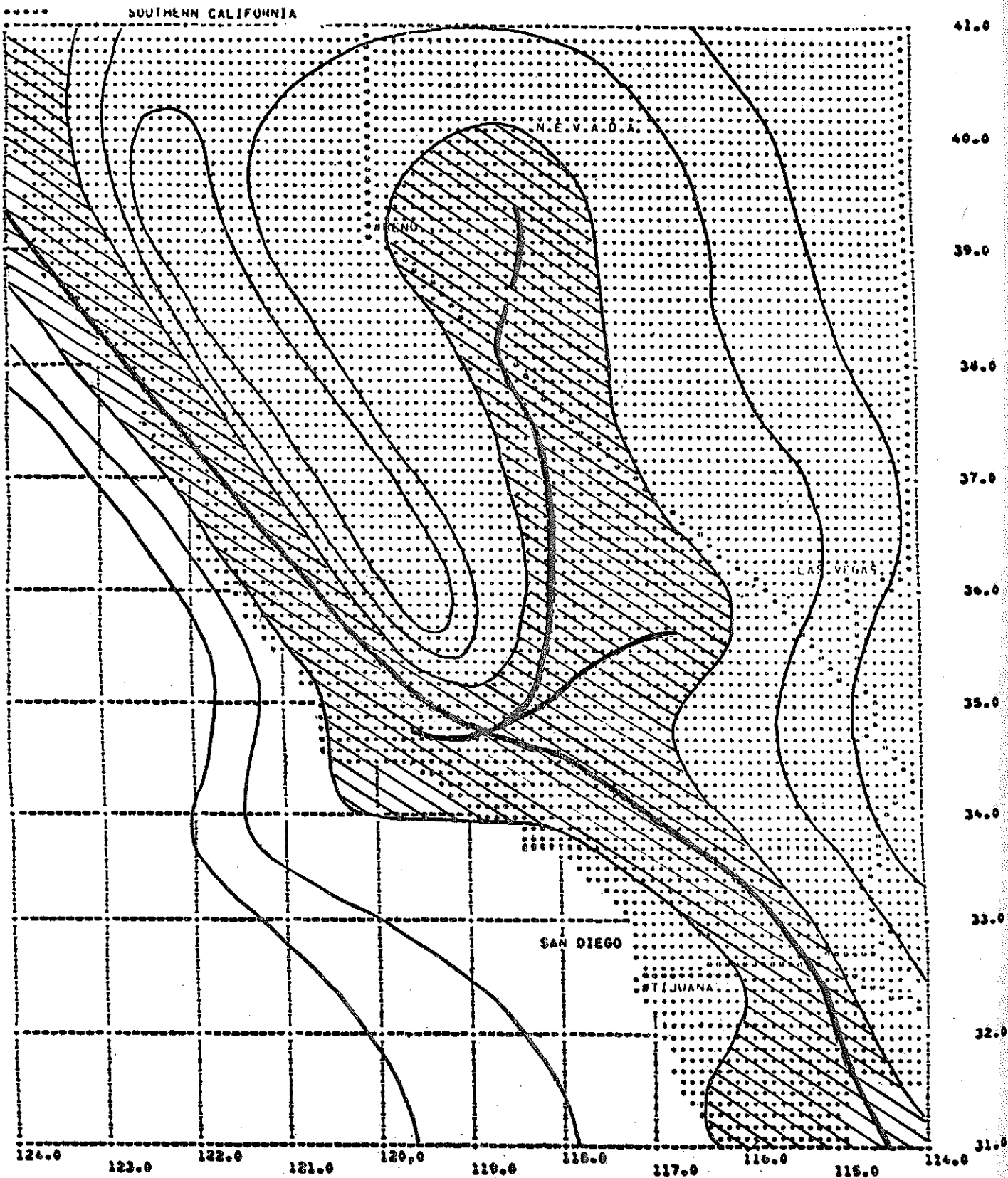


Exhibit 18. Hypothesized pattern of earthquake source regions in California and Nevada. It is assumed that this pattern also can be used to represent a probability surface for severe earthquake location. The surface is highest along the major fault zones and decreases with distance from these zones.

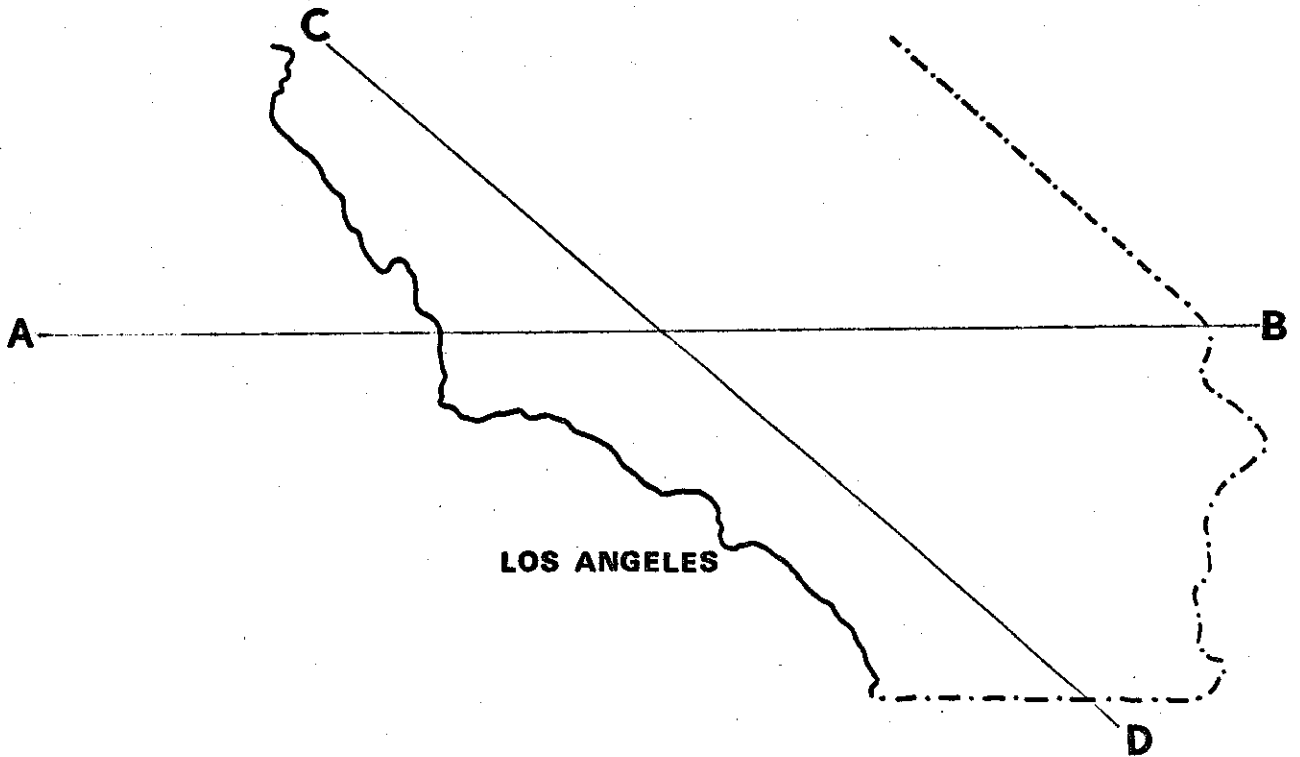


Exhibit 19. Location at cross sections of probability surface.

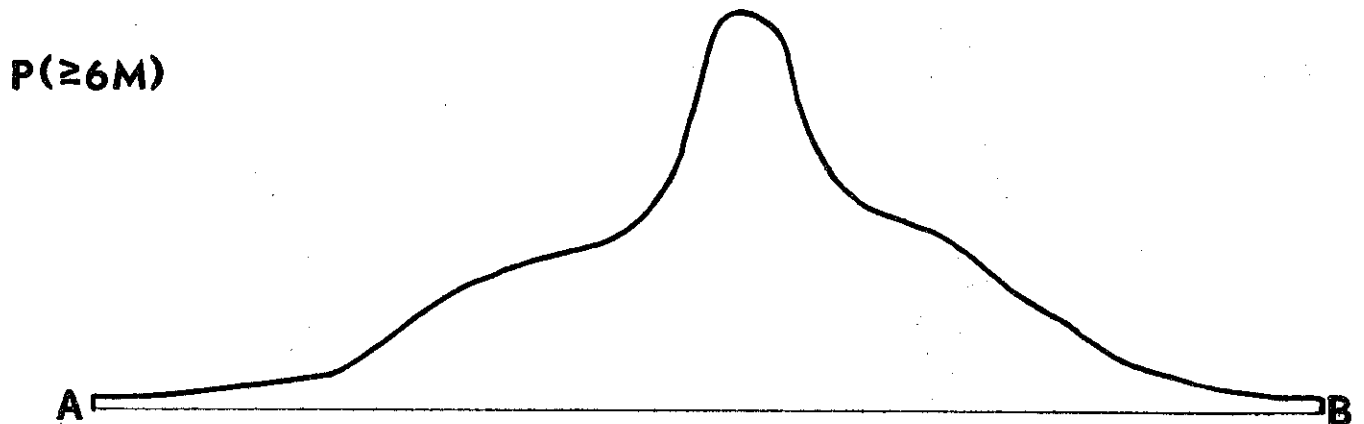


Exhibit 19a. Cross section intersecting major fault zone.

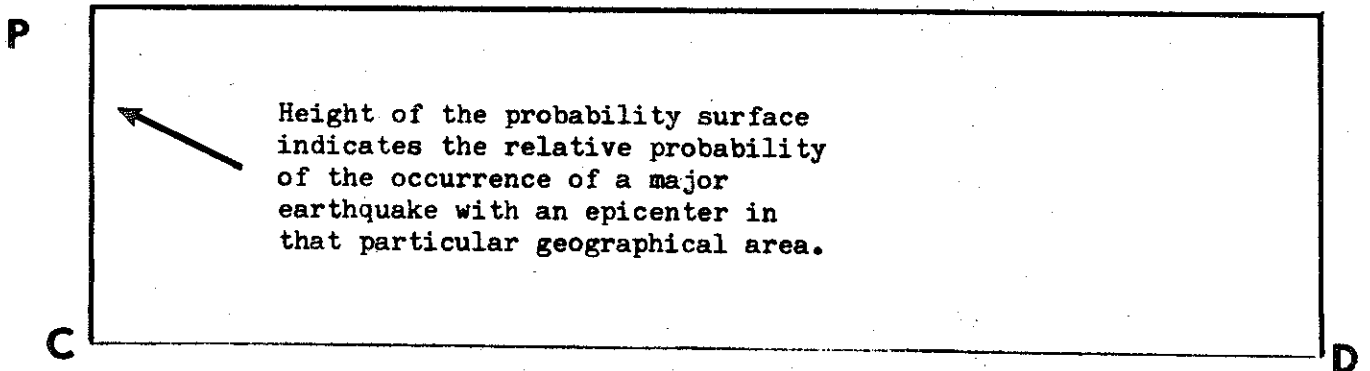


Exhibit 19b. Cross section along major fault zone.

Exhibit 20. Assumed extent of probability surface depression along fault zone due to occurrence of Richter magnitude 5, 6, 7 and 8 earthquakes.

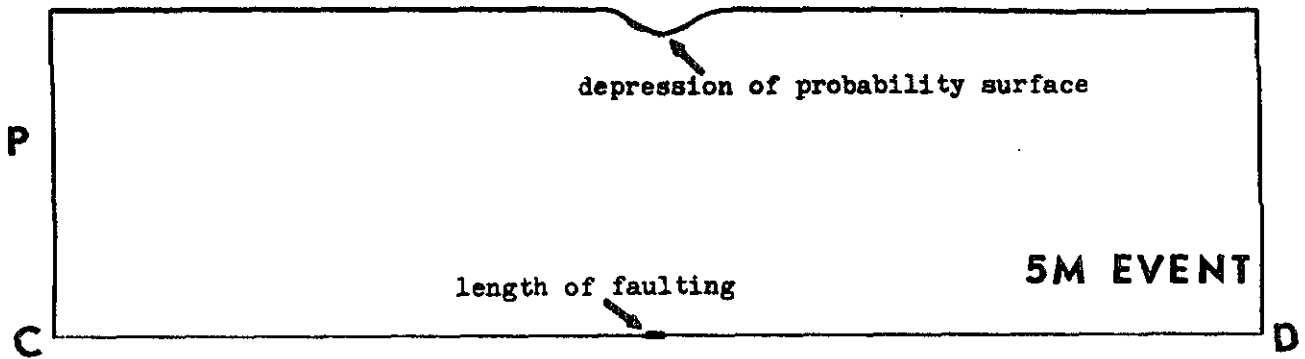


Exhibit 20a. Richter magnitude 5 earthquake (cross section CD of Exhibit 19).

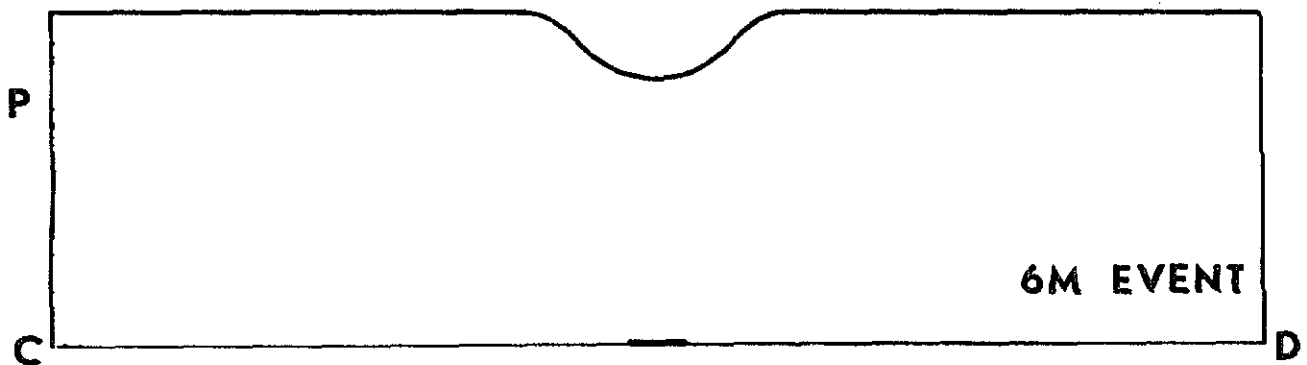


Exhibit 20b. Richter magnitude 6 earthquake.

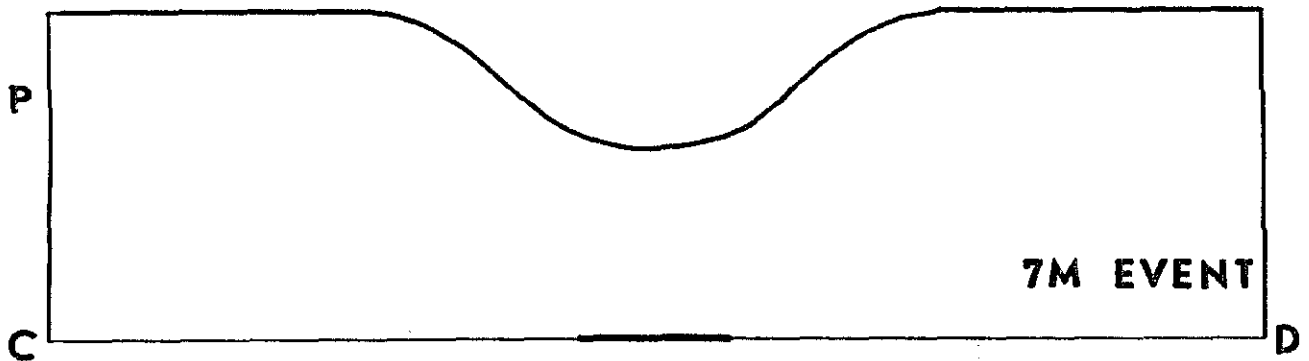


Exhibit 20c. Richter magnitude 7 earthquake.

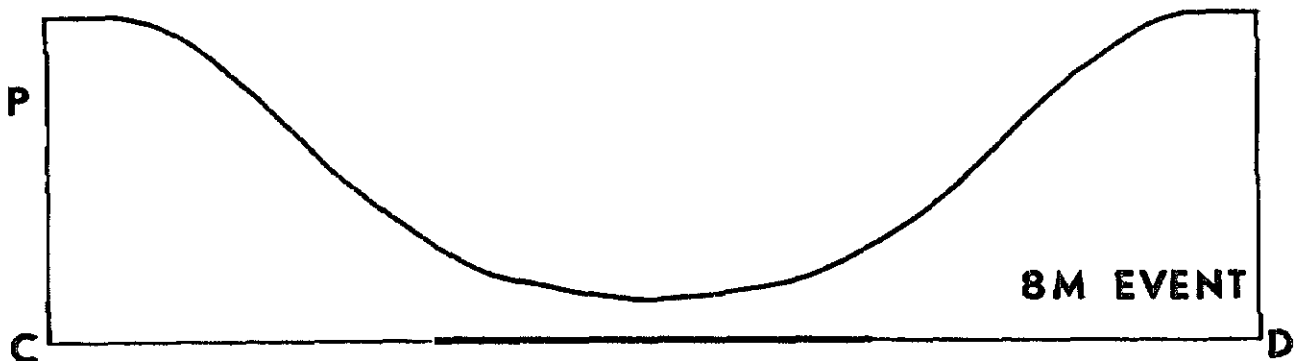


Exhibit 20d. Richter magnitude 8 earthquake.

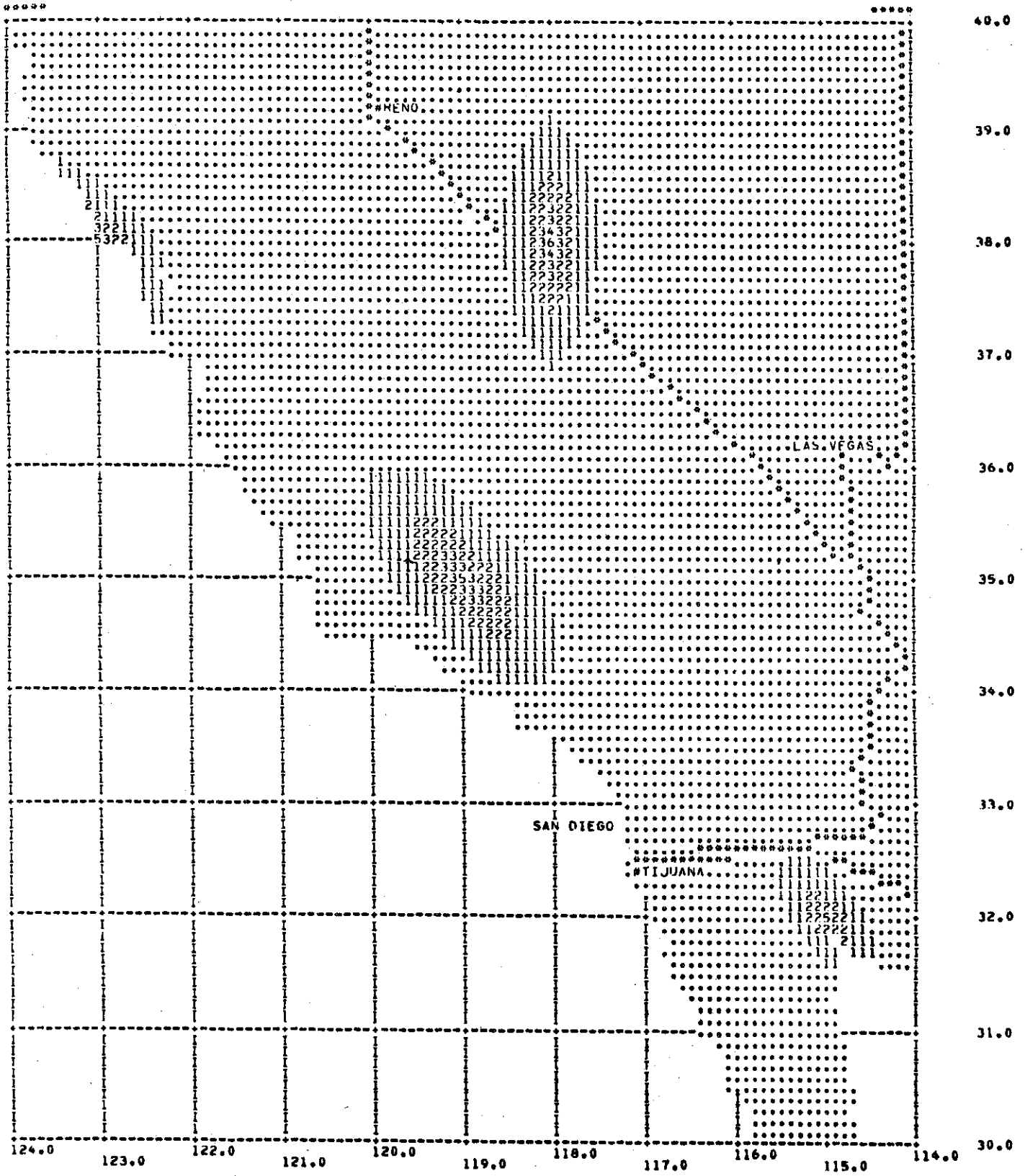


Exhibit 21. Computer derived patterns to be used in "depressing" the probability surface.

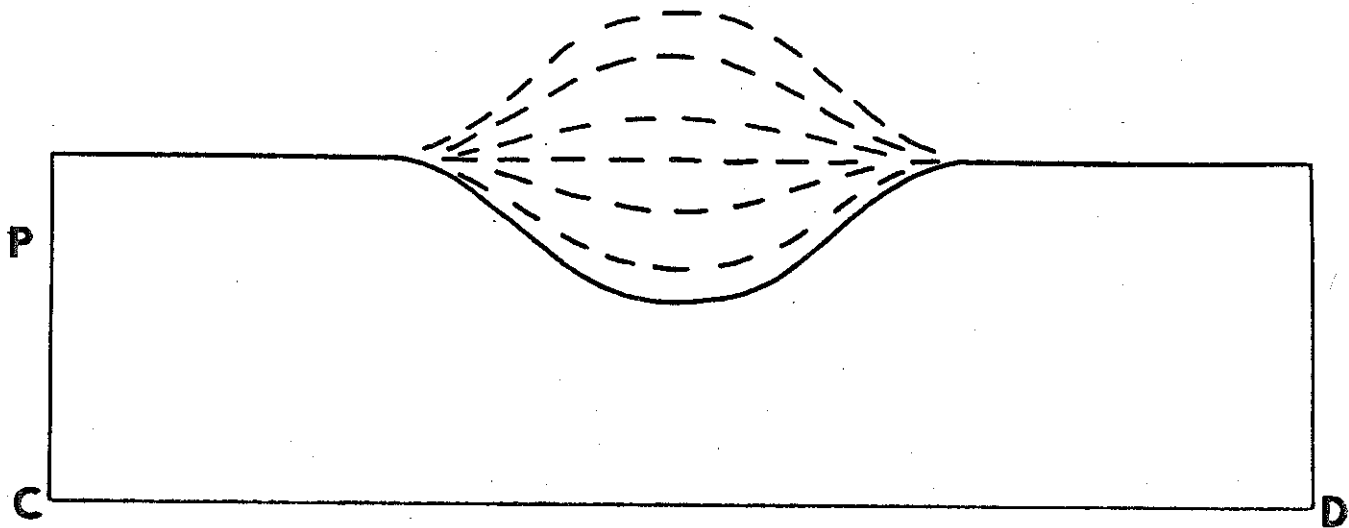


Exhibit 22a. Differential growth over a period of years in the probability surface following the occurrence of a large earthquake if no additional earthquakes occur.

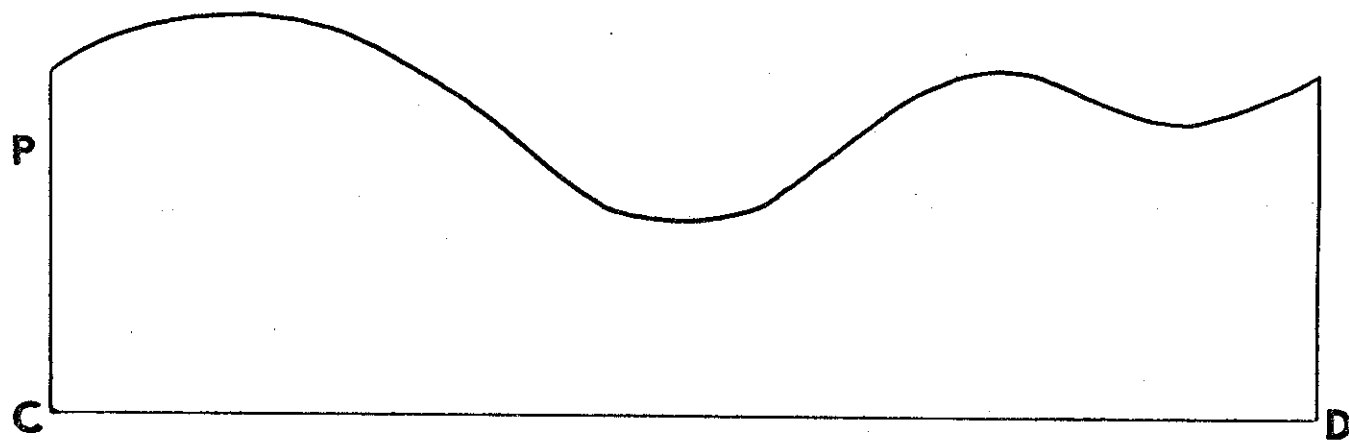


Exhibit 22b. Irregularity in level of probability surface along fault zone (cross section CD of Exhibit 19) using earthquake source generating model with a memory in space and time.

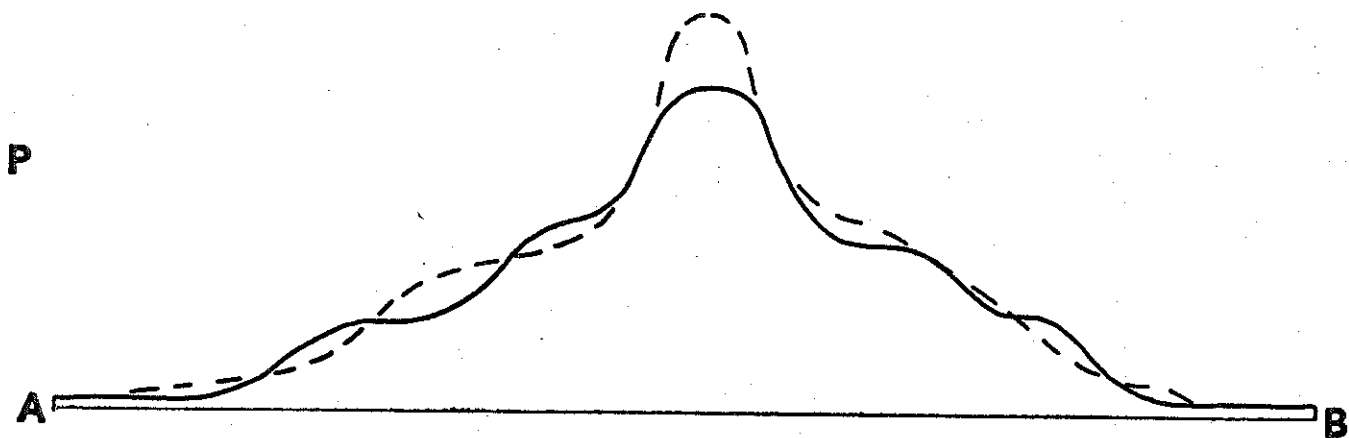


Exhibit 22c. Irregular level of probability surface across major fault zone. (cross section AB of Exhibit 19).

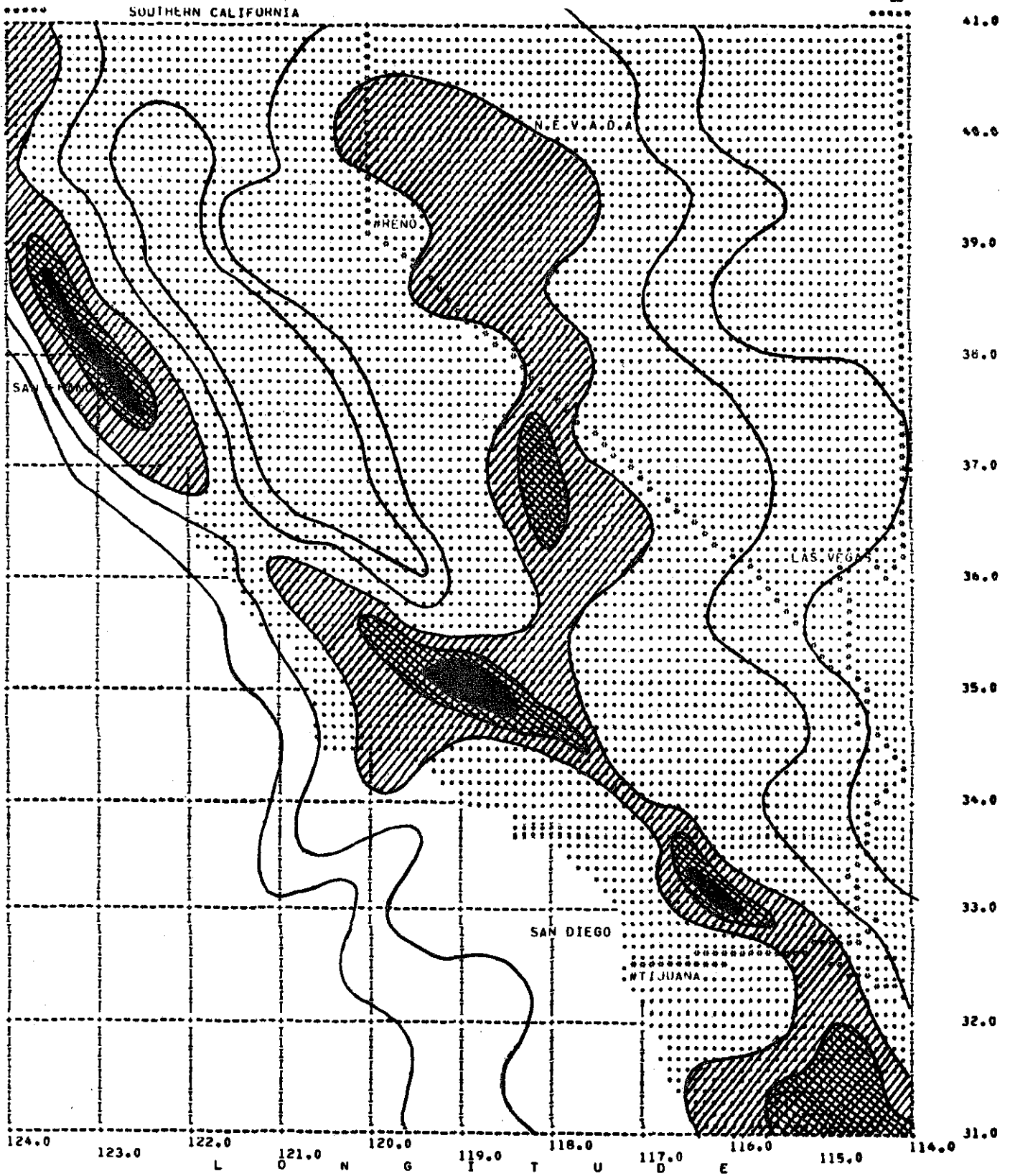


Exhibit 23. Hypothetical probability surface derived from earthquake source generating model which has a memory in space and time.

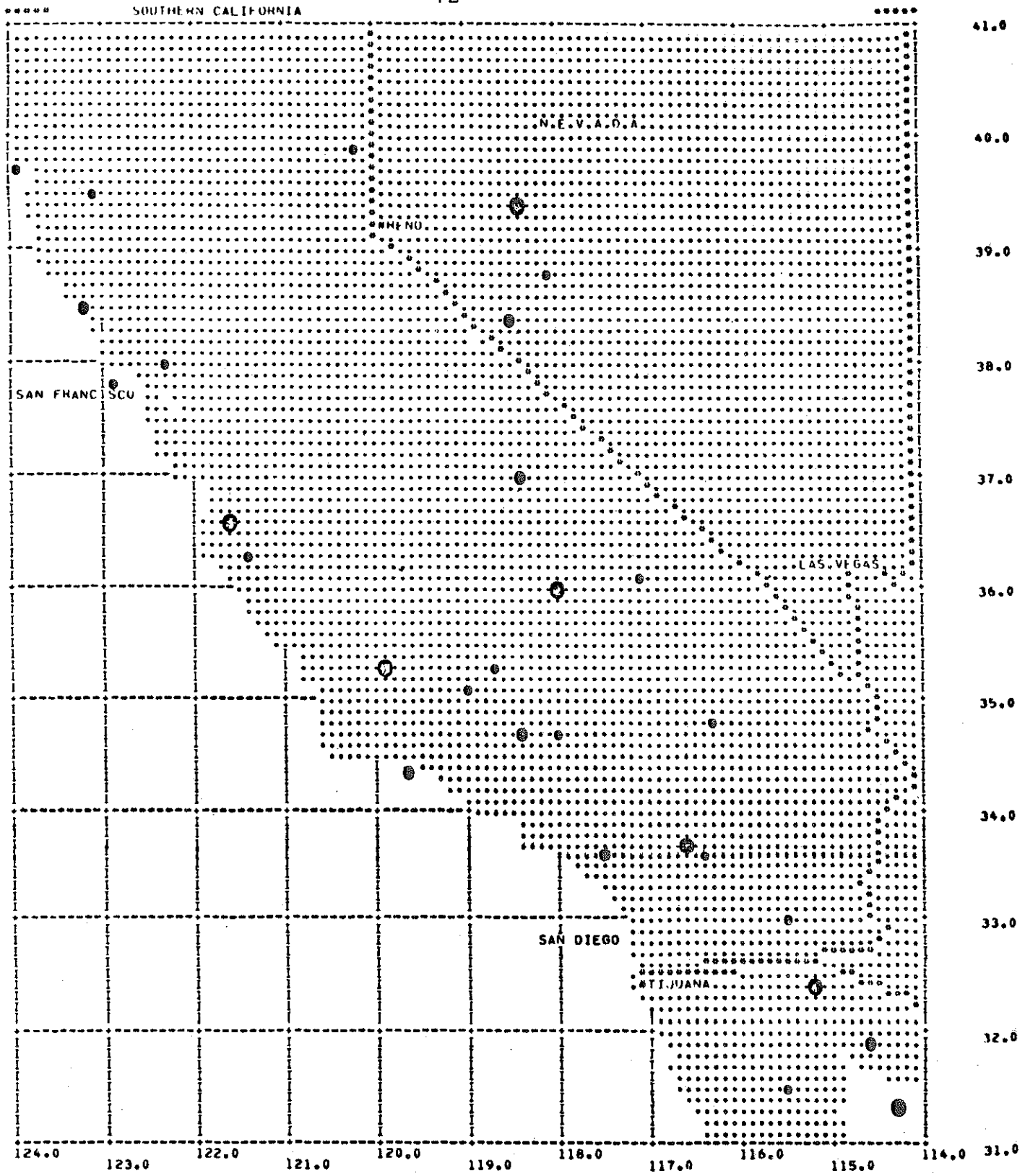


Exhibit 24. Example of possible pattern of epicenter locations derived from earthquake source generating model.

EARTHQUAKES AND FIRE PROTECTION

by J. C. Fulton^{*}

I would like to thank the California Institute of Technology for this opportunity to discuss a timely and serious problem — that of fires following earthquakes. It has been heartening to see the progress made in recent years in the understanding of earthquakes and of the response of man's structures to ground shaking. We, of the Earthquake Research Affiliates, can be especially thankful for the efforts of Caltech to help us understand and deal with our individual problems as they relate to earthquakes.

I come here today with some concern that perhaps man, and his curiosity about earthquakes, may have overlooked one of the more serious side effects of ground shaking, that of the ensuing fire. We have seen all too often in the past where the fire has completed the damage left undone by the earthquake. In recent years we have made commendable advances in seismic-resistant building design. It would even now appear that the absolute earthquake-resistant building is quite feasible to attain. On the other hand, it appears to me that our codes which prescribe protection against fire, and our standards which relate methods of fire protection and control, consider only normal problems and not the problem of fires resulting from earthquakes. As an example, I can cite high-rise office buildings. These have been the subject of extensive research to make them earthquake resistant, however, experience in recent years has shown them to be extremely susceptible to disastrous fires. Code officials, learning from this experience, are now busy passing laws to require automatic sprinklers

^{*}Engineering Manager, Kemper Insurance Combined Property Department, Los Angeles. Mr. Fulton presented this paper at the ERA conference.

in such buildings. Some of these codes loosely state that the sprinkler systems and water supplies should remain functional following a severe earthquake. It is my opinion, however, that present technology cannot provide for an economical earthquake-resistant design for fire protection systems in such buildings, and that additional research is necessary to assure adequacy of design under these extreme conditions. This is only one example of the total problem facing the fire protection engineer. Hopefully, this talk today will serve as a stimulus to develop new thought on the problem by those concerned with fire prevention and protection.

Perhaps our best understanding of the future can come by looking at the past. The most damaging earthquake-fire, at least in the United States, was the 1906 San Francisco conflagration. This fire caused damages at least five, and perhaps ten, times greater than the earthquake caused in central San Francisco. An even more destructive fire occurred following the 1923 Tokyo earthquake. This fire fed on highly combustible Japanese construction and soon grew into a fire storm, generating hurricane-intensity winds and consuming available oxygen. The earthquake, fire, and oxygen deprivation caused a loss of life of 140,000 persons — more than the Hiroshima atomic bomb.

Just recently an earthquake of moderate size struck Managua, Nicaragua. Once again a conflagration, although of relatively minor proportions, raged unchecked for three days. It completed the destruction in 162 city blocks, and made rescue efforts impossible in the burning area. Our own San Fernando earthquake had its fires also. They were few, and there were only several major fires. I would hope that this fortunate lack of major fire or conflagration problems in San Fernando will not lull us into a false sense of security. We know, on the other hand, that southern California has a

seasonal fire conflagration hazard second to none anywhere in the United States. The timing of the San Fernando earthquake was indeed fortunate from this viewpoint. By looking back at San Francisco, Managua, San Fernando, and others, we can perhaps make some projections for the future. There are lessons to be learned from these disasters and we should take advantage of them.

It is perhaps appropriate at this time to review the first three objectives of the Seismological Society of America as stated on the cover of their bulletin, to remind us that this problem was also of much concern to the founding fathers of the Society:

Objective No. 1 is to "promote research in seismology and the scientific investigation of earthquakes and related phenomena."

Objective No. 2 is to "promote public safety by all practical means."

Objective No. 3 is "to enlist the interest of engineers, architects, contractors, insurance men, and property owners in their obligation to protect the community against disasters due to earthquakes and earthquake fires by showing that it is reasonably practicable and economical to build for security."

And "earthquake fires" it is said; Well, let's take a close look at what we've been doing about this problem, and I, as a fire-insurance engineer, will perhaps share some of the blame for not having yet given the thought to this problem that it still needs. To be sure some people will say that fires after earthquakes are inevitable. Perhaps they are, but with some foresight and imaginative consideration we can do much to reduce the hazard. What needs to be done at this point is to analyze the two basic elements of

the fire problem — prevention and suppression, to see some of those things that remain to be done.

It will be helpful first to consider some statistics from past earthquakes, and to review the problems associated with each event. For one insight, let me borrow from the words of John Stephen Sewell writing in the 1907 report of the U. S. Geological Survey on the San Francisco earthquake. "Immediately after the first shock of the earthquake, 16 alarms of fire, from widely separated localities, were turned into the Central Fire Station. The causes of these fires were directly traceable to earthquake effects, such as the upsetting of oil lamps and oil and gasoline stoves, the contact of combustible materials with lamps and gas jets, the rupturing of chimneys and flues, the scattering of chemicals, such as phosphorus, and the upsetting of boilers, furnaces, etc. It is claimed that currents of electricity did not originate any fire. Either the generators were disabled or the attendants switched off the currents." We know that this fire then proceeded to burn through the business district and the heart of the city. It destroyed nearly 500 city blocks. Compounding the problem was the nearly complete loss of the water mains, and also the loss of the Fire Chief who was killed by a falling brick chimney. The primary mechanism of fire spread was by direct exposure and radiant heat. Wind was not a major factor although some minor fire storms developed in residential areas of wood-frame construction. The fire was ultimately controlled by dynamiting firebreaks and laying hoselines from the bay. The total cost of the fire in 1950 dollars was \$1.1 billion.

Let's look at some statistics from San Fernando. During the first day of the earthquake there were 109 reported fires directly traceable to the earthquake, involving the fire departments of Los Angeles City, Los Angeles County, San Fernando, Burbank, Glendale and Pasadena. There were three major structural fires in Los Angeles City areas, involving two major

shopping centers and one industrial property. The total loss in these three fires was nearly one million dollars. In one case, there was no water available and only two fire engines responded. They had to obtain water from a hydrant some 1600 feet from the fire, and then from a hydrant which contained only residual gravity-effect water. The industrial property was a 200 by 100 ft electronics factory with brick walls and a plywood roof. It was unsprinklered and was totally destroyed. As far as I know, the direct causes of these fires were never determined.

More than a dozen residential structures were destroyed by fire or explosion in the epicentral area. Most of these probably started from overturned gas appliances and electrical failures. At least three fire stations in the epicentral area had jammed doors which made it difficult to get the apparatus out. Two of these stations suffered severe structural damage.

Water supplies were totally disrupted in San Fernando City and Sylmar. Communications, except by two-way radio, were nonexistent. Aerial surveillance by helicopter was necessary to help direct fire department operations. There are many favorable factors which helped prevent more serious fire incidents during the San Fernando earthquake:

1. The main Sylmar fault break ruptured many high-pressure gas transmission mains, causing loss of service throughout the epicentral area. This loss of gas pressure undoubtedly prevented additional fires from occurring.
2. Electrical service went out throughout the epicentral area, eliminating a major ignition source.
3. Most people were in bed, thus eliminating potential ignition sources from human activities, such as cooking and smoking.
4. A major disastrous brush fire in late 1970 had eliminated highly combustible growth from the hillsides behind Sylmar. Thus the slopes were

covered only with grass, green from recent rains.

5. The earthquake struck at a time of absolute atmospheric calm. There was virtually no wind blowing. However, Santa Ana winds began blowing the next day, and on the following Friday the winds were blowing in excess of 50 mph throughout the San Fernando Valley and temperatures reached 95° F.

6. A large armada of emergency resources was available from the surrounding metropolitan area to help the smaller stricken area. Such would probably not be the case during a great earthquake, or a similar earthquake striking a more densely developed area such as downtown Los Angeles.

Looking at the Managua earthquake, whose magnitude was similar to that of the San Fernando earthquake, we find a different situation. Managua was a modern city of 275,000 inhabitants, but was mostly of nonearthquake-resistant construction. The fire department consisted of one chief, two assistant chiefs, 43 paid firemen, and 230 volunteers. There were three fire stations. The main station was reportedly designed to be earthquake resistant. At the time of the shock it housed four of the city's eight pumpers and four of the five ambulances. The fire station collapsed during the earthquake, destroying all apparatus within. Remaining apparatus was not able to cope with the fire and rescue problem which followed. Furthermore, all water mains were out of service. Several small fires quickly grew into a conflagration which lasted three days. It was controlled by means of perimeter firebreaks constructed with heavy equipment of the U. S. Army, plus 24 fire trucks from other towns in Nicaragua and six surrounding countries. One basic cause of the Managua fires was probably the breakage of propane gaslines. There were no natural gas pipelines in Managua, so liquid propane gas was in widespread use for heating and cooking. Electrical hazards may have been a factor also. Some fires may have been set intentionally.

Taking lessons from San Fernando and Managua, let's review some of the common fuels and ignition sources which can be expected to produce problems in future earthquakes. The wide use of natural gas to supply heating appliances is probably the most hazardous source of accidental fire from earthquakes. The use of strong steel pipe with relatively ductile welded joints makes improbable the rupture of underground gaslines during strong earthquakes, except where gross ground deformations are involved. Such was the case in San Fernando when rupture of a high-pressure gas transmission main quickly caused loss of gas pressure throughout the epicentral area. We cannot expect such a fortunate occurrence in a future great Los Angeles earthquake. What we can expect possibly is the shifting of domestic hot-water heaters and stoves in homes. Ironically, a law passed some years ago to elevate hot-water heaters and gas dryers in residential garages to prevent emission of accidentally spilled gasoline fumes, introduced the widespread use of flexible gas supply lines. These flexible lines permit the appliances to oscillate freely during earthquakes with consequent overturning and breakage of gaslines which were responsible for many dwelling fires in the San Fernando earthquake. The exact number is unknown because of some discrepancies in record keeping by fire departments during the confusion of the earthquake. The remedy for this problem is simple; perhaps some ambitious entrepreneur could amass a small fortune by selling a simple kit to enable homeowners to brace their hot-water heaters. Gas appliances in commercial and industrial structures will produce their share of problems also. Witness the shifting of three gas-fired boilers at Olive View Hospital Power Plant. The shift caused a failure in the weak link of the gas piping train, causing complete fracture and separation of the cast-iron body of the safety shutoff valve, unfortunately on the upstream side. The instant result was a massive fireball in front of each boiler. Fortunately, breakage of underground gas mains outside the premises caused these three

fires to diminish rapidly.

California safety codes require boilers to resist 10%g lateral forces. Although the Olive View boilers were not anchored to the floor, calculations indicate they could resist 30%g due to friction alone, ignoring vertical accelerations. If these boilers could resist 30%g and slid during forces of perhaps 40-50%g, what do you suppose will happen to many other 10%g boilers in existence that won't be able to resist the ground accelerations expected from a great earthquake?

Another interesting side problem is the following; the hospital gas supply line was equipped with an earthquake-actuated gas safety shutoff valve, but it reportedly did not function during the earthquake. That the power plant building was not destroyed by the gas fire was due to the numerous ruptures of gas mains by nearby faulting. Is there a problem with reliability of these earthquake gas valves? Perhaps so, because, for other than schools, as far as I know, there is no agency which approves such valves.

Causes of Earthquake Fires.

We can classify some of the basic causes of fires during or immediately after the earthquake, and we can also prescribe some protective measures that can be taken to prevent these fires.

1. We have already mentioned natural gas as probably the prime fire cause. The solution is to brace adequately the gas appliances so as to minimize strains on the gas piping. This will perhaps require code legislation and massive public educational efforts if we are to eliminate this hazard. Hazardous gas appliances in the home include hot-water heaters, gas dryers, kitchen ranges, central or unit wall heaters, and swimming pool heaters.

2. Gas appliances in commercial structures include small hot-water boilers, steam boilers, gas heater or air-conditioning units using gas, cooking

ranges, and perhaps suspended unit space heaters. Some of you may recall the two-story office and restaurant building in Westwood that exploded one day after the San Fernando earthquake. Ten people were injured in this explosion. There are obviously many such structures having inadequately braced or anchored gas appliances, because code requirements are ineffective or non-existent. Future codes should consider such protection. I would like to recommend that the insurance industry undertake the responsibility for requiring bracing or provision of earthquake-actuated gas safety shutoff valves on existing properties, where necessary.

3. Industrial properties have special problems that have to be considered. Important processes using natural or liquefied petroleum gases include boilers, ovens, furnaces, air-conditioning units, central heating units, suspended gas units, base heaters, etc. In modern industries we find some exotic gases in common usage, such as hydrogen and acetylene. Many hospitals use a highly explosive gas, ethylene oxide, for sterilizing. This gas is also found in certain industrial plants and there are no general fire protection codes to regulate its use. Certain other highly toxic gases, such as chlorine, ammonia, and carbon dioxide may introduce life hazards during earthquakes. The control of gas hazards due to earthquakes in industrial plants requires careful study. Earthquake-activated safety shutoff valves may be desirable. However, accidental shutoff, or shutoff during less than damaging earthquakes, may produce secondary damage to certain industrial processes such as melting furnaces or kilns which require controlled cooling to prevent structural failures. From the property conservation standpoint, control of fire hazards to large industrial plants is very critical. It is very important that the plant properly anchor heavy equipment that uses gas, and take all precautions necessary to control release of gas following the earthquake. Certainly emergency procedures should include

prompt shutoff of gas supplies if conditions warrant. This entire subject of control of gas hazards in both commercial and industrial facilities should be the subject of further intensive study by all concerned with the problem.

4. Collapsing structures will certainly break gaslines, thus producing potential sources of fire. At one industrial plant a three-inch gaspipe was broken by chunks of falling concrete. The control of ignition sources, such as electrical sparks, becomes especially important when gas is escaping into a structure.

5. Electrical disturbances will probably play a major role in producing fires. During the recent Oxnard earthquake, a transformer inside an industrial building exploded when shorts on the secondary output caused an internal fault to develop before protective devices could operate.

6. Spillage of flammable liquids in laboratories and industrial plants may start many fires. I have seen many laboratories and chemical storage rooms in industrial plants where incompatible chemicals were stored in glass bottles next to each other. The solution is to isolate incompatible chemicals from each other, and to provide restraints on cabinets and shelves to prevent toppling. This is especially a problem in school laboratories, and nearly every important recent U.S. earthquake has had a school laboratory fire.

7. A compounding problem during earthquakes will be structural damage to fire walls or fire barriers. Concrete or brick walls are commonly used in industrial structures to limit the spread of fire. High-rise buildings require two-hour fire walls around vertical stairways. Structural damage to such walls may permit ready passage of fire and could cause a catastrophe in high-rise buildings.

Many fires have started some time after the main earthquake. As examples of other potential ignition sources after major earthquakes, we can

expect the following:

1. Widespread use of charcoal braziers to cook food. Some people may be foolish enough to cook inside the house and may asphyxiate themselves in the process.
2. Use of fireplaces to heat the home or cook food in the absence of gas and electricity. Many chimneys will be slightly damaged and will permit sparks and hot gases to enter into attics or combustible walls.
3. Deactivation of gas and electric supply may cause some fires and explosions because of damaged gaslines and damaged electrical wiring. A common source of fire is overturned, portable electrical heaters which are forgotten, only to start a fire when power comes back on. Domestic irons toppled from housewives ironing boards may accidentally turn themselves on, thus posing another ignition source.
4. Spilled flammable liquids in industrial facilities and in residential garages, kitchens, and bathrooms may ignite from electrical sparks, from smoking, or from careless handling. Paints and solvents in hardware stores may also prove hazardous. Liquor stores are very susceptible to fires as the alcohol in most spirits is highly flammable.

It is clear that fire departments will have unusual problems following a major quake. First, there will be difficulty getting apparatus out of stations. Some stations will probably collapse. There will be no communications to advise of fires. Alarm systems will not be functioning. It should be noted that many private central stations which supervise commercial and industrial fire alarms are not designed to handle a sudden onslaught of hundreds of simultaneous burglar and fire alarms, most of them false, but some real. Fire equipment will have difficulty moving over damaged or debris-littered roads. It now appears that our freeways may not be useful after a major earthquake. It is probable that all of the water mains in some

area may be damaged. San Fernando has shown that the modern materials of construction and methods of joining waterpipes are far more subject to failure than was previously thought.

Fire departments may have to face an unusual element, should they concentrate on rescue activities or on fighting fires? The Managua fire department made a logical choice under the circumstances; they concentrated on fighting the fire and delegated rescue operations to other governmental services and citizens.

The most serious fire situation facing fire departments, excluding the danger of conflagration in residential and mercantile areas, is the large industrial fire. Most industrial plants have automatic sprinkler systems. Some larger plants have independent water supplies consisting of water tanks with electric motor or internal combustion-engine driven fire pumps. The NFPA requires sprinkler systems to be able to resist 50%g forces. I know of no sprinkler system in San Fernando that remained intact after undergoing approximately 50%g. There were cases of systems suffering moderate damage between 25%g and 50%g, and even some minor damage at 10%g which required shutdown to prevent water damage. Many design changes of an inexpensive nature, and some that are more costly, could be made to sprinkler systems to improve their performance. Use of malleable iron fittings at certain critical joints should be made mandatory. More durable gaskets in flexible couplings are necessary. Improved methods of connecting earthquake sway braces to wood construction members and also to beam flanges will help prevent failures. The dynamic behavior of typical sprinkler systems during earthquakes has never been studied; this should be done.

I would make one comment on fire protection water storage tanks. They are typically designed for only 10%g. They clearly can fail during strong

earthquakes as did some water storage tanks in San Fernando. An importance factor is needed for such tanks. Now, even if underground water mains should fail, it would be helpful to be able to withdraw water from the tank, even if the pump is inoperative. Most such installations have pump test headers with 2-1/2 inch fire hose connections. However, to conserve water, there is now a trend toward calculated nozzles discharging into the top of the tank. If such a nozzle is provided, then the hose header may be omitted, leaving no means for fire department or plant emergency organizations to utilize the water for fire control. There are no standards or codes regulating lateral force anchorage of fire pumps and drivers. Also, approved standards do require engine controllers to start the engine if electrical power fails. This may be foolish during an earthquake, since the pump might simply feed broken water mains and waste precious water. It has become clear that severe earthquakes will require that manual emergency operations take precedence over normal automatic protection features that were not designed for earthquake conditions.

This last statement gives us a clue to the very nature of the earthquake - fire problem. It is clear that an earthquake is an abnormal situation and requires imaginative reasoning in order to be dealt with adequately. The best way we can treat the problem is to educate the people to take necessary steps to prevent fires, such as anchoring hot-water heaters. Man must also plan ahead for the contingencies arising from an earthquake emergency. Fire protection engineers must re-engineer basic protection methods that obviously are inadequate.

Finally, I would like to say, all other factors considered, that the west coast metropolitan areas probably have a much better feel for this problem than do other portions of the country. Most of the advancements

in fire protection engineering principles are generated in Boston, Massachusetts, home of the National Fire Protection Association . This year the MFPA will hold its annual convention in St. Louis. Is Boston ready for a repeat of the 1755 earthquake? Is St. Louis ready for a repeat of the 1811 and 1812 earthquakes? Perhaps San Francisco is no longer the only "City that is Waiting to Die."

THE STORY OF THE SAN FRANCISCO FIRE
AS VIEWED FROM AN ADJUSTER'S STANDPOINT

by W. A. Bament*

California has always commanded the admiration of the world for its magnificent scenery, wonderful climate, and boundless resources, but these have all been temporarily obscured by the terrible catastrophe which has befallen its Metropolis, the City of the Golden Gate, and the sympathies of the race have gone out to the victims of one of the greatest earthquakes, and by far the most disastrous conflagration in the world's history.

Within a week after the news reached the East, I left for the Pacific Coast, feeling quite confident that first reports as to the extent of the disaster, were, as usual, grossly exaggerated, and that the situation could not possibly be as bad as pictured in the press dispatches; but, as we crossed the Bay and viewed the barren hill-tops of the once proud and stately City, and then rode for miles, picking our way through such streets as were passable, and finally viewed the panorama of seemingly endless ruin from the summit of Nob Hill, I then realized that the half had not been told, and that no one without seeing could have any adequate conception of the calamity which had so suddenly overtaken the people of San Francisco, and the underwriting interests of two Continents.

So much has already been said and written regarding the disaster, that this paper will be restricted to a brief review of general conditions, and to the events leading up to and connected with the adjustment of losses under

* General Adjustor, Home Insurance Company, New York. This is a reprint of a paper read before the National Association of Fire Insurance Agents, Indianapolis, Indiana, October 17, 18 and 19, 1906.

no less than one hundred thousand policies of fire insurance, amounting in the aggregate to nearly two hundred and fifty million dollars.

According to the official report of the investigating committee of engineers, the time of the beginning of the earthquake, as recorded at the University of California, was twelve minutes past five o'clock on the morning of April 18th, and its duration one minute and five seconds. Within an hour of the main shock twelve minor shocks were observed, and, during the day, thirty-one shocks were noted in addition to the main disturbance. The earthquake zone was approximately four hundred by fifty miles in extent, although its intensity varied greatly and pronounced evidence of its effects was restricted to a much smaller area. Water pipes, conduits and bridges were rent asunder, trees were uprooted and thrown to the ground in large numbers, and fissures opened in the earth and closed again, while in one instance a cow was engulfed, an innocent victim of the disaster, in this respect differing somewhat from the historic animal of Mrs. O'Leary, which is said to have been both the originator and victim of the trouble she kicked up in Chicago in 1871.

Immediately following the earthquake, fires broke out in different portions of the city, doubtless due either to defective flues, escaping gas, the overturning of lamps or to short circuits caused by the breaking of electric wires. As the water mains had been disconnected by the shock, the Fire Department was practically helpless, and in addition to this series of unfortunate occurrences, the Fire Chief was killed by a falling wall. Dynamite was freely used to stay the progress of the flames, but all to no avail, and the fire extended in every direction, finally burning itself out, but not until it had covered an area of approximately four square miles.

The effects of the earthquake were most pronounced in that portion of the city south of Market Street, where there were three distinct slips, covering an area of several blocks, the earth movement ranging from one to six feet.

In other portions of the city large areas indicated some earth disturbance, and it is quite noticeable that these were most marked on soft sandy soil and on made ground. There were comparatively few chimneys in San Francisco and in the surrounding country, which were not thrown down; brick, terra cotta and metal cornices and portions of front and rear walls fell; in some instances side walls fell on lower buildings adjoining; and in certain cases buildings totally collapsed.

It is safe to say that high "Class A" buildings of steel frame construction on firm foundations were damaged comparatively little by the earthquake, but practically all of them were completely gutted by the fire, and owing to under-insurance, the loss in most cases proved nearly or entirely total under the policies.

Frame buildings, except in comparatively few instances, suffered very little from the shock, and aside from fallen chimneys and cracking of plastering, there was scarcely more than one frame building in five hundred in the saved residence district which showed any signs of damage, while all classes of stock, except those of a breakable nature, escaped with comparatively little damage.

The earthquake was evidently no respecter either of religion, education or government, but seems to have had a special antipathy to these three important pillars of our social and political fabric, for there was scarcely a church, schoolhouse or public building either in the burned or unburned district but what was either partially wrecked or quite badly damaged by the shock. And this seems to have been true of all buildings of large area which did not have the benefit of division walls or supporting columns, while the City Hall, which, on account of its isolation, sustained practically no fire damage, remains a standing monument to poor construction under political direction. In striking

contrast to this, the brick building of the California Electric Company, located in the southern portion of the city, which was equipped with wireglass windows, stands practically uninjured in the midst of the ruin by which it is surrounded, a monument to first-class construction and fire protection. Fortunately for the people of San Francisco, the City Hall was not a fair criterion by which to judge general earthquake conditions.

On the other hand, the earthquake was particularly considerate in the time of its appearance, for if it had occurred several hours later while the streets were crowded with people, the falling chimneys, walls and cornices would undoubtedly have resulted in a mortality frightful to contemplate.

Before the fire was fairly out, the Pacific Coast Managers, who were fully alive to the situation and the responsibility which rested upon them, moved their offices with the remnant of their records to Oakland, Berkeley and Alameda - a trio of cities across the Bay from San Francisco - secured accommodations as best they could, and promptly effected a permanent organization known as the "General Adjusting Bureau," with headquarters at Reed's Hall, Oakland, where all meetings of the General Body were held. Mr. George W. Spencer, General Agent of the Aetna, was elected Permanent Chairman. An Executive Committee, a Building Committee and a Salvage Committee were immediately appointed, and a Post Office and Information Bureau established.

A corps of engineers was employed who made a thorough examination of the burned district and prepared a map showing the solid and filled ground and the areas of pronounced earthquake disturbance.

Competent builders were employed under the direction of the Executive Committee who made a thorough examination of the unburned portion of the city and reported upon the earthquake damage to different classes of buildings therein, with a view to giving the adjusters some basis upon which to estimate

the damage to similar structures within the burned district. This work, however, was found to be of little practical value, for subsequent investigation clearly demonstrated that the effect of the earthquake was much more severe in some sections than in others, and that the extent of the damage depended upon conditions other than the force of the shock itself.

In addition to this, the entire burned area was inspected by the Fire Insurance Patrol, and a very exhaustive report rendered as to conditions in each block. In many instances, they also reported upon the condition of specific buildings in the different blocks, which proved of great value to the adjusters in their subsequent investigations.

On the 3rd of May, just two weeks after the fire, officers and adjusters from all parts of the country having arrived, a General Adjusting Committee - consisting of fifteen representative adjusters - was formed, for the purpose of taking charge of all losses where six or more companies were interested. Mr. H. F. Atwood, Secretary of the Rochester German Insurance Company, was elected Chairman of the Committee, but, as he was called East shortly afterwards, he tendered his resignation and his duties were assumed by the General Adjuster of the Home. Some of the companies had already commenced to settle and pay individual losses, but, after the appointment of the Committee of Fifteen, the principal work in the line of adjustments began. The Committee, for the first few weeks, met daily and attended to the assignment of losses to Sub-Committees, but as the work progressed, this was found to be unnecessary, and meetings were held every alternate day, and finally, only once a week.

As the premium receipts of San Francisco were larger than those of Baltimore, and as the fire was fully five times as great, it was at first supposed that the number of Committee losses would be larger in proportion, and that we would have to provide for the adjustment of several thousand Committee losses, but, to our great surprise, these aggregated only thirteen hundred and

thirty-seven, or only two hundred and twenty-six in excess of those at Baltimore. This is easily accounted for by the fact that re-insurance was a very decided factor in San Francisco underwriting circles, individual company lines of from fifty to one hundred thousand dollars being quite frequent. This naturally kept numerous large claims out of the hands of the Committee and placed them in the column of individual losses. Then again, at Baltimore the Committee assumed jurisdiction where four or more companies were interested, while at San Francisco the limit was placed at six or more.

It was decided by the General Body that Sub-Committees should act under a non-Waiver Agreement; that they should only have authority to agree with claimants upon the sound value of the property and net fire losses thereon, after making proper deduction for earthquake damage, but that no Committee should have power to admit liability in behalf of any company, or to waive the conditions of any company's policy.

Matters progressed very smoothly until the first few Sub-Committees had filed their reports, and when it was discovered that very little if any deduction had been made for earthquake damage, a cloud commenced to appear upon the horizon, and at the next meeting of the General Adjusting Bureau the first note of discord was sounded and the first sign looking toward a possible division made its appearance in the shape of a resolution introduced by a prominent adjuster, which had for its object the placing of still greater restrictions upon the power of the Sub-Committees, limiting their authority to the ascertainment of the sound value of the property immediately preceding the earthquake and the amount of visible salvage, thus leaving each individual company free to discuss the question of earthquake damage with the claimant and reach a final adjustment. The resolution was strenuously opposed by the representatives of the larger companies, but it was adopted by a vote of forty-four to thirty-three, and the authority of the Sub-Committees was restricted accordingly.

By the end of May, considerable headway had been made by the representatives of many companies in the settlement of individual losses, while others - who were awaiting instructions from headquarters - had done practically nothing. All kinds of conflicting reports as to general conditions had been received in New York, England and Germany, and it is not at all surprising that the exact situation was not properly understood by company officials. About this time vague rumors were in circulation to the effect that large influential business and financial interests in San Francisco, New York and London were at work looking toward the bringing about of a speedy cash compromise settlement of all losses on the basis of some fixed percentage of the insurance, and the hope was seriously entertained by many that some such solution might possibly be reached in the interest of all the companies and all the people.

It subsequently developed that these rumors and hopes had for their origin a meeting of American companies which was about to be held in the City of New York, which finally took place May 31st, 1906. There were present executive officers representing eighty-five per cent of the liability of the American companies growing out of the disaster, and a number of resolutions were unanimously adopted, expressing their views as to the class of cases which should be subject to a reasonable compromise, but the meeting wisely refrained from making any suggestions or expressing any opinions as to what such compromise should be, evidently and rightly assuming that each case would have to be considered on its merits and that the application of arbitrary percentages would be neither equitable or practicable.

The resolutions, which were ably prepared and eminently sound in principle, were promptly telegraphed to San Francisco, where they were fully endorsed and adopted as a basis of procedure in the settlement of all losses of a doubtful nature.

At the same time private telegrams were sent to San Francisco intimating that while not expressed in the resolutions, the sentiment among a majority of the companies was that all losses where any doubt whatever as to legal liability existed, should be compromised at from fifty to ninety per cent of the insurance irrespective of values, and in order to give practical effect to this sentiment a resolution was introduced in the General Adjusting Bureau, on the 12th day of June, that all losses of a doubtful nature (and it was generally understood that under existing conditions it would be proper to consider practically everything doubtful) should be compromised at sixty-six and two-thirds per cent of the face of the policies. An amendment was offered raising the figure to seventy-five per cent, and the resolution as amended was adopted by quite a decisive majority.

These private telegrams, however, did not reflect the views of the leading American and British companies, whose instructions to their San Francisco representatives were to adjust each loss on its merits in a broad and liberal spirit in keeping with their usual practice, having due regard, however, for their rights under their policy contracts. Therefore, when the vote was taken on the compromise proposition, the parting of the ways had come. The minority, consisting of thirty-five companies, were referred to by the daily press as "one hundred per centers" or "dollar for dollar" companies, while the majority were characterized and caricatured as "six-bitters" and "welchers," thus adding several new words to the insurance vocabulary. The thirty-five companies still retained their connection with the General Adjusting Bureau, but effected an auxiliary organization and entrusted to a Committee of Five the supervision and final approval of all their Committee losses. This Committee consisted of Mr. A. R. Hosford, of the Royal, Chairman; E. R. Morrison of the Aetna, J. C. Corbet of the Northern, W. B. Seaman of the

Liverpool & London & Globe, and W. N. Bament of the Home.

The difference of opinion between the two elements, and the rock upon which they split, was simply this: One class of companies took the position, that owing to the extraordinary conditions, the obliteration of evidence, and the consequent uncertainty as to the effect of the earthquake, it was only right and proper that there should be an equitable division of the loss, between the unfortunate policy holders, and the scarcely less unfortunate stockholders, and in the judgment of those entertaining these views, seventy-five per cent of the face of the policies irrespective of values was regarded as a fair proportion to be assumed by the companies. The other class was equally insistent upon a proper allowance being made for earthquake damage, and for depreciation from causes other than fire, but held that deductions should be made from the sound value of the property and not from the face of the insurance, except where there was a clearly defined doubt as to legal liability, and in cases of this nature companies were unanimous in the opinion that compromises should be based on the face of the policies.

Never was a great work involving so many millions and requiring such expedition in execution undertaken and prosecuted under such unfavorable conditions. Not a hotel was saved; the street car service was out of commission; maps, records and policies were destroyed; the Hall of Records was destroyed; office furniture and stationery were difficult to obtain; freight traffic was congested; some companies had offices in Oakland one-half a mile apart, while others had theirs in San Francisco, twelve miles distant, from one to three miles apart; claimants who had traveled long distances crowded our waiting rooms, and altogether the adjusters led anything but "The Simple Life" for about three months.

Companies using the New York standard form of policy relied mainly on defenses of a general nature, chief among which were under the "Fallen Building" and "Civil Authority" clauses. The universal opinion among eminent lawyers was, that unless some substantial portion of the building fell there could be no defense under the first, but on the question of dynamiting by order of Civil Authority to arrest the spread of the flames, there was quite a difference of opinion among counsel.

Much has been said and written in regard to the "earthquake" clauses in the policies of certain companies. Some of these, which stipulate that they shall not be liable for loss or damage occasioned directly or indirectly by earthquake, are quite strong, leaving grave doubt as to the legal liability of the companies, while others, which state that they shall not be liable for loss by earthquake unless fire ensues and in that event for damage by fire only, have no legal defense whatever. In fact, in the opinion of many good authorities the clause is weaker than the New York standard form, as it might possibly be held that it nullifies the "Fallen Building" clause, when the fall is due to earthquake.

Several companies which have an "earthquake" clause as strong as the strongest, have voluntarily waived it and have paid their losses in full. Several other companies having a similar clause are paying from fifty to seventy-five per cent owing to location of the property, the time of fire, and general conditions.

Some of the German companies, whose policies contain the weakest form, have, up to the present time, paid nothing whatever, and are setting up as a defense that the fire was due to an act of God. One of these companies which had several million dollars at risk, has offered to pay fifty per cent under all policies of five hundred dollars or less, and to one claimant who had the misfortune to have a policy for fifteen hundred it was suggested that in order to secure the benefit of this munificence, he might voluntarily reduce his

policy to five hundred dollars, and he could then collect two hundred and fifty.

The Supreme Court of California had, in a very strong decision, sustained the validity of the clause in the New York standard policy requiring proofs to be filed within sixty days, and in order to protect policyholders, the Insurance Commissioner requested all companies to waive formal notice of loss and to grant sixty days extension for filing proofs. A majority of the companies complied, having previously granted such extension by publication, but notwithstanding this, the people, not wishing to take any chances, filed their claims, and it is perhaps no exaggeration to say that during the week ending June 18th, 1906, no less than thirty thousand Proofs of Loss were received by the various companies, some having been sent by registered mail and others delivered in the presence of witnesses.

The Sub-Committees, after completing their labors, filed with the General Adjusting Bureau - on blanks prepared for that purpose, - a full report showing sound value of the property and amount of visible salvage, together with full information, affidavits and photographs, if any, bearing on the subject of earthquake conditions. These were promptly mimeographed and copies sent to each company interested. A copy was also handed to the Committee of Five, and if the case presented reasonable grounds for compromise on account of incomplete records, earthquake damage or otherwise, the questions involved were taken up with the claimant for consideration, and the conclusion reached was accepted as final by the thirty-five companies represented by that Committee.

Numerous photographs had been taken by professionals and amateurs immediately after the earthquake and these of course afforded by far the best evidence as to the condition of specific risks. In many instances claimants had no personal knowledge regarding the condition of the property, and there can be no reasonable doubt but that many losses were paid in full which,

had a photograph been taken or all the facts known, would have been fair subjects for compromise. Single negatives, showing collapse of buildings, were sold for as high as one hundred dollars.

There were a number of cases where people, in order to escape the rapidly approaching flames, placed their belongings on wagons and moved them to a supposed place of safety, only to have them caught while in transit by another section of the fire coming more rapidly from a different direction, thus literally "jumping from the frying pan into the fire." These claims were either paid in full or by the application of the average clause.

In many instances inventories and books of account were destroyed either in whole or in part, while in some cases only one set of books was kept covering merchandise in several warehouses, with no means whatever of determining the values in each. Losses of this character were usually settled by compromise, the allowance being a matter of mutual agreement, depending upon the number and character of the missing links in the chain of evidence.

Losses on buildings were generally settled on the basis of builders' estimates, with proper deduction for depreciation and earthquake damage. Losses on "Class A" buildings where large amounts were involved were settled by appraisers, but aside from these, there were very few appraisements.

The largest loss was that of the Palace Hotel, which amounted to \$1,852,423.31 on building and contents, with an insurance of \$1,518,500.00. This is said to have been the largest loss on a single risk which has ever been adjusted in the United States.

The world-famous Chinatown - like all of the business district - was totally destroyed and is now a thing of the past. Chinese losses belonged in

a class by themselves and some of the companies had special departments for the consideration of these claims. Books were kept in Chinese hieroglyphics, and interpreters were employed at the rate of \$5.00 for the first hour and \$1.00 for each succeeding hour. A high-school girl was once asked by her teacher how many words there were in the Chinese language, and she replied "About fifty thousand." "And how many words would one have to know in order to understand the language?" asked the teacher. She replied, "Five thousand," and, judging from what I saw and heard, her estimate was none too high.

Chinatown has always been particularly free from disastrous fires, and as a consequence, the percentage of value to insurance on Chinese risks was probably less than on any other class of property in the city.

Many of the companies made it a rule to insist upon affidavits from claimants and their employees in regard to the extent of the earthquake damage in all cases, but it soon developed that, like Artemus Ward, who was willing to sacrifice all his wife's relations for the good of the country, everyone was perfectly free to admit that the earthquake had done considerable damage to his neighbor's property, while some special Providence had protected his own.

If our faith in the time-honored axiom that the whole is no greater than the sum of all its parts has not been unduly shaken by recent events, then, judging by these affidavits alone, one will inevitably be forced to conclude that San Francisco either had no earthquake worthy of the name, or that, instead of being one of the greatest within the knowledge of man, it was in reality one of the smallest.

As proofs for nearly ninety-five per cent of the losses had been filed prior to June 18th and it was absolutely impossible to get much more than

half of them adjusted within sixty days, we were all apprehensive that promptly after maturity we would be overwhelmed with demands for immediate payment, but to our great surprise and to the credit of San Francisco claimants be it said, that they not only patiently awaited the convenience of the companies, but sixty or ninety days after claims were filed, they voluntarily granted from one to two per cent discount for cash payment, on the theory that satisfactory proofs had not been furnished until the claim had been formally approved by the Committee.

One of the anomalies of the situation was the fact that five months after the fire there was a general complaint among the leading companies that it was next to impossible to get claimants to call and collect their money. I mentioned this to a caller, an old Scotchman, who said he knew a number of companies which had no such complaint to make, but that it was just like the old story of Pat and the Priest. Said the Priest: "Pat, suppose the Devil should meet us right now, which one of us do you think he would take?" "Shure, your Riverence," said Pat, "he'd take me." "Why, Pat," said the Priest, "what makes you think he would take you?" "Why shure," said Pat, "he knows very well he can get you at any time, and he's not at all shure about me."

The re-insurance bug-bear made its appearance on the scene quite early, and all the leading companies were officially notified by their re-insurers that they would not stand for any allowances in the way of liberal concessions or recognize any claims except those for which there was an unquestionable legal liability. This ghost seems to still be haunting some of the companies, but in general they have pursued the even tenor of their way undisturbed, have settled their losses strictly in accordance with their policy conditions, and have collected in full from their re-insurers. Some of the companies which

have not made the slightest pretense of settling losses with direct claimants have paid their re-insurers in full, thereby very properly admitting that they are bound by the conditions of the re-insurance rider, which takes precedence over the terms and conditions of their own policies.

At one of the early meetings of the General Adjusting Bureau a resolution was adopted to the effect that all losses in the hands of Public Adjusters should be put at the bottom of the list for attention after all other claims had been provided for. Adjusters for the People had not succeeded in getting a foothold at Baltimore and had never yet made their appearance on the Pacific Coast, so it was proposed to eliminate them as a factor in the adjustment of conflagration losses. A resolution looking to that end was accordingly introduced and carried by a unanimous vote, a number of gentlemen from the East having refrained from voting out of consideration for the views entertained by their associates on the Coast. But this evolutionary product of the insurance business is not easily suppressed, and it was soon discovered that the Public Adjuster was to be something of a factor in loss adjustments, although the number of claims settled through that medium were comparatively few.

One of these gentlemen, who had several cases with our office, after a sojourn of four months called to say "Farewell." I inquired whether he had enough money to get home on, whereupon he presented for my inspection the latest check he had received from a client, which was for an amount that almost any special agent would be glad to accept in exchange for a year's salary, and as this was only one of fifteen of almost similar amounts which he had received, I concluded that by the exercise of a reasonable degree of economy he might possibly manage to get home without experiencing any great discomfort. I afterward learned that he was a "nonboarder" and had secured the first mentioned case by underbidding his competitor to the extent of two

thousand dollars.

Another gentleman of this school is currently reported to have had over four million dollars in claims to collect, and even calculating at the modest percentage which he usually secures for his services, it does not require a mathematical genius to figure out that he will be fairly well compensated for five months' work, all of which demonstrates that this is a branch of the business which in its financial possibilities is almost as attractive as a local agency.

There was one actor in the drama who stood out more prominently than all the rest and occupied the centre of the stage from the beginning, and that was the "Eastern Adjuster." He was constantly in the lime-light and received daily consideration, either at the hands of the editor, the critic or the cartoonist.

One kind hearted citizen suggested that the insurance atmosphere might be cleared considerably if some of those gentlemen from the East were taken out and hanged.

A coach filled with sightseers was held up by a highwayman in the Yosemite Valley and it was immediately concluded that any one with such colossal nerve could be none other than an Eastern Adjuster who had stolen away from the field of his usual activities for a brief vacation.

The latest arrival at the Infernal Regions is reported to have looked about and expressed the opinion that there was a great deal of salvage to be found there, and he was not only accorded a cordial welcome, but was immediately hailed as an Eastern Adjuster who had come direct from San Francisco.

A claimant said to a skeptical special agent that he could secure any number of affidavits in support of his contention that there was no earthquake

damage to his property. The Special replied that according to the latest quotations the market price of affidavits was steadily advancing, whereupon the claimant said, "I really don't believe that the influx of Eastern Adjusters has had such a demoralizing effect upon the people of San Francisco that they cannot tell the truth, especially when under oath."

He was a very much advertised and criticised individual, and if he possessed any virtues, they were not discovered, or at least not recognized by the local press, but through it all he managed to pay out on an average about a million dollars daily during his entire sojourn on the Coast, which indicates that with all his alleged faults he was no mean paymaster.

The situation in San Francisco presented greater opportunities for the study of human nature than it did of the fine points in loss adjustments, for owing to the extraordinary conditions, many losses were not adjusted, but simply settled. Some companies, whose estimated losses were equal to or in excess of their entire assets, effected settlements at from thirty to fifty per cent by reason of their financial condition, and their drafts were accepted philosophically by rich and poor alike. Other companies effected settlements at from sixty to eighty per cent and their drafts were accepted as a matter of compromise to avoid litigation, while others adjusted losses on their merits to the mutual satisfaction of themselves and of the assured, and their drafts were received with appreciative thanks and expressions of good will.

It must not be assumed that all virtue was vested in the thirty-five companies represented by the Committee of Five, for there were a few companies of the highest standing which acted independently of that organization and settled their losses in full in the most honorable manner, while some within the fold are reported to have fallen from grace temporarily, and later on some of the "six-bitters" got religion and paid as rapidly and as generously as the rest.

In attempting to form any just conclusion regarding the settlement of these losses, all fair-minded and unprejudiced men must take into consideration the unprecedented events leading up to the fire, as well as the extraordinary conditions prevailing after its occurrence. An earthquake of enormous proportions had taken place, and it was not in the power of human wisdom even to approximate the ruin it had wrought. The Adjusters were confronted with a state of affairs which had never before arisen, and it may well be doubted whether the people of San Francisco as a whole would have been accorded as generous treatment by the Blindfolded Goddess herself, as they have received at the hands of their insurers.

This, the greatest of all fires, following so closely those at Baltimore and Toronto, has again directed the special attention of Underwriters to the fact that the conflagration hazard in all our large cities is one which has to be reckoned with and adequately provided for. It has also brought up for serious consideration the question of re-insurance between companies which transact business in the same territory. It has called attention to the desirability of uniformity in policy contracts. It has given food for thought to the scientist, the architect, and the engineer, and to the people at large it has demonstrated that the subject of insurance is one which deserves more careful consideration at their hands than it has ever before received.

The average ratio of loss to insurance, as finally paid by companies of the first class, is known to be between ninety and ninety-five per cent; that of the next class of companies will be fully eighty-five per cent; and the general average of all companies will in all probability not fall much short of eighty per cent.

There were one hundred and twenty authorized companies, besides a large number of surplus-line companies, interested in the fire, and the official

list shows that two hundred and twenty-one adjusters participated in the adjustments.

Up to September 24th, when all but ninety-nine Committee Reports out of thirteen hundred and thirty-seven had been received, the sound value of property embraced in said reports amounted to \$120,000,000 with a gross insurance of \$84,000,000, or exactly seventy per cent, and a visible salvage of \$8,750,000, or about seven and three-tenths per cent.

It is too early to form any definite conclusions, but from the best information thus far obtainable, I think it may be safe to assume that the total loss occasioned by the San Francisco disaster will not be much short of \$300,000,000 and that the net insurance loss will prove to be between \$175,000,000 and \$200,000,000 of which \$125,000,000 were paid within five months after the fire.

Never in the history of the world has such an overwhelming calamity, the combined result of two such powerful elements of destruction, been visited upon a community, and never has a Nation responded more promptly or more generously than have the people of these United States to the pressing needs of their unfortunate countrymen. But these voluntary offerings of a sympathetic people, great as they have been, can hardly be mentioned in comparison with the contributions which have been made by the Insurance Companies of the Old and New Worlds in fulfillment of their policy obligations, and while a few have been weighed in the balances and found wanting, and others have not quite measured up to their usual standard in the settlement of conflagration claims, those companies which represented the greater part of the amount at risk have met the situation in a manner worthy of the best traditions of the business, and, when accounts are finally settled, it will be

found that Insurance Companies as a whole have not only acquitted themselves well, but have more than fulfilled public expectations and have contributed infinitely more than any other single agency toward the rebuilding of a Greater San Francisco.

THE CALIFORNIA INSURANCE COMPANY - 1906

by George W. Brooks^{*}

The California Insurance Company having played one of the leading parts in the reconstruction of San Francisco following the disaster of 1906 and there being no record of its activities, I have, after insistent and repeated requests from directors, stockholders and others, finally yielded to their importunities to preserve for reference my impressions and memories of that most important crisis ever known to fire insurance.

From the time when Nero played the violin accompaniment to the burning of Rome, down, through the ages, to 5:15 a.m., April 18, 1906, and up to the present date, the San Francisco disaster is the most prominent recorded in history. It was the greatest spectacular drama ever staged and produced the biggest heap of the "damn'dest, finest ruins" the world has ever seen.

In transferring the records from the tablets of my memory to the printed page, I am dealing with accurate historical facts of the California Insurance Company together with my own impressions. The facts and figures regarding the Company are incontrovertible. My own impressions are but those which were felt by thousands of other San Franciscans in a greater or lesser or more varying degree. These may be taken as merely the local color, the object being to set forth for enduring vision, the splendid performances of honorably disposed fire insurance companies amongst which

* This account, under the title "The Spirit of 1906," was originally published in the form of a brochure by the California Insurance Company (3rd printing 1952). George Brooks was secretary of the company and he wrote this account some years after the earthquake.

none discharged to policyholders the liabilities under their contracts with any greater sense of equity, honor and liberality than did the California Insurance Company.

The Morning of April 18. - In common with the other half million citizens of San Francisco on that fateful morning, I was awakened from a sound sleep by a continuous and violent shaking and oscillation of my bed. I was bewildered, dazed, and only awakened fully when my wife suddenly screamed, "Earthquake!" It was a whopper, bringing with it a ghastly sensation of utter and absolute helplessness and an involuntary prayer that the vibrations might cease. Short as was the period of the earth's rocking, it seemed interminable, and the fear that the end would never come dominated the prayer and brought home with tremendous import the realization of our insignificance, of what mere atoms we become when turned on the wheel of destiny in the midst of such abnormal phenomena of nature's forces.

It was 5:15, broad daylight, and as I glanced at my watch those figures were indelibly fixed in my memory for the rest of my existence. The terror and horror which suddenly sprang like a beast of prey out of the gray dawn and grasped our heart strings, came unheralded from a day that otherwise promised all that should make life worth living. The night had been particularly warm and inviting. So vivid was this impression of the glory of the morning that I was possessed by a feeling of irony that such a beginning should herald the inception of so bitter a calamity. Fascinated, I stood gazing at a weather-vane on the top of a house across the street. It swayed to and fro like the light branch of a tree in a heavy gale. I was jarred out of my inattention by a terrific shock. The house lurched and trembled and I felt that now was the end. It was afterward discovered that this crash and jar was caused by the falling of a heavy outside chimney, attached to the adjoining house. It had broken and struck our dwelling at about the first floor level and torn away

about twenty feet of the sheathing, some of the studding and left a big hole through which the dust and sound poured in volumes, adding to the already almost unbearable confusion.

The first natural impulse of a human being in an earthquake is to get out into the open, and as I and those who were with me were at that particular moment decidedly human in both mould and temperament, we dressed hastily and joined the group of excited neighbors gathered on the street. Palefaced, nervous and excited, we chattered like daws until the next happening intervened, which was the approach of a man on horseback who shouted as he "Revere'd" past us the startling news that numerous fires had started in various parts of the city, that the Spring Valley Water Company's feed main had been broken by the quake, that there was no water, and that the city was doomed.

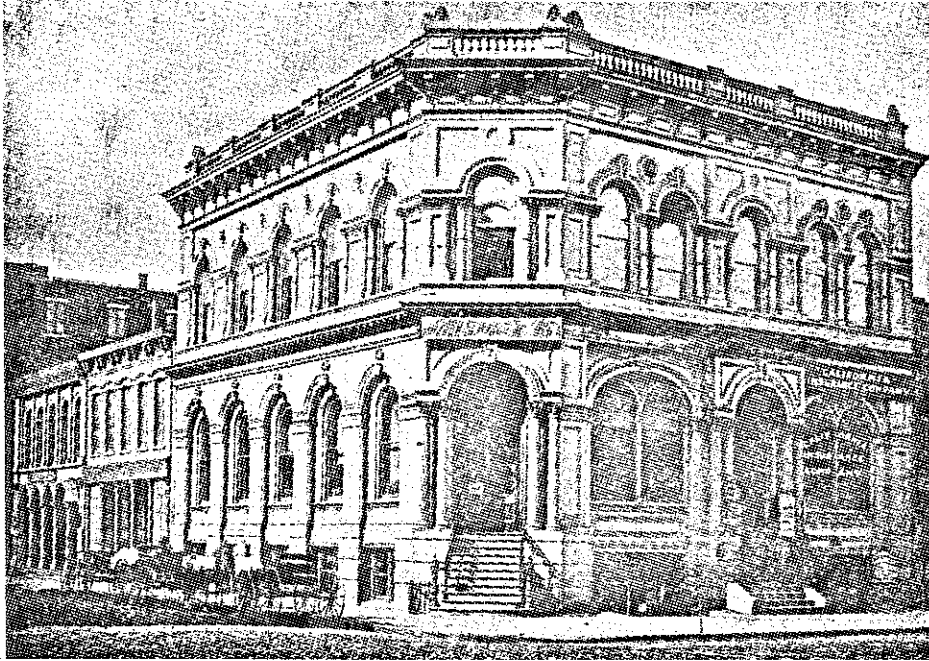
This was the spur I needed. Fires and no water! It was a call to duty. The urge to get downtown and to the office of the "California" enveloped me to such an extent that my terror left me. Activity dominated all other sensations and I started for the office. As all streetcar lines and methods of transportation had ceased to operate, it meant a hike of about two miles.

My course was down Vallejo Street to Van Ness Avenue, thence over Pacific Street to Montgomery. When I reached the top of the hill at Pacific Street where it descends to the business section, a vision of tremendous destruction, like a painted picture, opened before my eyes. I saw fires on the water front, fires in the commercial district and also portentous columns of smoke hovering over the southern part of the city. Then like a blow in the face came the realization that all fire fighting facilities were nil owing to the lack of water. One short hour previous, San Francisco was sleeping peacefully in its prosperity, and now the sight was appalling. Devastation,

far as the eye could see, was spelling death and destruction.

My route was down Clay Street from Montgomery to Sacramento. In that one block I counted twenty-one dead horses, killed by falling walls. They had belonged to the corps of men who bring in to the market with the dawn the city's supplies. When I reached the corner of California and Sansome Streets (the California office being one block away on California and Battery) I found a rope stretched across from the Mutual Life Insurance Company Building to the site where the Alaska Commercial Company building now stands. All beyond was policed. A soldier of the regular army was on guard and no one was permitted to pass. Arguments and beseechments to get to the office were of no avail. The necessity and the emergency, however, stimulated my determination and aroused my ingenuity. Suddenly, I ducked under the rope and ran a Marathon which was not only a surprise to myself but also to the officers and the crowd who yelled after me. I am sure that in this one block my speed record for a flat run still stands unequalled.

I reached the office and there found every intimation of a hasty departure on the part of the janitor. The front door of the building stood wide open. I rushed in, threw open my desk and hastily gathered an armful of what I deemed were the more important books and papers. Glancing around to see if there was any way of saving anything else I again received a jolt by noticing that the fire was coming down a lightshaft from an adjoining building and through an open window into the rear office of the "California's" office. In fact, furniture was already burning in the president's room. This was no place for me. The only avenue of escape was the way I had come, since so rapid was the spread of the conflagration that north, south and east were already in flames.



*Office of the Company, No. 230
California Street, San Francisco.
from June 1905 to April 18, 1906.*

Upon reaching California Street I rushed and headed west, and the instant I had passed, the entire four-story outer wall of the building located on the southwest corner of California and Battery Streets (then known as the "Insurance Building"), fell with a roar, completely blocking the street over which I had just made my escape. Realizing that my safety was measured by a matter of seconds, I was for a moment unnerved. My legs trembled, my heart pounded, and my breath came quickly, and only by a great exertion of will induced by the thought that it was time to do and not to hesitate, I made the effort and arrived safely at the rope from which I had started. I shook as if with the ague. Sweat and grime poured from me, but the shout that went up from the watching crowd and the many friendly hands that sought mine, gave me my second wind.

I had already made up my mind that possibly the Liverpool and London and Globe Insurance Company and Colonel C. Mason Kinne would allow me to store within their vaults whatever salvage I had taken from my desk. My trust in their courtesy was justified. I was made welcome and the Colonel, in the name of the company, placed anything and everything that it had in the shape of assistance at my disposal.

As we stood talking on the corner of California and Leidesdorff Streets, a friend still living in San Francisco who had an office in the Liverpool and London and Globe Building suggested to me that I had better take an option on some of that company's vacant rooms. I spoke to Colonel Kinne, a verbal agreement to that effect was made, and I turned and smilingly remarked, little knowing what the future had in store, that the California Insurance Company would resume business in the Liverpool and London and Globe Building "tomorrow morning."

I then stood and watched the firemen lower a suction pipe through a manhole in the middle of the street and pump sewerage on to the old Wells Fargo Building. It had about as much effect as a garden hose and the supply was soon exhausted. The firemen stood perfectly helpless, like soldiers without ammunition, in front of the enemy. The fire had now destroyed about everything east of Sansome Street and in the absence of water it was only a question of one or two days at most when the entire city would be in ashes. This was not alone my impression but the same ghastly prospect impressed itself upon all those who were gathered in the vicinity.

The minutes had ticked off until it was now about 8 A.M., when another violent shock occurred — a sort of postscript to the original 5:15 temblor. It was of short duration but while it lasted it was decidedly impressive. The crowd scattered and I with them, for we suddenly realized that another wall might fall with a crash and that we might be caught. This is the only reason I can assign for our agility in getting away, unless it might be that we simply followed the first and natural impulse of our overwrought nerves.

The Dominant Thought. - As the various impressions and shocks succeeded one another, there always came in the interim the dominant thought of the California Insurance Company. This thought again became uppermost and I concluded to at once get in touch with the president. I proceeded by devious ways over bricks, past wreck and ruin, through the stunned and gaping crowds, until I reached the St. Francis Hotel where he resided, and finally found him in the lobby, which was packed by an excited throng of humanity. If ever the St. Francis needed the S. O. S. sign, it was the morning of this day. Everybody in the hotel must have been, with others, in the lobby.

The president was in his usual hopeful and optimistic frame of mind. He had no fear whatever but that the fire would be shortly under control. How

this was to be brought about, he could not tell, but he was perfectly satisfied that it would be done. I looked at the man in wonder and admiration. Such colossal optimism was superb. To expect from fate what appeared to me to be the impossible was indicative of a hope sublime. I envied such a nature. It was not only a great asset but was also a great solace in the face of an unprecedented disaster. But he had not been where I had been nor had he seen what I had seen.

Then my thoughts turned toward home and my depression increased almost to despair as I walked past the wreck and ruin and through the crowds who themselves were fleeing in undescrivable habiliments and with all sorts of futile treasures grasped in their hands.

No water! Little, if any, police protection! In fact, nothing, apparently, except Divinity itself, to prevent the conflagration from finally burning to the ocean. A most appalling tragedy! It meant the impoverishment and lack of homes to thousands; it meant the sweeping away of accumulations of years of endeavor; it might mean starvation; it meant beginning again to climb the uphill trail to success; and last, but worst, it meant the tremendous death toll either from immediate causes or from after effects. Even today, years after the conflagration, many men and women live in San Francisco in a greater or lesser degree of ill health, the seeds of which were planted by the terror and mental strain which they endured on the morning of that day.

Progress of the Fire. - The day passed. Neither I nor any other can remember all the details which marked the hours of suspense. It is to be presumed that others like myself found various, and what then appeared to them to be tremendous, things to claim their attention and then — the second day!

The fire had now reached Van Ness Avenue and again came the messengers on horseback who shouted in passing that everyone must move. My home was on Vallejo Street about five blocks beyond Van Ness and it was generally believed that inasmuch as that street was one hundred and twenty feet wide that it would form a firebreak which could not be crossed. Backfiring had already been started to meet the oncoming conflagration, but everything, including the elements, seemed to favor destruction and, as time passed, the worry and fear increased. Owing to inability to combat the fire, through the lack of water, doubt began to creep in as to whether the width of Van Ness Avenue and the puny attempts at fire fighting would check the march of the flames.

About this time the question dawned upon myself and neighbors as to what we should do with the more precious of our personal belongings. Mr. Joseph Weisbein, a friendly neighbor, since dead, and myself evolved a scheme to bury our belongings in the garden at the rear of my house. We assembled four trunks, packed these with silverware and wearing apparel, and some of the hardest physical work I have ever done was in burying these trunks, digging the hole with a worn out shovel and a broken spade. Then, with the help of our Chinese cook, I brought out of the cellar a baby's buggy which had lain forgotten and unused for several years. We loaded it with bedding and other things and trundled it down the hill to Lobos Park near the bay shore. Trip after trip we made before we decided that we had all that was necessary or, rather, absolutely needful for a camp existence. The next question was shelter. After prowling around the partially quake-wrecked gas works, I found some pieces of timber out of which I constructed a sort of framework for a large A tent. I borrowed a hatchet from another refugee, a stranger in adversity. The disaster had broken down the barriers

of formality and we all lent a willing hand each to the other. I secured some spare rope and got up my framework. This was covered to windward with some Indian blankets sewn together by those we were trying to make comfortable. Under that hastily erected rude shelter nineteen people slept on mattresses that night. I did not have the good fortune to sleep. Sleep would not come to "knit up the ravelled sleeve of care," and through the long hours I watched the intermittent flashes, heard the noises and in the darkness went through the added suffering of overstrained nerves.

A neighbor, J.F.D. Curtis, since dead, but at that time and for years after the manager of the "Providence Washington Insurance Company," passed the silent watches of the night with me, each of us smoking ourselves blind and watching — talking but little, although thinking and feeling a whole lot. We were a mile from the fire, nevertheless it was so light that a newspaper could easily have been read by its glow from the time when the sun set on the ruins to the hour when it rose on the next day of horror. Curtis, turning and pointing to the flaming city, inquired in quiet tones if the California Insurance Company could pay the bill. I replied that as a stockholder in the company, I felt that I was ruined and I feared that the company would "go broke." He stated that he believed the Providence Washington would weather the storm and if the worst came to the worst with me, he would like to have me join him in the management of the company he represented. It was a ray of sunshine. It was a beacon of hope. It was like a life buoy thrown to a drowning man, and I shall never forget the encouragement that came with his offer nor the gratitude I felt, and, although subsequent events have shown that my first fears were wrong, my gratitude endures to this day.

The night passed and while we were eating a cold breakfast, principally composed of sandwiches, the man on horseback arrived again; this time,

however, with the glad tidings that the fire had been stopped at Van Ness Avenue and we could return to our homes. It was afterward learned that the salvaging of the section of the city beyond Van Ness Avenue was due to the excellent work done by two salt water streams pumped from the bay by tugs stationed at the foot of Van Ness Avenue and carried along by relays of fire engines. So intense and so furious was the fire that while one set of firemen, their heads covered with blankets, held the hose, the second stream was used to drench them, also the engine. Further proof of the fierce and terrific heat was shown in the circumstance that houses one hundred and twenty-five to one hundred and thirty-five feet across the avenue had windows cracked and paint blistered. The last grand heroic stand of the fire fighters was made at the corner of Van Ness Avenue and Vallejo Streets.

A man was found with a wagon to cart our things back to the house and, while we did not have much worldly wealth in our clothes, we were prepared to pay liberally. Under the circumstances, when his modest charge of two dollars was met we felt that he had earned it many times and in addition, our gratitude. Arriving at the residence, we found the sidewalks and the street in front of it three inches thick with ashes and cinders. Now came the task of unearthing the trunks and with it came the thought that had this section been entirely burned how difficult it might have been to locate the place where they had been buried. Necessity for action and to be up and doing was too strong, however, to allow time for any such conjectures. There was too much going on to dwell on post-mortems. That night the streets were patrolled by marines from United States warships in the harbor, whom the government had hurried to the scene of action with all promptness possible.

No lights or fires were permitted in houses. It was either retire at sundown or retire in the dark. Whatever water was needed had to be carried

from the nearest well and even after the mains had been restored to normal efficiency this practice was continued for fear that the possibly broken sewers might contaminate or pollute the water. No fires or cooking were permitted in any building until every chimney and flue had been passed upon by the authorities.

In order to obtain water it was necessary first to procure buckets, then carry it from an old well in Lafayette Square, some dozen blocks away. Baths were forgotten and shaving was a luxury. It entailed severe labor to secure water with which to prepare the necessities of life and to maintain a reasonable degree of personal cleanliness. In common with every other citizen our stove was placed on the curb and this was our kitchen and dining-room for over six weeks. As there was no oven, baking and roasting had to be dispensed with, boiling and frying being the established fashion.

The second day after the fire, a food station was opened across the street in an old carriage house which belonged to Mr. J. L. Flood. Here lines would form to receive rations, the millionaire rubbing shoulders with the laborer. The panhandler got as much as the plutocrat. The disaster levelled all classes. A million dollars in one's pocket would have been of little use. Nothing could be bought with it and it could not serve as either food or drink.

Getting Back to Work. - Betweenwhiles, as one crisis after another came and went, I was still constant to the idea and still felt my responsibility to the California, and from time to time as circumstances permitted, was strenuously endeavoring to reach the directors and stockholders. The president, in spite of his optimism, had fled from the Hotel St. Francis and gone to the home of his mother on Clay and Larkin Streets. For the same reason he left there and went to the yards of the Fulton Iron Works where his yacht "Lady Ada" was laid up, got her off the ways and tacked over to Tiburon where he remained

for some time. Finally word was received from him that the directors of the company would hold a meeting at the Blake and Moffitt Building on the corner of Eighth and Broadway, Oakland, on May 2, 1906. Who really located them, scattered as they were, and finally got them together, has remained an unexplained mystery. It must have been either the president or Chief Clerk Shallenberger. The late Mr. James Moffitt, a stockholder in the company and the owner of the building named, kindly secured for us two rooms in that building for an office. They were on the third floor facing Broadway and the location and the habitat of the company was disclosed by a canvas sign which, banner-like, hung upon the outer wall proclaiming this to be the office of the California Insurance Company. For furniture, there was a flat top desk and a typewriter (both second-hand) and the balance of the equipment was hand-made, of ordinary lumber, by a local carpenter. There was not very much cash among those thus assembled, but, fortunately, the company had maintained a deposit in an Oakland bank and this was immediately available for checking purposes.

First Meeting of the Board of Directors. - Quietly and almost silently the Directors gathered. The only emotion apparent was that of the usual caution shown by men of large affairs who meet to face a crisis. The President called the meeting to order and stated that the object of the gathering was to inform the Directors that the company was heavily involved in the conflagration which visited San Francisco on April 18, 19 and 20, 1906, that the amount of which obligations was at present unknown, that they overshadowed the resources of the company, and that ways and means would have to be devised to finance the California through this crisis.

The fire maps of the company were entirely destroyed and it was not advisable to open the safe in which the records of the company were kept



*Office of the Company, Corner of
8th and Broadway, Oakland,
California, from April 1906 to
June 1906.*

until it was sufficiently cool to prevent danger of combustion. In light of these facts, it was impossible to immediately ascertain the actual amount of the company's obligations.

In response to an inquiry as to the probable extent of our liabilities. I, as Secretary of the company, ventured the statement that I believed they would reach a total of \$1,500,000 net, explaining that I based this estimate upon the company's income and the average rate. I also knew that the larger part of the entire liabilities in San Francisco were in the burned area and that if the safe did not afford protection it would mean the loss of the company's records, leaving it without means of ascertaining the amount of the loss until claims were filed. This would cause a delay of several months before the exact total could be developed. I explained that the policy contract allowed sixty days for filing claims and expressed the thought that this limit would undoubtedly be extended by legislative action in view of the magnitude of the disaster.

In the meantime, in the April 27 edition of the Examiner, on the first page, extending over its entire width, had appeared the following statement:

"THE CALIFORNIA INSURANCE COMPANY WILL PAY IN FULL"

This was discussed and the meeting began to assume a more lively interest and the members to more actively participate. Director W.E. Dean offered a resolution that has passed into history as being, possibly, the most noticeable ever adopted by the Directors of a fire insurance company. It is a question whether a motion under like conditions had ever before been put or carried or ever will be in the future. This motion was seconded by Director Mark L. Gerstle. It was as follows:

"That the action of the President of this corporation
in publicly announcing that the California Insurance Company
would pay all its losses in full as ascertained and adjusted, be,

and the same is hereby confirmed and ratified, provided that each of the Directors of the corporation affixes his signature to the matters of this meeting. Unless such ratification be unanimous and evidenced by the signature of each Director to the matters of this meeting, the above action of the Board be null and void."

The signature of each and every Director was subsequently affixed to this resolution and it then remained a matter of detail to find how funds were to be procured to make this resolution possible of fulfillment and something more than a mere matter of words.

In the absence of any specific or definite information as to the amount of the company's indebtedness, this action of the Directors was a most magnificent exemplification of nerve and integrity and a superb testimony reinforcing the axiom that a California man's word is as good as his bond.

The Board might have instructed its Secretary to make the best compromise settlements possible and have wound up the affairs of the corporation. The public mind was in a receptive mood to accept such compromise settlements and such action would have resulted in extreme financial advantage to the stockholders at the time when the resolution was passed. No one at that time believed that the California would discharge its obligations on a parity with the largest and strongest insurance companies in the world. Indeed the public announcement that the company would pay in full was regarded as ridiculous and unbelievable and was generally considered in the light of an extremely sagacious bluff.

The Directors of the company were not bluffers; they were made of different stuff. They did not hesitate. They were in deadly earnest and

and absolutely meant to live up to their spoken word and the world knows how they redeemed their promises.

My original estimate of \$1,500,000 fell far short of the final net payment which amounted to \$1,840,000, but long before this had developed the stockholders were too deeply involved to think of turning back even had they desired to do so. Staunchly and loyally they stayed and paid to the end, building a monument to their good name that turned the sneers of welshing competitors into envy and admiration.

Second Meeting of the Board of Directors. - In the advance of the company, the next historical date of importance was May 11, 1906, when the succeeding meeting of the Board of Directors was held at the home of Director Mark L. Gerstle, 2350 Washington Street, San Francisco. Again, I was called upon to bring bad news. I was compelled to inform the Board of Directors that all the records of the company had been destroyed as the safe which contained them had been smashed by falling walls and the contents absolutely obliterated. The only thing recovered was some rolls of silver coins melted together by the intense heat. I also reported that three hundred and fifty claims had been filed for an amount totalling over \$650,000.

The loss of the records was a very serious matter and complicated proceedings to a degree apparently almost insurmountable. Lost in the destruction of the safe were some \$900,000 in reinsurance policies. This meant restoration of this data from the records of the reinsuring companies and at that time this looked like a superhuman undertaking. However, I immediately detailed two employees with instructions to devote their entire time to this angle of affairs. The companies met the situation with every courtesy and finally after several months' exertion all of the reinsurance was located, with the exception of about \$18,000.

I do not like to harbor the thought, but nevertheless I feel that some company or companies, possibly still doing business, know that they owe the

California some part of this reinsurance, which goes to show that in the insurance business, as in other enterprises, there are those who cannot bear the light of day.

About twelve months after the "Big Fire" I remember having received a reinsurance claim from a company whose home office is in New York. As this particular company was one of the very few that declined to respond to the request to assist us in restoring the lost data, I thought it the better part of wisdom to ask it to furnish the information previously requested, holding up their claim in the meantime while awaiting their reply. It never came, and their claim against the California still remains unpaid. The conclusion is too glaring to need further comment. A few similar instances might be recorded but they are best forgotten.

This meeting also made history. It levied the first assessment of \$40 per share on the six thousand shares of capital stock of the corporation. This would bring in \$240,000 and was subsequently followed, month by month, by seven others, until the total assessment had reached \$305 per share, amounting in all to \$1,830,000, of which \$1,800,000, or 98 per cent, to the everlasting glory of the stockholders of the California, be it said, was paid.

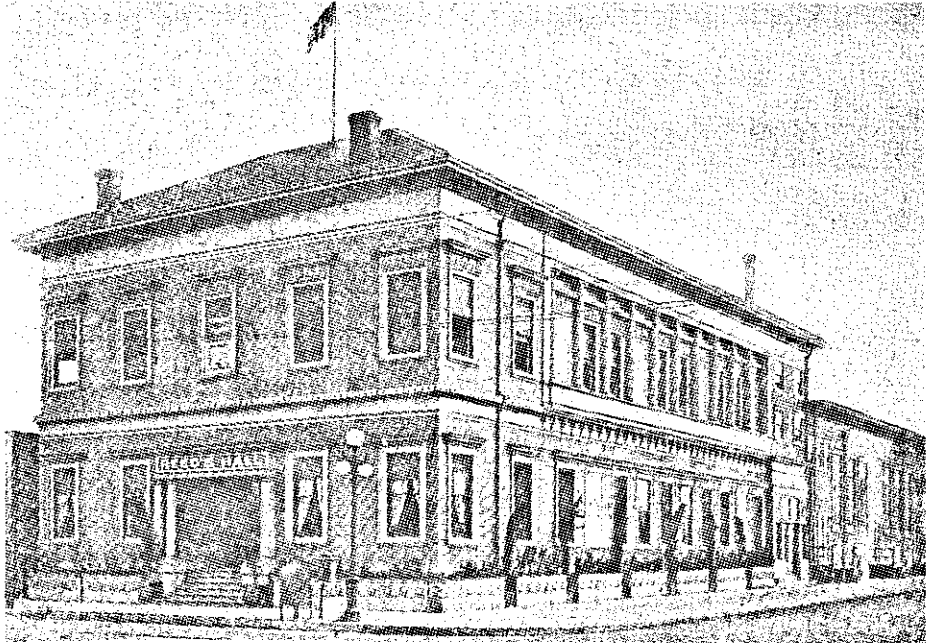
The resolution bringing this about was as follows:

"Notice is hereby given that at a meeting of the Directors held on the 11th day of May, 1906, an assessment of forty (40) dollars per share was levied upon the capital stock of the corporation payable on or before the 13th day of June, 1906, to Mark I. Gerstle, Assistant Secretary, at the principal place of business of the corporation, No. 2350 Washington Street, San Francisco, California. Any stock upon which this

assessment shall remain unpaid on the 13th day of June, 1906, will be delinquent and will be advertised for sale at public auction, and unless payment is made before will be sold on the 2d day of July, 1906, at 2 o'clock P.M., to pay the delinquent assessment, together with cost of advertising and expenses of sale."

The "Dollar for Dollar" Resolution. - It became my duty to inform the Directors that a meeting of the representatives of all the fire insurance companies interested in the conflagration was called for an early date at Reed's Hall, Oakland, and that I understood the principal object of this meeting was to secure an expression of opinion as to the method to be adopted in settling San Francisco losses, whether seventy-five cents on the dollar should be paid or settlement on a 100 per cent basis be made, and I requested instructions. This was merely pro forma as the company had already announced its position publicly as being in favor and promising to pay cent for cent the full obligation of its contracts. The board gave me the instructions I had expected.

The meeting at Reed's Hall was a most memorable one. The late George W. Spencer, at that time manager of the Aetna Insurance Company, presided, and to his fair and impartial rulings and usual courtesy and dignity of manner, is attributable the fact that there was not considerably more friction than developed. Even as it was, the discussions were acrid and verged at times close to personalities and the oratory, especially on the part of those who advocated the "six-bit" policy, was both perfervid and vociferous. However, the representatives of the companies that had made up their minds that their honor and contracts were worth dollar for dollar had little to say and were not influenced by the alleged arguments of the "six-bit-ers."



*Reed's Hall, Oakland, Calif.,
where the "Dollar for Dollar"
Resolution was adopted.*

They felt that in the last analysis there was no logical, honest argument for the discounting of payments unless it were a case of absolute insolvency with individual companies. It was maintained by the opponents to the "six-bit" policy that the insuring public had paid for what it assumed to be valid contracts and was entitled to just indemnity and payment in full. Finally, the roll call came to ascertain the sense of the meeting — seventy-five cents or one dollar. The roll call was thrilling in the intensity of feeling it developed and in the position in which it revealed each company's standing, whether for an honorable fulfillment on the one hand or a dishonorable scaling of losses on the other. Alphabetically, the California Insurance Company came early in the list and I voted with those who felt their obligation to be one hundred cents on the dollar. The position which the California would take had been awaited with considerable interest. The public announcement that the company would pay dollar for dollar was still recent and this announcement had appealed to nearly every person at that gathering as a promise which the company was absolutely and physically unable to perform. The registering of the vote called forth quite a demonstration. Laughter, smiles and sarcasm predominated in the part of the hall where I was located. For a moment I was the center of attraction.

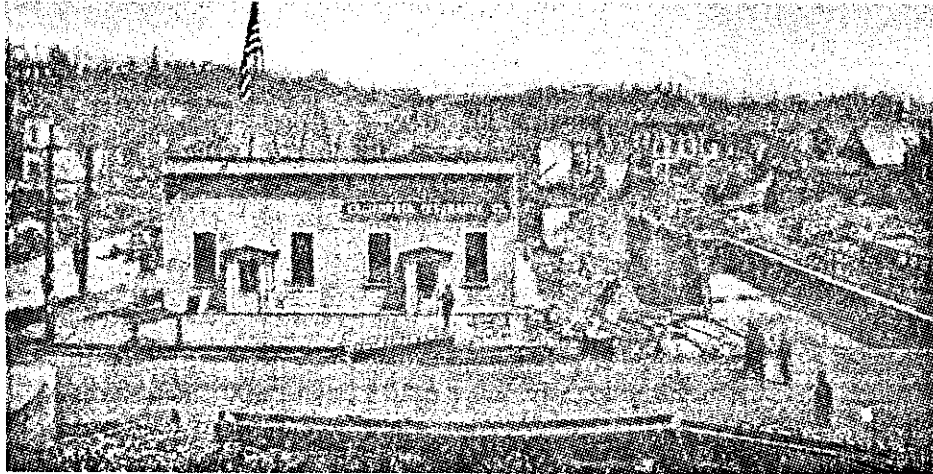
Despite the embarrassment and annoyance under which I labored, I felt that I was called upon to defend the good name of the company and, gaining recognition from the chairman, I said that the manner in which the "California" voted seemed to cause some of those present considerable amusement and that, individually, I didn't see anything in it that was funny; that it was more of a tragedy than a comedy, and that it was a solemn and serious matter for the company of which I was the representative to go on record for the second time, publicly, as pledging itself to pay so tremendous an amount

of money out of the pockets of its stockholders; that I was present at the meeting to carry out the expressed instructions and wishes of these same stockholders and that they intended to be scrupulously careful in keeping their promises, backing their words with their deeds and dollars. This statement brought from the dollar-for-dollar companies a gratifying amount of applause and the "six-bit-ers" sank into silence.

As the days passed and the "tumult and shouting" died, it gave a certain amount of satisfaction to find that amongst the jeerers and sneerers at the memorable Reed's Hall meeting, those who had battled most vigorously for the horizontal cut of twenty-five cents were those who afterward developed into the worst welshers and shavers in the entire history of the loss settlements of the San Francisco or any other conflagration. The "sparkling" Rhine, the "still" Moselle, the far-famed "Dutchess," the German of Freeport, the Traders of Chicago, the Austrian Phoenix, the Calumet, the American of Boston and others soon after sought the seclusion which a receiver or cessation of business in California grants, and like the Arab, they folded their tents and silently stole away.

At the termination of the meeting, President Chase of the Hartford, President Damon of the Springfield, Chairman Spencer and several others, all leaders in dollar-for-dollar ranks, some of whom are alive and some of whom are gone, gathered around and congratulated the California upon its attitude. Individually, it gave me a feeling of pride and satisfaction to be the representative of a company which manfully stood up to the rack with the best traditions of American fire insurance. It may be well to recall to mind as a historical fact that it was at this meeting the term "dollar-for-dollar" companies was born.

Coming Back to San Francisco. - Early in June we made arrangements to vacate our quarters in Oakland in the Blake and Moffitt Building, and on the 5th of that month the California was moved to an office in San Francisco. This was a temporary frame structure erected on identically the same site which the company had occupied prior to the fire, and where the magnificent new skyscraper known as the "Newhall" Building now stands. As things go now, it was not much of an office either as to style or appearance, but it was roomy, light, well ventilated and comfortable and in every respect preferable to the two crowded rooms that had so hospitably housed us in Oakland. The return to San Francisco heartened us. The daily trip from the city to Oakland and return had been a hardship, in addition to the time lost when every minute was too precious to be wasted. Less time was lost in crossing the bay than in getting to and from the Ferry. The streetcars were not in operation and I was compelled daily to make the walk over the hills and through the ruins, threading my way through the ashes and over brick piles a distance of quite two miles, from my home to the water front. This twice a day for six days a week, and often seven, was exhausting in the extreme, so the wear was not altogether mental. The thought was very often in my mind that I had about the most trying job of anyone in the business. Other managers seemed to me to be paying very little attention, if any, to the detail of settling claims and, of course, had nothing whatever to do with providing the sinews of war. They were fortunate in being able to pursue the even tenor of their way, their entire business and time being occupied with current routine, just as if nothing of an extraordinary nature had happened. This condition arose from the fact that the companies in the East hurried to San Francisco and Oakland all the adjusters, both near and alleged, that they could obtain from any portion of the United States and a few from abroad, in order that the losses might be promptly taken care of. The home offices saw to it that the funds were provided.



*Office of the Company, No. 230
California St., San Francisco,
June 1906 to September 1907.*

The special agents and field men of these offices were not disturbed in their usual work and were rarely, if ever, made use of at headquarters to make adjustments. With the California it was quite different. Our entire field force was called in and promptly clothed with authority to adjust. This left our agency plant entirely unprotected as to cultivation. Financially, we were in such a crippled condition that we felt we could not afford the expense of employing independent adjusters. These were a luxury in any event and some of them, alas, would have been dear at any price. The thought often comes that perhaps this policy was poor economics. This was a golden opportunity for representatives of the "dollar-for-dollar" companies to secure valuable agents, as carrying capacity was in large demand to replace those companies that had either failed or made unsatisfactory loss settlements. That there was an abundance of the latter admits of no dispute. Possibly, we might not at that time have been able to secure many of these valuable connections, even if we had had the field force requisite for the required technical work, for the reason that doubts were still expressed as to our ability to fulfill our promises.

The Duties of the Secretary. - In the California Insurance Company office, the position of Secretary was closely akin to that of the celebrated "Pooh-Bah." Attached to the office was the duty of collecting the assessments on the capital stock, adjuster in chief, the underwriting, a court of appeal on technical points in disputed settlements, a diplomatic agency and encouragement dispensatory with and for the stockholders. The latter item took considerable time. Singly and in groups they fired their questions: "How many assessments will there be?" "How much do you think the losses will total?" "How soon will you know the amount?" "When we do get out of this shall we be as big as any other fire company or bigger?" This was the daily grind. But since it was their money

and they were laymen, their anxiety was as pardonable as their courage was commendable.

The President occupied an office on the other side of the hall, directly opposite mine. The one door was lettered "President" and the other "Secretary."

One of the stockholders cornered me and demanded a full and explicit statement of conditions. I gave him the facts and frankly confessed that the prospect was not alluring. He bade me goodbye with a long face and went directly across the hall into the office of the President. In a brief while, he returned, his face wreathed in smiles, and quietly said that the President's office was "Heaven" and my office was "Hell"; that I was a "gloomy Gus" anyway, but I couldn't help it and he pitied me, but as for the President, he was the right man in the right place, and he knew our exact position. I did not make any reply. The optimism of the President was a very great asset and in those days optimism and hope were at a premium.

Turning of the Tide. - Finally the tide turned. Several months had elapsed, however, before it became generally known and admitted and the insurance world had hammered into it the conviction that the California was truly "Californian." At this time our field men were again in the saddle and the agency of the California was not only readily accepted whenever offered, but eagerly pleaded for by connections which materially contributed to subsequent success.

Adjustments . - There are millions of stories with regard to the adjustment and settlement of claims during this period. All kinds of pressure, all kinds of seduction and all kinds of bribes were offered the adjusters. There appeared to be in the minds of many a conviction that this was the time to make a claim against the insurance companies; that everything was burned and that with the

upset conditions any old claim could get by. Stevedores, laborers and others not generally credited with an excess amount of worldly wealth gayly and festively swore to proofs showing the loss of family plate, ancestral pictures, silk underwear, ball gowns, evening clothes and jewels. There was no possibility of disciplining these perjurers and it was up to the expertness of the adjusters to defend their companies from being looted.

There were all kinds of attempts to defraud on the part of other policyholders. One instance in which the California was interested was a proof for a \$16,000 loss on a policy covering on stock of dry and fancy goods located in a building on Market Street. I received a visit from the policyholder who made a request for prompt payment. I explained that our funds were being raised by assessments which were levied once a month and that, if agreeable, we would pay him sixty per cent of his claim and balance in sixty days. This appeared to be satisfactory and he left in a happy frame of mind. Thirteen thousand dollars of the risk in question was ceded to other companies and we naturally filed claims with the reinsurers for their proportion. The following day a friend who was acting as chief adjuster for another office which was one of the reinsurers on this risk, called upon me regarding this particular claim. He laid upon my desk a photographic album and called my attention to a large photograph of the building wherein the stock was located. It was a two-story brick and the picture showed that the entire front of the second story had, as the result of the earthquake, been thrown into the street. This was taken before the fire had reached the property. He stated that the authenticity of the photograph was absolutely guaranteed and that in event of litigation, the testimony of the photographer was available. He further stated that acting for the reinsuring company, he would not follow the California for more than sixty-five cents on the dollar. I borrowed the photograph and at once sent for the

claimant. He called the next day. It was found on examination that he had made the statement to the general adjustment committee that the property was not damaged prior to the fire. Unfortunately, no affidavit was taken from him to that effect. With the photograph before me, I realized at once that the claim was not an honest one. I explained that the larger part of our policy had been ceded to other companies and that some of them demanded earthquake affidavits with every claim; that while I regretted to put him to any inconvenience, it would be necessary for him to produce this testimony. He looked me squarely in the eye and said, "I'll sign it and swear to it. Not a brick in the whole building was disturbed." He attached his signature to the affidavit. I showed him the photograph and then stated that we should be compelled to penalize him to the extent of thirty-five cents on the dollar. As a matter of equity, there was little, if any, liability under the policy. He shouted, "Fake!" "No," I replied, "simply a matter of contractual rights and of justice. The picture is absolutely bona fide." He left, emphatically stating that he would at once "go to the bat." I suggested that he submit the matter to his attorney. Fortunately for him, he had a wise one who promptly advised that he accept the terms offered.

This is another angle of the settlement of the San Francisco losses — no more nor less in fact, methods, and manner, than that with which other legitimate companies had to contend.

Another instance is recalled of a claim for a thousand dollars covering on lodging house furniture in a building on Sixth Street, with the loss made payable to the owner of the building. I supposed that the policy was collateral for payment of rent. It developed that the claimant was a widow with one child. She was without a cent in the world, and called to request payment. By this time the company was running short of ready funds to such an extent that

instructions had been issued to adjusters that all claims hereafter would take the customary sixty days before payment. She stated that the fire had cancelled her lease, that she had seen the payees and that they would waive the claim, and that she was absolutely destitute and would be willing to take whatever we would offer, if she could get the cash. The position of the company was explained to her with the result that she felt that we were working for a discount. But it was not the intention of the California to take advantage of people's necessities and we informed her that such was the case. Her claim was a just one. I accepted her proofs, paid her twenty-five per cent cash and the balance at the end of thirty days. These are but isolated instances among many.

Special Meeting of Stockholders. - Another historical meeting was held August 9. This time at the office of the company. It was a special meeting of the stockholders. Three assessments had been levied of forty dollars each, amounting in all to \$720,000. This money had been paid out in settlement of claims. This was the first meeting of the stockholders proper since the fire. The Directors realized that in response to inquiries from the stockholders who were principally interested, that they were entitled to a report as to the progress made and the policy to be adopted for the future. Over ninety individual stockholders were present and in order to accommodate the crowd, the employees removed their desks and chairs, and during the time of the meeting adjusted losses and discharged their duties on the sidewalk in front of the building. The early-comers had seats. The late-comers stood, but so interesting was the meeting that discomforts were forgotten. The President made a very full and analytical report, finishing with the announcement that another million dollars would be needed to continue the splendid work and accomplish the final result of bringing the California through the disaster

with justice, equity and fairness to all its contract-holders. The atmosphere was charged with optimism and enthusiasm and amongst all the speeches made, and they were many, not one bore any intimation of regret or of any desire to do other than march steadily ahead. Mr. Ignatz Steinhart, at the time manager of the Anglo-Californian Bank, careful, cautious, shrewd and a hard-headed financier, in his speech practically struck the keynote of the whole meeting. He said in substance:

"I have lived here many years and I expect to die here.

I love San Francisco and I know you all feel the same and it is my honest conviction that the Directors of the California have adopted the proper and only course and that its stockholders will stand behind them, and that the company will pay its losses at the rate of one hundred cents on the dollar without discount. I now present a motion that it is the sense of this meeting that the Board of Directors be given all that they request and that all their actions are hereby heartily ratified, approved and confirmed."

There was not a single dissenting vote. At this time a stockholder enthusiastically jumped on his chair and proposed three cheers for the company and the management. The clerks on the sidewalk and some of the passersby rushed into the crowd to see what was the cause of the commotion. When the meeting adjourned, the confidence of all was renewed. The barometer of their enthusiasm and determination had risen and smiles and handshakes put the period to the gathering. Seldom, if ever, has an Irish dividend meeting been held and disbursed with such a wholesome feeling of satisfaction. It was more like a "melon cutting" than a preparation to excavate to still lower depths their pocketbooks. Never was the true California spirit more faithfully portrayed.

The Final Supreme Effort. - The annual statement of the company at the end of the year showed beyond the peradventure of a doubt that the company had kept the faith, but it was left with a very attenuated surplus. Then business began to grow by leaps and bounds. The bread which had been cast upon the waters was returning and another problem now confronted the company - to protect the reserves on the rapidly increasing income. This required a working surplus and meant more assessments which seemed to be adding insult to injury. The stockholders had already provided the funds to pay losses and to now ask for more money for any other than loss-paying purposes, gallant as was the spirit of those directly interested, seemed dangerous. The Directors and some of the more prominent stockholders met informally and discussed the situation and the consensus of opinion was that the honor of the company demanded that it continue to the end to accomplish to the fullest that for which so many financial sacrifices had been made - to take any other course, to discontinue, to fall down, or to break faith with those who had given us their confidence would be suicidal. In this deduction proof was given of the sound judgment and business acumen of those who bore the brunt of the burden in those hot days of battle. They took the position that the reputation which the company had already builded was an asset of almost unlimited value and realized that the peak of the mountain was just a few steps further on - that summit from which the company could look out upon the valley of success and reap the full reward for all the sacrifices its stockholders had made. Plan after plan was submitted for financing, change after change was suggested, but for a time concerted action seemed almost impossible of attainment. Finally, I called upon the largest stockholder and Treasurer of the company, Mr. Geo. L. Payne, in his office at the Payne Bolt Works. I laid before him the plan of increasing the capital stock from six thousand shares to ten thousand

shares by the sale of four thousand shares at sixty dollars per share which would realize for the company a total amount of \$240,000 of which \$160,000 could be applied to capital, bringing that item up to \$400,000, and \$80,000 to surplus. While this did not make the surplus as much as was desirable, we were used to economies, to making every dollar count. This has always been a feature of the management of the company. With this sum and by a continuance of conservative methods and proper management we believed it possible to provide for all contingencies. Mr. Payne listened quietly, a pad of paper before him and a pencil in his hand. When I had exhausted every argument and made the best possible statement of the exact conditions, he stated that he realized fully the gravity of the position and then came the flood. He said that, if it became necessary, he, as the largest stockholder in the company, would endorse the proposition to the extent of taking the entire issue. The balance of the consummation of the idea was merely a matter of detail. Another meeting of the stockholders was called and of the many meetings that we had gone through, this stands out brightest of all. The plan was presented and as might naturally be expected invoked little enthusiasm and did not appear to interest anybody. Mr. Payne quietly rose to his feet, explained the position of the company as he saw it and then shocked the assemblage into activity by making public the announcement of his willingness to take the entire issue of additional stock. That was a flash of optimistic lightning the bolt of which apparently struck every man in the room. They sat up, took notice, and awoke to the fact that they were possibly missing something worthwhile. The outcome was that Mr. Payne was only able to secure his pro rata as the entire issue was promptly over subscribed by the stockholders, it being understood that the right of subscription should be confined rigidly to stockholders of record. Never in my business career have I seen the value

or virtue of a leader expressed in so forceful a manner as in the effect of Mr. Payne's offer upon that meeting. It was the greatest evidence of applied psychology that ever it has been my good fortune to experience.

Recapitulation. - These memoranda I have written years after the happenings which they sketch. They are drawn from the records of the company and from the tablets of my memory. Those upon which I have touched were amongst the higher lights, they are vivid in recollection and as well remembered as if they had taken place at a recent date.

Those were strenuous times. Times that not alone tested the dignity and honor of men, but rocked them to their very foundations. Only the admittedly honest and honorable men survived the experiences of those days without blotch upon their escutcheons. It is naturally to be presumed that the minds of those who passed through those days of reconstruction recall many deeds of heroism, of sacrifices made upon the altar of duty. Each has the surmounting of his individual trials to remember, but amongst all that was done as the result of the San Francisco conflagration there is, in my opinion, nothing carrying greater honor or higher integrity than the work and sacrifice of that gallant band of men who were Directors and shareholders of the California Insurance Company. They were the pioneers and the sons of pioneers who braved the hardships and terrors of desert and sea — the founders of this great commonwealth. Incidents and happenings which have passed from public record will still live in the memory of those who played a part. The wonderful rehabilitation period, with all that it meant of physical and mental suffering, but typifies today in concrete, stone and brick the sturdy and stalwart spirit of those men who were made absolute pioneers by the ashheap of 1906. Some of these have gone to their last accounting, but



*Office and Building of the Company,
315 Montgomery Street, San Fran-
cisco, California, from December 1921.*

for those who are still serving, and still tugging at the oar, there remains but to guard the heritage which they bequeathed — to bring upon the results of their work a continuation of their ideals.

The spirit of 1906, glorified by San Franciscans, which alone made possible the resurrection from the ashes of that "city loved around the world," sitting serenely upon its seven hills by the portals of the Golden Gate and whose destiny is oblivious of fire and earthquake, is worthy of more than a passing tribute. Its example should thrill and encourage those who are inclined to falter. It is a beacon light to those who are to continue the struggle with the petty details and the larger duties of everyday life. And among the contributors none are more to be admired or borne in reverent respect than the Directors, those men who held either large or small investments in the "California" and were true to their trust.

Conclusion. - Whether the end justifies the means depends upon the judgment of the critic. It is possible that there is too much of personality herein, but in justice to the writer, it must be borne in mind that no attempt has been made for literary style; that the task imposed upon him was attempted solely to comply with the insistence of others and that the use of the first personal pronoun is the readiest vehicle of expression.

No special mantle of credit rests upon his shoulders. If there be any such garment it drapes the shoulders of every man connected with the company from the humblest employee up through the heaviest stockholders to the highest official. It overlaps and falls with becoming dignity on the shoulders of those who are fellow citizens and fellow Californians, who shared with us as we shared with them the heat and burden of the days succeeding the never-to-be-forgotten disaster of April 18, 1906.

DYNAMITING THE SAN FRANCISCO FIRE*

The Misuse of Explosives. - One feature of the conflagration will interest miners and if they had observed it, we believe that they would agree with us in thorough-going condemnation. We refer to the misuse of explosives in blasting buildings. If it had been planned systematically and carried out properly much of the City could have been saved, but it was far otherwise. The use of high-grade explosives by people ignorant of their strength and proper application, was instrumental in destroying a vast amount of property without the result desired, and in many cases it actually spread the conflagration. The work was done by Dick, Tom and Harry, until the very end of the operations when the naval officers from Mare Island took a hand and directed affairs in a scientific manner. Before that the police, the militia and volunteer firemen used a box of dynamite where a pound would have sufficed, they blasted on the wrong side of walls and did such foolish things as placing a keg of black powder in the center of wooden buildings, with the result that they set them afire instead of bringing them to the ground. Spectators could see that the explosion threw up a lot of dust, to be followed forthwith by flame. They dynamited buildings already on fire and simply made an avenue for the spread of the conflagration instead of creating an obstacle to its advance. Under such conditions, the explosion scattered brands right and left. On Van Ness avenue there was a deplorable amount of damage needlessly done to handsome frame buildings by the use of black powder, that utterly failed of its purpose. It was the veering of the wind and the

* From the book, "After Earthquake and Fire - A Reprint of the Articles and Editorial Comment Appearing in the Mining and Scientific Press Immediately After the Disaster at San Francisco, April 18, 1906," published by Mining and Scientific Press, San Francisco, 1906.

persistent application of blankets and sacking soaked in the waters found in kitchen boilers by heroic volunteer firemen that eventually saved the Western Addition. However excusable the poor judgment shown during a time of great strain and excitement, there was nothing to palliate the stupidity exhibited in the attempts to blast dangerous walls when the conflagration was at an end. While such operations were being carried out on Market street, there was danger to anyone within three or four blocks; 150 pounds of dynamite were used where as much could have been accomplished by five or six pounds properly applied. Boxes containing 50 pounds apiece were placed against a wall with a light cover of sand and exploded with needless waste and danger. A drill-hole or two properly pointed would have thrown the wall in any direction desired. There was plenty of time to do it properly. A glaring example of such blunders occurred at the Post Office several days after the conflagration; this building was hardly injured by either fire or earthquake, but when the amateur blasters came on the scene, they nearly wrecked it in their childish efforts to pull down the walls of the neighboring Odd Fellows building. It is officially stated that the foundations of the Post Office were hurt by the blasting and the south side was so wrecked that the damage is estimated at \$100,000. It might be supposed that with so many experienced mining men in the community, it would have been possible to get their help in work which they understood and we can state that several of our friends did volunteer to give suggestions and to proffer systematic aid, but in vain. It is difficult to persuade a man that he does not understand what he is doing. San Francisco has reason bitterly to rue the misuse of the explosives that properly employed have proved so powerful an aid to the advancement of mining.

Misuse of Dynamite. - In regard to the misuse of dynamite during the conflagration in San Francisco and the blasting operations afterward, we have received several letters endorsing the criticism appearing in these columns two weeks ago. Mr. Frank A. Leach, the superintendent of the Mint, informs us that he offered to supply the services of experienced men, but the individuals doing the blasting claimed that they understood the use of explosives in demolishing buildings better than any miners. Mr. Leach now possesses a piece of iron weighing a quarter of a pound that landed in the court of the Mint when a blast was fired in the Phelan building several blocks away. Other similar pleasant projectiles were hurled to the same spot from other blasts far away. In contrast to the foolish doings of the amateur miners, we quote an instance of the intelligent — and therefore safe — use of explosives in removing masonry. When electric power was installed at the Mint in place of steam and the 150-horsepower engine, which was placed on the main floor of the building, was removed, the huge foundation of brickwork laid in cement, which filled the space in the basement underneath, was useless, and, room being needed, the superintendent concluded to remove it. It was a solid mass about 30 feet long, nearly 20 feet wide, and 12 feet high. Mr. Leach put some men at work with picks, gads and hammers, but they made so little headway that it began to appear a hopeless task, when one of the Mint employees, Andrew Cuneo, came along and said that if Mr. Leach would allow him to use dynamite he could guarantee to tear the foundation down in good time. He was asked if he was sure he would not damage the building. He replied by saying that he would not only not damage the building, but would not break a pane of glass of the three windows situated not more than six feet away. He was allowed to proceed with the undertaking, and fulfilled all his assertions. This story confirms what we have said, that dynamite

is a safe and wonderfully effective agency in experienced hands, and it needs no further remark from us to emphasize the inefficiency and danger of powerful explosives when employed by the inexperienced.

Brochure Issued by Passenger Department
of the Southern Pacific Company, 1907.

SAN FRANCISCO
HOTELS
and
RECONSTRUCTION

Introductory.

Unquestionably the greatest fire that ever burned in any city of any time, left the heart of San Francisco three days after its beginning, April 18, 1906, a ruin of such stupendous proportions as to stagger the comprehension. Nearly three thousand acres which had been one of the most compactly built urban sections of the world, covered with towering business blocks, great manufactories and solid block after block of thickly populated residence districts, presented simply an indescribable tangle of melted and bent steel and iron building frames, great mounds of brick, amid which in some sections streets were scarcely distinguishable, and an uneven surface of burned-over land, marked with partly filled holes which at one time had been basements of buildings. The property loss was probably five hundred millions of dollars, may be three-fourths of a billion. In the burned district public utilities were practically destroyed or rendered temporarily useless. Nothing of utility survived the terrific heat of the fire, except some two dozen of the ordinary fireproof, steel frame, Class A buildings, which had been constructed in recent years.

It was this wilderness of bent and broken steel and iron and brick that the indomitable courage of San Francisco set itself to reclaim as its own. The task was not one of rebuilding primarily, but first of all the clearing of a wilderness.

The attack was instantaneous all along the line. The railways laid temporary tracks on the streets for use in handling this debris. Great gangs of men were set to work clearing the principal avenues of traffic. The street car companies restored the service along the principal streets with marvelous celerity. The business men of San Francisco housed themselves temporarily in the residence and undestroyed manufacturing sections around the outskirts of desolation that they might take care of business, and then gave up what had erstwhile been leisure hours to the greater problem of rehabilitation. Property owners looked at the destruction calmly, each having the utmost confidence in the belief that the future of the city was not imperiled, and that it presented the same problem to him as if his building alone had been destroyed and the rest of the city had been left intact, save indeed that under the new conditions all the elements that enter into the construction would be more expensive and more difficult to procure.

One year after shows such a change as cannot be described in words, and only inadequately expressed in pictures. The problem of clearing the way was solved, with amazing celerity, and today much of the area in the burned business district and in the residence district has been cleared. The tangled structural material has been almost altogether taken away. All of the streets are clean and open for traffic. Nearly all of the street car lines have been re-established. The reconstructing of the city's street car system has cost \$6,385,425.00. Of this amount, \$712,290.00 has been used to purchase new cars. The work of reconstruction has included temporary buildings of burned brick and of wood, and also the largest reinforced concrete building in the world, an eighteen-story Class A steel structure. Land values have not depreciated and the owners of new or restored buildings in the burned district are receiving as great or greater rentals than they did before the fire, while real estate to the value of \$1,700,000.00 changed hands during the month of August.

The preparation of the ground for the foundations of the new Palace Hotel is going forward with a large force of men, and it is announced now that the building will be finished in two years. Plans are being made for a banquet on the completion of the new Palace that will eclipse anything ever attempted.

Work on the St. Francis is going steadily ahead, and, as this is being enlarged by one-third, its completion means much additional room for travelers and tourists.

A number of the great business and office structures are approaching completion, the steel frames of others are rising, and foundations for still others are being laid daily. The work of rebuilding has not slackened during the dull season of July and August.

August is the heart of the vacation season, and this year shows two features: the rest season has been more widely used than ever before and more prolonged; the resorts have never been so crowded, nor for so long a period. This shows, perhaps, two things - money to spend and the strenuous work of the year, necessitating rest.

San Francisco is now a great city. The bank clearances of San Francisco for the fiscal year ending June 30, 1907, approximate \$2,000,000,000, an increase of 8.93% over the previous year, showing the city in its supposedly crippled condition to be equal in a business way to Pittsburg, the greatest manufacturing and commercial center of all cities of its class in the world.

PRESENT BANKING CAPITALIZATION OF

		Capital and Surplus
San Francisco.....		\$70,342.543
Greater than:	Capital and Surplus	
Minneapolis	\$12,390,200	
St. Paul	7,432,970	
Omaha	4,552,060	
Kansas City	14,713,500	
New Orleans	<u>23,275,047</u>	
		\$62,363,777

Within the boundaries of ten blocks there are now in course of construction over one hundred and fifty business buildings, to be from five to twenty stories each. There will be no limit during the next few years to building activity except by the amount of building material and by the number of workmen available. Transcontinental railways are using the utmost efforts to handle the immense volume of business pouring into the city. The Southern Pacific Company alone is spending millions of dollars in increasing its Oakland and San Francisco terminals - a work that began immediately after the fire. There are hundreds of cargoes of steam and sailing vessels en route to San Francisco from practically all parts of the earth. The steamship companies are doing an immense business. But, above all, these conditions strikingly illustrate a community of spirit working for the community of interest, and a common pride and faith in the city, which is assurance of how irresistible is the movement for the making of a greater city than the people of San Francisco had ever dreamed of before the fire.

The continued activity in business is shown under several heads as follows:

San Francisco Customs Receipts, \$480,282.82

San Francisco Real Estate Sales, 612; value, \$1,700,000.

San Francisco Bank Clearings, \$184,151,723.66.

San Francisco Bank Clearings, August, 1906, \$180,844,594.75.

Up to date, 2500 more invoices have passed through the U. S. Appraiser's office than for the same period last year.

The receipts from the Customs Parcels and Post show a gain of \$1162 over last year, with 695 more entries.

Building material: Lumber, 768,802,886 feet; bricks, 27,593,108; gravel and crushed rock, 517,360 tons; shingles, 276,115,200; laths, 130,781,350; shakes, 4,361,775; cement, 80,307 tons, and window glass, 3840 tons.

The lumber delivered at this port represents a year's run for the forty largest sawmills in the country.

The City Assessor figures actual gain in property values over last year at \$90,000,000 - a good showing.

In this booklet special attention is given to San Francisco hotels because of the erroneous, though widespread, belief that strangers cannot find accommodations in the city. The list herewith is accurate and up to date. It represents an extraordinary rehabilitation equaled, perhaps, in no other line of business. The stranger coming to San Francisco will meet with no more difficulties in securing accommodations than he is apt to meet with in any other city at the busy season, and this will be a busy city with a continuous busy season for a long time to come. Rooms may be reserved by letter or telegraph. The prices for accommodations are quoted and speak for themselves, and usually are very reasonable.

The list of hotels and lodging houses shows available rooms now ready for occupancy, as follows:

	Hotels
San Francisco	20,559
Oakland	1,236
Alameda	84
Berkeley	491

Bank clearings for week ending August 1st, \$39,975,993.

To indicate how the supply is keeping pace with the demand, the list also includes bona fide projects for increased facilities. From time to time this circular will be reissued and distributed over the country for the benefit of travelers, and will be filed with Southern Pacific agents in the East. Street cars meet all Southern Pacific trains in San Francisco, Oakland, Alameda and Berkeley, taking passengers direct to hotels.

SAN FRANCISCO HOTELS

NOW OPEN

Name	Location	Rooms	Plan	Rates
Adams	391 Leavenworth St.	51	European	\$1.00 and up
Alden	1645 Buchanan St.	40	European	1.00 and up
Alexandria	2018 Bush St.	14	American	1.50 and up
Alta	1270 McAllister St.	50	European	1.00 and up
Alta Vista	930 Ellis St.	25	American	1.50 and up
Alton	964 Howard St.	60	European	0.50 and up
Angelo	293 Eighth St.	40	European	1.00 and up
Angelus	1221 Buchanan St.	30	European	1.00 and up
Angelus	Hyde and Bush Sts.	50	European	1.00 and up
Anona	2910 San Bruno Ave.	20	American	1.50 and up
Anona	776 McAllister St.	33	European	1.00 and up
Ansonia	1756 Geary St.	39	European	1.00 and up
Arcadia	1645 Buchanan St.	70	European	1.00 and up
Argo	2432 Mission St.	50	European	1.00 and up
Arch	100 Sixth St.	30	European	1.00 and up
Ariel	1293 O'Farrell St.	40	Amer. & European	2.50 and up
Arthur	Post and Jones Sts.	40	European	1.50 and up
Astor	1350 Golden Gate Ave.	60	European	1.00 and up
Atherton	1651 Octavia St.	40	American	2.50 and up
Audubon	928 Ellis St.	90	European	1.50 and up
Auto	861 Golden Gate Ave.	9	European	1.00 and up
Baltimore	1015 Van Ness Ave.	100	European	2.00 and up
Bay View	570 Harrison St.	35	Amer. & European	1.00 and up
Bellevue	835 Golden Gate Ave.	30	European	1.00 and up
Best	964 Howard St.	50	European	0.50 and up
Bohemia	1834 Steiner St.	33	European	1.00 and up
Bon Air	Stanyan and Oak Sts.	200	European	0.75 and up
Boulevard	696 McAllister St.	23	European	1.00 and up
Bradbury	1600 California St.	100	European	1.00 and up
Brandon	2216 California St.	22	Amer. & European	1.00 and up
Bristol	1528 Sutter St.	90	American	3.50 and up
Broadway	2255 Broadway St.	28	American	2.00 and up
Brown Palace	570 O'Farrell St.	50	European	1.00 and up
Buchanan	1909 Buchanan St.	25	Amer. & European	1.00 and up
Burlington	125 Larkin St.	40	European	1.00 and up
California	1816 California St.	16	Amer. & European	1.00 and up
California House	270 Natoma St.	215	European	\$1.00 and up
Carlton	721 Turk St.	63	European	1.50 and up
Capitol	733 Harrison St.	180	European	0.25 and up
Carling	1160 Market St.	75	European	1.00 and up
Carmel	1859 Post St.	62	European	1.50 and up
Carmel	126 Third St.	70	European	0.50 and up
Carleton	246 Fourth St.	75	European	0.35 and up
Casa Loma	610 Fillmore St.	90	European	1.00 and up
Castro	Stockton and Vallejo Sts.	53	European	1.00 and up
Catharine	1589 Sacramento St.	50	European	2.00 and up
Cecil	1805 Franklin St.	20	American	3.00 and up
Cecil	1054 Howard St.	40	European	1.00 and up
Central	1226 Golden Gate Ave.	34	European	1.00 and up

SAN FRANCISCO HOTELS—Continued

Name	Location	Rooms	Plan	Rates
Central	589 Third St.	500	European	0.35 and up
Cherokee	629 Golden Gate Ave.	35	European	1.50 and up
Chesterfield	1757 Post St.	35	European	1.00 and up
Clay	378 Third St.	150	European	0.50 and up
Clyde	1616 Jackson St.	50	European	1.00 and up
Colonial	317 Stockton St.	125	Amer. & European	3.00 and up
Columbia	321 Van Ness Ave.	50	European	1.00 and up
Commercial	761 Turk St.	50	European	1.00 and up
Congress	721 Turk St.	24	European	1.00 and up
Congress	Fillmore and Ellis Sts.	102	European	1.50 and up
Coscy	989 Oak St.	40	European	1.00 and up
Cosmopolitan	526 Green St.	57	Amer. & European	1.00 and up
Craig	1562 Ellis St.	35	European	1.00 and up
Crystal	Franklin and McAllister	75	European	1.00 and up
Dale	1037 Fillmore St.	150	European	1.00 and up
Dahl	1641 O'Farrell St.	22	European	1.00 and up
Delmar	1190 Turk St.	26	European	1.00 and up
DeFrance	1312 Powell St.	40	European	1.00 and up
De La Mar	356 Third St.	90	European	0.50 and up
Denver House	221 Third St.	300	European	0.50 and up
Dignan	1999 Post St.	24	American	1.50 and up
Dolores	2606 Market St.	84	European	1.50 and up
Domus	959 Webster St.	48	European	1.00 and up
Dorchester	Sutter and Gough Sts.	105	Amer. & European	4.00 and 2.50
Earl Cliff	1201 Gough St.	25	American	1.50 and up
East Lake	Webster and Bay Sts.	68	American	0.50 and up
Eddy	227 Eddy St.	100	European	1.00 and up
El Drisco	2901 Pacific Ave.	110	American	\$4.00 and up
Ellis	1941 Mission St.	100	European	1.00 and up
Elysee	3143 Sixteenth St.	30	European	1.00 and up
Enterprise	1144 Market St.	60	European	1.00 and up
El Monteiey	301 Montgomery Ave.	57	European	1.50 and up
Eureka	474 Broadway	100	European	0.50 and up
European	810 Montgomery St.	20	Amer. & European	1.00 and up
Fairmont	Mason and California Sts.	600	European	3.50 and up
Fillmore	1714 O'Farrell St.	29	European	1.00 and up
Fillmore Block	1031 Fillmore St.	—	European	1.00 and up
Fenton	259 Seventh St.	75	European	1.00 and up
Ferry	48 East St.	90	European	0.50 and up
Franklin	1239 Franklin St.	65	European	1.00 and up
Fulton House	429 Fulton St.	65	European	0.50 and up
Germania	37 Woodward Ave.	72	European	1.00 and up
Girard	761 Howard St.	150	European	0.50 and up
Geary	1479 Geary St.	38	European	1.00 and up
Glencoe	1693 Polk St.	40	European	1.00 and up
Glendale	1015 Folsom St.	330	European	0.25 and up
Glensmayer	1124 Gough St.	30	European	1.50 and up
Golden Eagle	255 Third St.	310	Amer. & European	0.50 and up
Golden Gate	1008 Golden Gate Ave.	22	European	1.00 and up
Golden State	131 Fifth St.	50	European	1.00 and up
Gould House	824 Laguna St.	44	European	1.00 and up
Grand	57 Taylor St.	165	European	1.00 and up
Grand Central	1412 Market St.	160	European	1.50 and up
Grove	Grove and Gough Sts.	40	European	1.00 and up
Hamlin	337 Eddy St.	100	European	1.00 and up
Harrison	1001 Harrison St.	60	European	0.50 and up
Harvard	1214 Geary St.	30	Amer. & European	1.50 and up
Helvetia	3884 Mission St.	22	American	1.25 and up
Hemphill	2020 Broadway	20	American	3.00 and up
Hiller	352 Eddy St.	50	European	1.00 and up
Holland	110 Ellis St.	140	European	1.50 and up

SAN FRANCISCO HOTELS—Continued

Name	Location	Rooms	Plan	Rates
Hotchkiss	792 McAllister St.	40	Amer. & European	1.00 and up
Howard House	749 Howard St.	152	European	0.50 and up
Humboldt	1136 Mission St.	150	European	0.50 and up
Hygeia	2042 Mission St.	30	European	1.00 and up
Il Trovatore	500 Broadway	25	European	0.50 and up
Imperial	951 Eddy St.	104	European	1.50 and up
Imperial	1126 Gough St.	40	European	1.00 and up
Irwin	Fourth and Mission Sts.	200	European	1.00 and up
Iturbide	Van Ness and Fulton St.	50	European	1.00 and up
Jefferson	Turk and Gough Sts.	350	Amer. & European	2.00 and up
Kahmar	565 Sixth St.	50	European	0.50 and up
Kensington	226 Sixth St.	50	European	\$1.00 and up
Kirk	Haight and Stanyan Sts.	60	American	1.50 and up
Knickerbocker	2576 Fillmore St.	12	American	5.00 and up
Kohlen	579 O'Farrell St.	40	European	1.00 and up
Kozy	2032 Mission St.	50	European	1.00 and up
Lando	395 Eddy St.	50	European	1.00 and up
Larsen	56 Eddy St.	50	European	1.00 and up
Laurel	2176 Mission St.	70	European	1.00 and up
Leola	2395 Mission St.	45	European	1.00 and up
Lewis	319 Fifth St.	97	European	0.50 and up
Lincoln	365 Golden Gate Ave.	60	European	1.00 and up
Lorraine	1635 Sutter St.	16	Amer. & European	2.00 and up
Mabel	830 Folsom St.	90	European	0.50 and up
Majestic	Sutter and Gough Sts.	120	European	2.00 and up
Majestic Annex	1529 Sutter St.	—	Amer. & European	3.00 and up
Mars	341 Golden Gate Ave.	50	European	1.00 and up
Martinet	1101 Geary St.	80	European	1.00 and up
Maybelle	311 Van Ness Ave.	30	European	1.00 and up
Maywood	131 Fell St.	40	European	1.00 and up
McAllister	1412 McAllister St.	22	European	1.00 and up
Melbourne	2282 Mission St.	50	European	1.00 and up
Menlo	340 O'Farrell St.	140	European	1.00 and up
Meredith	737 McAllister St.	24	European	1.00 and up
Metropolitan	975 Harrison St.	75	European	0.50 and up
Metropole	1601 Buchanan St.	50	European	1.00 and up
Milton	158 Third St.	160	European	0.50 and up
Miramonte	1740 Ellis St.	62	European	1.00 and up
Mission Central	504 Valencia St.	75	European	1.00 and up
Model	759 Broadway	35	European	0.50 and up
Monarch	722 Golden Gate Ave.	50	European	1.00 and up
Monopole	1001 Golden Gate Ave.	20	European	2.00 and up
Monplaisir	818 Pacific St.	14	Amer. & European	1.00 and up
Monte Christo	600 Presidio Ave.	20	American	1.50 and up
Monviso	2124 Polk St.	30	Amer. & European	1.50 and up
Mechanics	919 Howard St.	180	European	0.25 and up
Metropolitan	975 Harrison St.	89	European	1.00 and up
Mt. Vernon	1192 O'Farrell St.	30	Amer. & European	2.00 and up
Netherlands	1139 Market St.	110	European	0.75 and up
Nevada	825 Van Ness Ave.	40	European	1.00 and up
New Buffalo	Brannan and Sixth Sts.	40	European	0.50 and up
New California	2239 Mason St.	100	Amer. & European	1.00 and up
New Lick House	Mission and Fifth Sts.	125	European	1.00 and up
New Orleans	1411 Stockton St.	60	European	1.00 and up
New St. George	391 Fifth St.	75	European	0.50 and up
New Southern	Bryant and Sixth Sts.	90	European	1.00 and up

SAN FRANCISCO HOTELS—Continued

Name	Location	Rooms	Plan	Rates
New Southern	Bryant and Sixth Sts.	90	European	\$1.00 and up
New Washington	650 Fourth St.	150	Amer. & European	1.00 and up
New Western	Washington & Kearny	100	European	1.00 and up
New Wilson	236 Fifth St.	50	European	1.00 and up
Norden	Fourth and Howard Sts.	100	European	0.75 and up
Oaklin	45 Franklin St.	50	European	1.00 and up
Oliver	375 Fifth St.	75	European	0.50 and up
Orlando	Sixth and Howard Sts.	75	European	0.50 and up
Ormond	1207 Gough St.	25	European	1.50 and up
Oxford	Post and Franklin Sts.	50	Amer. & European	1.00 and up
Pacific Grand	125 Ellis St.	130	European	3.50 and up
Pacific House	Pacific & Stockton Sts.	40	European	0.50 and up
Parisien	Webster and California	16	American	2.00 and up
Parker	801-3 Golden Gate Ave.	30	European	1.00 and up
Piedmont	752 Vallejo St.	25	Amer. & European	1.00 and up
Pilcher	445 Octavia St.	42	European	1.00 and up
Pioneer	734 Montgomery St.	40	European	0.50 and up
Pioneer House	142 Third St.	200	European	0.50 and up
Planters	288 Second St.	100	Amer. & European	1.50 and up
Pon	1012 Fillmore St.	50	European	1.00 and up
Ray	288 Third St.	50	European	0.50 and up
Railroad House	624 Fourth St.	40	European	0.50 and up
Raleigh	1951 Sutter St.	37	European	1.00 and up
Ramona	1969 Sutter St.	40	European	1.00 and up
Regal	Third and Folsom Sts.	100	European	0.50 and up
Rex	240 Third St.	140	European	1.00 and up
Rice	129 O'Farrell St.	20	European	1.00 and up
Richland	1906 Mission St.	70	European	1.00 and up
Roma	412 Broadway St.	60	European	1.00 and up
Robbins	Post, nr. Leavenworth	140	European	1.50 and up
Roessel	955 Howard St.	50	European	0.50 and up
Romanie	1180 O'Farrell St.	35	European	3.00 and up
Rondel	16th and Rondel Place	69	European	1.00 and up
Ross House	520 Hayes St.	100	Amer. & European	0.75 and up
Royal	1739 O'Farrell St.	95	European	1.00 and up
Royal	193 Fourth St.	200	European	0.50 and up
San Remo	906 McAllister St.	62	European	1.00 and up
Santa Fe House	684 Folsom St.	55	European	0.50 and up
St. Ann	Turk and Taylor Sts.	90	European	1.00 and up
St. Beryl	1117 Geary St.	52	European	2.00 and up
St. Cecil	115 Fell St.	100	European	1.00 and up
St. Charles	653 Third St.	40	European	1.00 and up
St. Charles	Grant Ave. and Bush St.	75	European	2.00 and up
St. Clement	271 Fourth St.	90	European	1.00 and up
St. Francis	Powell and Geary Sts.	185	European	\$2.00 and up
St. George	Eighth and Howard Sts.	600	American	0.50 and up
St. Ives	Eddy and Larkin Sts.	35	European	1.00 and up
St. Clement	271 Fourth St.	90	European	1.00 and up
St. James	Fulton and Van Ness	200	European	1.50 and up
St. Julien	1304 Stockton St.	60	European	0.50 and up
St. Margarets	1205 Gough St.	28	American	1.00 and up
St. Regis	1740 Geary St.	40	European	1.00 and up
St. Rose	Webster and Ellis Sts.	65	European	1.00 and up
Savoy	Ellis and Van Ness Ave.	250	European	1.00 and up
Sierra	610 McAllister St.	150	European	1.00 and up
Southern	328 Third St.	75	European	0.75 and up
Sphier	293 Fourth St.	95	European	0.50 and up
Splendid	1102 Masonic Ave.	26	American	2.00 and up
Standard	Sixth and Folsom Sts.	450	Amer. & European	0.35 and up
Stanford	634 Golden Gate Ave.	30	European	1.00 and up

SAN FRANCISCO HOTELS—Continued

Name	Location	Rooms	Plan	Rates
Stanley	1542 California St.	—	European	1.50 and up
Stockton	200 Oak St.	45	European	1.00 and up
Sunset	McAllister and Webster	84	European	1.00 and up
Talmage	903 Webster St.	50	European	1.00 and up
The Carlton	274 Fourth St.	88	European	1.00 and up
The Imperial	672 Howard St.	200	European	0.50 and up
The Vallejo	Powell and Vallejo Sts.	53	European	1.00 and up
The Winchester	611 Howard St.	175	European	1.00 and up
Tonopah House	757 Howard St.	150	European	0.50 and up
Tyrone	997 Golden Gate Ave.	32	European	1.00 and up
Thorncroft	640 Golden Gate Ave.	26	European	1.50 and up
Union	Sansome & Washington	150	European	0.50 and up
Vallejo	Cor. Vallejo and Powell	50	European	1.00 and up
Van Cortland	Geary St., near Powell	30	Amer. & European	1.00 and up
Van Ness	619 Van Ness Ave.	30	European	1.00 and up
Venice	2439 Mission St.	50	European	1.00 and up
Versailles	1349 McAllister St.	22	European	1.50 and up
Virginia	642 Third St.	40	European	1.00 and up
Waldemar	300 Baker St.	75	American	1.50 and up
Waldorf	128 Jones St.	40	European	1.00 and up
Waldorf	Sutter and Pierce Sts.	45	European	1.00 and up
Warren	1617 Pine St.	85	European	1.00 and up
Webster	1341 Webster St.	20	European	1.00 and up
Weller	908 Post St.	75	European	1.00 and up
Whigham	911 Folsom St.	50	Amer. & European	1.00 and up
White Palace	Market, opp. Van Ness	500	European	0.50 and up
Whittier	3562 Twelfth St.	60	European	1.00 and up
Winton	O'Farrell St. near Jones	115	European	1.00 and up
Yorke	California & Larkin Sts.	100	European	1.50 and up

SAN FRANCISCO APARTMENT HOUSES

NOW OPEN

Name	Location	Rooms	Rates
Abbey	401 Cole St.	40 apts., 3 and 4 rooms	\$30 to \$50
Adleigh	Pine St., near Powell	65 apts., 3 and 4 rooms	30 to 50
Altona	186-9 Buchanan St.	75 apts., 4 and 5 rooms	30 to 50
Baldwin	Polk and Post Sts.	116 apts., 3, 4 and 5 rooms	50
Bay View	801 Vallejo St.	50 apts., 3 and 4 rooms	35 to 45
Bertram	850 Hyde St.	35 apts., 3 and 4 rooms	30 to 40
Buchanan	415 Buchanan St.	26 apts., 3 and 4 rooms	22 to 50
Catherine	1589 Sacramento St.	90 apts., 3, 4 and 5 rooms	50 to 65
Clifton	1436 California St.	13 apts., 4 and 5 rooms	50 to 55
Clinton	Jones and Washington Sts.	60 apts., 4 and 5 rooms	45 to 50
Colonial	3169 California St.	29 apts., 2 rooms	45
Columbus	Pacific and Larkin Sts.	42 apts., 2, 3 and 4 rooms	22 to 50
Commack	995-97 McAllister St.	20 apts., 3 and 4 rooms	25 to 50
Doric	835 Post St.	25 apts., 2 and 3 rooms	25 to 35
Duboce Apts.	Duboce Ave. & Fillmore St.	300 rooms	35 to 75
Dundee	736 Stanyan St.	70 apts., 4 rooms	50
El Monterey	1560 Leavenworth St.	50 apts., 3 rooms	35
Enterprise	2164 Fourth Ave.	40 apts., 3 and 4 rooms	35 to 60
Everett	829 Fell St.	15 apts., 2 and 3 rooms	30 to 40
Frederick	901 Stanyan St.	30 apts., 2 and 4 rooms	18 to 25
Gainsborough	2889 Pacific Ave.	12 apts., 4 rooms	40
Gladstone	Eddy and Polk Sts.	100	25 & up
Glenwood	416 Turk St.	60 apts., 3, 4 and 5 rooms	50 to 60
Golden Nugget	2315 Bush St.	14 apts., 4 rooms each	35 to 40
Grand	945 Golden Gate Ave.	44 apts., 2, 3 and 4 rooms	25 to 100
Griffin	500 Fillmore St.	12 apts., 2 rooms	31.50

SAN FRANCISCO APARTMENT HOUSES—Continued

Name	Location	Rooms	Rates
Hathaway	1492 Larkin St.	34 apts., 3 and 4 rooms	35 to 45
Hillcrest	California and Jones Sts.	50 apts., 3 and 4 rooms	40 to 45
Jackson	Jackson & Leavenworth Sts.	25 apts., 2 and 3 rooms	32 to 40
Kenilworth	Bush and Powell Sts.	53 apts., 3 and 4 rooms	50 to 60
Lafayette	2135 Sacramento St.	12 apts., 5 and 6 rooms	40 to 65
Laguna	1898 Market St.	32 apts., 2 and 3 rooms	40 to 80
Loring	Van Ness Ave. & Green St.	50 apts., 2 and 3 rooms	37 to 45
Madrid	1260 California St.	50 apts., 4 rooms	50
Makta	2285 Market St.	40 apts., 4 rooms	50 to 90
		41 apts., 2 and 3 rooms	30 to 60
		25 rooms	0.50 & up
Marsden	Presidio and First Aves.	65 apts., 4 rooms	50
Maryland	315 Page St.	179 apts., 2 and 3 rooms	50 & up
Merodine	1714 Clay St.	30 apts., 2 and 3 rooms	35 to 50
New El Rey	1530 Green St.	40 apts., 4 rooms	50
Raymond	2517 California St.	10 apts., 5 rooms	60 & up
Regillus	1760 Pacific Ave.	10 apts., 6 and 7 rooms	60 to 110
Rosemont	214 Haight St.	90 apts., 2, 3 and 4 rooms	35 to 60
Rousseau	1478 California St.	125 apts., 3 and 4 rooms	\$30 to \$45
San Carlos	1770 Pacific Ave.	12 apts., 4 rooms	40 to 80
St. Cecil	1223 Octavia St.		30 & up
St. Elmo	1452 Devisadero St.	45 apts., 4 rooms	50
St. Francis	Valencia and 20th Sts.	50 apts., 2, 3 and 4 rooms	30 to 50
St. Gabriel	1739 Pine St.	— apartments, 4 rooms	50
St. Helens	2070 O'Farrell St.	— apartments	25 & up
St. Hilaire	1532 Laguna St.	24 apts., 3 and 4 rooms	45 to 60
St. Margaret	Fell and Octavia Sts.	35 apts., 3 rooms	40 to 50
Santa Barbara	California and Buchanan Sts.	53 apts., 3 and 4 rooms	30 to 50
Santa Ynez	2127 Fillmore St.	35 apts., 3 and 4 rooms	50 & 60
Sheffield	1616 Pine St.	— apartments	30 & up
Sphier	659 Fillmore St.	45 apts., 2 and 3 rooms	45 to 50
Stirling	1831 Polk St.	40 apts., 2, 3 and 4 rooms	25 to 40
Tyrone	987 Golden Gate Ave.	— apartments	25 & up
Van Ness	2128 Van Ness Ave.	25 apts., 5 and 6 rooms	50 to 150
Vista Del Mar	Jackson and Jones Sts.	75 apts., 3, 4 and 5 rooms	35 to 60
Washington	1327 Leavenworth St.	21 apts., 3 to 5 rooms	30 to 60
Wawona	2189 Pine St.	12 apts., 5 rooms	60 to 70
Whitefield	1228 Market St.	50 apts., 2 and 3 rooms	45 to 50

SAN FRANCISCO HOTELS—PROJECTED

Location	Rooms	Remarks
Broadway and Montgomery, N. E. Cor.	210	Three stories, cost \$85,000. Completed Sept. 17, 1907.
Bush St., N. line E. of Mason	200	
Bush and Polk Sts.	60	Five stories, brick and steel, cost \$78,000. Completed Dec., 1907.
Clay and Larkin, S. W. Cor.	78	Five stories, cost \$91,000.
Ellis St., N. line, near Mason	200	All modern appliances.
Ellis and Mason Sts., N. W. Cor.	75	Four stories, brick, cost \$50,000. Completed December, 1907.
Ellis St., south side, west of Powell	120	Five stories, brick, cost \$19,000.
Fifth and Folsom Sts., S. W. Cor.	125	Reinforced concrete.
Folsom St., west of 7th	50	Three stories, cost \$18,000. Completed September, 1907.
Geary and Taylor Sts.	260	Woodruff Company, Contractors.
Geary and Taylor Sts., S. W. Cor.	256	Hotel Bellevue. Seven stories. Completed December, 1907.
Geary St., near Van Ness Ave.	200	Five stories, brick, cost \$90,000. Completed November, 1907.
Gough and Sutter Sts.	260	Normandie Hotel. Cost \$250,000.
Gough St.	268	Four stories, cost \$25,000.
Howard St., west of Third	112	Five stories, reinforced concrete. Cost \$75,000, comp. Sept., 1907.

SAN FRANCISCO HOTELS—PROJECTED—Continued

Location	Rooms	Remarks
Howard St., bet. Third and Fourth	56	.....
Jessie and Sixth Sts., N. W. Cor.	150	Five stories, brick, cost \$89,000. Completed October, 1907.
Jones St., near Golden Gate Ave.	125	Seven stories, brick, cost \$95,000. Completed December, 1907.
Kearny and Pacific Sts.	82	Five stories, brick and steel, cost \$94,000. Comp. Nov., 1907.
Leavenworth St., near Ellis	50	Four stories, brick, cost \$23,000. Completed October, 1907.
Mason and Lombard Sts.	94	Three stories, cost \$17,500. Completed August, 1907.
Mission, near Fourth	120	Four stories, reinforced concrete. Cost \$82,000. Comp. Oct., 1907.
Mission, near Fourth	140	Six stories, reinforced concrete, cost \$90,000. Comp. Oct., 1907.
Montgomery Ave and Pacific St.	94	Five stories, reinforced concrete, cost \$110,000. Comp. Oct., 1907.
Nob Hill, near Fairmont Hotel	800	Cost \$1,000,000.
O'Farrell St., bet. Mason and Powell ..	126	Seven stories. Sanford L. Gold- stein, Mgr.
Post and Gough Sts.	175	.....
Post St., near Mason .....	.....	Hayston Hotel.
Powell and Ellis Sts.	250	Golden West Hotel will be rebuilt on old site and under old man- agement.
Sixth and Harrison Sts.	89	Five stories, brick, cost \$45,000.00.
Sixth and Howard Sts.	200	Four stories and basement; brick.
Sixth St., near Mission .....	.....	Reinforced concrete.
Sutter and Hyde Sts.	200	Seven stories. Hotel Granada. Court designed after that of Palace. M. S. Mullin, Mgr.
Sutter and Octavia Sts. ....	—	.....
Third and Clementina Sts.	250	Cost \$100,000
Third and Mission Sts.	300	.....
Third and Tehama Sts.	—	Five stories, brick, cost \$125,000. Rolkin & Sharp.
Third St., near Market	350	American and European plan.
Third St., bet. Harrison and Bryant ..	75	Three stories, cost \$25,000. Completed December, 1907.
Third St., bet. Harrison and Bryant ..	150	Five stories, brick, cost \$60,000. Completed November, 1907
Turk St.	60	..... Three stories and basement.
Turk St., near Larkin	180	.....
Turk St., bet. Polk and Larkin	180	.....
Turk St., west of Larkin	150	Six stories, reinforced concrete, cost \$100,000. Comp. Dec., 1907.
Turk St., bet. Jones and Leavenworth ..	140	Six stories, steel and brick, cost \$120,000. Comp. Dec., 1907.
Valencia and 14th Sts.	80	Three stories, cost \$55,000. Completed February, 1908.
Valencia and 15th Sts.	95	Four stories, brick, cost \$62,000. Completed December, 1907.
Valencia St., near 16th	100	Four stories, cost \$70,000. Completed October, 1907.