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JAPANESE PRIVATE SECTOR EARTHQUAKE PROGRAMS AND THEIR APPLICABILITY IN THE UNITED STATES

Volume III:

Transferability of Private Sector Earthquake Programs in Japan and the United States

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16. Abstract: Comparisons are made of Japanese and United States Private Sector Earthquake Programs and the limits of transferability are explored. It is noted that: (1) a great earthquake in Japan can have a much greater national impact than is the case in the United States; (2) Japan is more seismic than the United States; and (3) Japan has experienced disasters on a scale far greater than anything to date in the United States. Cultural factors and government-business relationships vary in the two countries and contribute to differences in the development of earthquake programs. Conclusions are drawn concerning the applicability of Japanese earthquake programs to conditions in the United States. Recommendations include: (1) application of technological developments in the field such as electrical and gas controls that respond to earthquakes and base-isolation devices for valuable items; (2) development of long-term, policy-directed corporate programs; (3) emphasis on practical countermeasures; and (4) provision of active practical assistance by government agencies. Far fewer recommendations are listed for applications of United States earthquake program experience in Japan, but include: (1) promotion of inter-company communication; and (2) standardization of countermeasures.

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JAPANESE PRIVATE SECTOR EARTHQUAKE PROGRAMS AND THEIR APPLICABILITY IN THE UNITED STATES

Volume III:

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by

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EXECUTIVE SUMMARY

This volume provides conclusions concerning the degree to which lessons learned in Japan with private sector earthquake programs can be transferred to the United States, and vice versa.

In the first section of this volume, the limits to transferability are explored.

National significance - A great earthquake in Japan can have a much greater national impact than is the case in the United States, and this partially explains the greater national investment and priority placed on earthquake hazard reduction in Japan by corporations and government agencies.

Seismicity - Japan is also more seismic than the United States, and even if the comparison is restricted to Japan and California, Japan will still be found to be exposed to a greater level of seismic risk. This is true in terms of numbers of moderate to large earthquakes that occur, and it is especially true with regard to the amount of urban and industrial development located in very high seismic areas. The difference in the risk faced by a facility located in San Francisco, for example, as compared to Tokyo is not great enough, however, to explain why Japanese firms are generally ahead of California firms in their implementation of earthquake programs. If studies from the International Institute of Seismology and Earthquake Engineering in Tokyo concerning seismicity in Japan are compared with work from Stanford University concerning California seismicity, it appears that a site in Tokyo has about a 2/3 chance of experiencing at least damaging levels of ground motion (240 gals, or about 1/4 g) during a 50-year time period, while for San Francisco, there is about a 50-50 chance.

History of disasters - Japan has experienced disasters on a scale far greater than anything to date in the United States. The death toll in the 1923 Kanto earthquake, in excess of 100,000, is much greater than any U.S. earthquake's casualty sum, and the economic impact of the 1923 earthquake was felt by the national economy for over a decade. The fact that Japan has had disasters such as 1923 makes it easier to motivate people to prepare for future events, while in the United States, much of the motivation for preparedness is tied to scenario studies that estimate what might happen.

Earthquake prediction - Earthquake prediction has had a major impact on Japanese earthquake preparedness programs, while to date it has had very little effect in the United States. Preparations for responding to a Tokai earthquake prediction are very extensive, and companies located in Shizuoka Prefecture have been especially active in the development of earthquake programs because of the likelihood of a future earthquake prediction in that area. There is no counterpart in California of corporations establishing or extensively enlarging earthquake programs because of the prospect of earthquake predictions.

Government-business relationships - Japanese businesses respond to informal peer pressures and government leadership in ways that are not paralleled in the United States. Specific earthquake regulations pertaining to companies in California are lacking (with the exception of the building code regulations for building construction, requirements for nuclear power plants, and a few other special cases). In Japan, the earthquake regulations are more extensive, and the government more actively interacts with private industry in non-regulatory ways.

Cultural factors - There are many cultural factors that are different between Japan and the United States. One important factor is the degree to which Japanese citizens or employees generally follow the instructions given to them by leaders. Japanese corporations are noted for their lifetime employment policies and the way they resemble a large family. Long-term perspectives are common, and five-year plans are a sign of that way of thinking. Safety programs, including earthquake projects, are maintained over the long-term because the corporations operate with a view of the future that extends out into decades, measured by increments of five-year plans. The ups and downs of safety or earthquake program budgets that are the common complaint of U.S. safety managers are much rarer in Japan.

Commercial development of earthquake products - Japan has many commercial products designed specifically for earthquakes, while this is rare in the United States. Automatic gas shutoff valves are more extensively used in Japan and are available in greater variety; hardware stores sell prepackaged sets of angles, screws, straps, etc. that will fit ordinary household furnishings to provide earthquake restraint; more than one firm has developed sophisticated floor isolation systems to protect raised computer floors from earthquakes; there are several base-isolated buildings in Japan but only one in the United States; there is a small base-isolation device available for statues or other small objects; automatic TV turn-on alarm devices are now mass marketed to provide instant warnings to residents of tsunamis and other disasters; a major office furnishings manufacturer has shake table tested a wide variety of its products to determine the best means of earthquake protection.

The second section of this volume deals with conclusions concerning the applicability of Japanese earthquake programs to conditions in the United States. These recommendations are organized under the following categories:

- o Commercialize and apply technology.
- o Develop long-term, policy-directed corporate programs.
- o Emphasize practical countermeasures.
- o Learn quickly from disasters to better prepare for future ones.
- o Pay more attention to the fire and hazardous materials issues.
- o Aim research at practical results.
- o Make government a leader by example.
- o Make active assistance available from government agencies.
- o Define standards of practice with governmental or trade/professional standards.
- o Tie education/awareness efforts to specific action-oriented goals.

The third section discusses the transferability of lessons learned in California to Japan, using the following topics to structure the subject:

- o Promote inter-company communication.
- o Standardize countermeasures.
- o Avoid dependence on predictions.
- o Consider behavioral aspects.
- o Prepare smaller as well as larger companies.

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CONTENTS

Section 1
COMPARISONS OF JAPANESE AND UNITED STATES PRIVATE SECTOR EARTHQUAKE PROGRAMS: THE LIMITS OF TRANSFERABILITY

One of the major points of similarity between Japan and the United States is that both countries have free market economies. In both cases the private sector is the backbone of the national economy, and speedy recovery of companies after a natural disaster will be one of the factors determining the rate of national recovery. Both countries are also highly industrialized, having industries covering practically every industrial sector, from primary refining through secondary manufacture and high technology. Both countries have areas of very high seismicity, or a high frequency of damaging earthquakes. Another point of similarity, particularly relevant to this study, is that both countries are also great centers of earthquake engineering.

Despite these basic similarities, there are also some key differences between the two countries, and these differences must be carefully considered in any evaluation of the transferability of lessons learned from corporate earthquake programs in Japan to the context in the United States, or vice versa. The major differences between the two nations, as concerns the topic of private sector programs developed to deal with earthquakes, can be divided into the following categories.

NATIONAL SCOPE AND SIGNIFICANCE OF EARTHQUAKES

The impact a natural disaster such as a large earthquake would have on the national economy of the United States is relatively small compared with the nationwide effects of past and predicted disasters in Japan. The 1923 Kanto earthquake in Japan had a negative effect on the national economy of Japan that persisted for more than a decade, while the largest natural disasters in U.S. experience have had only a more limited effect. Japan is much smaller in land area with its industries concentrated to a much greater degree in high seismic areas than in the United States. The consequences of a natural disaster on the national economy would therefore be much greater, especially if it occurred in a heavily industrialized area such as the Kanto or Tokai regions, which are especially seismic. In the United States, the damage and disastrous economic effects from a great earthquake would be primarily confined to one region. Effects of less than disastrous scale may propagate through other regions, but to a much lesser degree than in Japan.

In Japan there is no need to argue the point that earthquakes are a national problem, whereas in the United States, proposals submitted for funding to national research agencies or justifications for federal funding for earthquake programs generally begin with an argument that earthquakes are a national problem in the United States. Because there is a much greater variation in seismic risk in the United States than in Japan--with most of the United States lying within only moderate to almost nil seismicity zones--the issue of the national scope of the earthquake problem is debatable, while in Japan there is no need to argue the issue since the national scope and significance of earthquakes is obvious.

SEISMICITY AND RISK

Japan's seismicity is greater than that of California, as measured by the frequency of large magnitude earthquakes. Japan and California have nearly identical land areas. In California within a little more than a century, there have been two magnitude 8 events (1872 Owens Valley and 1906 San Francisco). In Japan, within half this time span, since the 1923 Kanto earthquake in the Tokyo region, there have been four magnitude 8 events and twelve of magnitudes between 7 and 8.

The direct concern, however, is not the frequency of large magnitude events, but rather the frequency of damaging levels of ground motion. The two are distinct, since a large magnitude event will cause only minimal shaking when a large distance separates the source, the earthquake, and the receiver, or the site of interest. When the risk of experiencing at least a moderate level of ground motion is compared for Japan and California, the difference is much less than in the case of magnitude comparisons. This is partly because many of the largest of Japan's earthquakes are released offshore, where the subduction zone exists. As the down-thrusting plate underlying the Pacific moves beneath the plate where Japan is located, the source of earthquakes becomes deeper and deeper as these hypocenters, or foci, move farther inland. In California, where the earthquakes are usually centered on land and at shallow focal distances, sites within 15 or more miles of the epicenter (point above the first release of vibrations at depth) are usually shaken strongly enough for damage to result, even if the magnitude is "only" 6. In Japan, it is possible for an earthquake of this magnitude to occur directly beneath a city--but much farther beneath it than in the case of a California earthquake--and yet cause no damage. This was demonstrated quite memorably to the authors when they were in Tsukuba, Japan on August 12, 1985 when an earthquake of over magnitude 6 occurred beneath the city (in other words, we were right at the epicenter). The waitresses continued to serve during the shaking, which was perceptible for 20 seconds, no glassware

toppled off shelves, and conversations were only briefly interrupted to acknowledge the event.

Figure 1 places in the same format seismic risk analyses for Japan and California, stated in terms of the chance of reaching or exceeding certain levels of shaking (in peak ground acceleration), during certain exposure periods or time spans. The Japanese analyses were conducted at the International Institute of Seismology and Earthquake Engineering; the California work was conducted at Stanford University's Blume Center for Earthquake Engineering. The two studies were placed into a comparative format and considered for their validity for this project by a seismologist, David Leeds, and a structural engineer, T. C. Zsutty.

Figure 1 indicates a 64% chance of experiencing at least 240 gals (about 1/4 g) of ground motion in Tokyo in 50 years, while a building located in San Francisco for 50 years would have a comparable chance of 49%. An acceleration of 1/4 g is a reasonable benchmark to use in comparing sites, since lower levels of shaking would not generally cause widespread or major damage. By this measure, there is not a great difference in the seismic risk or chance of experiencing major shaking in Tokyo and San Francisco. For the same terms (1/4 g peak ground acceleration, 50 year exposure period), the odds are 2/3 in Tokyo, and 50-50 in San Francisco: The spread in these odds is not so great as to warrant a major difference in levels of preparedness or investment in earthquake hazard reduction in the two places. As an analogy, if one were faced with a two-thirds chance of having a building burn down, versus a 50-50 chance, wouldn't fire insurance be desirable in both cases?

Thus, while Japan experiences many more large magnitude earthquakes than California, there is less difference in the frequency of earthquakes causing damaging levels of ground motion. The general public perhaps has an inaccurate perception of the degree to which Japan is more subject to strong earthquakes, and this may partly account for differences in preparedness among companies in the two places. From an objective standpoint, variation in the chance of receiving strong ground motion should not be a major factor in leading California firms to do much less than is done in Japan, since the risk in California is not drastically less. For over 50 years, Japanese and California seismologists and structural engineers have compared notes on seismic design practices, building code provisions, and damage that has occurred in their earthquakes precisely because these experts have found more similarities than differences between the two places in their levels of risk of experiencing strong earthquakes.

From a national or regional standpoint, another factor is of major concern, and that is the location of development in relation to high seismic zones (or areas where

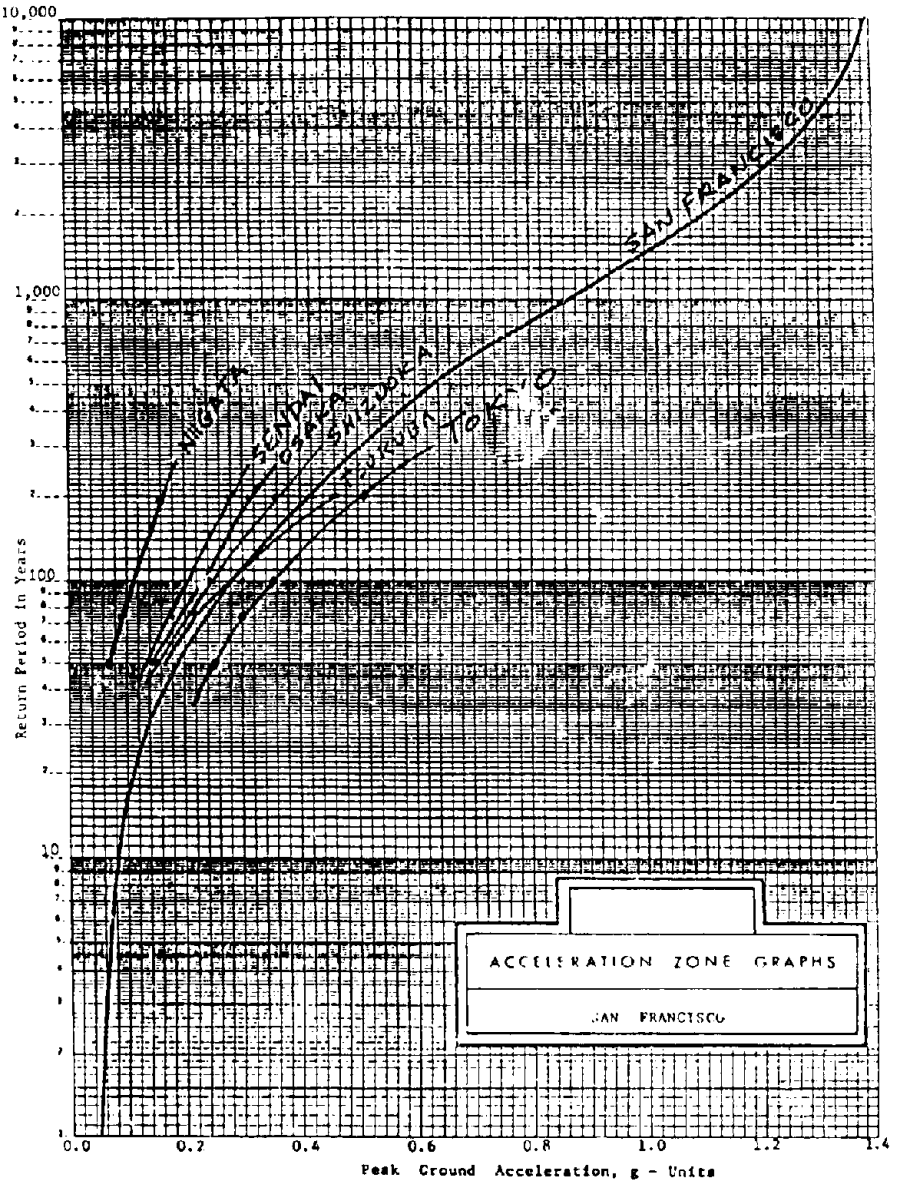

Figure 1. Comparative Seismic Risk in San Francisco and Selected Cities in Japan.

Sources:

A. Kiremidjian and H. Shah, **Seismic Hazard Mapping of California,** John A. Blume Earthquake Engineering Center, Stanford University, November 1975.

Sadaiko Hattori, "Presumable Maximum Earthquake Motions in Tokyo," **Bulletin of Seismology and Earthquake Engineering,** Vol. 14, International Institute of Seismology and Earthquake Engineering, 1976.

The above two sources were placed in a comparative format by Dr. T.C. Zsutty and David J. Leeds.

strong earthquakes are expected frequently). A given company may be located near several faults and have a high chance of receiving strong ground motion in either Japan or California, but as a whole, there are many more companies (and schools, residences, etc.) in Japan in high seismic zones than in California, simply because there is so much more development in Japan. The population of Japan is five times greater than California's and the economic base is even greater. As compared to the entire United States, the higher degree of seismic risk (including the exposure of facilities to ground shaking, not just the chance of the occurrence of strong ground shaking) is much greater. The largest cities and industrial centers of Japan are in seismic areas, and the largest urban area, Tokyo, is in one of the highest risk locations in the country and has been visited with catastrophic earthquakes in the past. This should have a greater influence on public policy than on corporate policy, since those companies that are located in high seismic areas of California--and 80% of the state's population and development is within the highest seismic zone of the Uniform Building Code--should be concerned about their high level of risk, even if from a national government perspective, the problem has a lower priority. This relates to a point made previously about the difference in the national scope of the problem in Japan and the United States, and also relates to a topic to be discussed later concerning government-business relations and the significance of Japanese government leadership in promoting private sector earthquake measures.

HISTORY OF DISASTERS

In the United States, and even in California where several major earthquake disasters have occurred, the main sources of motivation for undertaking earthquake protection measures are the projections or estimates of the huge losses that could occur in future earthquakes, not just the actuarial tabulation of historical losses. In Japan, the historical "track record" alone is sufficient grounds for incurring large investments in earthquake hazard reduction efforts.

The 1906 San Francisco earthquake (more properly the northern Californian earthquake, since it affected a much greater area than just one city) is the greatest earthquake disaster in U.S. history. The traditional life loss figure of approximately 700 may be increased to perhaps 5,000, based on recent in-progress research by Gladys and Richard Hansen (now the San Francisco Earthquake Research Project of the California Academy of Sciences). The 1918 Puerto Rico (tsunami, 116 deaths), 1933 Long Beach (115 deaths), 1946 Hawaii (tsunami, 173 deaths), and 1964 Alaska (mostly tsunami, 131 deaths) earthquakes are the only other U.S. earthquakes with fatality totals exceeding 100.

In Japan, the life loss from the 1923 Kanto earthquake and fire is usually given as 99,000. Since 1923, there have been seven other earthquakes with fatality tolls of approximately 1,000 or greater.

Loss estimate studies for major cities in the United States in seismic zones project thousands of fatalities. Studies by the National Oceanic and Atmospheric Administration in 1972 for San Francisco and 1973 for Los Angeles estimated that great earthquakes would cause fatalities of 10,360 and 20,728 respectively. Even if a tenth of these losses materialized, it would be a historic disaster by U.S. standards. Yet, the "marketing" power of these studies is far less than the impact of history. In Japan, history is a strong "sales" force, while in the United States, earthquake disaster history is far less convincing.

Losses from other natural disasters have also been high in Japan, encouraging a widespread concern over disasters of all types in that country. While the hurricane with the greatest life loss in U.S. history is the 1900 Galveston, Texas event, with approximately 6,000 fatalities, no other hurricane has caused more than 1,000 fatalities. In Japan since World War II alone, there have been seven typhoons (hurricanes) that have caused at least 1,000 deaths.

EARTHQUAKE PREDICTION

When people perceive that a valid earthquake prediction will materialize in the near future, it can be a powerful source of motivation for earthquake response planning and hazard reduction measures. Earthquake prediction in Japan is a subject of great concern and is taken very seriously by the general population, companies, and the government agencies who have undertaken major prediction research efforts. In the United States, by contrast, the topic of earthquake prediction is a more academic topic of interest to researchers. This difference is another factor that helps to explain why at least in certain areas of Japan there is more activity than in the United States.

The Japanese have predicted in a long-term way that great earthquakes will occur in the Tokyo and Tokai regions, each of which contains millions of people and a tremendous amount of industrial and commercial activity. In the case of the Tokyo region, the long-term prediction, and the justification for the intensified earthquake prediction effort underway, is based on the statistical analysis of the occurrence of past earthquakes. Researchers at Tokyo University announced in 1978 that any time from then until 2004 a great earthquake would probably occur, immediately getting the attention of private and public officials. In the case of the prediction effort for

the Tokai region, where Shizuoka Prefecture would be most affected, the long-term prediction is based on the seismic gap theory. Offshore of Shizuoka Prefecture in the Suruga Trough, large earthquakes have occurred at relatively regular intervals along segments of the fault, but one of these segments is a gap or is overdue. The short-term prediction efforts include the use of a wide variety of instrumentation, including undersea seismographic instruments and the most intensive geodetic surveying system in the world to measure strain as it builds up. Data from these instruments are telemetered to the Japan Meteorological Agency's headquarters in Tokyo and are monitored 24 hours a day.

A significant portion of earthquake preparedness and planning, especially in the Tokyo and Shizuoka regions, is based on the assumption that a short-term prediction can be made. To some extent this gives rise to concern for the occasion when a short-term prediction cannot be made. The Japanese do expect to have faulty predictions, either there being an earthquake when no prediction has been made, or there being no earthquake when one has been predicted. Nevertheless, the general expectation is that of an accurate prediction preceding the earthquake, in the case of a great earthquake for the Tokyo or Tokai regions. Most private and public earthquake response plans in these areas begin with the assumption of a National Disaster Warning, with other provisions for unpredicted earthquakes.

In the United States, the Parkfield, California earthquake prediction project of the U.S. Geological Survey is the effort of greatest likelihood to result in a short-term prediction. In some ways, this project bears similarities to the Japanese cases in terms of the science involved. The Parkfield experiment, in which a dense array of several kinds of instruments are deployed in the area around this rural segment of the San Andreas Fault, has been chosen as a research effort of promise because of a sort of seismic gap or seismic cycle theory. On the basis of the past, uncommonly regular, behavior of this one segment of the San Andreas, the U.S. Geological Survey issued, and the National Earthquake Prediction Evaluation Council validated, what is still to date the only official earthquake prediction in the United States, the occurrence of an earthquake of about magnitude 6 in 1988, plus or minus 5 years.

The Japanese and California cases are quite different in their practical aspects, however. The Japanese examples of the Tokyo and Tokai regions are major urban regions, and the earthquakes expected are of great size. The Parkfield case involves an earthquake that would be centered in a rural area and the earthquake would probably be moderate in size.

The Japanese scientific work relating to the Tokai earthquake prediction project has been accompanied by planning and exercises involving the personal

participation of the governor of the prefecture, the Prime Minister, and cabinet officials. The Parkfield prediction in California has yet to be officially acknowledged by the governor of the state, let alone the President of the United States. The eight-year old draft California Office of Emergency Services earthquake prediction response plan has yet to be finalized into full operational form, and none of the local governments in the area that would be affected by a Parkfield earthquake has implemented earthquake prediction response plans in the year and a half since the announcement of the long-term prediction and the possibility of the short-term prediction. This difference in the perceived significance of earthquake prediction by political leaders and the general public is another factor that helps to account for the different levels of priority the earthquake topic has in the two countries.

GOVERNMENT-BUSINESS RELATIONS

The relationship between the public and private sectors in Japan is more cooperative and less antagonistic than in the United States. The private sector, including big business, is held in greater esteem in Japan than is the case in the United States. While large corporations in the United States are routinely subjected to public and media criticism on a variety of environmental and political counts, Japanese society generally looks upon its large companies less critically, identifying business with the national political-economic system on which everyone's welfare depends. This is not to assert the superiority of the Japanese system, but simply to point out distinguishing features. The U.S. system places high value on competition, checks and balances, and public accountability of large corporations; cartels and collusion are regarded as evils. The aim here is to merely bring to the forefront of the reader's mind these basic differences, without digressing into the political or economic advantages and disadvantages of the two systems.

In the United States, government must enforce specific regulations to compel companies to undertake safety programs, though many U.S. companies exceed statutory minimums voluntarily. In Japan, major corporations feel they should do their part in helping with the nation's earthquake problem. The national leadership has enunciated this as a goal or policy in numerous acts of legislation, and yet it is perhaps more important that the basic goal and expectation has been set by the national leadership than that specific laws have been passed. While for some industries in some areas of Japan there are specific regulatory requirements relating to earthquakes, there are many other examples where companies have voluntarily developed programs in response to a de facto standard of practice or expectation.

In California, neither CalOSHA nor federal OSHA imposes any significant earthquake regulations, and so the role of the government in a regulatory sense is largely limited to building code provisions for the construction of new buildings. Emergency action and fire prevention plans are required under General Industry Safety Order 3220 and 3221 in California, but these regulations are at best vague with respect to earthquakes, since they were primarily intended to deal with fire. This is in contrast to the case in Japan where several laws, among them Shizuoka Prefecture's law requiring the submission of earthquake plans by companies to the Prefecture's earthquake preparedness division for review, specifically guide companies on the contents and form of earthquake plans.

In the case of Shizuoka Prefecture and the Tokyo Municipal Government, it is noticeable how the extent of cooperation, rather than conflict, between the national and more local governments is an advantage in dealing with the earthquake problem. The fact that there is no doubt in Japan that earthquakes are a problem of national scope helps greatly in this regard.

The leadership, as distinct from regulatory, role of government is also much less developed in California than in Japan. There are numerous government agencies one may visit in Japan where nonstructural earthquake protection measures are visibly in place--such as wire-restrained overhead light fixtures in emergency operating centers, file cabinets and similar office furnishings retrofitted with restraint hardware, base-isolated or shock-absorbing raised computer floor systems in telecommunications and computer centers, and so on. This leadership by example is much less present in California and the United States, or at least the record is more spotty and less suitable for use as a selling point in convincing the private sector to follow the example.

While California imposed earthquake-resistant building construction requirements on local school districts in 1933 following the Long Beach earthquake, the state's system of colleges and universities was exempted from these requirements, with the result that a recent seismic evaluation of 800 of the University of California system's buildings found that about 1/5 were in the category of "very poor." The state Capitol was seismically strengthened and modernized at a cost of $60 million, but this was a one-shot project, unconnected to any state-wide seismic safety program. Most local governments' emergency operating centers contain computer equipment, and in most cases, these pieces of equipment are not restrained to resist earthquakes. The large public gas utilities in Japan actively promote the use of seismically actuated shutoff valves, while the utilities in California either remain noncommittal about the idea or are mildly negative. The list of what seem to be embarrassingly low levels of earthquake protection in the

public sector in California seems endless, while in Japan, it is quite easy to spend weeks touring public facilities that have been earthquake-protected to an impressive degree.

There are many fewer examples of government bureau self-preparedness in California than in Japan. In the Shizuoka Prefectural government's emergency operations center, the photocopy machines, pendant fluorescent light fixtures, and even the telephones on the tables are earthquake-restrained. The National Land Agency's national government emergency operations center for earthquake response also features equipment restraints. By contrast, when the California Office of Emergency Services commissioned an engineering survey in 1985 of six state-run telecommunications facilities that are essential for emergency communications, all six were found so deficient in structural or nonstructural earthquake resistance, or both, as to be very unreliable in the event of an earthquake. In an informal survey of the staff of one government bureau dedicated to earthquake preparedness in California, it was found that only 10% of the staff had restrained their water heaters at their homes. In a tour of one of the most extensive county emergency operating centers in the state (designed in the 60's with civil defense rather than earthquakes in mind), the large emergency power generator, as well as the motor-generator's batteries and the battery-powered lights for the room, were found to be completely unrestrained for earthquakes, even though the facility is located in the highest seismic zone within the state. By chance, this condition happened to be brought to the attention of the emergency services manager of that county twice within the space of a few months by two experts in earthquake engineering, on two different tours, and both times the response was similar--a shrug of the shoulders and inaction. These anecdotes are not unusual in California, and the government staffs involved freely volunteer this information. In Japan, to admit to such personal inaction in protecting one's essential government facilities or personal household, and yet to hold a government position of an earthquake preparedness nature, would be considered hypocritical or shameful. There are numerous examples of government agencies in Japan who can lead by example in the earthquake field, while in the United States, even with respect to such a basic matter as following current earthquake resistive codes (most government entities having immunity from the regulatory scope of local building codes), numerous government agencies are less advanced than the private sector.

Public officials can be held accountable for their performance relative to the earthquake issue in Japan, while in the United States, it would be a very rare case where earthquakes ever surfaced as a political issue. In his successful 1980 gubernatorial campaign in Shizuoka Prefecture, Governor Yamamoto made earthquake safety a significant campaign issue. The Prefecture subsequently developed an

Earthquake Preparedness Division staff of approximately 20 full-time personnel, including architect and engineer professionals. In California, the issue is not considered significant enough to become a major issue. In the 1982 and 1986 gubernatorial campaigns, for example, the mayor of Los Angeles, Tom Bradley, had a strong local identification with the most extensive municipal earthquake hazard reduction program in the United States, yet this was not emphasized as a positive attibute in his state-wide campaign, probably because of the perception that, compared with crime, budgets, education, pollution, and other issues, earthquakes simply ranked too low to be of major concern to voters.

Standards of practice are aided by the government in Japan in pervasive ways, and the influence of the government can even extend to directing private sector investment policy and national economic planning to an extent that does not occur in the United States. This extends to the earthquake arena, where earthquake resistant construction standards for petroleum facilities, or voluntary manufacturer's standards for earthquake-protected kerosene heaters, have been instigated by government agencies. As discussed later, some corporations have developed earthquake hazard reduction devices even when the possible commercial returns are rather minimal, partly because of a desire to act as a responsible Japanese company. In California, a similar informal consensus that at least the larger firms should have some sort of earthquake program to protect their employees and their surroundings, if not also their economic stake, is also developing, but to a lesser degree than in Japan.

CULTURAL FACTORS

A comparison of Japanese and California private sector earthquake programs cannot be made without considering the differing cultural contexts in which firms on the two sides of the Pacific operate. The Japanese are known for their respect of tradition and authority, Americans for their disregard of these very qualities. This broad-based cultural difference would have to be considered whether the question is why Japanese students have higher literacy rates than their American counterparts or why Japanese companies have higher levels of earthquake protection.

More specific than the general culture in which Japanese are raised is the corporate culture. Japanese corporations operate on the principle that the corporation is a business analogy for the family. Employment in large companies is normally for life--it is a mark of failure both for the company to lay off employees and for the employees to switch jobs. Employees within a company of various levels of status or with differing types of jobs are much more likely to know each other and

interact than are employees of similar types of jobs who work for different corporations. In the United States, engineers, health or safety staff members, or security personnel are likely to know other companies' like-category employees through union, trade/professional association, or other conferences and meetings. The survey of companies in California conducted in this research project found that most companies learn the most about how to establish and run their earthquake programs from other companies, and this learning is facilitated by inter-company contacts.

One means of overcoming this lack of inter-company communication through informal contacts in Japan is by means of the General Affairs Division of each company. Japanese companies and public agencies typically have a department or division called the General Affairs Division, which has no direct equivalent within the typical corporation in the United States. The General Affairs function is a corporate function that transcends and coordinates the various departments, divisions, or subsidiaries that constitute the corporation. Arranging stockholders' meetings, public relations, and employee education are all General Affairs tasks, as is generally the job of managing the company's earthquake program. The safety department usually resides within General Affairs.

In the Tokyo area, there is an organization called the Souyoukai, which is an association of the General Affairs managers of companies. This organization serves as a forum for professionals holding similar positions to gather and exchange ideas. One of the main committees in the Souyoukai is its Earthquake Research Committee, which meets periodically; the participants conduct a wide variety of discussions about what is being implemented or planned in each company.

The motivation for the Japanese corporate structure to become heavily involved in earthquake emergency preparedness appears to have come from several sources. One of the primary sources is undoubtedly the government, which has done an excellent job of promoting such activities. On the other hand, Japanese companies also seem to be acutely aware of their weakness in the event of an earthquake. They are so heavily dependent on their export market that they fear losing it should they have any extended business outage. Another important reason seems to stem from their own perception of their role in society--to provide security and jobs, not just to individuals, but also to the nation. They feel it is important that they be able to maintain this productive role.

Allocation of funds for earthquake hazard reduction follows the normal budgetary procedure within the corporate structure. Every year, as the annual budget for the following year is being prepared, the planned amount for hazard

reduction is included, and it follows the same path of approval (or disapproval) as any other budget item. Japanese companies do not appear to consider money spent on hazard reduction a non-productive investment, but rather a necessary investment or one of the implied costs of doing business over the long term.

Earthquake program expenditures, as do other corporate budget items, follow a five-year or ten-year plan, with a certain amount of the term's goals targeted for each year. There are measurable performance objectives in the earthquake program as there are in the other programs. While earthquake budgets may fluctuate from the planned levels because of economic fortunes, this is generally a matter of modification of funding levels, rather than drastic re-direction of funds. The oil price drop of the past two years has had a major effect on Japanese petroleum companies, and yet their earthquake programs have remained intact and well-funded over the past few years. The numerous Japanese companies who are very dependent on exports of their products have suffered from the great rise in the value of the yen in the past year and a half. The Japanese product that cost US $2 now has a cost of $3.50, all other things being equal, greatly affecting the competitiveness of the export industry. This has had an effect on earthquake program expenditures, but it has not caused dismantling of programs. By contrast, one of the major U.S. oil companies that had established a reputation for having a model corporate earthquake program and which was about to embark on a structural engineering evaluation of the earthquake vulnerability of all of its California facilities, completely eliminated the earthquake program and associated personnel when a large budget cut was necessitated. Japanese companies enter new markets or introduce new product lines with an expectation that they will be successful over the long term, but instant success is not required. Quarterly performance in terms of profit is not so greatly regarded as the single important indicator of a company's performance as it is in the United States.

Long-term versus short-term perspectives are a very important issue in the earthquake field, since the risk faced in a short period of time is much different from that in a longer time span. California structural engineers, one of the longest standing sources of support for earthquake safety in the United States, have been said to believe that each of the buildings they design will undergo at least one significant earthquake during its lifespan of perhaps 50 years or more. Quite different from this long-term perspective of the Japanese corporation or the California structural engineer is the California business manager, who frequently is under great pressure to concetnrate only on quarterly or annual goals. In any one year the chance of an earthquake disaster is low, as is the chance of a fire disaster, but extensive fire regulations require evacuation plans, fire extinguishers, fire sprinkler inspections, safe storage of materials inspections by the fire department

etc. There is no comparable set of extensive earthquake regulations, and so, left to the intuitive if inexplicit estimate of risk, calculated on a very short-term basis, the manager often opts to invest nothing in earthquake protection. In Japan, even though regulations often do not require it, corporations consider the fate of their organization over the next few decades and find earthquake protection a necessity.

To some extent in Japanese firms, the personal capability of the safety manager affects the extent of the earthquake budget, but less so than in the United States. More than one large company's earthquake program in California appears to owe its strength largely to the efforts of one or two people who were highly motivated to establish a higher level of safety in this regard. Japanese firms are less dependent on the initiative of any one safety manager, because the earthquake program is more institutionalized within the organization. Japanese safety personnel move to other job categories more frequently than in the United States, and yet the introduction of new people into jobs with earthquake-related tasks appears to create no problems of continuity.

COMMERCIAL DEVELOPMENT

In California there are commercially available products intended specifically for earthquake hazard reduction purposes, but this is a much smaller area of enterprise, and engaged in by smaller firms, than is the case in Japan. In some cases, large firms in Japan appear to have developed earthquake-related products because of their leadership role in a certain market area, such as architecture-engineering-construction in the case of several large firms that have developed and constructed their own base isolated buildings, or seismic gas shutoff valves and seismic shock absorbers in the case of a large manufacturer whose main lines of products are gas valves and automotive shock absorbers.

The case of Uchida Yoko, a large office furnishings manufacturer, is instructive in this regard. Approximately $500,000 of the firm's funds were invested in extensive shake table testing of typical assortments of their product line--file cabinets, computer tape rack cabinets, drafting station equipment, raised computer floors, etc. Retrofit hardware was developed for their older product lines, and new built-in restraint devices for their new products. The investment, especially as regards the carrying of retrofit products, is justified mainly as an obligation to previous customers and a necessary investment to maintain customer goodwill and a leadership image in the field, since the sales benefit of carrying this line of earthquake-protection items is rather small.

There is also a larger market for various earthquake-related products in Japan than in California, and this is the predominant motivation for the introduction of some products. Some of these are off-the-shelf items, the more common ones being latches, braces, etc., which can be bought even in hardware stores. Compared to Japan, the development of such commercial items for earthquake hazard reduction is lacking in the United States. What is marketed by firms in California today is essentially restricted to natural gas shutoff valves and some bottled-gas holding racks for industry. This difference can be attributed to the difference in the size of the market that exists for such products. The situation in the United States definitely calls for a "hard sell", with public awareness lacking. The Japanese, on the other hand, appear to be more willing to allocate funds for earthquake hazard reduction, and thus they have been more successful in their commercial developments.

In all cases except two, the companies have developed these products with their own funds, and on their own initiative. Another feature is that earthquake hazard reduction products have been developed by companies that already had product lines that were somewhat similar. For example, the major gas utilities have developed automatic gas shutoff valves. Meidensha, a high voltage electrical equipment manufacturer, has developed control panels that would be more resistant to earthquakes. Two major furniture manufacturers have developed modularized furniture that would be earthquake resistant. Gas shutoff valves for bottled gases have been developed by companies that were already in the business of manufacturing a variety of safety valves.

The two exceptions to the generalization that these devices have been developed without government funding are an automatic alarm that can be attached to the TV set, and a kerosene unvented space heater that shuts off when shaken. The first product, the automatic alarm, was developed by two electronics companies in conjunction with the Japan Broadcasting Corporation (NHK). This device is to be installed onto a regular TV set, and it will turn the set on when the National Government issues a Disaster Warning. The kerosene space heater was improved to contain a shutoff device within it when the Tokyo Fire Department appealed to manufacturers to do so. This appeal was issued after a Fire Department study showed that the department would not be able to respond to the 10,000 fires that could be expected in the case of a major earthquake in the Tokyo region.

This section has discussed seven factors that help to explain why Japanese firms have in general achieved greater levels of earthquake preparedness, have reduced their structural and nonstructural hazards to a greater extent, and have allocated higher budgets to these tasks, than their California counterparts. No single factor

can explain the extent of superiority of the Japanese firm's earthquake protection, and even in combination, these factors do not constitute a solid argument against the idea that California companies could be much better protected at reasonable cost. There is a great deal of mystique surrounding Japanese companies and Japanese earthquakes, but there are more similarities than differences between the case of Japan and California. This leads to the main subject of interest: How can we learn from the Japanese? How can lessons learned from the more extensive experience of the Japanese company be transferred to California? Taking into account the differences between the two places, as discussed in this section, how can the lessons of the Japanese be translated into successes in California?

Section 2
RECOMMENDATIONS FOR APPLICATIONS OF JAPANESE EARTHQUAKE PROGRAM EXPERIENCE TO THE UNITED STATES

1. Commercialize and Apply Technology

While the Japanese companies with effective earthquake programs owe this success more to effective management of their risk reduction effort than to reliance on technical gadgets, there is also great potential to apply some of the technological developments in the field. Electrical and gas controls that respond to earthquakes are one example where a typical California company can greatly reduce its risk of post-earthquake fires and hazardous materials releases. Base isolation devices for individual statues or pieces of equipment are manufactured in Japan at a cost that is quite reasonable when the item to be protected is of high value or of critical function. Earthquake-isolated raised computer floors that have been designed, manufactured, and installed in Japan in numerous critical installations, several of which have successfully undergone large earthquakes, should be considered by firms whose computer operations are especially essential. At the low end of the technology scale, there is the simple device of packaging the screws, wires, brackets, adjustable braces, or other hardware required to restrain a tall and hazardous piece of household furniture into a packaged kit, available in hardware and department stores.

American architecture-engineering-construction firms who attempt to compete with the Japanese for overseas construction projects where earthquake protection is critical should be concerned that many of the current technological developments in the field are occurring in Japan, and that these developments, such as the invention of new base isolation products and the installation of these systems on several new large buildings, are investments the private A-E/contractor firms are making, to ensure that they are abreast with the state of the art. It is often noted in engineering circles that the largest reaction wall testing facility (where full-size multistory buildings can be subjected to a simulation of an earthquake) in the world is in Japan, at the Building Research Institute's center in Tsukuba. Less often noted is the fact that, until the Japanese government built this facility, the largest in the world was at the research facility of a Japanese architecture-engineering firm, Ohbayashi Gumi. Such investments in technology are essential to the long-term strategy of Japan to maintain its position of industrial strength.

2. Develop Long-Term, Policy-Directed Corporate Programs

The earthquake programs of Japanese companies vary considerably--some involve structural strengthening, while for other firms, this measure was not required or was not judged a high enough priority. Industrial firms emphasize prevention of fires and hazardous materials, while financial corporations have emphasized their ability to provide essential services during a disaster period. All of the more active programs of Japanese firms, however, have one characteristic in common: They are balanced, well-proportioned, comprehensive programs. One is not likely to find a company where a single-minded concern along "survivalist" lines has led to the stockpiling of food while obvious nonstructural hazards have been left untouched. Sophisticated gas shutoff valves may be installed, but this is merely one aspect of fire prevention in the event of an earthquake, and employee training in the use of fire extinguishers is just as important. Some of the programs of Japanese firms are quite modest in budget, but they still generally aim at sorting out the various problems and allocating resources to the more important threats, attacking with more than one tactic--physical changes to improve safety as well as training to improve response.

The various earthquake protection measures employed should be selected on the basis of their costs and effectiveness in carrying out the company's earthquake policy. Many California companies fail to ever develop a policy, yet end up collecting various forms of earthquake protection. At a minimum, the priorities placed on life safety, property loss onsite, property loss off-site due to onsite fires or spills, and functional losses should be specified as a matter of corporate policy. This requires prioritizing, since, for example, one cannot simply wish that "the company will remain completely functional." The policy must make some tough decisions as to which of the many functions that normally occur should be protected against earthquake outage, since it would be too costly to protect every function against the largest of earthquakes, when all utility service might be interrupted, for example.

This policy-directed approach sounds quite simple, perhaps simplistic, but there are many California firms that appear to have developed an earthquake program in a very piecemeal way, sometimes simply according to the personal preferences or phobias of the person in charge, without any brief but factual assessment of all the various ways the company could reduce its risk. It is obvious upon reflection that emergency supplies of food will not save employee lives, but would rather be a matter of comfort or would allow employees to continue to work at the site during post-earthquake turmoil. These may be goals, but to most companies they have a lesser priority than the goal of preventing death and injury, and also a lesser priority

than preventing major fires or spills that could involve the building or site, and also a lesser priority than protecting a few key functions, records, or pieces of equipment. Yet, it is not unusual to find major California companies preoccupied with emergency food supplies when these higher priority items have not been properly covered.

In the case of fire safety (apart from earthquakes), it is not a question of whether fire sprinklers or smoke detectors should be used--it is generally a matter of integrating both systems into a building. Apart from the physical environment's protective design, fire safety also routinely assumes that the building's occupants should be made a part of the fire safety system, and to this end signs indicating exits are ubiquitous, there are training and public information campaigns about fire safety, and fire extinguishers are provided for the use of occupants.

The long-term perspective of the typical large Japanese company is a distinct advantage in developing and maintaining an earthquake program. There is a secure place in the organization chart for the earthquake effort, and its support over the decades is taken for granted. The growth or decline of the company affects the size of the earthquake program, but it is recognized that, like fire insurance, one does not forego protection selectively in low-budget times and then acquire protection when funds are plentiful, but rather protection at some minimal level is a long-term necessity.

In some cases, California firms could re-evaluate their initial effort in a long-term perspective and find that the initial enthusiasm will not be viable, and that a scaled back or simplified approach is actually more effective. The lessons offered from the experience of the Japanese private sector often point out what not to do--because it is too costly, too difficult, etc.--as well as what should be done.

A typical public sector example of short-term thinking that is generally doomed to ineffectiveness is the neighborhood earthquake preparedness effort that attempts to assign specific response duties to each member of a neighborhood, itemize who has what resources, etc., without clearly realizing that this level of organization might have to be maintained for a decade or more before being used even once. Simpler schemes that take turnover and the ebb and flow of interest in the earthquake topic into account are more likely to succeed, even though at first glance they may seem less effective than the more ambitious approach.

Annual or more frequent earthquake drills or exercises are typical of Japanese firms that have active earthquake programs. This is less common in California, and yet it is difficult to imagine how, over a timespan of decades when employees are changing jobs every few years and new employees are being hired and others retiring,

a company's level of earthquake protection would be maintained unless there is an annual briefing on proper response procedures. The short-term approach is to invest in the staff time (often about a half person-year or more) to develop an earthquake plan and stop there; the long-term perspective is that if it warranted the cost to develop the plan in the first place, it is necessary to maintain it over future years in a routine manner.

Even very large Japanese firms, such as Sony or Kajima, have benefited from the personal involvement of the chief executive officer in the management of earthquake programs. If the earthquake program is important, then it should be well managed and not just allowed to randomly and amorphously grow. The safety manager who carries out the details of the earthquake program is usually on a generalist's career track into management, with promotion opportunities beyond that available within the safety function on the organization chart. Good performance in managing an earthquake program can lead to placement in a position where good management of some other type of program is required, while in the United States, the safety or risk management function is more often separate from the general flow of management promotions. Because earthquakes, unlike hazardous materials, are not a major regulatory and liability concern, the typical California company isn't likely to devote much management attention to the subject. The short-term perspective is that earthquake risk reduction doesn't contribute to quarterly earnings per share, and in fact, the slight cost of the program is a negative factor. The long-term, more typically Japanese view is that the earthquake program is one of those essential costs of doing business that will guarantee the corporation's future into the next century.

3. Emphasize Practical Countermeasures

California companies can learn from the way Japanese firms focus their earthquake programs on the countermeasures that can have the greatest practical effect on reducing the losses from future earthquakes. The image of the program is relatively unimportant, and the public relations angles are typically not calculated. The general earthquake awareness of employees is too vague a goal to count for much in a Japanese firm's earthquake program, whereas specific training objectives for various classes of employees are carefully set. Earthquake plans contain specific emergency response checklist items, sometimes organized along a time line so that there is coordination among various employees or at different parts of a site.

Some of the efforts of California firms appear to be well-intentioned but unlikely to make any signficant change in the outcome of their next earthquake

experience. The content in the earthquake brochures given to employees often sets the tone for the lack of practicality in the company's program, and contrariwise, those California firms with earthquake brochures that contain useful, specific information for employees to use at home or work are more likely to have programs that are likely to make a difference in an earthquake. The impractical variety of brochure admonishes the reader to "brace the water heater," perhaps including a cartoon sketch of a water heater. This leaves the reader no better off than before when it comes to how to brace the water heater--the specific hardware and installation technique required.

The more prevalent investment in structural and nonstructural strengthening or protection projects in Japan is another sign of their practical orientation. Most facilities would experience nonstructural damage that would endanger the occupants, unless a special survey and retrofit project is conducted. A significant minority of the buildings in which California companies are located would suffer great structural damage in a major earthquake. Once this structural and nonstructural damage occurs, the best of emergency response plans or training programs for employees can only try to mitigate the disaster after it has happened.

4. Learn Quickly From Disasters

While learning from earthquakes occurs in both Japan and the United States, the extent to which the Japanese learn a lesson from an earthquake and then quickly apply that lesson was a surprising finding in this research project. This learning process has pervaded both the private and public sectors. Using the example of petroleum refineries, there have been two earthquakes in recent times that have damaged such facilities--the 1964 Niigata earthquake and the 1978 Miyagi-ken-oki earthquake. In both instances, the causes of damage have been identified and practice rectified so the same cause will not result in damage in future earthquakes. The ignition source provided by floating oil tank lids with metal-to-metal seals was eliminated with the use of plastic seals throughout Japan, for example, after the Niigata earthquake.

This learning and application has been done not just by industries on their own accord, but the government has also stepped in and revised its regulations. The net result of this is that even refineries that have never suffered damage from an earthquake have retrofitted their facilities so if an earthquake were to occur, the same kinds of causes would not lead to damage. The attitude of "it has never happened here" is absent.

The Japanese have also learned a great deal from foreign earthquakes. While U.S. engineers and earth scientists have also learned from earthquakes in other countries, it is difficult to find examples where changes in practice have occurred to the extent found in Japan. At many agencies and companies in Japan it was mentioned, for example, that the 1971 San Fernando earthquake (sometimes referred to as the 1971 Los Angeles earthquake) helped crystalize a consensus that earthquake programs should be a standard of practice among Japanese companies. By the time the 1978 Miyagi-ken-oki earthquake occurred, some companies had already begun their programs and government agencies were working quite hard on the topic. At Kajima Corporation, for example, the 1978 Miyagi-ken-oki earthquake served as a test of the company's disaster planning and the earthquake protection measures in place at its facilities closest to the earthquake, because following 1971, earthquake activities were already underway in the firm. The 1978 event pointed out other lessons and led to further refinements in the company's efforts.

This rapid response to past disasters in improving protection from future ones is less a matter of research to discover the lessons and much more a matter of applying the lessons in practical ways.

5. Deal With Fire and Hazardous Materials Risks

There is greater concern over earthquake-caused fires in Japan, and since there is probably more risk there, that is quite expectable. The lower level of major earthquake-caused fires in the United States, partly because of lower densities of development, however, does not mean that this is not a serious problem. Most of the various techniques available to deal with the problem--anchorage of appliances, equipment, and piping that could cause fires, auto shutoff devices, training on rapid manual fire prevention efforts by people, fire resistant construction of fire breaks on an urban scale, and so on--have been tried out in Japan. These measures have been found so effective that the past several earthquakes in Japan have caused many fewer fires than had been expected, because of the well-trained response of the population.

In some areas of the United States, the threat posed by hazardous materials releases caused by earthquakes is every bit as great as in Japan, and the attention given to this issue in Japan seems appropriate. In any review of the potential problems that could arise at a company's facility, fire and hazardous materials should be carefully considered.

6. Aim Research at Practical Results

While there is always a need for basic research that is not focused narrowly on the solution to a particular problem, there can be an overemphasis on such research at the expense of the more problem-directed variety of practical research. This is primarily a matter of public policy concern, but there are also corporate implications. As an example from Japan, Kajima designed and conducted its own tests of office furnishings on a shake table, subjecting the test set-ups to several different earthquake records, as a very practical research attempt to devise nonstructural protection standards for its own facilities. Guidelines for which kinds of items required restraint, and the details of the restraints, were quickly specified at the conclusion of the research, with the result that a visitor to the corporation's Tokyo headquarters can see how the nonstructural components of the building have been protected. Uchida Yoko's shake table research project was aimed at the similar practical problem of determining which of its office products required restraints, related to various levels and frequencies of motion, with the result that now this firm can work with a client's specific building characteristics to specify how the equipment should be restrained. Base isolation research by Kajima, Ohbayashi, Takenaka, and others has led to the introduction of their own systems, tested in their own buildings. These companies had practical goals and conducted practical research efforts to realize them. While not all U.S. earthquake research should be narrowly focused on the development of products or solutions to individual rather than generic problems, there is often in the U.S. research effort the development of solutions in search of problems.

7. Make Government a Leader By Example

The private sector's willingness to undertake earthquake programs would be significantly increased if the government led by example, rather than merely telling others to be prepared. Japan's successful business earthquake programs owe some of their success to the examples provided by many Japanese agencies. If you want to convince someone it may rain and that it would be a good idea to take an umbrella along, the best way is to carry your own. Present government programs in the United States at the federal, state, and local levels usually attempt to increase private sector earthquake efforts by putting the government in roles such as a provider of information, a sponsor of conferences, a funding source for research, a provider of disaster aid, and as a public relations effort. It may be that without the additional role of government leading by example, these other roles are much less effective.

8. Provide Active, Practical Assistance by Government Agencies

The 20-person staff of the earthquake preparedness division of Shizuoka Prefecture includes architects and engineers who have prepared earthquake evaluation design guidelines for use by other architects and engineers. Members of the staff even visit facilities to suggest improvements based on their technical training in the area of earthquake hazards. Model earthquake plans for more than a dozen industries--plans with substantial content rather than just plan outlines--have been prepared and distributed. Pamphlets are prepared for the homeowner to apply in rating the earthquake resistance of a dwelling, and homeowners can receive free visits from municipal building department staff members in the Prefecture to advise on ways to increase their dwelling's earthquake resistance. In the United States, agricultural extension agents are the closest analogy to this government provision of consulting expertise, whie it is rarer in the earthquake field.

There are some parallel earthquake instances in California, but much less than in Japan. The earthquake preparedness videotape developed by the Beverly Hills Fire Department, for example, includes an interview with a building department official who offers the department's assistance in finding drawings and evaluating a building's earthquake resistance. Some state, regional, and local government offices provide assistance in finding the location of sites on geologic hazard maps, and some fire departments now provide advice on their fire inspections as to proper earthquake-resistant storage of compressed gas cylinders or chemicals on shelves. The earthquake videotape of the City of San Bruno offers its citizens a free visit by a fire department team who will check a residence for earthquake hazards and even install the necessary bracing on the hot water heater. These techniques are likely to be very effective.

9. Adopt Governmental or Trade/Professional Standards to Define Standards of Practice

While some California companies, even large ones, do not intend to develop earthquake programs, many already have begun this effort and might actually welcome the development of some standards of practice to guide their efforts. While such standards, even if non-regulatory, would pressure the firms to take certain actions, if only because of liability concerns should the earthquake occur and find the company's efforts inadequate, it is also true that such standards would indicate what is not required. Prior to 1981 when General Industry Safety Orders 3220 and 3221 were adopted, it was more difficult for a firm to know when it had adequately considered handicapped employees' evacuation needs, how many people

had to be trained to be able to lead fire evacuations, what difference it made when an employer occupied several different floors of a building rather than being located on one floor, etc. With regard to earthquakes, California firms are developing a consensus that a large firm should have an earthquake program, but there are no guidelines to tell how much or what kind of program is required.

The earthquake-protected storage and use of hazardous materials is an area where more standards are needed. The Uniform Building Code only as of its 1985 edition references hazardous material equipment and piping in its earthquake regulations, but this code applies only to new construction or major remodels, rather than the installation of individual pieces of equipment after the building is built. The Uniform Fire Code does not specify how chemicals on shelves should be restrained, yet this is a likely source of hazardous materials problems after future California earthquakes. Federal and California OSHA regulations have many hazardous materials requirements, but none that relate to earthquakes. The 1985 state law, AB 2185, which goes into effect in 1986, requires companies with even small quantities of hazardous materials to inventory them for their fire department, but the emergency planning requirements, such as to post appropriate after-hours telephone numbers for fire department use, do not have any specific earthquake provisions.

10. Tie Educational Efforts and Budgets to Specific Risk Reduction Goals

Earthquake education and awareness is a good thing, everyone would agree--but why? From a practical standpoint, it is good only insofar as it leads people to take the appropriate actions that will reduce the risk of damage and injury in future earthquakes or will improve disaster response. The types of negative consequences that could occur can be specifically defined--fires, spills, nonstructural damage, structural damage, in some cases exposure to tsunami inundation, and so on. In Japan, awareness campaigns have begun with these specific negative consequences and an assessment of the behavior the campaign is trying to change or to produce.

Earthquake-caused fires are such a major threat in Japan that most public education earthquake efforts have included this problem within their scope. How to operate a fire extinguisher, how to reduce hazards associated with gas-fired appliances, which routes to take to open space refuge areas if large urban fires result--all these specific and practical pieces of information are then devised and convincingly presented. The mobile shake-vans that are common in Japan usually include a corner that has a kitchen mockup, complete with a countertop gas cooking appliance that is common in Japan. Those who "ride" the exhibit can practice

turning off gas valves and observe how countertop cookware (which in the actual earthquake might contain oil) are thrown about. There are many other examples of how the Japanese have tied their expenditure of public funds for earthquake awareness to the specific risk reduction goal of fewer earthquake-caused fires, and the lower-than-normal occurrence of these fires in the past few earthquakes has led most earthquake preparedness experts in Japan to conclude that such educational efforts and training programs have been very successful.

In the United States, most awareness or educational efforts are much more diffuse. They are well-intentioned, but there is no clear strategy on how the good intentions will lead to good works. They are not tied to the specific behaviors they presumably intend to change. They may convince people there is a problem, but they usually stop short of telling them how to solve the problem. Brochures in Japan are available on how to anchor everything from household objects to vending machines, while in California, the common case is the brochure which merely says, verbally or with sketches that have no detail, that one should anchor objects. It is difficult to document that such vague preparedness efforts will have a great beneficial effect in future earthquakes, whereas the Japanese can already document the signficant improvement in earthquake-caused fire incidence rates since the implementation of mass educational campaigns. Companies who help their employees prepare at home are much more likely to have employees who can help the company when an earthquake arrives.

Section 3
RECOMMENDATIONS FOR APPLICATIONS OF UNITED STATES EARTHQUAKE PROGRAM EXPERIENCE IN JAPAN

Although the list of items that California firms can learn from Japanese is much longer than the following list, there are a few innovations or approaches in California that are applicable to Japan.

1. Promote Inter-Company Communication

In this research project, we found that our role as foreigners and the courtesies extended by Japanese agencies and companies enabled us to learn about a great breadth of activities underway among companies in Japan. While this information is not hidden by one company from another, it does not naturally percolate into the same water table of ideas because most large Japanese firms are extremely vertically integrated and socially cohesive, but somewhat isolated one from another in terms of informal contacts by employees. A California facility or safety engineer would probably be more likely to attend an earthquake conference and meet counterparts in other industries than would a person in Japan, for example.

The Tokyo organization, Souyoukai, which brings together General Affairs managers of different corporations, is a valuable way in which companies can learn from one another. More such organizations would be beneficial. In the United States, there are a variety of inter-company avenues of communication that are less prevalent but still exist in Japan, such as trade/professional associations, government-sponsored conferences for companies, and so on. As compared with common practice in the United States, it is much less likely for a Japanese employee to pick up the phone and call a person in another organization whom he or she has not previously met. In California, consultants or corporate representatives who have given talks often receive phone calls later in the week from strangers who attended the meeting and who ask for some followup information or a suggestion on where to find a particular point of information or a product or service. This is less likely to occur in Japan.

There also are fewer counterparts to the many volunteer or non-profit organizations in the United States. Since the Golden Gate (San Francisco) Red Cross has been quite influential in bringing together companies at disaster meetings to discuss issues and attend seminars in the San Francisco Bay Area, and since the

Los Angeles and Orange County Red Cross chapters have also been active in southern California, this means that some other forums could be devised in Japan. (There is a Red Cross in Japan, but its function is different from that of the American Red Cross and more limited to provision of medical services.)

Surveys of the extent of earthquake preparedness among Japanese firms, and indications of the types of countermeasures found to be most effective, have been published by Toyo Keizai, for example, and this is a good way for the company in Japan to learn about what other firms are doing in the area of earthquake hazard reduction. This topic has little or no competitive or proprietary aspect to it, and thus is not a problem.

By whatever means, but probably through the auspices of national, prefectural, and local government, and in relatively structured ways in which ongoing personal contacts are established through committees, increased inter-company communication about earthquake programs could be encouraged in Japan. It is obvious that there is a great wealth of information these companies could share.

2. Standardize Countermeasures

To take nonstructural retrofits as an example, there is a great variety that can be seen in the workplace in Japan, ranging from the extremely sophisticated and well-engineered to installations that may not work properly in a large earthquake. The sophisticated installations are more numerous in Japan than in California, and Japanese engineers need no advice on how to proceed with developments such as base isolated raised computer floors or mounting pads for statuary, or automatic gas shut-off devices. The lesson that might be learned from some California firms is the need to standardize nonstructural retrofit details wherever possible.

In the case of Japanese training efforts, quality circles that discuss and devise their own suggestions, or the common overlap of social/work unit in which a dozen or two employees and their superiors develop consensus approaches to solving problems, are great aids to earthquake preparedness. This makes it much easier for everyone to understand the earthquake plan's provisions and to be familiar with what each person is to do. When it comes to carrying out the nuts and bolts of nonstructural earthquake protection schemes, however, it may be desirable to rely on company-wide standards as much as possible, rather than having the people in each work area devise differing solutions. It may be valuable to have everyone initially work on innovative solutions, but once they have been reviewed by engineers, the types of protection required should be standardized or listed as optional ways of handling certain situations.

Undersized anchor bolts on equipment or furnishings hold-down angles, for example, and hardware not strong enough for the loads that could occur, were the most common cases observed where a lack of standardization affected quality. This is also common in California, where it seems difficult for anyone but the structural engineers to understand that Newton's second law (F = ma) means that very massive objects tend to exert very large inertial forces. Maintenance staffs of facilities in California typically underestimate the amount of earthquake force an object should be able to withstand. Thus this is not necessarily a lesson that Japan can learn from California, for it a lesson that needs to be learned in both places, but the implementation of standardization would probably proceed differently in a Japanese firm because of its group orientation in the workplace.

3. Avoid Dependence on Predictions

While the major Tokai prediction effort underway in Japan, and the extensive preparedness measures tested for use in contending with a short-term prediction situation, have done much to advance the state of the art of earthquake preparedness in Japan, it is possible that in some cases there is an excessive reliance on the possibility that the Tokai earthquake will be accurately forecast. Many of the training efforts and response procedures are applicable to predicted and unpredicted earthquakes, but some of the preparations for a predicted earthquake are quite different. California could also learn from Japan's greater emphasis on earthquake prediction; certainly, companies and agencies in California should develop some basic procedures, at least for the possibility that a series of possible foreshocks will lead scientists to issue earthquake advisories about possible larger shocks.

4. Consider Behavioral Aspects

Japanese emergency plans generally assume that employees, or the general population, will respond as they have been told to do in an earthquake disaster by going to certain locations, taking certain protective actions, following various instructions, and so on. More consideration of the behavioral aspect of earthquake response could be given to ensure that plans are flexible enough to adapt to different ways in which people may behave. Though quite different from the case of Japan, the 1985 Mexico earthquake illustrated how consideration of the way people behave in emergencies had a bearing on emergency response.

After the September 19, 1985 Mexico City earthquake, the government attempted to relocate homeless residents into designated camps and vacant buildings.

To aid in this process of communication, and to try to obtain the trust of the people (who often did not want to leave their neighborhoods where their damaged residences and possessions were), the government mobilized prominent members of the Mexican actors guild for media and public appearances. This type of adaptation to the sociological and psychological context of the situation was found useful, at least to the Mexican government. In the United States, it has been found that merely telling people to evacuate an area because of a tsunami, hazardous material spill, or fire is often not sufficient to result in a 100% evacuation. Companies with earthquake plans in California have developed some ways to deal with the possibility that employees will leave work after an earthquake, that they will want to stay at work and obtain shelter, and that, if at home, they will either want to stay at home or return to work for shelter. Each of these outcomes imposes different demands on the emergency plan of the company. Since behavioral science is also an art, some companies have developed contingency plans to at least cope with any of the basic ways in which employees could respond.

From a company's standpoint, the usefulness of social science research lies in providing practical guidance concerning the earthquake program, whereas from an academic standpoint, the usefulness of disasters is in providing raw material for research concerning the ways individuals and groups behave. Some social science research in Japan on earthquakes is notable for its specific focus, such as studies of how people behave in earthquakes so that better guidance can be given in the future, or studies of how well power plant operators can function during an earthquake. More work of a similar nature will help remove behavioral uncertainties from the subject, but there will still be a large number of unknowns in future earthquakes concerning how people will respond, and emergency response plans should be flexible enough to contend with this unpredictability.

5. Prepare Smaller as Well as Larger Companies

This point is not really a lesson that Japanese firms can learn from California any more than it is a lesson California can learn from Japan, since in both places there is large divergence in the degree of earthquake protection activity of the big versus the small firm. Small companies are a significant factor in both economies, employing numerous people. In the United States, the status of the small company is probably greater than in Japan, and there is a greater tendency for people to switch from a large company to a small one, or to start a small one, or for employees of small firms to switch to the employment of large companies. While the earthquake preparedness needs of small firms are often much less, since they have smaller facilities and fewer employees, they should not be forgotten. A very streamlined

approach to emergency planning, and a simplified way of dealing with structural and nonstructural hazards, is usually appropriate for a small business that has no full-time safety or facility manager or engineer, and so the lessons learned about the programs of large companies may not be completely applicable.