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Industrial Earthquake Preparedness in Shizuoka and the Role of the Prefectural Government

Guna S. Selvaduray, M. EERI

The Shizuoka Prefectural Office in Japan plays an important role in promoting earthquake emergency preparedness among its industries. In addition to implementing regulatory requirements and enacting new regulations as necessary, the Prefectural Office also provides significant guidance to industry. This includes making publications available and periodic surveys of the status of industrial emergency preparedness. A pharmaceutical company in the prefecture has developed an impressive earthquake preparedness program and hazard reduction techniques. This program addresses both primary and secondary effects of earthquakes.

INTRODUCTION

Japan faces all of the major natural hazards - earthquakes, typhoons, tsunamis, and a high risk of fire damage resulting from a high density of wooden structures. Of particular concern at the present time is the Great Tokai Earthquake, which has been predicted to occur in the Suruga Trough adjacent to Shizuoka Prefecture⁽¹⁾ (see Figure 1⁽²⁾). This earthquake is expected to be of at least intensity 5 on the Japan Meteorological Agency (JMA) scale; this is equivalent to an intensity of 8 on the Modified Mercalli scale. (A comparison of the JMA scale and the Modified Mercalli scale (MMI) is shown in Figure 2.) It has also been predicted that another earthquake of similar magnitude can be expected to occur in Tokyo between the years 1978 and 2004.⁽³⁾ Some of the preparations underway to mitigate the disastrous consequences that could arise from these earthquakes have been reported in the past.^(4,5) A significant portion of the disaster preparedness planning in Japan is geared towards protection of industrial capability because the country has few valuable natural resources. This article, based on a recent visit by the author to Japan, examines the activities undertaken by the Shizuoka Prefectural Government in promoting disaster preparedness planning, and in particular industrial earthquake preparedness planning.

The "Large-Scale Earthquake Countermeasures Act" (LECA), which was passed by the Diet (Japanese legislative assembly) on June 16, 1978 and became law in December, 1978,⁽⁶⁾ provided broad coverage, enabling the government to take important steps to reduce damage particularly from the expected Tokai Earthquake. In particular, it permitted the designation of certain areas to be "under intensified measures against earthquake disasters."⁽⁷⁾ (See Figure 1). In areas that have been so designated, all organizations, both public and private, are obligated to have both disaster preparedness plans and disaster countermeasure plans. When this provision is coupled with other laws (the Disaster Countermeasures Basic Law, the Fire

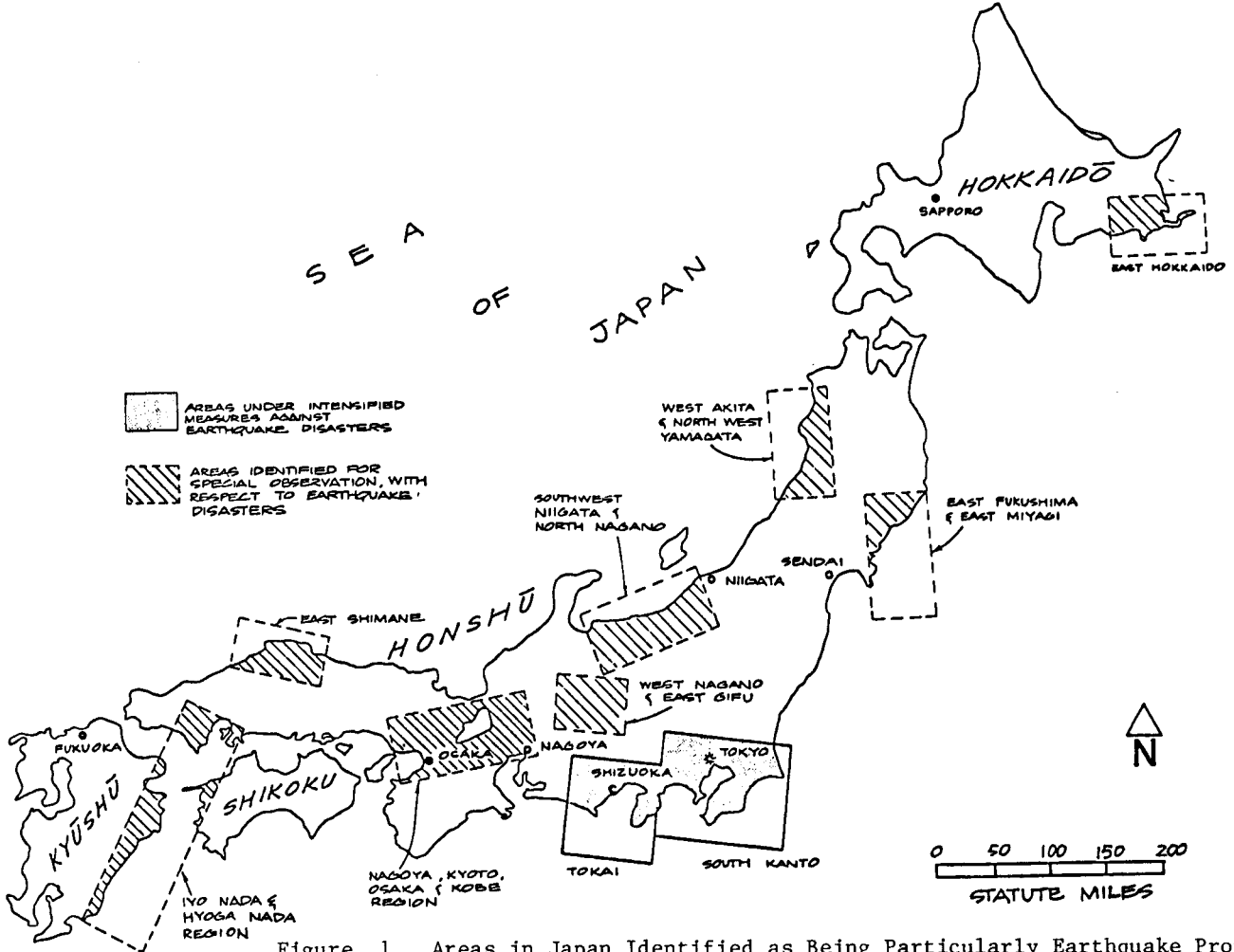


Figure. 1. Areas in Japan Identified as Being Particularly Earthquake Prone. (2)

MMI (Modified Mercalli Intensity) Scale	JMA (Japan Meteorological Agency) Intensity Scale
I. Not felt.	0. Not felt.
II. Felt by persons at rest or on upper floors.	
III. Felt indoors, hanging objects swing.	I. Felt only feebly.
IV. Hanging objects swing. Vibration like passing of heavy trucks.	II. Felt by most persons; slight shaking of windows and Shoji (Japanese latticed sliding doors).
V. Felt outdoors. Sleepers wakened. Liquids disturbed. Small unstable objects displaced or upset.	III. Some people are frightened; heavy rattling of windows and Shoji, swinging of hanging objects, sloshing of liquids.
VI. Felt by all. Knickknacks and books fall off shelves. Some cracking of plaster and unreinforced masonry walls.	IV. Overturning of unstable objects, spilling of liquids out of vessels.
VII. Difficult to stand. Some unreinforced masonry chimneys, parapets, and cornices fall.	V. Cracking of brick and plaster walls, overturning of stone lanterns and gravestones, damaged chimneys.
VIII. Unreinforced masonry buildings damaged, most buildings designed to resist earthquakes structurally undamaged.	
IX. Major damage to most unreinforced masonry and many minimally earthquake resistant buildings.	VI. 1% to 3% of Japanese wooden houses severely damaged; soils effects such as liquefaction and large landslides.
X. Most non-resistant buildings heavily damaged or collapsed; some major damage to minimally earthquake resistant buildings, including collapse.	
XI. Increasing intensity of ground motion (defined by soils failures such as slippage of railroad track beds).	VII. More than 30% of Japanese wooden houses severely damaged; soils effects such as large landslides and fissures.
XII. Increasing intensity of ground motion (defined by soils failures such as displacement of large rock masses).	

Figure 2. American and Japanese Intensity Scales.

Sources: Modified Mercalli Scale adapted and abbreviated from 1956 revised version by Richter; JMA Scale adapted and abbreviated from 1951 Kawasumi version, as revised by Japan Meteorological Agency; correlation of the scales from P.J. Barosh, "Use of Seismic Intensity Data to Predict the Effects of Earthquake and Under-ground Nuclear Explosions in Various Geologic Settings," U.S. Geological Survey Bulletin No. 1279, 1969.

Prevention Law, the Fire System Law, Control of Dangerous Materials Law), it, in effect requires companies:

1. To undertake disaster preparedness planning.
2. To install the necessary equipment for hazard mitigation.
3. To maintain the equipment.
4. To hold regular drills and exercises.
5. To take emergency countermeasures upon the Prime Minister's declaration of a state of emergency.

INDUSTRIAL EMERGENCY PREPAREDNESS PLANNING

Since 1975 all corporations employing 50 or more people have been required by law to have emergency preparedness plans. However, implementation of LECA in December 1978 made it obligatory for practically all organizations (with the exception of private households) not only to formulate disaster preparedness plans, but also to maintain them. In August 1979 all corporations employing 50 or more people were required to submit their emergency preparedness plans for approval within 6 months; 84% had complied by the end of June 1983. New companies must submit and obtain approval of their emergency preparedness plans before their business licenses are issued.

The prefecture has conducted two surveys so far in order both to assess the state of industrial emergency preparedness and also to find out the requirements of industry to improve their emergency preparedness profiles.

The first survey of 1,100 companies employing 100 or more people (termed large companies) was conducted from December 1980 to January 1981.⁽⁸⁾ Seven hundred and fifty-one companies (68.3%) responded. The second survey of companies having between 50 and 99 employees (termed medium-sized companies) was conducted between January and February 1982.⁽⁹⁾ Of the 1,738 companies surveyed, 1,227 (70.6%) responded. The two surveys were essentially the same and consisted of questions in the following areas:

1. Characteristics of company: Type and scale of company, site conditions, hazards, number of employees, and conditions of employment.
2. Disaster Countermeasures and Emergency Response Planning: Role of employees, reception and transmission of disaster warning, personnel responsible.
3. Earthquake Countermeasures: Implementation of countermeasures, detailed examples, improvement of disaster mitigation equipment, storage of food supplies, medical response, and cooperative agreements with outside organizations.
4. Training and Education: Implementation of Disaster Drills and Training programs.
5. Response to Emergency Warning: Evacuation & refuge, return of employees to their homes, effect on operations, coordination with labor unions.

Although the results have been tabulated in great detail, the salient features of the results of this survey are summarized in Table 1. As might be expected, the larger companies in general appear to be better prepared than the medium-sized companies. This is probably reflective of the greater economic resources available to the former.

The questionnaire also sought to identify the requirements (and desires) that industries had in order to improve their earthquake emergency preparedness. Topping the list of "demands" was the requirement that there be some financial provision, in the form of tax incentives, subsidies, or some other form of preferential treatment, which would alleviate the cost involved in implementing countermeasures. Other major requests that industries had toward the national and prefectural governments included:

1. Improving the speed, accuracy, and reliability of earthquake predictions and relay of information.
2. More comprehensive earthquake insurance.
3. More guidance from governmental agencies.
4. Applicability of workers' compensation to earthquake incurred injuries.
5. Improved Public Relations for disaster countermeasures, and implementation of education and training.

FINANCIAL INCENTIVES

Although the prefectural government does not offer direct monetary aid or subsidies, it offers several economic incentives. Some of the economic incentives in effect at the present time are:

1. All equipment readily identifiable as improving the company's earthquake resistance, such as emergency shutoff valves, firefighting equipment, are tax deductible.
2. Expenses incurred in preventing glass shattering and dispersion of fragments (by pasting a plastic film on it) are tax deductible.
3. Low interest loans to companies having 300 or fewer employees.
4. Accelerated depreciation of earthquake preparedness capital outlay permitted from 1983.
5. A 33% reduction in property tax applicable to equipment installed for improving earthquake resistance, preparedness, and countermeasures. This measure came into effect in 1982.

The prefectural government is currently negotiating with the Ministry of Labor to include injuries incurred from earthquakes under workers' compensation programs. The outcome of this negotiation is not yet known.

In addition to national and prefectural funds for promoting earthquake preparedness, Shizuoka Prefecture has instituted a 10% surtax to be levied on corporations and higher income bracket individuals as an additional source of income for its activities in this area. Shizuoka is the only prefecture to have this

Table 1: Results of Industrial Earthquake Preparedness Surveys
Conducted by the Shizuoka Prefecture^(7,8)

	Large Companies 100 emp.	Medium-Sized Companies 50-99 emp.
1. Time required to implement Emergency Response Plans		
- 1 hr	21.7%	69.1%
- 2 hr	44.2%	21.0%
- 5 hr	2.7%	0.9%
2. In-house earthquake countermeasures activities		
- Begun	75.4%	56.0%
- Planned	22.8%	26.2%
3. Earthquake analysis of facilities		
- Completed	23.3%	18.7%
- Being done	5.7%	2.0%
- Planned	48.9%	27.8%
- Will not do	20.5%	48.5%
4. Tie-down of equipment:		
- Prevention of equipment overturning	45.1%	28.4%
- Prevention of equipment falling	36.9%	22.2%
- Fixing of tables	5.4%	3.8%
- Tie-down of lockers, etc.	25.6%	11.7%
5. Installation of automatic shutoff valves:		
- High pressure gas	45.5%	42.3%
- Propane	29.8%	29.8%
- Fuel oil	30.2%	32.9%
- Other hazardous materials	28.3%	25.5%
6. Disaster drills		
- Conducted	75.9%	61.2%
- Number of drills in 1980		
a. Once	41.2%	61.1%
b. Twice	34.2%	24.5%
c. Three times	8.4%	2.3%
7. Decision regarding operations upon reception of earthquake warning		
- Total halt	79.8%	65.6%
- Partial halt	13.6%	20.3%
- Will continue	3.1%	1.8%
- Undecided	3.6%	12.3%
8. Refuge area		
- Within facilities	68.6%	51.4%
- as designated by municipality	22.8%	45.7%

measure, which was introduced in 1979 for a five-year period. It has been extended for a further five-year period, from 1984 to 1989. The projected and actual incomes from this measure, for the years 1980 to 1983, are shown in Table 2.

Table 2: Projected and actual income from 10% surtax⁽¹⁰⁾

Year	Projected million US\$	Actual million US\$
1980	30.5	37
1981	40.5	37
1982	36.1	38.7
1983	36.5	

Note: Budget figures have been converted from Japanese yen to U.S. dollars.

In principle, the prefectural government keeps 50% of this revenue for its own expenditures for its various programs, and disburses the other 50% to cities, villages and communities in the prefecture to aid them in their earthquake preparedness activities. Some of the specific activities for which these monies are earmarked include:

- Establishment of community disaster prevention centers
- Improving communications (wireless) systems
- Improving firefighting facilities
- Education of voluntary disaster prevention groups
- Earthquake resistance evaluation of public buildings

GUIDANCE FROM THE PREFECTURAL GOVERNMENT

The prefectural governments are required by law to have complete plans for earthquake disaster preparedness and countermeasures. In keeping with this, the Shizuoka Prefectural Government has embarked on a program, unprecedented in magnitude, to educate the prefectural population on earthquake disaster preparedness.

One of the key areas being emphasized by the prefectural government is promotion of disaster preparedness and planning in industries. Although the prefectural government does not provide any direct subsidies to individual companies to aid them with the planning, the emphasis is on "creating an environment conducive to disaster preparedness planning," which includes technical support and the financial incentives described earlier.

The prefectural government's Earthquake Preparedness Division provides considerable guidance to companies for the formulation of disaster preparedness plans. A 50-page guidance booklet on the formulation of Earthquake Disaster Prevention and Emergency Response Plans published by the prefectural government in June 1980 outlines in detail who has to prepare disaster plans, where to submit these plans for approval, and in how many copies.⁽¹¹⁾ Chapter 2 of this booklet

outlines the assumptions that should be used in planning, and spells out typical warning times, expected earthquake characteristics, and conditions that could be expected, such as shutting off of utilities (electricity, gas, water), discontinuation of transport facilities, and the communications media that would be available.

The booklet states that the plans formulated should not be abstract, but rather detailed plans of who is to do what, when, and how, and that all employees should not only be aware of the existence of such a plan, but also be familiar with it. Towards this end, the booklet outlines:

- How disaster information will be transmitted from the National headquarters
- How companies should organize themselves for earthquake disaster countermeasures and emergency response
- How evacuation is to be conducted
- The organization of emergency medical response
- Procedures for inspection of property and equipment for earthquake resistance
- What emergency supplies are to be stockpiled
- The planning and conducting of disaster drills (more than once a year)
- The types of education programs and information to be disseminated regarding earthquakes and countermeasures.

Special attention is paid to the fact that different organizations, such as hospitals, theaters, small companies, companies handling hazardous materials, large companies, will have different requirements. This booklet outlines special measures different organizations should take, or provide for, based upon their occupational hazards. A detailed example of a disaster plan is also given as a model.

Another booklet published by the prefectural government, entitled "Organization of Independent Disaster Prevention Groups," explains in detail all aspects of earthquakes, including origin, consequences, the laws governing disasters, and countermeasures that can be taken.⁽¹²⁾ An example of a Disaster Plan for a foundry is given, including aims, organizational structure, specific actions to be taken for structural inspection, improvement of fire protection facilities, handling of hazardous materials, materials to be stockpiled, evacuation routes and drills, and actual response activities and responsibilities.

A third publication by the prefectural Earthquake Countermeasures Division is a compilation of 16 case studies of industries that have complied with and implemented earthquake countermeasures.⁽¹³⁾ In each case, a brief description of the company (location, number of employees, products) is followed by a description of its site conditions. The next section describes the development of emergency (earthquake) preparedness activities in the company, frequently quoting starting dates, the section or division that was in charge, and the establishing of objectives. Practical examples of the organizational structure (with organizational charts and flow charts) in each of the companies and the countermeasures taken (with photographs and sketches) are also given. The training and education programs taken by each of these companies are described next, with frequent reproductions of the actual materials used. Each case study is concluded with a section on how the company is coordinating its efforts with the immediate neighborhood, including the city government, and residents. This is probably to be contrasted with the U.S. corporate structure, where there is little, if any, interaction between companies and the neighborhood population.

In addition to the above planning guides, the prefectural government has also published several engineering guides for retrofit design criteria and inspection of wooden, reinforced concrete, and steel frame structures. (14-17)

COMPANY PROFILE - YAMANOUCHI PHARMACEUTICALS

One of the companies that has been active in emergency preparedness and planning, Yamanouchi Pharmaceuticals, was visited by the author during his visit to Japan. One of the most striking things was the extremely cordial and friendly relationship between the prefectural officials and the company officials. It was definitely an attitude of: "We have to help each other."

This company started its earthquake and disaster preparedness activities in 1974. A Disaster Prevention Committee consisting of six full-time employees was formed initially to get the program off the ground. They have now been reformed into the Environmental Management Section, with Mr. Tohno as the section manager, and two employees under him. According to Mr. Tohno, the first activity of the committee was to educate the employees on disaster prevention and counter-measures. The next activity was to tie down all equipment in the factory and offices. Mr. Tohno has been given personal authority by management to discard any material left sitting on top of filing cabinets, etc. All fuel oil, acid, and gas tanks are connected to feed and outlet pipings with flexible connections, and are also equipped with emergency shutoff valves. They have spent a total of \$500,000 on earthquake preparedness hardware alone, not including time spent by factory personnel in planning and training. All employees are trained in CPR and First Aid. Sixty employees (out of a total of 600) are trained in firefighting, and form the company's Fire Brigade.

The communications line to the prefectural office (for earthquake prediction and/or warning) is open 24 hours a day. Mr. Tohno will receive the announcement from the prefectural office, and announces the warning over the PA system. The plant will begin shutdown once the Assessment Committee meets.* There are evacuation maps for each floor and each department. Three evacuation drills are held each year. The company has complete plans for its employees to return home; they return in groups of three, and no one goes alone. People living farther away leave earlier. The homes of all employees have been surveyed, and information on them has been filed in the company's computer. A group of 100 employees will remain to carry out disaster prevention activities, plant shutdown, and other necessary tasks. These people are expected to take turns going home to confirm the safety of their families, before returning to the factory. The company also recommends that this group of people not live in areas prone to tsunamis. Over the last three years the company has aided some employees to relocate away from tsunami areas by providing them with loans. These one hundred essential employees will be housed in an existing one-story building and buses in the parking lot. None of the management personnel is expected to return home!

* The Japan Meteorological Agency, upon determining that one or more of the sites under observation for earthquake prediction is showing abnormal behavior, can recommend convening the earthquake Assessment Committee. This Committee of six experts evaluates the instrument readings and decides if an earthquake is going to occur, in which case they recommend to the Prime Minister that he declare a national emergency. The whole process is expected to take about two hours.

Some of the specific earthquake countermeasures taken by this industry at their Yaizu factory site to date are:

1. All buildings have been analyzed for earthquake vulnerability
2. Installation of an 800 kW diesel, and several smaller standby generator sets.
3. The chemistry laboratory has halon installations with automatic release at 80°C.
4. All acid and reagent bottles are placed in drawers that have bottle holders made from PVC piping; this prevents the bottles from knocking against each other, overturning, or sliding.
5. All filing cabinets, copying machines, portable furnaces, etc. have been tied down with brackets.
6. All partitions using glass have been replaced with polycarbonate.
7. Automatic emergency shutoff valves are installed on all gas piping.
8. All compressed gas cylinders have valves that would automatically shut them off if they fall over.
9. All tanks containing fluids have flexible connections.
10. There is a strict company policy of not putting anything on top of filing cabinets, or any other location from which it could slide and fall off.
11. All window panes in the plant are being covered with an adhesive, transparent film to prevent their shattering.
12. The hydrochloric acid tank has been located adjacent to a sodium hydroxide (alkaline) tank. Leakage from one will cause the other to discharge, so that the leak is neutralized.
13. Dike retaining walls are designed to contain 110% of the capacity of tanks containing fluids.
14. All lockers are fixed at top and bottom, and cross-braced.

CONCLUSIONS

It is obvious, both from the author's visit, and also from reports written by other researchers, that Japan is not only rather serious about earthquake preparedness, but is also actively involved in implementing the necessary programs to achieve this objective. The planning and implementation is a nationally coordinated effort, with both long-term and short-term goals clearly identified. The implementation is methodical, and receives financial support from both national and prefectural governments. Another important point to note is that the governmental agencies play not only a regulatory role, but also several extra-regulatory roles in order to promote industrial earthquake preparedness. They have taken on an active support role by providing guidance and economic incentives. On

a comparative basis, Japan is obviously far ahead of the United States in this field, and we have much to learn from them. This, of course, will be to our benefit.

Of the prefectural governments in Japan, probably none is more serious about, and dedicated to, the purpose of disaster prevention than the Shizuoka Prefectural Government. The Earthquake Preparedness Division consists of 18 staff members who are professional people and take pride in their work. The main philosophy behind their efforts is based on the fact that the damage incurred (both life and property) is going to be inversely proportional to the extent of preparedness. Further, and more important, emphasis is placed on preparedness by every single member of society. The relationship between the prefectural government and the corporate structure is extremely cordial, whereby both groups help each other attain their common objective - total preparedness for an earthquake. Corporate emergency preparedness also recognizes the fact that employees generally have family members, and expect employees to care for their families.

Although recently the Japanese earthquake preparedness program has been receiving increased attention in the United States, the focus has been primarily on governmental activities, such as planning and conducting exercises. Industrial earthquake preparedness activities in Japan are as impressive as, if not more impressive than, the activities of the government. It is the industries that have been innovative in this area, in terms of developing hardware to improve earthquake hazard reduction.

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