

THE CITY OF LOS ANGELES EXPERIENCE DURING THE 1994 NORTHRIDGE EARTHQUAKE: MANAGING RESOURCES AND INFORMATION

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SUMMARY

A successful disaster response depends greatly on how well and how quickly resources can be mobilized and allocated. To do this effectively, there must be a system in place that can collect, prepare and send the resources; and a system at the other end that can effectively receive and deploy them.

The information gained from the Northridge Earthquake and the lesson learned by the City of Los Angeles and its surrounding areas can be of great value to jurisdictions around the world in planning and preparing for future disaster and emergency situations.

GENERAL

General Description of the Los Angeles Area

Area and Population

Los Angeles is approximately 460 square miles in area with a 3.5 million people - a population comparable to that of New Zealand. It is immediately surrounded by over 90 smaller incorporated cities and unincorporated Los Angeles County areas.

Los Angeles is the largest city in Los Angeles County, accounting for quarter its area and half its population. It is irregular in shape with boundaries stretching over 60 miles from its northern end in the San Fernando Valley ("the Valley") to its Southern point on the San Pedro Peninsula and sea port and extends east-west approximately 40 miles at its greatest extent.

Resource Problem

To serve its citizens, the City of Los Angeles has over 30,000 city employees, a huge public works department, its own water and power department, and large inventories of equipment as well as the largest building department in the world. Yet even with all these resources it can easily be overwhelmed by a large scale disaster. Just like any other smaller city or town, Los Angeles must depend on outside technical and material resources. It just experiences these limitations at a much larger scale.

Building Stock

The City's 800,000 parcels of land with well over 2.0 million structures presents a dauntingly complex emergency response problem. These structures are mostly of wood frame stucco exterior construction. Most are single family, single story residential buildings; there are also many multi-story apartment and condominium buildings.

In addition, there are large numbers of buildings considered extremely vulnerable to seismic activity, including older unreinforced masonry buildings and nonductile concrete and infill wall buildings. Most of the seismically vulnerable buildings are confined to the more densely populated metropolitan areas.

There are also over 600 large concrete or steel frame structures, mostly used as business offices and medical buildings

The San Fernando Valley

The San Fernando Valley area currently has a population of over 1.2 million. Most of the construction activity in this area has occurred since the late 1940s (shortly after WWII) in response to the demand for housing.

The Valley area developed into a suburban area consisting mostly of one and two story houses and two or three story apartment buildings (many with tuck-under parking).

There are also numerous commercial and industrial buildings - mostly single story. The Valley area is approximately 15 miles east-west and 10 miles north-south.

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The Department of Building and Safety (DBS)

Size

The Building Department's large staff of over 1,000 employees was at the time of the Northridge Earthquake composed of approximately:

- 550 Building Inspectors
- 200 Engineers (mostly civil and structural and smaller number of electrical and mechanical)
- 250 Administrative and Clerical Personnel

Mission

a. During Normal Times

During normal times the Department of Building and Safety staff enforces building, zoning, electrical, and mechanical codes through plan review and building inspection.

b. During Emergencies

During emergencies however, the Department also becomes responsible for (with respect to private property):

Structural safety assessment of damaged buildings and structures and the identification of those that are unsafe to occupy.

Identification of imminent hazards; when these are found, the Department can order abatement including repair, temporary shoring, or demolition.

Estimating the extent of damage, including the total and individual cost of repair of damaged structures.

EMERGENCY PLANNING HISTORY

A series of jolting events helped the City cope with the Northridge Earthquake. These events had a great influence on emergency planning and preparedness efforts.

A. Prior Events and Disasters

1971 Sylmar Earthquake, a major earthquake in the San Fernando Valley (6.4 magnitude):

- Damaged City Hall and brought down structures 30 miles away.
- Led to the establishment of the Emergency Operations Organization in 1980. The EOO is charged with citywide emergency planning and preparedness efforts.

1985 Mexico City Earthquake:

- Collapsed a large number of modern high rise buildings and resulted in over 5,000 deaths.
- The emergency response and rescue efforts lacked coordination and planning.

These factors spurred stronger interest in preparedness and emergency planning.

1987 Whittier Narrows Earthquake:

- Happened in the immediate area of Los Angeles - only 30 miles South of Metro LA
- Occurred in the midmorning and pointed to inadequacies in the City's ability to quickly determine the structural integrity of key City buildings.
- Approximately half the City employees went home for fear of reentering their buildings.
- Reoccupancy of city buildings and establishing emergency response functions immediately after the event became primary considerations.
- As a result, special Damage Assessment Team were established to make immediate inspections of key facilities for structural safety after earthquakes or other disasters.

1989 Loma Prieta Earthquake (San Francisco area):

- Los Angeles sent mutual aid assistance for building structural safety assessment.
- Over 200 Department engineers and inspectors were organized, coordinated, and transported for emergency activities.
- This showed that the Department could coordinate its large staff for emergency response purposes.

Invaluable experience was gained in damage assessment activities. This marked the first use of the ATC-20 standardized placarding and assessment methodology which had been introduced by State Office of Emergency Services only two months before.

1992 Civil Disturbance:

- Resulted in a high degree of coordination with other City Departments and County and State agencies.
- Marked the Department's first extensive use of the Incident Command System in a major response activity. This organizational structure allowed the Department to effectively mobilize and quickly handle its structural safety assessment operations.

All of these events, as well as a series of other national declared disasters in the Los Angeles area (wild fires, floods, mudslides, etc) expanded the experience level of both Department personnel and the staff of other City departments.

B. Emergency Operations

The Emergency Operations Organization (EOO)

The Emergency Operations Organization (EOO) played a key role in the City response to the Northridge Earthquake. It effectively brought together all the critical City departments and resources. All response and recovery operations were coordinated through its divisions and member departments.

The EOO is composed of the Mayor (who acts as Director during emergencies) and the Emergency Operations Board.

which is made up of the general managers of key City departments. Staff from the city departments making up the EOO serve on various committees to develop and improve the City's emergency response plans and recovery plans. The roles of some of the Departments that make up the EOO are

Department of Personnel (Volunteer registration and resource pool)

Department of Public Works (Demolition and debris removal)

Department of Building and Safety (Structural Safety Evaluation)

Police Department (First responders)

Fire Department (First responders, urban search and rescue)

Department of Recreation and Parks (Sheltering)

Department of General Services (Equipment and supplies)

The Emergency Operations Centre (EOC)

An important element of the EOO is its Emergency Operations Centre (EOC). During emergencies the EOC coordinates and allocates emergency resources and coordinates with County, State and Federal emergency agencies.

The Emergency Operations Centre is the most important communications and intelligence link between city departments during an emergency. It puts together in one room representatives from all departments so that they can communicate, coordinate and give mutual support. It also serves as an information centre for all departments when allocating the city's emergency resources. Very importantly, it coordinates with County, State and Federal emergency agencies for additional resources when necessary.

During the Northridge Earthquake the face-to-face contacts in the Emergency Operations Centre made it possible for Building and Safety to quickly communicate needs to other departments. These requests included the installation of safety barricades, making utility cuts, emergency demolitions, and many other needs.

THE 1994 NORTHRIDGE EARTHQUAKE

A. The Earthquake Threat:

Physical Geography

The physical geography of Los Angeles developed primarily as a result of continual crustal movements and is described by the Santa Susana Mountain range, which bounds the city on its north-eastern edge and separates it from the Mojave Desert.

The San Fernando Valley, the area where the earthquake was centred, is defined by the Santa Susana Mountains and the Santa Monica Mountains to the West. The San Fernando Valley is separated from the metropolitan area of Los Angeles by the Hollywood Hills, running generally east-west.

Earthquakes

Los Angeles faces a serious earthquake threat as a result of its position on the Pacific Rim. This threat has seemingly become more ominous in recent years as a result of increased knowledge of the complex web of faults that lie underneath the city. While the locations of many of these faults are known, many faults have not yet been identified and located.

Underlying the Los Angeles basin area are a series of known active faults capable of 6.7 magnitude earthquakes every 10 to 20 years, and 7.3 to 7.6 magnitude earthquakes every 100 years. Some seismologists believe the area possible of generating earthquakes in excess of magnitude 8. More importantly, there exist numerous blind thrust faults whose locations have not yet been discovered. Both the 1994 Northridge Earthquake and the 1971 Sylmar Earthquake (both epicentred in the San Fernando Valley) occurred on previously unknown and unsuspected faults.

The Los Angeles basin is considered a very seismically active area, being located along the edge of the Pacific tectonic plate. It has over the course of millions of years reformed from what was at one time a flat plain to a series of mountain ranges with alluvial fill forming the basin and valleys. The peaks of the mountains can be likened to the peaks of the European Alps, with their bases being buried miles below the surface of the basin.

The San Andreas fault stretches the length of California, and is located approximately 50 miles from the Los Angeles civic centre. Although this major fault has a potential for a greater than 8 magnitude earthquake, an occurrence of this nature it is not considered as threatening or devastating as a major rupture on any of the known or hidden blind thrust faults underlying the metropolitan areas of the city.

B. Time / Magnitude / Extent

On Monday, January 17, 1994 at 4:31 AM, the earthquake threat to Los Angeles became a reality when a 6.7 magnitude rupture occurred 12 miles below the San Fernando Valley community of Northridge. It occurred on an unknown blind thrust fault. The epicentre was located approximately in the centre of a residential area containing approximately 1.2 million people.

EMERGENCY RESPONSE EFFORTS

A. Immediate Response

When the earthquake hit a series of automatic emergency response functions were automatically initiated.

These important functions were:

Assuring that key city facilities could be reoccupied and used by emergency response personnel,

The mobilization of Department technical staff and material resources, and

The activation of the Emergency Operations Centre and the staffing of the Department station.

1. Assuring Reoccupancy of Key City Facilities (Damage Assessment Teams)

The 1987 Whittier Earthquake taught an important lesson. Half its employees went home for fear of the structural integrity of buildings. As a result, a program to immediately assess the structural safety of key city facilities after a disaster was implemented.

Triggered by the earthquake, specialized Building and Safety Damage Assessment Teams (DATs) were automatically dispatched to the City's eight major buildings that would be needed for carrying on emergency response functions. These teams consisted of specially equipped groups of structural engineers and building inspectors with preassigned city buildings. These buildings included City Hall, Parker Centre (the main police building), and six other Civic centre buildings. These buildings, used by city employees during emergency response efforts, must be immediately evaluated to assure that they are not structurally compromised and can be reoccupied.

The team members are equipped with hand-held two way radios, cellular phones and beepers used to communicate with each other, the Department, and any other city agency. They are outfitted with a special uniform, field equipment and insignia identify them and help assure their entry into city buildings and through police lines.

Once key city buildings are reviewed, the Damage Assessment Teams (DATs) are on call to evaluate other city buildings on request. The DAT members are also heavily depended on for establishing and getting the Department command posts up and running.

On the morning of the earthquake, the first team members reported to City Hall at 4:45 AM.

Mobilization of Resources

a. Building and Safety Personnel

All Department personnel carry a wallet card with instructions on what to do in the event of an emergency. These instructions call for them to report to their normal work location or the nearest Building and Safety District Office after an emergency. They are also instructed to tune their radios to a special broadcast channel for instructions.

The Broadcast Company, KFVB, is a very active participant in the City's emergency planning and has agreed to play an important part in communicating information and instructions to City staff during emergencies.

The time and location of the earthquake greatly affected the ability to respond. Most of the Department's staff live in the San Fernando Valley and were directly impacted by the earthquake. Many were awakened by extremely violent shaking of their homes. Structural and nonstructural damage forced many Department employees to tend to personal emergencies and disasters and they were unavailable for city service for two or three days following the event.

Also, the loss of freeway access heavily impacted transportation. Resulting congestion on surface streets created severe transportation delays. A normal 45 minute commute from the Valley to the downtown civic centre could now taking 90 minutes and longer.

So even though the city had a great supply of personnel and material resources, in the immediate aftermath of the earthquake many of the resources were not available for emergency use.

b. Command Post

Once the Department staff began showing up at the District Offices, they needed to be organized and directed. This was done through the field command post.

Establishing the Command Post was a priority but it was fraught with a number of resource and intelligence problems..

- These difficulties stemmed mainly from the lack of decision making information.
- It became important to know about the extent of damage and where it was concentrated so it could be determined where resources were most needed.

The "big picture" of the extent of damage came slowly as department staff reported from their neighbourhoods. Information was also coming in from that collected in the City's Emergency Operations Centre and communicated to the Department Operations Centre (DOC) in City Hall

Based on the early information, the Van Nuys District Office (the Department's major San Fernando Valley office) was established as a field command post on the morning of the earthquake. Eventually three other smaller command posts were established.

Initial reconnaissance information from police and fire department indicated that the Valley area was the hardest hit.

- Fire trucks drove up and down city streets to survey damage.
- Police and fire helicopters performed aerial survey
- The Van Nuys command post lacked power and water, and emergency damage assessment supplies and communications equipment were in short supply.

Electric power had been temporarily disrupted and emergency generators were not available.

Water was unavailable for over a week. The main distribution system started at the North end of the Valley and was heavily damaged.

All phones including cellular were not working, and initial communications were through hand held radios, of which the Department had approximately 70.

An organizational structure had to quickly be established to handle supplies, logistics, the media and converging technical staff support.

c. Emergency Operations Centre

The most important communications and intelligence link that any city department has is through the Emergency Operations Centre. It is a facility developed by the EOO to serve as a centralized information and coordination centre for all city departments during emergencies.

The centre allowed us to quickly communicate with other departments for necessary assistance. We often required structures to be barricaded by Street Maintenance, and emergency demolition and rubble removal to be done by Public Works.

The Emergency Operations Centre was activated around 5:30 on the morning of the earthquake. Building and Safety quickly staffed the EOC from its cadre of 30 employees trained to work the Department EOC station. Even with this number, the constant 24 hour demand placed on them began showing within a few days of the event. All response activities involving other departments and outside agencies and the County were coordinated through the EOC.

B. Organizational Structure (Incident Command System)

We learned from a number of past disasters that a specialized organizational structure had to be immediately established.

Emergency functions are far different than normal operations. Engineers, inspectors, and administrative staff are mobilized and tasked to do something very different, to report to different supervisors and in many cases work in a different environment - field versus the office.

As a result of experience with other disasters we knew we had to manage the quickly moving events and expanding responsibilities of the Department. The specialized structure temporarily reorganized the Department into four main functions placed under the direction and control of one individual. The Incident Command System (ICS) model was borrowed from the Fire Department for this purpose. It includes an Incident Commander and

- The Operations Section, which is responsible for all field operations issues.
- The Planning Section, responsible for intelligence, future direction, and handling the media.
- The Finance section, responsible for tracking and managing the costs associated with the event.
- The Logistics and Supplies Section, which obtains and maintains necessary supplies and equipment.

This system provided for better control of the large amounts of resources that were distributed over the city's large area. The ICS structure was the channel through which all interdepartmental activities were coordinated. Emergency Operation Centre information and major request were brought to the ICS system and acted on by the heads of the ICS Sections.

New issues continually arose, some of which included:

- Emergency demolitions, reentry into red tagged buildings, and possession recovery from red and yellow tagged buildings.
- Re-placarding, the media, tent cities, emergency code changes, documentation, resource needs, and on.

There were daily meetings of the ICS to monitor the fast paced changes and developments that were taking place.

C. Major Issues

There were a number of major issues that began facing us as we geared up for the response.

Communications

After the earthquake there was a vital need for good communications. The field people couldn't talk to the command post. The command post couldn't talk to the Department Operations Centre and as a result everyone was in a state of confusion.

We only had a limited number of old style hand held radios, and there were so many users on the communication system that it was almost impossible to talk to anyone. We had some cell phones and we needed more. But we couldn't get any from the city because they were reserved to police and fire department use. So we went directly to private cellular phone companies and asked for help. They immediately gave us over 300 phones and free unlimited air time. The air time lasted for almost a year after the event, and when we went to return the phones the company told us to keep them for the next disaster.

This demonstrates how much private industry is willing to assist in emergency response efforts after a major disaster.

2. Hotlines

When people started looking at their damaged buildings, they immediately looked to Building and Safety and their local Department inspectors for help. Requests for emergency inspections were coming in at such a high rate (over 200 per hour) that the publicized local phone lines were not capable of handling them. There was a need to increase the number of telephone hotlines, but it took well into a week before additional toll free 800 number lines could be added. A phone bank was created and staffed with department clerical and volunteers.

Staff working the hot lines completed an emergency inspection request form which was documented and then forwarded to a command post. This function ran around the clock for the first weeks and continued for well after 6 months after the earthquake. Because of this we now recognize that a room with dedicated toll free 800 number phone lines must be ready for immediate setup with phones ready for connection.

3. Staffing, Mutual Aid & Volunteer Coordination

It was very becoming very apparent that additional technical staffing would be needed. There were 3 resources from which we could draw for technical help:

- Other City Departments
- Through Mutual Aid
- From spontaneous volunteers who just showed up to help.

The general flow of technical resources is illustrated in Figure 1.

a. Available B/S Resources

Department resources included 550 inspectors and 200 engineers, and 300 administrative and clerical staff who were working well over an average of 12 hours per day, 7 days a

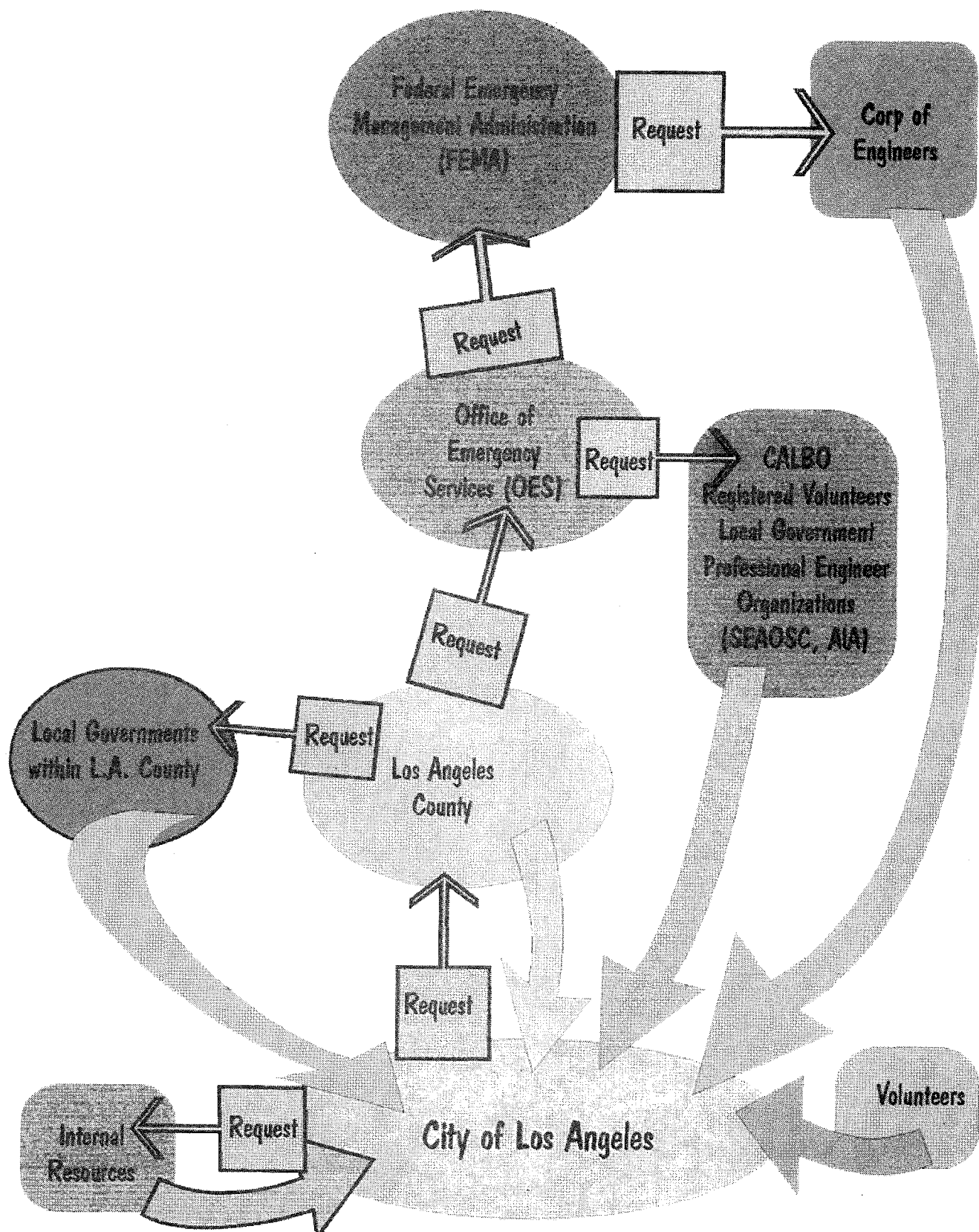


FIGURE 1 Technical resource flow

week. These people were getting tired very quickly. Since most of them lived in the Valley and were personally impacted by the earthquake, they needed time off to rest and take care of their families and attend to their own repairs and relocation. Many of them had to take time to apply for disaster assistance from the Federal Emergency Management Agency, the Small Business Administration, and their insurance companies.

b. Other City Departments

First we looked for help from other City departments. We had assistance from more than 500 engineers and technical people who came from the Department of Public Works, the Department of Water and Power, and the Department of Sanitation. We had fortunately trained most of these people just prior to the earthquake. All they needed was some additional refresher training on the ATC-20 placarding standards and instructions on the documentation procedures. These resources came as a group and were coordinated and managed by their own organizations. This helped immensely by reducing the burden on the command post administrative staff.

c. Mutual Aid

Additional technical support had to come from outside the city through existing state and local government mutual aid agreements. This included the Statewide Master Mutual Aid Agreement and the Mutual Aid Agreement Between Southern California Counties. These agreements stipulate the understandings under which the resources are provided between government agencies. They include important agreements relating to recovery costs for salaries, supplies, and use of equipment.

Whenever mutual aid is provided under a declared state or federal disaster, there are special rules that must be followed if disaster costs are to be recovered. These rules require that certain protocols be followed. The requester must anticipate exhausting all available resources before asking the next level for assistance. All expenditures must be carefully documented for reimbursement to be made.

OES Supplied Engineers

We established direct contact with the State of California Office of Emergency Services (OES) coordinator on the first day of the earthquake and requested additional engineers and inspectors.

The next level of assistance, Los Angeles County, could only provide a few engineers as they had their own problems to contend with- collapsed and damaged County buildings and facilities taxed their limited resources.

The OES engineers and inspectors came with distinct advantages in that they were:

- Pretrained
- Prequalified
- Housed and fed directly through OES
- Some even came with their own transportation.
- The OES supplied engineers from SEAOSC, AIA, CALBO, ASCE and other government jurisdictions.

These agencies have a disaster volunteer registration program under which the volunteers are trained and certified as disaster workers. They came ATC- 20 trained and had all accommodations arranged and paid by OES. The disadvantage was that most were committed for only 3 days maximum.

Professional commitments and the physical difficulties of the work limited their participation. Then a new set of people were sent and had to be oriented and instructed on our specific requirements.

There were some problems with a few of these engineers. Some came to look at major structures and were unhappy when assigned to respond to the less glamorous single family wood frame buildings. They didn't want to look at broken chimneys and collapsed masonry walls. Some others followed their own standards on safety evaluations, which in some cases was more conservative than ATC-20 standards and caused the unnecessary vacating of a few buildings. In some cases, engineers handed out their business card after having just placarded a building to solicit business for themselves. This was regarded as a conflict of interest.

Most of the professional organizations supplying the volunteer engineers are registered with OES in providing assistance during emergencies. SEAOSC has a long standing agreement with OES going back to prior to the 1971 Sylmar Earthquake for technical assistance. SEAOSC provides a resource pool of well qualified design engineers for structural assessment of hospitals, public schools, state universities and state buildings, which come under the jurisdiction of the State of California. OES draws from this pool when requests for local government assistance are made.

Army Corps of Engineers

The OES also supplied Army Corps of Engineer staff through its FEMA resource. Army Corp Engineers stayed for 30 days at time and came as a unit. They were well organized, had a good command structure and required little direction from the command post administrative staff. They were very good and helpful in setting up and handling the processing of inspection requests and documentation.

There were some problems were with the fact that many were not familiar with building construction or earthquake damage. Many had just come from parts of the United States that had suffered flood disasters. A number of them were environmental engineers. They required extensive training at the command post before they were teamed up with Department field staff.

The Army Corp provided continuous long term assistance. Their staff stayed on well into March 1994 and assisted greatly as the Department regular staff transitioned back into normal plan check and inspection activities.

d. Spontaneous Volunteers

The most cumbersome and difficult technical resource to manage was the spontaneous volunteer. Spontaneous Volunteers came from everywhere, including outside California. The principal disadvantages were that they required housing, feeding, transportation and equipment. Their qualifications had to be verified to make sure they were civil, structural engineers or architects, and whether or not they had any knowledge of buildings and structures. We went through large quantities of hard hats, clip boards and training materials because of them.

Many literally came showing up at the airport and asking to be picked up and taken to their hotel. We accepted them by first registering them with the Personnel Department. This was for Workers Compensation liability insurance and emergency notification reasons in case they were injured, as well as to

document who was helping. These technical volunteers were given a brief ATC-20 training and orientation and teamed with a Department field person. The Personnel Department set up a station near the Van Nuys command post to register all the spontaneous volunteers. Volunteers were put up in nearby hotels with which the Personnel Dept had boarding agreements. Costs were documented and forwarded to OES for reimbursement.

As a result of all this help we were able to put a total of 1500 Damage Assessment people on inspection duties at one time. However, because of the limited time that volunteers could stay we had a turn over rate of over 200 engineers per day during the heavy weeks immediately after the earthquake.

6. *Damage Assessment Data Processing*

a. *Data Entry Staffing*

Data entry staffing and equipment needs created a bottleneck in production of daily damage assessment reports. It took 3 minutes to enter the information from report forms. Old equipment and poor screens made it difficult and hard on the data entry staff. Staffing was provided by other Departments and the function run 24 hours a day to keep up with the backlog. Two weeks after the disaster additional, better, and faster monitors and staff arrived with assistance from City's Information Technology Department.

b. *Daily Damage Assessment Reports*

Because of the number of damage assessments done, a simple few page report grew to more than 8 inches in thickness. Distribution grew also, from internally to over 60 outside requesters, including OES, FEM., the Mayor, and numerous other agencies. More and more people wanted copies of this report and their demands soon exceeded the ability to produce enough copies. The computer printers could not keep up with the volume of work. Eventually the information was compressed and placed on a floppy disk which was distributed.

In addition to the information that was collected, we discovered there was a demand for additional information that was not allowed for on our damage assessment forms. There was a high demand from researchers and other government agencies for all types of information, including such things as:

- Type and ethnicity of business displaced;
- Number of people displaced;
- Inventory type and loss.

Data files were sent to Public Works for plotting and hard copies of reports were stored for future reference.

7. *News Media*

Requests for information from the news media were constant. They wanted to know where, why, and what we doing about the disaster. Most often we did not have access to this information ourselves. Newspaper reporters from around the world were constantly calling for information. The television media was demanding and always wanting to shoot coverage of damage and field inspectors doing their job.

We faced challenges from the media, who demanded to know why buildings collapsed and who was at fault. There were

attempts to blame "the inspector" for not doing his/her job. We had to carefully explain what we are doing and why.

The media was very helpful, however, in getting information out to public on the meaning of placards and what damage to be concerned about. Department representatives appeared on radio and television shows to explain the placarding system. It is important to have people to do this when need arises. Pressure from media was useful in getting action on the steel frame building inspection ordinance.

The media was on our side in getting stronger codes and retrofit standards in place during the response and short term recovery period. After some time though, when the ground stopped shaking and fewer buildings were seen in disrepair, they started to refocus on the costs and the impact of all these measures.

8. *Command Post Issues*

Within the first week, the large numbers of damage assessment workers and the heavy volume of inspections placed extraordinary strains on the Van Nuys Command Post and its operations staff. It had to expand in physical size. The original 50 by 30 room had to be restricted to command post staff only. As the necessity arose:

- Outdoor sheltering and lighting had to be provided.
- Temporary canopies had to be leased to protect disaster workers from the rain.
- Outdoor lighting, banks of phones, and two way radio communications all had to quickly be arranged.
- Water and food had to be stockpiled daily
- Portable restrooms had to be added.
- Supplies were continually being ordered
- Placards had to be quickly printed up.
- The original 20,000 placards of each colour that were stockpile were quickly exhausted. Over 100,000 of each colour were quickly obtain through city print shop.
- A shortage of banner tape created when the police dept exhausted the supplies throughout the state, required us to go all the way to a neighbouring state to find a supplier.
- All these costs were reimbursable through OES and FEM..
- Parking became a serious issue and was handled by overflowing into adjacent public and private lots and the street.
- Work time sheets and worklogs were very difficult to maintain because of the constant turnover of personnel and the surfacing of new problems. This was very important because reimbursement from OES and FEM. are based on audits of this information.
- The training and dispatching of the constant flow of new volunteer help required us to dedicate staff solely for this purpose.

- Every day a room full of new engineers and architects were given an orientation on the city and how to document damage assessment information.
- There were lots of media people, who were always wanting to talk to someone and get the story on what was happening
- And then there were the daily escorts and tours of the damaged areas by politicians, bureaucrats, the media, and foreign visitors. The Northridge Earthquake became such an attraction that we had to reserve two vans and develop 4 different sightseeing tours.

9. Structural Safety Assessment of Damaged Buildings

a. The ATC-20 (Applied Technology Council 20) System

For structural assessment purposes, we used the ATC-20 Post Earthquake Safety Evaluation of Buildings methodology. This system was established by Office of Emergency Services in 1989 as a standard method for identifying structurally hazardous buildings. It uses three placards to identify buildings that have been inspected.

RED	-	Unsafe
YELLOW	-	Limited Entry (Restricted Entry)
GREEN	-	Inspected (Not necessarily undamaged)

The system, as used, was limited to a rapid and cursory inspection intended to assure that occupants would not re-enter an unsafe building. However, the system was reluctantly expanded during previous disasters to include collecting the cost of damage. This is very difficult for engineers and inspectors to do, especially since they are untrained as adjusters. It is not possible for them to accurately estimate damage costs, especially in a very limited time, generally lasting 10 to 15 minutes.

b. Personnel Deployment

At first, a house to house, block by block, structural safety assessment began at the north end of the San Fernando Valley but this was abandoned when it became apparent that it was taking too long. We went to an inspection by request system with priority being given to the most heavily damaged areas.

A dispatch system was worked out at the Van Nuys command post using requests for inspection forms completed by Hotline call-ins. Staff were assigned to a specific geographical area and given packets of requests. In the process, when seriously damaged buildings were found they would be documented and placarded. DAT evaluation of critical facilities was conducted as previously described. Emergency requests were received through EOC from the Police, Fire, and other Departments, including:

- Reassurance Team functions.
- Reinspection.
- Shoring and Demolition
- Possession Recovery
- Detailed structural evaluation of Yellow tagged, or those that were questionable.

10. Unanticipated Problems

A number of unanticipated problems soon appeared.

a. Placarding System

(1) Political Issues

Even though approximately 50% of the damage was concentrated in two City Council Districts, we began getting calls from the other 13 Councilpersons complaining that their Council Districts were being neglected.

This meant that we had to pull inspection personnel out of the more heavily damaged areas to respond to their demands.

(2) Non Standard Use and Interpretations

Because training on the ATC-20 system was often minimal, it was not uncommon to find that different standards of assessment were being applied by different groups. In the worst case the system degenerated to simply describing the degree of damage: Red: very badly damaged, Yellow: medium damage, Green: minimal damage.

b. Disaster Applications Centres

Then there was the additional burden placed on the department to provide staff for special disaster centres being set up throughout the damage affected areas.

(1) Victim Assistance

As soon as the earthquake hit, the Mayor, the Governor, and the President declared the Los Angeles County area a disaster area so OES/FEMA disaster assistance became available to everyone. Over 13 Federal Disaster Applications Centres (DACs) were opened throughout the greater Los Angeles area. We had to staff those within the City of Los Angeles with at least two technical people familiar with the code and permit procedures. This took up well over 26 technical staff.

The centres included a number of organizations such as:

Office of Emergency Services and the Federal Emergency Management Agency Housing Department

Red Cross

Small Business Administration

Housing and Urban Development Los Angeles County Health Dept Internal Revenue Service and Franchise Tax Board Los Angeles City Department of Building and Safety

However, as it turned out, Building Inspectors provided the most valuable help to victims. The public relied heavily on their expertise and assurances. Department staff spent much of their time hand holding victims, especially apartment tenants. They came describing their damage, and most left confident that their buildings weren't going to collapse on them.

Within a week after the earthquake, a tie-in between housing assistance and Building and Safety damage assessment information was developing. The Housing Department, which normally would verify the occupancy condition of a damaged

building before providing assistance, didn't have enough Housing Dept inspectors to handle the work. The Housing Department, to our alarm and considerable objections, began using a red or yellow placarded building as the criteria for providing housing assistance. Worst of all, they began using the daily Department damaged buildings printout for this purpose.

(2) Housing Department Tie-in with Building and Safety Placarding

This unanticipated and unplanned use by the Housing Department of Department's tagged colour as a criteria for aid placed heavy burdens on the damage assessment staff.

The Housing Department provided important displacement assistance to home and apartment occupants that were displaced.

"Section 8" HUD subsidies provided the difference between pre-earthquake monthly rents and new rent amounts. This was especially critical to low income renters and fixed income elderly persons.

The DACs played a critical role in placing victims in livable housing. Building and Safety staff helped tenants by working with the Housing Department through telephone dispatching of reinspection teams to specific addresses.

There were problems with tenants in undamaged portions of a damaged apartment building now arguing for a "red placarding" so they could get better housing, just like their neighbours.

c. Reassurance Teams

Many recent immigrants are from countries where aftershocks are a major concern. Within days over 30,000 people were living in parks and open spaces. Of course, it was going to rain. The Mayor and EOB reluctantly decide to have the National Guard pitch tents. This is not something that should be done, as it only prolongs victims' stay in temporary shelters and created health, sanitation and major security problems.

Building and Safety staff, Los Angeles County Social Services, the Housing Department, translators, community leaders, ministers, and local priests formed into Reassurance Teams to encourage them to return to their homes. Teams went out every night to the parks and spoke with victims trying to get them back into their homes and apartments. Department technical staff assessed the safety of the buildings in question and either tagged them as being unsafe or reassured occupants that it could be reoccupied. Buildings found hazardous were red placarded and tenants given housing through the Housing Dept. with the difference in rent subsidized for up to months.

d. Reinspection and Possession Recovery

As the number of tagged buildings grew so did the requests to reenter buildings and retrieve personal belongings. Owners of placarded buildings, especially those with tenants and contractual leases, began challenging the tagging. Two special teams of engineers and inspectors were specifically tasked to handle these problems. Special telephone numbers were provided for the public as the numbers grew.

e. Reinspection Teams

Engineer and Inspector Reinspection Teams were specially tasked to reinspect tagged buildings or to respond to requests

from DAC staff to verify the condition of a building or tenant space for eligibility for "Section 8" housing.

f. Possession Recovery Teams

Special Teams of engineers and inspectors were tasked with assisting owners in securing possessions in red and yellow tagged buildings. A set of procedures had to be developed which allowed for different possible ways owners could get in and retrieve their possessions. They could secure their own engineer who provided a procedure that safely allowed tenants and owners in. This included temporary shoring and escorting through the building.

Another method involved Building and Safety engineers, the Personnel Department and Building owner and tenants. This procedure was laborious and involved verifying and documenting every individual who sought access. In addition, those re-entering had to sign a "hold harmless" statement specifying that they would not hold the City liable if anything happened to them. In some cases where it was considered too dangerous to reenter, the Fire Department's Urban Search and Rescue team (USAR) would go in and pull out specifically requested possessions, such as vital records or valuables.

RECOVERY

A. Demolition of Damaged Buildings

Based on an ordinance put in place to remove 1992 riot damage buildings, free demolitions were offered to all owners of buildings with over 50% damaged. A notice of hearing was sent to all owners of buildings that were severely damaged, red tagged buildings first, then followed by those yellowed tagged. Owners of buildings damaged 50% or more were given 15 days to appear and explain why their buildings should not be demolished. Buildings subject to immediate removal and demolition were referred to a special demolition division in the Department of Public Works.

The DPW had a pool of demolition contractors who would bid on the demolition work. Within a week or so of DPW getting the referral, the building was gone. FEMA paid for all demolitions, including all permit and inspections costs. There was also a significant amount of coordination with Los Angeles County with respect to asbestos and other hazardous materials, and demolition load clearances for transportation to dump sites.

Swimming Pools - because of the large numbers of swimming pools, problems with mosquitos, and breached pool protection enclosures had to be addressed. This was handled in coordination with the Department of Water and Power, who fenced the sites (apartments and homes); the County Health Dept, who had a listing of all public pools (those associated with apartment buildings); Building and Safety; and the Los Angeles County Hazardous Materials Unit, that cleaned sites of toxic substances.

B. Short Term Recovery

The pattern of damage became evident within two to three weeks as demolition and temporary shoring and repair of damaged buildings began taking place.

Normal Department plan checking and inspection operations were held to a minimum in order to handle the large volume of

requests for safety inspection.

The Army Corp took up more of the clean up safety inspections as time progresses, approximately through April 1994.

Streamlined permit and inspection procedures were put in place and a "no fee" permit system for earthquake repair was instituted. (The costs to the City in terms of lost revenues to pay staff was picked up by FEMA).

A tilt-up building retrofit ordinance and other emergency repair ordinances were implemented.

C. Debris Removal

A FEMA funded debris removal program was handled by the Department of Public Works. The program was free to owners and lasted into June of 1995 and was responsible for removing over 2.1 million tons of earthquake debris at curbside.

A staging area was set up at the site of the old General Motors automobile assembly plant. Debris was sorted and recycled. Over 90% of debris collected was recycled, thus saving precious landfill capacity. This rate could have been greater if property owners had been required to separate domestic garbage from debris. This program was very cost effective and had very low administrative costs.

D. Engineering Task Force Studies of Damage

Within a month after the earthquake, the intensity of the immediate response began to subside. Debris removal and demolition of the most heavily damaged buildings was underway.

Many of us in the Department were becoming concerned about losing a great opportunity to learn from the disaster. The damage caused by the earthquake cut across a broad spectrum of construction types. Even buildings constructed under recent codes had suffered unexpected damage. A number of Engineering Task Force Committees were formed, composed of Department staff engineers and volunteer private engineers and architects. Most of these engineers came highly qualified and had extensive specialized experience in the design of many of the buildings that were damaged. Eleven Study Committees were quickly created to survey different classes of structures and develop findings and recommendations.

These recommendations were quickly incorporated as emergency code changes that immediately affected repairs and new construction. The recommendations have also been adopted as permanent code changes, which include five retrofit strengthening standards.

IMPROVEMENTS TO THE LOS ANGELES CITY BUILDING CODE

Over 100 private and government engineers and architects from SEAOSC were involved in developing emergency code changes and new retro fit standards for:

- Concrete Tilt-up Buildings
- Cripple Wall Buildings
- Wood Frame Apartment Buildings
- Unreinforced Masonry Buildings
- Nonductile Concrete and Infill Wall Buildings
- Steel Frame Buildings

- Concrete Parking Structures
- Hillside Buildings
- Nonstructural Hazards (Glazing, Suspended Ceiling, Computer Floors, Storage Racks)
- Base Isolated Buildings
- Soils and Grading

E. Modifications to Emergency Response

Every disaster has its unexpected benefits. After the Northridge Earthquake, citizens of Los Angeles and other communities poured in over \$1 million in unsolicited donations to the Office of the Mayor. This money was used to enhance the Emergency Operations Centre by: doubling its size and number of stations; computerizing it with a message exchange system using PCS and lotus notes; and creating a Local Area Network connection between the EOC and each Department's Disaster Operations Centre.

MAJOR EMERGENCY RESPONSE CHANGES AS A RESULT OF NORTHRIDGE EARTHQUAKE

Improvements in the hand-held radio system to 800 MHz. This included new relay towers throughout the city in place of the single one on Mount Lee. The Mount Lee tower was found to have been damaged as the result of the Northridge Earthquake and overloaded with numerous antennae, making them susceptible to failure in another disaster. The radios can be easily programmed to communicate with any other emergency responder agency - such as Police, Sheriff, Fire, Highway Patrol.

EOC Improvements. As a result of over \$1 million in donations to the City, the EOC was doubled in size and number of stations per department; computerized with lotus notes for message logging and transmission; had a power backup system installed; communications to OES through satellite linkup were created; and a direct computer linkup with each department's Department Operations Centre was developed.

F. Distribution and Cost of the Northridge Event

In the period following the Northridge Earthquake, over 110,000 buildings had been inspected, some numerous times. Done over an eight week period, this was the largest damage assessment ever done.

- STRUCTURES PLACARDED RED - approximately 2000
- STRUCTURES PLACARDED YELLOW approximately 11,000
- Total number of apartments and dwelling vacated - in excess of 25,000
- Even though the remaining number were green tagged, all suffered damage, many extensively.

After an additional 2 months, many more inspections had to be done because of after shocks; the total number of structural safety evaluations made was over 250,000. Although not known for at least a week or more after the event, there was widespread distribution of damage throughout the greater Los Angeles area. While most of the damage occurred in the San Fernando Valley, significant damage also occurred in portions

of central Los Angeles, and in surrounding cities, including the Santa Monica area.

The underlying geology and age of the buildings had a great effect on the damage distribution.

Total costs of the Northridge Earthquake to date have exceeded \$30 billion:

- 2/3 attributed to private property
- 1/3 to government facilities.

Costs to Federal, State, and Local Government account for \$17.5 billion of the total amount.

57 fatalities are directly or indirectly attributed to this event, with 16 people dying as a result of one collapse - the Northridge Meadows apartments.

Peak ground accelerations exceeded those predicted, and in several locations were close or exceeded 1 g.

CONCLUSIONS AND LESSONS LEARNED

We were fortunate to have had a centralized resource provider which quickly assembled, transported and accommodated the technical staff we needed. The OES coordinated program of providing volunteer engineers and inspectors worked very well for us. The longer term staff support and technical assistance provided by the Army Corps of Engineers made possible our ability to reallocate our staff to normal functions without reducing the safety assessment process.

We suffered from backlog and delays in reporting the listings of damaged structures. This was due mainly to the use of a manual data collection system. The use of currently available technology such as a Geographic Information System to map the data, a Global Positioning System to automatically locate sites, as well as digital cameras and cellular telephone and radio communications to transmit the data would have greatly improved our speed and accuracy in collecting this information.

Our City and Department are both large and compartmentalized. The normal operational structure is not well suited for major emergencies where events are fast developing and time is compressed. A separate and distinctly different organizational structure helped us to bring together various parts of our Department into an effective emergency response system.

We found that a variety of resources are available in the response and early recovery phases of a disaster. Under normal circumstances, these resources are not available.

We recognized the desire for most people to come to the assistance of disaster victims. We benefited from this spirit of cooperation and made use of engineers and architects to provide technical assistance when it was needed the most.

We were encouraged by the emergency mentality to make necessary changes in the emergency preparedness system and to stockpile materials and resources for future disasters.

We took the opportunity to learn from the disaster by setting up damage study committees as soon as possible and developing findings and recommended code changes, especially those that we knew would meet resistance under normal circumstances.

We also worked to develop emergency repair criteria that not only allowed repair to existing levels but upgrade to higher standards of construction.