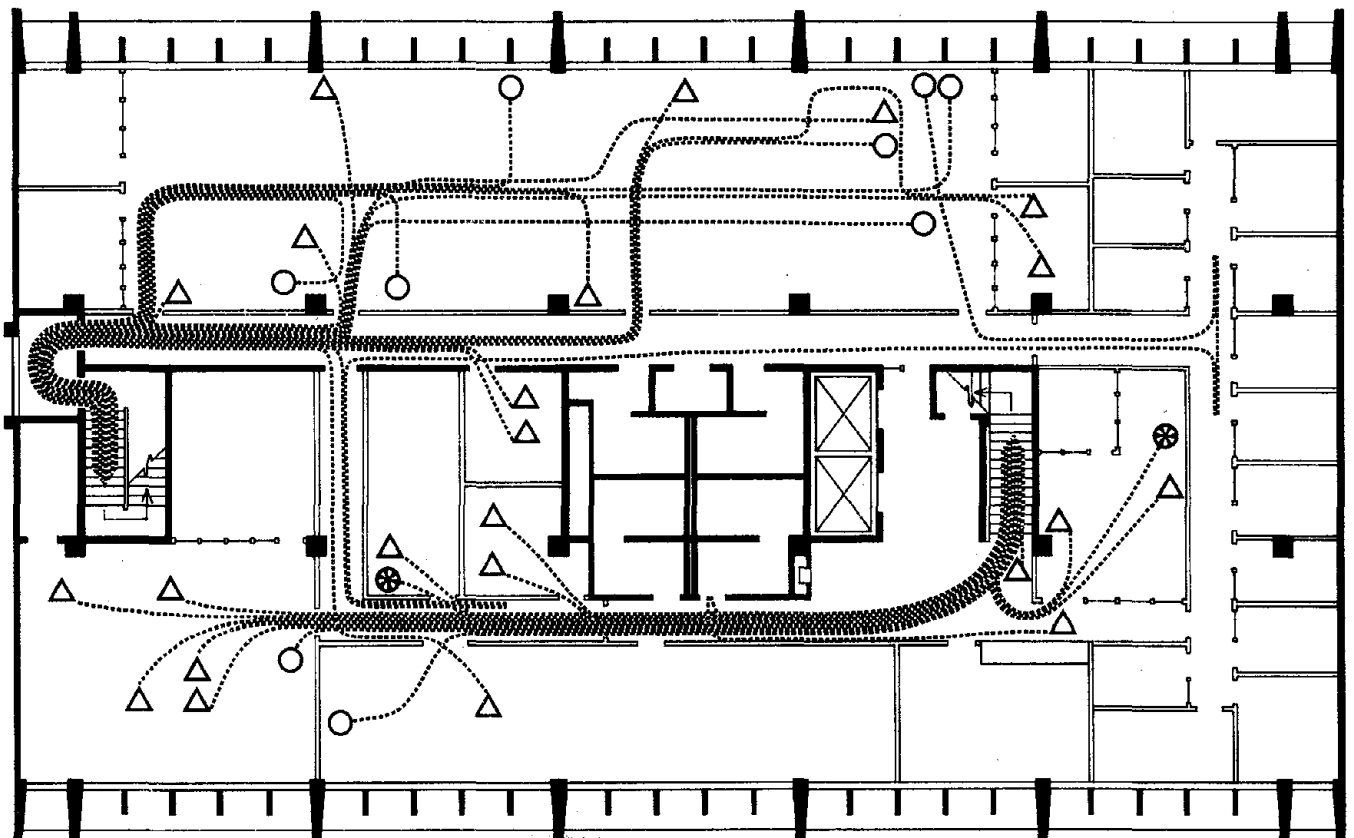


Imperial County Services Building

*Occupant Behavior and Operational Consequences
as a Result of the 1979 Imperial Valley Earthquake*

Christopher Arnold, Michael Durkin, Richard Eisner, and Dianne Whitaker



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August 1982

A study conducted by Building Systems Development, Inc.,
San Mateo, California
under a grant from the National Science Foundation,
Washington, D.C.

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Opinions, findings, conclusions, and recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the employees of Imperial County or the National Science Foundation.

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Randy Rister, Director of Buildings and Grounds, has given unselfishly of his time to provide us with chronological documentation of the relocation and recovery process. He is an unequalled source of information about the impact of the 1979 earthquake on the County.

This study could not have been completed without the assistance and cooperation of the employees of the County of Imperial who were occupants of the County Services Building at 4:16pm on the 15th of October, 1979. Their frank responses to our questions provide the basis for this study.

Preface

At the time of the October 1979 earthquake in Imperial County, Building Systems Development was beginning a study on the effects of earthquakes on hospital function. The damage to the heavily occupied Imperial County Services Building in El Centro provided a unique opportunity to study the effects of a severe, but not disasterous, earthquake on the occupants of an institutional building. In addition, it provided an opportunity to record the operational consequences of the event on the workings of the 11 county departments within the building.

Although the engineering effects of earthquakes in individual buildings have been extensively studied in recent years, little work has been done in documenting precisely how people behave during an earthquake and what the operational consequences of an earthquake are, in terms of disruption, time and cost. More detailed information is needed on behavior because knowledge of how people act during and immediately after a severe earthquake can assist us in giving advice and training on how to act in ways that will reduce panic, injury or death in future events. And we need to know more about operational consequences because the shutting down of vital public services (or private commercial institutions) brings hardship to those who depend on them, and represents a serious financial drain on local, state, and federal institutions.

After the October earthquake the Imperial County Services Building represented a unique laboratory for study. It was the only building in El Centro that was over four stories in height. It was a 1968 design with an extensive array of seismic instrumentation, and full data available on its engineering design and construction. Due to the high incidence of earthquakes in the Imperial Valley the entire locality was well instrumented, and the building itself was better instrumented than any building in history that has suffered severe damage.

Since the building accommodated county offices and public service employees, a questionnaire administered to the occupants was treated as a job task. Thanks to the excellent cooperation of all the county departments, almost all of the occupants of the building at the time of the earthquake completed the questionnaire.

The information obtained in this study refers to a particular group of people, in a particular building, suffering a specific type of ground motion resulting in a specific damage pattern. The exact circumstances will never be repeated. However, our existing information about these issues is so scarce that the information obtained from this building for the first time converts many issues of speculation into specific knowledge.

This study tells us exactly what the occupants were doing when the earthquake struck and how they reacted. We learn much about the effectiveness of previous training, the importance of familiar actions, and the effect of specific emergency drills. We find out how long it took to relocate all the dislodged departments, where they went, how it affected their work, and the problems of departments perceived as socially undesirable by new neighbors. The costs, in time and money, of the damage and eventual demolition of this single building gives useful information on the consequences of a more serious event in which many institutions, public and private, suffer similar disruption and relocation.

At the time of this writing, a new building is under construction and is scheduled for occupation in October 1982, three years after the event. The new building is a two-story light steel frame structure, located on the same site, containing the same floor area as the original building.

SUMMARY AND CONCLUSIONS

A. Introduction

On October 15, 1979 the six-story Imperial County Services Building in El Centro, California, was severely damaged in an earthquake: 44 persons were injured, none seriously. At the time, the building, which housed 11 county agencies, was occupied by 123 people. This study reports on two issues: occupant behavior in the building, and the relocation process for the county agencies that were forced to move, through the closure and eventual demolition of the building.

B. Occupant Behavior

Questionnaires were administered to the 118 building occupants still in county employ. At the time of the earthquake, occupants were widely distributed about the building, performing a variety of office-type tasks.

The first action of 36% of the occupants was to get under a desk; 15% stood in a doorway (these are the two most frequently recommended actions); 37% stayed put.

Of those that got under their desks, for 30% the desk moved away. Of these 1 was injured by movement of the desk. Seventy percent (70%) based their first action on previous instructions in school, drills in the building, or previous experience in earthquakes.

Within 4-5 minutes the building was evacuated. However, although the evacuation alarm was sounded, none reported hearing it. Fifty percent (50%) of the occupants evacuated the building because it seemed sensible.

Mapping of the occupants' exit routes revealed a most unexpected pattern of usage of the two exit stairs from the building. On the third, fourth and sixth floors, 57 persons exited down the west stair and only 2 from the east stair.

Although this pattern of use produced no problems, if the predominantly used stair had become blocked, a concentration of evacuees down this one exit might have caused very dangerous congestion.

The reason for this pattern was that the building had suffered bomb threats and several emergency evacuations had taken place. Because the elevator lobby was regarded as a place of danger under bomb conditions, occupants were advised not to use the stair that led to the lobby. Hence, in the earthquake, most occupants followed the bomb threat procedure, even though the lobby stair was safe, usable, and in many cases closer.

C. Injuries

Forty-four (44) people, or 37% of the occupants were injured. No injuries were serious, and most resembled those which normally occur in offices: people bumping into doors, bruising themselves on the corners of desks and the like.

D. Relocation

The condition of the building after the earthquake was such that it was necessary to relocate all eleven county agencies. The relocation was roughly divided into three phases.

Phase One was the immediate ad hoc relocation of departments to ensure some essential services, such as providing welfare checks, were maintained. This phase lasted approximately two weeks.

Phase Two lasted for about the next six months, and involved longer term moves into rented or loaned properties, or other county facilities. Furniture and equipment were moved from the ICS Building during this period.

Phase Three was signaled by the decision to demolish rather than repair the damaged building. As a result, temporary locations had to be accepted as longer term than had at first been anticipated. Phase Three lasted for approximately two and a half years.

Special problems were faced in the relocation of some departments. In particular, the largest department, that of Welfare, was forced to move three times. Space for it was leased at a nearby shopping mall, but complaints from other tenants drove the Welfare Department away. Finally a long-vacant building in the downtown business district was selected as the new location.

The Public Works Department suffered great communication problems in Phase One, using vehicle radios and pay telephones. In Phase Two it moved into the Naval Air Facility, eight miles from town with strict access and security, isolated from the public and the Board of Supervisors.

E. Cost

The cost of relocation is estimated at approaching one million dollars, including lease of office space, moving and refiling, repairing and replacing equipment, and shoring and engineering studies on the damaged building. The cost of replacing the building is \$4.3 million: the total time from the earthquake to occupation of the new building is 3 years.

F. Conclusions

1. Previous experience in earthquakes and in drills strongly influenced people's behavior in the immediate aftermath of the earthquake.
2. Decisive action by individuals exerted a strong influence on the behavior of others at the time of the emergency.
3. Although the building had two escape stairs, 79% of the occupants exited from one stair, although many of these people walked past the other exit stair to reach it. This pattern was caused by recent evacuation drills related to bomb threats which required the use of that particular stair.
4. Drills are very effective, but the rules must be simple and evaluation of alternatives is not likely to be done in an emergency.

5. At this level of building damage, with severe structural failure but no collapse, injuries were widespread but minor, many being comparable to normal injuries suffered in offices.

6. Although building contents, including heavy filing cabinets, desks, etc., toppled or were displaced, people suffered only minor injuries.

7. Although a number of windows were broken, no one was injured by broken glass.

8. No one was injured by falling light fixtures, air diffusers, or other ceiling-supported objects.

9. The major operational costs were leasing and associated costs caused by the need to relocate for a long period of time.

10. Although required to relocate, county services were resumed after a very short period of time.

11. It was clear from our interviews that repair of the County Services Building was not acceptable to the community, based on the fact that 68% of the building occupants who completed a questionnaire, said they would not return to work in the building had it been repaired and they were assured of its safety.

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I. INTRODUCTION

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A. The Earthquake

At 4:16pm, Monday, October 15, 1979, the Imperial Valley in Southern California experienced a "moderate" earthquake. The Richter Magnitude assigned to this earthquake varies depending on the location of the recording station, 6.4 and 6.6 being the two most commonly cited. The epicenter (the point on the Earth's surface directly above the point of first rupture of an earthquake) was located on the Imperial Fault, 16km (9.6 miles) east of Calexico, approximately 8km (5 miles) south of the U.S.-Mexico border, and 29km (18 miles) from the city of El Centro.

The quake produced approximately 30km (18 miles) of surface rupture along the Imperial Fault, which runs in a northwest-southeast direction. The duration of strong shaking lasted approximately 8 seconds in the horizontal direction, and 6 seconds in the vertical direction.

Following the main shock, the area continued to experience many aftershocks, moving in a north-west direction from the initial epicenter, along the Imperial Fault. The three largest aftershocks each recorded a Richter Magnitude greater than 5, occurring approximately 6½, 7, and 7½ hours following the main shock. In addition, the area experienced a 4.9 Magnitude aftershock, 24 hours later. Property loss, including damage to buildings, canals, and crops, is estimated at 30 million dollars for the 1979 quake.

The October 15, 1979 earthquake was the strongest earthquake in the 48 contiguous states since the Sylmar-San Fernando, California shock on February 11, 1971, which was also of Magnitude 6.5, but killed 65 people. The Imperial Valley earthquake was felt within a 300 mile radius; in California, Arizona, Nevada, and Mexico. It was reported that tall buildings swayed in such distant cities as Phoenix, Las Vegas, and San Diego. The damage, however, was concentrated in the Imperial Valley.

The earthquake resulted in no loss of life, and the most common complaint was that of spilling library racks, store merchandise, and other shelved items. There was some property damage but, in general, the only major structural damage was primarily to very low quality commercial structures. The majority of the commercial buildings located in the affected towns are one and two-story structures of varying age, and fall into one of two groups: relatively old buildings of unreinforced masonry, or recent structures of comparatively modern architectural and structural design. Serious damage was generally confined to parapet damage, veneer loss, architectural damage and/or structural cracking which necessitated condemnation.

B. The Building

The Imperial County Services Building was an office building designed in 1968 to house county service agencies, including the Welfare, Planning, Agriculture, and Public Works Departments. Since its completion in 1971, the building occupancy had expanded to include about 250 employees among eleven departments. However, at any one time this number would be considerably less, since many of the employees were field personnel.

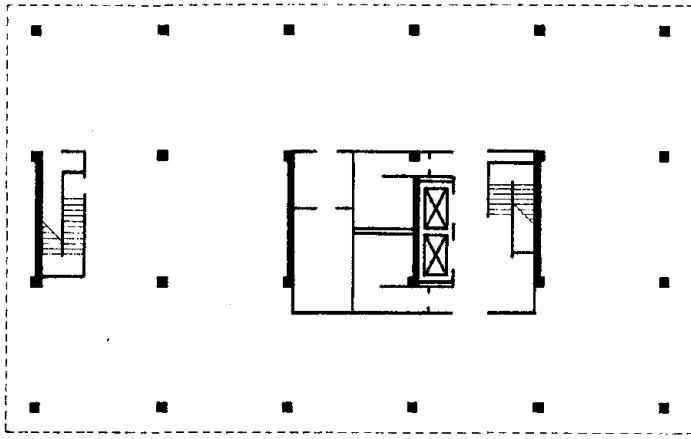
The building was a six-story, reinforced-concrete frame and shear wall design of pre-cast and cast-in-place units. The plan was rectangular, roughly 136 by 185 feet, with all the offices located in the upper five stories. This "box-like" portion was supported by free-standing columns, spaced on a 25-foot square grid, at ground level. Only 15% of the plan area of the upper portion of the building was enclosed at ground level, forming an entrance lobby with elevators and stairs at one end, and a secondary staircase at the opposite end (Figure 1, First Floor Plan). Mechanical equipment was housed in a small penthouse.

The exterior treatment of the building was handled in one of two ways, depending upon the orientation. The longitudinal elevations, which faced north and south, were predominantly glass behind a concrete "sun-screen" arrangement of pre-cast vertical fins, cast-in-place elongated columns, and horizontal "platform" extensions of the floor slabs, all extending five to six feet outward from the window plane. The short, or end elevations, facing east and west, were entirely of exposed concrete, with no windows. The west elevation was slightly different, in that it was perforated vertically, about mid-span, with openings at stairway landings. These elevational treatments occurred on the second through sixth floors only (Figure 1, East and West Elevations).

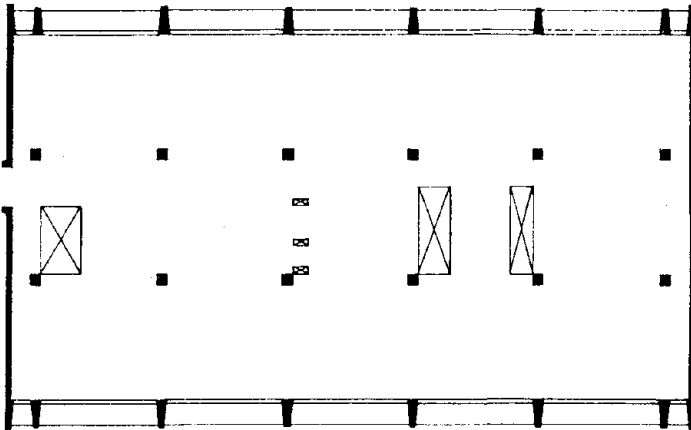
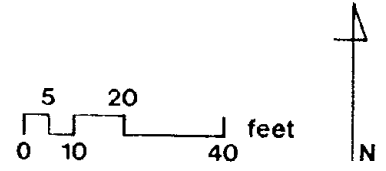
Vertical loads were carried by four reinforced-concrete frames that ran the length of the building. In the transverse direction, reinforced-concrete pan joists supporting concrete floor slabs, were supported on the longitudinal frames. The building rested on a concrete pile foundation system, extending 45 to 60 feet into the ground, which was interconnected with reinforced-concrete grade beams.

Lateral loads were resisted by the four concrete frames in the east-west direction and four reinforced-concrete shear walls at the first floor level in the north-south direction: there were no longitudinal shear walls in the building. Above the second floor, the two exterior end walls were the only shear walls in the transverse direction. These walls, which were the full width of the building, continued from the second floor to the roof. At the second floor the west shear wall was off-set horizontally some five feet, and its length decreased from 85 to 25 feet, before continuing to the foundations. The east shear wall had a similar off-set at second floor level. However, the shear forces had to be transferred some thirty feet horizontally through the second floor diaphragm before continuing to the foundation through a 25 foot long shear wall at the ground level. In addition, between the first and second floors, two more 25 foot long shear walls ran in the transverse direction between the center two frames.

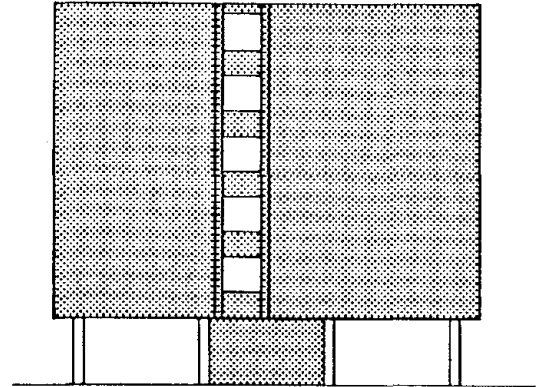
The upper floors of the building exhibited almost identical interior planning. The center area of each floor was devoted to the service core, which consolidated the elevators, a stairway, and restrooms into one location. Around this service core was located the main corridor from which the departmental offices were entered. Interior partitions were constructed of demountable steel studs and gypsum board; those enclosing the service core were 2-hour walls constructed of 4-inch steel studs with 1-inch of plaster each side. In addition, several of the individual offices had interior glass panels to the side of the door.



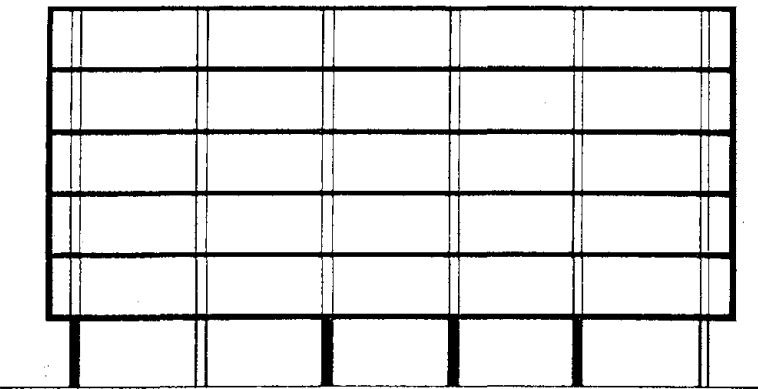
FIRST FLOOR PLAN



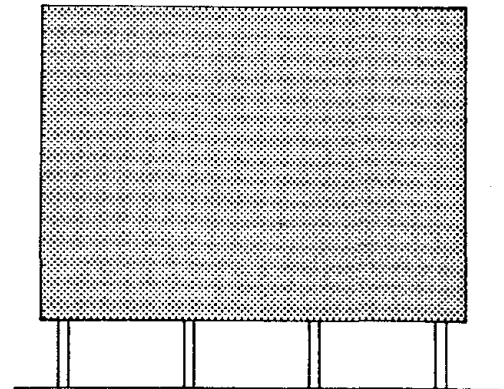
TYPICAL FLOOR PLAN



WEST ELEVATION



LONG. SECTION



EAST ELEVATION

Figure 1. Imperial County Services Building: plans, elevations, and section.

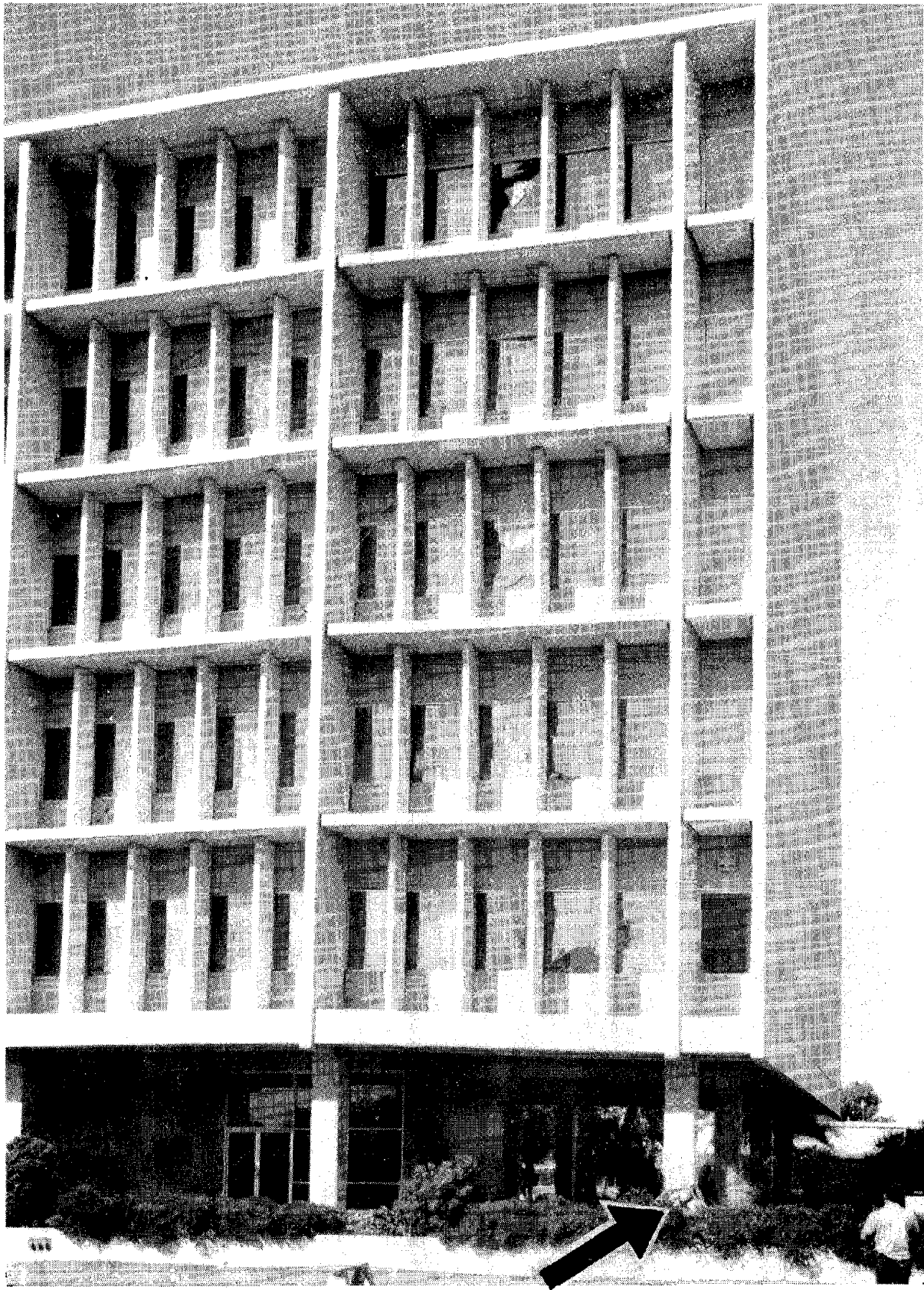


Figure 2. Damaged east end of the Imperial County Services Building. Arrow points to line of columns that failed at their bases, causing floor fractures and sagging at this end of the building.

C. The Damage

The Imperial County Services Building was located approximately 7.6km (4.7 miles) southwest of the Imperial Fault and 29km (18 miles) northwest of the October 1979 epicenter. In downtown El Centro many older, unreinforced masonry and nonengineered commercial buildings suffered minor structural damage. The County Court House (located across the street from the County Services Building), built in 1924, suffered minor cracking and plaster damage. In contrast, the Imperial County Services Building sustained significant structural damage during the earthquake, and probably came close to collapse.

Damage was concentrated at the east end of the structure which suffered a first-story failure of all four columns located at this end of the building. Concrete columns were badly shattered in the area immediately above the ground, exposing the column reinforcing. The horizontal tie bars had opened up, allowing the vertical bars to buckle severely. From observation, it appeared that the columns collapsed vertically without leaning in any one direction. From measurements, it was determined that the columns shortened approximately 9 inches during the main shock, and an additional 3 inches during the strongest after-shock (Figure 2).

The settlement of these four columns resulted in a hinge forming at the east end of the building, along the adjacent interior column line. A major crack appeared, running the width of the building, at this location in all the floor slabs. The east shear wall leaned outward noticeably.

Elsewhere in the building, widespread cracking occurred. Minor cracking and/or spalling was evident at the top (just below the second floor beams and slab) and at the base of all ground level columns. Cracks were also found in the cross members of the second floor slab. The end shear walls showed small diagonal cracks, but there was no major failure.

The distortion of the structure resulted in some nonstructural damage and dislocation of building contents, particularly at the east end of the building. However, most partitions were in remarkably good condition, and no ceiling panels or light fixtures fell. Window breakage was minimal, even though the structure around some frames was distorted. It is speculated that metallic adhesive film, applied to south-facing windows to reflect solar heat gain, was responsible for reducing shattering and holding the glass intact even where window breakage occurred. The interior contents - papers, files (many departments used open filing systems), plants, etc. - were spilled throughout the building (Figures 3, 4). Nonstructural damage to architectural, mechanical, and electrical components was minimal. With the exception of the east end of the building, almost all doors were operable.

Elevators and related equipment in the building suffered no apparent damage, and were reported to be in operating condition immediately following the quake, although they were not used, in accordance with standard emergency instructions. Air-conditioning equipment, located on the roof, was mounted without hold-downs. It was shaken from its supports and moved approximately 12 inches.

Post-earthquake analyses of the Imperial County Services Building indicated that damage to the columns occurred when the horizontal reinforcing ties proved

inadequate to handle the high overturning forces (rocking motion) experienced along both axes of the building. Forces were significantly higher in the transverse direction, under the discontinuous upper shear wall, causing greater damage to the outer columns than to the inner columns. The floor slab cracks were due to the subsequent settlement of the structure at the east end.

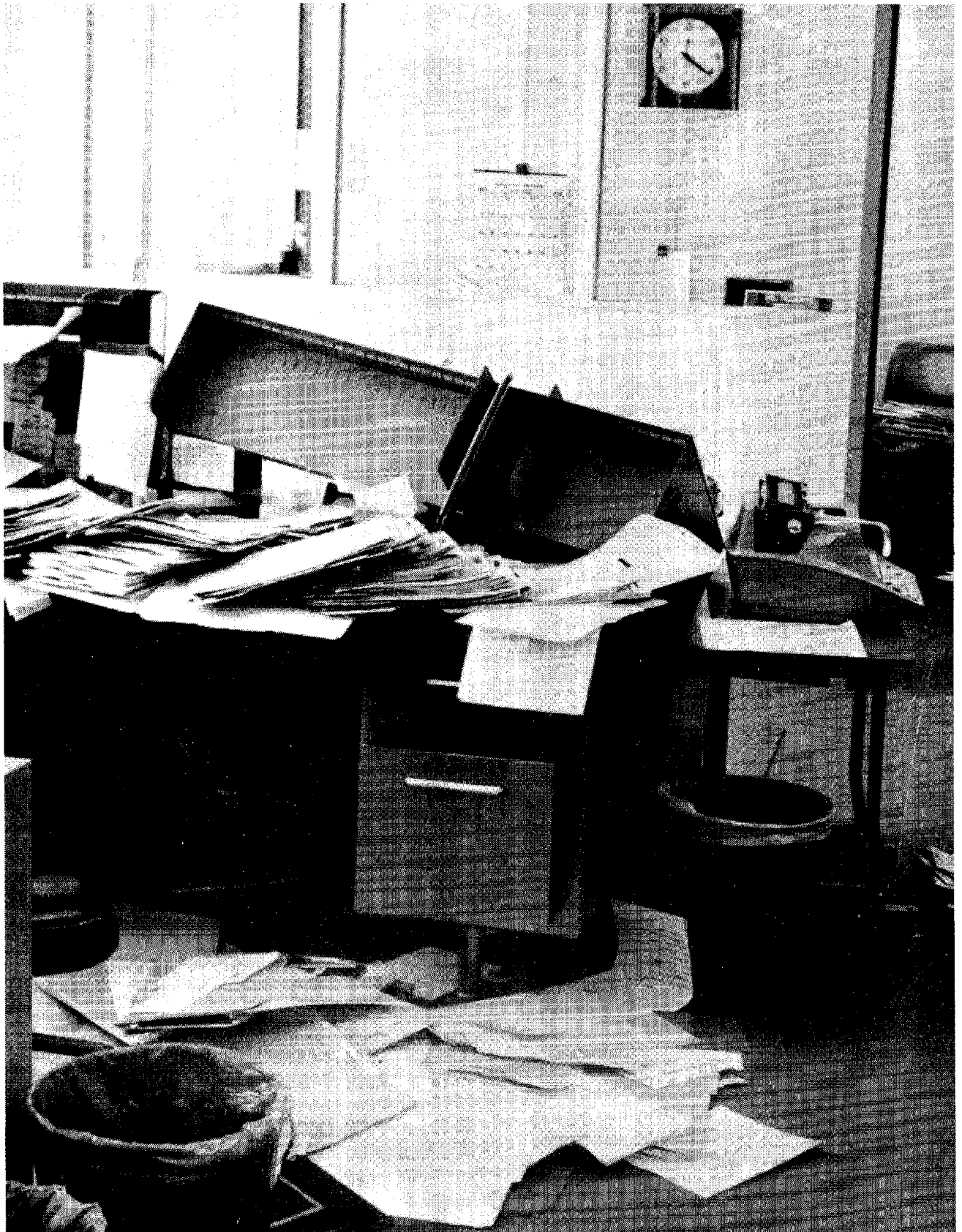


Figure 3. Spilling of interior contents was common throughout the building. Notice that the power remained on for a few minutes following the earthquake. Photograph courtesy of Imperial Valley Press.



Figure 4. Most bookshelves emptied their contents, and many file cabinets toppled after the shaking caused their drawers to open, which set the unit off-balance. Photograph courtesy of Imperial Valley Press.

II. OCCUPANT BEHAVIOR

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A. Introduction

The sensation of the earthquake has been graphically described by some of the building occupants.

"At the time of the earthquake, I was convinced that the building was going to collapse and that I was going to die. Because of this feeling I felt it was unnecessary to get under my desk. Then the shaking increased, I could no longer stand up and crawled under my desk. After the shaking stopped, I wondered if I could get down the stairway without being trampled to death. When I got out, I crossed the street, was counted and told to go home. I had no concept of time and was in a state of shock. I started walking home (I live 12 or 13 miles from work) and was found by my husband."

- Second floor occupant

"This was the most up and down earthquake that I have experienced. When I realized that the earthquake was not just another window rattler, I was seated at my desk. After several hard jolts, I felt as though I were falling through space before coming to a stop, still in my chair. I am certain that sensation was related to the building falling on that side. I then rose from my chair and staggered to my supervisor's office because there was a new wood door with no door knob and I was afraid she would be trapped in her cubicle. Her office was about ten feet behind my desk but the rolling motion made walking very difficult. I opened the door by flinging it against the wall and together we staggered back to my desk and the adjoining empty desk in the Social Services room where we crawled under the desk. I was under my desk for several more shocks and then the motion ceased. Someone said 'let's get the hell out of here' so I grabbed my purse and lunch bag and walked the route we have practiced for bomb scares."

- Third floor occupant

The experience of this building and its occupants presented a unique opportunity to use the building as a laboratory for the study of building occupant behavior in a frightening and dangerous earthquake. The fact that the building was under county management greatly simplified the problem of identifying and questioning the occupants.

With the active cooperation of the County Board of Supervisors, the Chief Administrative Officer, and the department heads, a questionnaire was answered by 118 occupants of the building who were still in county employ, a 100% response. It is estimated that this accounted for all but five employees, or 96%, of the occupants of the building at the time of the earthquake.

The purpose of the questionnaire was to focus on factual information, rather than feelings, and to establish, in detail, where people were at the time

of the shock, what they were doing, and what was their immediate response. Questions of a more speculative nature asked the reasons for their response, their particular worries at the time, and why they decided to leave the building. In addition, respondents were asked whether, if the building were to be repaired, they would return to work in the building. The structure and content of this questionnaire were based on semi-structured interviews previously conducted with occupants of the San Fernando Valley hospitals damaged in the 1971 earthquake.

The entire questionnaire, with a tally of the responses, is reproduced in Appendix II. Since all questionnaire respondents were named, additional information could be sought from them in cases of conflict and lack of clarity. All responses were displayed for analysis on a single graphic matrix, enabling comparison and evaluation of responses. The questionnaire provided the source of information for the mapping described in Section E below.

B. Where Were They, and What Were They Doing?

At the time of the earthquake, the occupants were distributed around the building as shown in Figure 5. This shows that the majority (77%) of the occupants were on the 2nd, 3rd, and 4th floors. Also that 27% of the occupants were concentrated in Bay E, which suffered the most severe damage.

FLOOR	BAY					UK*	
	A	B	C	D	E		
6	3	1	3	1	5	0	13
5	0	0	0	6	7	1	14
4	10	2	5	1	4	3	25
3	6	2	4	3	11	0	26
2	8	10	2	10	5	5	40
	WEST ← → EAST						
TOTALS	27	15	14	21	32	9	118

Figure 5. Distribution of all occupants by floor and bay.
 * precise location is not known

When the earthquake began, people's location, position, activity, and grouping were as indicated in Tables I, II, III, and IV.

TABLE I LOCATION	
at work station	75%
in the main corridor	2%
somewhere else in dept.*	18%
other**	5%

TABLE II POSITION	
standing	30%
sitting	68%
walking	2%

* visiting offices away from their work station, in conference, or in interview rooms.

** three were exiting an elevator, whose door was open.

TABLE III ACTIVITIES	
talking	37%
writing	36%
reading	3%
filing	5%
other*	21%

TABLE IV GROUPS	
with others	81%
alone	19%

(more than one answer permitted)

* 9% were typing; others stapling, stuffing envelopes, walking.

C. What Did They Do?

The first thing that people did was to:

TABLE V FIRST ACTION	
get under a desk	36%
stand in doorway	15%
stayed put	37%
went into main corridor	3%
left building	2%
dodged to avoid falling objects	8%
other*	14%

(more than one answer permitted)

* stood up at desk, laid on floor, tried to get under desk, told others to get under a desk, got out of elevator. The form of this question was oriented toward people at their work station.

Of those that got under their desk (a recommended action): the desk moved away in 30% of the cases: of these, 1 was injured by the movement of the desk.

D. Why Did They Do It?

In answer to the question "What prompted you to respond the way you did?"

previous drills in elementary school	18%
previous drills in this building (e.g. fire, bomb)	27%
seemed sensible	31%
advice from co-worker	18%
don't know	8%
experience with other earthquakes	25%
other	9%

(more than one answer permitted)

Note that 45% acted according to previous instructions and drills. Add to that the 25% who based their action on previous earthquakes and we have 70% acting out previous experiences, either in drills or earthquakes. Experience in other earthquakes was common: 83% of the respondents had experienced previous earthquakes, as indicated in a separate question.

After the shaking stopped, the second thing that people did is shown in Table VII.

went into main corridor	8%
remained where they were	19%
returned to work station	6%
left the building	56%
other*	23%

(more than one answer permitted)

* 2 persons got under a desk; 2 got into a doorway

In fact, actions after an earthquake may be quite complex, and people vary greatly in the clarity of their recollection. Here is an unusually clear recollection:

"During the second period of shaking, which lasted longer and got more violent, I was able to get up and dash for the door, but not in time to keep it from slamming shut. I turned around to go towards another door that was shut but didn't seem jammed, but by then a huge file cabinet had overturned and a heavy drafting table had shifted towards that door, so there I stood trapped until rescue came.

The door near the drafting table that was blocking it, was the only door that could be pried open to allow me to squeeze through to the main hallway, and then run the length of the building to the only way out of that building."

- Fourth floor occupant

From other reports the evacuation of the building was very fast; within 4-5 minutes the building was clear with the exception of one woman trapped in an interior office and one woman in a wheelchair being evacuated down the stairs from the 5th floor by co-workers.

Occupant responses to the question "Why did you decide to leave the building?" are indicated in Table VIII.

TABLE VIII DECISION TO EVACUATE	
evacuation announced by floor monitor	25%
evacuation announced by co-worker	26%
seemed sensible	50%
others were leaving the building	16%
other	11%

(more than one answer permitted)

The answers to this question obviously cannot be precise: people are being asked to recreate a thought process which may not have existed: action may have been instinctive or much influenced by others.

"There was no panic during evacuation, no screaming, no crying but no one needed to be told to evacuate."

- Sixth floor occupant

Under the circumstances, evacuation would seem a sensible thing to do, as, in fact, 50% of the people responded. But the floor monitors were clearly effective, with 25% of the respondents specifically crediting them with the decision.

Two further aspects of the evacuation procedure are worth noting. The first is that not one of the respondents mentions hearing the alarm. Yet David Pierson, Director of Public Works, pulled the alarm and reports that it worked; subsequently he checked with the floor monitors to make sure everyone was evacuated.

Second, the doors leading from the exterior smoke tower landings to the east stairwell opened inward against the established flow of occupants evacuating from the floors above. (A smoke tower is a balcony open to the outside air, required by building codes, to separate the building from the staircase: the staircase can only be reached via the smoke tower landing). This arrangement of the door may be responsible for some of the crowding reported at the entrances to the stairs by 31% of the respondents: several respondents mentioned this reason specifically.

From these responses it would seem, that at the levels of damage suffered by this building, evacuation was an instinctive reaction for many; floor monitors would reinforce this action as correct and provide the necessary orders for those still uncertain; and the decisive action of some, based on whatever instinctive or reasoned judgment, would be followed by others.

Only one person tried to use the elevators, which shows either that people obeyed the instruction not to use elevators in case of emergency, or through instinctive distrust or rational evaluation, decided not to attempt to use them.

E. Mapping Occupant Behavior

As part of the questionnaire response, occupants were asked to show on a floor plan where they were located at the time of the earthquake, and their subsequent movements. Each questionnaire provided the correct floor plan for each respondent, so that a respondent located on the fourth floor would receive a fourth floor plan with the questionnaire. Complete responses were provided on 104 questionnaires (i.e. location and path).

Figure 6 shows a key plan of a typical floor of the building, with the more severely damaged east portion of the building shown tinted.

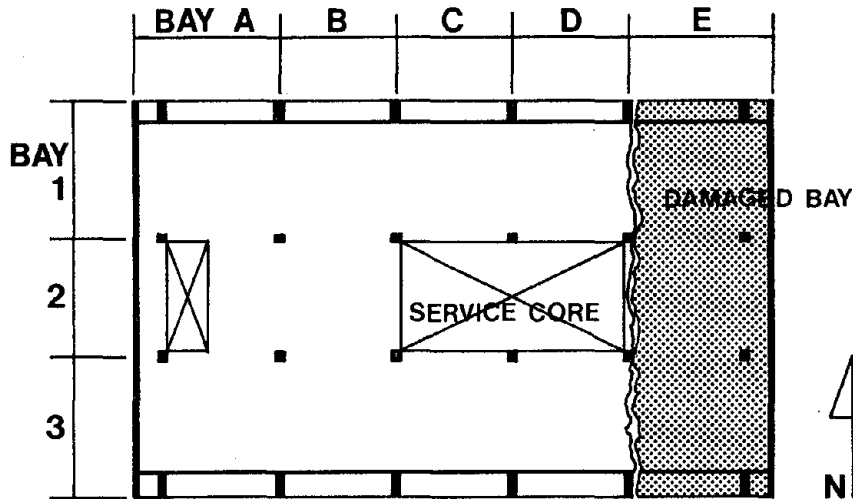


Figure 6. Key plan of typical building floor.

Plans of the six floors of the building are shown in Figures 7, 8, and 9. On these plans the initial location and subsequent movement of each respondent can be traced. Unusual exit routes of several respondents can be attributed to movement during the shaking (Questions #10 & #16 from Questionnaire), floor monitors checking restrooms and offices, or other individuals checking on friends or co-workers (i.e. sixth floor plan). The number of occupants using each stairwell is given for each floor level, with an overall total appearing on the ground floor plan.

F. The Mysterious Exit Patterns

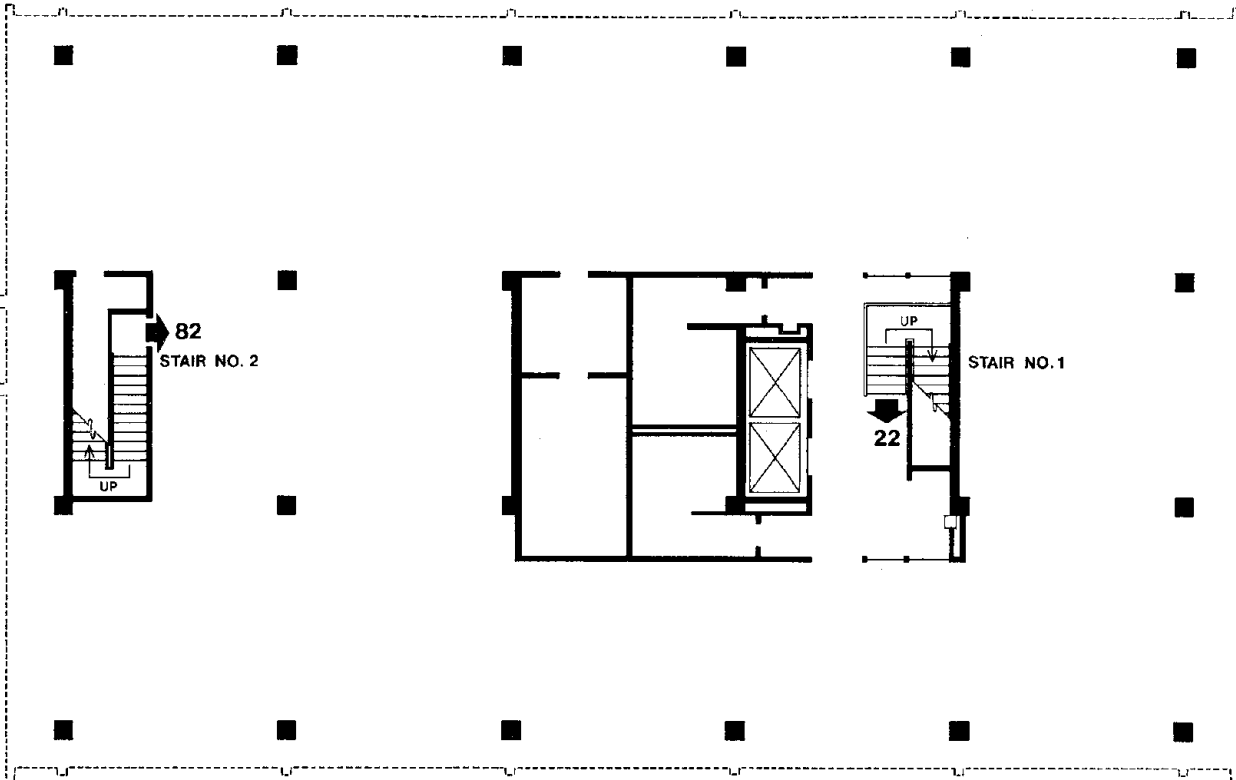
The most striking fact that emerges from these maps is the pattern of exiting shown on floors 3, 4 and 6. The plans show that from these floors 57 persons exited down the west stair (stair 2) while only 2 exited down the east stair (stair 1), one of whom was on the stair at the time of the earthquake. However, only on the second floor was there the near equal use of the two stairs (18 and 16 persons) that one might expect from the location of exits in this building.

Although 31% of the occupants reported crowding at the entrance to the stairway, no significant problems were encountered; and the stairs, though slightly damaged, were not blocked. However, if the predominantly used stairway had been blocked, or if this had been a taller or more heavily populated building, the concentration of evacuees down this one stair might have caused very serious congestion, with possible panic and injury.

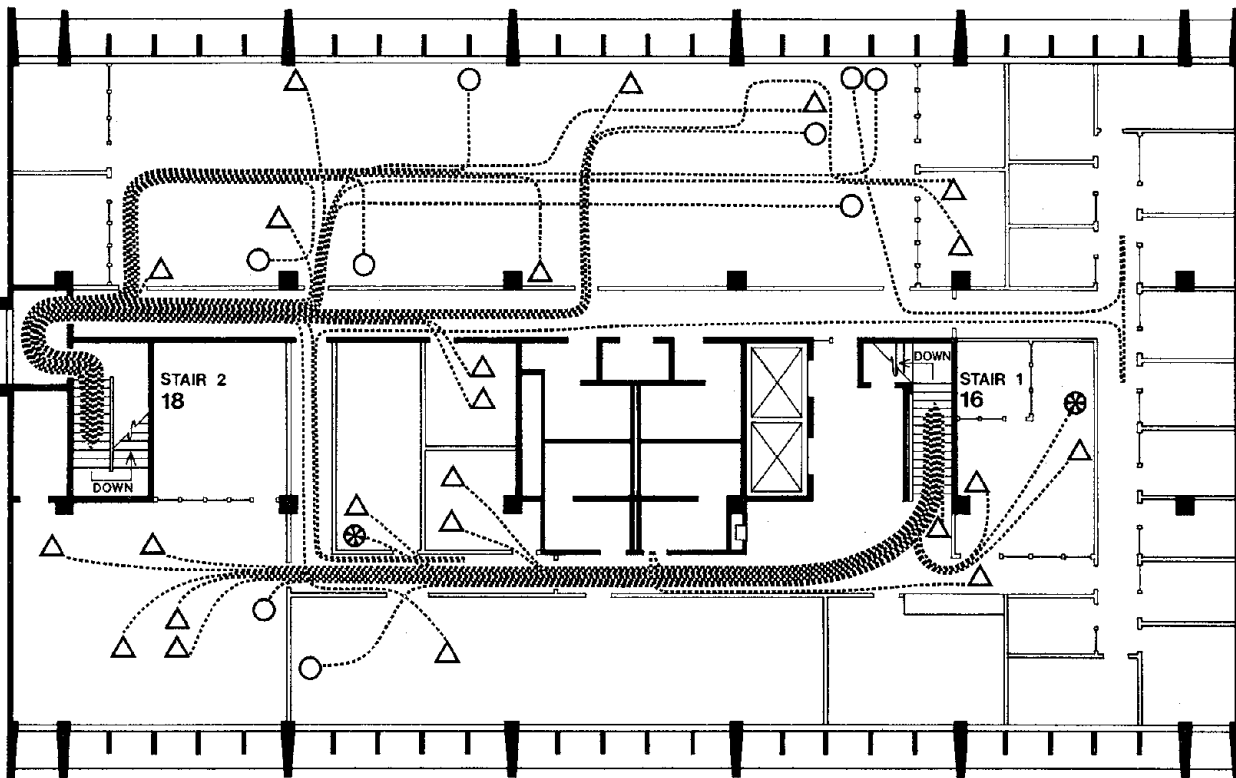
What was the reason for the majority use of one staircase, even by people who had to walk the length of the building to reach it, when many had a much more convenient stair close by?

David Pierson, Director of Public Works, had instituted an evacuation program for the building in case of fire, and held practice drills approximately every 6 months. Moreover, the building had been subjected to bomb threats allegedly from the United Farm Workers, who were out on strike: during the 3 months previous to the earthquake, 2 or 3 emergency bomb threat evacuations of the building had taken place. Because the east stairway adjoined the elevator lobby, which was felt to be vulnerable to bombing, occupants were told to evacuate by the west stair. When the earthquake emergency occurred, most occupants were then following their drill instructions.

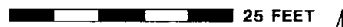
Although the damage was most severe at the east end of the building, the east staircase was not in the end bay that dropped. The cracks in the floor slab occurred east of the staircase so that occupants coming from the damaged bay - on the third floor for example - walked over the crack in the floor, past the doorway to the east stairway (Figure 10).



GROUND FLOOR



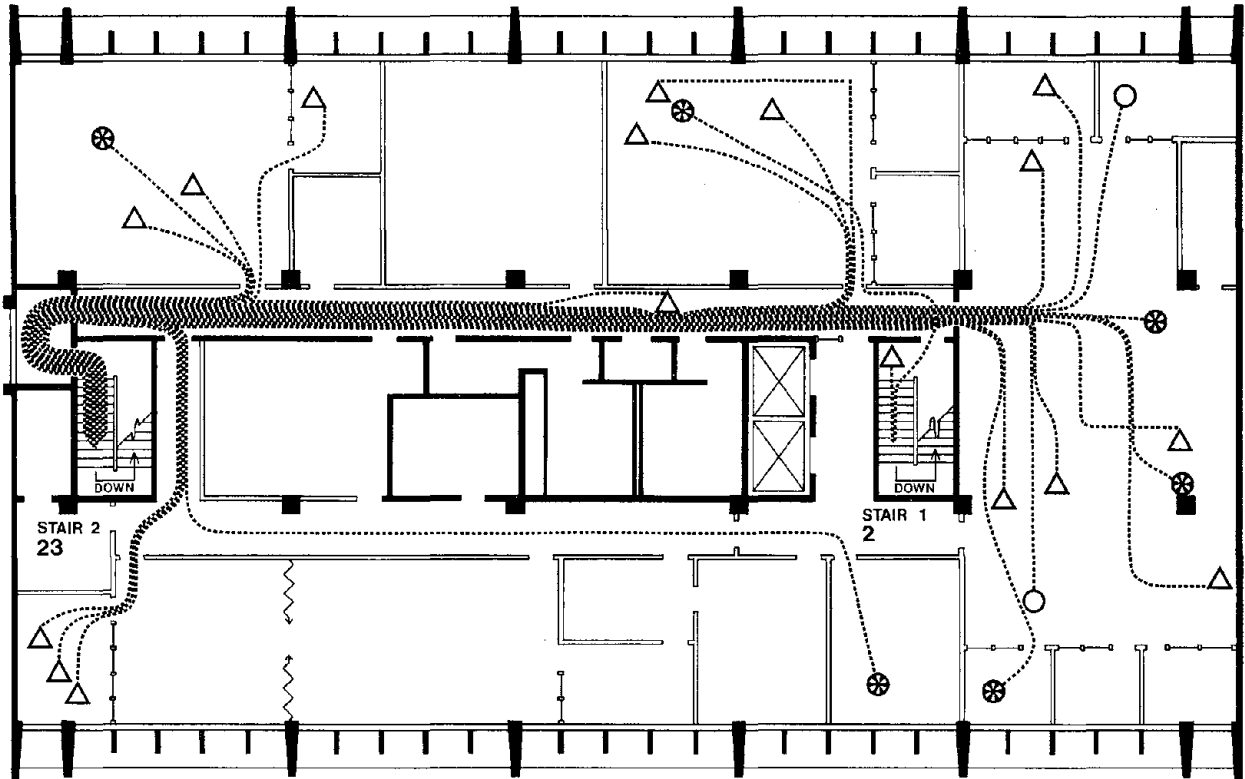
SECOND FLOOR



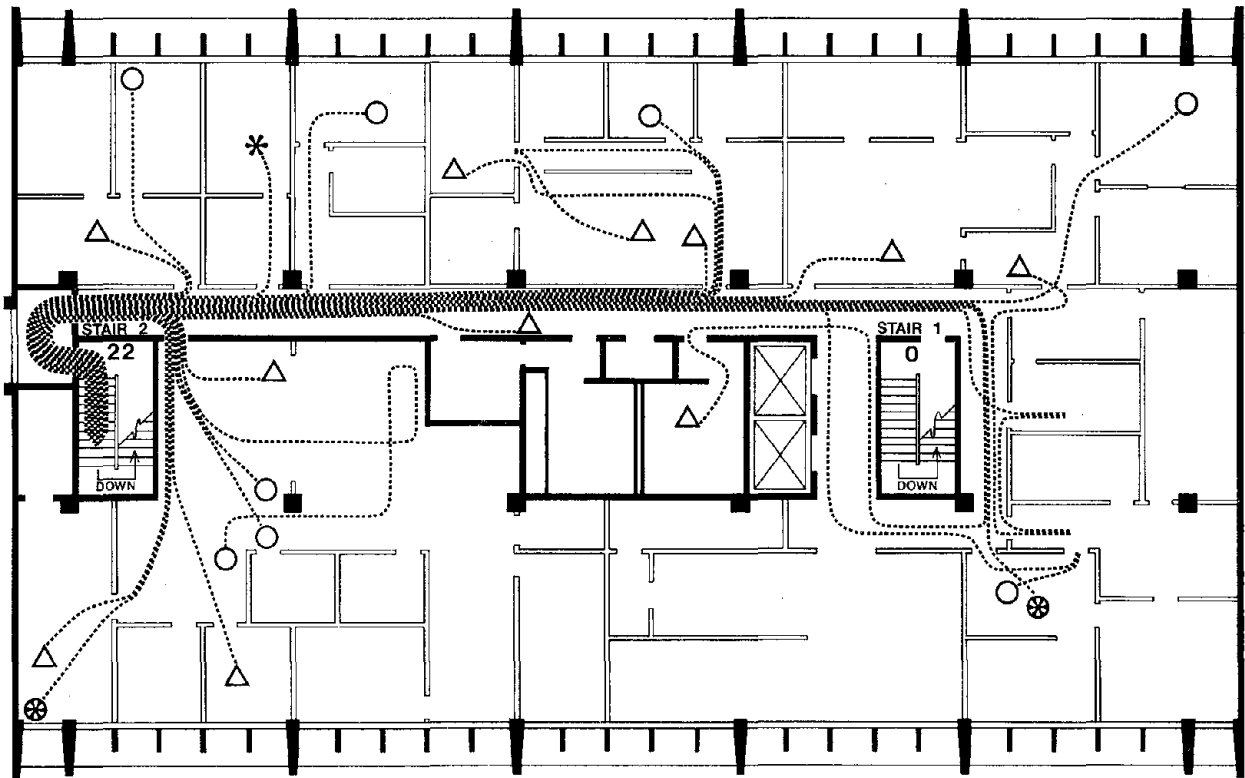
IMPERIAL COUNTY SERVICES BUILDING

EXIT ROUTE KEY: Δ : PERSON \circ : STRUCK PERSON * : INJURED PERSON \otimes : STRUCK & INJURED PERSON NORTH

Figure 7. Ground floor and second floor plans showing initial locations and exit paths of building occupants.



THIRD FLOOR



FOURTH FLOOR

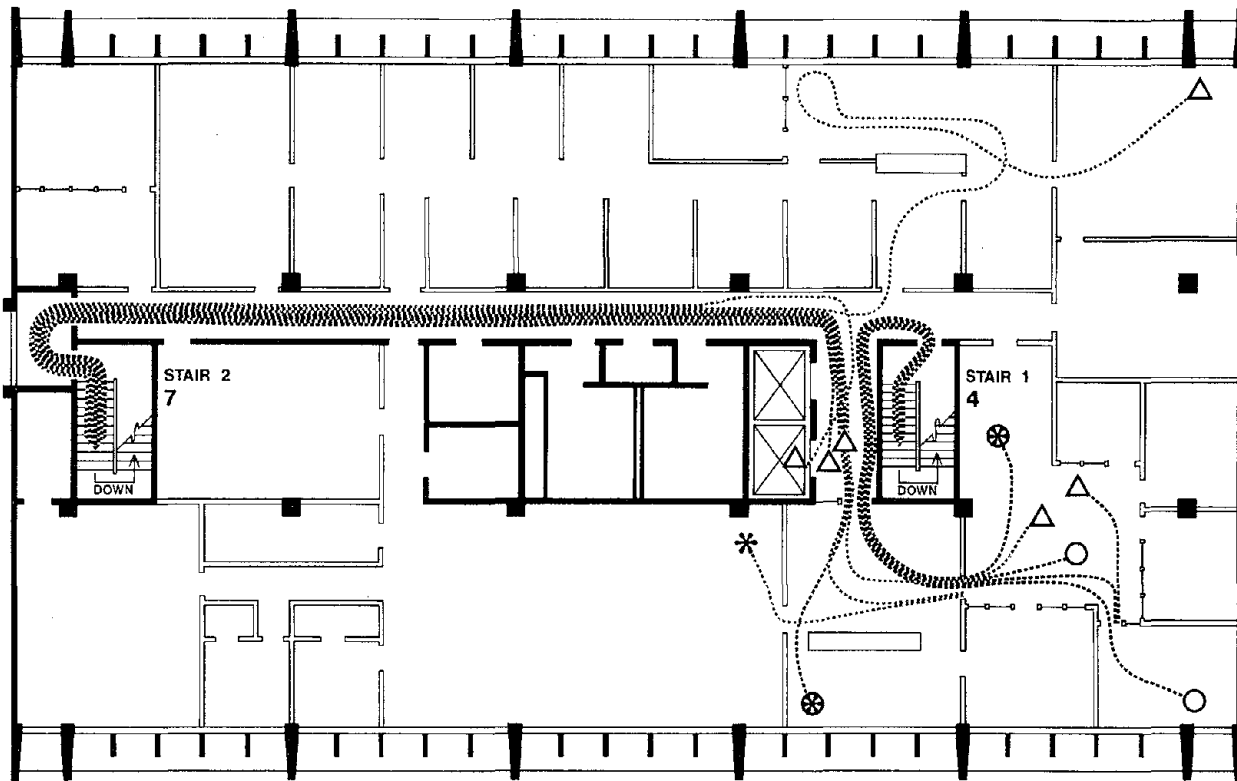
25 FEET

IMPERIAL COUNTY SERVICES BUILDING

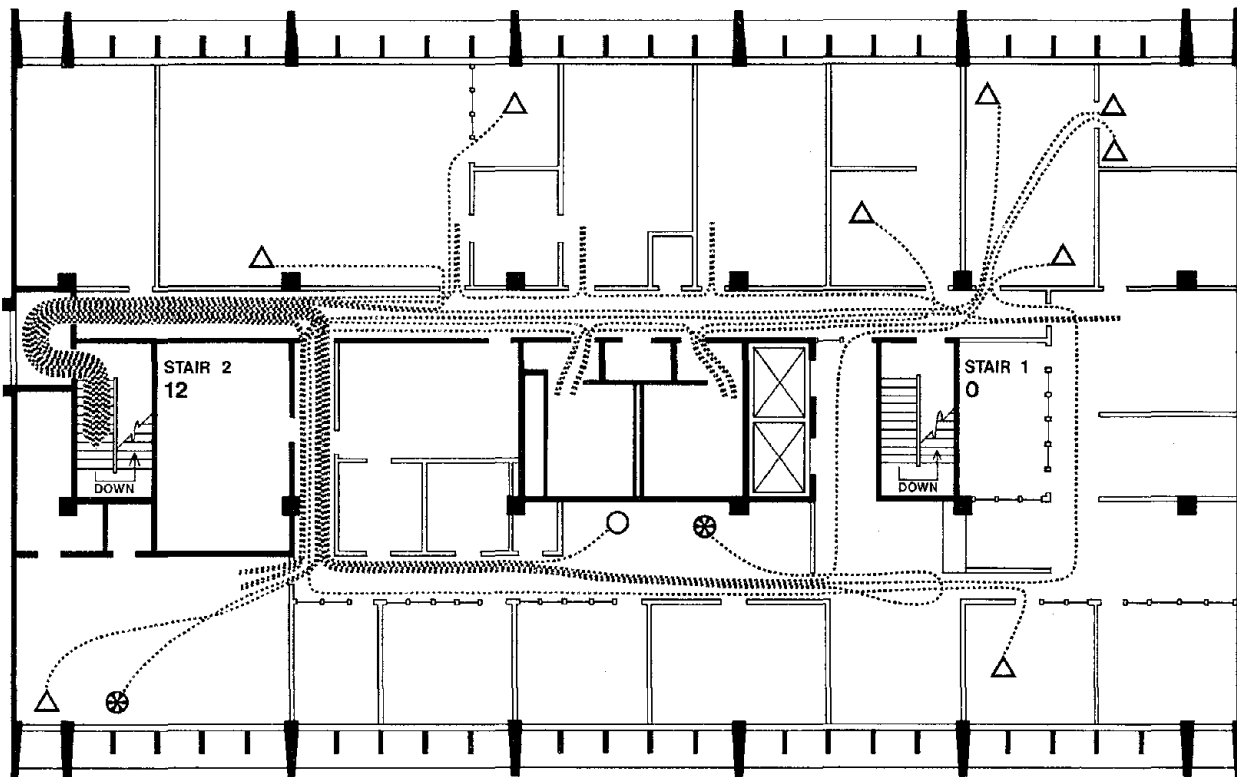
EXIT ROUTE KEY: Δ = PERSON \circ = STRUCK PERSON * = INJURED PERSON \otimes = STRUCK & INJURED PERSON

NORTH

Figure 8. Third floor and fourth floor plans showing initial locations and exit paths of building occupants.



FIFTH FLOOR



SIXTH FLOOR

25 FEET

IMPERIAL COUNTY SERVICES BUILDING

EXIT ROUTE KEY: Δ - PERSON \circ - STRUCK PERSON * - INJURED PERSON \otimes - STRUCK & INJURED PERSON NORTH

Figure 9. Fifth floor and sixth floor plans showing initial locations and exit paths of building occupants.

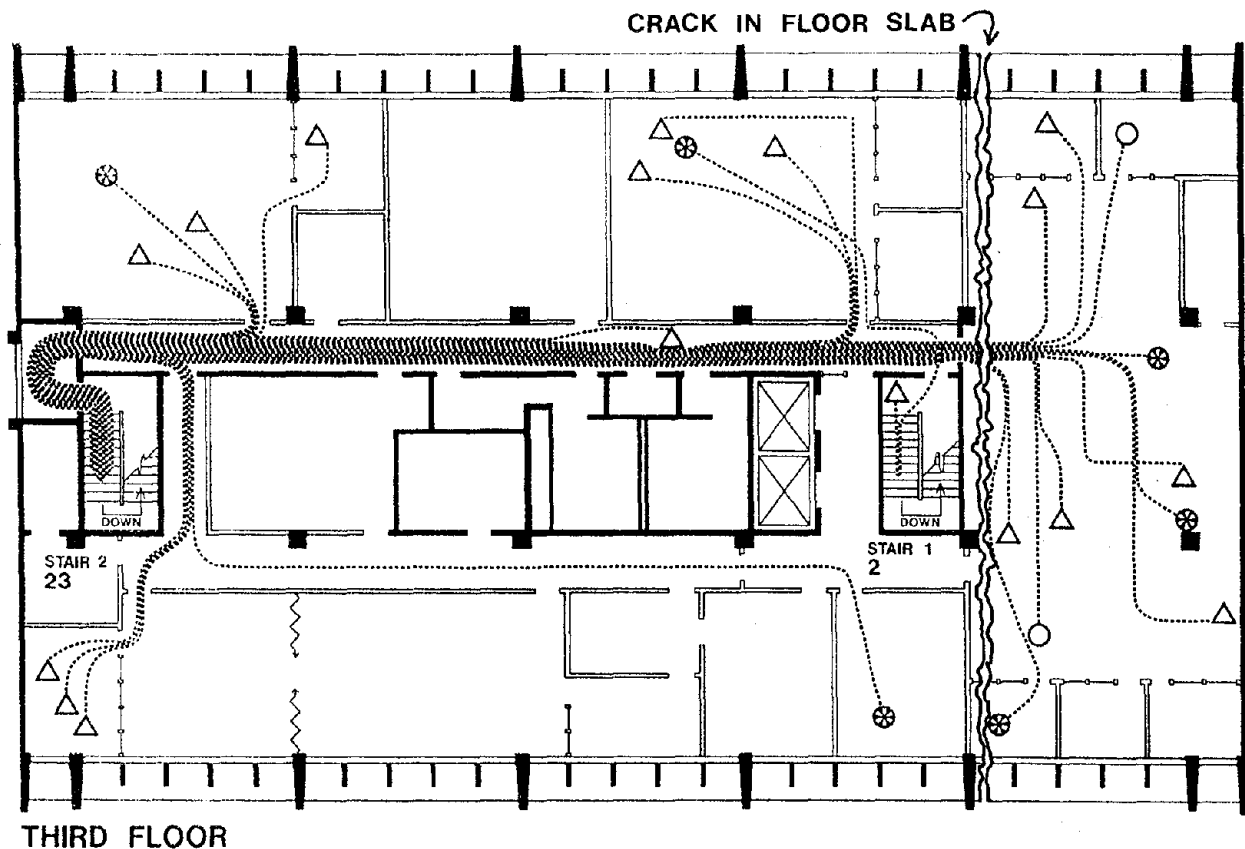


Figure 10. Floor slab crack in relation to escape stairs.

It is clear that on the 3rd, 4th, and 6th floors a flow of traffic to the west stair was established, so that people coming out of doors in the center of the building would tend to move with the flow to the west.

If drill procedures clearly required the use of the west stairway, why then, did anyone at all use the east stair?

All those who used the "wrong" exit were specifically asked later their reasons for doing so. As might be expected, no specific pattern of reasoning emerged, but leadership was significant:

"I chose the wrong one (exit). I was scared, it seemed the closest exit out. I exited with from 4-8 other people. I was the beginning of the group so they followed me. I was the first one out of my room, but the last one, practically, out of the building. I sat under my desk. When I was little we were told "When there's an earthquake, get under your desk." So that's where we were. There was no one in the corridor when I exited my room and proceeded to the east exit. Everyone followed me. No one was going the other direction. I was new to the place too, although we had practices, and stuff, I just automatically went out the door I usually came in."

In fact, 5 others are recorded as being in the room with this respondent, and all went to the east exit (which was not the closest, but the route was more direct). Others also mentioned using their familiar stair for entering and exiting.

G. The Significance of Drills

This exiting behavior is extremely important: it shows the force and value of drills, since 79% of the occupants followed the drill.

It also shows the value of familiarity. The frequent fire drills and bomb scares had created a pattern of familiarity. This, of course, is the basis of drills; to establish a pattern which is correct, instinctive, and requires no evaluation. In some cases, however, the instinctive pattern (using the familiar staircase) outweighed the correct procedure according to drill.

It also seems clear that to expect people to evaluate the alternative procedures ("if this is a bomb then I should use the west stair: if not then I should use the east which is closer") is unreasonable. The drill instructions must not call for evaluation and hence must be simple and correct for the maximum number of conditions.

H. Other Analyses of Questionnaire Responses

Following Kobayashi and Horiuchi*, patterns of exiting and injury were analyzed by sex and occupation (managerial or clerical). No significant correlation was found.

In the questionnaire, respondents were asked to estimate the duration of the first period of shaking. Responses ranged anywhere from 1 second to 30 minutes, and a dozen people had no idea, said forever, or long enough. However, the three most frequent responses were 30 seconds (15%), 1 minute (14%), and 20 seconds (8%). Seismological data from instruments located approximately 340 feet east of the building, indicated that the period of strong shaking ($>0.10g$) lasted about 4.5 seconds, at ground level.

However, the duration of strong shaking as recorded by instruments, lasted considerably longer inside the building. Accelerographs from the thirteen California Division of Mines and Geology (CDMG) accelerometers located in the building, were analyzed with the following results.** Instruments oriented in the

* Dr. Masami Kobayashi and Dr. Saburo Horiuchi, "Analysis of Occupant Behavior in an Office Building under Fire," a paper presented at the Second International Seminar on Behavior in Fire, October 30 - November 1, 1978; National Bureau of Standards, Washington D.C.

** These numbers should not be taken as precise values. They were derived by BSD, using graphic means, from copies of records shown in Compilation of Strong-Motion Records and Preliminary Data from the Imperial Valley Earthquake of 15 October 1979, which may have been distorted in the reproduction process.

north-south direction, located at the east end of the building, recorded strong shaking continued for a maximum of approximately 5.8 seconds at ground level, 11.7 seconds on the second floor, and 13.7 seconds at the roof. In the east-west direction, a maximum duration of strong shaking was recorded of 5.4 seconds at ground level under the eastern portion of the building. Instruments located near the center of the building, recorded maximum durations of 8.7 seconds on the second floor, 8.4 seconds on the fourth floor, and 18.1 seconds at the roof.

With the one exception at the 4th floor in the east-west direction, these numbers show that the duration of shaking greater than 0.10g ("strong shaking") increased with height in the building. We then analyzed the responses received on the questionnaires to see if the occupants' vertical location in the damaged building could account for the wide range of responses. No collaborating pattern was found to exist. For example: the majority of second floor occupants (32%) said the strong shaking was in the 4 minutes or longer time period; while on the sixth floor, the majority of occupants (39%) felt that strong shaking lasted in the 11 to 30 second range.

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III. INJURIES

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Of the 118 surveyed occupants of the building, 44 persons, or 37% of the occupants, were injured. Figure 11 shows the location of building occupants related to location of those injured. Of these, 27 were struck by some object, 15 were struck and injured, and 2 were injured only. All these injuries were minor: only two persons reported for treatment, of whom one suffered a crushed finger and hypertension, the other suffered lower back displacement from the jolt and shaking when bracing herself in a doorway.

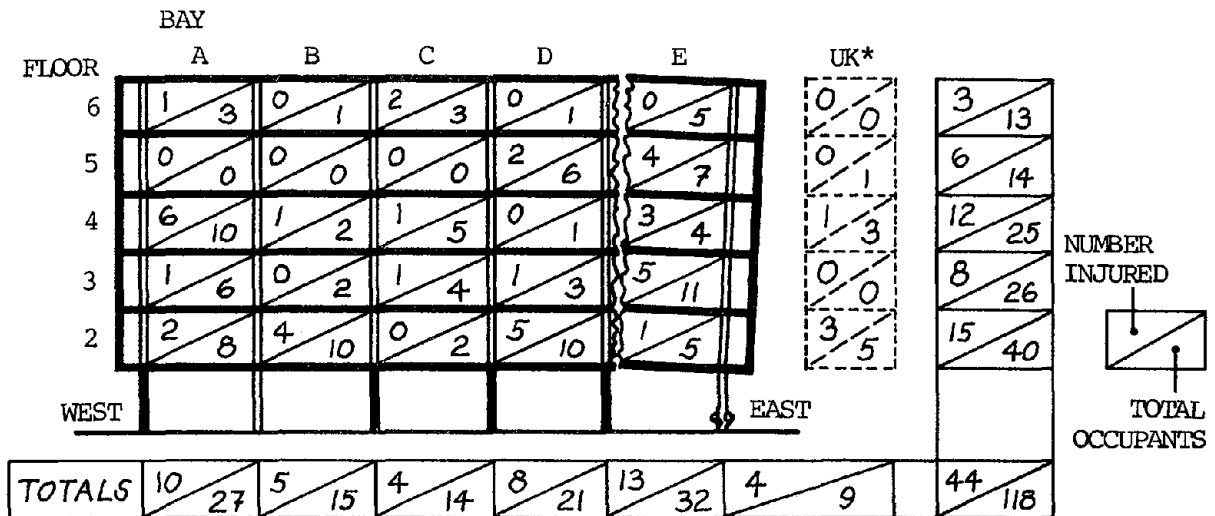


Figure 11. Distribution of building occupants and injured.

Those who were struck by or bumped into an object were hit by desks, filing cabinets, doors, books, tables, shelving. Injuries resulted primarily from being knocked down, resulting in bruises or scratches. No one was injured by broken glass: as noted previously, it is speculated that window breakage was greatly reduced by the application of glare-reducing film. Also, due to the good performance of the ceiling, no one was injured by falling ceiling elements.

Most of the injuries in fact resembled those which occur daily in offices: people bumping into doors, bruising themselves on the corners of desks and the like. The earthquake concentrated several months or years of normal office injuries into a few seconds.

Of the 44 people injured in some way, 30 were injured by building contents, and 14 by building components. Of the latter, 13 were banged by doors, and one was bumped (but not cut) by broken glass.

Study of Figure 11 shows that the location of injuries was spread around the building in an apparently random distribution. Structural damage was much more severe in Bay E, but the relative number of people injured in this bay was not significantly different from those injured in other bays. Although more people (13) were injured in Bay E than any other bay, this bay also had the greatest population (32). The percentage of population injured in this bay is 41%. However, in Bay A, which suffered the least damage, 37% of the population was injured.

One might also expect that the percentage of injured occupants would increase with height in the damaged building. This however was not the case: 23% of the employees on the sixth floor were injured, the lowest percentage of all floors. The fourth floor had the highest percentage of its occupants injured at 48%.

A formal way of analyzing the relationship between injuries and location in the building is to express the probability of injury in a particular location as an "attack rate," as shown in Figure 12.

FLOOR	BAY					UK*	
	A	B	C	D	E		
6	33%	0%	66%	0%	0%	—	23%
5	—	—	—	33%	57%	0%	43%
4	60%	50%	20%	0%	75%	33%	48%
3	17%	0%	25%	33%	45%	—	31%
2	25%	40%	0%	50%	20%	60%	38%
	WEST				EAST		
TOTALS	37%	33%	29%	38%	41%	(44%)	37%

Figure 12. Attack rates by occupant location (floor level and bay).

This epidemiological methodology is useful in ascertaining patterns of injury that might relate to particular locations or populations. The provision of such patterns for a large number of buildings would provide a basis for the analysis of injury in relation to building location from which useful conclusions might be drawn.

In the case of the Imperial County Services Building, the sample of occupants in each location is very small, so that the attack rates have little real meaning (for example in location A-6, injury to one additional person would change the attack rate from 33% to 66%). In addition, injuries are not caused directly by location, but by objects that fall and strike people; or by the people themselves hitting parts of the building or furniture. Furthermore, people's proneness to injury varies: in a similar exiting situation one person will be uninjured, another will bump into the corner of a desk, a third may pinch their finger in a door. All these factors must be evaluated in the development of an effective methodology for the study of earthquake related injuries, but in the almost total absence of this kind of study, the tentative methodology investigated here becomes an important first step.

From analysis of the injury nature and pattern in this building, we can draw the following conclusions:

1. The location of those occupants who were injured did not correlate with those areas in the building that suffered the most structural damage.

2. At this level of building damage, with severe structural failure but no collapse, injuries were widespread but minor; many being comparable to normal injuries suffered in offices.

3. Although building contents, including heavy filing cabinets, desks, etc., toppled or were displaced, people suffered only minor injuries.

4. Although a number of windows were broken, no one was injured by broken glass.

5. No one was injured by falling light fixtures, air diffusers, or other ceiling-supported objects.

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IV. OPERATIONAL CONSEQUENCES: RELOCATION

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A. Introduction

The condition of the building and the emotional state of its employees following the earthquake was such that it was unthinkable to resume normal operations in the building. It was therefore mandatory that space be found for the displaced departments. For some departments, such as Welfare and Public Works, time was a critical factor. At this time it was not known whether the building would be repaired or replaced.

On the morning following the earthquake the department heads assembled at the fire station, located at the Imperial County Airport (County Center #3), to discuss the relocation issue. This location was the just-completed Office of Emergency Services, requiring only installation of emergency phone lines to become operational. (A task required after each disaster). A few of the department heads who had already located available space received an informal go-ahead, and so proceeded to plan their moves. For the majority of the departments, however, the task of locating available space and then assigning it fell to the Department of Buildings and Grounds: specifically to Jim Roberts and Randy Rister, then Director and Assistant Director of the Department.

The Department of Buildings and Grounds is responsible for the operation and maintenance of all county-owned facilities, of which there are approximately 100. This number includes all the live-in facilities as well, such as the jail, the juvenile hall, the Imperial Valley Association for the Retarded (I.V.A.R.) facility, and Los Ninos (dependent children's home/orphanage). Due to the nature of their jobs, Roberts and Rister were already familiar with vacant spaces available within the County. In addition, they were in the process of shuttling departments around to accommodate new construction and renovations, so they were also familiar with the space needs and requirements of the various departments. Since the Department of Buildings and Grounds was not located in the Imperial County Services Building, their post-earthquake functioning fortunately was not hampered by their own need to relocate.

B. The Three Phases of Relocation

Randy Rister has sub-divided the relocation process into three phases. These phases correspond to the different activities that occurred following the earthquake, at varying lengths of time from the earthquake.

Phase I began immediately following the earthquake and its primary activity was the immediate ad hoc relocation of departments. An informal assessment of needs and available space was conducted, and the first priority was to attempt to enable the departments to function within existing county buildings. Although time and availability were the key issues, it was also desirable to keep the departments as near to the downtown area as possible. Several departments had satellite field offices and/or labs, or warehouse storage located elsewhere within the City or County, which were called into use as "temporary" locations for their departments.

Departments were asked to maintain operations at these temporary locations as best they could with a minimum of furniture and equipment, until they could be removed from the damaged building. According to Randy Rister, within two days everyone was working.

During Phase I, the County Board of Supervisors made it known that they intended to construct a "one-stop permit facility" to house the Public Works, Planning and Building Inspection, Agricultural Extension, Agricultural Commissioner, and Environmental Quality Control Departments. The probable location of the future facility was the airport. The idea was to group all the departments under one roof, simplifying the process of taking-out a permit.

Toward the end of Phase I, which lasted approximately two weeks, the Navy notified the County that there would be space available at the Naval Air Facility, located 8 miles west of El Centro.

Phase II was initiated approximately two weeks following the earthquake. It is described as an assessment of needs and the evaluation of space. The first task was an inventory of available space for rent within the towns of the County. This had been started in Phase I, but there was now a formal process to identify space and move into it as soon as possible. At this point, a rental of 6 months to 1 year was anticipated.

During Phase II, furniture was removed from the I.C.S.B. and was then transported to the current location of the individual offices. Some of the departments were moved from their temporary locations to the space offered by the Navy at the Naval Air Facility.

Very early in Phase II, it became clear that the money budgeted for the new "one-stop permit facility" was more urgently needed elsewhere. The idea of the "one-stop permit facility" was abandoned, and the money was used to make immediate road repairs within the County.

Phase III of the relocation began approximately 6 months after the earthquake. It was decided that the Imperial County Services Building should be replaced rather than repaired, necessitating a longer period of "temporary" locations than had previously been anticipated. So, Phase III essentially became a holding pattern, until a replacement facility was completed. Those departments that could remain in their present location did so. Those departments whose space was needed for previously-scheduled activities or whose lease could not be renewed were forced to move once again: this time, for a period of approximately 2 years.

Unusual difficulties were suffered by some departments during their relocation period. For Public Works the single largest problem during the first few days was the inability to communicate. During the early hours, Public Works personnel coordinating the survey and inventory operation were able to use the pay phone in the fire station for outbound calls, but the public had no way of contacting them to report damage. Later, it was requested that damage be reported to the nearest road yard, which would then relay the messages to the central operations base.

On the move to the Naval Air Facility, the Deputy Director of the Public Works Department commented that the space was adequate and they were lucky to get it, but it had disadvantages such as strict access and security procedures, long distance from weekly Board of Supervisors meetings and the Planning Department, isolation from the public, and the need to adjust to the Navy way of doing things.

The Welfare Department was by far the largest county department forced to relocate, and this, combined with the public's image of a "typical welfare client", led to many problems in finding a new location. When the Navy offered its available space at the Air Facility to the County, it made it clear that it would not accept the Welfare Department. The Navy foresaw problems of access and security, and did not want "welfare-types" on base. The Department moved to a shopping mall, but when the initial lease expired complaints about shoplifting and loitering from other mall tenants were such that Welfare was requested to move again, and space was finally found in a long-vacant building in the downtown business district.

The Agricultural Commissioner's Office experienced delays in finding a satisfactory location for the entire staff. Since one of the employees was wheelchair-bound, handicap access and facilities became a prime issue.

The Planning Department was willing to accept a space one-third its original size as a compromise rather than splitting-up the staff between several locations. Eventually two trailers were added to ease their critical space shortage.

C. The Conclusion of Relocation

In October of 1982, if all goes as scheduled, the replacement building should be complete and the final move to the new building can take place. Not all of the departments originally located in the Imperial County Services Building will be returning to the new facility, which will be known as the New County Administration Center.

Several services previously located in the Imperial County Court House will be joining the returning Departments of County Administration, Personnel, Affirmative Action, Welfare, Family Support, and the Snack Bar (State Department of Rehabilitation) in the new building. The space vacated in the Court House by these additional departments will be taken over by court-related departments that were displaced by the earthquake, or were previously scattered around the County. The remainder of the displaced departments will be located in county-owned buildings at the three County Centers. County Center #1 is the group of buildings in downtown El Centro in the immediate vicinity of the Court House; County Center #2 is a collection of buildings located 3.2 miles south of El Centro, at the Imperial County Hospital; and County Center #3 is located at the Imperial County Airport, 2.9 miles north of El Centro (Figure 13). Figure 14 shows El Centro, and Figure 15 shows County Center No. 1.

Figures 16, 17 and 18 provide a description of the moves each of the departments made, presented in a time-line chart format. It is important to realize that not all departments were in Phase I at the same time, nor for that matter, Phase II or Phase III. The boundaries between phases are somewhat fuzzy, and the labeling corresponds to what type of move was made, why the move was made, and the expected duration of the move - all issues which were unique to each department. Therefore, location of phase boundaries as shown on these charts should be viewed as a graphic convenience only. Appendix I provides the detailed description of departmental moves represented on these charts.

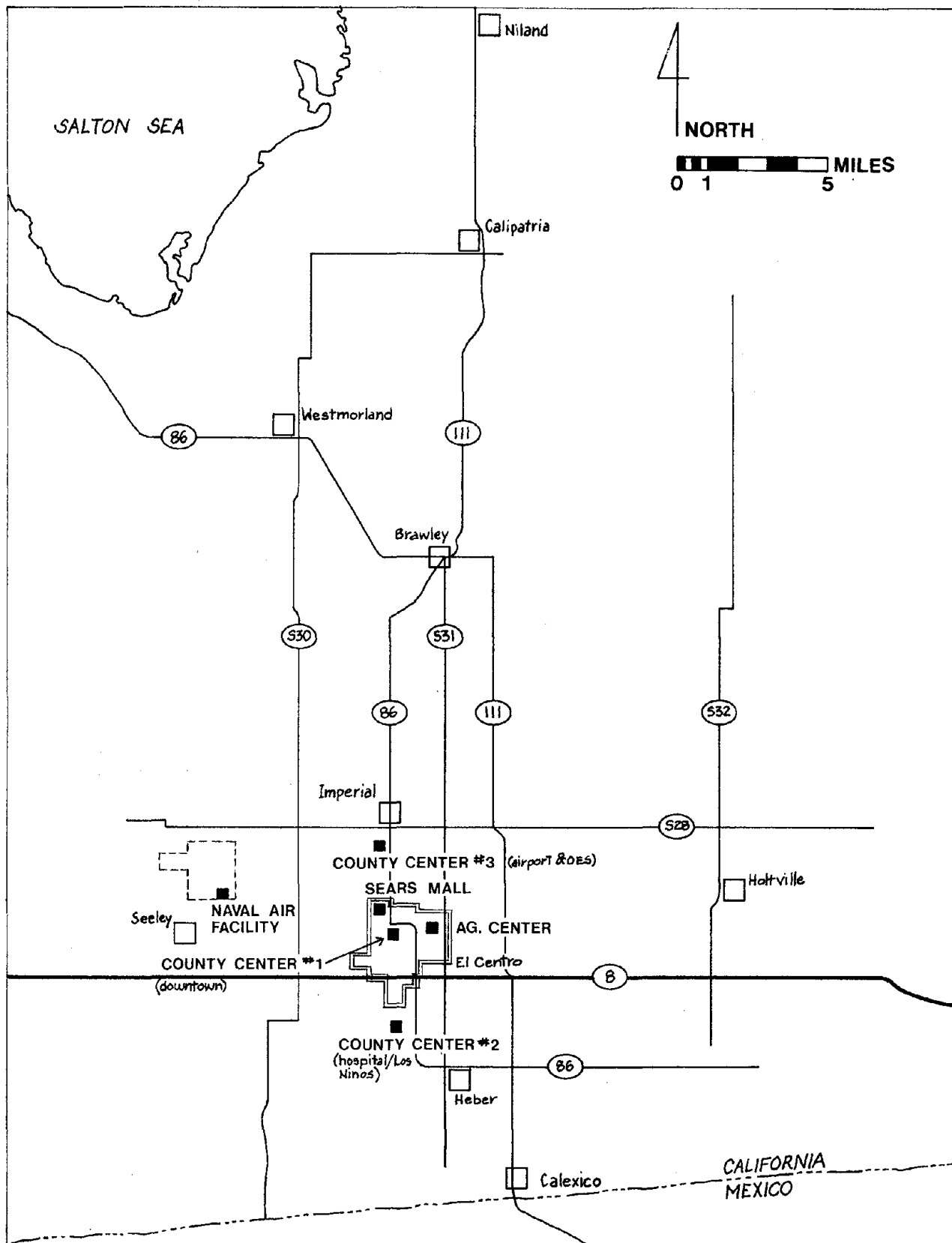


Figure 13. Relocation sites distributed throughout Imperial County, California.

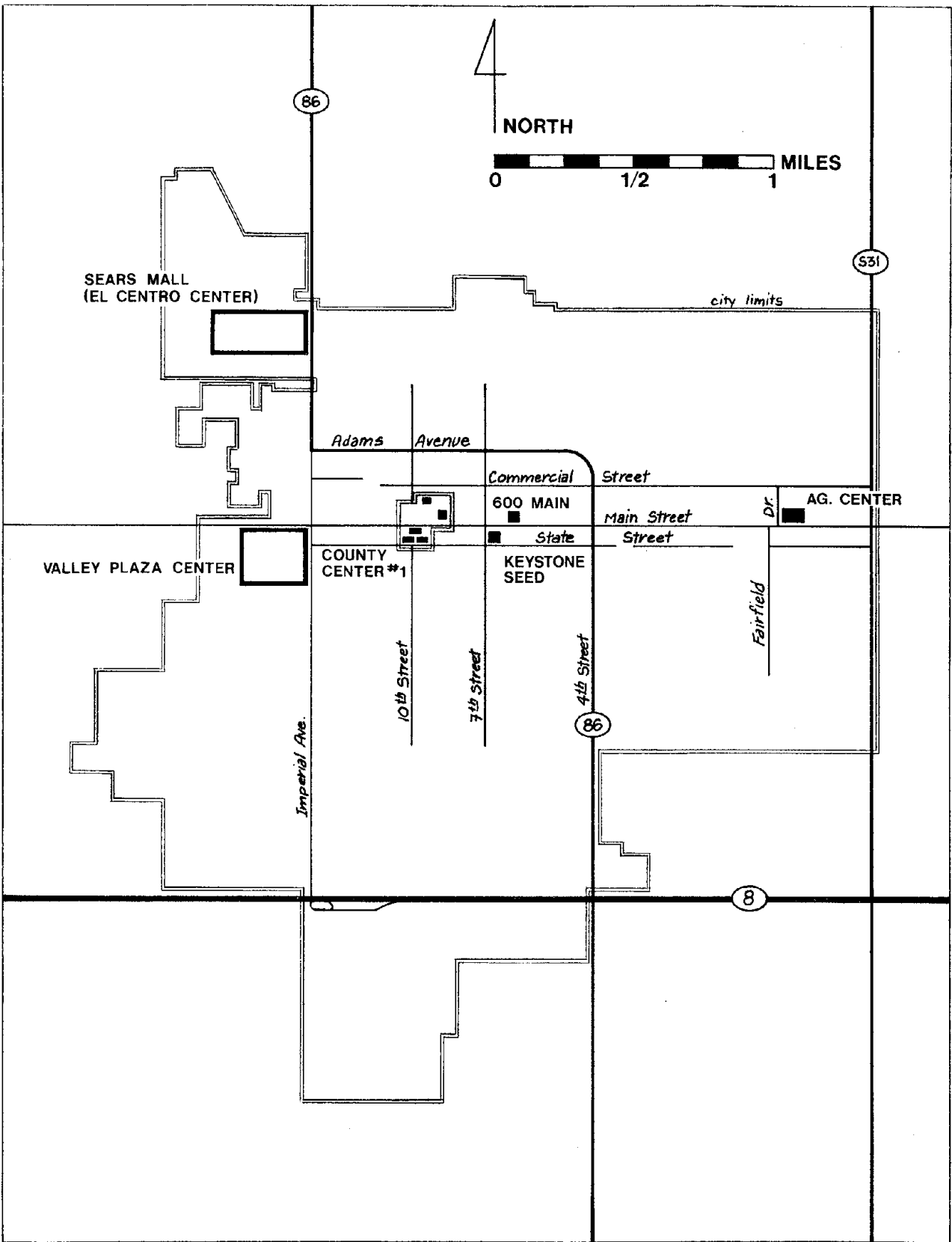


Figure 14. Relocation sites within El Centro city limits.

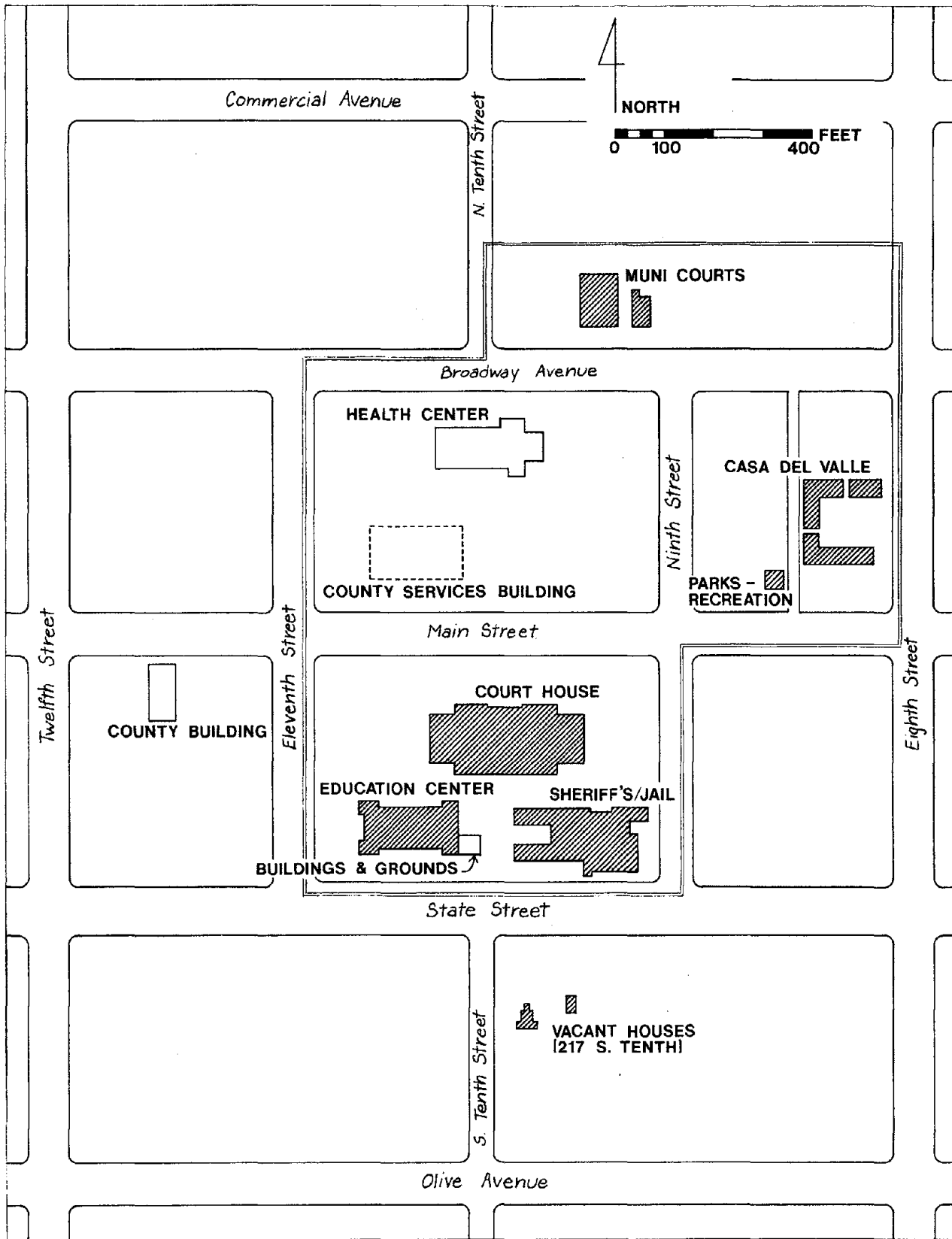



Figure 15. Relocation sites in County Center #1: downtown El Centro.

*** _____ PHASE 1**

DATE DEPARTMENT	OCTOBER 79															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
ADMINISTRATIVE ANNEX	C.S.B./NON-FUNCTIONING								COUNTY ADMINISTRATIVE OFFICE IN COURT HOUSE							
AFFIRMATIVE ACTION	C.S.B.			BASEMENT OF EDUCATION CENTER												
AGRICULTURAL COMMISSIONER	C.S.B.	ADMINISTRATION - FAIRFIELD WAREHOUSE AT AG. CENTER AIR POLLUTION - AIRPORT (COUNTY CENTER #3) FIELD INSPECTORS - BRAWLEY														
AGRICULTURAL EXTENSION	C.S.B.	FAIRFIELD WAREHOUSE AT AG. CENTER														
COURT RECORDS	C.S.B.	MUNICIPAL COURTS														
FAMILY SUPPORT	C.S.B.		KEYSTONE SEED WAREHOUSE FILES - PREEBLE BUILDING AT FAIRGROUNDS (NR. C.C.#3)													
PERSONNEL	C.S.B.			2 VACANT HOUSES SOUTH OF COURT HOUSE												
PLANNING	C.S.B.			I.V.D.A. BUILDING AT AIRPORT (COUNTY CENTER#3)												
PUBLIC WORKS	C.S.B.	HEBER	DE ANZA RESCUE AT AIRPORT (COUNTY CENTER #3)										N.A.F.			
SNACK BAR (STATE DEPT. OF REHABILITATION)	C.S.B.	NON-FUNCTIONING														
VETERAN'S SERVICES	C.S.B.	BASEMENT OF COURT HOUSE														
WELFARE	C.S.B.	INTAKE, PUBLIC FUNCTIONS - LOS NINOS AT COUNTY CENTER #2 EMERGENCY ASSISTANCE CENTER - VALLEY PLAZA CENTER FILES - PREEBLE BLDG. AT FAIRGROUNDS (NR. C.C.#3)														



Figure 16. Phase One of Relocation.

KEY: C.S.B. = (Imperial) County Services Building,  = previous phase,
---- = exact date of move unclear, * = time of earthquake.

*

PHASE 2

DATE	OCT. 15	NOVEMBER 1 15	DECEMBER 1 15	JAN. 80 1 15	FEBRUARY 1 15	MARCH 1 15	APRIL 1 15
ADMINISTRATIVE ANNEX	COUNTY ADMINISTRATIVE OFFICE IN COURT HOUSE						
AFFIRMATIVE ACTION	BASEMENT OF EDUCATION CENTER						
AGRICULTURAL COMMISSIONER	NAVAL AIR FACILITY						
AGRICULTURAL EXTENSION	EXPAND TO TRAILERS AT AG. CENTER						
COURT RECORDS	MUNICIPAL COURTS			CASA DEL VALLE- PUBLIC DEFENDERS			
FAMILY SUPPORT	SEARS MALL (EL CENTRO CENTER)						
PERSONNEL	2 VACANT HOUSES SOUTH OF COURT HOUSE						
PLANNING	I.V.D.A. BUILDING AT AIRPORT (COUNTY CENTER #3)					ADD TRAILER	
PUBLIC WORKS	NAVAL AIR FACILITY						
SNACK BAR (STATE DEPT. OF REHABILITATION)	NON-FUNCTIONING						
VETERAN'S SERVICES	BASEMENT OF COURT HOUSE						
WELFARE	LOS NINOS AT COUNTY CENTER #2 VALLEY PLAZA CENTER FREEBLE BLDG. NEAR C.C.#3			SEARS MALL (EL CENTRO CENTER)			

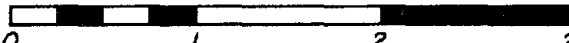

SCALE  MONTHS

Figure 17. Phase Two of Relocation.

KEY: C.S.B. = (Imperial) County Services Building,  = previous phase, ---- = exact date of move unclear, * = time of earthquake.

*

PHASE 3

DATE	80	81	82	83
DEPARTMENT	OCT. JAN.	OCT. JAN.	OCT. JAN.	OCT. JAN.
ADMINISTRATIVE ANNEX		C.A. OFFICE IN COURT HOUSE	OLD SHERIFF'S OFFICES	NEW BLDG.
AFFIRMATIVE ACTION		BASEMENT OF EDUCATION CENTER	PARKS AND REC. BLDG.	NEW BLDG.
AGRICULTURAL COMMISSIONER		NAVAL AIR FACILITY		OLD SHERIFF'S OFFICES
AGRICULTURAL EXTENSION		BLDG. + TRAILERS AT AG. CENTER		NEW BLDG. NEAR MELOLAND
COURT RECORDS		CASA DEL VALLE - PUBLIC DEFENDERS OFFICES		COURT HOUSE
FAMILY SUPPORT		SEARS MALL	OLD SHERIFF'S OFFICES	NEW BLDG.
PERSONNEL		2 VACANT HOUSES SOUTH OF COURT HOUSE		NEW BLDG.
PLANNING		I.V.D.A. BLDG. + TRAILER AT AIRPORT (C.C.#3)	ADD 2nd TRAILER	BASEMENT OF COURT HOUSE
PUBLIC WORKS		NAVAL AIR FACILITY		EDUCATION CENTER BUILDING
SNACK BAR (STATE DEPT. OF REHABILITATION)		NON - FUNCTIONING		NEW BLDG.
VETERAN'S SERVICES		BASEMENT OF COURT HOUSE		BASEMENT OF COURT HOUSE
WELFARE		SEARS MALL	600 MAIN STREET (DOWNTOWN)	NEW BLDG.

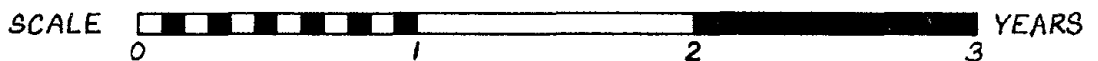



Figure 18. Phase Three of Relocation.

KEY: C.S.B. = (Imperial) County Services Building,  = previous phase, ---- = exact date of move unclear, * = time of earthquake.

D. Cost of Relocation and Rebuilding

The total cost of relocation approximates three-quarters of a million dollars. Six months after the earthquake the County had the following claims awaiting approval by the Federal Emergency Management Agency (FEMA).

Replace/repair damaged equipment and furniture	\$ 32,900
Structural engineering consultant - CSB study	87,200
Shoring, fencing, etc., - CSB	111,400
Renovate leased facilities	51,400
Lease 3 mobile office units	26,400
Lease office space	361,000
Moving from CSB to temporary facilities	43,800
Refile records, etc.	11,000
Emergency overtime, meals, etc.	19,100
Communications systems	<u>19,400</u>
	\$763,600

Swamped by claims, and still processing claims from earlier floods in Los Angeles and the volcanic eruption of Mt. St. Helens, FEMA was slow to respond with money, although damage assessment teams were quickly dispatched following the earthquake. One year after the earthquake the County had received \$129,000 from the Federal Government. The County was able, however, to use FEMA money recently received in response to claims following flood damage from Tropical Storm Kathleen, two winters previously.

Much county office time was spent in computing and justifying damage claims to FEMA: Public Works estimated that their office work load doubled while this work was in progress. The County was familiar with FEMA's documentation requirements, since they had undergone the process after Storm Kathleen.

Other hidden costs were incurred. The county dumps had to process greatly increased volumes of debris and materials. The Building Department waived fees for earthquake damage repair, though it had to process a sudden influx of requests.

The initial estimate, by county engineers, for repairing the existing building was \$4.99 million. The estimate for a new building of the same size and design was \$6.8 million. In order to justify demolition of the damaged building to FEMA, the County reduced the design and the design criteria, while keeping the same square footage as the original building (55,000). This lowered the replacement cost to \$4.3 million, which included demolition of the damaged building. This latter option was adopted, and a two-story light steel frame building is scheduled for completion and occupancy in October 1982; three years after the earthquake.

Influencing the decision of the County in taking this route was a very strong feeling among the occupants of the damaged building that, if it were repaired, they would not return to it. As one occupant recalled "...I could never have worked in that building again regardless of any assurances that might have been made, and was delighted when it was finally torn down as that removed all doubt as to whether we would be asked to work there again... ."

APPENDICES

APPENDIX I

Detail of Departmental Moves Shown on Relocation Charts

NOTES TO ACCOMPANY RELOCATION CHARTS (Figures 16, 17, and 18) AND MAPS
(Figures 13, 14, and 15)

ADMINISTRATIVE ANNEX

(1 person)

At the time of the earthquake, this was a one-man in-house office of Risk Management for the County Administrative Office. For the week following the earthquake, this employee worked with the Emergency Services group helping to re-establish function within the County and listening to complaints about relocation problems. Work was resumed the second week in available space located in the County Administrative Office, in the Court House. In July 1981, the department was moved to the old Sheriff's building, southeast of the Court House. The Administrative Annex will be absorbed into the County Administrative Office, when it moves into the new replacement building upon its completion.

AFFIRMATIVE ACTION

(2 persons)

The staff had no responsibilities for two days following the earthquake. By mid-week they had been assigned space in the basement of the Education Building and so returned to the County Services Building four days after the earthquake to recover necessary materials. This space was much larger, but had no windows. In December of 1981, they were moved to the Parks and Recreation building. When the New County Administrative Center is completed, Affirmative Action will make its second and final move into the new building.

AGRICULTURAL COMMISSIONER

(34 persons)

Because one employee was confined to a wheelchair, the number of spaces suitable for relocation was limited. The Department was initially split-up in three locations. The majority of the Department, which included the administrative personnel, relocated to the Fairfield Warehouse at the Agricultural Center in El Centro. The Air Pollution Control staff moved to a vacant space in the terminal building at the airport (County Center #3) which was wheelchair accessible. The field inspectors used the Inspection Dock in Brawley as their headquarters.

This three-way split lasted for a short time only. Within a week of the earthquake, the Navy offered space to the County at their nearby Air Facility. Since the N.A.F. was accessible by wheelchair, the Agricultural Commission, as a unit, was one of the first departments assigned to this space.

The final location of the Agricultural Commission will be in the old Sheriff's Offices at the Jail, southeast of the Court House. This move will occur when Family Support moves out, into the new replacement building.

AGRICULTURAL EXTENSION

(17 persons)

By the day following the earthquake, a decision had been made to move to a warehouse at the Ag. Center, located at Fairfield and Commercial Streets

in El Centro. The staff spent the next two days clearing-out the building and by the fourth day was functioning with a radio, minimal furniture, and minimal equipment. Telephones, typewriters, and desks were in use by the end of the second week. By November 1st, 1979, two trailers had been added at the Ag. Center site to increase their available space.

A new, three-way financed structure is to be constructed at the Meloland Experimental Station, east of El Centro. The 7,900 square foot building will be financed by the University of California, the local Growers Association, and the County. The Agricultural Extension Department will be the only tenant. Completion is scheduled for July 1983.

COURT RECORDS

(1 person)

Following the earthquake, the Court Records were moved to the Municipal Courts, located on Broadway near 10th Street. In early 1980 they moved to the Public Defender's Office at Casa del Valle, an old motel now owned by the County, also located in the downtown area. Court records will eventually reside in the Court House once the non court-related offices move out.

FAMILY SUPPORT

(16 persons)

Family Support very quickly set up operations in a vacant warehouse known as the Keystone Seed Company at State and 7th Streets. The building was owned by a member of the County Board of Supervisors who offered it as an interim location. For three weeks the Department operated without files while temporary partitions were constructed around them.

On November 9, 1979 they moved to vacant space at El Centro Center, a shopping mall locally referred to as the Sears Mall. They were very pleased with this new location, since the space had been remodeled to their specifications. In addition, their files had now been sorted and were available for use.

In January of 1980, the Welfare Department joined Family Support at the Sears Mall. This was a welcomed move since the two departments sometimes worked closely together. The majority of the other tenants in the Mall, however, soon began complaining about the large number of Welfare/Family Support clients loitering around their shops. Some even reported increased incidences of shoplifting. One future tenant, Mervyn's Department Store, would not sign a lease until Welfare moved out of the Mall. As a result, their leases were not renewed, and Family Support moved once again on October 20, 1980.

Family Support moved into space vacated by the Sheriff's Office located in the Jail Building, on the northwest corner of State and 9th Streets. The space had become available when the Sheriff moved to the new jail facility at County Center #2. Family Support will join the Welfare Department in the New County Administrative Center once it is completed.

PERSONNEL

(7 persons)

On the day after the earthquake, Personnel was assigned to two residences owned by the County, south of the Court House. Both residences were vacant and scheduled for demolition to make way for a parking lot. The combined area of the two houses provided more space than was available to the Department in the County Services Building, and it will continue in this location until the new replacement building is completed.

PLANNING

(12 persons)

The Planning staff and the Building Inspection staff had previously worked long and hard to consolidate their services at a common location. Therefore, their greatest concern during relocation was that the Department remain together as a unit. On the fourth day after the earthquake they were assigned to the vacant Imperial Valley Development Agency (I.V.D.A.) building at the entrance to the airport (County Center #3) on a temporary basis, even though the building was 1000 square feet short of space, lacked privacy, and had inadequate space for laying out materials. The staff agreed to this less than ideal solution rather than split-up the Department. It took approximately four weeks before all equipment, records, and desks were moved to the new location.

In early 1980, a leased trailer was added to lessen the space shortage, thereby establishing that this was no longer seen as a temporary solution. A second trailer was leased in January of 1982. For a short time, the Public Works Department was also located at the airport - an ideal situation. Public Works subsequently moved to the Naval Air Facility which has led to difficulties in transportation and communication between the two departments. The eventual location of the Planning Department will be the basement of the Court House, when the Fiscal Services are moved to the new building.

PUBLIC WORKS

(22 persons)

It was the responsibility of this department to survey the County and compile an inventory of damaged roadways, bridges, and other public facilities. This information was needed at once, so for several hours immediately following the earthquake, Public Works employees, including the Director who was coordinating the reconnaissance, operated out of their vehicles and communicated by radio. The majority of the staff are field personnel, who either work out of their cars or one of the seven road yards, and so do not normally report to the County Services Building.

By the day following the earthquake, a temporary headquarters with a portable radio had been set up at the Heber Road Yard, located in southern Imperial County where most of the damage had occurred. After approximately three hours, the Board of Supervisors instructed them to move to the De Anza Rescue Building near the airport fire station (County Center #3): they complied, with the overflow remaining at Heber Road Yard. Communication between the Department and the public was a major problem during this period.

After about a week and a half, Public Works moved into the old command headquarters at the Naval Air Facility. Although a better space, its remote location caused some inconvenience.

The final location of the Public Works Department will be the Education Center Building. This move will occur when the Education offices move into a new pre-fabricated facility to be constructed near the new jail at County Center #2. This move will locate the Planning, Public Works, and Agricultural Departments on one central downtown block and will greatly simplify the permit process.

SNACK BAR

(1 person)

The snack bar, sponsored by the State Department of Rehabilitation, was operated by an elderly blind man. Following the earthquake, a pre-assigned county employee assisted his evacuation from the County Services Building. The subsequent scattering of relocated county departments meant the dissolution of the snack bar until the replacement facility was completed. It is speculated that the loss of his job and the absence of social contact it provided, proved too traumatic an experience: the operator has since died while awaiting the reopening of the snack bar.

VETERAN'S SERVICE

(3 persons)

Very soon after the earthquake, Veteran's Service was assigned space in the basement of the Court House. By the day after the earthquake the move had been initiated. This will be the permanent location of the Veteran's Service Department.

WELFARE

(118 persons)

Time was critical immediately following the earthquake, so the largest county department split-up to simplify and quicken the relocation process. Important public functions, such as intake, were moved to the old county hospital building at County Center #2, which had just completed remodel construction for Los Ninos (dependent children's home) one week prior to the earthquake. An emergency assistance center was set up at the Valley Plaza Center. When the records were finally removed from the damaged building, they were taken to the Preeble Building at the fairgrounds, across from the airport, to be sorted.

When the Navy offered its available space at the Air Facility to the County, it made it clear that it would not accept the Welfare Department. The Navy foresaw problems of access and security, and did not want "welfare-types" on base. Space was ultimately leased at the Sears Mall, which contained enough square footage to accommodate the entire Welfare Department as well as Family Support - a department that worked closely with Welfare. Department records were also moved to this location, since their storage space at the fairgrounds was required for the Winter Fair about to take place.

When this lease expired, it was not renewed in response to tenant complaints, and a long-vacant building located in the downtown business district was selected as the new location. Family Support relocated to the offices

previously occupied by the Sheriff's Department in the Jail Building. When the New County Administrative Center building is completed the two departments will once again be located in the same building, enabling better communication.

After removal from the damaged building, county files and records from almost every department were first taken to the fairgrounds for sorting. They were next moved to old buildings and trailers at the Ag. Center. Those records and files not required by the departments, will be permanently stored in the old jail cells, once they become vacant.

APPENDIX II

Questionnaire

BSD BUILDING SYSTEMS DEVELOPMENT INC.

1.

Architecture/Research 120 Broadway San Francisco, California 94111 (415) 434-3830

QUESTIONNAIRE TOTALS

NAME: _____	125 RESPONDING
	- 7 NOT IN BUILDING
AGE: _____	118 QUESTIONNAIRES FROM BUILDING OCCUPANTS

LENGTH OF TIME EMPLOYED BY IMPERIAL COUNTY: _____ Years. _____ Months.

JOB TITLE AT TIME OF EARTHQUAKE _____ . DEPARTMENT _____ .

CURRENT JOB TITLE _____ . DEPARTMENT _____ .

PHONE NUMBER _____ .

INSTRUCTIONS.

Building Systems Development is conducting for the National Science Foundation a study aimed at improving safety in office buildings during earthquakes. As an important part of this project we are interested in learning how occupants of the Imperial County Services Building responded to the 1979 earthquake.

Please answer each question as accurately as you can since your answers will provide a basis for planning to prevent injuries and lessen damage during future earthquakes. All answers will be kept confidential.

Please answer all of the questions on this form. On multiple choice questions, please place an (X) next to the appropriate answer. If you answer OTHER please specify what the answer is.

There is a space following the questions for any additional comments that you may have.

The final page contains a floor plan of the floor of the building that your work station was on. Please draw a circle on this floorplan to indicate the place that you were when the earthquake began. Then draw a line to indicate the route that you took in evacuating the building and the stairway that you used.

Please refer any questions and return the completed form to your department head.

Thank you for your help.

QUESTIONS.

		2 · 41	35%
		3 · 25	21%
		4 · 25	21%
		5 · 14	12%
		6 · 13	11%
1. On the day of the earthquake what floor of the Imperial County Services Building was your work station located on?		<u>2 · 40</u>	34%
		3 · 25 + 1 stairwell	22%
		4 · 25	21%
		5 · 14	12%
		6 · 13	11%
2. When the earthquake occurred what floor of the building were you on?			
3. When the earthquake began where were you?			
	a) at my work station	<u>88</u>	75%
	b) in the main corridor	<u>3</u>	2%
interview room conference room clerical area supervisor's office	c) somewhere else in the department space (please indicate where)	<u>21</u>	18%
	d) other (please specify)	<u>6</u>	5%
	elevator 3 stairway 2 restroom 1		
4. When the earthquake began were you:			
	a) standing	<u>35</u>	30%
	b) sitting	<u>80</u>	68%
	c) walking	<u>3</u>	2%
	d) other (please specify)	<u>∅</u>	
5. When the earthquake began were you: (multiple answer)			
	a) talking	<u>44</u>	37%
	b) writing	<u>43</u>	36%
	c) reading	<u>4</u>	3%
	d) filing	<u>6</u>	5%
walking operating office equipment stuffing envelopes	e) other (please specify)	<u>14</u>	12%
	- typing	<u>11</u>	9%
			21%
6. When the earthquake began were you:			
	a) alone	<u>22</u>	19%
	b) with others (how many)	<u>96</u>	81%

7. How did you first know that an earthquake was occurring? (you may indicate more than one answer)

a) heard noise	<u>65</u>	55%
b) felt building move	<u>100</u>	85%
c) saw furniture/equipment move	<u>31</u>	26%
d) heard or saw glass break	<u>13</u>	11%
e) told by a co-worker	<u>10</u>	8%
lights went out floor sagged windows rattled } → f) other (please specify)	<u>9</u>	8%

8. How long do you think the first period of shaking lasted?

see following page

9. During the first period of shaking were you:

a) able to move about easily	<u>15</u>	13%
b) able to move about with some difficulty	<u>75</u>	63%
c) not able to move about at all	<u>26</u>	22%
— no answer	<u>2</u>	2%

10. During the first period of shaking what was the first thing that you did? (multiple answer)

a) got under a desk	<u>42</u>	36%
b) stood in a doorway	<u>18</u>	15%
c) stayed where I was	<u>44</u>	37%
d) went into the main corridor	<u>4</u>	3%
e) left the building	<u>2</u>	2%
f) dodged to avoid falling objects	<u>10</u>	8%
stood-up told others to evacuate told others to get under a desk } → g) other (please specify)	<u>16</u>	14%

11. If you got under a desk did the desk move away from you?

a) yes	<u>13</u>	30%
b) no	<u>31</u>	70%

Detailed summary of responses to Question #8.

ESTIMATED DURATION	# OF RESPONSES	%	ESTIMATED DURATION	# OF RESPONSES	%
1 second	1	1%	50 seconds	2	2%
4 seconds	1	1%	1 minute *	16	14%
6 seconds	1	1%	1-2 minutes	2	2%
6-8 seconds	1	1%	2 minutes	5	4%
8-10 seconds	1	1%	2-3 minutes	3	2%
10 seconds	4	3%	3 minutes	5	4%
15 seconds	4	3%	3-4 minutes	1	1%
15-20 seconds	1	1%	4 minutes	1	1%
20 seconds *	10	8%	4-5 minutes	1	1%
20-30 seconds	1	1%	5 minutes	4	3%
30 seconds *	18	15%	5-8 minutes	1	1%
30-45 seconds	1	1%	30 minutes	1	1%
30-60 seconds	2	2%			
35 seconds	2	2%	long enough	4	3%
40 seconds	2	2%	too long	2	2%
40-50 seconds	1	1%	forever	4	3%
45 seconds	3	2%	no idea	4	3%
45-60 seconds	2	2%	no answer	6	5%

* three most common responses.

NOTE: This summary chart is based on duration estimates provided by the building occupants when answering the questionnaire. BSD did not provide them with a list of time frames from which to choose.

12. What prompted you to respond the way that you did? (multiple answer)

a) previous drills in elementary school	<u>21</u>	18%
b) previous drills in this building (e.g. fire drills)	<u>32</u>	27%
c) seemed sensible	<u>37</u>	31%
d) advice from a co-worker	<u>21</u>	18%
e) don't know	<u>9</u>	8%
f) experience with another earthquake	<u>29</u>	25%
too scared to move didn't know was an eq. previous advice → g) other (please specify)	<u>11</u>	9%

13. Have you been in other earthquakes? (If so, please indicate the year(s) of the earthquake(s) and the city(ies) that you were in.

YES	98	83%
NO	12	17%
no answer	8	

14. Did you notice any damage to the area that you were in when the earthquake began (you may indicate more than one answer)

a) files overturned	<u>68</u>	58%
b) papers on floor	<u>92</u>	78%
c) desks moved	<u>57</u>	48%
d) cracks in walls	<u>74</u>	63%
e) cracks in ceiling	<u>45</u>	38%
f) broken light fixtures	<u>29</u>	25%
cracks in floor broken windows &/or glass overturned file cabinet door jammed wall-plaster on floor → g) other (please specify)	<u>38</u>	32%
- no damage	<u>6</u>	5%

15. Did you worry that any of the following things might happen: (multiple answer)

- no worries	7	6%	a) building would collapse	<u>100</u>	85%
- death	6	5%	b) ceiling would fall in	<u>59</u>	50%
			c) I would be cut by flying glass	<u>32</u>	27%
			d) the walls would fall in	<u>45</u>	38%
would fall out a window floor would fall out from underneath feet →			e) there would be a fire	<u>14</u>	12%
			f) other (please specify)	<u>13</u>	11%

16. After the first period of shaking stopped what was the first thing that you did? (multiple answer)

	a) went into the main corridor	<u>10</u>	8%
	b) remained where I was	<u>23</u>	19%
	c) returned to my work station	<u>7</u>	6%
checked co-workers helped open a jammed door ordered the evacuation assisted evacuation & floor check	d) left the building	<u>66</u>	56%
	e) other (please specify)	<u>22</u>	19%
	- got under desk	<u>2</u>	2%
	- got into doorway	<u>2</u>	2%
			23%

17. Why did you decide to leave the building? (multiple answer)

	a) evacuation announced by floor monitor	<u>30</u>	25%
	b) evacuation announced by co-worker	<u>31</u>	26%
	c) seemed sensible	<u>59</u>	50%
fear that building would collapse possible aftershocks with more damage	d) others were leaving the building	<u>19</u>	16%
	e) other (please specify)	<u>13</u>	11%

18. Did you encounter any obstacles in leaving the building? (multiple answer)

	a) door jammed	<u>15</u>	13%
	b) overturned file cabinets blocked doorway	<u>14</u>	12%
	c) elevator didn't work	<u>13</u>	11%
plaster & cracks in stairs debris in hallways lights out in stairwell people	d) crowding at entrance to stairway	<u>37</u>	31%
	e) other (please specify)	<u>37</u>	31%
	- none	<u>35</u>	30%

19. Did you suffer any injuries in the earthquake? no answer 5 }
 (If so, what were they and how did they occur) NO 92 } 82%
 YES 16 }
 nerves 5 } 18%

20. Did you have any difficulty finding the exit to the building ?

a) yes	<u>4</u>	3%
b) no	<u>114</u>	97%

21. Did you try to use the elevators to exit the building?

a) yes	<u>1</u>	1%
b) no	<u>117</u>	99%

22. During the earthquake, were you struck by any objects or did you bump into any objects? (If so, what objects)

no answer	3	} 66%
NO	75	
YES	<u>40</u>	34%

23. Did you go back into the building after it had been evacuated? (If so, please indicate when)

no answer	2	} 62%
NO	71	
YES	<u>45</u>	38%

24. Where did you go when you left the building?

across street	72	61%
home	29	24%
other	<u>15</u>	13%
don't recall	1	1%
no answer	1	1%

25. During the earthquake, what was your major concern? (multiple answer)

a) my personal safety	<u>72</u>	61%
b) the safety of my family	<u>76</u>	64%
c) damage to my home	<u>13</u>	11%
d) my belongings in the building	<u>3</u>	3%
e) other (please specify)	<u>19</u>	16%

Safety of other county employees
successful building evacuation
building would collapse

26. If this building had been repaired immediately after the earthquake, and you were assured that it was safe, would you have returned to work in the building?

a) yes	<u>31</u>	26%
b) no	<u>80</u>	68%
unsure	<u>7</u>	6%

27. Would your answer to this question be the same six months after the earthquake?

a) yes	<u>99</u>	84%
b) no	<u>12</u>	10%
unsure	<u>7</u>	6%

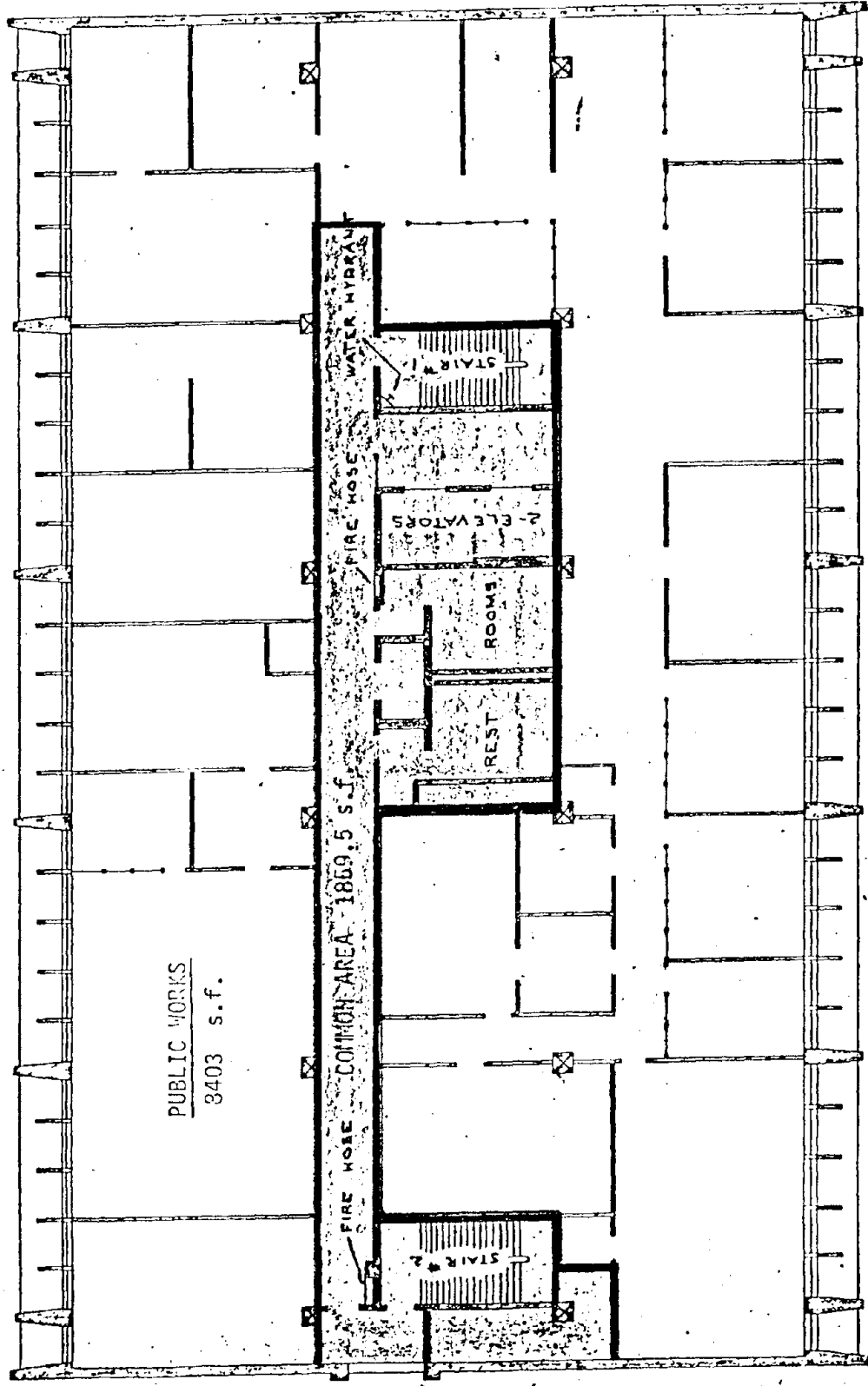
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SEP 1979

Dir. Sigs. & Grds.



SCALE: 1/8" = 1'



SIXTH FLOOR PLAN

10,262.5 s.f.

COUNTY SERVICES BLD
BUILDINGS & GROUNDS

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