SLAC TN-79-1

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TRIP REPORT

UCSB EARTHQUAKE DAMAGE SURVEY

On September 25, 1978 we made a trip to the Santa Barbara campus of the University of California to talk with people and gather information regarding the earthquake which occurred there on August 13, 1978. This technical note summarizes our activities.

During the day, we visited and interviewed the people listed in EXHIBIT A. Their complete cooperation, including giving us ready access to consultants reports, viewing of slides, photographs of damage, a tour through the area and listings of damages sustained by the various groups involved was sincerely appreciated.

EXHIBIT B is a review of the basic systems involved and how they performed subsequent to the earthquake.

EXHIBIT C is a summary of the remarks made by various individuals regarding disaster planning, follow-up problems and the level of support for earthquake safety planning.

EXHIBIT D contains general comments and observations.

EXHIBIT E is a copy of the emergency procedures of the Facilities Management Department. Note that due to an organizational change the Plant Facilities Department referred to in the exhibit is now known as Facilities Management.

A set of slides showing the damage sustained by the UCSB campus is available for viewing, along with a brief summary of the technical details of the earthquake and short description of the scenes shown in the slides.

EXHIBIT A

A listing of people we interviewed and the departments they work for.

PLANT FACILITIES

Mr. Theodore Town, Physical Plant Department, Physical Plant Administrator. We had a brief general meeting, during which he discussed the broad implications of the earthquake and its impact on his department's facilities and budgets.

Mr. William Dolby, Physical Plant Department, Assistant Physical Plant Administrator. Mr. Dolby was our principal contact. He arranged for interviews with the safety department and with Dr. Richard Miller. He spent several hours giving us a detailed account of their emergency plan, how it operated, damage reporting and repair efforts. Since he was at the site shortly after the earthquake, he was able to present us with a detailed statement of their response. He was deeply involved with the follow-up analysis of damage, and the direction of the consultants and local contractors working on clean up and repair operations. He helped collect the cost estimates for repairs, for action by the University of California Regents.

A preliminary estimate of the UCSB costs indicate damages to facilities and equipment will be approximately 3.5 million dollars.

Safety Department

Mr. William Steinmetz, Director of Safety, Environmental Health and Safety department. During our brief meeting, he made several pertinent observations. 1) Gas cylinder chaining was ineffective. "C" clamps securing cylinders failed. Chain links also broke; they should have been sturdier. 2) Restraints made of insulated electric wire (about 12 gage) tied across the outside, about 2" above the shelf, do keep bottled chemicals from falling off shelves (Simple and effective). 3) Anchored bookcases stayed up, as did anchored files. 4) Have a photographer available and on duty. Mr. Steinmetz introduced us to Mr. Larry Parsons, who presented a slide show of the damaged areas.

Mr. Larry Parsons, one of the two safety officers employed at UCSB. A trained professional photographer, Mr. Parsons took a large number of excellent color photographs. A duplicate set of his slides is available at SLAC. He guided us on an extensive tour of campus buildings during which he pointed out areas where damage had occurred. We were fortunate that he was able to spend several hours with us. He also arranged for an interview with Julie Deanda of the Business Office.

National Science Foundation

Dr. Richard Miller, Assistant Professor, Mechanical and Environmental Engineering Department. Working on an NSF grant, Dr. Miller is preparing a narrative report of the Santa Barbara earthquake. We had a short visit with him during which we made arrangements to get a copy of his report, when it is available. He also provided us with a copy of a paper, "The Earthquake Design and Analysis of Equipment Isolation Systems", by W. D. Iwan and the address of a company, Mason Industries, which specializes in state-of-the-art motor mounts.

Business Office

Julie Deanda, Insurance Risk Coordinator, Business Office. Shortly after the earthquake all departments at UCSB were asked to submit lists of the equipment damaged. The lists were extensive. Over 100 major items of equipment were either destroyed or damaged. All departments suffered damage, to some degree. The total value was estimated to be in the vicinity of $300,000, but reports were still coming in. Since Monday, September 25, 1978 was the first day of the semester and some of the faculty had just returned, additional reports are anticipated.

We were encouraged to review the departmental reports and had an in-depth discussion of the problems this department faced.

EXHIBIT B

Stopped clocks indicated that the Santa Barbara earthquake occurred at 3:57 P.M., August 13, 1978. Since it was late in the summer, on a quiet Sunday afternoon, few people were on the UC Santa Barbara campus. There were no casualties among the people present. The earthquake was measured at 5.1 on the Richter scale with ground accelerations of .45 to .37, considered large for an earthquake of that magnitude.

Response was quick. Many employees converged on the campus and started recovery operations, in conjunction with the employees that were on campus. In accordance with an emergency plan, facilities people and other departmental personnel gathered at a central point in the Physical Plant Department area, where reports on damages and action teams were to be coordinated. Communication was primarily by radio, since power was out, as were the telephones. By coincidence, a command room, complete with power from an emergency generator had been moved only the previous Friday to a new location. Emergency power had not been reconnected in the new location, rendering the new area useless. However, radio communications were adequate.

All electric power was immediately lost. Some of the emergency generators did function. Others, fed from underground gas lines were inoperative as the gas lines were ruptured and had quickly been shut off. According to a prearranged plan, emergency generator units of various sizes were dispersed throughout the campus. They were diesel or gasoline operated and were immediately put into operation.

Feeders to the electrical substation failed immediately and all normal power to the campus was off. This situation continued for about three hours. Prior to restoring power, all feeder circuit breakers and switches throughout the campus were turned off. In a planned, orderly incremental sequence, power restoration commenced three hours following the earthquake. Almost all of the distribution circuits were intact. The substation was undamaged. Power was restored in all areas very quickly. In a few isolated instances, restoration took up to twenty-four hours.

The water system was operative despite the fact that the main feed to the campus broke off. Crews were able to shunt water around the main, keeping the system continuously in operation. Adequate water for fire fighting purposes was available at all times.

The gas system, consisting of natural gas with an LPG alternate system was immediately turned off, leaving only the residual gas in the pipe lines. There were two major breaks in the gas lines. Gas services were restored the following morning.

Without electrical power, the sewage situation could have been a disaster since all sewage is pumped from the campus area to the mainland via a main and stand-by line which cross a lagoon on a trestle.

Sewage is pumped from four collection points to the outgoing lines. Mr. Dolby referred to this system as one of the hidden problems which could have assumed major proportions, if lack of pumping power had continued for any period of time. The entire area might possibly have had to have been evacuated if the health situation had deteriorated.

Eighteen of forty-four elevators were immediately inoperative due to the power failure. One person was trapped, but was uneventfully released. Counterweights on one elevator in the Engineering Building had jumped out of guideways and were hooked on structural beams. For some unexplained reason, the roof mounted traction equipment kept pulling even though power, including emergency power, was off. This caused heating of the drum, through rope

friction and was a possible fire hazard. It was theorized that had gas been present in the building, damage, due to the heat and resultant fire could have been extensive.

More recently installed elevators, designed in accordance with OSHA standards were undamaged and fully operational shortly after the earthquake. In Mr. Dolby's opinion, the value of the OSHA design requirements had been proved.

Damage to roads on the campus was minor. All roads were passable, in spite of some cracking. Full access to all areas was possible at all times.

A bridge which is the main means of access to the University sustained damage at the junction of the bridge ramp and the road bed on the incoming side. A "bump" reported to be six inches high occurred. Initially, this caused no problem and many people crossed the bridge. Later, the bridge was shut down completely for several hours, preventing access to the campus while damage to the structure was assessed. One of the people held at the bridge was the official University photographer.

The University seismic consultant, Stanley Mendes Incorporated, proceeded directly to the campus. He toured all buildings and quickly reported on their status.

Except for areas such as the library and a chemistry lecture auditorium which were a mess, the buildings were deemed structurally safe to enter. There was concern for personnel safety in chemical labs, due to spilled chemicals. Roof mounted fume hoods were damaged and in disarray. A groundless rumor, regarding poisonous snakes, loose in a biological laboratory circulated for some time, but was soon dispelled.

The fire alarm system functioned continuously during the entire episode. No fire damage was sustained.

EXHIBIT C

A summary of remarks made by various individuals during the course of the day we spent at UCSB. In some cases, the same remark was made by more than one individual, indicating a general problem.

Disaster Planning

A Disaster Plan had been developed for the University. A copy of the portion of the plan, related to the Facilities Management Department has been received by SLAC. See EXHIBIT E.

In accordance with the plan, key staff members reported to preassigned locations and a review of the status of all of the major systems was completed. It was reported that events flowed smoothly, people went about their assigned tasks and did their jobs well. There was no general panic. Few people were on the campus. It was theorized that had the earthquake occured at a time when more people were on campus, there would have been many injuries. In some areas, plate glass windows had shattered and heavy objects had fallen.

Follow-up Problems: "Inspectors"

Several groups of inspectors visited the campus shortly after the earthquake. It was difficult to tell which of the groups really had authority. The instructions of one group, in some cases countermanded those of another. Since UCSB is a State funded institution, the staff felt obligated to listen to all of the comments and acted on those they felt were reasonable. The staff felt that too much of their time was spent on showing these visitors the damaged areas. Some system for screening inspectors should have been set up in advance. It could have saved some time of the already overburdened staff.

Funding

Funding for the initial emergency repairs was accomplished with operating money.

A major effort was immediately started under the direction of the University Architect to identify all of the work that would be required to bring the facilities up to full operations. The Plant Facitities Department was responsible for gathering all of the imformation on damages to the facilities. The Business Office did the same for the damaged and destroyed equipment.

It became immediately apparent that there would be a difference of opinion on what constituted repairs to a particular area, or improvements. As Mr. Dolby pointed out, what is the point in repairing something to its original condition when it would fail again under similar circumstances? The people in charge of funding had different ideas and proving that one method of improvement was superior to another, was difficult. The problems were of course resolved, but it was in some cases a compromise.

Damaged equipment as opposed to damaged facilities presented a different problem. Equipment replacement or repair funds were sought by going back to the group that originally provided the funds. Since many groups and funding sources provided the equipment, backtracking through them was a major task.

It was apparent that an expedited procedure for handling disaster repairs and replacements was needed both in the Facilities and Business groups.

The complexities of funding repair and replacement efforts were extensive. It was one of the most significant problems facing the staff. And, it was expected to go on for some time, possibly years. This effort cost the staff time and energy by placing upon them a burden in addition to that of their normal routine work, with no end in sight.

Earthquake Safety Planning

University construction is carried out by the use of outside consultants, who develop the plans and specifications, for competitive bidding. The structures are designed in accordance with the Uniform Building Code (UBC). Earthquake design is incorporated within the UBC and it is the criteria. No separate or special seismic design review is carried out. Normal construction supervision is carried out by the University.

The University has a seismic consultant, available through an open-ended contract.

There is no in-house group specifically charged with the responsibility of reviewing design and compliance with criteria for earthquake safety.

EXHIBIT D

General Comments

The overwhelming concern one has upon viewing the scene of a disaster, such as the earthquake in Santa Barbara, is with people. How did they react? Were there many injuries? Was first aid available and sufficient? Was there any unnecessary suffering?

Happily, at Santa Barbara, the earthquake occurred at a fortunate time. People on the campus were uninjured. If people had been in the chemistry lecture hall, the library, or in some of the air conditioning and heating areas when it struck, it could have been a far different situation. Large objects were in motion and considerable damage was being caused by this relatively minor earthquake.

A month after the earthquake, people were still "jumpy". One of the people we visited reacted quickly to a loud noise outside of his office. Since it was unfamiliar, he immediately got up, looked out of the window and generally acted nervously.

Some of the people who worked at the university were afraid to reenter the buildings. Since many of the walls had cracks in them and there was considerable visual damage, their concerns were understandable.

It would seem desirable for the SLAC Earthquake Safety Committee to consider the following thoughts. Certain preliminary steps must be taken to help insure the safety and well-being of people here.

1. SLAC people, not just management, should have some education in earthquake survival. The entire staff should particitate in basic training sessions which should cover how to react, where to go, the indivduals responsibilities to himself, his family and SLAC and other subjects of general interest. The session should be low key, brief and informative, with lots of handouts. (eg. The Earthquake Game and other pertinent data.)

2. SLAC staff people in more responsible positions such as group leaders, building managers etc. should have training sessions which should cover the staffs' responsiblities, in depth. Each should understand his role and be comfortable in it. Prehaps some of these concepts should be in the Emergency Manual, as well.

3. A photographer, preferably two, with no other SLAC responsibiiities should be appointed. There should be no prior demands on his or their time, so they could be free to take the necessary historical photographs.

4. A screening group composed of responsible people with a good understanding of earthquake response procedures should be appointed. They should have broad discretionary power to do such things as close off the area to sightseers, check credentials of inspectors, the press and others before permitting entry to the site, assign emergency vehicles and equipment etc.

5. Immediately following an earthquake, a seismic review of all major buildings should be undertaken to insure that occupancy of buildings is safe, closing off those deemed unsafe. It may be advisable to have an independent consultant availabe for this purpose.

6. Since immediate, rapid repair work will be required, a team of Plant Maintenance people should be available. They should be designated individuals who have knowledge of the facilities and their operations.

7. An agreement with an outside architectural firm should be arranged. Detailed data will be needed for budgetary and repair purposes. Some work will be required very quickly, prehaps to alleviate dangerous conditions. Trained specialists should be immediately available for this purpose. If the earthquake is widespread, these people will be very difficult to find. They will be employed elsewhere.

8. A communication center, complete with emergency power should be established. It should have all the necessary communications systems.

EXHIBIT E

UCSB Facilities Management Emergency Procedures

NOTE that due to an organizational change, the Physical Plant Department (PPD) referred to in the exhibit is now known as Facilities Management.

I. PURPOSE

This directive describes the emergency procedures to be implemented by the PPD during various emergency events that may occur on this campus.

II. DEFINITION OF EVENTS

The typical emergencies concerned in this plan are described in the basic EOP. There are still others that are critical to the campus for which the PPD plays a prime role. These involve the total loss of any one of the utilities, a communication blackout, and a heavy wind or rain storm. For example: Loss of sewage pumping capability for over two hours during a heavy population period would most likely require partial evacuation and closing of the campus.

III. RESPONSIBILITY

Upon activation of this plan, the EOP Director will assume full responsibility and direction. PPD, while under this direction, will retain its normal internal chain of command (that is, from Superintendent to Supervisor to Employee) in order to avoid the conflict of instructions that is typical during such period of stress.

IV. COMMUNICATIONS

PPD's old and new two way radio systems, as well as the pagers and telephones, if in service, will be used with the communication and PPD control center at the Dispatch Room in the PPD Office Building 439. The PPD Administrator, the Assistant Administrator or one of the Superintendents, will remain at the PPD control center at all times during an emergency to provide direction for the PPD efforts appropriate to the event or as directed by the EOP Director if he is in charge at the time.

V. RECALL

A. During Normal Duty Hours

1. All PPD personnel reassemble in the Corp Yard during general emergencies) earthquake, major fire).

2. PPD employees return to Corp Yard only as directed during other than major events such as utility outages.

B. During off duty periods

1. PPD Administrator, Assistant Administrator and all Superintendents report to PPD Office as soon as possible during major emergencies.

2. All other PPD personnel will contact their Supervisor or the PPD Control Center as soon as possible in the event of a major emergency but will not be required to return to campus until recalled.

3. Supervisor will be alerted and recalled as needed by the Superintendent in charge during any event. Supervisors will be responsible for notifying their employees if to be placed on recall or standby.

VI. SPECIAL INSTRUCTIONS

A. Damage Survey/Assessment

1. PPD control center will dispatch individuals or teams)including consultant engineers) as appropriate to investigate damage conditions and report restoration needs. Operations and Grounds Zone Men could be very helpful due to their familiarity with particular areas.

2. If the emergency is such that major damage has occurred to buildings and utilities, PPD control will coordinate all assessments with EOP Director and insure liasion with other damage investigations being performed by A & E.

B. Recovery Efforts

1. PPD control center will organize and dispatch damage correction teams (shop personnel, groundskeepers, custodians) as the situation dictates.

C. Equipment and Materials

1. Stockroom and the Equipment Maintenance Shop will insure that PPD emergency equipment and supplies, including safety supplies, are always available and serviceable.

D. Contractor and Equipment Support

1. The Material Coordinator will maintain a current list of emergency handling equipment (cranes, earth movers, etc.) as well as contractors to be called into service as needed. No formal commitments of these items are intended, however, current addresses, telephone numbers and contacts for quick reference during an emergency will be maintained in the Emergency Instructions Book.

E. Planning Data

1. Information, such as utility layouts, building plans, basic data pertaining to elevators, generators and special systems, will be maintained in ready reference files in the PPD Map Room, together with the Emergency Instructions Book.

F. Alternate PPD Control Center

1. If the primary control center is unavailable for use, then an alternate control center will be established in the Bio II Building 571 Basement.

G. Logs, Reports, Records

1. All possible efforts will be made to maintain a log of significant information (conditions, directives, happenings, times, etc.) as it occurs during the emergency. This information will be helpful for post emergency actions.

2. Oral situation reports (written if requested) will be given to the EOP Director. Similar information appropriate to the condition will be passed on to the Chancellor's Office for minor emergencies.

H. Lateral Assistance

1. In all probability, some level of support by PPD 1 will be needed by the Police Department, Fire Department and perhaps even surrounding communities. This may be provided to the extent available upon approval of the EOP Director after PPD essential tasks and obligations on campus have been satisfied.

I. Training

1. Success in implementing this plan depends upon each employee's familiarity with its contents. To insure effective response at the time of an emergency, all PPD work centers will review, discuss and practice as appropriate, the requirements of this plan at least semi-annually. Employee safety (clothing, procedure, equipment) will be included.

J. Helpful Information Pertaining to Various Emergencies

1. LPG Plant

a. Plant is automatically water deluged in event of fire.

b. Gas escaping from this plant is heavier than air. It will stay close to the ground and may drift to the airport, thus causing a hazard. A north wind could carry it onto campus.

c. Evacuation of Buildings 552, 560, 528, 427, 402, 451 should be considered due to their vulnerability in the event of an explosion.

2. Natural Gas

a. Main natural gas vault (with shut off valve) enclosure near West Kiosk.

b. Most emergency generators run on natural gas, therefore, without gas there will be no emergency power generation.

c. To control all gas on campus, secure natural gas at West Kiosk valve, and secure propane by means of valve at the LPG Plant.

3. Electricity

a. Call Southern Cal Edison for assistance on the 16.5KV Service on campus. 4160 KV Service is UCSB owned and is controlled entirely by PPD. West Campus Service is SCE to the meters and PPD beyond the meters.

b. Generators in the following buildings are automatic and should activate immediately with a loss of primary power.
See attached list. (page 32)

c. Portable generators from the PPD Electrical Shop may be dispatched to Building 408 for support of laboratory animals; 444 to sustain traffic signals; East Kiosk to serve the Kiosk and the Gas Company facility; Building 444 to maintain environmental control for a cadaver and to 491 for certain specimens. In case of dire emergencies, traffic signals can be ignored as signs will substitute.

d. Place the large diesel portable generator in operation at 439 to provide basic power for PPD control center and shops.

e. The repeaters for the campus radio system are located in buildings 525 and 528. If normal electrical power is lost, the generators located in those buildings will serve the load. If the generators fail, then special arrangements will have to be made for this power requirement depending upon the circumstances.

4. Water

a. All campus water is furnished through the booster pumps in Building 585 where all water can be secured via a single valve. Water pressure is controlled automatically through use of multiple pumps. The pumps can be operated manually and selectively during unusual situations if automatic control is not appropriate.

b. Almost a million gallons of water are available in the main swimming pool for general use.

5. Sewage

a. The main sewerage lift station, Building 529, has a diesel generator to keep the pumps running automatically in case of power failure. The oil tank should be checked at regular intervals. If pumping ability is lost or delivery lines to Goleta Sanitary are broken, then campus sewage will overflow to the ocean at the lift station. Depending on the severity of the situation, it may be necessary to partially evacuate the campus in order to control sewage. This decision will be made by the Chancellor or EOP Director.

6. Wind Storms

a. During heavy wind conditions, overhead power lines in parking lot #10, near Buildings 478 and 419 should be monitored, since they are susceptible to damage from the eucalyptus trees.

b. The Grounds Division should be placed on watch for clearing hazards and relieving tree limb problems as they occur.

c. Downed wires or those in contact with tree limbs should be cleared by electricians prior to removal of all debris.

7. Special Hazards

a. Depending on the emergency, consideration should be given to the presence of the following items on campus:

(1) Nuclear reactor in RM 1356 of Physics Building 572.

(2) Waste Management Building 596.

(3) Bacteria, drugs, chemicals and other harmful materials in Bio I (544) and Bio II (571), Chemistry 557, Psychology 551 and 598.

Fixed Emergency Generator Sets

BUILDING NO.	MAKE	CAPACITY KW	LOCATION
525 II	ONAN	25	0322 A
525 III	ONAN	55	9544
526	POWER PAC	10	022
526	ONAN	55	1001 B
529	KOHLER	55	101
531	ONAN	15	roof (3400)
533	ONAN	25	1101
538	KOHLER	10	1301
543	ONAN	10	Mechanical Room
544	ONAN	30	1267
552	ONAN	55	0131
554	ONAN	15	1430
556	ONAN	25	1775
557	ONAN	45	1419
559	ONAN	55	Mechanical Room
560	KOHLER	25	4543 B
563 (Lec Hl)	ONAN	10	2964 C
563 (Main)	ONAN	40	4606
571	ONAN	170	7128

BUILDING NO.	MAKE	CAPACITY KW	LOCATION
572	ONAN	75	Well (0001)
574	KOHLER	25	1232 A
577	CUMMINS	175	Mechanical Room
579	KOHLER	50	Mechanical Room
588	KOHLER	65	1040 B
591	PINCOR	30	Mechanical Room

NOTE: All Generators except 529 and 577, which are diesels, are natural gas powered.

VENDORS TO CALL FOR HEAVY EQUIPMENT DURING EMERGENCIES

Eldon Smith Equipment

822 E. Yanonali St.

Santa Barbara, CA

Phone: 962-9917

Lambert Inc.

55 South Kellogg Avenue

Goleta, CA

Phone: 967-4593

Giffin Rental Corp.

285 Rutherford

Goleta, CA

Phone: 967-6484

ITEMS ASSEMBLED FOR EMERGENCY PREPAREDNESS

The items listed below have been assembled in the following areas as indicated below:

I - Emergency Cage (behind PPD stockroom)

Items of Equipment	Cage Location
Welding Goggles	Cabinet A
Welding Torch Tips	" "
Welding Striker	" "
Welding Hammer	" "
Welding Wrench	" "
Striker Flints	" "
1/4" Drill Motor w/Drill Bits	" "
Ear Protectors (Ear Muffs)	" "
Gas Valve Wrench	" "
Pump Pliers (Extra Large)	" "
Hip Boots	" "
Knee Boots	" "
Rain Suits	" "
Gloves	Cabinet A

Items of Equipment	Cage Location
Safety Goggles	Cabinet A
First Aid Kit	Cabinet A
Hand Lanterns	Cabinet B
Flashlights	" "
Carpenter Tool Kit	" "
Explosion Proof Spot Lights	" "
Lamps (Spares for Light Standards)	" "
Extension Cords (100 ft)	" "
Pump Strainer (Spare for 3" Trash Pump)	" "
7 1/2" Skil Saw	Cabinet B
Submersible Pump	Right Side of Cage
Welding Tanks & Torch	" " " "
Trash Pump 3"	" " " "
Generator 3.5 KW	" " " "
Chains	Hanging Right Side of Cage
Fire Extinguishers	
Pressurized Water & #15 CO^2	Hanging Right Side of Cage
Smoke Ejector (Blower/Extractor Electric)	Left Side of Cage
Light Standards (Flood Lights)	Left Side of Cage
Traffic Cones	Bin #2 in Cage
Sand Bags	" #5 " "
Traffic Signs	Bins #8, 9, & 14
Rope	Bin #10

Items of Equipment	Cage Location
Chain Saws	Bin #11
Gas Keys	Bin #12
Water Keys	" #12
Siedge Hammer	" #12
Fire Ax	" #12
Fire Hydrant Wrenches	" #12
Hose for Smoke Ejector	Bin #15
Chain Hoist (Block & Tackle)	Bin #17
Screw & Hydraulic Jacks	Bin #17
Barricades (A Frame)	On Top of Bin
Barricades (Flasher)	On Top of Bin
Ladder 6' (Step)	Hanging on Left Side of Cage
Bolt Cutters (Large)	Right side of Cage

II - Tool Crib (#584)

Explosimeter	Sheif, Left Side

III - Work Order Holding Area (#584)

Construction Plywood	On Top of Bins 3 & 5
2" x 4" x 12' Douglas Fir	" " " " " " "