NUREG-0766

50-133

Reconnaissance Report: Effects of November 8, 1980 Earthquake on Humboldt Bay Power Plant and Eureka, California Area

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

K. S. Herring, V. Rooney, N. C. Chokshi

Available from

GPO Sales Program
Division of Technical Information and Document Control
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Printed copy price: $2.50

and

National Technical Information Service
Springfield, VA 22161

NUREG-0766

Reconnaissance Report: Effects of November 8, 1980 Earthquake on Humboldt Bay Power Plant and Eureka, California Area

Manuscript Completed: April 1981
Date Published: June 1981

K. S. Herring, V. Rooney, N. C. Chokshi

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ABSTRACT

On November 8, 1980, an earthquake of a reported surface wave magnitude of 7.0 occurred off the coast of California, west of Eureka and the Humboldt Bay Power Plant. Three NRC staff members visited the site the following week to survey any damage associated with the earthquake, with the objective of using collected data to assist the NRR staff in ongoing seismic evaluations of older operating nuclear power plant facilities. This report contains their observations. They concluded that the effects of the earthquake on Humboldt Bay Power Plant Unit 3 were minimal and did not endanger the health and safety of the public. They recommended that improvements be made to seismic recording equipment and that generic preparation for future post-earthquake reconnaissance trips be made before the actual occurrence of earthquakes.

CONTENTS

FIGURES

1 INTRODUCTION

The Humboldt Bay Power Plant consists of two fossil generating units, Units 1 and 2, which began operation in 1956 and 1958, respectively, and the nuclear Unit 3, which began operation in 1962. Unit 3 has been shut down under a U.S. Nuclear Regulatory Commission (NRC) Order since July 2, 1976 because of concern about its seismic qualification. Since the time of shutdown, Pacific Gas and Electric Company (PG&E), the licensee, has performed substantial seismic upgrading of Unit 3 safety-related structures, piping, equipment, and components, but not all of the necessary upgrading has been completed. Spent fuel remains in the fuel storage pool and the vessel core; however, the four-year decay time has reduced both the fission product inventory and the cooling requirements by several orders of magnitude below what is normally considered for shutdown reactors.

On November 8, 1980 at 2:28 a.m. Pacific Standard Time, an earthquake of a reported surface wave magnitude of 7.0 occurred off the coast of California, west of Eureka. The epicenter was first believed to be about 30 miles NW of the city of Eureka and the Humboldt Bay Power Plant (see Figure 1 for relative locations), but now the distance is believed to have been substantially greater. In the first 24 hours following the earthquake, there were 12 more seismic events above magnitude 3.5, with the largest being magnitude 5.2.

Preliminary reports from PG&E indicated that peak accelerations of 0.4 g (E-W), 0.2 g (N-S), and 0.16 g (Vert) had been measured at the operating floor in the refueling building of Unit 3.

There were some reports of disturbed ground (some fissures and slumps) in the vicinity of the plant, but no fault rupture has been discovered. Damage reported along the coast includes several houses moved off supporting posts, some chimneys downed, and one highway overpass collapsed. Unspecified damage at two pulp mills also was reported.

The NRC sent three members of the staff of the Office of Nuclear Reactor Regulation (NRR) to survey the damage associated with the earthquake. This report contains the observations of Kenneth S. Herring of the Systematic Evaluation Program Branch, Dr. Vernon L. Rooney of Operating Reactors Branch 2 and Dr. Nilesh C. Chokshi of the Structural Engineering Branch. Their field survey was conducted on November 13 and 14, 1980.

The Humboldt Bay Power Plant Unit 3 was of primary interest to the NRC reconnaissance team because of the similarity of its structures, piping, equipment, and components to those of other older operating nuclear power plant facilities. The two fossil units at the site were of special interest because they had been initially designed to less rigorous standards than the nuclear unit, and they had not undergone any upgrading as the nuclear unit had. The NRR team toured the facility to assess the degree of damage sustained, with the objective of using collected data to assist the NRR staff in ongoing seismic evaluations of older operating nuclear power plant facilities.

2 DESCRIPTION OF GROUND MOTION

2.1 Reports from Individuals

Individuals who experienced the earthquake have estimated that the duration of the ground motion ranged from about a half minute to a minute. Typical observations of individuals experiencing the quake include the following.

(1) Several Humboldt Bay plant operators considered this quake no worse than the last two large earthquakes which took place on February 3, 1979 and June 6, 1975.

(2) A highway superintendent with the California Department of Transportation compared this quake to the San Fernando Valley earthquake of 1971 which he had experienced. He described the 1980 Eureka quake as more rolling and gentle.

(3) Several individuals reported that bottles and other merchandise had been knocked off shelves in some stores.

(4) Two individuals in second stories of frame houses reported that shaking was sufficiently violent that they could not pass through doors between rooms.

Records of ground motion at the U.S. Geological Survey (USGS) measuring sites in the vicinity of the Humboldt Bay Power Plant and Eureka are not yet available. The currently available information regarding measured ground motion is given in Appendix 1.

As noted in Appendix 1, instrumentation to measure strong motion was present at the Humboldt Bay Power Plant site. In conversations between members of the staff and PG&E before the staff visit to the site, the licensee indicated that preliminary readings of peak accelerometers located at the operating floor of the refueling building for Unit 3 showed peak accelerations of 0.4 g (E-W), 0.2 g (N-S), and 0.16 g (Vert). Further, the licensee told the staff members that data from the accelerographs was expected to be processed and data from the response spectrum recorders was expected to be finalized by the time of the site visit. However, when the staff members reached the site, they were informed by PG&E that of data from these three different sources, only the data from the response spectrum recorders were considered reliable.

2.2 Instrumentation Reports

Humboldt Bay Power Plant is equipped with a TERA Technology seismographic system to sense triaxial acceleration at three locations and record digital time histories on magnetic tape. Because of an apparent degraded low-voltage power supply in the recording system at the time of the quake, analysis of these accelerograph tapes has thus far produced no useful record. The instrumentation was on a one-year service interval and was scheduled to be serviced one week after the quake.

As back-up for these accelerographs, the plant was equipped with three TERA Technology film recorders which sense and record the triaxial peak accelerations which occur at their locations. Thus, nine different readings were possible. Based on the staff's visual inspection of one of the instruments, it appears that these instruments were not maintained in such a way to prevent a build-up of dirt and grit on the internal mechanisms. As a result, they did not function properly. The only readings obtained from the potential total of nine were the preliminarily reported peak accelerations of 0.4 g (E-W), 0.2 g (N-S), and 0.16 g (Vert); moreover, because of the condition of the instruments, these are considered to be highly unreliable. It is also important to note that these readings were not all obtained from the same instrument.

The only instrument which is believed to have functioned properly was the Engdahl peak shock recorder located at the operating floor (+12 ft elevation) in the refueling building of Unit 3. This recorder provided triaxial peak spectral accelerations at selected frequencies; these data are presented in Appendix 1. The Engdahl data show that the predominant direction of motion was in the plant-designated E-W direction (defined as being rotated counterclockwise 35 degrees from true E-W), with the N-S and vertical measured motions significantly less. Appendix 1 includes a comparison of the E-W response spectrum recorded for the November 1980 event (from the Engdahl recorder data) with the correspondence spectrum derived from the record of the 1975 earthquake in the Humboldt Bay area.

The 1975 spectrum should be viewed and compared to the 1980 event spectrum with care. The 1980 event spectrum was obtained directly from a 2% damped recorder; the spectrum for the 1975 event was available only at 5% damping. Therefore, it was necessary to approximately adjust the 5% spectrum to a level consistent with 2% damping. This was accomplished in a simple manner by ratioing 84th percentile spectral amplification factors from NUREG/CR-0098* for two different dampings and applying them to the 5% damped spectrum. However, because the amplification factors in NUREG/CR-0098 are applicable to smoothed, broad-band design ground spectra and correspond to a mean-plus-one standard deviation of amplification factors considering a suite of earthquake time histories, this spectrum can be considered only approximate. It is useful for only a qualitative comparison; its quantitative value is questionable.

From a comparison of the two spectra, it appears that the 1980 earthquake had more energy associated with lower frequencies than did the 1975 event, although the 1975 earthquake had more energy associated with the higher frequencies than did the 1980 event. This observation is consistent with: (1) the near-field, short-duration nature of the 1975 event versus the far-field, long-duration nature of the 1980 event; (2) the observations of personnel who experienced the 1980 event; and (3) the types of damage (or lack thereof) observed in the staff's reconnaissance tour (discussed below).

Based on consideration of the above and of the results of previous seismic analyses of Humboldt Bay Power Plant Unit 3, it appears that the peak ground acceleration in the free-field at the plant may have been in the range of about 0.15 g to 0.25 g E-W.

---

*"Development of Criteria for Seismic Review of Selected Nuclear Power Plants," USNRC Report NUREG/CR-0098, Nathan M. Newmark, Consulting Engineering Services, June 1978.

3 OBSERVED EARTHQUAKE EFFECTS

3.1 Effects in the Area Around Humboldt Bay Power Plant

The most conspicuous earthquake damage in the area around the Humboldt Bay Power Plant was the collapsed span of the west lane of the concrete overpass on U.S. 101 about 3 miles south of the plant (see Figure 2). This damage was reported nationally by the news media.

At the ends of the overpass which contact the embankments, the four spans are supported by bearing plates which, in turn, are supported by concrete piers (Figure 3). Of the three ends of the still-intact spans, one had the bearing failure in the concrete of the span shown in Figure 3, but no collapse resulted. The other two ends experienced only bolt failures in the bolts attaching the bearing pads to the concrete (Figure 4). In the spans between the embankments, the sliding joints shown in Figure 5 were incorporated in the design. These joints provided approximately a 6-in. overlap.

Examination of the embankment end of the collapsed span indicated that failure similar to that shown in Figure 3 had not occurred. Also, the columns supporting the intact spans showed no evidence of flexure-induced cracking. It appears that the collapse of the span was simply caused by excess slippage in the joints as the result of underestimating displacements in designing the overpass. Because this type of failure has been common in California, a statewide program has been instituted to install cables at these types of joints to prevent such collapse. Unfortunately this overpass had not yet been modified.

It is interesting to note that a relatively fragile-looking wooden structure (shown in Figure 6) within several hundred feet of the collapsed span of the overpass was still intact following the earthquake.

At Fields Landing, about a mile south of the plant, some other damage was noted. Several small-to-medium-sized two-story houses supported by wooden posts about a foot to a foot-and-a-half high and resting on concrete piers were swayed off these posts and hit the ground. No lateral bracing had been supplied for the posts. One of these houses is shown in Figure 7. In the photo, the house has already been raised back into position and lateral braces have now been supplied. Note that some lateral bracing had been in place for similar posts which supported the intact structure shown in Figure 6. Other problems reported in the Fields Landing area included a few damaged masonry chimneys and a few toppled stacks of lumber in a lumber yard.

The effects observed by the staff are discussed above. In addition, conversations with people in the Eureka area indicated that merchandise had fallen off shelves in some stores and that two nearby pulp mills suffered some damage. However, the type or extent of this damage could not be determined. PG&E personnel reported that the effects on their transmission facilities had been limited to a few broken insulators and some power interruptions caused by contact between swaying transmission lines.

3.2 Effects on the Humboldt Bay Power Plant

The NRC Region V Office of Inspection and Enforcement (IE) had completed a post-earthquake inspection of the site before the NRR visit. The IE team concluded that the effects of the earthquake on Humboldt Bay Power Plant Unit 3 did not endanger the health and safety of the public.

The effects of the earthquake on plant structures, piping, equipment, and components appeared to be minimal; these effects supported the predominance of the E-W motion that was indicated by the response spectra recorder data. Except for safety-related nuclear structures, piping, and equipment, the plant was reportedly generally designed to resist a 0.2 g horizontal static load. The safety-related nuclear structures, piping, and equipment were initially designed to resist a 0.25 g horizontal static load, but they have since been evaluated for substantially higher seismic loads and many upgrades have been performed.

Both Units 1 and 2 were operating at the time of the earthquake and were shut down because of it. According to reports, they were shut down because:

(1) A protective relay for the Unit 1 generator phase differential voltage vibrated open and tripped the generator (the relay was GE type 2CFD 12B2A).

(2) Gas flow to both Units 1 and 2 was lost when vibration caused closure of mercoid switches on the low-to-high pressure gas piping isolation lines. The switch closure caused the valves to close.

(3) Air-flow indication was lost for Unit 2 because a float, riding on mercury, came loose from the yoke for the indicator. Loss of indication necessitates unit shutdown.

3.2.1 Effects on Plant Structures

The effects on all plant structures--concrete, masonry, and steel--appeared to be minor. Many of the concrete and masonry surfaces had been repainted with a fairly resilient paint within the previous six months. Consequently, some minor cracking may not have been apparent. Many minor cracks were observed in those concrete and masonry surfaces which had not been repainted. However, these cracks appeared to be the type which are normally encountered in such structures as a result of the effects of shrinkage and temperature, and reportedly they existed before the earthquake. These cracks could have masked some small, new cracks.

The only real structural damage which was observed was a permanent deformation of the east reinforced masonry wall of the plant's one-story cold machine shop. The wall is about 18 ft high; it spans horizontally approximately 70 to 80 ft between cross walls. The permanent deformation was evidenced by a gap which opened up between the overhead crane support columns (structurally detached from the wall) and the wall at those columns located away from the cross walls (see Figure 8). The gap size varied from zero at the bottom of the wall to about 1/2 in. at the top. No gaps existed before the quake. Close examination of the wall revealed small cracks running essentially horizontal in some bed joints; these apparently were induced by flexure of the wall during the quake.

Chipped paint was noted on two structural members which were part of the sway brace system for the Unit 2 boiler (see Figure 9). The chipping occurred at bolted joints and seemed to be the result of their slippage. Although this chipping indicated loading of these members as a result of the swaying of the boiler, no obvious metal distress was apparent, and no other effects were noted. The vendor for the boiler (Riley and Stokes) also conducted a post-earthquake inspection of the Unit 2 boiler and reported no damage. The boiler was designed to resist a 0.2 g horizontal load.

Figure 10 shows a bent lateral support for a structural member for the Unit 2 preheater. However, this damage has occurred during the 1975 event, and the only effect of the recent quake was the chipping of some paint between the vertical member and angle on the right-hand side. Although this chipping indicates that some contact occurred, no additional deformation was obvious.

Several small cracks in the concrete near the base of the Unit 3 reinforced concrete stack were noted. These could have been induced by the earthquake; however, it was not clear that they were. Movement of the facility structures was also evidenced by the disturbance of what appeared to be caulking in the shake space between Units 2 and 3 in the vicinity of the Unit 3 control room.

3.2.2 Effects on Tanks

Movement at the base of three water storage tanks was evidenced by disturbance of the asphalt surrounding and in contact with the tanks at their bases. These tanks were the condensate storage tanks for Units 1 and 2 (estimated to be 25-30 ft in diameter and 40-50 ft high) and the raw water storage tank for the plant (estimated to be 35-40 ft in diameter and 50-60 ft high). A typical example of this movement was seen at the base of the Unit 2 condensate storage tank (Figure 11). At the time of the event three tanks were resting on the ground and were at least two-thirds full of water. No damage to the tanks themselves or attached piping was evident. The asphalt disturbance indicated E-W movement, but the disturbance was such that it was not readily discernible whether the tank movement was translational, rotational, or some combination thereof.

No damage to other tanks on site was reported. The Unit 3 condensate storage tank was not readily accessible for inspection; however, the tank was empty at the time of the event and no damage was anticipated. The tank pictured in Figure 12 showed no signs of "damage." Also, note that one of the hydrogen bottles shown in Figure 13 (2nd from left) was not chained. The wall against which the bottles are standing is perpendicular to the direction of strongest motion, yet it was not obvious that the tank had been disturbed.

3.2.3 Effects on Piping

Effects on piping were minimal. Only two piping failures and one support failure were noted for the fossil plant piping. None of these types of failures would be expected to occur in safety-related nuclear plant piping (and none did). One failure in the fossil piping was the result of a poor choice of a brittle material for a buried pipe. The other two failures appeared to be the result of severe deterioration caused by lack of inspection and maintenance.

The failure in the buried pipe was a leak in a 6-in. transite pipe for the fire loop around the plant. The pipe was buried about 6 ft. During the staff visit, plant personnel were still attempting to locate the leak. Reportedly, previous leaks in this piping have been caused by water hammer and by heavy equipment passing over it.

The second failure was a pinhole leak in a weld joint for a 2-in. boiler feedwater line for Unit 1. Reportedly, examination during repair revealed substantial wall erosion, necessitating the replacement of a complete spool piece. Figure 14 shows the piping and configuration after the repair. Note the chipped grout at the bottom of the support base plate. Unfortunately this figure does not show that only a vertical deadweight support was provided at the top of this piping configuration. Given the chipped grout and the piping configuration, it is obvious that the area where the leak occurred was highly stressed. The coupling of this stress with the pipe wall erosion apparently led to the development of the leak.

The third failure was a sheared bolt on a Grinnel vertical spring hanger for the Unit 1 main steam line (see Figure 15). The support was exposed to the weather and badly corroded. Examination of the sheared bolt indicated that the corrosion had frozen the bolt to the slot in which it was intended to slide. Only about two-thirds of the failure plane appeared to be attributable to the earthquake; about one-third of the surface appeared to have been cracked before the event. An identical hanger on the opposite side of the line (which appeared to have moved properly) seemed to be undamaged. Failure appeared to be the result of the locking of a partially failed bolt, which caused its overload.

The only obvious effect noted in the Unit 3 safety-related piping was a deformed expansion bellows on the shutdown system discharge line in the shutdown room near the line's containment penetration into the valve gallery.

Figure 16 shows spans of fossil plant piping about 60 ft long, supported by deadweight hangers only, which were apparently undamaged. The hangers are about 2 to 3 ft long. The direction of strongest motion was perpendicular to the spans. Interestingly, no denting of the insulation was obvious from vantage points approximately 15 to 20 ft away. Figure 17 shows typical weathered Unit 1 and 2 piping which was undamaged.

3.2.4 Effects on Mechanical Equipment

There was no obvious damage to the motors, pumps, and valves of all three units. All motors and pumps observed were anchored at their bases. The only noticeable effect on the Unit 3 propane generator was that some scale had been shaken from the exhaust line by the vibration of the line.

Two trailer-mounted 15 MWe diesel turbines had been brought into the Humboldt Bay power plant to partially substitute for the shutdown Unit 3 during periods of peak power demand. These diesel units are jacked up and supported on wooden cribbing on top of soft, wet dirt. They must be checked frequently for vertical alignment, even under normal conditions. Comparison with the fiducial mark indicated post-earthquake vertical misalignment on one turbine of about 1/16 in. Horizontal alignment is not measured. The turbines were reportedly run for about 3 hours in this misaligned state, without damage, before they were realigned.

3.2.5 Effects on Electrical Equipment and Instrumentation

The effects on electrical equipment and instrumentation which caused the shutdown of both Units 1 and 2 are described above. No other real damage was noticed. All equipment and cabinets observed which contained such equipment were anchored at their bases.

All transformers observed were anchored at their bases. Figure 18 shows the Unit 1 transformer for house power. This reportedly had been observed to be leaning before the earthquake. After the earthquake, the tilt seemed to be increased somewhat because of differential foundation settlement. Although difficult to see in the photograph, this tilting was manifest by the bending of the bus bars extending from the insulators at the top of the transformer.

Figure 19 shows a general view of the switchyard; no damage was obvious. Figure 20 shows one of the eight 60 kV transformers. The direction of strongest motion was parallel to the long axis. Figure 21 shows a closeup of one of the bolted supports for the transformer (the long axis of transformer is parallel to the concrete footing). The cracking of the paint shown here was evident for about half of the transformers. No metal distress was obvious.

Figures 22 and 23 show a comparison of typical Units 1 and 2 batteries and racks and the Unit 3 batteries and racks. No effect on the batteries or racks was evident.

3.2.6 Miscellaneous Effects

A heat exchanger tube bundle weighting more than 7,000 lb was reported to have shifted about 15 in. from its storage location in the Humboldt Bay Power Plant during the quake. It had been resting on wooden cribbing and, by the time the NRR team arrived, it had been returned to its original position. Operators observed that water in the spent fuel pool had sloshed to within 3 in. of the lip of the pool. The lip was about 14 in. above normal water level.

4 RECOMMENDATIONS

(1) Consideration should be given to improved reliability and surveillance for seismic recording equipment.

(2) General preparation for post-earthquake reconnaissance trips before the actual occurrence of earthquakes would help make future trips more productive. Advance preparation is called for so that the reconnaissance team can reach the field quickly after an earthquake, before weather effects or repair efforts have introduced ambiguity into the meaning of observations.

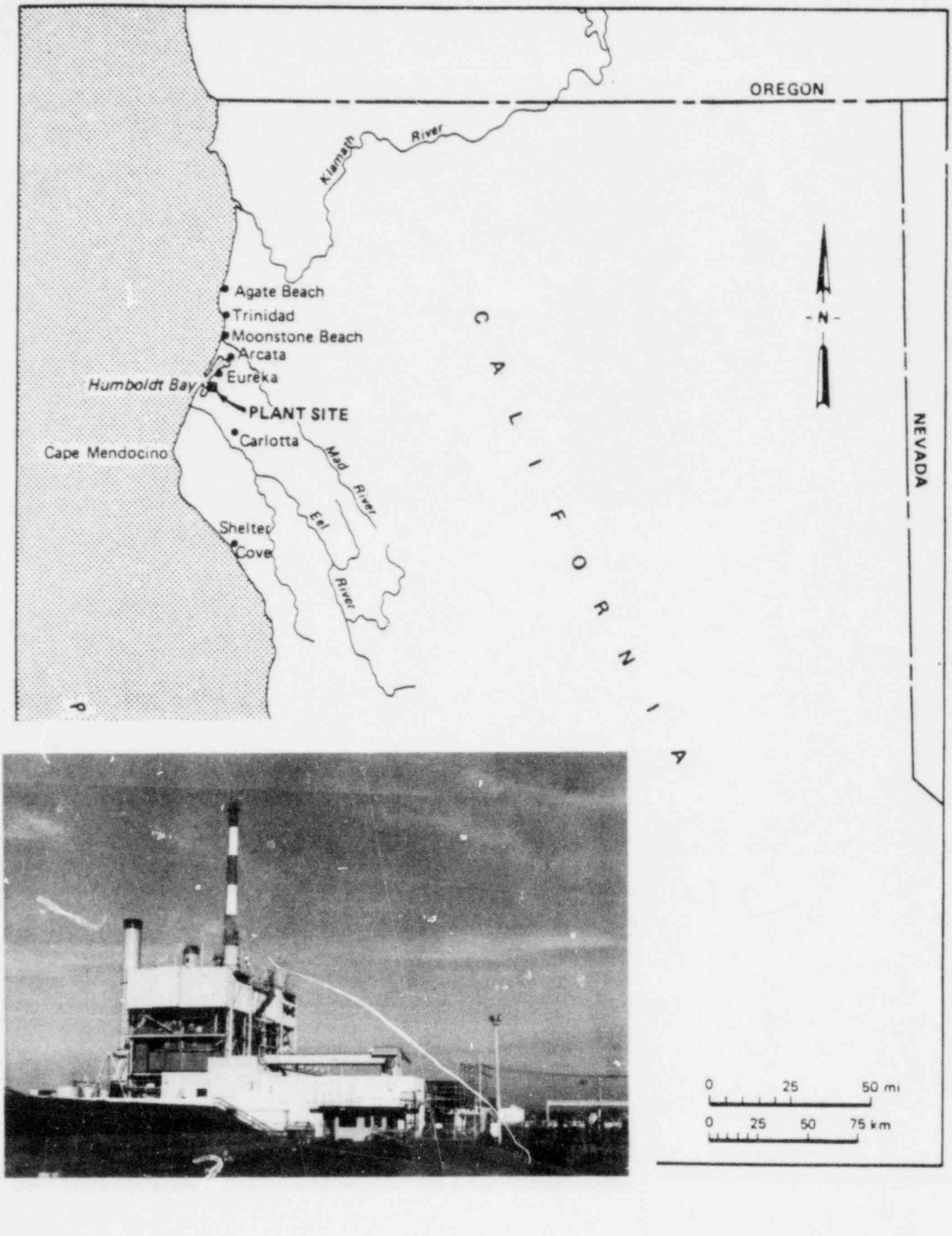


Figure 1 Location of Humboldt Bay power plant

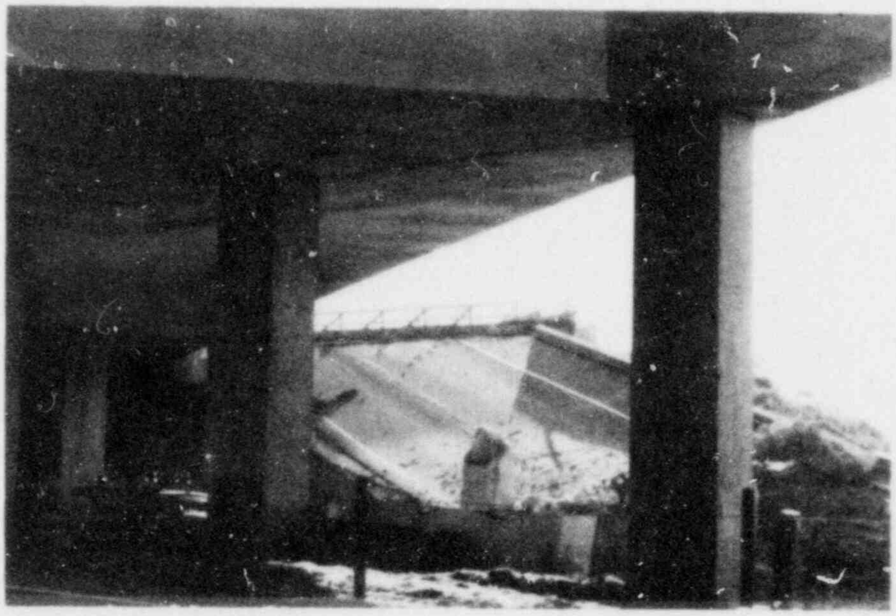


Figure 2: U.S. 101 Overpass

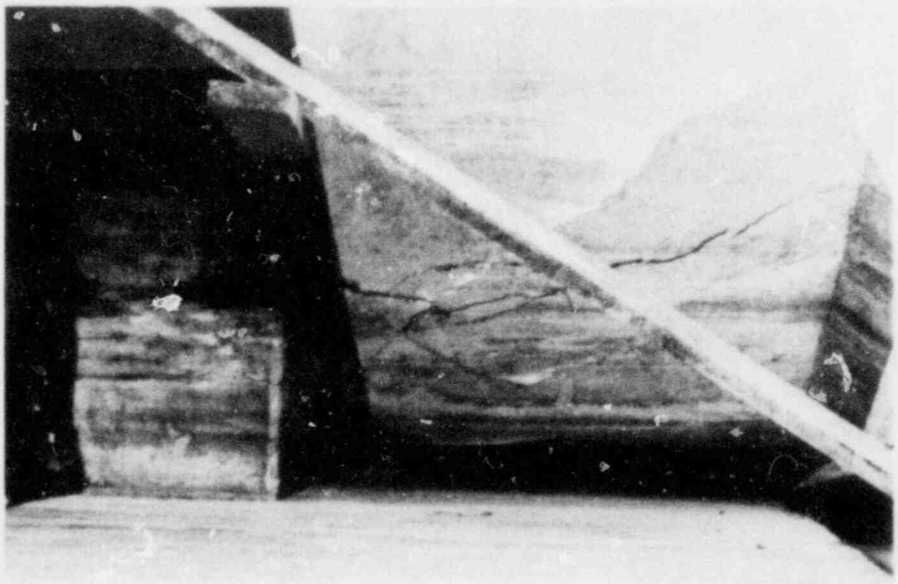


Figure 3: Bearing Failure of Support for the U.S. 101 Overpass

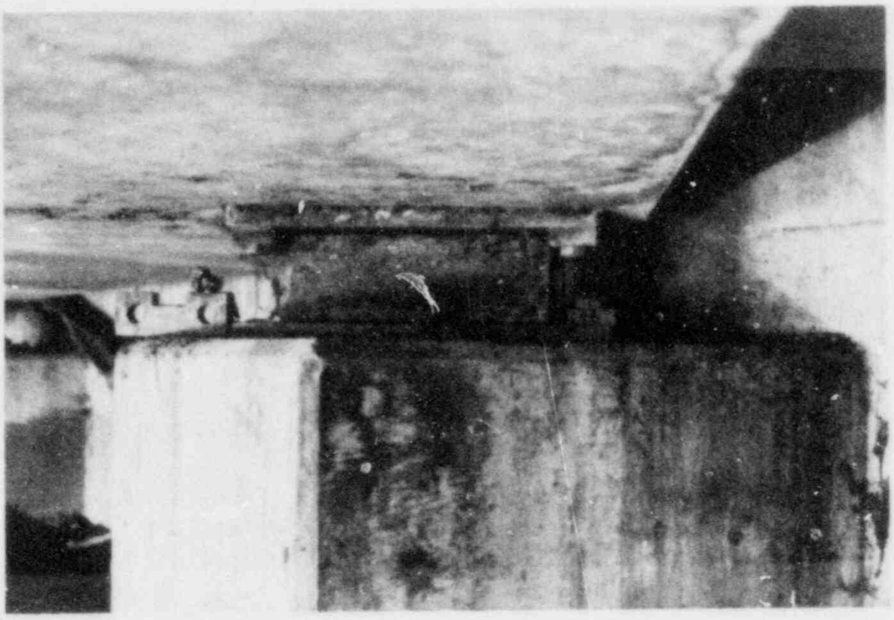


Figure 4: Typical Bolt Failure in Bearing Support of the U.S. 101 Overpass

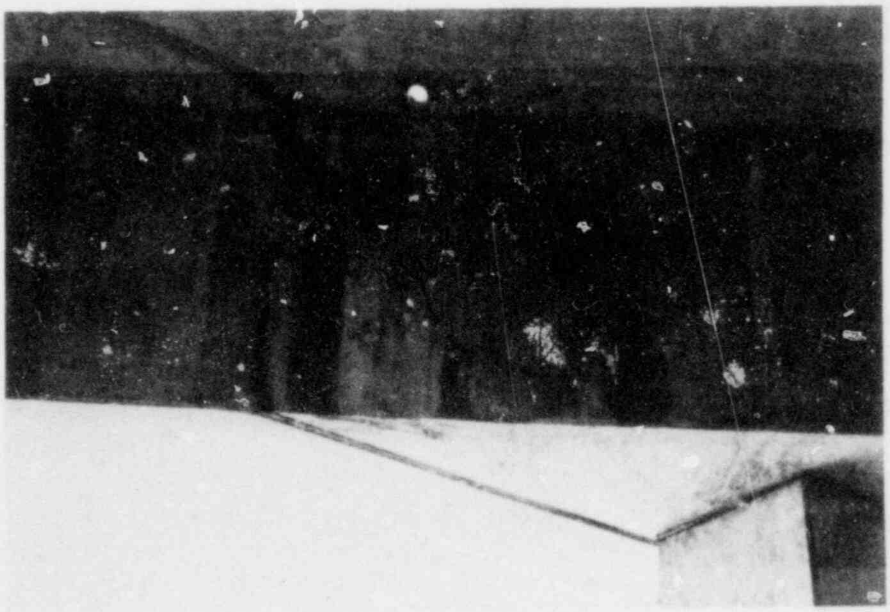


Figure 5: Typical Sliding Joint in the U.S. 101 Overpass

Figure 6: Wooden Structure Within a Few Hundred Feet of the U.S. 101 Overpass

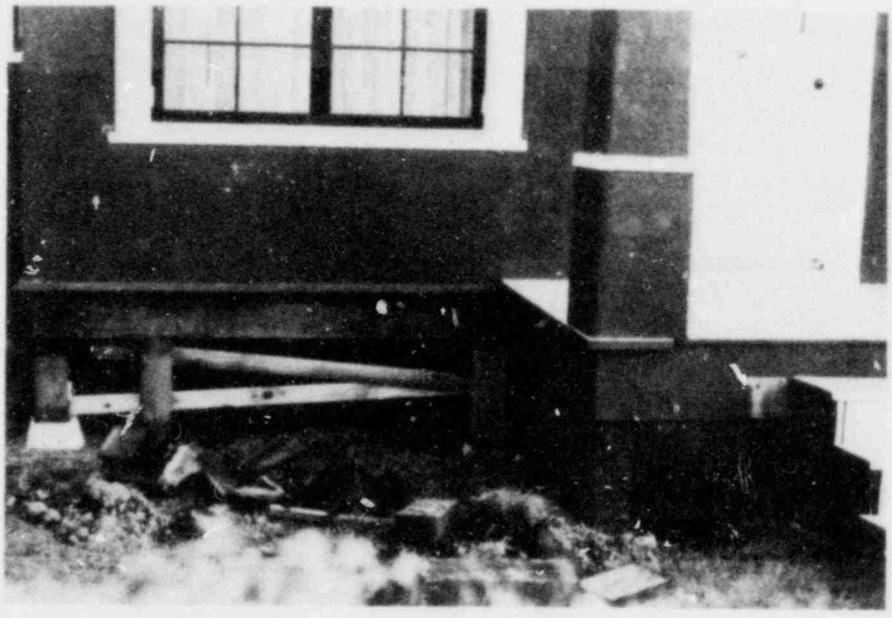


Figure 7: House at Fields Landing Which Swayed Off the Supporting Posts. (Note: House is shown here after being reraised. Lateral bracing of the posts was not present prior to its fall.)

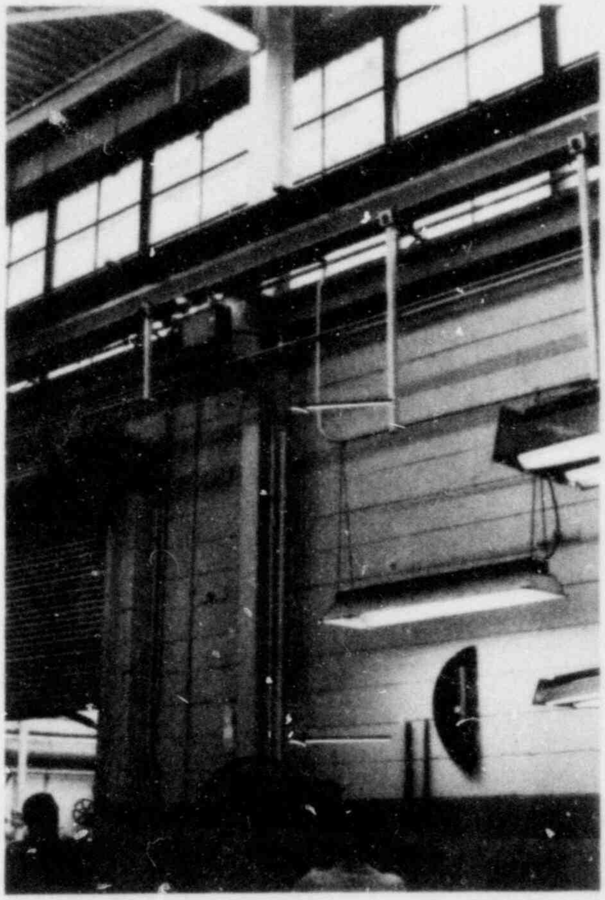


Figure 8: Gap Between the East Reinforced Masonry Wall of the Cold Machine Shop and the Overhead Crane Support Columns

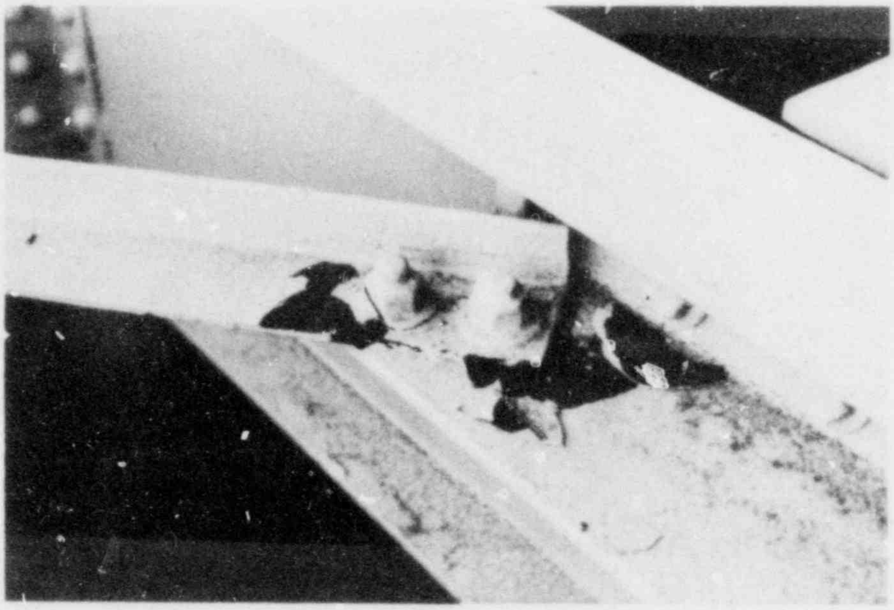


Figure 9: Part of the Lateral Support Structure for the Unit 2 Boiler. (Note chipped paint at bolted joint with no obvious metal distress.)

Figure 10: Lateral Support Damaged During the 1975 Earthquake But Not Damaged Further by the November 8, 1980 Earthquake

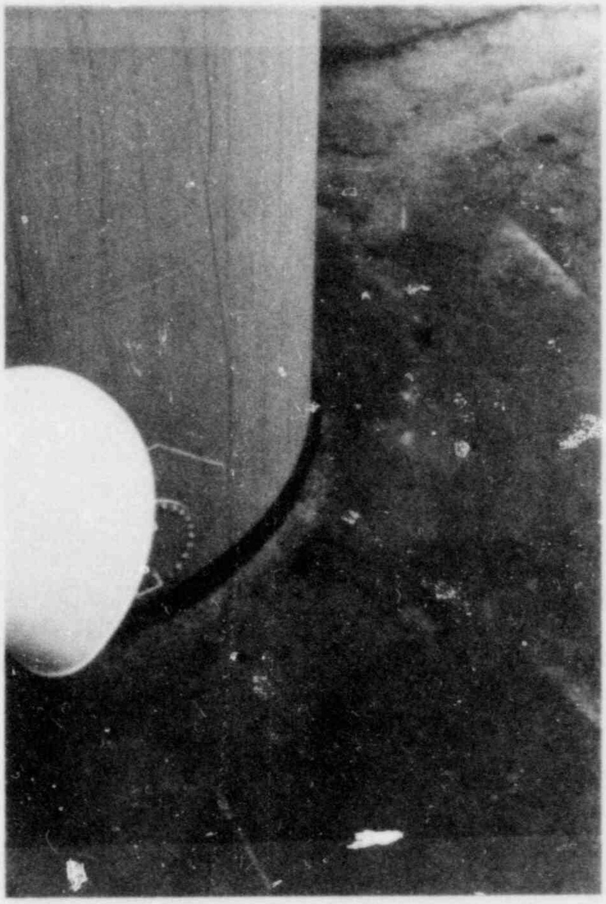


Figure 11: Asphalt Disturbed at the Base of the Unit 2 Condensate Storage Tank

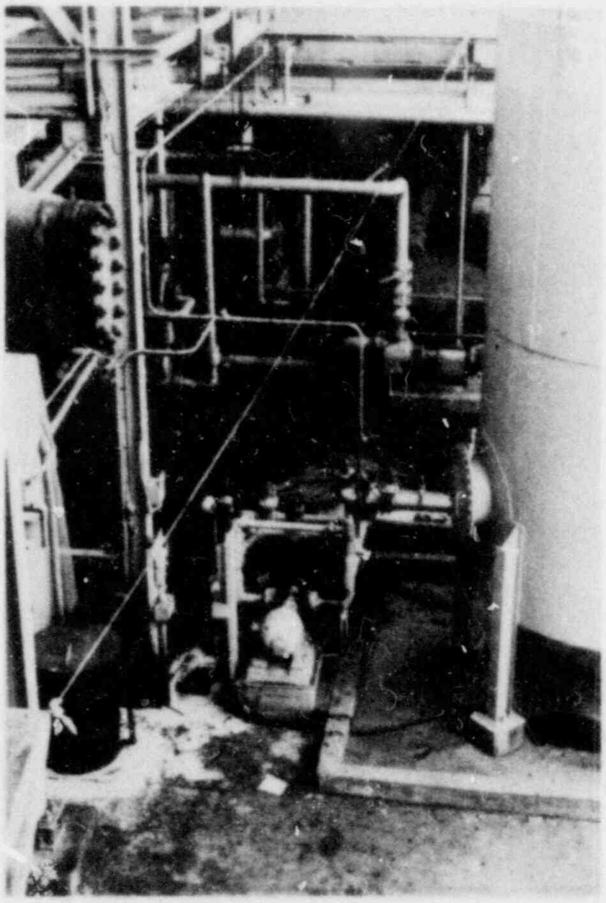


Figure 12: Column-Supported Tank Apparently Undamaged

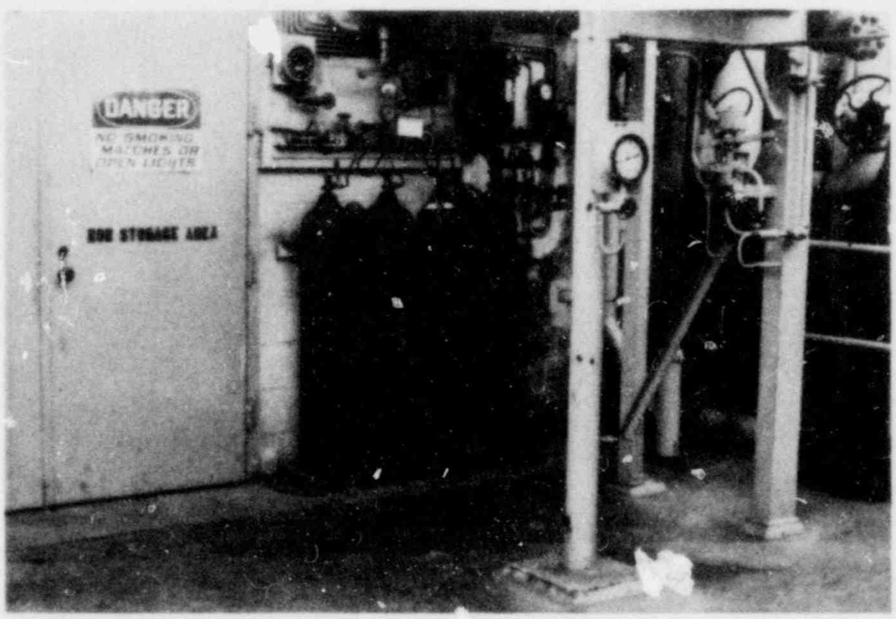


Figure 13: Unchained Hydrogen Bottle Apparently Undisturbed. (Strongest motion was perpendicular to the wall.)

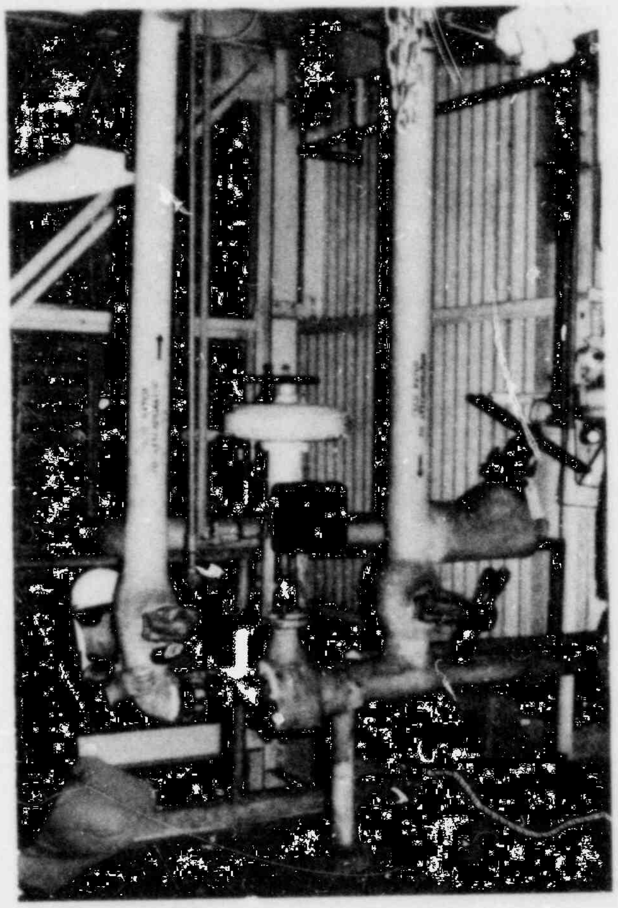


Figure 14: Eroded 2-in. Spool Piece of the Unit 1 Boiler Feedwater Piping Which Leaked at a Weld. (Note the chipped grout under the left side of the support base plate at floor.)

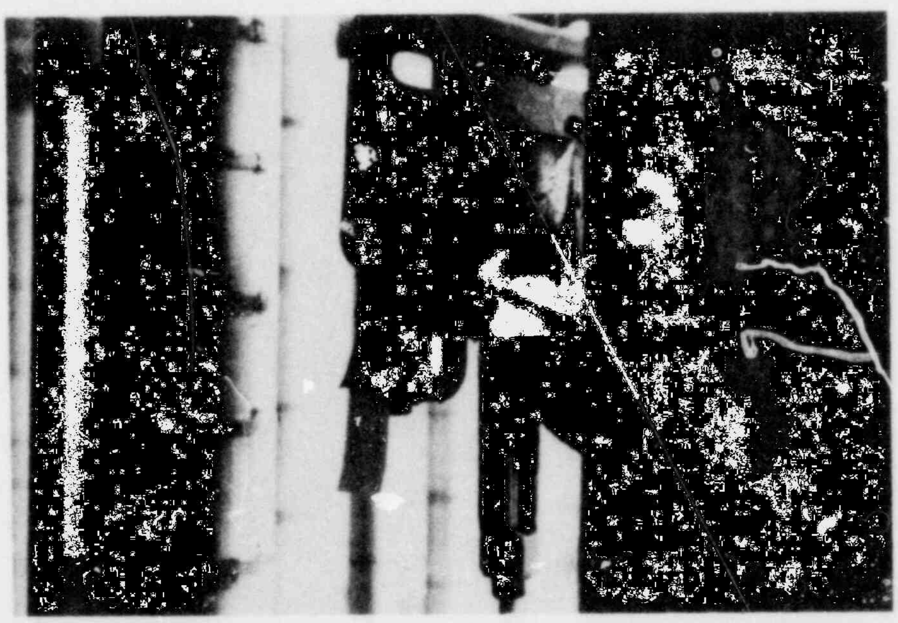


Figure 15: Sheared Bolt in Severely Corroded Unit 1 Main Steam Line Vertical Spring Hanger

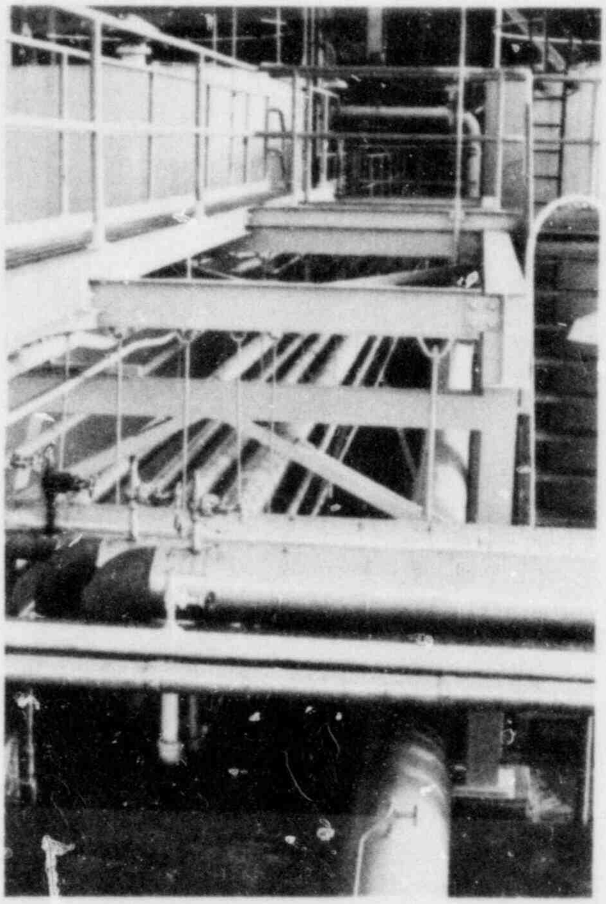


Figure 16: Apparently Undamaged Long Piping Spans (approx. 60 ft) Perpendicular to the Direction of Strongest Motion and Supported by Only Deadweight Hangers

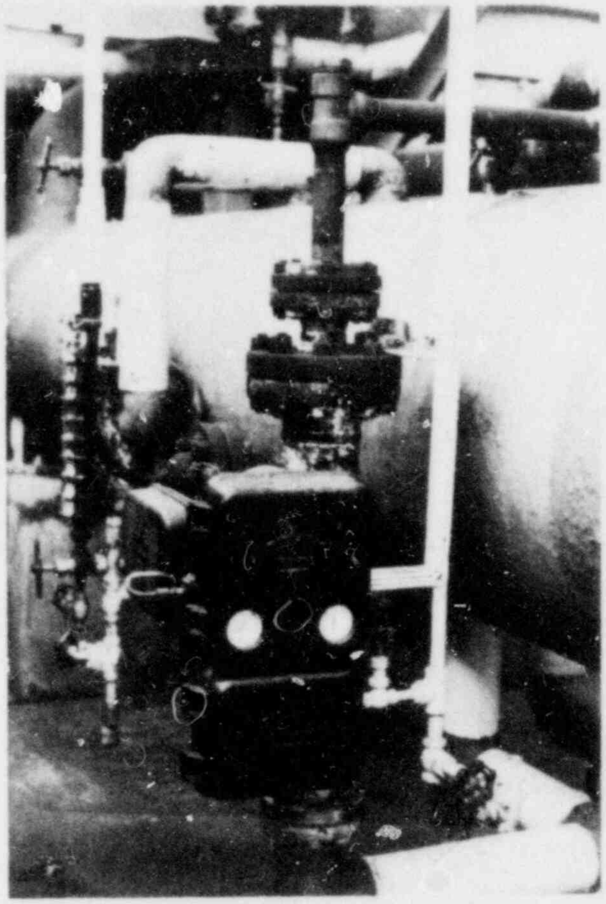


Figure 17: Typical of Weathered Units 1 and 2 Piping Undamaged by the Event

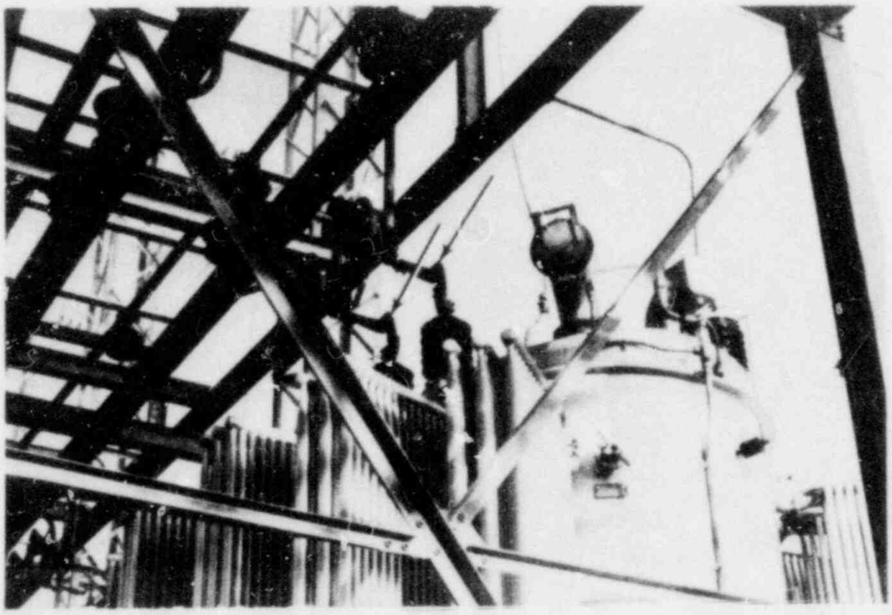


Figure 18: Deformed Bus Bars Extending from Insulators atop the Unit 1 Transformer for House Power

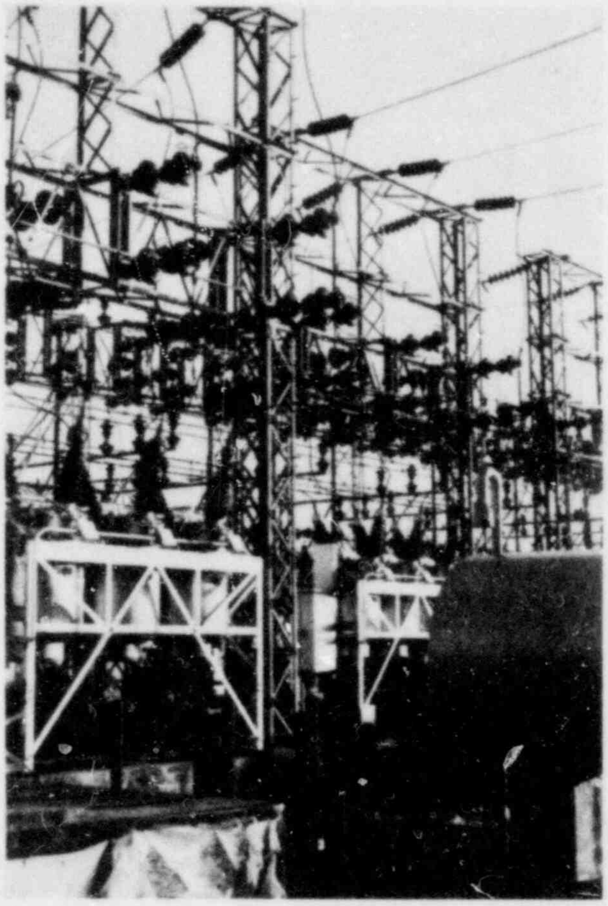


Figure 19: General View of Switchyard

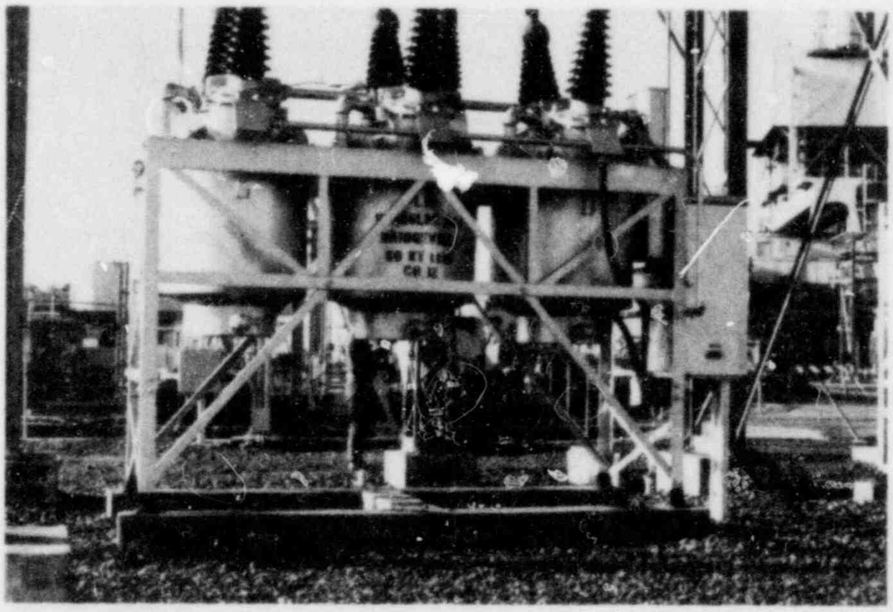


Figure 20: 60 kV Transformer

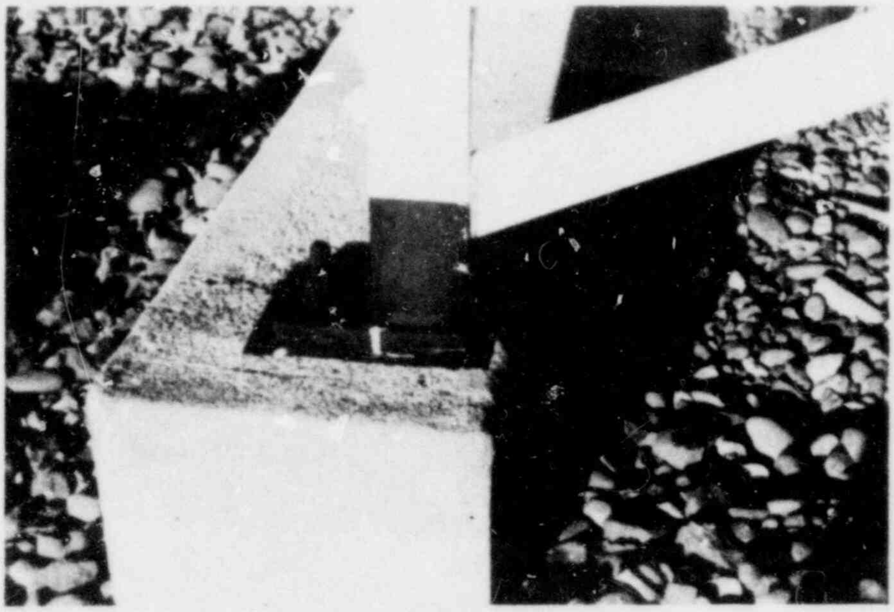


Figure 21: Cracked Paint at the Base of 60 kV Transformer Support

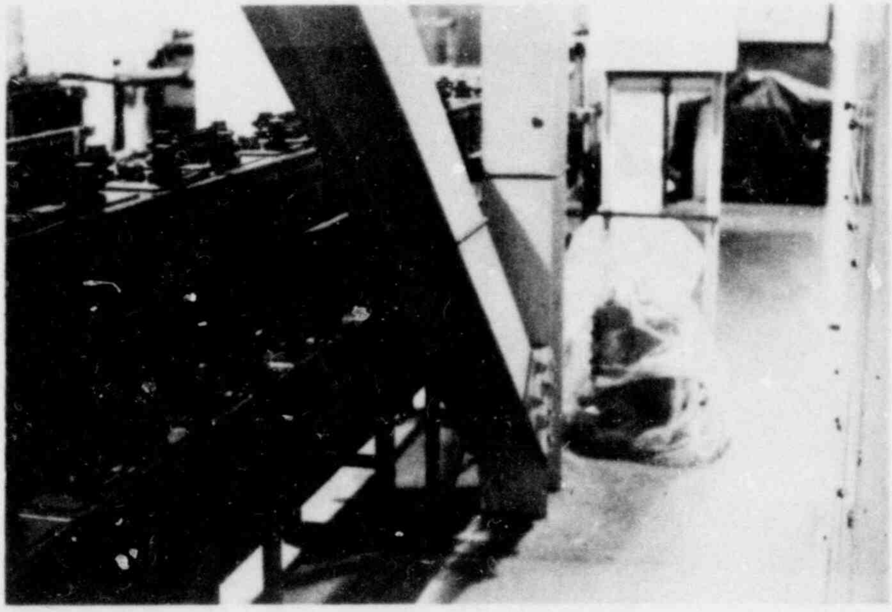


Figure 22: Typical Units 1 and 2 Batteries and Racks

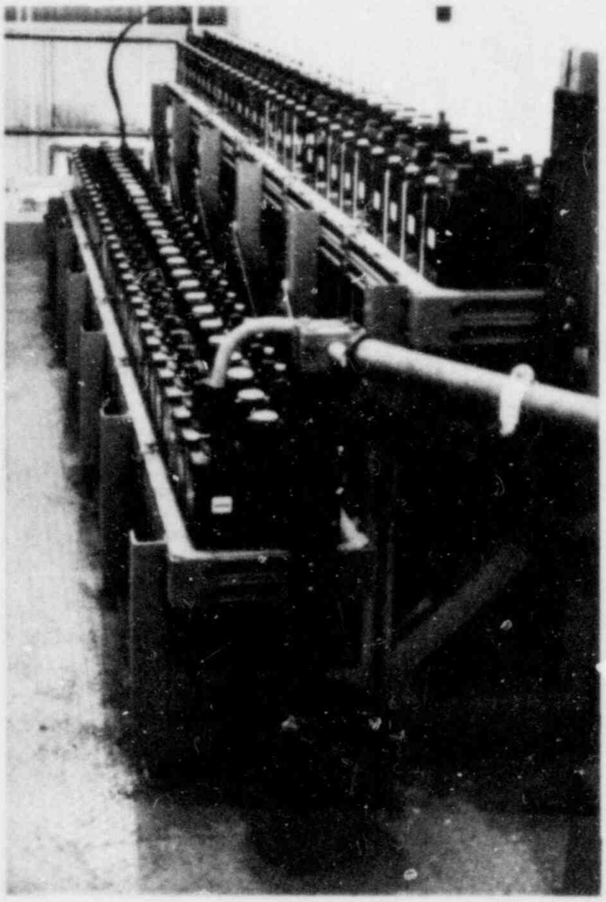


Figure 23: Unit 3 Batteries and Racks

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DEC 16 1980

MEMORANDUM FOR: Robert E. Jackson, Chief
Geosciences Branch, DE

THRU: Leon Reiter, Leader
Seismology Section, GSB, DE

FROM: Jeff Kimball, Seismologist
Seismology Section, GSB, DE

SUBJECT: UPDATE OF INFORMATION ON THE OFFSHORE CALIFORNIA EARTHQUAKE OF NOVEMBER 8, 1980

On November 13 a memo was issued (from J. Kimball to R. Jackson) describing information on the November 8, 1980 earthquake which occurred off the coast of northern California. This memo updates information received by the Geosciences Branch since that time.

More recent information on the earthquake location has suggested that the event was further offshore than first determined. The new epicenter locations are listed below.

	LAT(N)	LONG(W)
Univ. of California Berkeley	41.00	125.40
USGS Menlo Park	41.10	124.55

Depending on which location is used the event occurred between 40 and 120 km from the Humboldt power plant.

The strong motion information system of the United States Geological Survey has returned acceleration data from the California Division of Mines stations. Listed below are a samples of these results whose distances are based on the new epicenter locations

Location	Distance (km)	E-W	W-S	Vertical
Eureka Federal Bldg.	35-115	.12g	.10g	.05g
Rio Dell Overpass	60-140	.15g	.06g	.03g
Petrola General Store	70-150	.07g	.06g	.02g

Attached to this memo are tables of acceleration data measured in the refueling building by a Engdhal frequency analysis. The east-west component of this recording was plotted against the recording in the same building during the

1975 earthquake (this figure is also attached). One can notice the general similarity in these two records in terms of the response spectra (the 1980 peak acceleration being slightly less than 1975 peak acceleration).

Updates of further information from this earthquake will be provided when they become available.

Jeff Kimball

Jeff Kimball, Seismologist
Seismology Section
Geosciences Branch, DE

Attachment:
As stated

cc: w/attachment
J. Knight
H. Denton
E. Case
D. Eisenhut
R. Vollmer
H. Levin
V. Rooney
T. Ippolito
GSB Staff

Calibration and Test Data Sheet

Peak Shock Recorder™

PSR1200 - H (EAST/WEST)

Recorder S/N 887 Calibration Date 1-2-80 *PO*

Record Plates S/N 14U1 Surface A

Reed Number	Frequency (Hertz)	Acceleration Sensitivity		Displacement *		Equivalent Static Acceleration (g)
		g/inch	g/mm	inches	mm	
1	1.98	.353	.0139	1.095	—	~~0.39~~
2	2.49	.509	.0200	1.743	—	0.89
3	3.14	.791	.0311	1.773	—	0.40
4	3.99	1.24	.0487	0.528	—	0.65
5	4.98	1.91	.0753	0.325	—	0.62
6	6.40	2.91	.114	0.164	—	0.30
7	7.95	4.63	.182	0.055	—	0.25
8	10.1	7.35	.289	0.029	—	0.21
9	12.8	6.33	.249	0.043	—	0.27
10	16.0	8.70	.342	0.025	—	0.22
11	20.3	16.1	.635	0.017	—	0.27
12	25.4	24.1	.949	0.015	—	0.36

* *Multiple zero lines. Strongest zero used to measure all peaks.*

Damping: 2% viscous damping (Q of 25)

Tester *Pacific Gas + Electric* Test Date *11-8-80*

Test Location *Humboldt Bay* Prepared By *[illegible]*

Test Number *7.1 Earthquake* Date *November 12, 1980*

Calibration and Test Data Sheet

Peak Shock Recorder™

PSR1200 - H (North (South)

Recorder S/N 898 Calibration Date 1-2-80 ODE

Record Plates S/N 14 H6 Surface A

Reed Number	Frequency (Hertz)	Acceleration Sensitivity		Displacement		Equivalent Static Acceleration (g)
		g/inch	g/mm	inches	mm	
1	1.96	.336	.0132	0.531	—	0.18
2	2.56	.545	.0215	0.367	—	0.20
3	3.12	.793	.0312	0.287	—	0.23
4	3.95	1.19	.0468	0.124	—	0.15
5	5.00	1.95	.0767	0.130	—	0.25
6	6.28	2.99	.118	0.037	—	0.11
7	7.92	4.61	.181	0.016	—	0.07
8	10.1	7.58	.298	0.006	—	0.05
9	12.7	5.85	.230	0	—	0.00
10	16.0	8.77	.345	*0.007	—	*0.06
11	20.2	16.0	.630	0	—	0.00
12	25.5	23.5	.926	0	—	0.00

~~[illegible]~~ ODE * Doubtful record since .007 vs .002 displacement seems physically impossible.

Damping: 2% viscous damping (Q of 25)

Tester Pacific Gas & Electric Test Date 11-8-80

Test Location Humboldt Bay Prepared By Paul D. Engblade

Test Number Z1 Earthquake Date November 12, 1980

Calibration and Test Data Sheet

Peak Shock Recorder™

PSR1200 - V (Vertical)

Recorder S/N 897 Calibration Date 1-2-80 OOE

Record Plates S/N 14 M 0 Surface A

Reed Number	Frequency (Hertz)	Acceleration Sensitivity		Displacement		Equivalent Static Acceleration (g)
		g/inch	g/mm	inches	mm	
1	1.98	.318	.0125	0.143	—	.045
2	2.55	.506	.0199	0.181	—	.09
3	3.17	.794	.0313	NO RECORD NO CONTACT	—	0
4	4.07	1.12	.0440	*0.014	—	.02
5	4.97	1.90	.0747	0.048	—	.09
6	6.35	3.07	.121	0.010	—	.031
7	7.97	4.71	.185	0	—	0
8	9.98	7.46	.294	0.008	—	0.06
9	12.7	6.23	.245	0	—	0
10	16.0	9.17	.361	0	—	0
11	20.1	16.3	.640	0		0
12	25.4	25.6	1.01	0	-	0

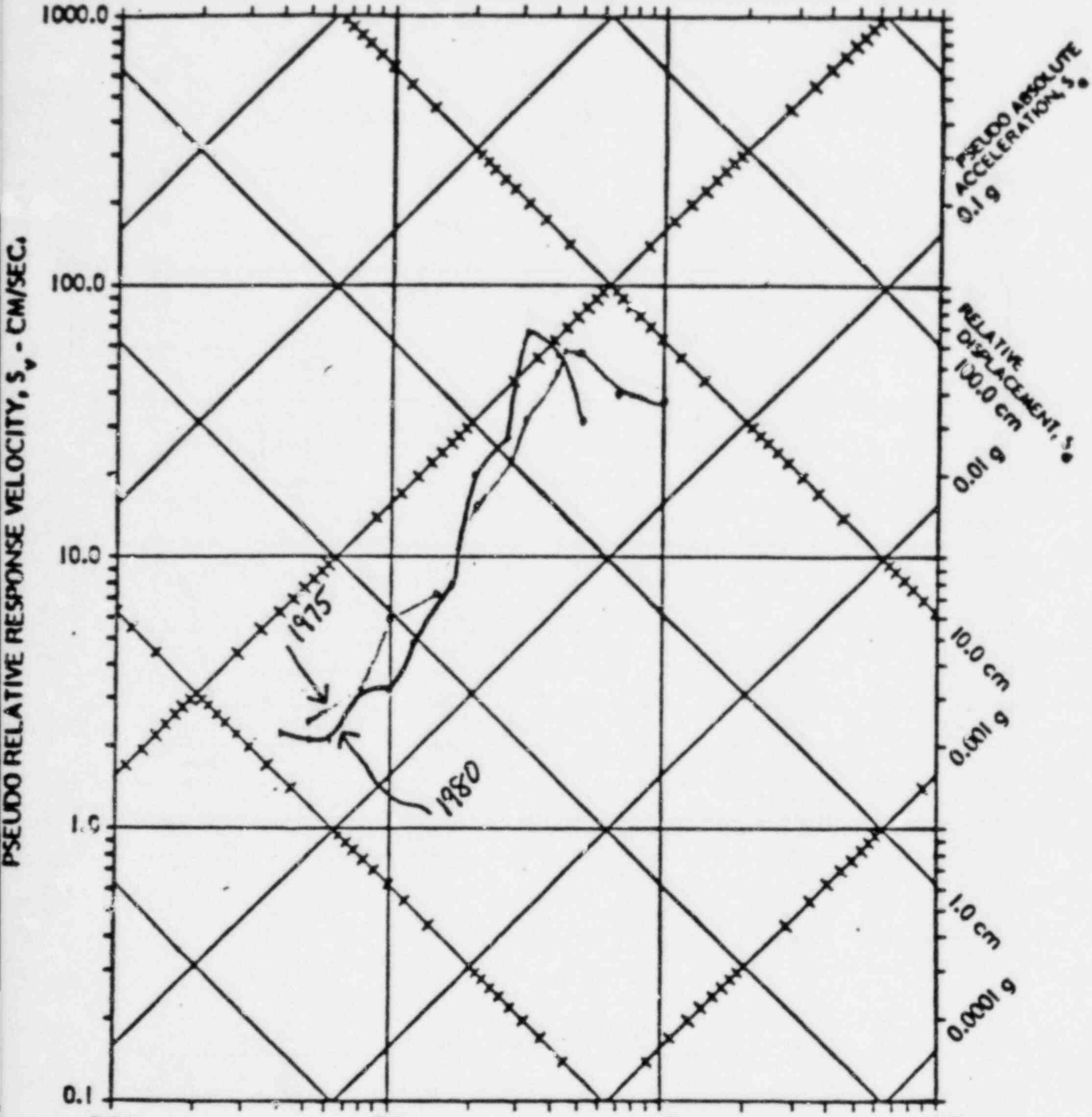
* Poor record - Poor contact,

Damping: 2% viscous damping (Q of 25)

Tester Pacific Gas & Electric Test Date 11-8-80

Test Location Humbolt Bay Prepared By Paul D. Engdahl

Test Number 7.1 Earthquake Date November 12, 1980



——— 1980 Engdahl freq. Anal 2%

——— 1975 Predicted 2% from actual recording

12' level refueling bldg.

NRC FORM 335 (7-77) U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET**	1. REPORT NUMBER (Assigned by DDC) NUREG-0766
4. TITLE AND SUBTITLE (Add Volume No., if appropriate) Reconnaissance Report: Effects of November 8, 1980 Earthquake on Humboldt Bay Power Plant and Eureka, California Area	2. (Leave blank)
	3. RECIPIENT'S ACCESSION NO.
7. AUTHOR(S) K. S. Herring, V. Rooney, N. C. Chokshi	5. DATE REPORT COMPLETED MONTH April YEAR 1981
9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Office of Nuclear Reactor Regulation U.S. Nuclear Regulatory Commission Washington, DC 20555	DATE REPORT ISSUED MONTH June YEAR 1981
	6. (Leave blank)
	8. (Leave blank)
12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Same as 9, above.	10. PROJECT/TASK/WORK UNIT NO.
	11. CONTRACT NO.
13. TYPE OF REPORT Reconnaissance Report	PERIOD COVERED (Inclusive dates) November 13-14, 1980
15. SUPPLEMENTARY NOTES	14. (Leave blank)

16. ABSTRACT (200 words or less)

On November 8, 1980, an earthquake of a reported surface wave magnitude of 7.0 occurred off the coast of California, west of Eureka and the Humboldt Bay Power Plant. Three NRC staff members visited the site the following week to survey any damage associated with the earthquake, with the objective of using collected data to assist the NRR staff in ongoing seismic evaluations of older operating nuclear power plant facilities. This report contains their observations. They concluded that the effects of the earthquake on Humboldt Bay Power Plant Unit 3 were minimal and did not endanger the health and safety of the public. They recommended that improvements be made to seismic recording equipment and that generic preparation for future post-earthquake reconnaissance trips be made before the actual occurrence of earthquakes.

17. KEY WORDS AND DOCUMENT ANALYSIS	17a. DESCRIPTORS
17b. IDENTIFIERS/OPEN-ENDED TERMS	

18. AVAILABILITY STATEMENT	19. SECURITY CLASS (This report)	21. NO. OF PAGES
Unlimited	Unclassified	
	20. SECURITY CLASS (This page) Unclassified	22. PRICE $