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

FEB 19 1986

Docket Nos.: 50-440/441

MEMORANDUM FOR: B. D. Liaw, Chief
Engineering Branch
Division of BWR Licensing

THROUGH: RGL
Robert LaGrange, Section Leader
Engineering Branch
Division of BWR Licensing

FROM: Phyllis Sobel, Geophysicist
Engineering Branch
Division of BWR Licensing

SUBJECT: JANUARY 31, 1986 EARTHQUAKE NEAR PERRY NUCLEAR POWER PLANT

At 16:46:41.7 GMT (11:46 EDT) on January 31, 1986 a magnitude 4.9 to 5.0 (m_b) earthquake occurred about 10 miles south of the Perry plant in northeastern Ohio. The USGS-NEIS report the epicenter was at 41.65°N and 81.10°W. The earthquake was felt as far away as Washington, D.C., about 300 miles from the epicenter and there were reports of damage such as cracked walls, falling roof tiles and shattered windows near the epicenter. There have been five small aftershocks; the largest was about a magnitude 2 to 2.3 on February 7. The aftershocks were 2 to 9 km deep and some were felt, although not at the Perry site.

A site area emergency was declared at the Perry site and plant personnel surveyed for any damage. The NRC project manager, John Stefano, a DSRO seismologist, Leon Reiter and a DSRO mechanical engineer, Tsung-Yung Chang inspected the plant on February 1, 1986. The initial reports indicated no significant damage. Another NRC team (including Arnold Lee of NRR and Jag Singh from EG&G) inspected the plant on February 6 and 7 and found no damage. The utility is continuing the survey for damage.

The January 31 earthquake triggered the in-plant seismic monitoring instruments. Preliminary acceleration data indicate that some of the recorded ground motions exceeded the Operating Basis and Safe Shutdown Earthquake design spectra at high frequencies (above 15 hertz). The earthquake motion recorded at the reactor building foundation was of short duration (about one second) and predominantly high frequencies. The utility met with the staff on February 11 and submitted their report on the earthquake data on February 12.

Contact: P. Sobel
X-27592

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3 PP.

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The size and proximity of the January 31 earthquake are consistent with observations of historical seismicity in the Central Stable Region. In the SER the staff compared the Perry SSE design spectrum to a larger event (magnitude 5.3) at this distance. The location of the earthquake, its aftershocks and focal mechanisms will have to be examined with respect to known geological features and statements in the SER to determine if significant new findings can be made. The significance of the high frequency peak accelerations observed in the plant is being assessed by the utility and the staff with respect to plant structures and components. The staff has contracted with Jim Johnson of NTS/Structural Mechanics Associates to inspect the Perry facility for structural damage and equipment failure or malfunction and to evaluate the seismic instrumentation recordings and the utility's findings.

I will notify you of any additional information we receive.

/s/

Phyllis Sobel, Geophysicist
Engineering Branch
Division of BWR Licensing

cc: R. Bernero
G. Lainas
W. Butler
F. Congel
L. Beratan
A. Murphy
R. LaGrange
R. Hermann
N. Anderson
J. Stefano
S. Stern
L. Reiter
S. Brocoum
A. Lee
P. Sobel

DISTRIBUTION:
DMB - Docket Files
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BWR - Perry Unit Files

OFC	:BW:EB	:BW:EB	:	:	:	:	:
NAME	:PSobel:cdd	:R.LaGrange	:	:	:	:	:
DATE	:2/19/86	:2/19/86	:	:	:	:	:

OFFICIAL RECORD COPY

From The Desk of:

J. A. Grobe

DICK,

THESE ARE COPIES OF ALL OF THE SEISMIC INSTRUMENT CALIBRATION DATA SHEETS. I THINK THAT THE DATA SHEETS ARE SELF EXPLANATORY. IF YOU NEED THE SPECIFIC PROCEDURES LET ME KNOW. HARRISON/MUFFETT SHOULD BE INTERESTED IN THIS INFO. ANY Q's CALL ME

JACK

FEB 2 - 1996

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

FEB 25 1986

Docket No.: 50-440
50-441

MEMORANDUM FOR: Walter R. Butler, Director
Project Directorate No. 4
Division of BWR Licensing

FROM: John J. Stefano, Project Manager
Project Directorate No. 4
Division of BWR Licensing

SUBJECT: SUMMARY REPORT OF THE EARTHQUAKE MEETING AT THE PERRY PLANT SITE ON FEBRUARY 11, 1986

The meeting was held to discuss CEI's preliminary findings from its assessment of the impact of the January 31, 1986 earthquake on the as-built Perry plant design, and to discuss the operational readiness of Perry Unit 1 for licensing. This report briefly summarizes discussions held in the morning of February 11, 1986, which were limited solely to the earthquake event and its aftermath. The NRC regional staff will report separately on discussions held in the afternoon of February 11, 1986, relative to the Perry Unit 1 readiness for licensing.

Enclosure (1) lists the NRC, USGS and principal CEI representatives who participated in the meeting. Other CEI personnel and members from the press, U.S. Congressional staff, the intervenors and other interested parties were also in attendance, but are not listed in Enclosure (1). Enclosure (2) contains the meeting notice (issued by the NRC Region III Office) and the slide presentation handout prepared by CEI and distributed to the meeting attendees.

In summary, CEI presented its independent investigative findings of plant status prior to, during, and after the earthquake event, including a listing of the safety and non-safety systems that were undergoing operational readiness tests when the event occurred; characterized the earthquake event and its geographical location relative to the plant site; described the geologic structure upon which the plant was built; and discussed the analytical results obtained from the seismic data recorded by instruments positioned at various locations within the Perry plant buildings. On the basis of CEI's analysis of the data recorded, CEI and its consultants have concluded that: (1) the tectonic province considered in defining soil-structure interactions for the Perry site-specific safe shutdown earthquake (SSE) intensity remains valid as described in the FSAR and as evaluated by the NRC staff in the Perry SER; and (2) that the exceedance of SSE limits recorded at the higher frequencies (greater than 16 Hz) was of such a short duration (less than 1 second), low velocity and small displacement as to not have imparted any significant energy to the plant structure and the components, systems, and equipment installed therein; although a more detailed assessment of the impact, if any, on the qualification of safety-related equipment in the plant has not yet been fully

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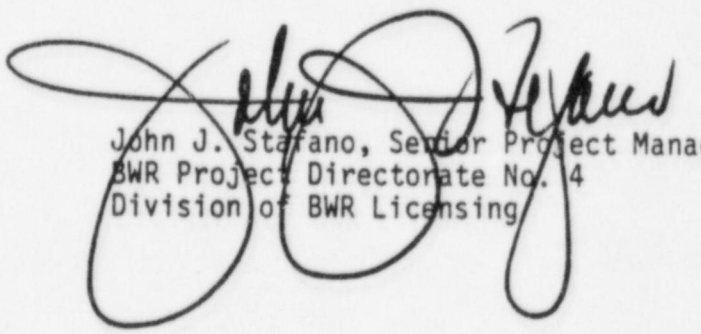
completed. In view of these conclusions, CEI maintained that the SSE design basis for the Perry plant remains valid. These conclusions appear to be borne out by the fact that little or no damage had been observed during an intense walkdown of the plant conducted by the CEI staff.

The NRC staff advised CEI that it still needed to conduct its own independent evaluation of the earthquake and that this effort would consider CEI's findings (a detailed report was filed by CEI with the Commission on February 12, 1986). The NRC staff also informed CEI that the issue would be discussed with the ACRS, and that meetings with the ACRS Subcommittee and the ACRS Full Committee were scheduled for February 12 and 13, 1986, respectively. (NRC and CEI briefed the ACRS on those dates). Lastly, the NRC staff advised CEI that its independent evaluation would not be completed before March 1, 1986, and that completion of its evaluation by that date assumed receipt of all outstanding data promised by CEI before February 17, 1986.

The morning session of the February 11, 1986 meeting was completed at 11:30 am after which time the NRC staff answered questions posed by the press and public representatives in attendance. The NRC staff also met with its respective CEI technical counterparts to go over in more detail the information presented by CEI during the formal meeting.



John J. Stefano, Senior Project Manager
BWR Project Directorate No. 4
Division of BWR Licensing

Enclosure: As stated

cc w/enclosure: See next page

cc:
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Perry, Ohio 44081

Enclosure 1

CEI/NRC MEETING
AT PERRY SITE

FEBRUARY 11, 1986
(MORNING SESSION ONLY)

EARTHQUAKE EVENT

CEI

M. R. Edelman
A. Kaplan
E. Buzzelli
F. Stead
M. Lister
R. Stratman
Others

NRC

R. M. Bernero, NRR/DBL
J. G. Keppler, RIII
C. J. Paperiello, RIII
R. C. Knop, RIII
J. A. Grobe, RIII
J. J. Stefano, NRR/DBL
W. R. Butler, NRR/DBL
R. Hernon, NRR/DBL
H. Polk, NRR/DBL
J. Johnson, Consulant (SMA)
J. Singh, Consultant (EG&G)
D. Guzy, RES
G. Cumming, Consultant

Gilbert Associates

C. Chen
R. Ailey

CEI Consultants

R. Holt

USGS

L. Langer

Enclosure 2

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, ILLINOIS 60137

NOTICE OF SIGNIFICANT LICENSEE MEETING

Name of Licensee: The Cleveland Electric Illuminating Company (CEI)

Name of Facility: Perry Unit 1

Docket No.: 50-440

Date and Time of Meeting: February 11, 1986, at 10:00 a.m. and 1:00 p.m.

Location of Meeting: Training Center Building
Perry Site
Perry, Ohio

Purpose of first meeting: Meet with CEI management to discuss the licensee's review of the January 31, 1986 earthquake.

Purpose of second meeting: Meet with licensee's management to discuss the operational readiness to load fuel at the Perry Unit 1 plant.

Region III Attendees:
J. G. Keppler, Regional Administrator
C. J. Paperiello, Director, Division of Reactor Safety
R. C. Knop, Chief, Projects Section 1 C, Division of Reactor Projects
J. A. Grobe, Senior Resident Inspector, Perry
Others as assigned

NRR Attendees:
R. M. Bernero, Director, Division of BWR Licensing, NRR
J. Stefano, Licensing Project Manager, NRR
Others as assigned

Licensee Attendees:
M. R. Edelman, Vice President, Nuclear Group
Others as assigned

NOTE: Attendance at this meeting by NRC personnel should be made known by COB February 7, 1986, by telephone call to R. C. Knop Region III (FTS 388-5547)

Distribution:
J. M. Taylor, Diector, Office of Inspection and Enforcement
E. L. Jordan, Director, Division of Emergency Preparedness and Engineering Response, IE
J. G. Partlow, Director, Division of Inspection PRograms
B. K. Grimes, Director, Division of Quality Assurance, Vendor and Technical Training Center Programs
R. Bernero, Director, Division of Boiling Water Reactor Licensing
W. Brach, Executive Coordinator for REgional Operations, DEDROGR
J. Stefano, Licensing Project Manager, NRR

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

SEISMIC EVENT EVALUATION

TECHNICAL PRESENTATION

AGENDA

FEBRUARY 11, 1986

INTRODUCTION & OVERVIEW	M. R. EDELMAN
PLANT STATUS AND RESPONSE	R. A STRATMAN
EARTHQUAKE ANALYSIS AND SEISMICITY	R. HOLT WESTON GEOPHYSICAL
PLANT SEISMIC DESIGN EVALUATION	DR. C. CHEN GILBERT COMMONWEALTH
SUMMARY AND CONCLUSIONS	M. R. EDELMAN

Plant Status Prior to Seismic Event

- Ongoing Testing, Calibration, Work Activities
- Preparation for Division II Diesel Generator Testing
- Startup Sources Not Yet Moved
- Systems Energized (In Operation and Standby Mode)
  - Safety Systems
  - Non-Safety Systems

System	Plant Status
G33 Reactor Water Cleanup	A & B Pumps with flow to the Main Cond. at 55 gpm No Filter/Demineralizers in service
G41 Fuel Pool Cooling and Cleanup	A Pump running B Filter/Demineralizer Train in service
M35 Turbine Building Cooling and Ventilation	B Fan running
M41 Heater Bay Ventilation	B Fan running
M45 Circwater Pump House Ventilation	A and B Fans running
N21 Condensate	A Hotwell Pump in shortcycle cleanup A, B, C Condensate Booster Pump Lube Oil Pumps
N23 Condensate Filtration	Filters B, C, E
N24 Condensate Demineralizers	Demineralizers A, B
N32 Turbine Control (EHC)	Recirculation pump running
N71 Circulating Water	A & B pumps running B, C, D Loops in operation Cooling Tower in bypass
P11 Condensate Transfer	Normal Pump running B pump in standby
P20 Water Treatment	A and B Coagulators in service
P21/22 Two-bed/Mixed-Bed Demineralizers	B Stream in service B Sulfite Pump running B and C Clearwell Pumps running
P41 Service Water	B and C Pumps running
P43 Nuclear Closed Cooling	B and C Pumps running A Heat exchanger in service
P44 Turbine Building Closed Cooling	B and C Pumps running A Heat exchanger in service

System	Plant Status
P52 Instrument Air	Unit 1 Compressor running
P55 Building Heating	A Pump running
P61 Auxiliary Steam	B Boiler C Boiler Feed Pump
P62 Auxiliary Boiler Fuel Oil	B Fuel Oil Pump
P72 Plant Underdrain	Pumps in Automatic
C11 Control Rod Drive	A Pump A Flow Control Valve
C41 Standby Liquid Control	Tank Heaters Energized
C71 Reactor Protection System	Energized
D17 Plant Radiation Monitors	Energized
E12 Residual Heat Removal	Keep Fill Pump for Loops B & C
E21 Low Pressure Core Spray	Keep Fill Pump for LPCS and RHR Loop A
E22 High Pressure Core Spray	Keep Fill Pump for HPCS
F42 Fuel Transfer Equipment	Energized
M11 Containment Vessel Cooling	B, C, E, F Fans running
M13 Drywell Cooling	1A, 2A, 3B Fans running B Cooling Coil
M15 Annulus Exhaust Gas Treatment	A Train running B Train in standby
M21 Controlled Access Ventilation	A Train running B Train standby
M23/24 MCC Switchgear & Misc. Area Ventilation/Battery Room Exhaust	A Train running B Train standby
M25/26 Control Room Ventilation/ Emergency Recirculation Mode	A Train running in normal mode B Train standby
M27 Computer Room Ventilation	A Fan running

System	Plant System
M32 ESW Pumphouse Ventilation	A and B Fans running
M40 Fuel Handling Building Ventilation	B and C Exhaust fans
M43 Diesel Generator Building Ventilation	2B Fan running
P45 Emergency Service Water	A and B Pumps running with all loads valved in
P47 Control Complex Chilled Water	A Chiller running with normal loads A Circwater Pump running
P49 Emergency Service Water Screen Wash	Both screens operating
P54 Fire Protection	Recirc Pump (construction) running No intitiation of CO_2, Halon, or sprinkler suppression systems

Inspections and Findings Following Seismic Event

- o Operator Survey (No Structural Damage)
- o Walkdowns By Plant Maintenance Personnel (No Structural Damage)
- o Systematic Plant Walkdowns by 65 Engineers and Technicians (No Structural/Equipment Damage)
  - Identify and Document All Discrepant Conditions
  - 480 Observations Documented (Minor Items)
  - Review for Relationship to Earthquake
  - Review of observations by CEI and NRC
- o Additional Inspections/Surveys
  - Site Survey
  - Plant Settlement Survey
  - Cooling Tower Walkdown
- o Seismic Clearance Inspection
- o Energized Electircal Equipment Study
- o Ongoing Surveillance (SVI's)
- o New Procedure
  - Assures CEI/NRC Review of All Potential Earthquake-Related Items
  - Review All Work Requests for Relationship to Earthquake
  - No Work on Earthquake-Related or indeterminate conditions without CEI/NRC Review

MAIN SHOCK

January 31, 1986

origin time :	11 : 47 am 16 hr 46 m 42.3 s U.T.
latitude :	41.649° N
longitude :	81.105° W
focal depth :	10 Km
based on :	64 stations (worldwide)
	M_b = 4.9 M_{blg} = 4.96 ⇐
location :	Geauga County Near intersection of Highway 86 and 166
est. distance to plant :	11 miles 17.7 km
based on :	NEIS solution

EARTHQUAKE MAGNITUDE & INTENSITY

4.96 M_{BLG} - USGS (EQUIVALENT RICHTER SCALE)

MODIFIED MERCALLI INTENSITY VI - PRELIMINARY -

WESTON GEOPHYSICAL

- **QUESTIONNAIRE**

- **REPORTED EFFECTS**

  FEW DAMAGED CHIMNEYS
  CRACKS IN WALLS
  CRACKED/FALLEN PLASTER
  BROKEN WINDOWS
  WELL-WATER EFFECTS


OTTAWA - BONNECHERE GRABEN
MADAWASKA HIGHLANDS
LAKE ONTARIO HOMOCLINE
ATTICA, NEW YORK & NIAGARA PENINSULA
MAR 27, 1912 - V
AUG 1929 - V
SEPT. 10, 1840 - V
JUNE 13, 1967 - V
5.1 (N4)
MICHIGAN BASIN
ALGONQUIN AXIS
200 Mile
100 Mile
MICH.
AUG. 10, 1947 - VI
CLEVELAND
SITE
OCT 29, 1934 - V
MAR 9, 1943 - IV-V
SEPT 9, 1928 - V
JUNE 27, 1906 - V
MAY 1, 1958 - V
MAY 26, 1955 - V
JUNE 29, 1955 - V
ILL.
PENN.
JUNE 10, 1931 - V
FEB 22, 1966 - V
KANKAKEE ARCH
FINDLAY ARCH
PRECISE MAG. SURVEY
SEPT. 1884 - VI
MAR 2, 1937 - VII
MAR 6, 1937 - VII - VIII
FEB. 9, 1882 - V
MAR. 8, 1929 - V
SEPT. 20, 1930 - V
MAR 3, 1937 - V
SEPT. 30, 1930 - VII
JUNE 27, 1956 - V
JUNE 18, 1875 - VII
SEPT. 20, 1931 - VII
ANNA, OHIO
OHIO
JULY 15, 1938 - V - VI
APPALACHIAN STRUCTURAL FRONT
(OHIO) 52
JUNE 20, 1952 - V
APR 8, 1967 - V
1776 - VI
MAY 7, 1901 - V
NOV. 5, 1926 - VI - VII
CINCINNATI
CINCINNATI ARCH
WAVERLY ARCH
SOUTH CENTRAL OHIO
ALLEGHENY
W. VA.
APPALACHIAN (AND VALLEY) UPLIFT
KENTUCKY RIVER
ROUGH CREEK FAULT ZONE
KY.
VA
BLUE RIDGE
PIEDMONT
ATLANTIC
1980 5.2 (Kentucky)
PDE 7/27 18:52 38.19 83.67 DEPTH=16KM 5.1 mb 5.2 mbLg

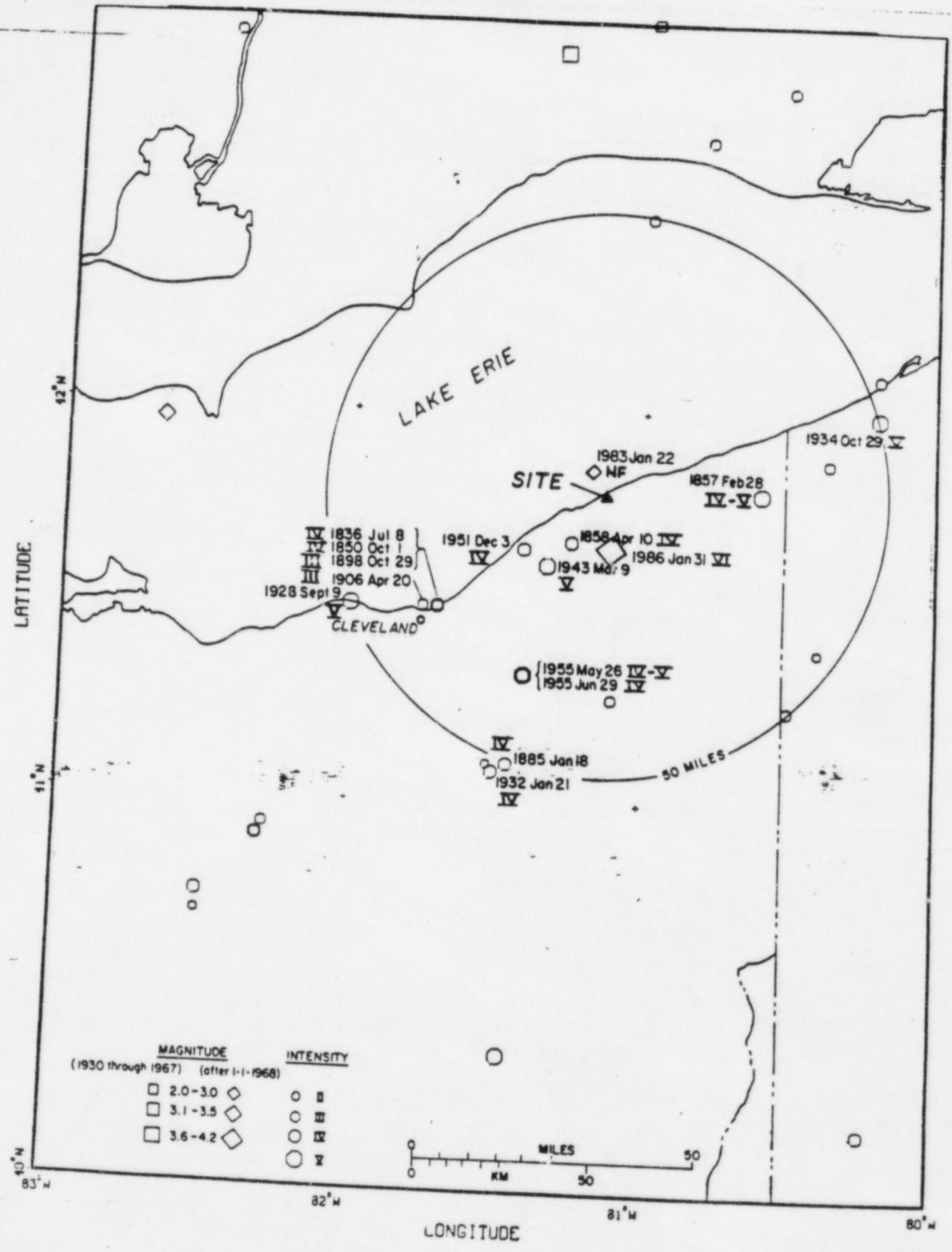
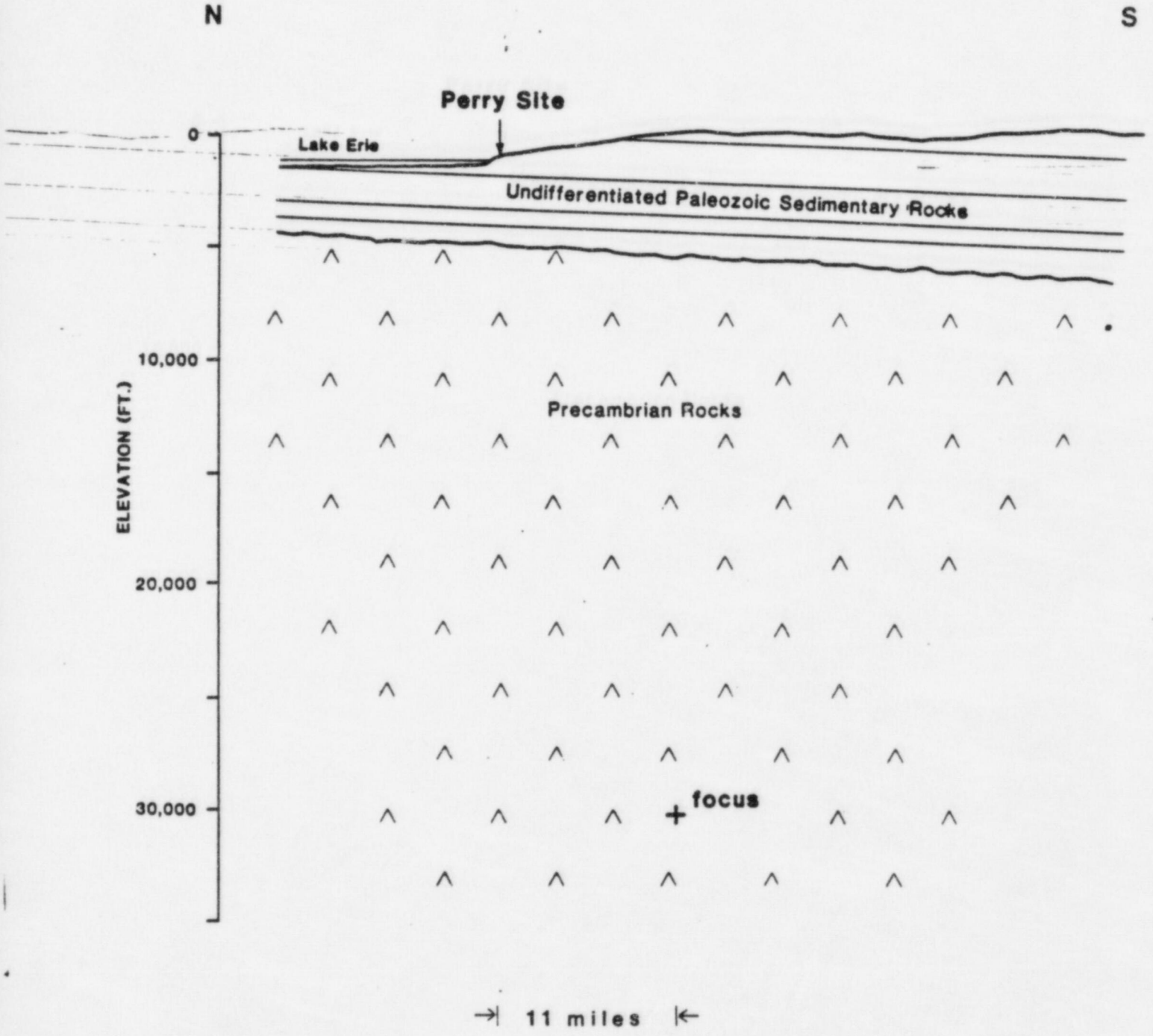


Figure 4 Seismicity Map


SITE
5 miles
FEB. 5
FEB. 3
FEB. 6
M_L 2.4
FEB. 1
FEB. 2
JAN. 31
M_b 4.9
0
3 MI


N
S
Perry Site
0
Lake Erie
Undifferentiated Paleozoic Sedimentary Rocks
10,000
Precambrian Rocks
ELEVATION (FT.)
20,000
30,000
focus
11 miles

SAFE SHUTDOWN EARTHQUAKE

MODIFIED MERCALLI INTENSITY = VII

PEAK GROUND ACCELERATION - 0.15 g

REGULATORY GUIDE 1.60 SPECTRA

SITE SPECIFIC SPECTRA

- 5.3 $M_{BLG} \pm .5$
- 5.5 $M_{BLG} \pm .3$

FIFTY-MILE SEISMICITY

RELATIVELY LOW SEISMICITY

NO CAPABLE FAULTS

HIGHEST INTENSITY - MODIFIED MERCALLI VI

INTENSITY (6) EST.

HIGHEST MAGNITUDE - 4.96 M_{BLG}

CONCLUSIONS

TECTONIC PROVINCE APPROACH STILL VALID

- NO CAPABLE FAULT
- NO TECTONIC STRUCTURE

SAFE SHUTDOWN EARTHQUAKE INTENSITY

- MODIFIED MERCALLI VII vs. VI

SITE SPECIFIC

- 5.5 ± .3 vs. 4.96
- 5.3 ± .5 vs. 4.96

EXCEEDANCE OF SAFE SHUDOWN EARTHQUAKE

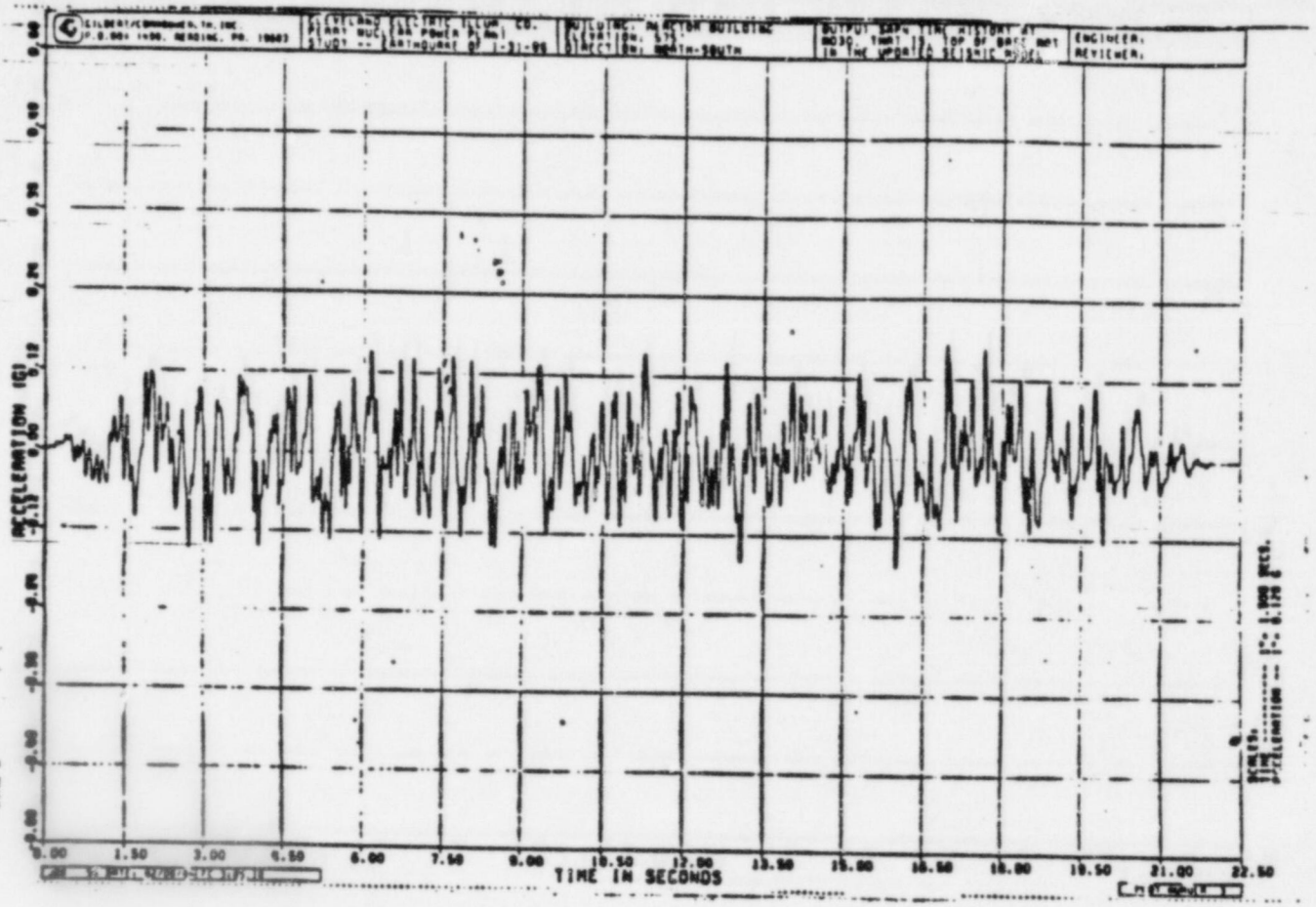
- SHORT DURATION (< 0.5 sec.)
- HIGH FREQUENCY (20 Hz)
- EXCEEDANCE ABOVE 84% EXPECTED

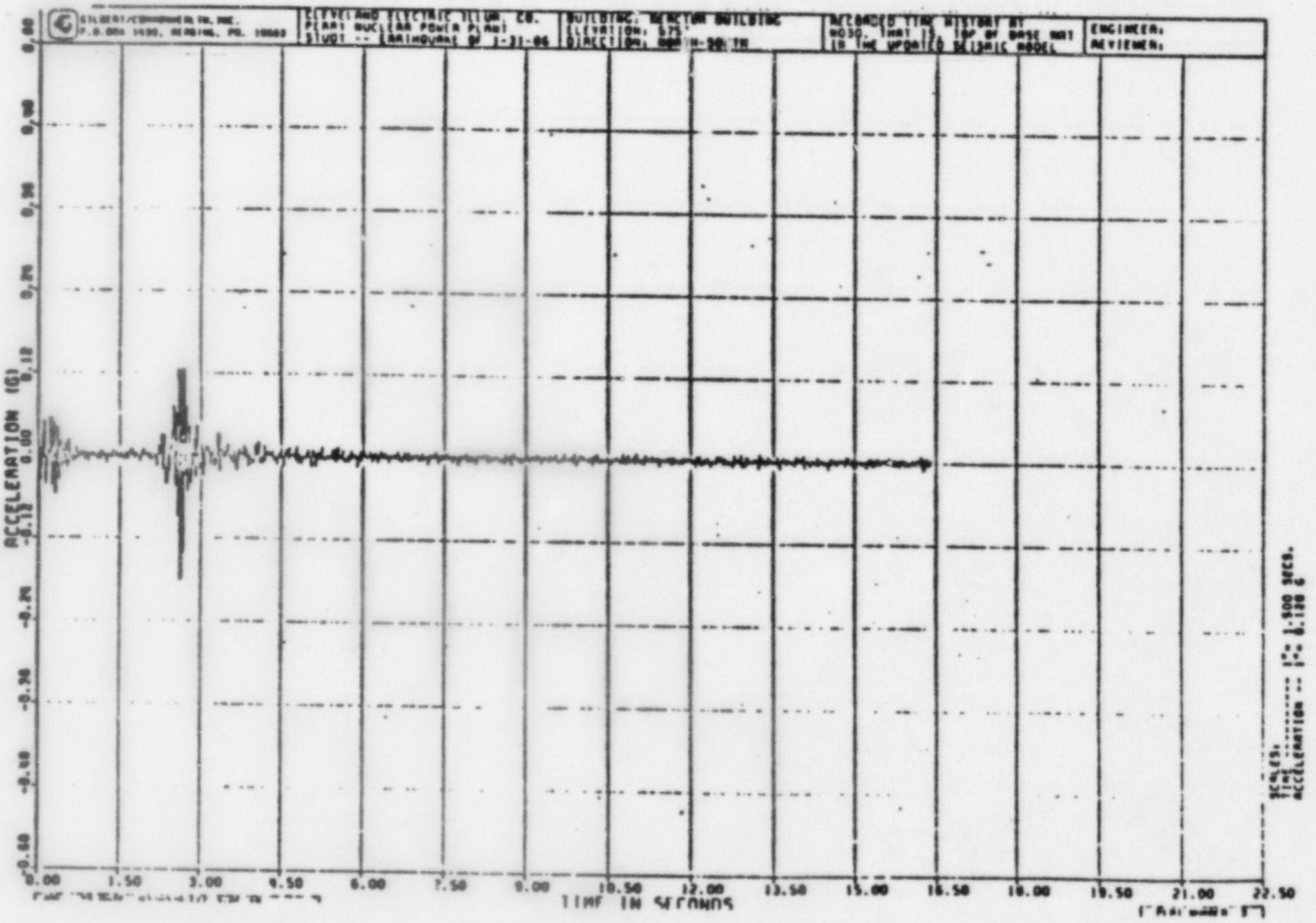
CHARACTERISTICS OF THE 1986 OHIO EARTHQUAKE

- HIGH FREQUENCIES
- SHORT DURATION
- LOW ENERGY
- LOW VELOCITY
- SMALL DISPLACEMENT

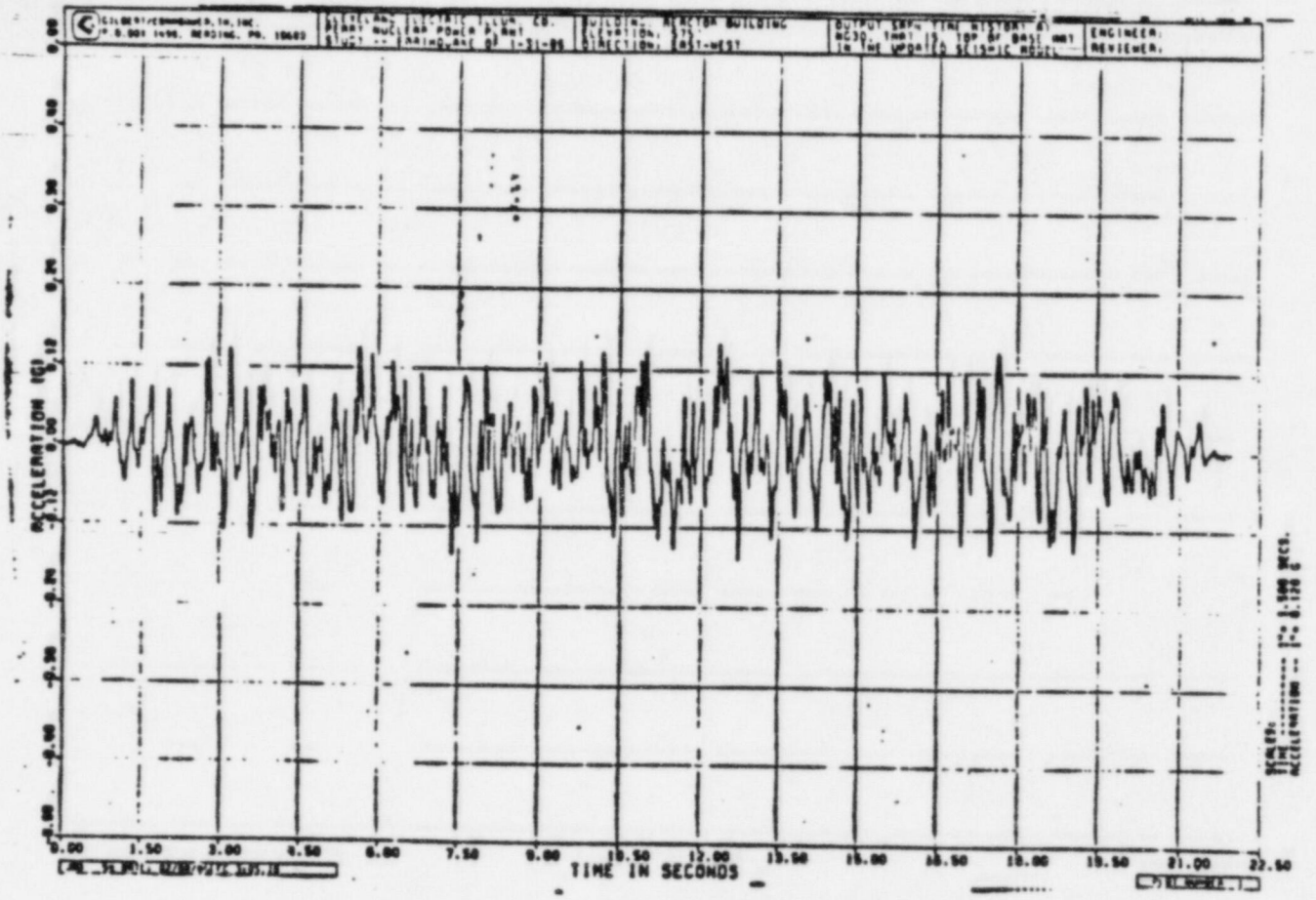
CHARACTERISTICS OF THE PERRY DESIGN BASIS EARTHQUAKE (SSE)

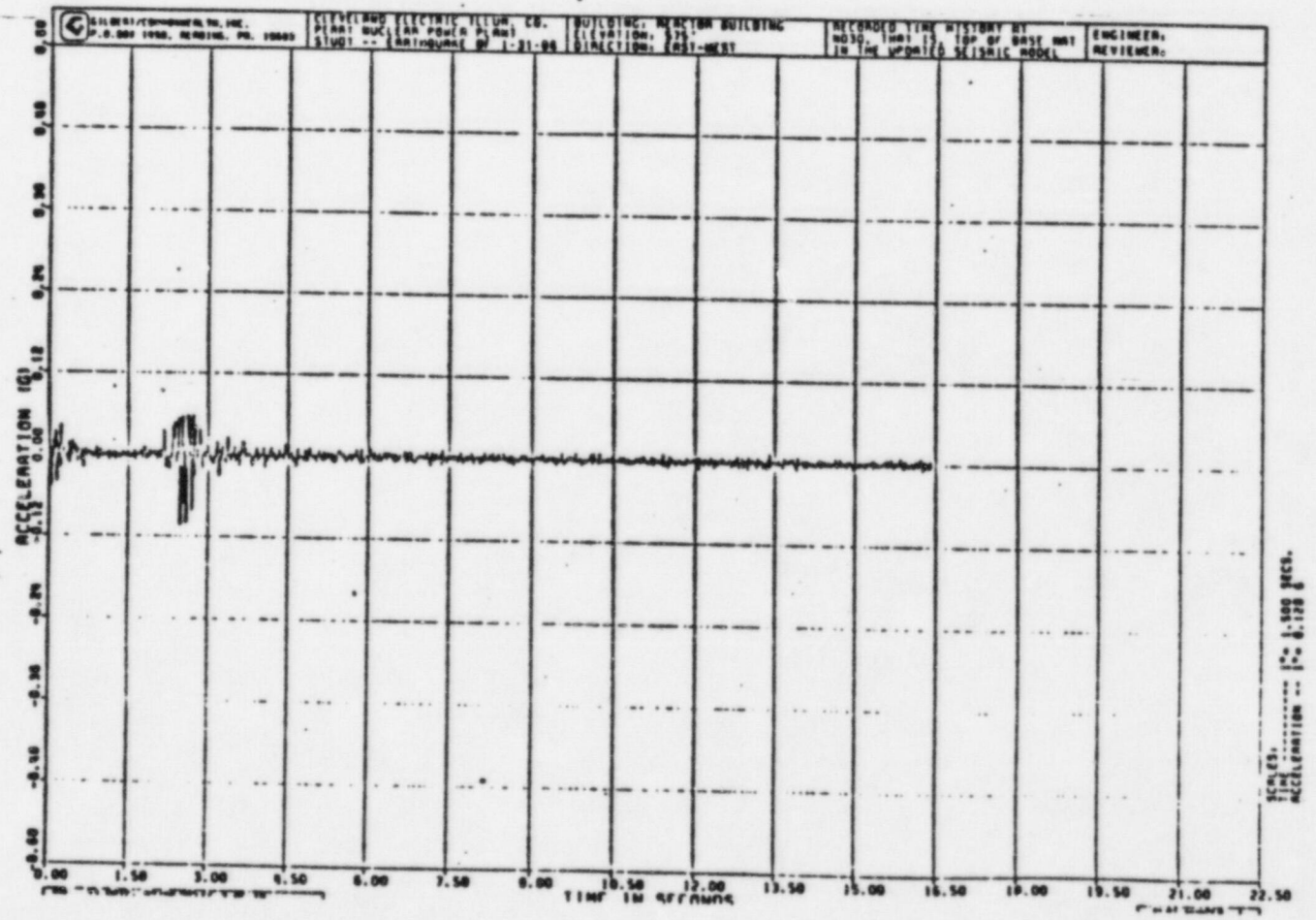
- BROAD BAND FREQUENCIES
- LONG DURATION
- HIGH VELOCITY
- LARGE DISPLACEMENT
- HIGH ENERGY


ACCELERATION (G)
TIME IN SECONDS

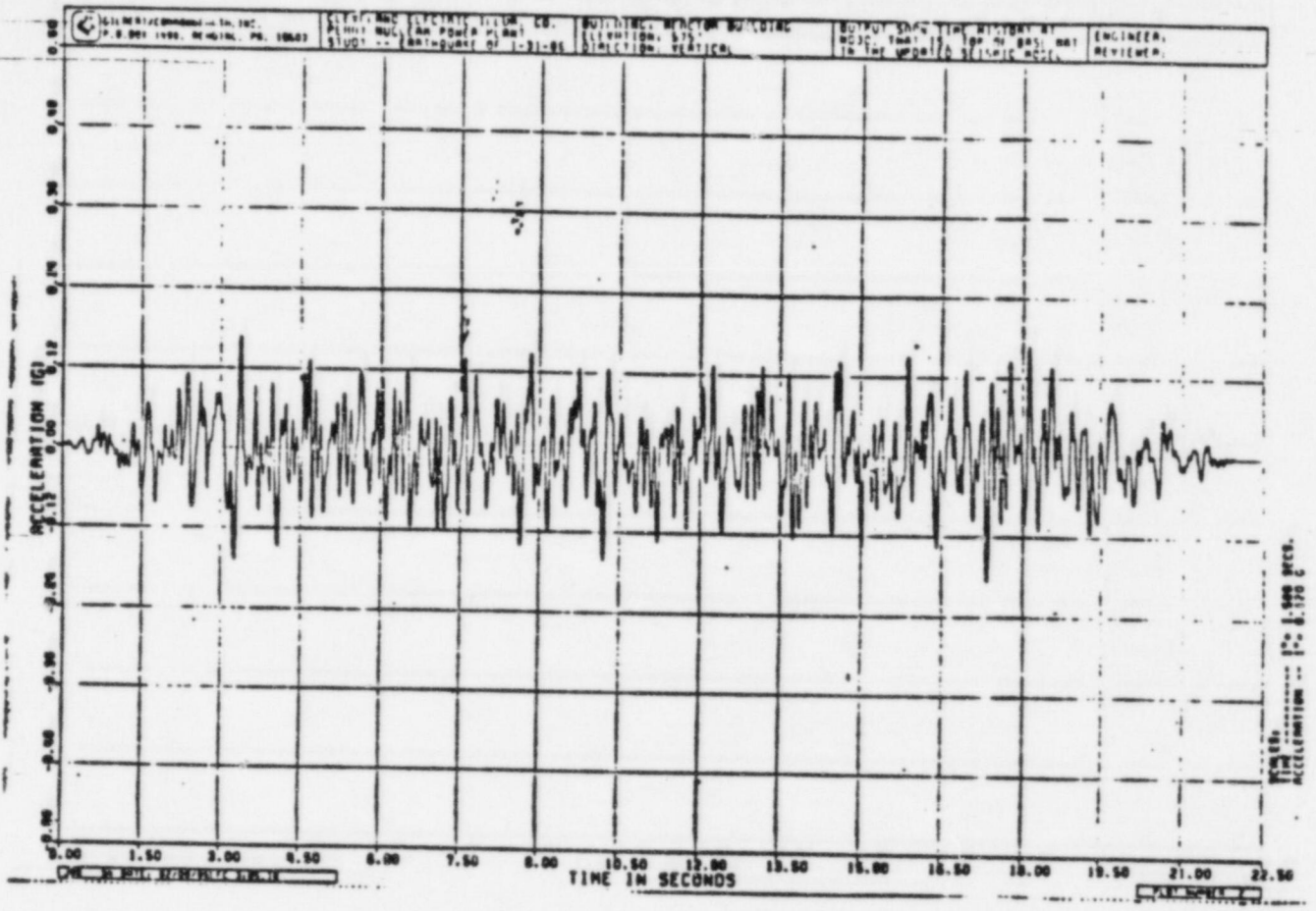

ACCELERATION (G)
TIME IN SECONDS

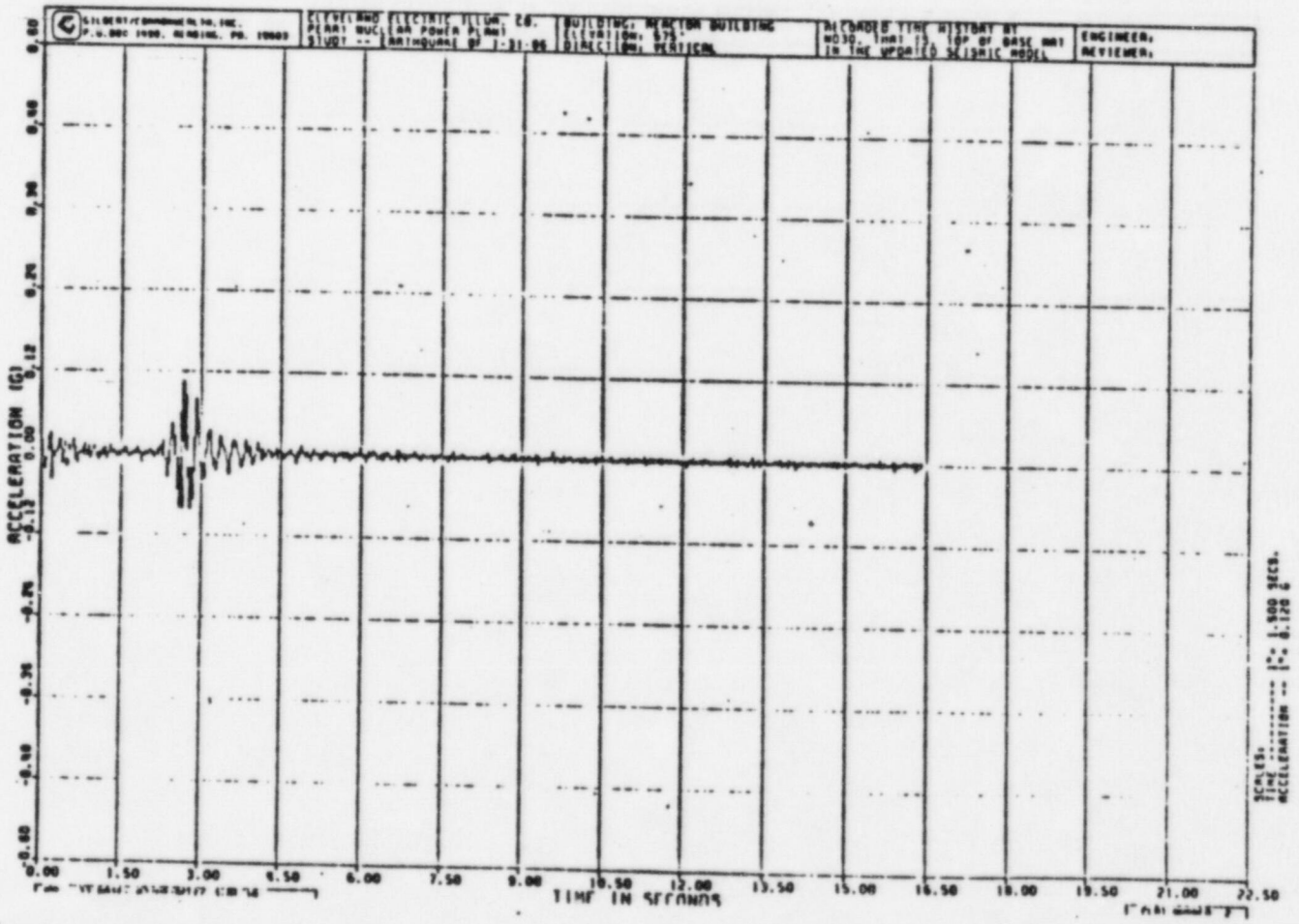
Rosemont N.S.


ACCELERATION (G)
TIME IN SECONDS

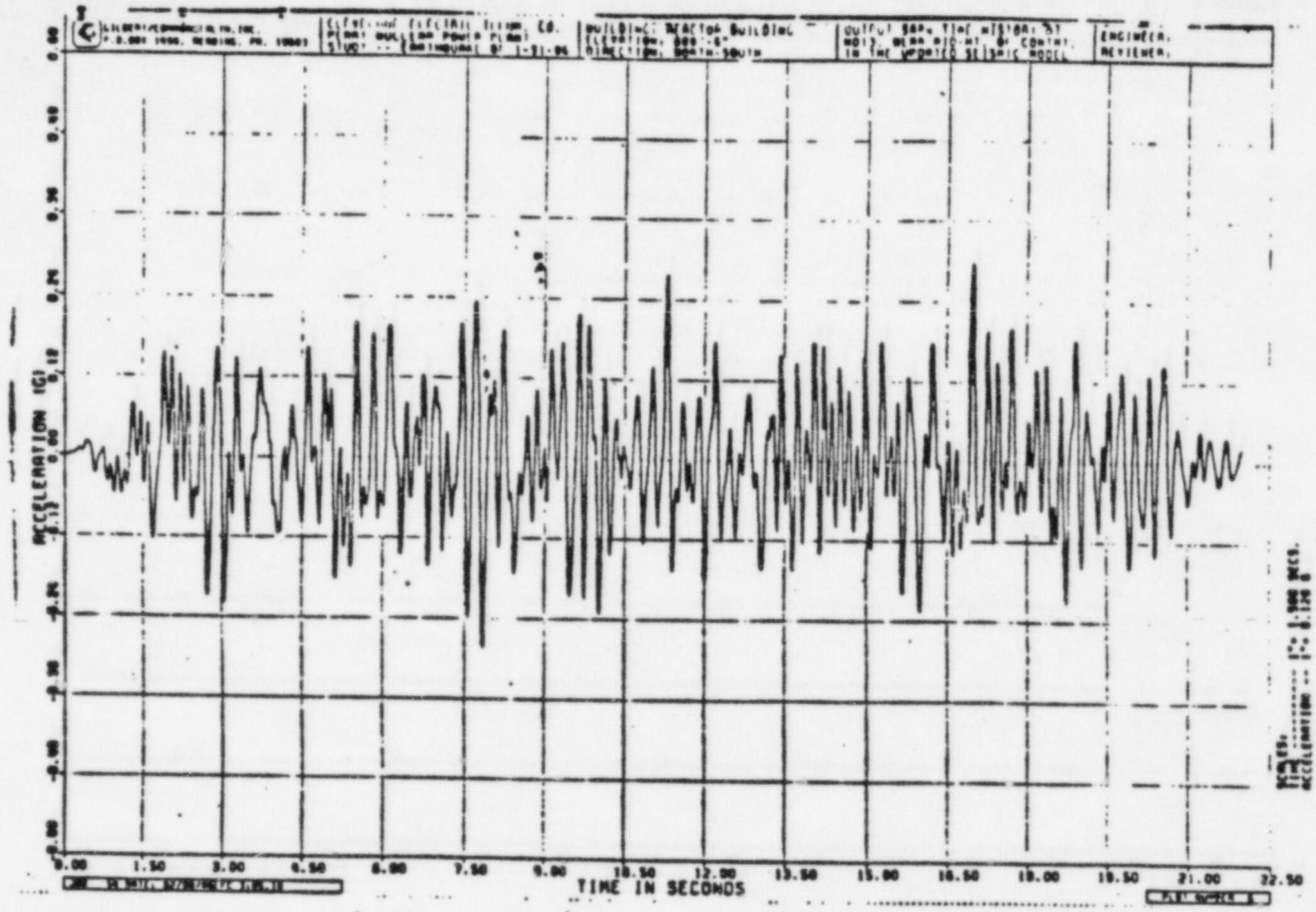

ACCELERATION (G)
TIME IN SECONDS

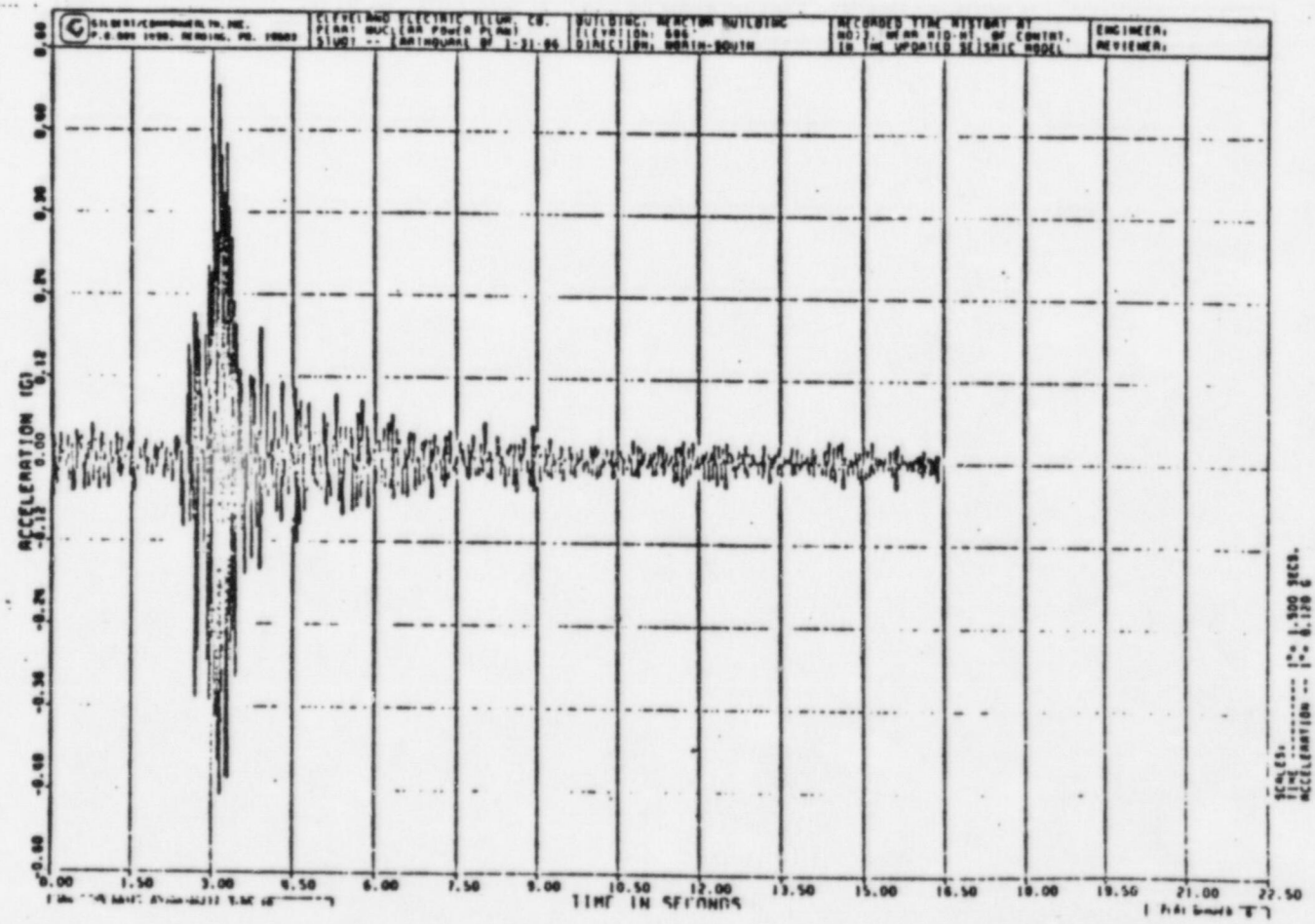
Basemat E-W





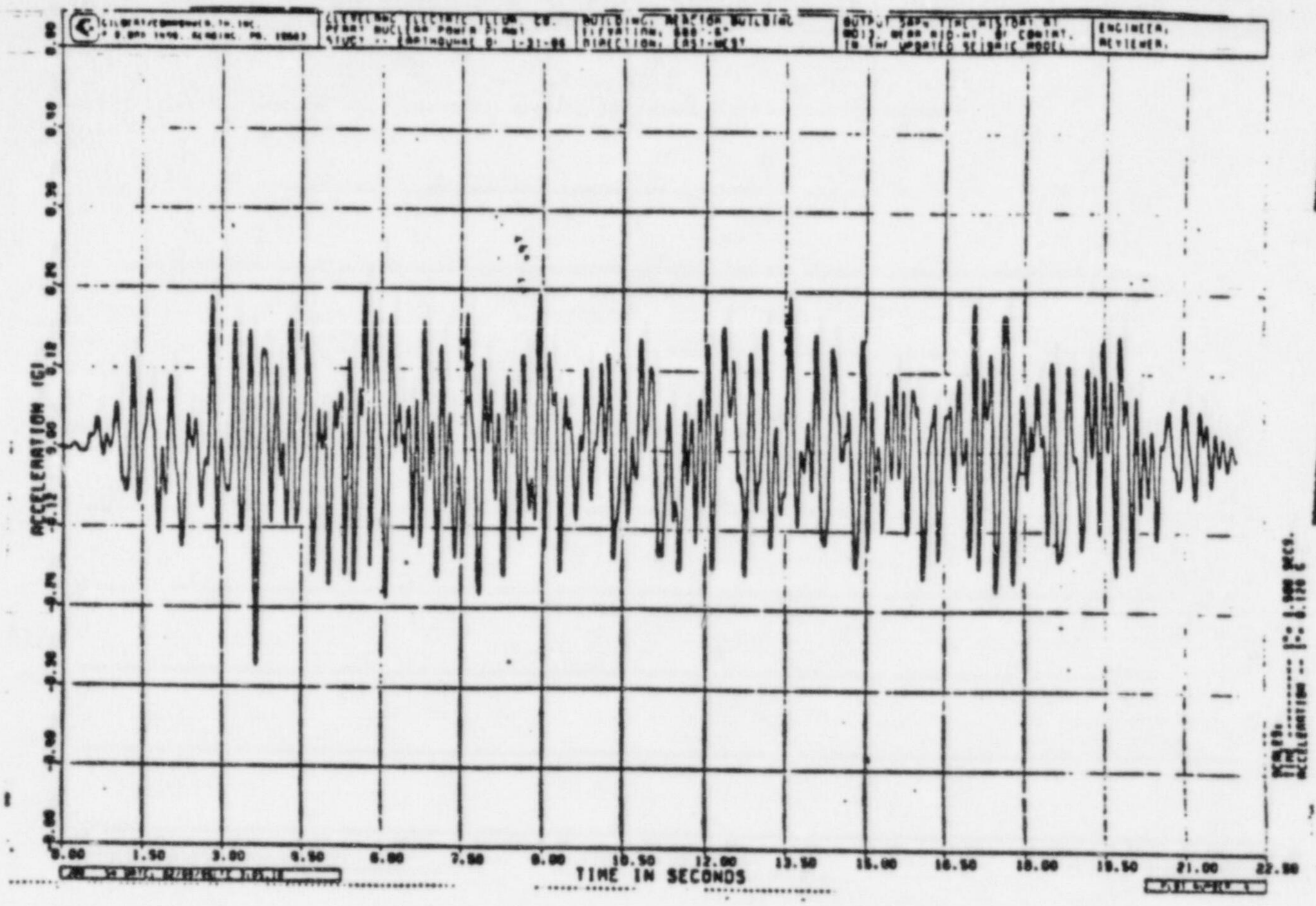
Basement Vert.

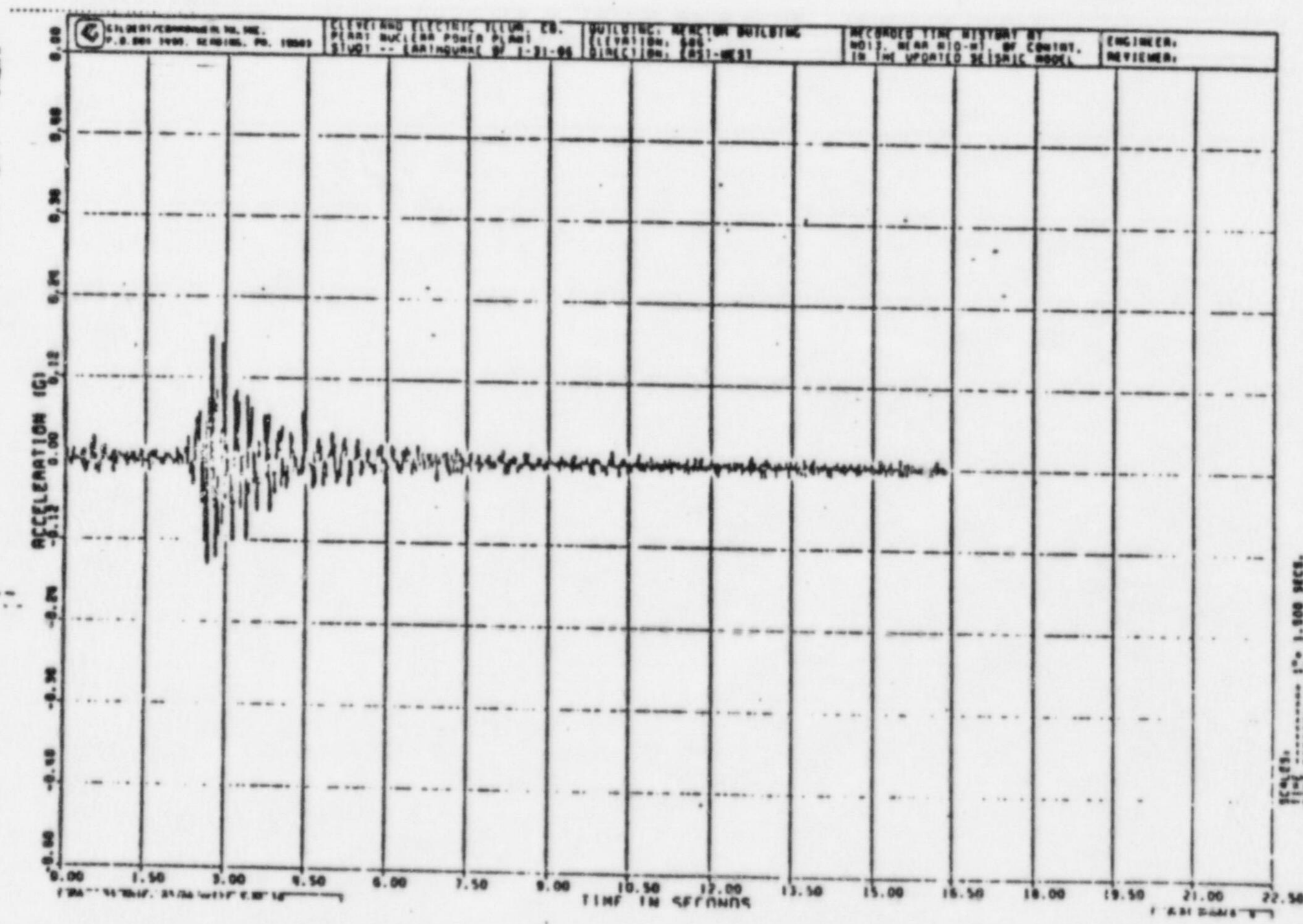

ACCELERATION (G)
TIME IN SECONDS


ACCELERATION (G)
TIME IN SECONDS

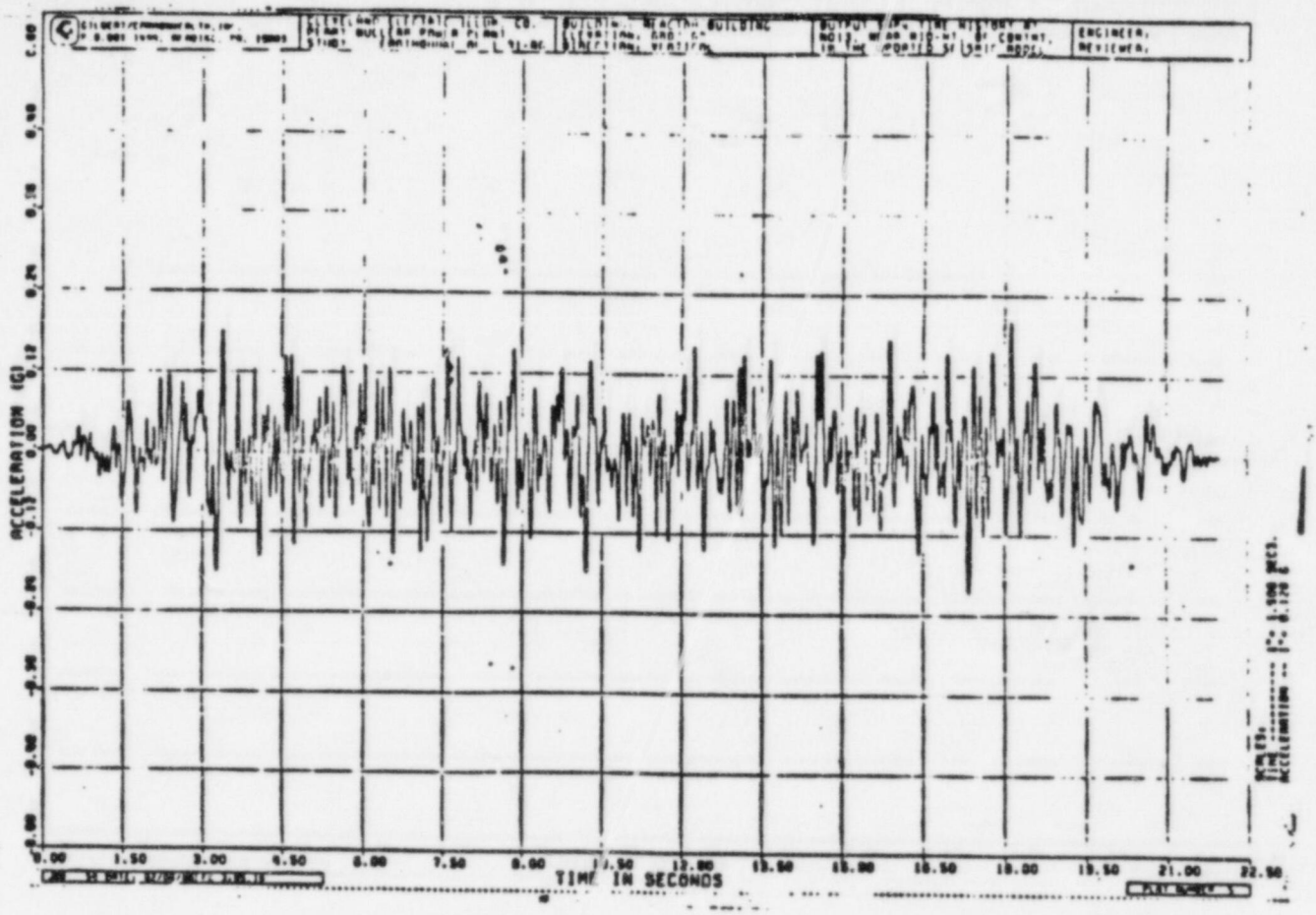
Hi ELEV

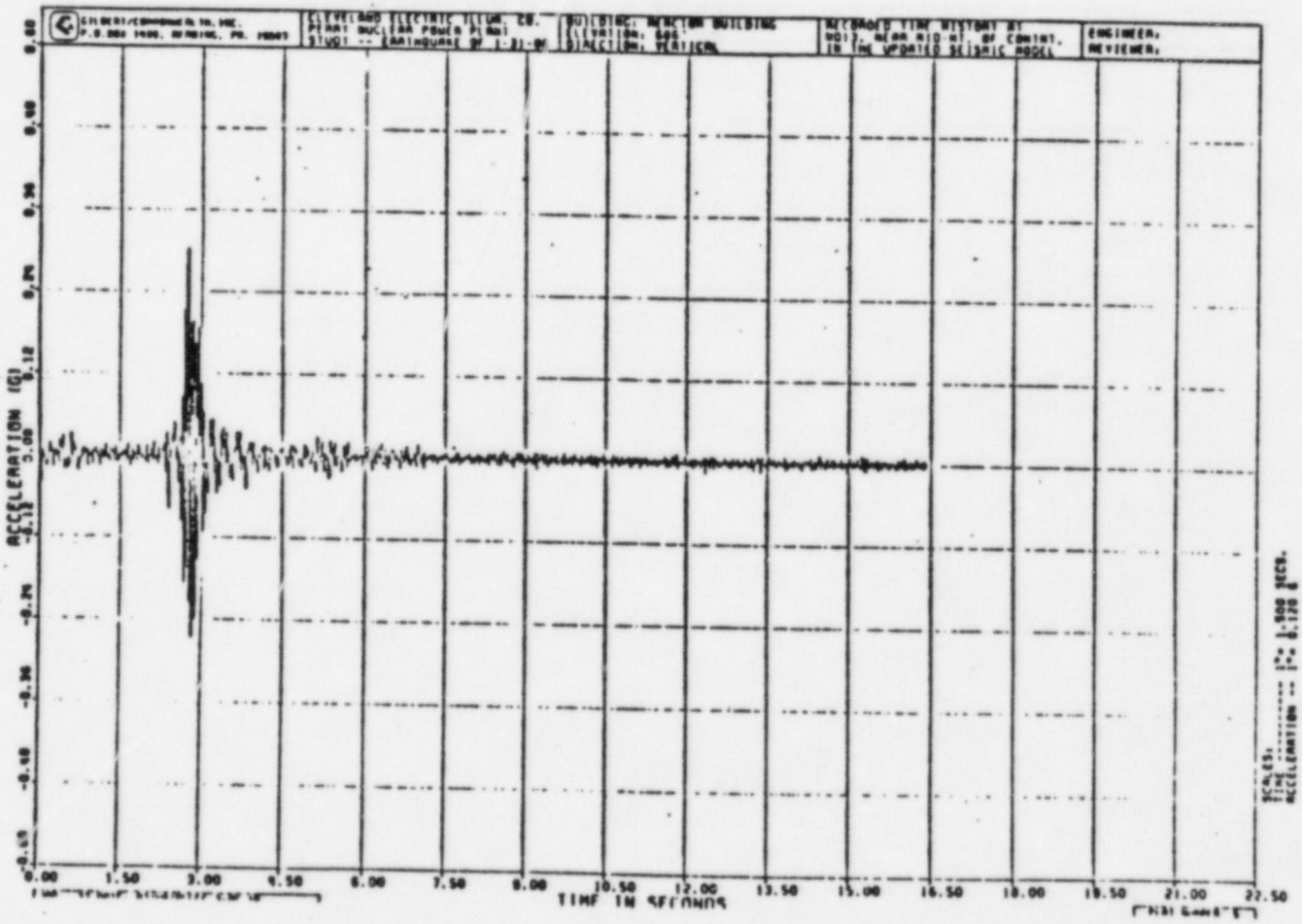
N-S


CLEVELAND ELECTRIC ILLUM. CO.
PERRY NUCLEAR POWER PLANT
STUDY -- EARTHQUAKE OF 1-31-86
BUILDING: REACTOR BUILDING
DIRECTION: EAST-WEST
ENGINEER:
REVIEWER:
ACCELERATION (G)
TIME IN SECONDS
0.00 1.50 3.00 4.50 6.00 7.50 9.00 10.50 12.00 13.50 15.00 16.50 18.00 19.50 21.00 22.50
SCALES:


CLEVELAND ELECTRIC ILLUM. CO.
PERRY NUCLEAR POWER PLANT
STUDY -- EARTHQUAKE OF 1-31-86
BUILDING: REACTOR BUILDING
DIRECTION: EAST-WEST
RECORDED TIME HISTORY
IN THE UPDATED SEISMIC MODEL
ENGINEER:
REVIEWER:
ACCELERATION (G)
TIME IN SECONDS
0.00 1.50 3.00 4.50 6.00 7.50 9.00 10.50 12.00 13.50 15.00 16.50 18.00 19.50 21.00 22.50
SCALES:

Hi Filter ——— E-W


ACCELERATION (G)
TIME IN SECONDS


ACCELERATION (G)
TIME IN SECONDS

HI-ELEV. VERT

SEISMIC DESIGN BASIS

- BROAD BAND FREQUENCY DESIGN RESPONSE SPECTRA

- SMOOTHED, 84 PERCENTILE SPECTRA

- COMPOSITE TIME HISTORIES WITH LONG DURATIONS AND HIGH ENERGY

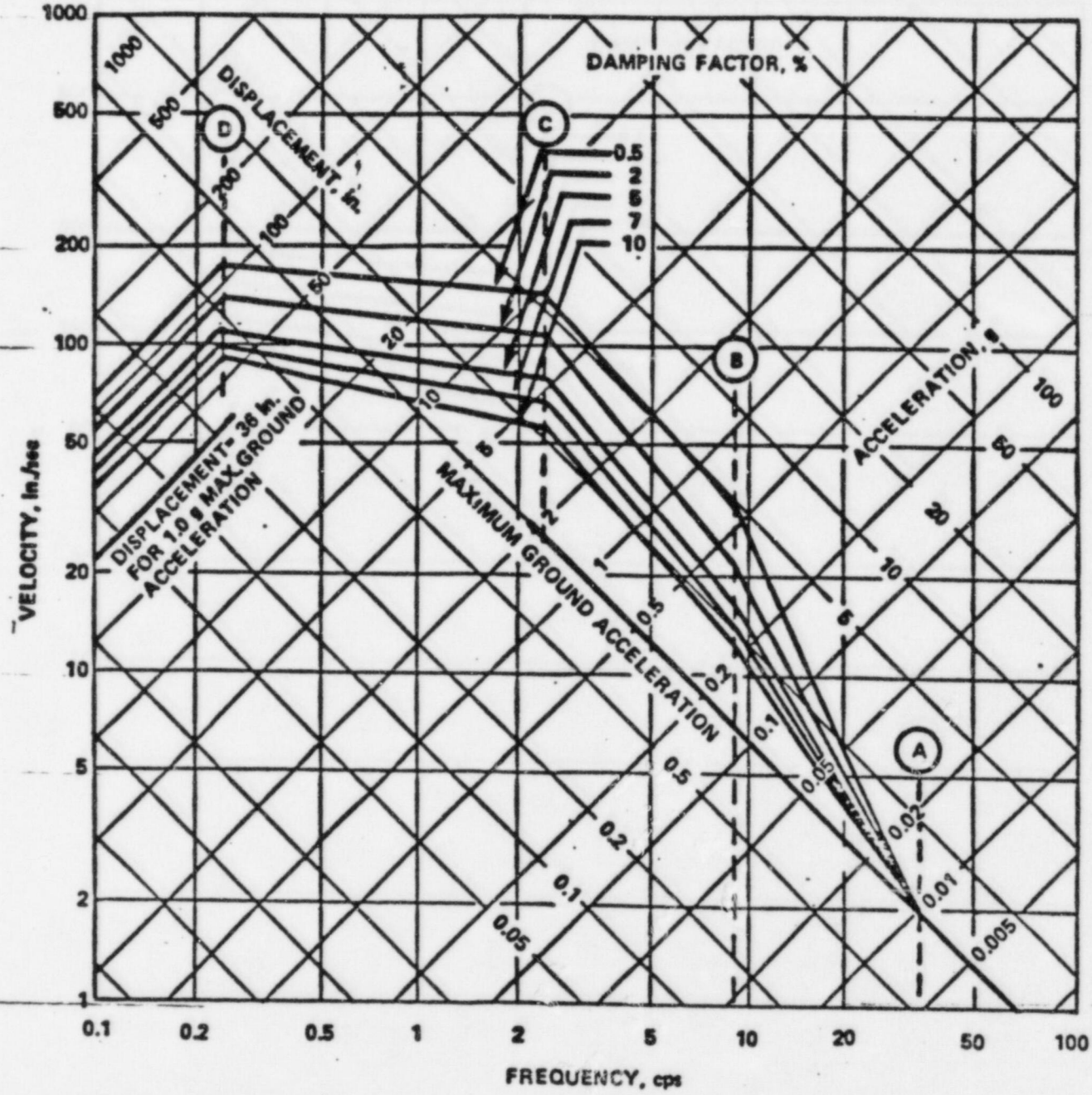
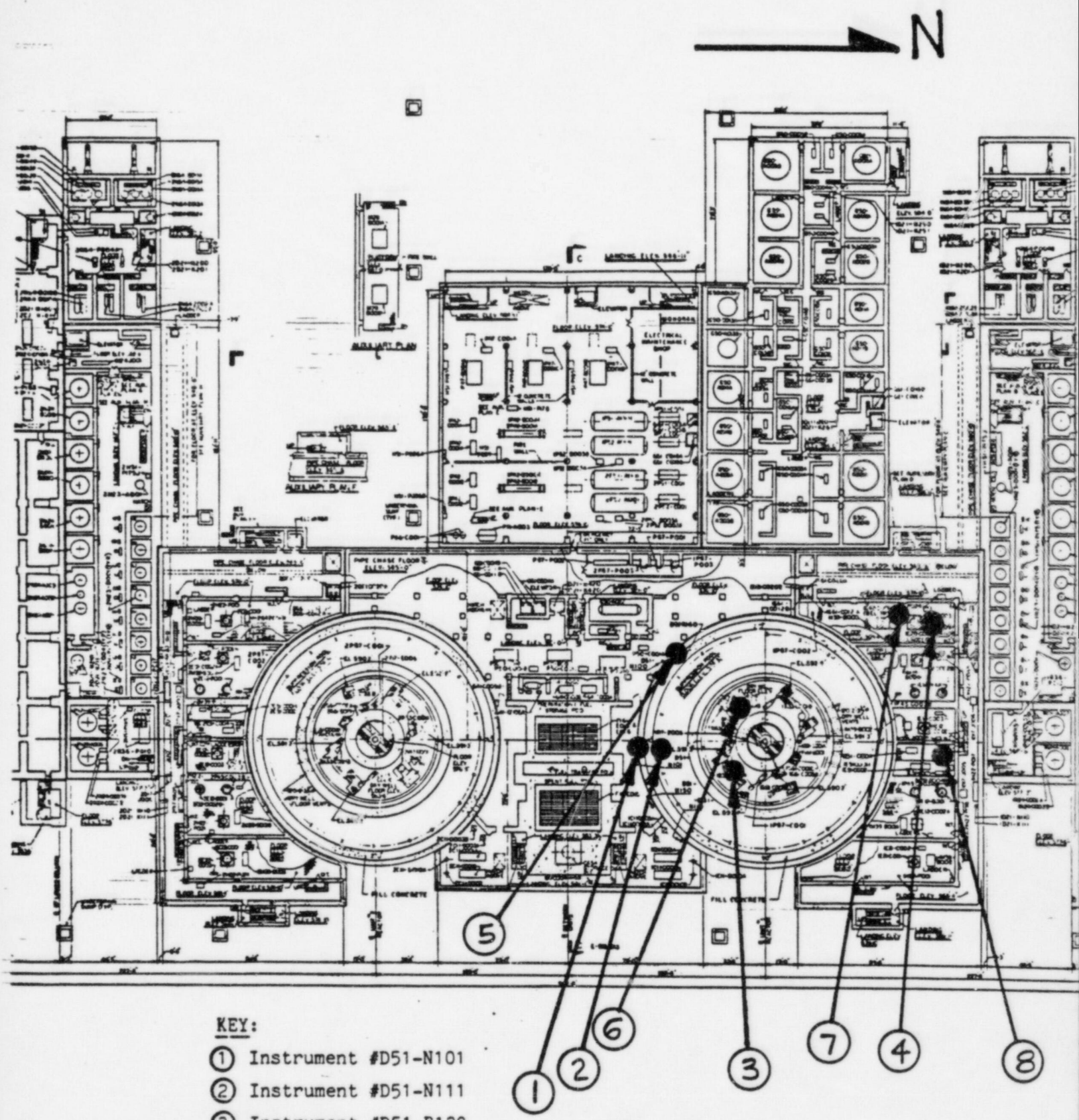
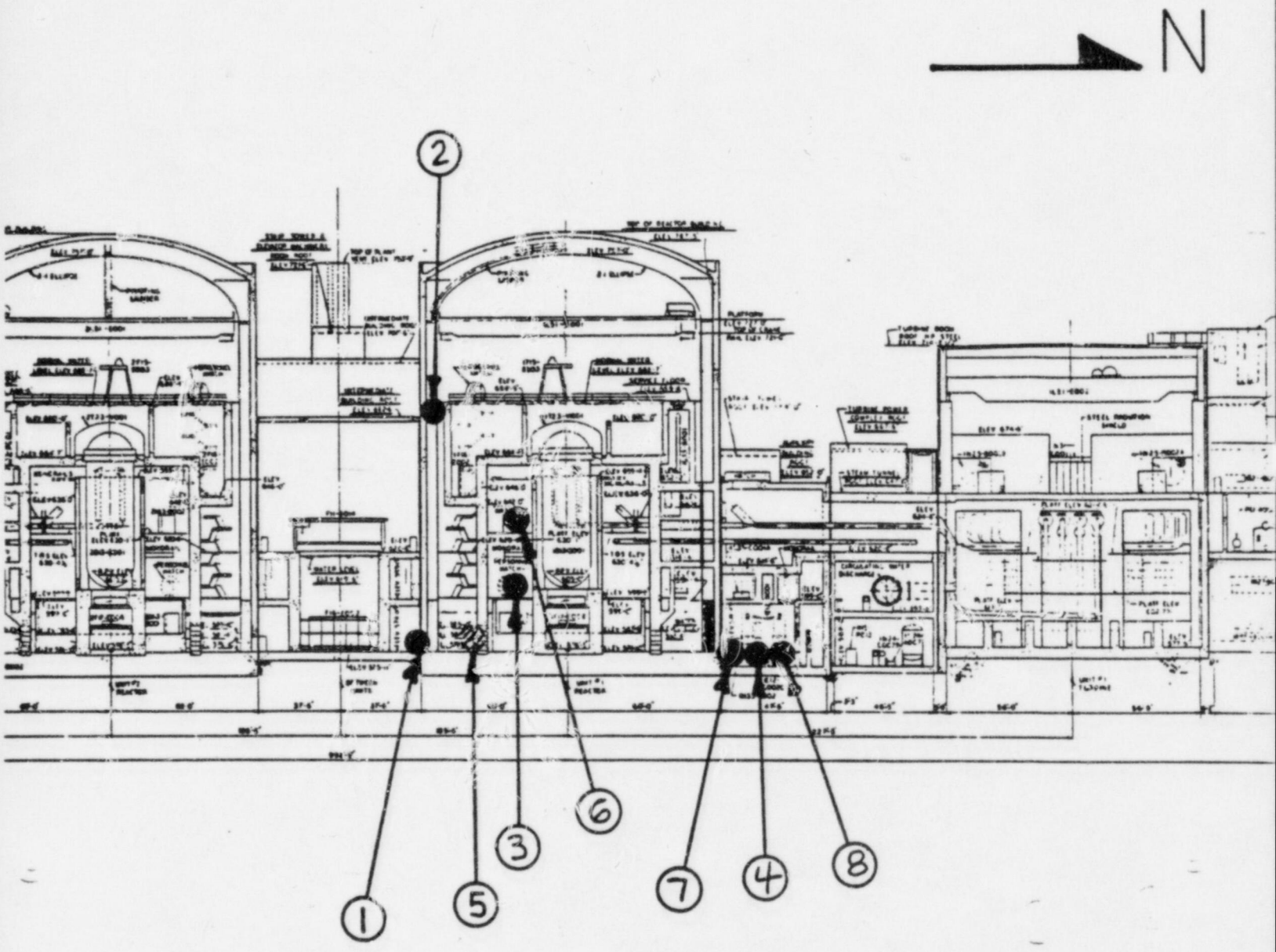


FIGURE 1. HORIZONTAL DESIGN RESPONSE SPECTRA – SCALED TO 1g HORIZONTAL GROUND ACCELERATION



KEY:

① Instrument #D51-N101
② Instrument #D51-N111
③ Instrument #D51-R120
④ Instrument #D51-R140
⑤ Instrument #D51-R160
⑥ Instrument #D51-R170
⑦ Instrument #D51-R180
⑧ Instrument #D51-R190 .



1. #D51-N101 R/B Foundation Mat, El. 575', Az. 175°
2. #D51-N111 R/B Containment Vessel, El. 686', Az. 174°
3. #D51-R120 Reactor Recirc Pump, El. 605', Az. 145°
4. #D51-R140 A/B Foundation Mat, El. 568'
5. #D51-R160 R/B Foundation Mat, El. 574' Az. 225°
6. #D51-R170 R/B Platform, El. 630' Az. 238°
7. #D51-R180 A/B Foundation Mat, El. 568'
8. #D51-R190 A/B Foundation Mat, El. 568'

PERRY NUCLEAR POWER PLANT UNIT NO. 1
SEISMIC MONITORING INSTRUMENTATION

TABLE IV

Instrument Number	Type	Manufacturer / Model Number	Location	References
D51-N101	(1)	Kinemetrics / SMA-3	Reactor Building Foundation Mat Elevation 575'–10" Azimuth 175°	Figures A and B
D51-N111	(1)	Kinemetrics / SMA-3	Reactor Building Containment Vessel Elevation 686'–0" Azimuth 174°	Figures A and C
D51-R120	(2)	Engdahl / PAR-400	Reactor Recirculation Pump (Inside Drywell, Reactor Building) Elevation 605'–0" (Approximately) Azimuth 145°	Figures A and D
D51-R130	(2)	Engdahl / PAR-400	OUT OF SERVICE	
D51-R140	(2)	Engdahl / PAR-400	Auxiliary Building Foundation Mat (HPCS Pump Room) Elevation 568'–4"	Figures A and E

1. Triaxial Time-History Accelerograph
2. Triaxial Peak Accelerograph
3. Triaxial Response Spectrum Recorder

PERRY NUCLEAR POWER PLANT UNIT NO. 1
SEISMIC MONITORING INSTRUMENTATION
TABLE IV

Instrument Number	Type	Manufacturer / Model Number	Location	References
D51-R160	(3)	Engdahl / PSR-1200-H / V-12A	Reactor Building Foundation Mat Elevation 574'–10" Azimuth 225°	Figures A and F
D51-R170	(3)	Engdahl / PSR-1200-H / V	Reactor Building 630' Platform (Inside Drywell) Elevation 630'–1" Azimuth 238°	Figures A and G
D51-R180	(3)	Engdahl / PSR-1200-H / V	Auxiliary Building Foundation Mat (HPCS Pump Room) Elevation 568'–4"	Figures A and H
D51-R190	(3)	Engdahl / PSR-1200-H / V	Auxiliary Building Foundation Mat (RCIC Pump Room) Elevation 568'–4"	Figures A and J

1. Triaxial Time-History Accelerograph
2. Triaxial Peak Accelerograph
3. Triaxial Response Spectrum Recorder

ZPA COMPARISON

- ZERO PERIOD ACCELERATION

- RECORDED ZPA'S VARY FROM BELOW OBE VALUES TO 74% OF SSE VALUES

  - EXCEPT AT CONTAINMENT VESSEL ELEVATION 686'

  - BUT RELATIVE DISPLACEMENTS AND STRESSES HERE (AS WELL AS ALL OTHER LOCATIONS) ARE LOW

~~Also~~ below OBE design value

REASON:

- HIGH FREQUENCY AND LOW ENERGY OF THE 1986 EARTHQUAKE

TABLE II

Comparison of Design ZPA's[1] VS Recorded ZPA's

(Expressed in g values)

		Auxiliary Building Foundation Mat Elevation 568' PAR 400 (Engdahl) D51-R140	Reactor Building Foundation Mat Elevation 574'–10" SMA–3 (Kinemetrics) D51-N101	Reactor Building Recirculation Pump Elevation 605" PAR 400 (Engdahl) D51-R120	Reactor Building Platform Elevation 630' Inside Drywell PSR 1200 (Engdahl) D51-R170	Reactor Building Containment Vessel Elevation 686' SMA–3 (Kinemetrics) D51-N111
NS	Recorded	.17	.18	.32	.09	.55
	SSE	.17	.18	1.06	.48	.40
	OBE	.10	.10	.86	.40	.24
EW	Recorded	.06	.10	.11	.16	18
	SSE	.20	.18	1.06	.48	.40
	OBE	.10	.10	.86	.40	.24
VERT.	Recorded	.03	.11	.05	Note 2	.30
	SSE	.20	.18	.47	.28	.24
	OBE	.10	.10	.38	16	.15
SRSS[3]	**Recorded**	**.18**	**.23**	**.34**	**Note 2**	**.65**
	SSE[4]	**.33**	**.31**	**1.57**	**.73**	**.62**
	OBE	**.17**	**.17**	**1.27**	**.59**	**.37**

1. Zero period acceleration
2. ZPA indeterminable from available data
3. Square-root-of-the-sum of the squares
4. Licensing basis is SSE

TABLE I

Comparison of Design Displacements[1] VS Recorded Displacements[1]

(Expressed in centimeters / one inch = 2.54 cm)

		COLUMN 1	COLUMN 2	COLUMN 2 minus COLUMN 1
		Reactor Building Foundation Mat Elevation 574'–10" SMA-3 (Kinemetrics) D51-N101	Reactor Building Containment Vessel Elevation 686' SMA-3 (kinemetrics) D51-N111	Relative Displacements for the Containment Vessel
NS	Recorded	0.09	0.17	0.08
	SSE	0.044	0.28	0.24
	OBE	0.023	0.17	0.15
EW	Recorded	0.16	0.21	0.05
	SSE	0.044	0.28	0.24
	OBE	0.023	0.17	0.15
VERT.	Recorded	0.05	0.07	0.02
	SSE	0.02	0.37	0.017
	OBE	0.013	0.022	0.009
SRSS[2]	**Recorded**	—	—	**0.1**
	SSE	—	—	**0.34**
	OBE	—	—	**0.21**

1. Displacements based on same time-step to determine relative displacements
2. Square-root-of-the-sum of the squares

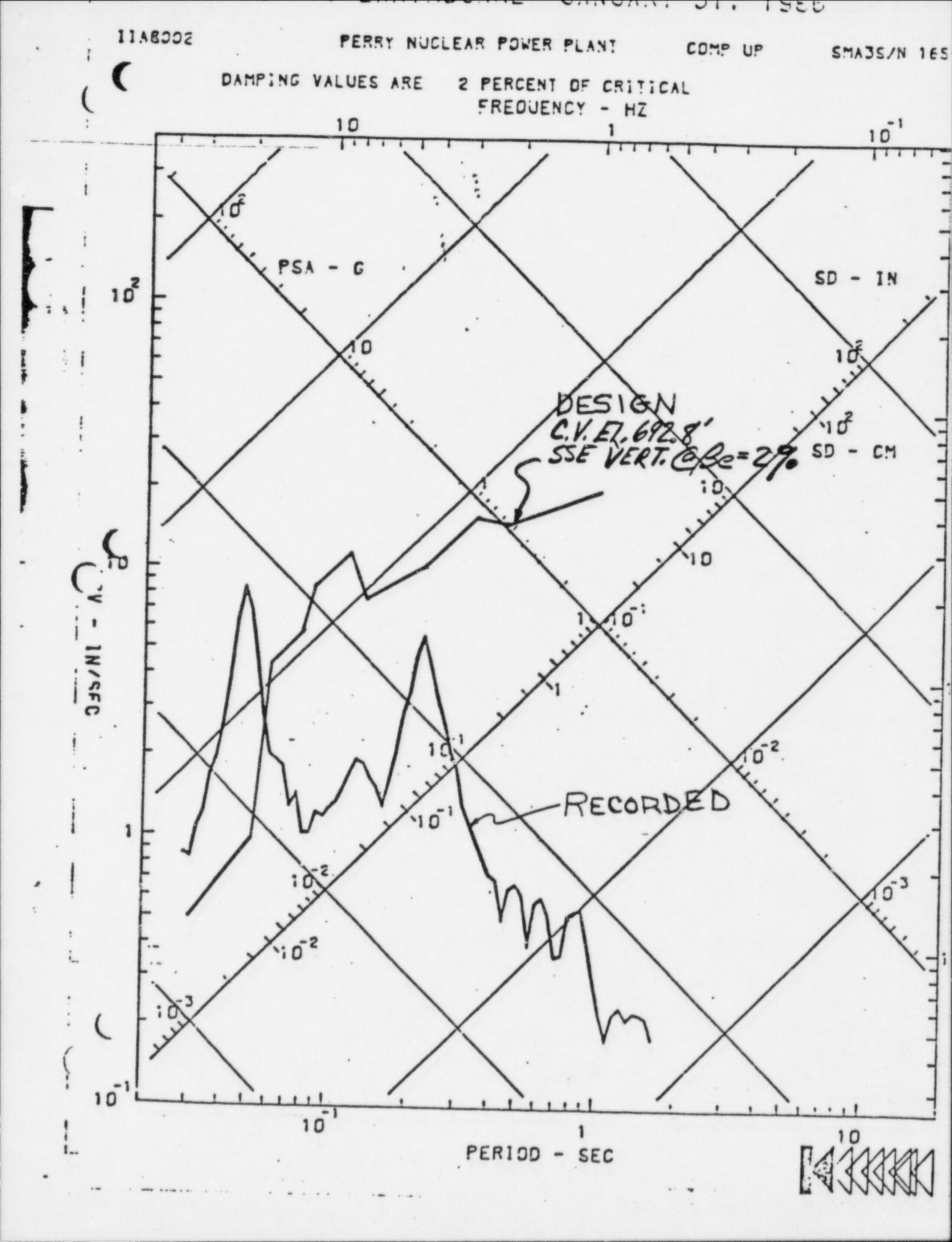
RESPONSE SPECTRA COMPARISON

- PERRY DESIGN RESPONSE SPECTRA ARE FAR ABOVE THE RECORDED SPECTRA IN THE FREQUENCY REGION BELOW 14 Hz.

- CERTAIN RECORDED RESPONSE SPECTRA EXCEED DESIGN SPECTRA VALUES IN THE REGION AROUND 20 Hz.
  - CORRESPONDING SMALL DISPLACEMENTS (EXAMPLE: 3/100 INCHES OR BELOW AT FOUNDATION MAT)
  - NO ENGINEERING SIGNIFICANCE

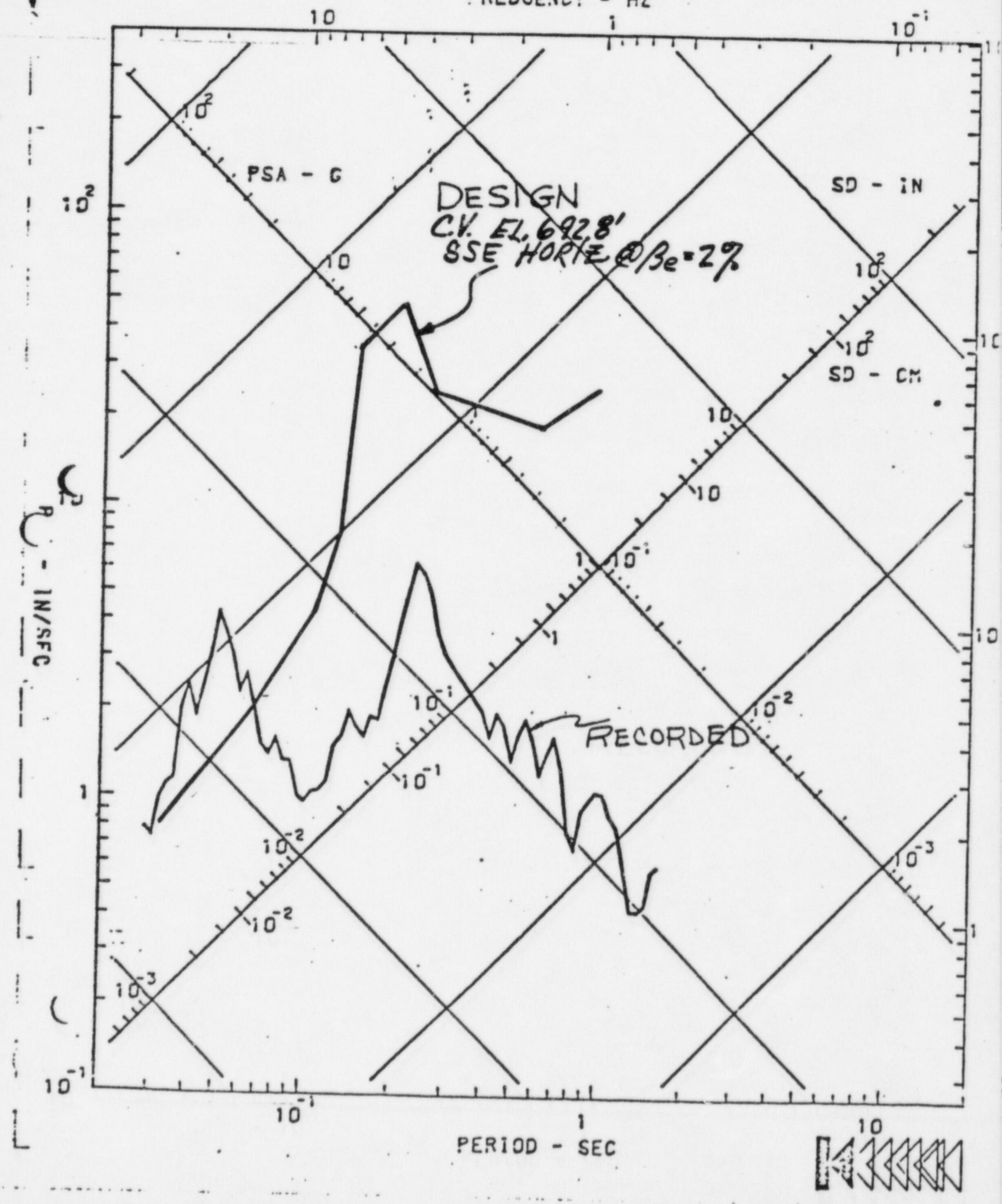
- RECORDED VELOCITY SPECTRA SHOW MUCH LESS ENERGY THAN THE DESIGN RESPONSE SPECTRA

DAMPING VALUES ARE 2 PERCENT OF CRITICAL



11AB002 PERRY NUCLEAR POWER PLANT COMP WEST SMA3S/N 165-2

DAMPING VALUES ARE 2 PERCENT OF CRITICAL

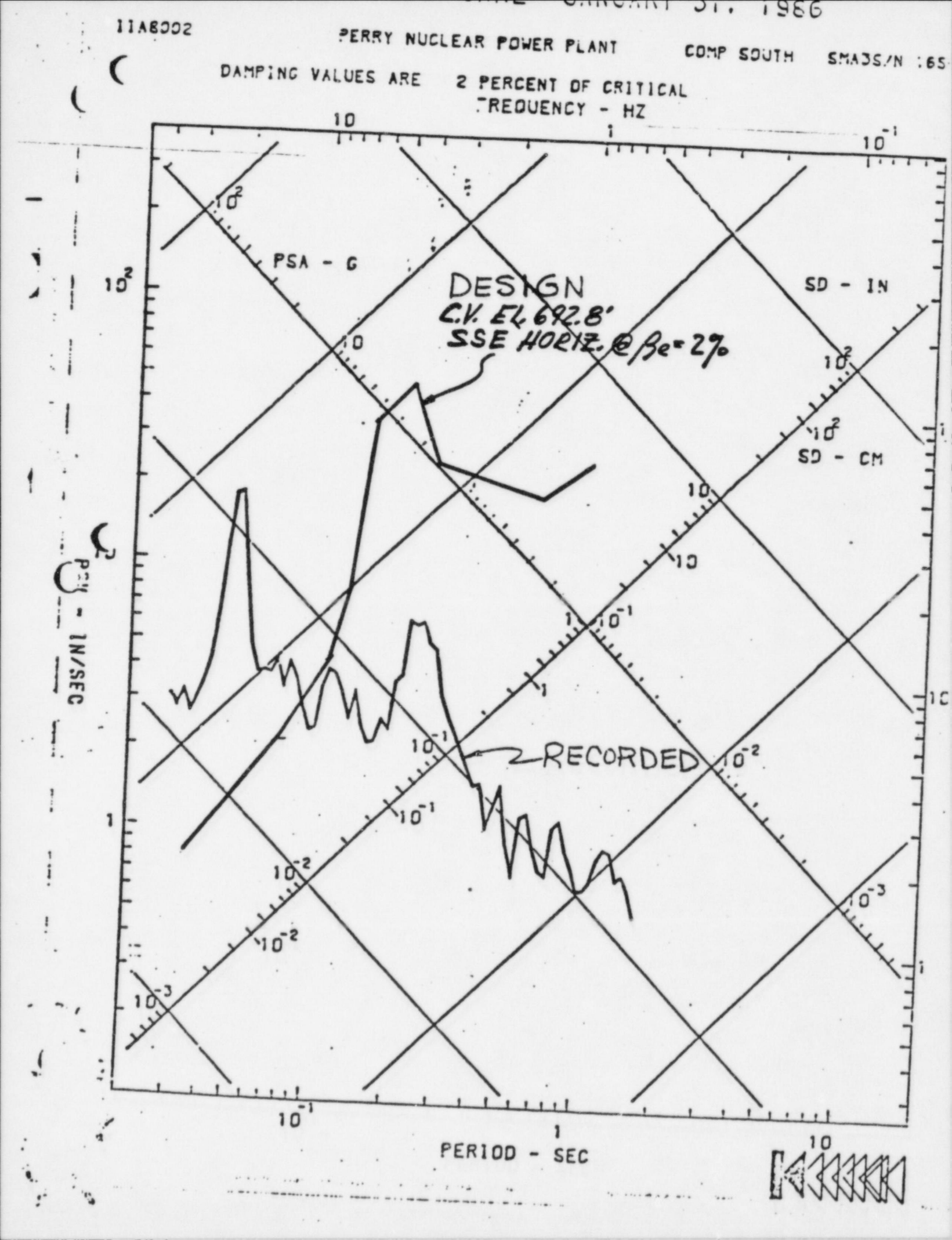


11AB002

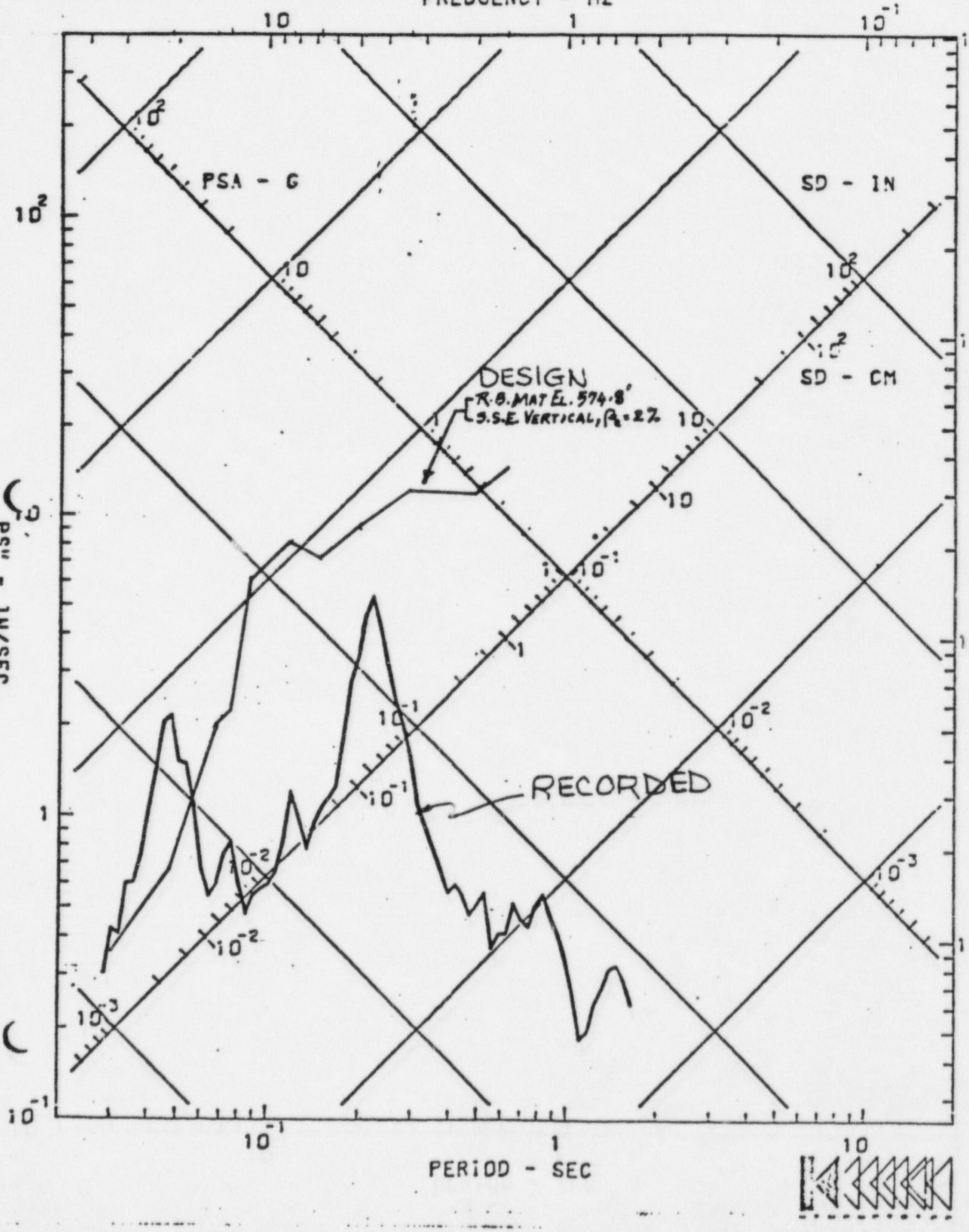
PERRY NUCLEAR POWER PLANT COMP SOUTH SMA3S/N :65

DAMPING VALUES ARE 2 PERCENT OF CRITICAL

FREQUENCY - HZ



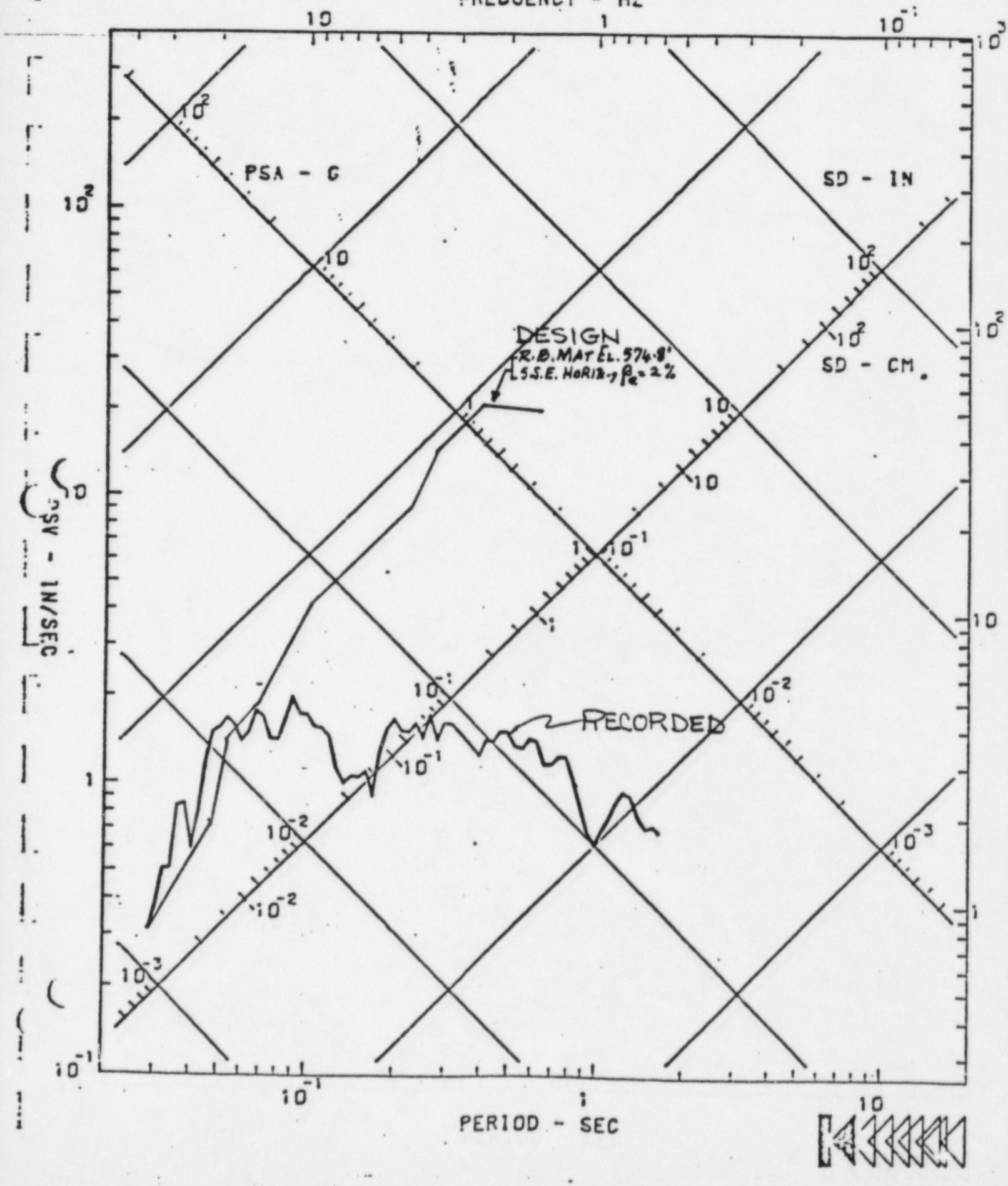
DAMPING VALUES ARE 2 PERCENT OF CRITICAL



ML 3.5 EARTHQUAKE JANUARY 31, 1986

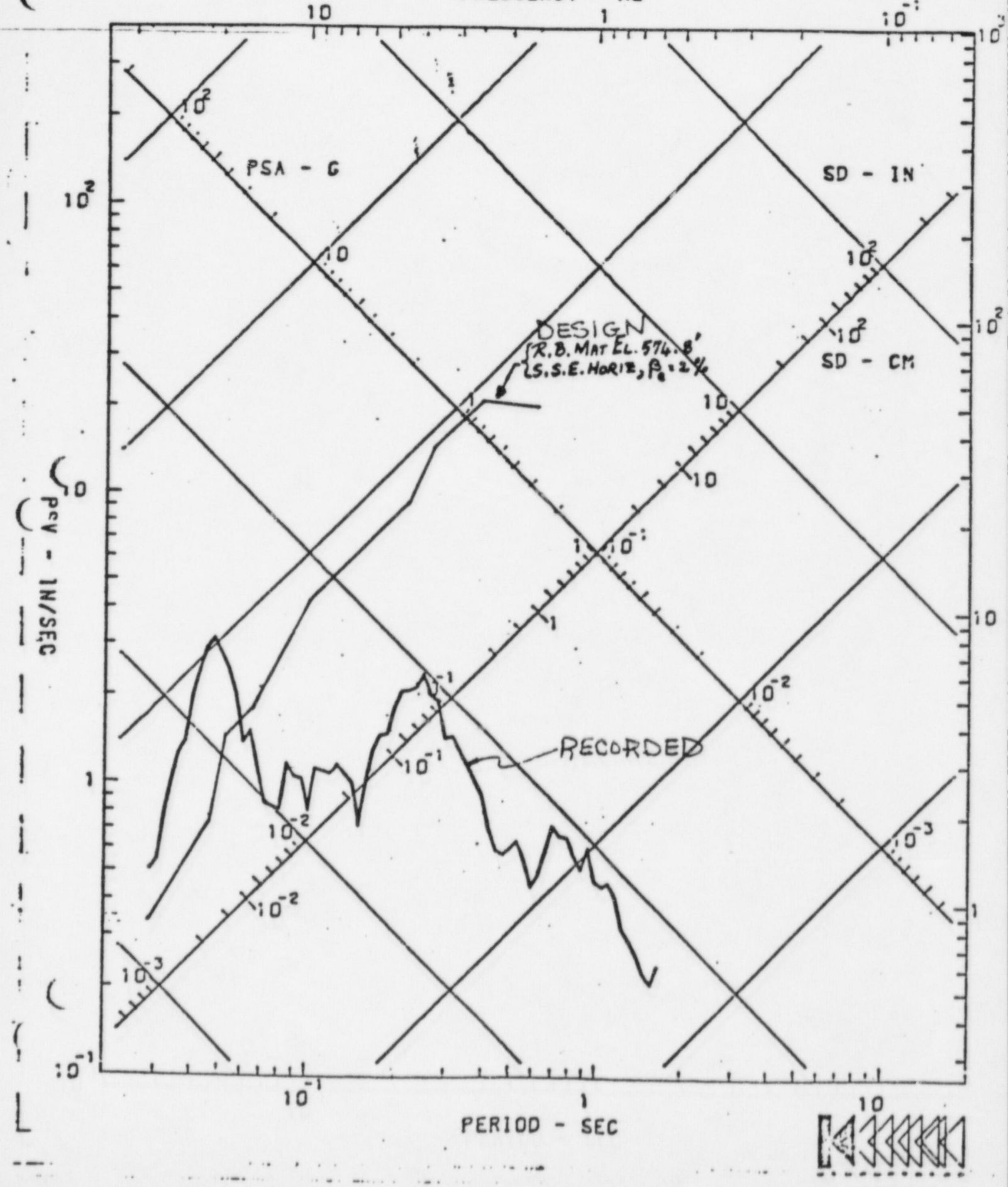
11A8001 PERRY NUCLEAR POWER PLANT COMP WEST SMA3S/N 165-1T

DAMPING VALUES ARE 2 PERCENT OF CRITICAL



11A8CD1 PERRY NUCLEAR POWER PLANT COMP SOUTH SMA3S/N 165-1L

DAMPING VALUES ARE 2 PERCENT OF CRITICAL



VERIFICATION OF THE LACK OF ENGINEERING SIGNIFICANCE OF THE 1986 OHIO EARTHQUAKE

- PROOF TEST - PLANT STRUCTURES UNAFFECTED
  - PLANT EQUIPMENT UNAFFECTED

- OTHER INDUSTRIAL CRITERIA CONFIRM THE CONCLUSIONS

  - PILE DRIVING OR BLASTING OPERATIONS - USE 1 INCH/SEC.PARTICLE VELOCITY AS THE NON-DAMAGE THRESHOLD FOR NON-ENGINEERED STRUCTURES

  - THE RECORDED MAXIMUM ACCELERATION AT THE PERRY FOUNDATION MAT IS ONLY 0.87 INCH /SEC.

  - IEEE 344 PROHIBITS QUALIFICATION BY SHOCK-TYPE TESTING (LOW ENERGY, HIGH FREQUENCY, SHORT DURATION)

Equip. Qual. considered impact of strong motion earthquake —

BUILT IN CONSERVATISMS OF PLANT DESIGN

- BROADENING AND ENVELOPING PROCESS OF FLOOR RESPONSE SPECTRA.

- EQUIPMENT QUALIFICATION BY GENERIC TESTS.

- STRAIN HARDENING NOT ACCOUNTED FOR AND STATIC ALLOWABLES USED FOR DYNAMIC LOADS.

- LOADING COMBINATIONS.

- PRIMARY STRESSES VS. SECONDARY STRESSES.

- DAMPING VALUES.

- RESPONSES OF EL CENTRO STEAM PLANT.

CONCLUSION

THE 1986 OHIO EARTHQUAKE:

- HIGH FREQUENCIES
- SHORT DURATION
- LOW ENERGY
- LOW VELOCITY
- SMALL DISPLACEMENT

No NEED to compare with Hydrodynamic loads because of the insignificant frequency comparing recorded vs design response spectra —

G.A. in process of quantifying equipment response —

margin quantification work. when to be completed?

SUMMARY AND CONCLUSIONS

- o PROOF TEST OF SEISMIC DESIGN
  - JANUARY 31, 1986 EARTHQUAKE - INTENSITY VI, 4.96 RICHTER
  - PLANT STRUCTURES AND SYSTEMS UNAFFECTED BY EARTHQUAKE
- o NO CHANGE TO CONCLUSIONS ON GEOLOGY AND SEISMOLOGY
  - DESIGN EARTHQUAKE BOUNDS JANUARY 1986 EVENT (MAGNITUDE, ENERGY ETC.)
  - INCLUSION OF RECENT EVENT WOULD NOT CHANGE DESIGN SPECTRUM
- o PLANT SEISMIC CAPABILITY ABLE TO ACCOMODATE JANUARY EARTHQUAKE
  - SHORT DURATION, HIGH FREQUENCY, LOW ENERGY LOW VELOCITY, SMALL DISPLACEMENT
  - MEASURED RESPONSE EXCEEDANCES OF NO ENGINEERING SIGNIFICANCE
- o FOLLOW ON ACTIVITIES
  - CONFIRMATORY PROGRAMS
  - SUPPORT OF GENERIC, INDUSTRY STUDIES
    - SOG, SQUG, EPRI

cc: H. Denton
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KINEMETRICS

682' Containment
North - South

ML 5.0 EARTHQUAKE JANUARY 31, 1985

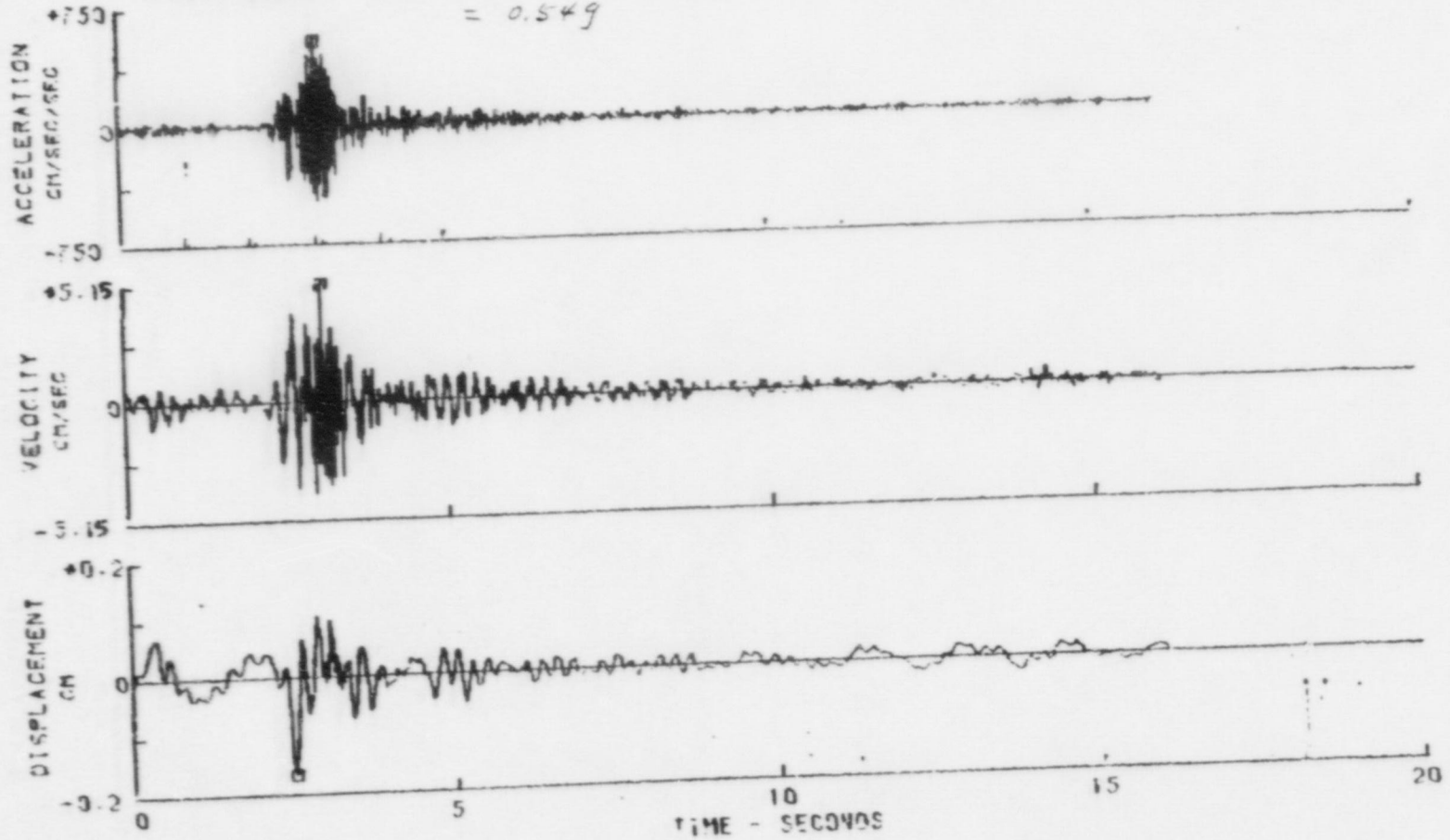
PERRY NUCLEAR POWER PLANT COMP SOUTH SMA3S/N 165-2L

1TA9002

ACCELEROGRAM IS BAND-PASS FILTERED BETWEEN 0.400- 0.625 AND 35.00- 40.00 HERTZ

PEAK VALUES: ACCEL= +535.17 CM/SEC/SEC VEL= +5.15 CM/SEC DISPL=0.17 CM

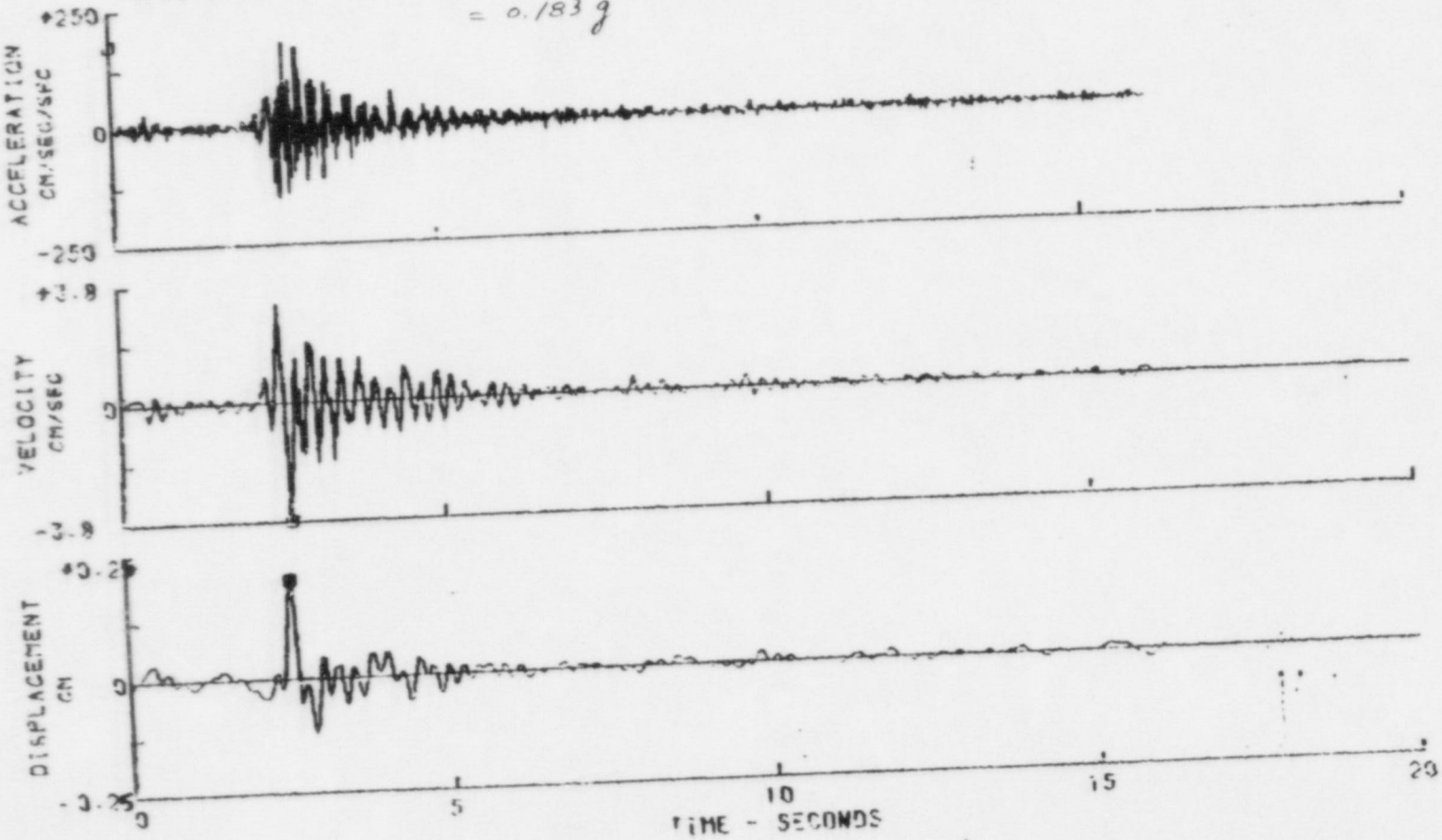
= 0.54g



KINEMETRICS

682' Containment
East - West

ML 5.0 EARTHQUAKE JANUARY 31, 1985
PERRY NUCLEAR POWER PLANT COMP WEST SMA33'N 165-2'
1TA8002 35.00- 40.00 HERTZ
ACCELEROGRAM IS BAND-PASS FILTERED BETWEEN 0.400- 0.625 AND
PEAK VALUES: ACCEL= +179.35 CM/SEC/SEC VEL= -3.77 CM/SEC DISPL= +.21 CM
= 0.183 g



KINEMETRICS

682' Containment
Vertical

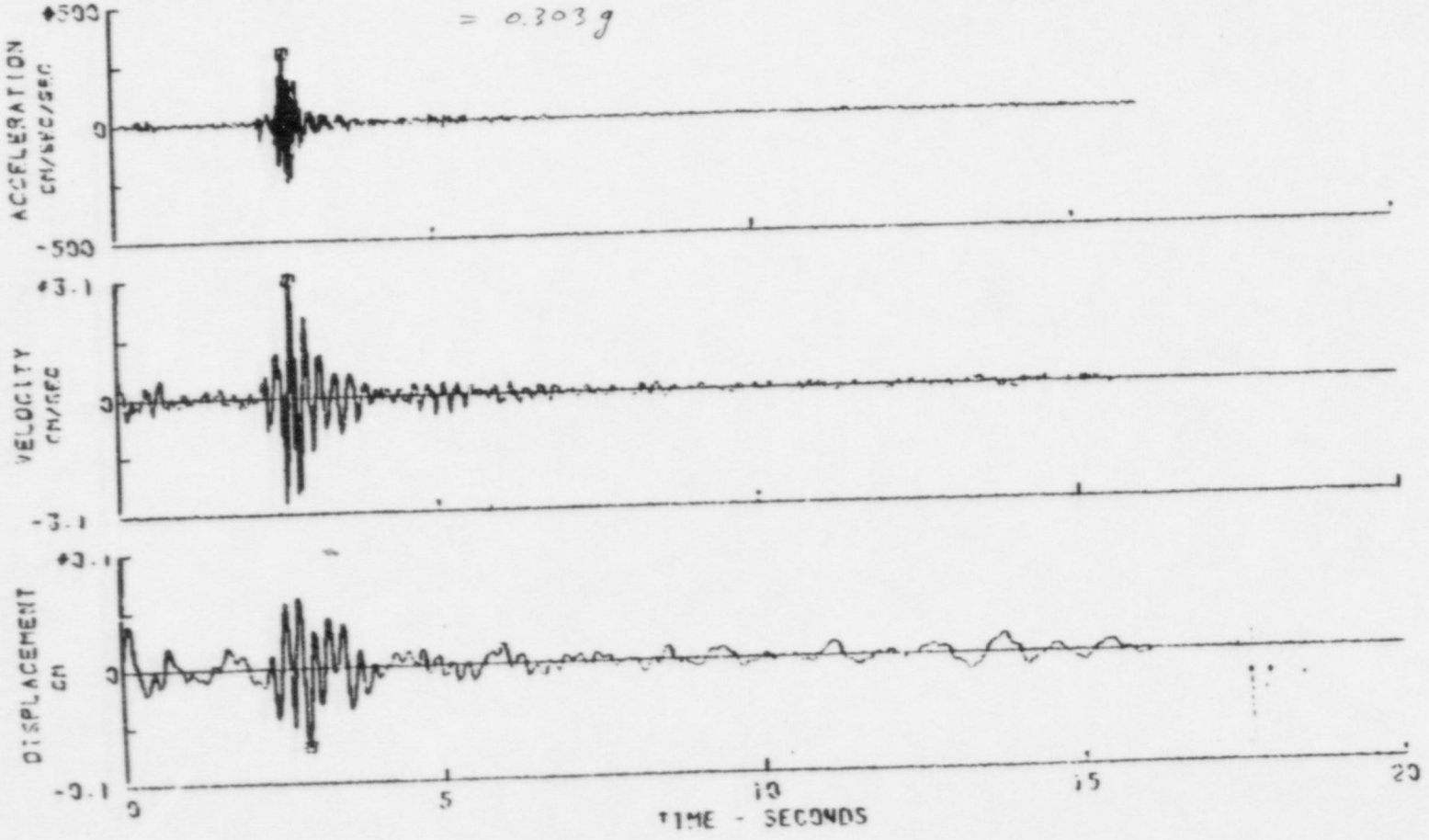
ML 5.0 EARTHQUAKE JANUARY 31, 1986

I1A9002 PERRY NUCLEAR POWER PLANT COMP UP SMA3S/N 165-27

ACCELEROGRAM IS BAND-PASS FILTERED BETWEEN 0.400- 0.625 AND 35.00- 40.00 HERTZ

PEAK VALUES: ACCEL= ±297.21 CM/SEC/SEC VEL= ±3.09 CM/SEC DISPL=0.37 CM

= 0.303 g

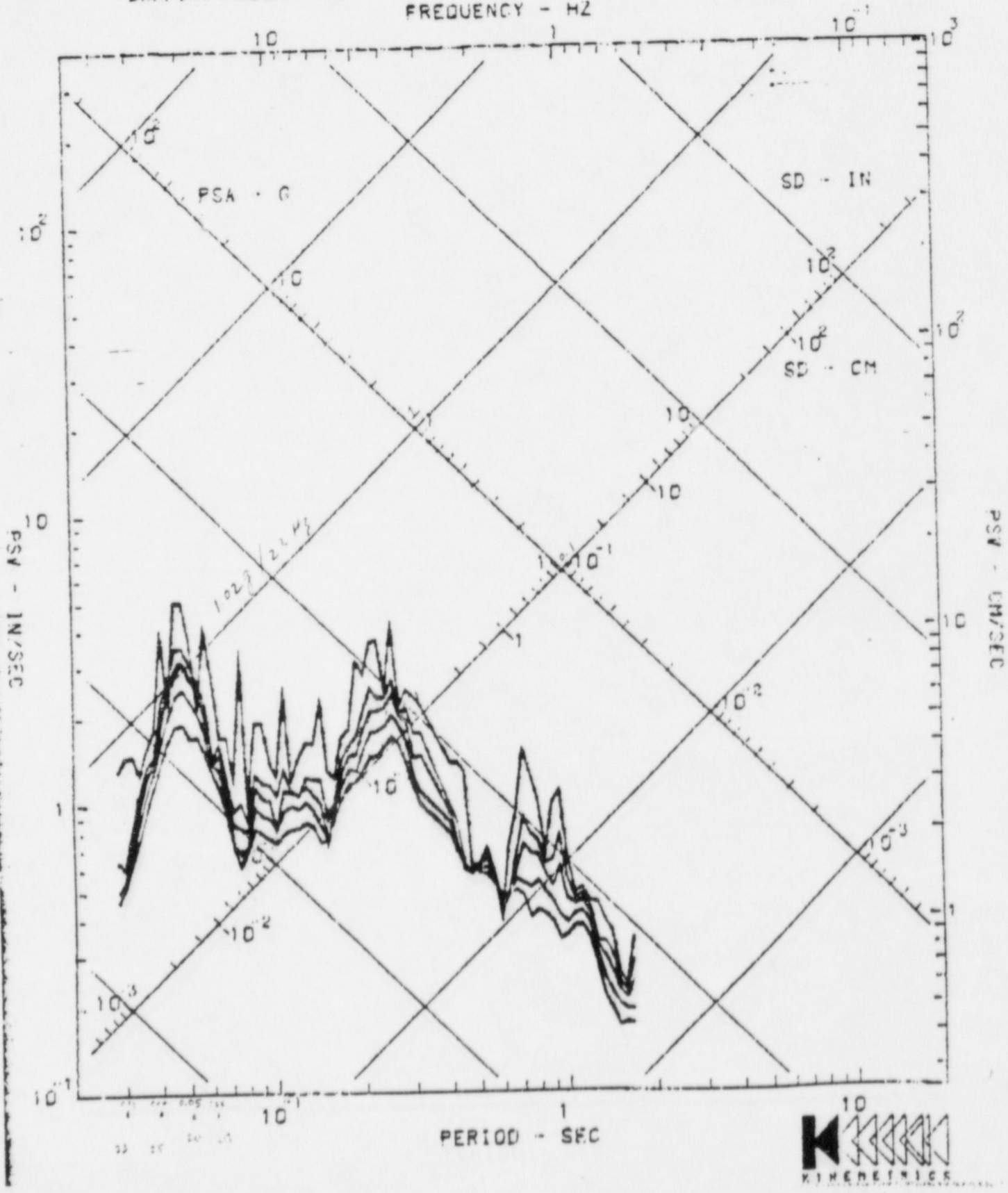


ML 5.0 EARTHQUAKE JANUARY 31, 1986

NORTH-SOUTH 575

PERRY NUCLEAR POWER PLANT COMP SOUTH SMA3S/N 165-1L

DAMPING VALUES ARE 0. 1. 2. 4. 7 PERCENT OF CRITICAL

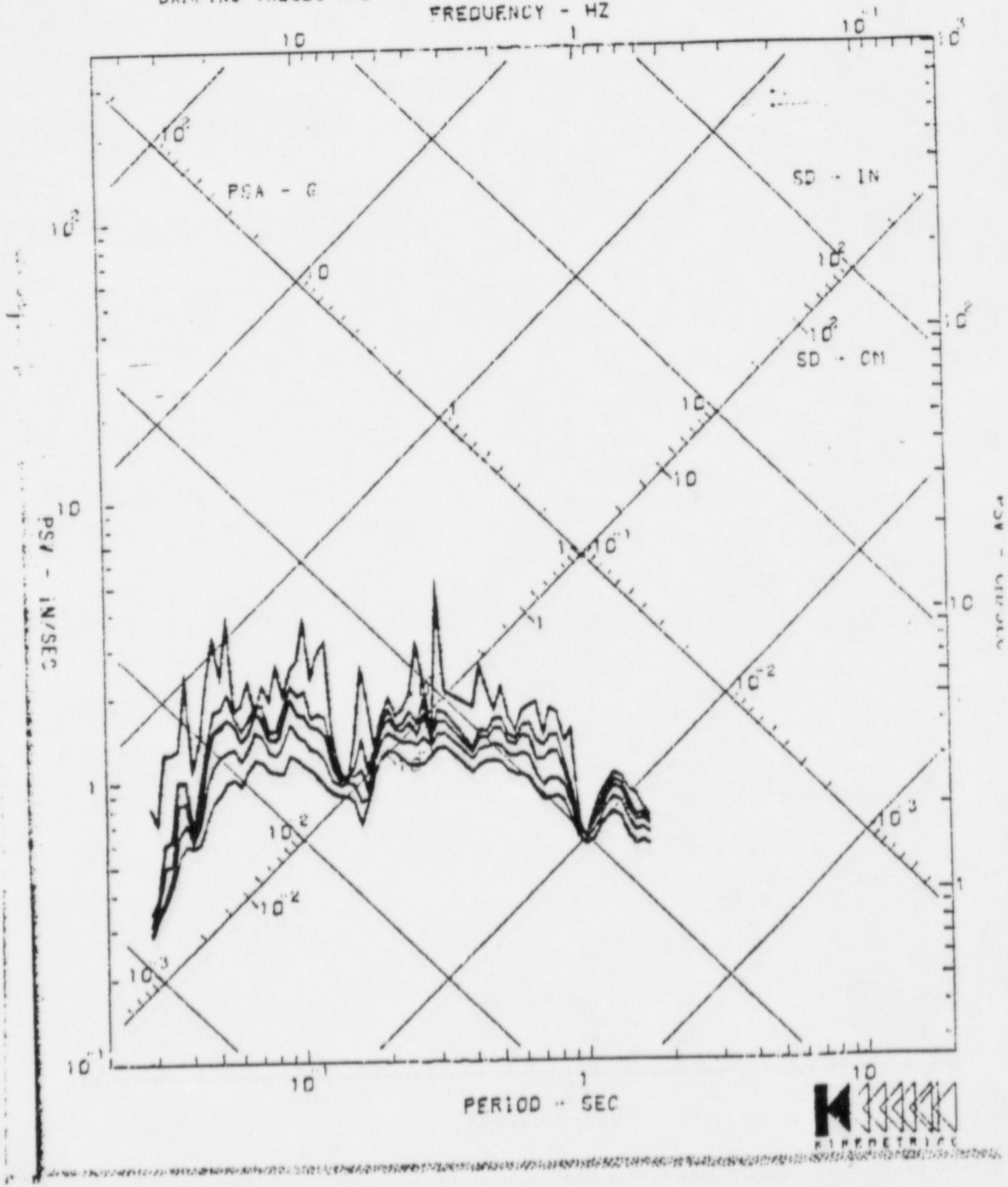


KINEMETRICS

ML 5.0 EARTHQUAKE JANUARY 31, 1986 EAST-WEST 57S

PERRY NUCLEAR POWER PLANT COMP WEST SMA3S/N 165-17

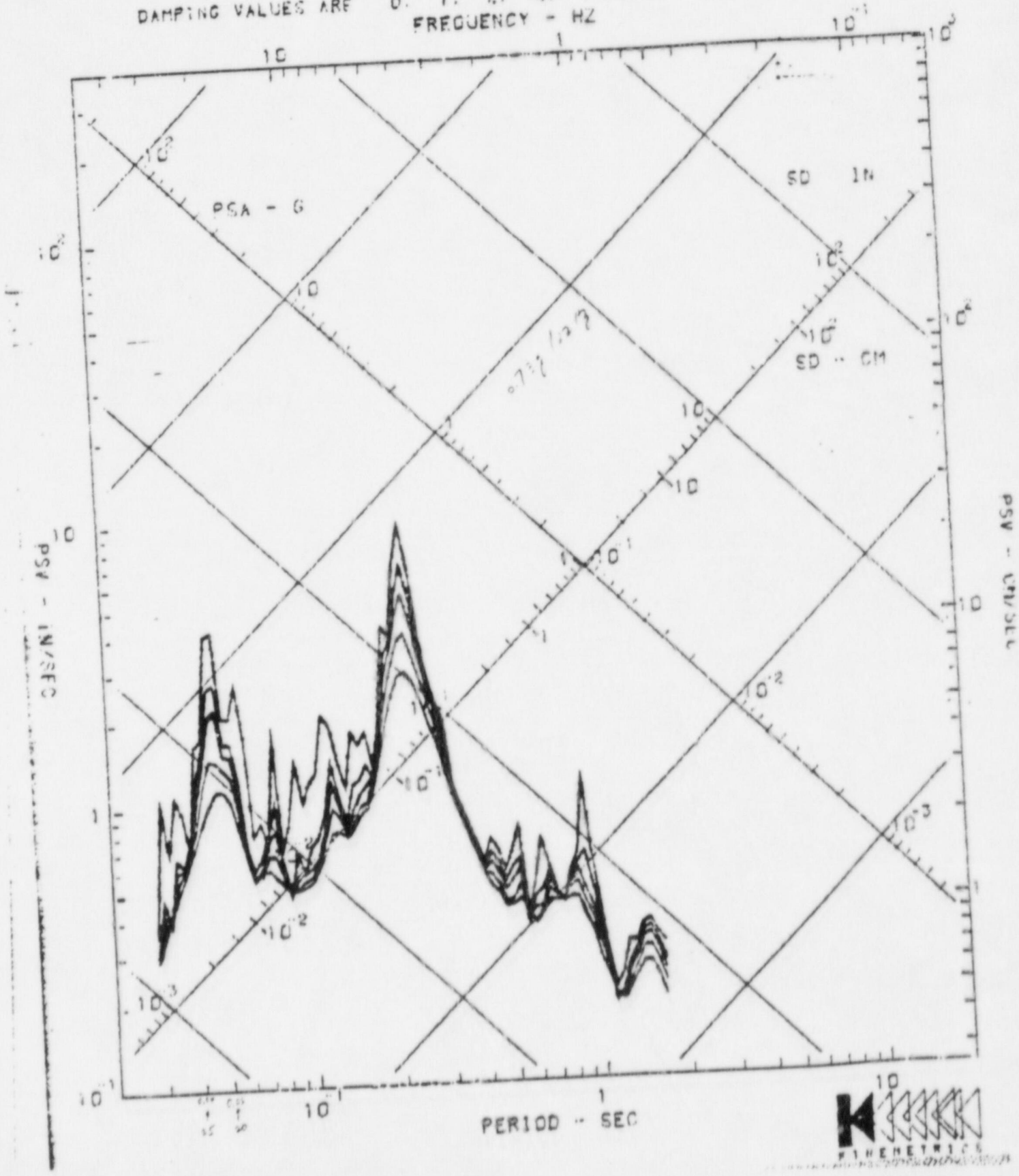
DAMPING VALUES ARE 0, 1, 2, 4, 7 PERCENT OF CRITICAL



ML 5.0 EARTHQUAKE JANUARY 31, 1986 VERT. 575'

PERRY NUCLEAR POWER PLANT COMP UP SMA3S/N 165-IV

DAMPING VALUES ARE 0. 1. 2. 4. 7 PERCENT OF CRITICAL



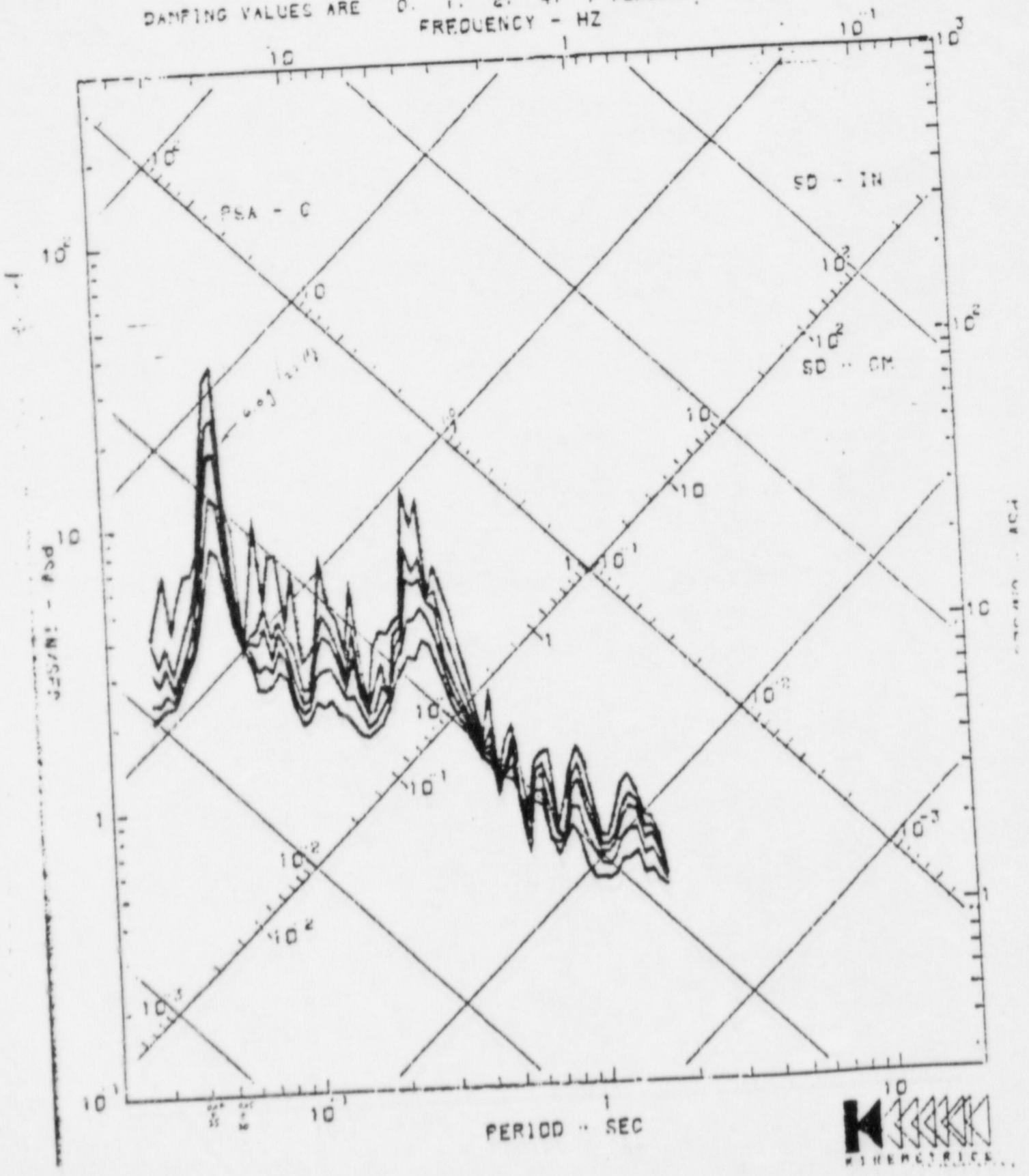
KINEMETRICS

ML 5.0 EARTHQUAKE JANUARY 31, 1986 NORTH-SOUTH 682'

PERRY NUCLEAR POWER PLANT COMP SOUTH SMA3S/N 105-2L

11AR002

DAMPING VALUES ARE 0, 1, 2, 4, 7 PERCENT OF CRITICAL



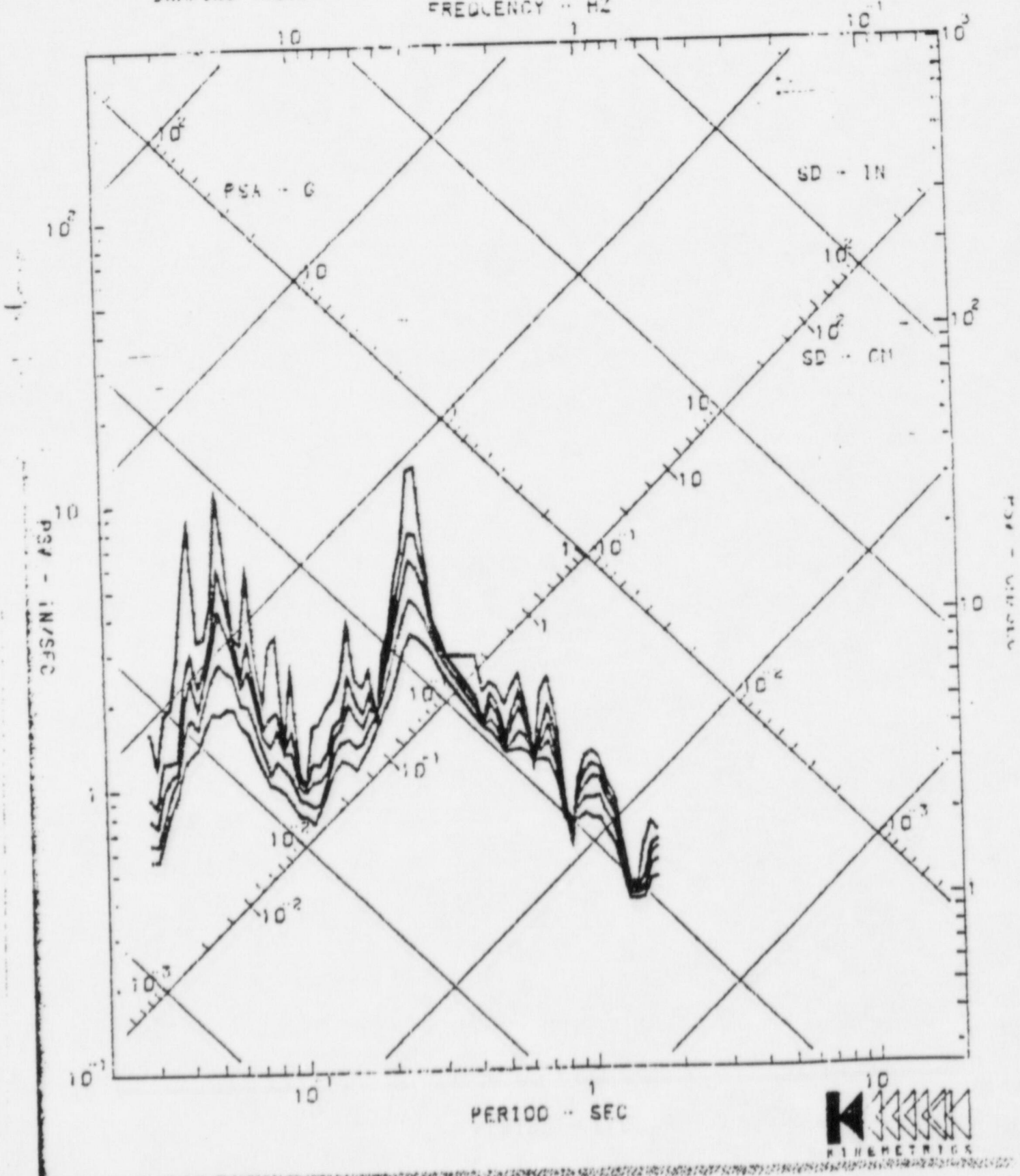
ML 5.0 EARTHQUAKE JANUARY 31, 1986

EAST-WEST 682'

TIAROCK

PERRY NUCLEAR POWER PLANT COMP WEST SMA35/N 165-27

DAMPING VALUES ARE 0, 1, 2, 4, 7 PERCENT OF CRITICAL



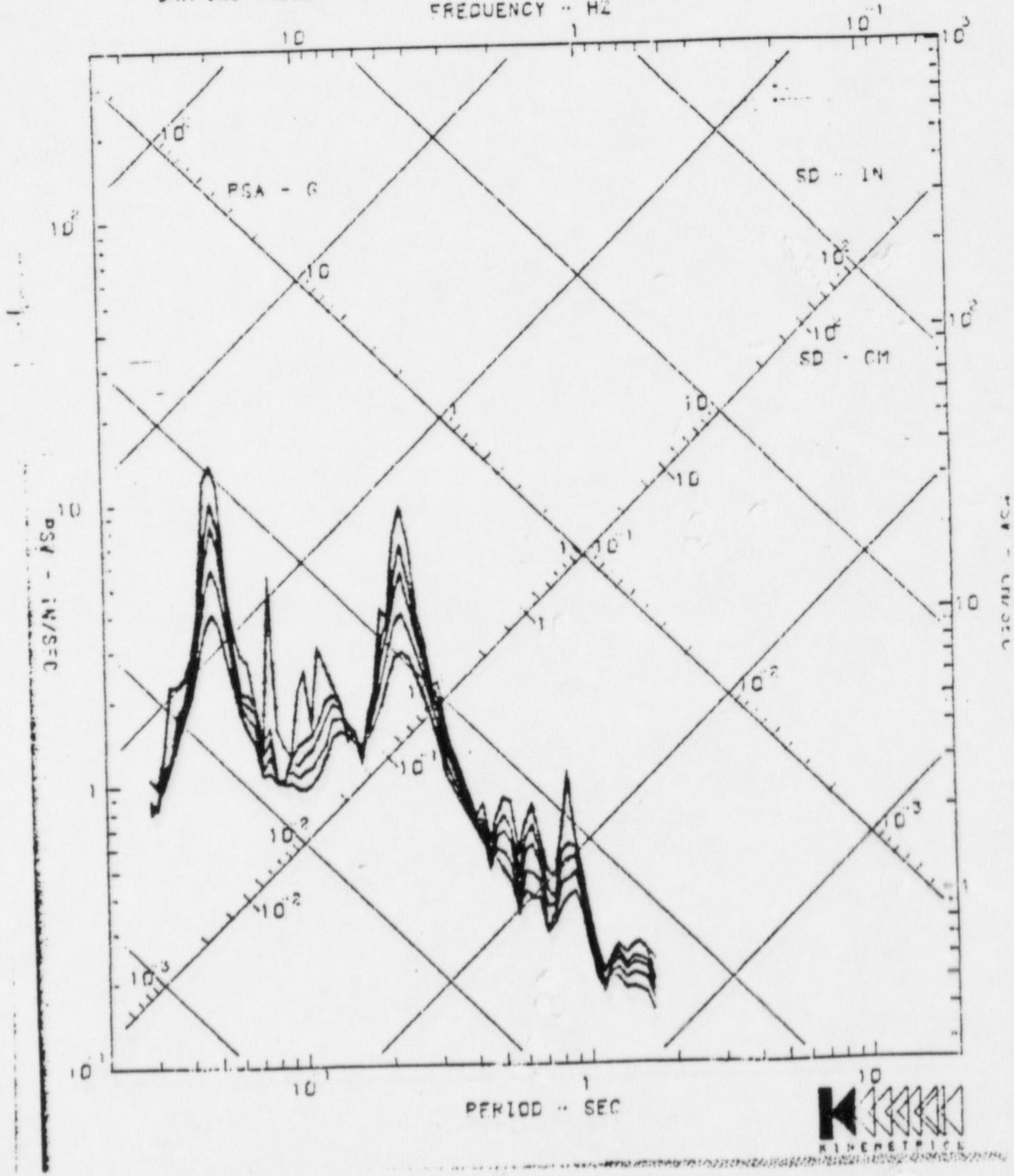
KINEMETRICS

ML 5.0 EARTHQUAKE JANUARY 31, 1986

VERT. 682

PERRY NUCLEAR POWER PLANT COMP UP SMA-1/N 165-2V

DAMPING VALUES ARE 0. 1. 2. 4. 7 PERCENT OF CRITICAL



KINEMETRICS

ENCLOSURE 6

2/2/86 Walk-down grade level: 626'

①

T. Y. Chang

① Air compressor for instrumentation tripped.

Make: Worthington Centrifugal Compressor
Type: CAP-15
Serial No. T96714
Location: Control Complex
Elevation: 574'

There are 1 instrumentation compressor & 1 [illegible] compressor for each unit. All 4 are connected to a common header. Anyone will provide enough compressed air for both units.

[illegible] set pt 16 mil) & vibration monitor (set [illegible] mil) are to measure shaft deflection, but both were not [illegible] by the earthquake. The applicant believed that however the earthquake caused the trip

* Bently Nevada Corp Model 5075-14

② Main turbine generator breaker tripped because of trip of No 86 relay (Turbine generator protection)

86 Relay ← Both on "generator relay panel" → 40-1 relay ([illegible] of excitation relay)

Type GE HEA lockout relay (toggle type)
Location: [illegible]
Elevation: 654'
Safety Related: no

Make/Type GE Model [illegible]
No. 40-1 [illegible]
Impedance type [illegible] current voltage [illegible]
Location: Control room
Elevation 654', Safety Related no

No 86 relay (lockout relay) tripped because of trip of No. 40-1 relay. At the time of earthquake, the turbine generator was not operating. There was no voltage on 40-1 since turbine was not working, and the disk was flopping there when earthquake came and caused the trip. Applicant said that had the generator been working, the relay probably would not have tripped. The trip is anticipated in view of the fact that the generator was not working

(3) Auxiliary Boiler tripped —

make: Burn Corp. Shut off valve (Maxon) shut.

Location: Aux boiler room

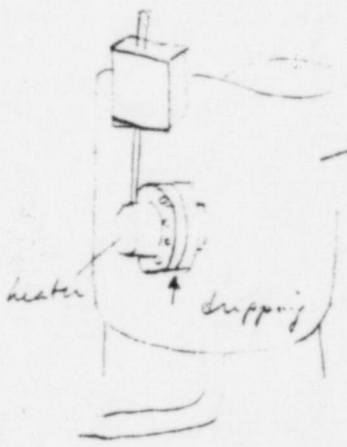
Elevation: 620'

This aux boiler tripped because of trip of No. 86 relay. (Tripped during transfer from aux. transformer to main transformer — by design)

(4) • Hot water heater pipe flange leaked.

Location: Rad Waste Bldg

Elev. 623' — see attached floor plan



This heater provides clean steam to evaporator. No. nothing to do with radiation waste

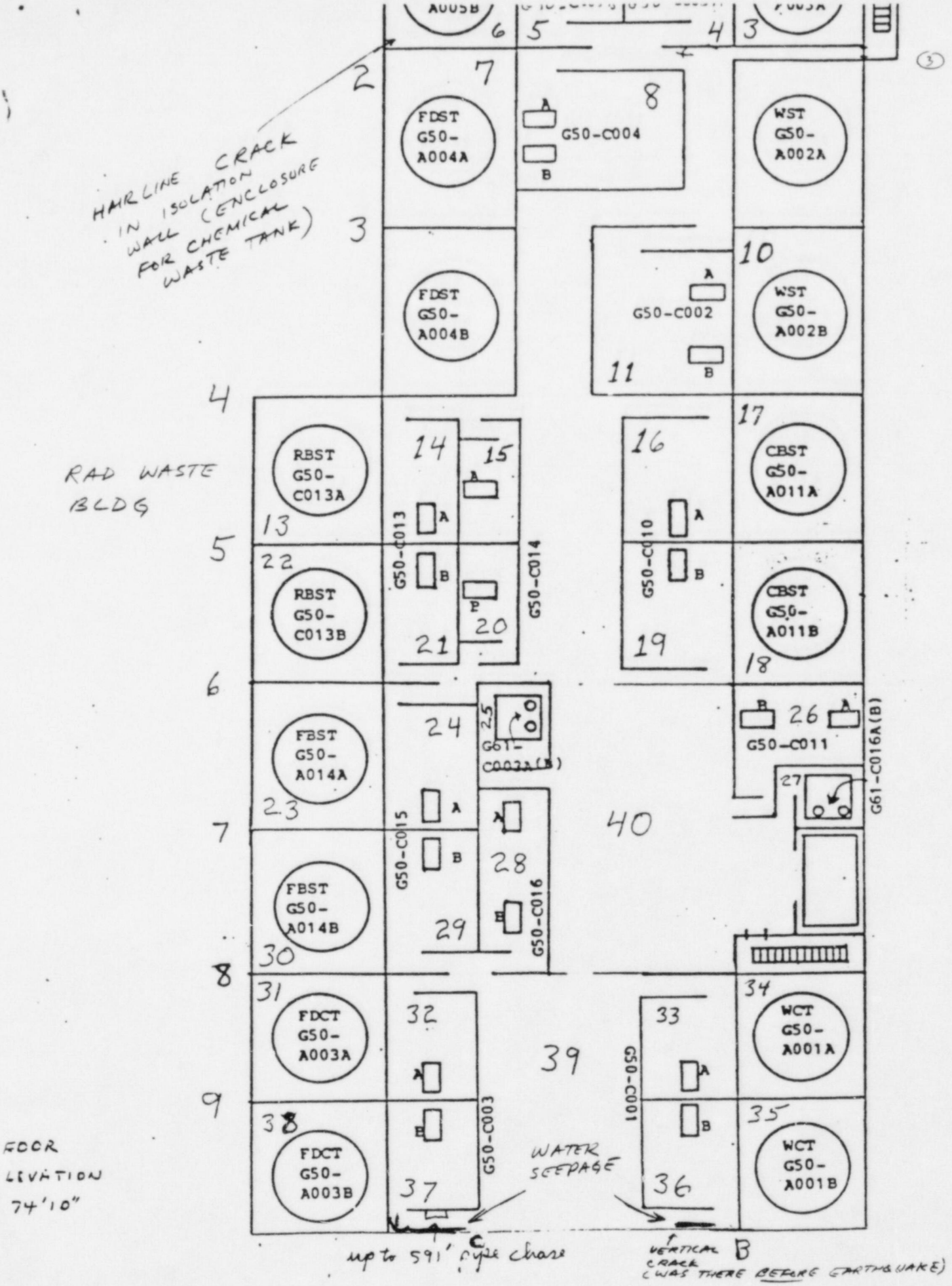
2 vertical, 1 diagonal

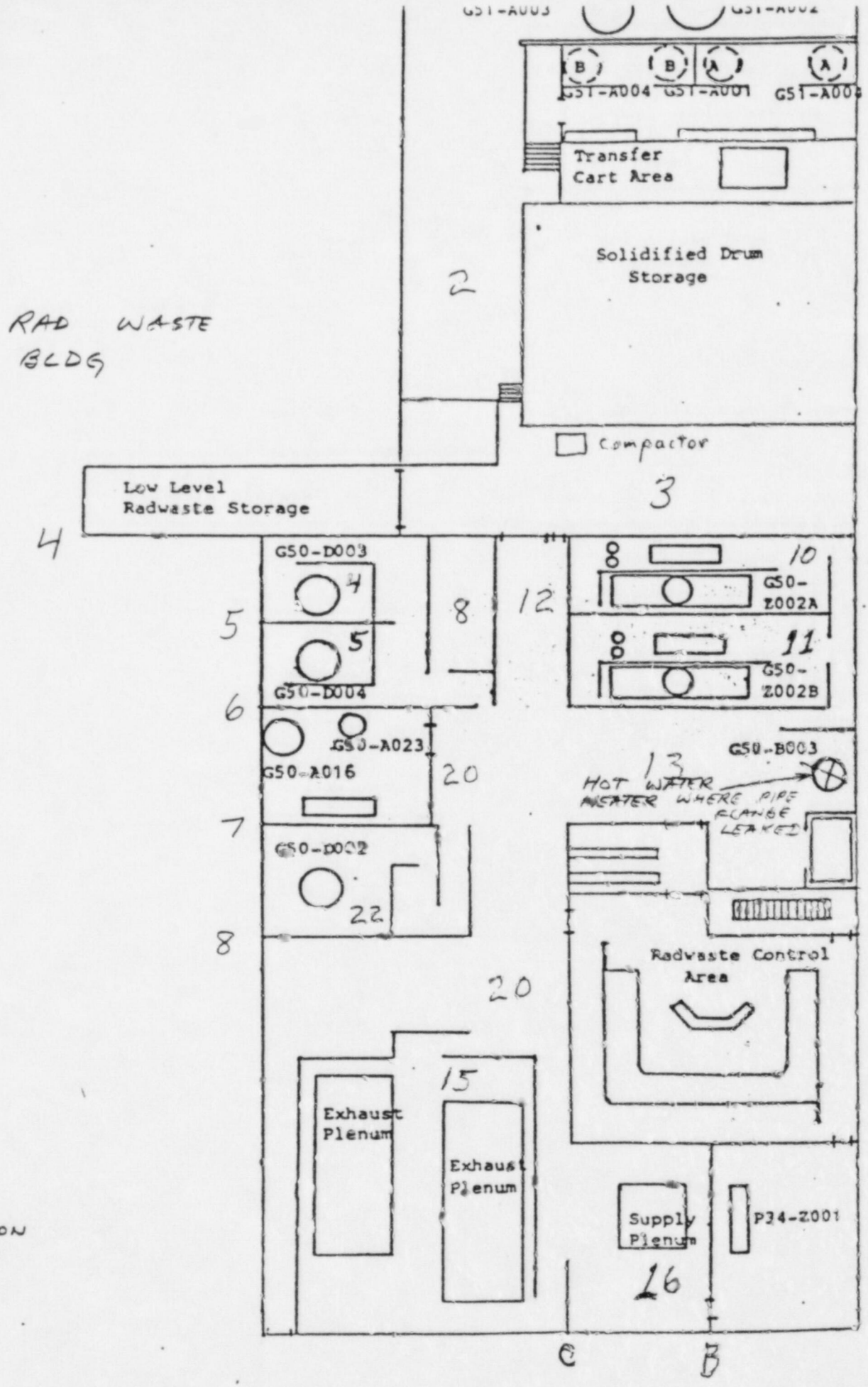
→ hairline cracks (don't know whether in there before earthquake)

- Wall crack for enclosure of chemical waste tank (2' reinforced concrete wall) — see attached sheet for location
- wall crack in aux. bldg.
- seepage through Rad Waste room wall. (~~ground~~ from Hable water)

(5) Suppression pool level indicator

right after earthquake, water level rose 1" → 1½", measured at 4 places. P-11 valve leakage. Water level now 1' → 1½' on ~~Sun~~ Saturday night. Still looking into this (recirculation?)


HAIR LINE CRACK IN ISOLATION WALL (ENCLOSURE FOR CHEMICAL WASTE TANK)
RAD WASTE BLDG
FLOOR ELEVATION 74'10"
FDST G50-A004A
FDST G50-A004B
G50-C004
WST G50-A002A
WST G50-A002B
G50-C002
RBST G50-C013A
RBST G50-C013B
G50-C013
G50-C014
G50-C010
CBST G50-A011A
CBST G50-A011B
FBST G50-A014A
FBST G50-A014B
G50-C015
G50-C016
G61-C003A(B)
G50-C011
G61-C016A(B)
FDCT G50-A003A
FDCT G50-A003B
G50-C003
G50-C001
WCT G50-A001A
WCT G50-A001B
WATER SEEPAGE
up to 591' pipe chase
VERTICAL CRACK (WAS THERE BEFORE EARTHQUAKE)



FLOOR ELEVATION 622'6"

John Stefano

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

FEB 25 1986

MEMORANDUM FOR: Robert J. Bosnak, Chief
Engineering Issues Branch
DSRO, NRR

Frank J. Congel, Chief
Reliability and Risk Assessment Branch
DSRO, NRR

FROM: T. Y. Chang, Task Manager
Leon Reiter, Sr. Reliability and Risk Analyst
DSRO, NRR

SUBJECT: REPORT OF QUICK RESPONSE TRIP TO OBSERVE EFFECTS OF THE NORTHERN OHIO EARTHQUAKE ON THE PERRY NUCLEAR POWER PLANT

Background

An earthquake occurred at 11:48 a.m. on January 31, 1986 near the Perry Nuclear Power Plant in Northern Ohio. Preliminary information from USGS indicated that the earthquake had a body-wave magnitude (m_b) of 5.0, and the epicenter is located approximately 12 miles south of the Perry site.

The Perry Plant is a General Electric BWR-6 with a Mark III containment. It is not yet licensed. Nuclear fuel is on site but has not been loaded into the reactor core. The owner of the plant is Cleveland Electric and Illuminating Company (CEI). The utility was performing pre-operational tests and according to CEI, most of the safety related systems were running when the earthquake occurred. Although Perry is not an operating plant and is not required to do so, CEI immediately activated the emergency plan in order to assess facility damage and personnel injuries. No injuries occurred. In addition, NRC and other relevant federal and local agencies were notified of this event. The plant was switched to the recovery mode in the afternoon of January 31, 1986. The recovery organization is shown in enclosure 1. A detailed walkdown inspection involving about 40, and at times 65, people was conducted for the whole plant, which covered buildings, equipment, instrumentation, piping systems, etc. Only minor damage was found (see preliminary findings below). The inspection was completed at 2:00 a.m. on February 1, 1986.

An Augmented Inspection Team (AIT) from NRC Region III and staff from NRR were sent to the Perry site on the morning of February 1. The team from NRR consisted of John Stefano (Perry Project Manager), Leon Reiter and T. Y. Chang (both from DSRO). They left Perry on the evening of February 2. The Region III group was led by Carl Paperiello (Director of the Region III Reactor Safety Division). The NRC team held several meetings with the CEI engineering and licensing staff, the Architect/Engineer (Gilbert Associates), CEI consultants (Weston Geophysical) and suppliers of the seismic monitoring instrumentation (Kinemetrics, and Engdahl Enterprises). A list of meeting

8603040441 26pp

A/62

attendees is attached as enclosure 2. The NRC team members reviewed preliminary seismic recordings and conducted a walk-through inspection of buildings and equipment.

PRELIMINARY FINDINGS

1. Seismic Records:

The plant had nine sets of seismic monitoring instrumentation on the site when the earthquake occurred. All but one were operating and recorded the earthquake. They are of three different types: triaxial time-history accelerographs (made by Kinemetrics), triaxial peak response spectra recorders, and triaxial peak accelerographs (both made by Engdahl Enterprises). A list of these instruments and their locations is attached as enclosure 3.

There were some difficulties in interpreting data obtained from the Engdahl peak response recorder. Each of these instruments has 12 tuned reeds, each tipped with a diamond stylus which makes scratches on a recording plate. Some of these instruments are wired to annunciators in the control room. Each annunciator has one set of 12 amber lights and one set of 12 red lights, with each set of lights marked with the corresponding 12 tuned reed frequencies. These amber lights and red lights are pre-set to be activated at FSAR values of 2/3 OBE spectral accelerations and full OBE spectral accelerations respectively for the corresponding tuned reeds. The recording plates have been in these instruments for about a year, and spurious annunications have occurred previously when there were no earthquakes. Paul Engdahl, President of Engdahl Enterprises, was present at Perry during the visit and helped interpret the data obtained from the scratched plates. Enclosure 4 shows the preliminary data from the Engdahl instruments in the reactor building and the auxiliary building as plotted on the FSAR spectra. The 2% damping spectra curves should be used for comparison since the reeds have a built-in 2% damping.

There were some concerns about the way the Kinemetrics instruments were installed at the reactor base mat level. The instruments are not located on the mat, rather they are positioned on brackets bolted on the containment wall 9" above the mat. A "ring" test done by Kinemetrics proved that the brackets are rigid enough to render the data valid.

Partial preliminary time history data obtained from the Kinemetrics instruments located at the reactor building foundation (575') and on the containment vessel annulus (682') and the associated response spectra generated by Kinemetrics are shown in enclosure 5. Note that the grade level of the plant is at 620'.

Enclosures 4 and 5 indicate that there is a strong possibility that both OBE and SSE design response spectra may have been exceeded in the frequency range of approximately 16 Hz and above. The design basis for SSE is a Regulatory Guide 1.60 design response spectra anchored at 0.15g, with the OBE spectra

anchored at 0.075g. Preliminary data indicated a Zero Period Acceleration (ZPA) value of 0.18g at the reactor base mat. These recorded data are being further studied by the NRC and CEI consultants and instrument suppliers.

2. Results of Preliminary Plant Inspection

Damage to the Perry Plant was assessed by CEI and found to be limited to hair line cracks in rad waste and auxiliary building walls and a pipe flange leak in a hot water heater in the rad waste building. In most cases CEI was not able to determine whether or not these cracks were there before the earthquake. The hot water heater supplies clean non-radioactive steam to an evaporator, and the leakage rate was estimated to be about 20 drops per minute. In addition, a rotating disc type protective relay for the turbine generators tripped, which in turn caused an auxiliary boiler to trip. Since the turbine generators were not in operation at the time of the earthquake, there was no voltage across the relay and, therefore, the rotating disc was hanging loose there. It tripped due to the earthquake motion which would be expected. An instrument air compressor tripped; however, one of the three other instrument/service air compressors in the plant automatically started. There was also an indication that suppression pool water level indicators might have malfunctioned during and after the earthquake. CEI is still looking into this matter. Seepage of ground water through the junction of wall and floor and through cracks in the wall was also observed in the rad waste building after the earthquake. The seepage was not considered severe.

The NRC staff participated in a walk-down of the plant to inspect for damage and anomalies. The NRC staff walk-down observations are recorded in enclosure 6.

CONCLUSIONS

1. No damage of any significance was observed at the Perry plant by the NRC staff during the trip.

2. Based on the preliminary records of seismic monitoring instruments at the plant, the staff concluded that there is a strong possibility that the OBE and SSE design response spectra (FSAR values) may have been exceeded in the frequency range above approximately 16 Hz. It has been pointed out that the high frequency range of Regulatory Guide 1.60 spectra is not as conservative as the lower frequency range. However, the records obtained at Perry are still puzzling since the seismic instrumentation on the containment wall at 682 (about 107' above base mat) still shows exceedance of FSAR floor spectra in the frequency range higher than approximately 16 Hz. One would normally expect that the responses in the frequency ranges higher than the building fundamental frequency would be filtered out by the building.

   Further analyses and study of the seismic data by CEI staff engineers and consultants may yield new information on this matter. It should be kept in mind that response spectra do not present all the information

about an earthquake. The energy content as a function of frequency is better represented by the Power Spectral Density (PSD), which is an important indicator of damage potential. Another damage potential indicator is the duration of the earthquake. On both accounts, the effects of the earthquake on the Perry plant were observed to be minimal. Normally responses in the high frequency range do not have much energy content. Furthermore, the peak time history reading at the base mat lasted for only about one half second.

NRC AND SQUG FOLLOW-UP ACTIONS

1. The location, aftershocks and travel mechanism of the earthquake sequence will have to be examined and compared with previous seismicity so as to determine if there is any impact upon the adequacy of assumptions made in the Safety Evaluation Report.

2. DSRO/NRR had a meeting with representatives of the Division of BWR Licensing on 2/3/86 to brief them of the findings at Perry. It was decided that since the investigation of the effects of this earthquake on Perry is plant-specific, the BWR Licensing Divsion should take the lead. DSRO will perform an oversight function and provide technical assistance if needed. R. Hermann and L. Reiter were appointed as team leaders in the structural/mechanical and geoscience areas respectively. A permanent review team is being formed to review the effects of this earthquake on the structural, equipment and geoscience aspects of the Perry plant.

3. A BWR site investigation team was sent to Perry on 2/6/86. This team consists of A. Lee (Engineering Branch/BWR Licensing Division/NRR) and J. Singh (INEL contractor), and will perform an independent review of safety related equipment.

4. Seismic Qualification Utility Group (SQUG) will send a team to Perry on 2/10/86 to collect seismic experience data. This information could be useful for the on-going Unresolved Safety Issue (USI) A-46, "Seismic Qualification of Equipment in Operating Plants."

5. As the analysis and review of the earthquake, and recorded data proceed, additional recommendations to specific generic issues may be forthcoming. among these presently being considered include increased use of parameters other than peak accelerations and response spectra to better reflect the damage potential of earthquake ground motion and a clearer definition of OBE and/or SSE exceedance and their implications.

T. Y. Chang
Task Manager

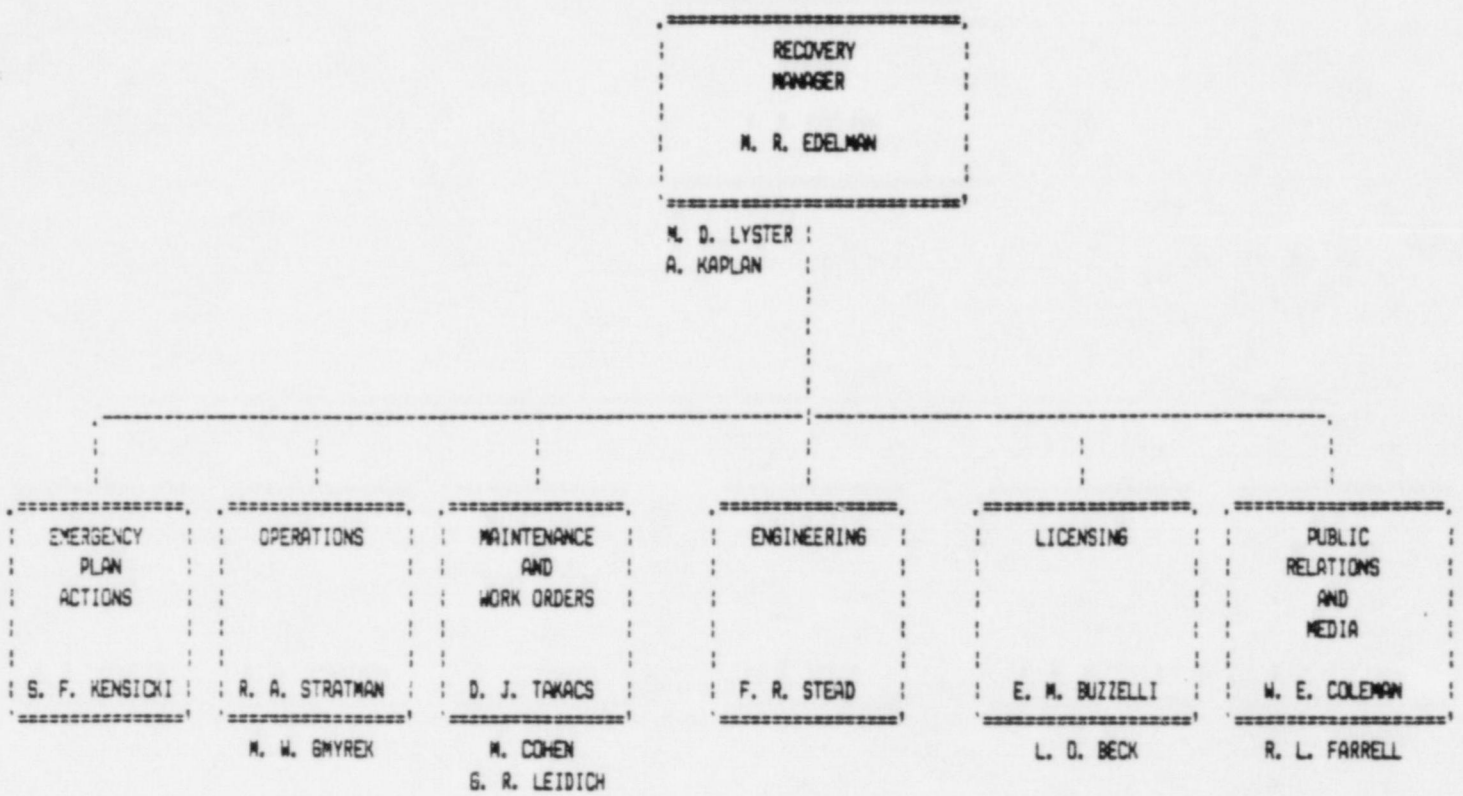
Leon Reiter
Sr. Reliability and Risk Analyst

cc: See Page 5.

cc: H. Denton
D. Eisenhut
R. Bernero
W. Butler
G. Lainas
J. Stefano
S. Stern
T. Speis
B. Sheron
N. Anderson
Lic. Div. Directors
Lic. Div. A/Ds
G. Arlotto, RES
J. Richardson, RES
C. Paperiello, Reg. III
S. Brocoum
L. Heller
N. Chokshi
L. Shao, RES
G. Bagchi
G. Giese Koch
P. T. Kuo
R. Rothman
A. Lee
P. Sobel
R. Hermann
C. P. Tan

ENCLOSURE 1

RECOVERY ORGANIZATION



ENCLOSURE 2

MEETING ATTENDANCE

February 1, 1986 - TEC

NAME	COMPANY	POSITION
N. J. Lehman	CEI	Staff Analyst
J. J . Waldron	CEI	Manager, Technical Dept.
K. A. Connaughton	NRC	Resident Inspector
J. W. Muffett	NRC, Region III	Plant System Section Section Chief
J. J. Harrison	NRC, Region III	Chief, Eng. Branch, DRS
C. J. Paperiello (Team leader)	NRC, Region III	Director, Div. Reactor Safet
C. R. Angstadt	CEI	Lead Structural Engineer
E. M. Buzzelli	CEI	Sr. Licensing Engineer
K. R. Pech	CEI	Gen. Sup. Eng., Nucl Constr.
M. N. Gmyrek	CEI	Sr. Operations Coordinator
R. A. Stratman	CEI	Gen. Supervisor, Operations
H. L. Williams	CEI	Executive Vice President
A. Kaplan	CEI	V.P. Nuclear Operations Div.
M. D. Lyster	CEI	Manager, PPOD
F. R. Stead	CEI	Manager, NED
B. A. Stiles	CEI	Community Relations Asst.
John J. Stefano	NRC/NRR	Perry Project Manager
Leon Reiter	NRC/NRR	Sr. Reliability & Pipe Analyst
T. Y. Chang	NRC/NRR	Task Manager
W. E. Coleman	CEI	GSE, Community Relations
G. R. Leidich	CEI	GSE, Outage Management
D. J. Takacs	CEI	Gen. Sup., Maintenance
J. A. Grobe	NRC	Sr. Resident Inspector
M. J. Hayner	CEI	Licensing Engineer

Attendance - February 1, 1986 - TEC

NAME	COMPANY	POSITION
M. H. Minns	CEI	Licensing Engineer
R. G. Schuerger	CEI	Chairman, NSRC
E. N. Levine	Weston Geophysical	Seismologist, Consultant to CEI
Gabriel Leblanc	Weston Geophysical	Seismologist, Consultant to CEI
Steve Kensicki	CEI	Technical Superintendent
Bill Kanda	CEI	GSE, Technical
Dan Hulbert	CEI	Emergency Planning Sup.
George Siegel	Kinnemetrics	Field Operations Sup.
Vince Concel	CEI	PPTD System Engr. Lead
Paul Engdahl	Engdahl Enterprises	President
Roger Alley	Gilbert, Inc.	Project Structural Eng.
Frank Kocsis	CEI	Independent Safety Eng.
Cyril Shuster	CEI	Manager, QA
Ronald L. Farrell	CEI	Manager, PPSD
Murray R. Edelman	CEI	V.P., Nuclear Group

ENCLOSURE 3

FINAL DRAFT

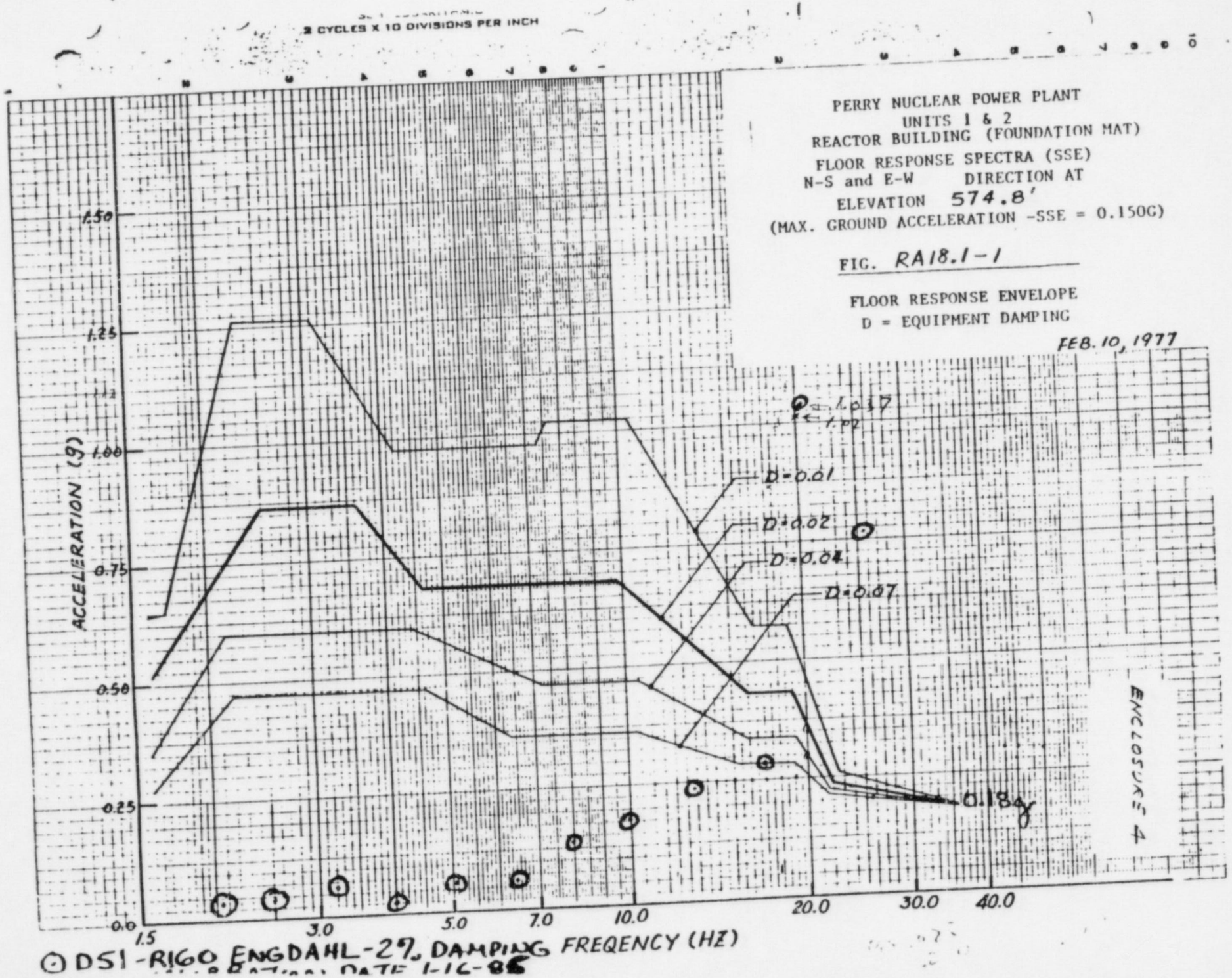
TABLE 3.3.7.2-1

SEISMIC MONITORING INSTRUMENTATION

INSTRUMENTS AND SENSOR LOCATIONS	MEASUREMENT RANGE	MINIMUM INSTRUMENTS OPERABLE
Triaxial Time-History Accelerographs		
a. D51-N101 Reactor Building Foundation	0.01 - 1.0g	1
b. D51-N111 Containment Vessel	0.01 - 1.0g	1
c. D51-N100 Reactor Building Foundation	0.005 - 0.02g	1(b)
d. D51-N110 Reactor Building Foundation	0.005 - 0.02g	1(b)
Triaxial Peak Accelerographs		
a. D51-R120 Reactor Recirculation Pump	0.05 - 1.0g	1
b. D51-R130 HPCS Piping in Reactor Building	0.05 - 1.0g	1
c. D51-R140 HPCS Pump Base Mat	0.05 - 1.0g	1
Triaxial Seismic Switches		
a. D51-N150 Reactor Building Foundation	0.025 - 0.25g	1(a)
Triaxial Response-Spectrum Recorders		
a. D51-R160 Reactor Building Foundation	2 - 25.4 Hz	1(a)
b. D51-R170 Reactor Recirculation Piping Support	2 - 25.4 Hz	1
c. D51-R180 HPCS Pump Base Mat	2 - 25.4 Hz	1
d. D51-R190 RCIC Pump Base Mat	2 - 25.4 Hz	1

(a) With control room annunciation.

(b) Seismic trigger with control room annunciation.


2 CYCLES X 10 DIVISIONS PER INCH
PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
REACTOR BUILDING (FOUNDATION MAT)
FLOOR RESPONSE SPECTRA (SSE)
N-S and E-W DIRECTION AT
ELEVATION 574.8'
(MAX. GROUND ACCELERATION -SSE = 0.150G)
FIG. RA18.1-1
FLOOR RESPONSE ENVELOPE
D = EQUIPMENT DAMPING
FEB. 10, 1977
ACCELERATION (g)
1.50
1.25
1.00
0.75
0.50
0.25
0.0
1.5
3.0
5.0
7.0
10.0
20.0
30.0
40.0
FREQENCY (HZ)
D=0.01
D=0.02
D=0.04
D=0.07
0.18g
ENCLOSURE 4
⊙ DSI-RIGO ENGDAHL-2% DAMPING

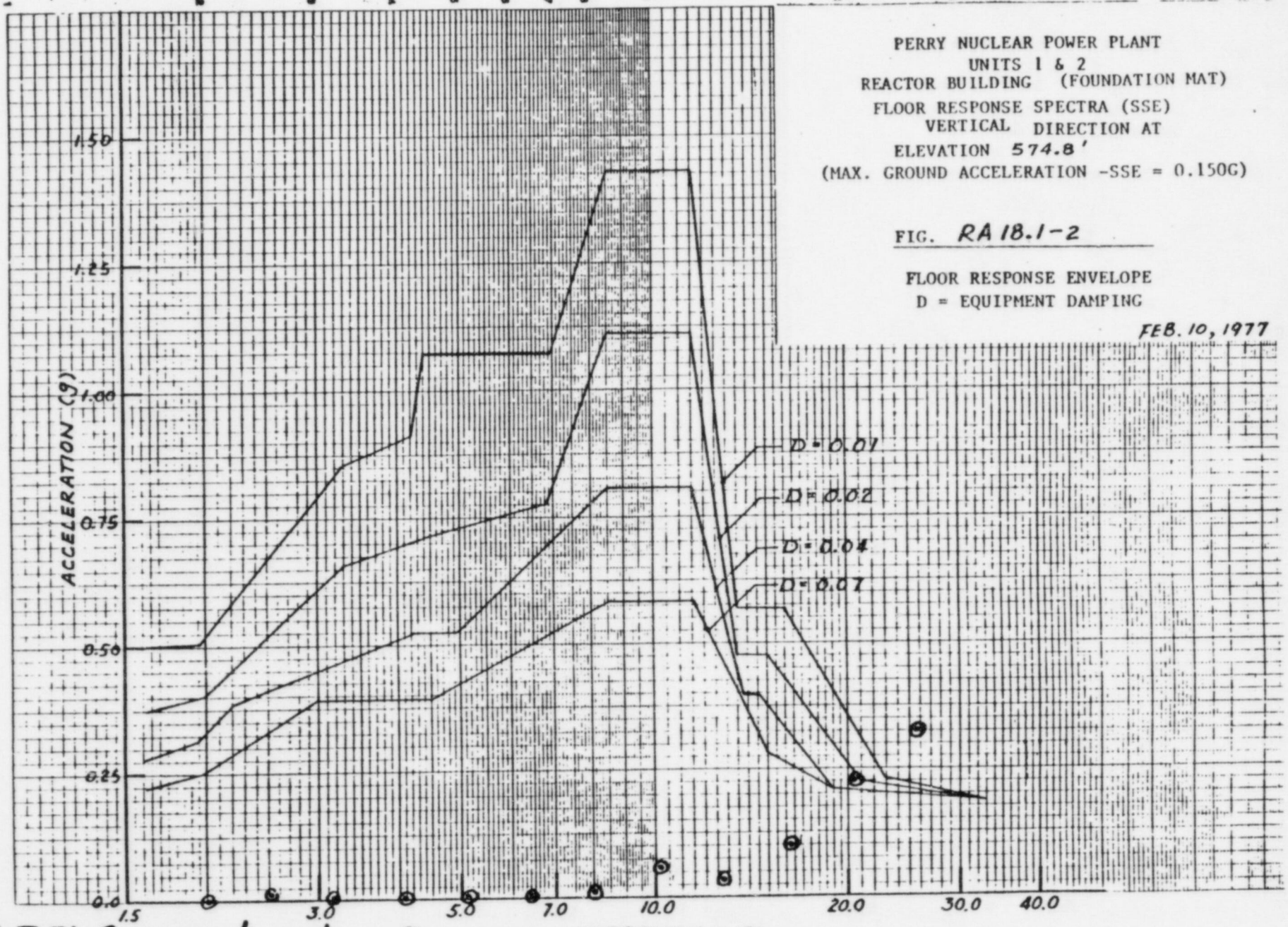
2 CYCLES X 10 DIVISIONS PER INCH

PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
REACTOR BUILDING (FOUNDATION MAT)
FLOOR RESPONSE SPECTRA (SSE)
VERTICAL DIRECTION AT
ELEVATION 574.8'
(MAX. GROUND ACCELERATION -SSE = 0.150G)

FIG. RA 18.1-2

FLOOR RESPONSE ENVELOPE
D = EQUIPMENT DAMPING

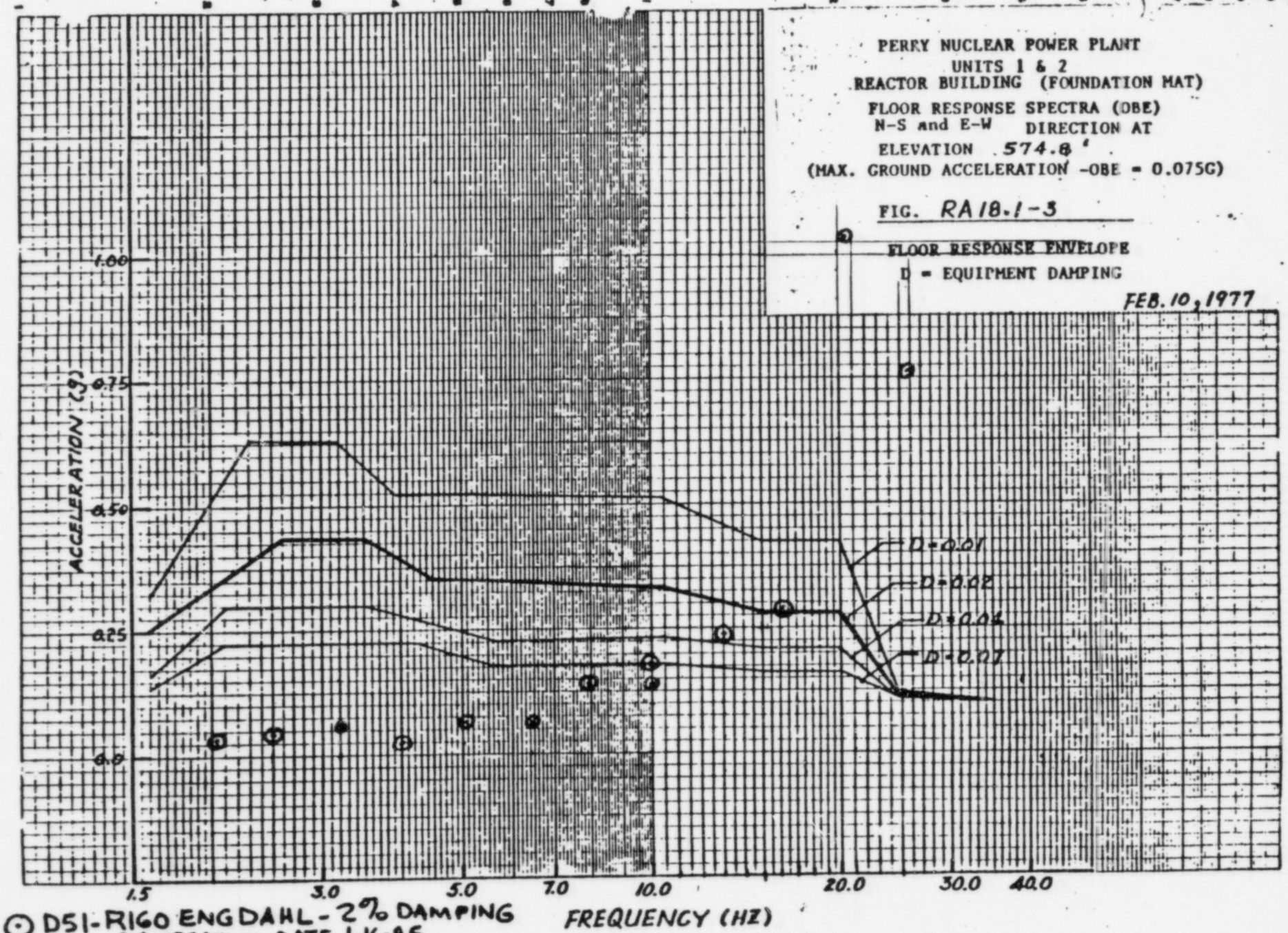
FEB. 10, 1977



⊙ DSI-R160 ENGDAHL - 2% DAMPING
CALIBRATION DATE 1-11-85

PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
REACTOR BUILDING (FOUNDATION MAT)
FLOOR RESPONSE SPECTRA (OBE)
N-S and E-W DIRECTION AT
ELEVATION 574.8'
(MAX. GROUND ACCELERATION -OBE = 0.075G)

FIG. RA18.1-3

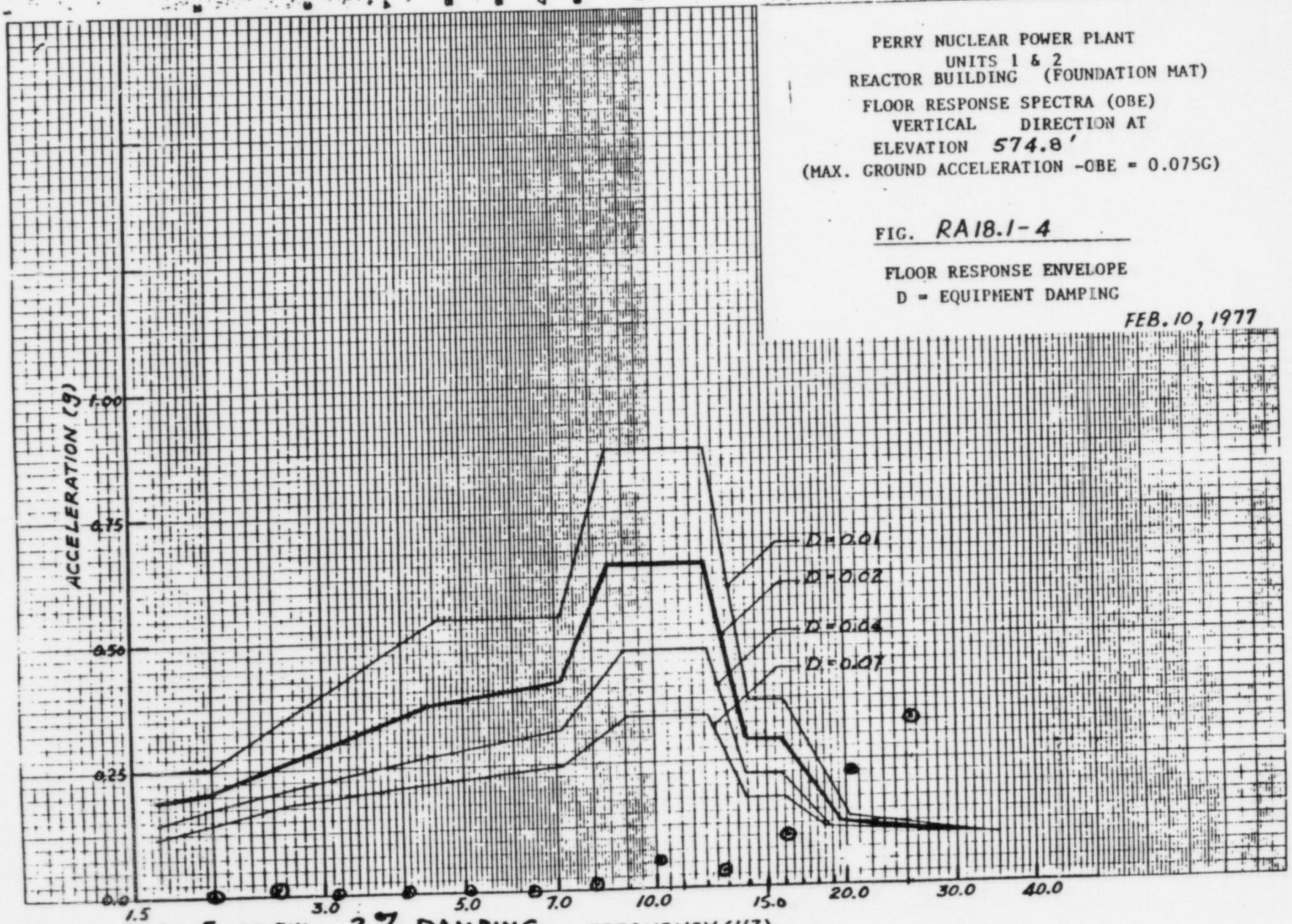


PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
REACTOR BUILDING (FOUNDATION MAT)
FLOOR RESPONSE SPECTRA (OBE)
VERTICAL DIRECTION AT
ELEVATION 574.8'
(MAX. GROUND ACCELERATION -OBE = 0.075G)

FIG. RA18.1-4

FLOOR RESPONSE ENVELOPE
D = EQUIPMENT DAMPING

FEB. 10, 1977



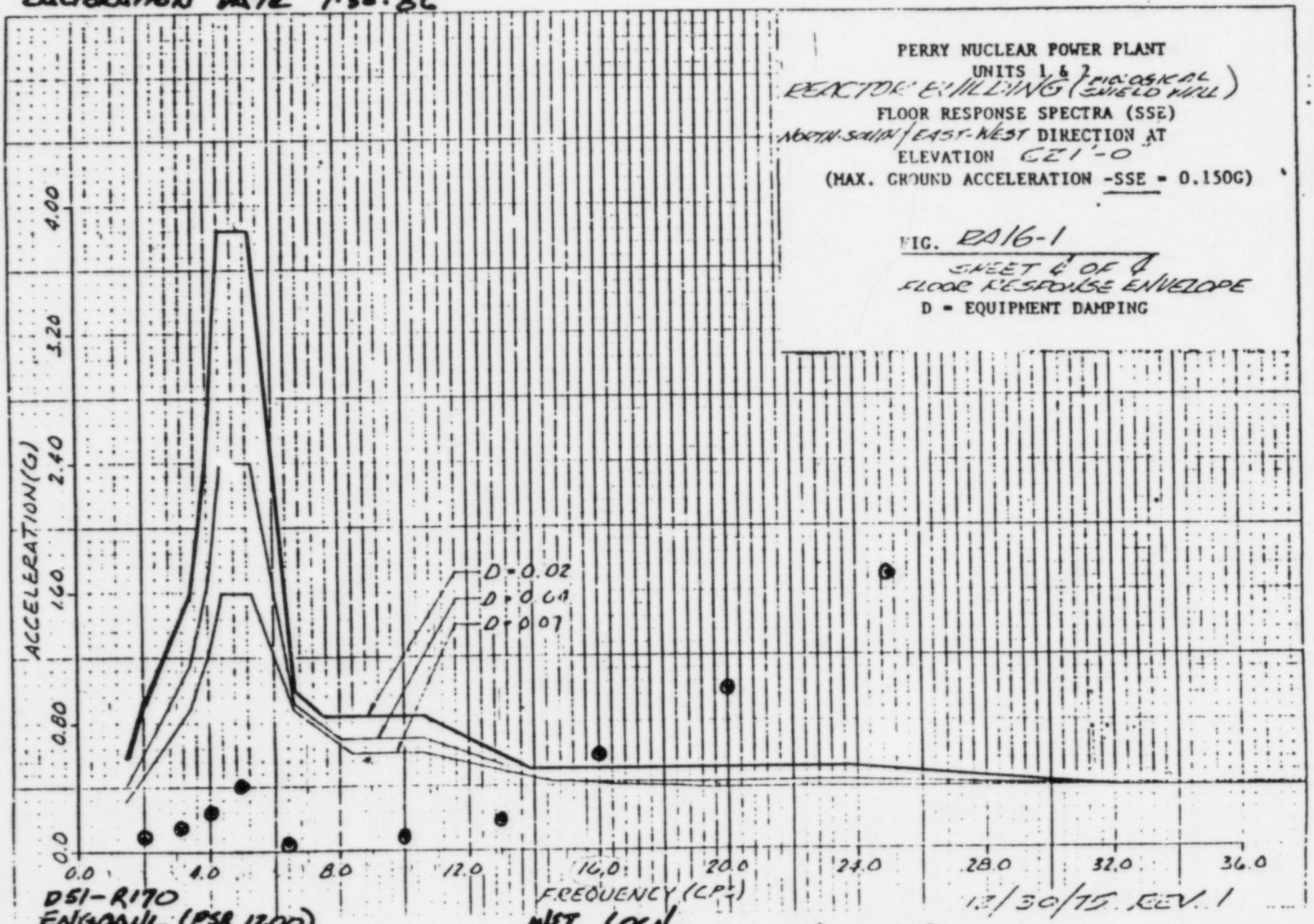
⊙ DSI-R160 ENGDAHL - 2% DAMPING

CALIBRATION DATE 1-16-85

CALIBRATION DATE 1-30-86

PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
REACTOR BUILDING (SECONDARY CONTAINMENT)
FLOOR RESPONSE SPECTRA (SSE)
NORTH-SOUTH / EAST-WEST DIRECTION AT
ELEVATION 621'-0
(MAX. GROUND ACCELERATION -SSE - 0.150G)

FIG. RA16-1
SHEET 4 OF 7
FLOOR RESPONSE ENVELOPE
D = EQUIPMENT DAMPING



DSI-R170
ENGDANL (PSR 1200)
E-W 2% DAMPING

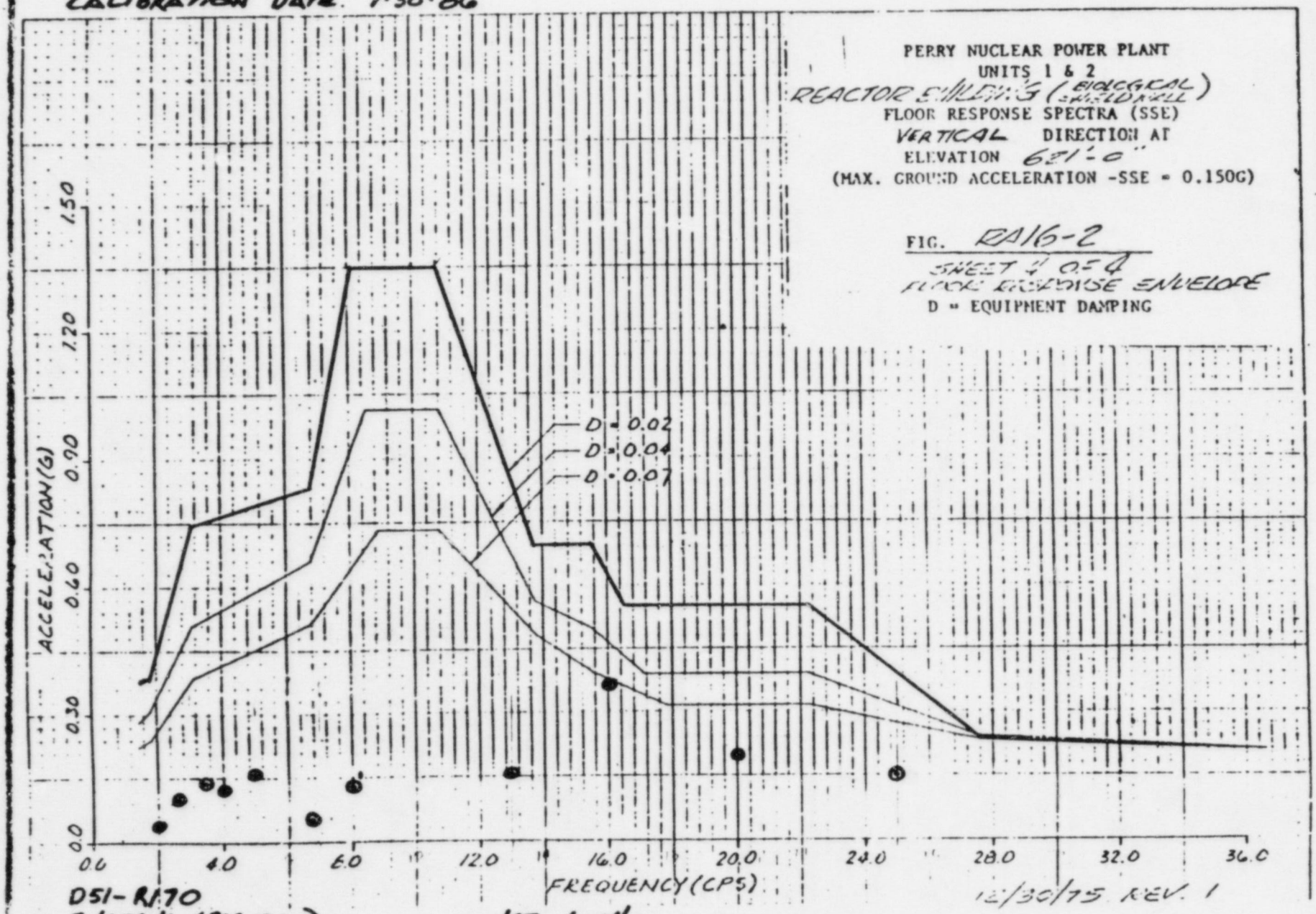
WEST LOCA
EL 630'-1" (R.B. INSIDE DW)

1.3/30/75 REV. 1

CALIBRATION DATE. 1-30-86

PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
REACTOR BUILDING (BIOLOGICAL SHIELD WALL)
FLOOR RESPONSE SPECTRA (SSE)
VERTICAL DIRECTION AT
ELEVATION 621'-0"
(MAX. GROUND ACCELERATION -SSE = 0.150G)

FIG. RA16-2
SHEET 4 OF 4
FLOOR RESPONSE ENVELOPE
D = EQUIPMENT DAMPING



12/30/75 REV. 1

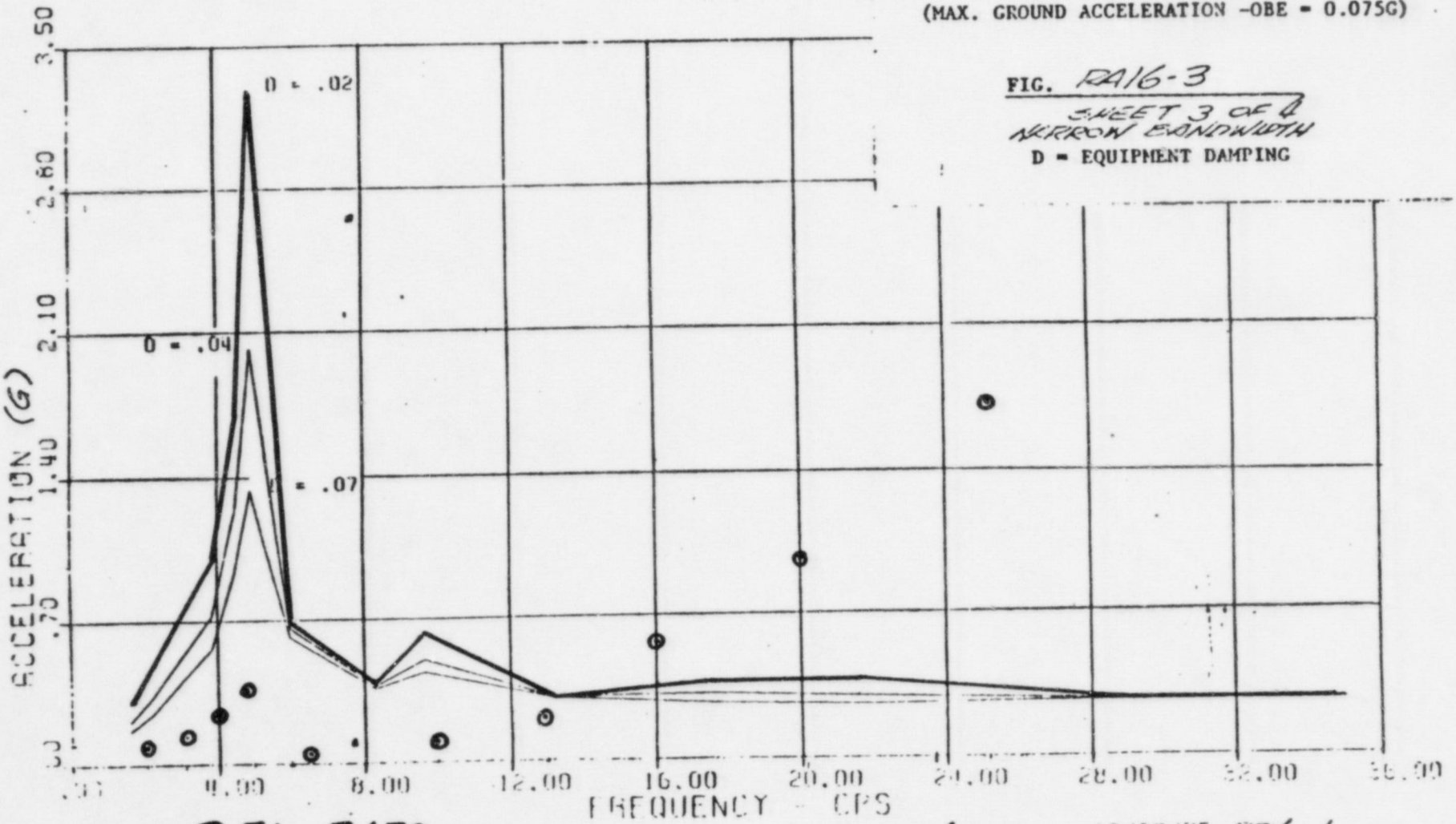
D51-R170
ENGDAHL (PSR 1200)
VERTICAL 2% DAMPING

INST. LOCN.
EL 630'-1" (R.B. INSIDE D.W.)

CALIBERATION 1·30·86
DATE

PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
REACTOR BUILDING (BIOLOGICAL SHIELD WALL)
FLOOR RESPONSE SPECTRA (OBE)
NORTH-SOUTH & EAST-WEST DIRECTION AT
ELEVATION @21'-0"
(MAX. GROUND ACCELERATION -OBE = 0.075G)

FIG. RA16-3
SHEET 3 OF 4
NARROW BANDWIDTH
D = EQUIPMENT DAMPING



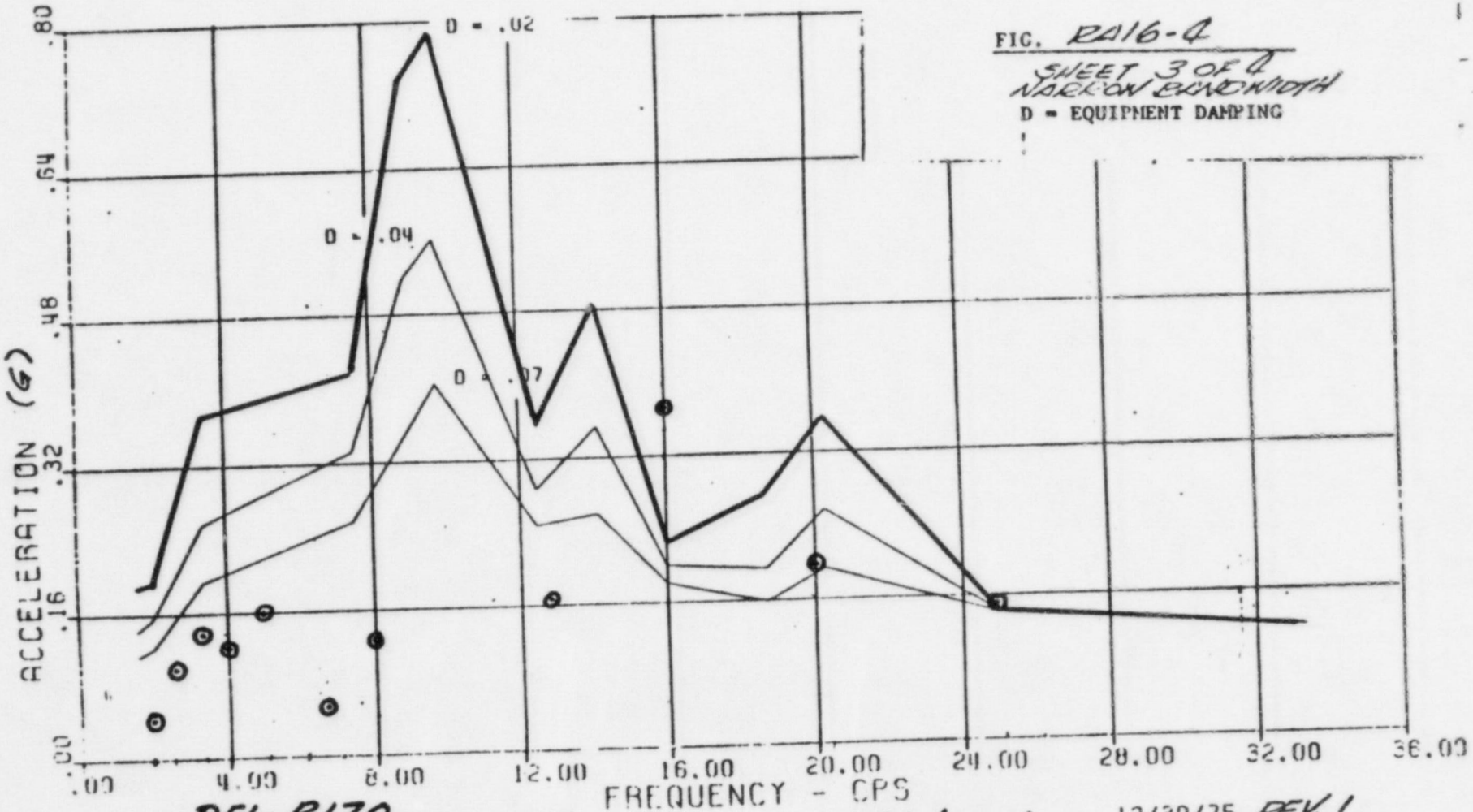
D51-R170
ENGDANL (PSR1200),

INST. LOCN. 12/30/75 REV. 1
EL. 630'-1" (R.B. INSIDE DD)

CALIBERATION 1-30-86
DATE

PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
REACTOR BUILDING (BIOLOGICAL SHIELD WALL)
FLOOR RESPONSE SPECTRA (OBE)
VERTICAL DIRECTION AT
ELEVATION 621'-0"
(MAX. GROUND ACCELERATION -OBE = 0.075G)

FIG. RA16-4
SHEET 3 OF 4
NARROW BANDWIDTH
D = EQUIPMENT DAMPING



D51-R170
ENGDAHL (PSR 1200)
2% DAMPING.

INST. LOCN.
EL. 630'-1" (R.B INSIDE D.W)

12/30/75 REV. 1

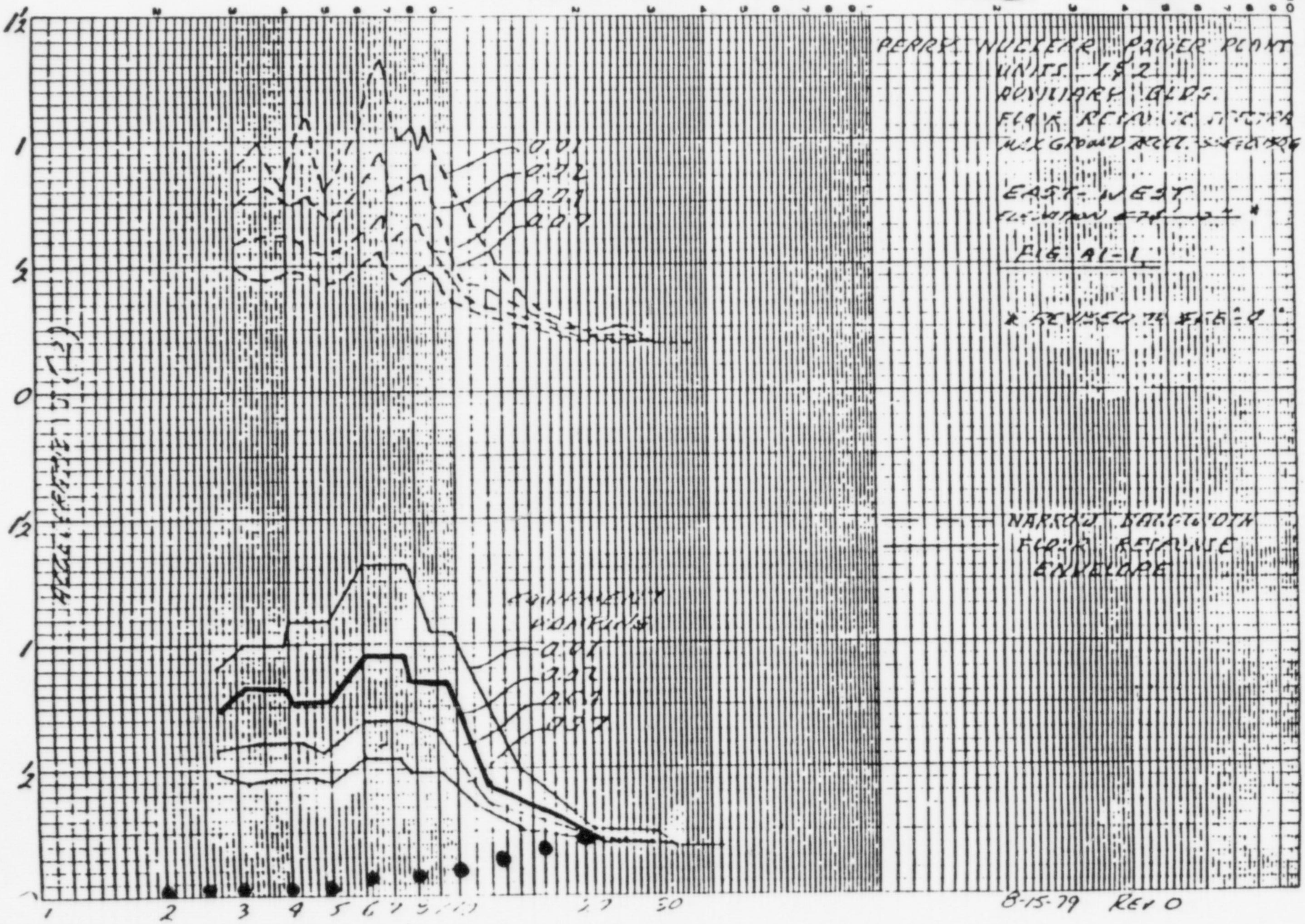
D5I-R190

NO. 340-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES × 10 DIVISIONS PER INCH

EUGENE DIETZGEN CO.
MADE IN U.S.A.

AUX BLDG EL. 568'-0"
FDN MAT
SSE EAST-WEST

● RECORDED DATA



NO. 340-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

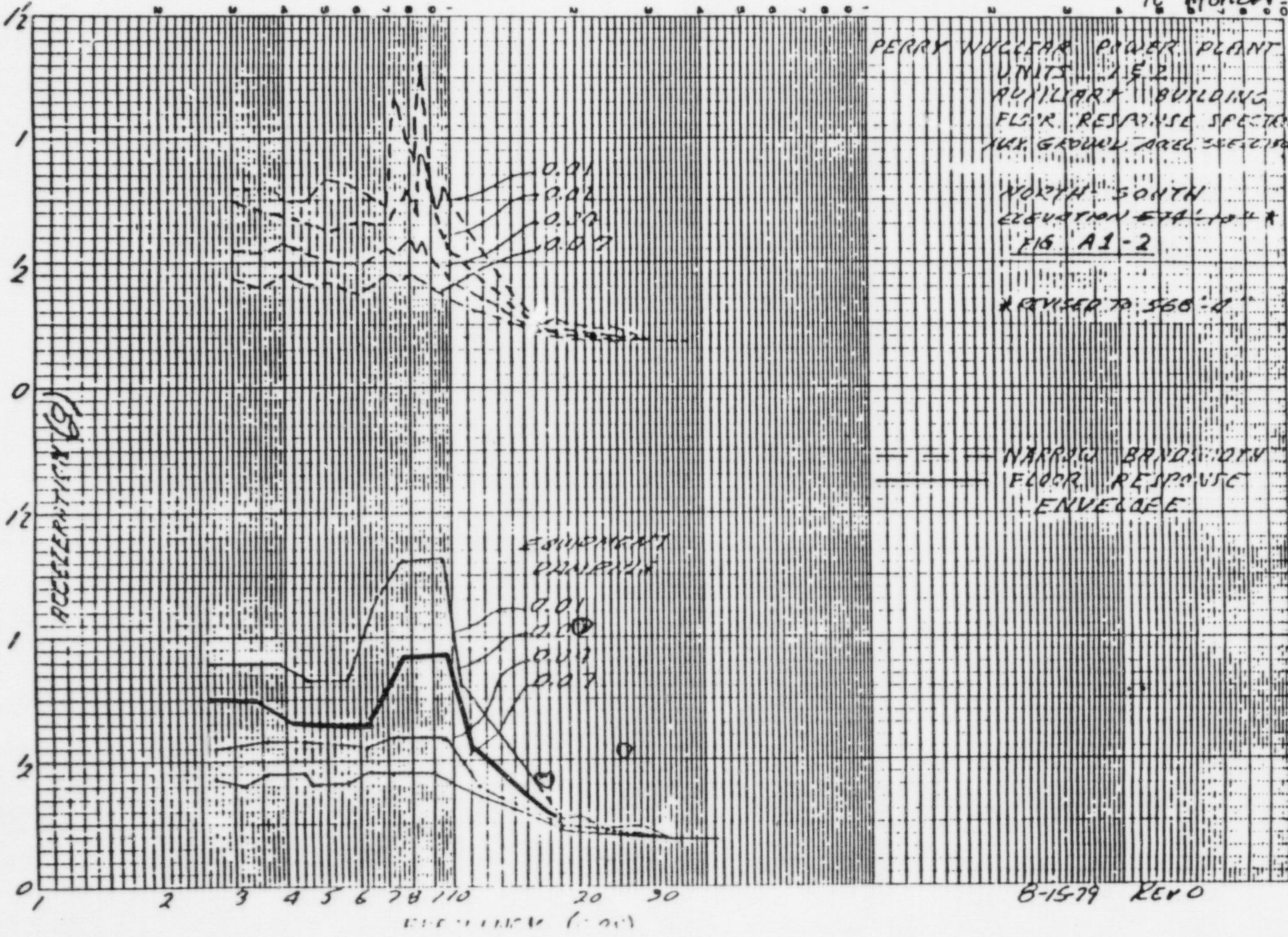
EUGENE DIETZGEN CO.
MADE IN U. S. A.

SSE

Aux Bldg EL 568
Found Mat

North-South

2/6 Horizontal



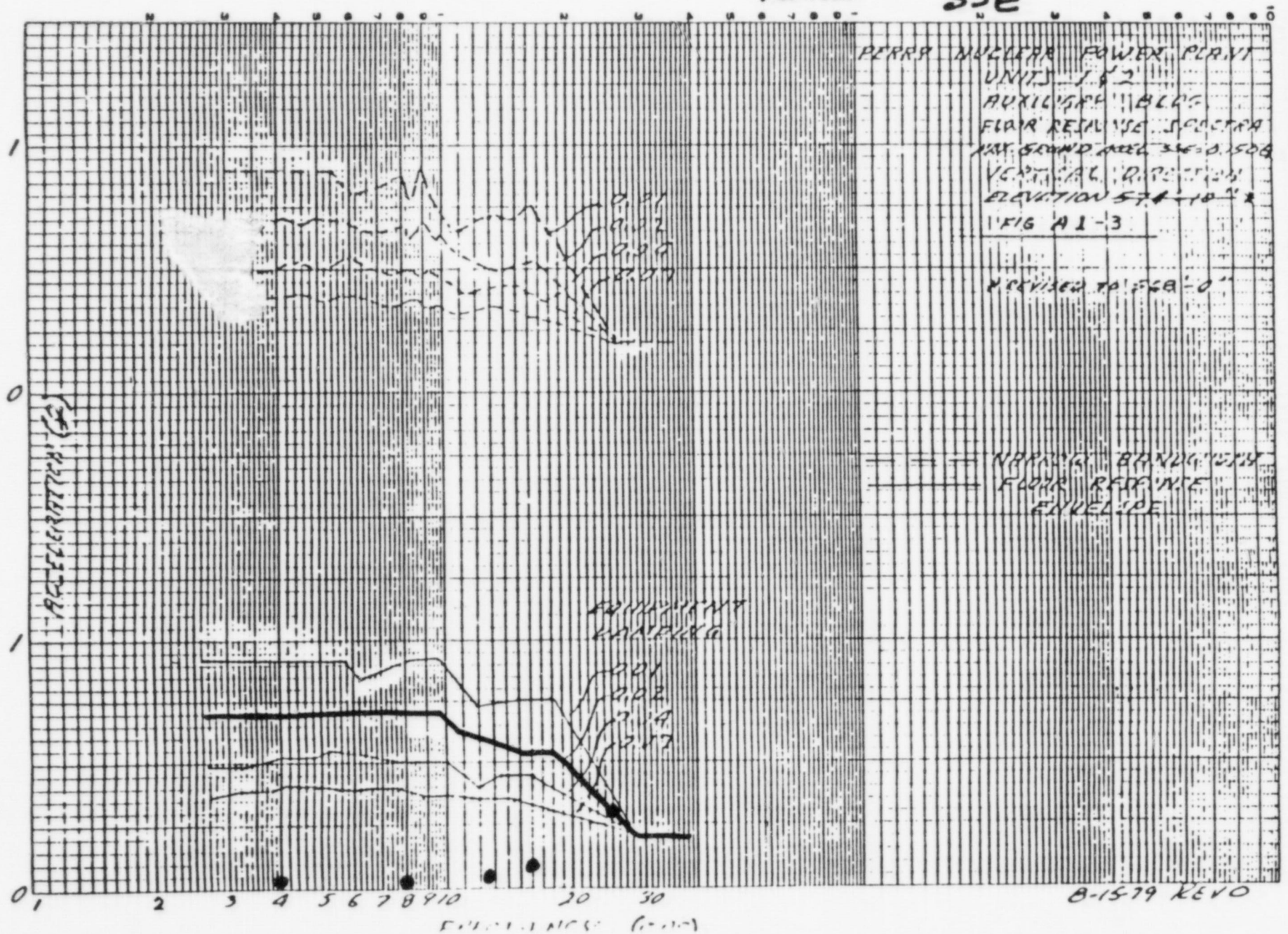
DSI-R190

NO. 340-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

Vertical

AUX BLDG, EL. 568'
FOUNDATION MAT
SSE



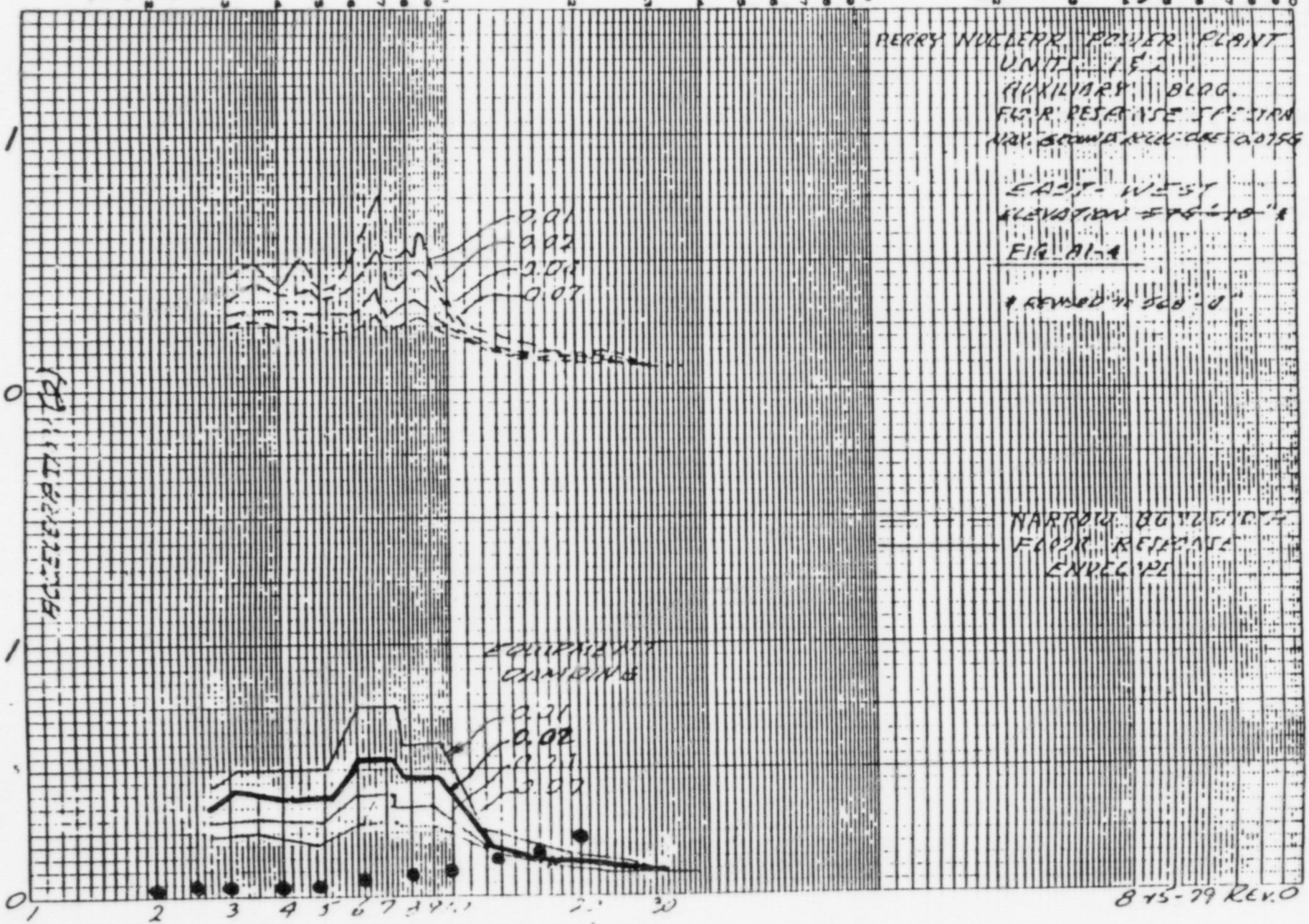
DSI-R190
ENGDAHL
#PSR-1200

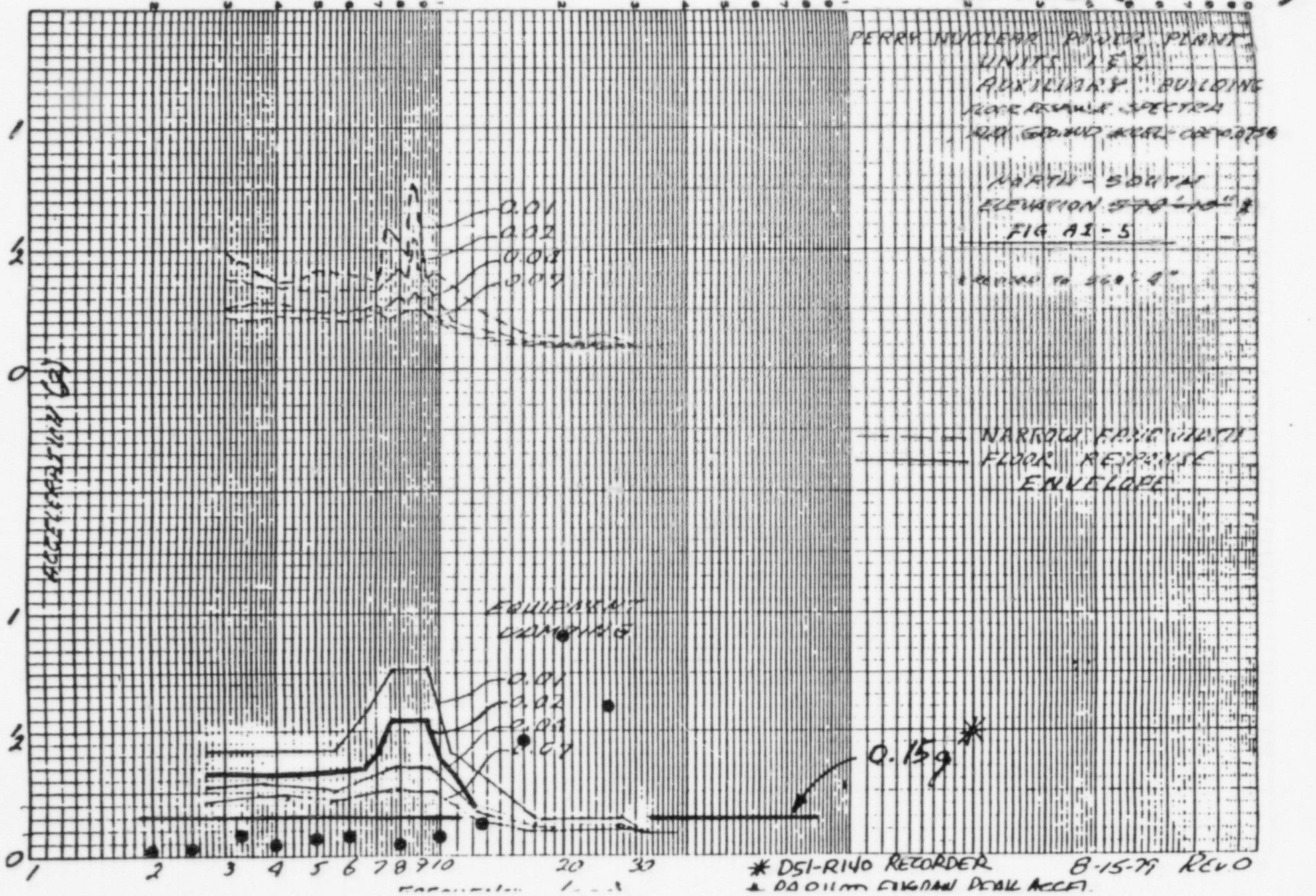
NO. 340-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

AUX BLDG EL 568'-0"
FOUND MAT
OBE (2%) EAST-WEST

● RECORDED DATA

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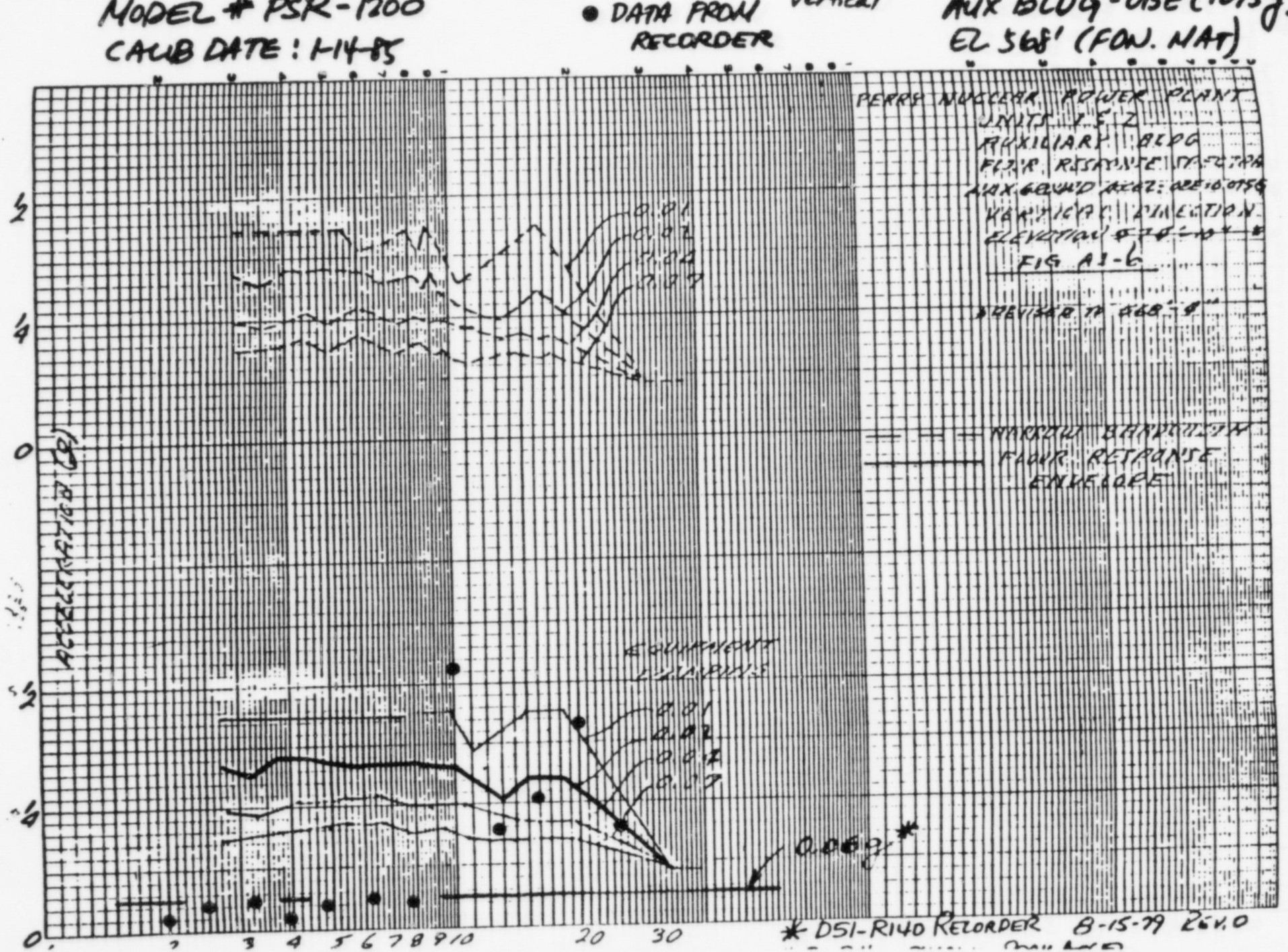
MODEL # PSR-1200 (ENGDAHL)
CALIB DATE : 1-14-85
• DATA FROM RECORDER
NORTH-SOUTH
AUX BLDG.-OBE(.075g)
EL. 568' (FDN. MAT)
PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
0.01
0.02
0.03
0.07
NARROW BAND FREQUENCY
FLOOR RESPONSE
ENVELOPE
0.15g
ACCELERATION (g)
FREQUENCY (Hz)
* DSI-RIVO RECORDER
8-15-79 REV 0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CALIB DATE: 1-14-85
• DATA FROM RECORDER
Vertical
EAST-WEST
AUX BLDG - OBE (.075g)
EL 568' (FDN. MAT)
PERRY NUCLEAR POWER PLANT
UNITS 1 & 2
AUXILIARY BLDG
FLOOR RESPONSE SPECTRA
AUX. BLDG. AREA: OBE (0.075g)
HORIZONTAL EXCITATION
ELEVATION 568'-0"
FIG A3-6
REVISED TO 568'-0"
BROADENED FLOOR RESPONSE ENVELOPE
EQUIVALENT DAMPINGS
0.01
0.02
0.05
0.07
0.06g*
ACCELERATION (g)
FREQUENCY (Hz)
* DS1-R140 RECORDER 8-15-79 REV. 0

ENCLOSURE 5

PROCESSING NOTES

grade level 620'

1. Sensor Locations:

SMA-3 S/N 165-1 (D51-N101) ⇒ Reactor Bldg Foundation, 575'

SMA-3 S/N 165-2 (D51-N111) ⇒ Containment Vessel Annulus, 682'

2. These plots are preliminary, as they have not been QC-checked. However, no changes are anticipated.

R. Nigbor
Kinemetrics
2/3/86

KINEMETRICS

575' Reactor Bldg Foundation

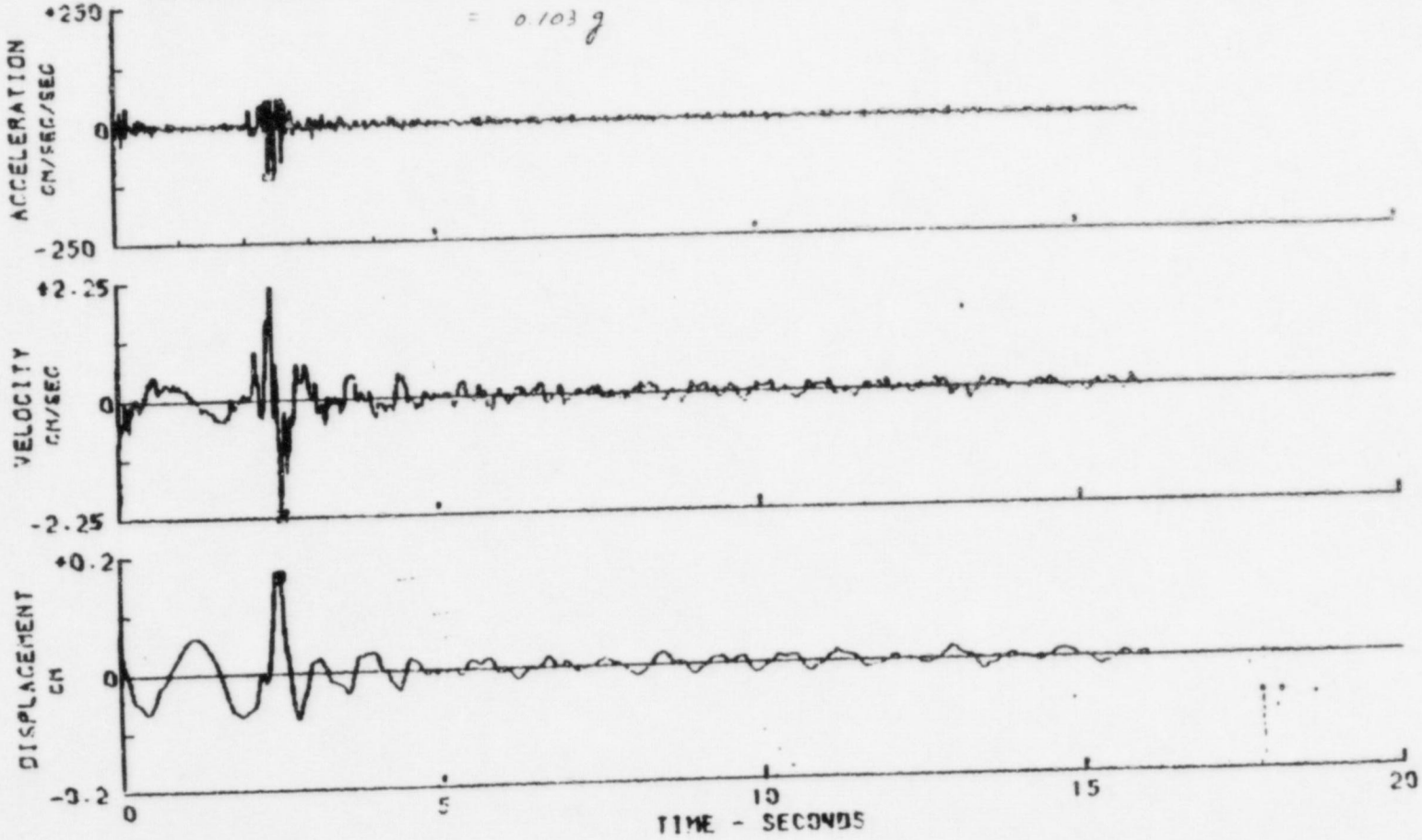
ML 5.0 EARTHQUAKE JANUARY 31, 1986

11AB031 PERRY NUCLEAR POWER PLANT COMP WEST SMA3S/M 165-11 EAST-WEST

ACCELEROGRAM IS BAND-PASS FILTERED BETWEEN 0.403- 0.625 AND 35.00- 40.00 HERTZ

PEAK VALUES: ACCEL = -101.12 CM/SEC/SEC VEL = -2.31 CM/SEC DISPL = 0.16 CM

= 0.103 g



KINEMETRICS

575' Reactor Bldg Foundation

ML 5.0 EARTHQUAKE JANUARY 31, 1986

PERRY NUCLEAR POWER PLANT

1TA8001 COMP SOUTH SMACS/N 165-1L North-South

ACCELEROGRAM IS BAND-PASS FILTERED BETWEEN 0.400- 0.623 AND 35.00- 40.00 HERTZ

PEAK VALUES: ACCEL= -177.21 CM/SEC/SEC VEL= +1.74 CM/SEC DISPL=-0.09 CM

= 0.181g → 0.15g.