UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Appeal Board

In the Matter of	)	
	)	
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY, et al.	)	Docket Nos. 50-440 50-441
	)	
(Perry Nuclear Power Plant, Units 1 and 2)	)	

AFFIDAVIT OF RICHARD J. HOLT

City of Washington)
: ss.
District of Columbia)

Richard J. Holt, being duly sworn, deposes and says as follows:

1. I, Richard J. Holt, am President of Weston Geophysical Corporation ("Weston"). My business address is Lyons Street, Westborough, Massachusetts, 01581. Weston designs and manufactures seismological instrumentation and performs seismic analysis and ground motion studies for major engineered facilities, including nuclear, fossil fuel, hydroelectric, and pumped

storage power-generating facilities; dams; pipelines; highways; tunnels; "hardened" sites such as missile silos, and other land and marine constructed facilities in the United States, Brazil, Taiwan, Italy, Venezuela and Central America. Over the past 30 years, Weston has performed geophysical and seismological evaluations for over 40 nuclear power plants.

2. A statement of my professional qualifications is attached to this Affidavit as Exhibit "A." I have worked as a geophysicist for over 30 years. In 1957, I founded Weston Geophysical. Since that time, I have performed numerous geophysical engineering evaluations with particular emphasis on seismic engineering at nuclear power plants. I have personal knowledge of the matters set forth in this Affidavit, which are true and correct to the best of my knowledge and belief.

3. On January 31, 1986, an earthquake occurred approximately 11 miles (17.7 kilometers) south of the Perry plant (the "1986 earthquake"). At the request of The Cleveland Electric Illuminating Company (CEI), Weston has made certain geological and seismological investigations of this event. The purpose of this Affidavit is to describe the results of these investigations and their impact, if any, on prior geological and seismological conclusions as reflected in the FSAR. The Affidavit first discusses the geological and seismological studies that formed the basis of the FSAR. The Affidavit then

discusses Weston's findings with respect to the January 31, 1986 earthquake.

PREVIOUS STUDIES

4. Weston has performed numerous geological and seismological evaluations of the Perry plant site for CEI during the course of the Perry project. Weston first became involved in 1972, when we performed foundation material investigations. Since that time, Weston has performed a wide variety of geological and seismological evaluations in connection with the Perry project, including the investigation of regional geology and tectonics, the probabilistic assessment of earthquakes recorded in the region, and detailed geologic mapping. Weston worked with Gilbert Associates (the project Architect/Engineer) and CEI in performing studies used in the preparation of Section 2.5 of the Preliminary Safety Analysis Report (PSAR) and Final Safety Analysis Report (FSAR). I am familiar with the geological and seismological information contained in that section of the PSAR and FSAR.

5. The PSAR and FSAR describe the basic geology and tectonics of the Perry region. This description can be summarized as follows.

REGIONAL GEOLOGY AND TECTONICS

6. The Perry site is located in the central part of the Eastern Stable Platform Tectonic Province, characterized by a Precambrian (600 to 900 million years before present ("MYBP")) crystalline basement and overlain unconformably by a sequence of Paleozoic (225 to 600 MYBP) sedimentary rocks. Basement rocks of this tectonic province comprise a complex sequence of high-grade metamorphics and include: schists, gneisses, marbles, and granulites consolidated during the Grenville Orogeny (950 MYBP) onto the North American craton.

7. The basement rocks are overlain by a 5000 feet thick sequence of sedimentary rocks, Cambrian to Carboniferous in age, which dips less than 5° to the south (Fig. 1). Sedimentary rocks within this sequence of Paleozoic sediments include shales, salt, sandstone, dolomites, and limestones.

8. A thin veneer, generally less than 100 feet of variable thick Pleistocene deposits, lies unconformably on the sedimentary sequence. These deposits include a lower till, dense and compact (approximately 30 feet thick) overlain by less compact till, lacustrine deposits and beach deposits.

9. Post consolidation tectonic deformation in the province includes the following structual elements. Paleozoic structures include broad upwarps: Cincinnati arch, Findlay

arch, Kankakee arch, Ozark uplift, Nashville dome, and intervening Michigan and Illinois basins. Uplift and subsidence produced localized faulting and folding. The north northeast-trending Waverly arch of west central Ohio is the nearest upwarp structure.

10. Faults in the site region include: Chatham sag faults; Peck fault, Howell-Northville anticline faults; Bowling Green fault; Anna Ohio faults; Cincinnati arch faults; Eastern Ohio faults; Western New York faults; and Appalachian Plateau and Northern Valley and Ridge faults. Within the region only the Clarendon-Linden fault system in Western New York is considered active.

SITE GEOLOGY

11. In conjunction with the PSAR and FSAR preparation and reviews, Weston and Gilbert conducted intensive geological and geotechnical investigations at the Perry site including: test borings (maximum depth 730'); 42" drilled exploratory shafts; in-situ testing and plate load tests; permeability determinations; piezometer installations; seismic analyses; seismic refraction and seismic shear wave determinations; and geologic mapping of excavations, tunnels and trenches.

12. Examination of the plant site foundation excavations revealed bedrock deformation caused principally by glacial

action. That deformation not due to glacial action is associated with the ancestral deposition of the sediments and consists of gentle northeast-trending folds with two to three foot wavelengths and 6" amplitudes. Two larger folds and several related faults were also examined. The folds terminated below foundation grade. Faults with characteristic north over south directed motion become bedding plane detachments at depth. One to three inch thick gouge occurs in the fault zones. Absence of foreign materials, no recrystallization of country rock or crystallization within fault zone or adjacent fracture zones is interpreted to result from localized low temperature, relatively low stress deformation. These non-tectonic features occur in glaciated terrain and are caused by glacial loading, unloading and/or ice push mechanisms.

DEFORMATION -- INTAKE AND DISCHARGE TUNNELS

13. Three minor low-angle north-northeast striking thrust faults occur in the intake and discharge tunnels to the north beneath Lake Erie. Displacements range between 0.5 and 2.5 feet, with the southeast block being thrust upward. Studies to define tunnel fault geometry included detailed mapping of tunnel walls, reconnaissance of the lake bottom and lake shore, exploratory borings, borehole logging, borehole hydrofracturing to determine in-situ stress conditions, chemical analyses using oxygen-hydrogen isotopes of Lake Erie and fault seepage water,

offshore and onshore magnetic surveys, and review of existing geophysical data.

14. Investigations of the vertical and lateral extent of faulting indicated that the faulting did not extend upward to the lake floor. Borings at the projected western shoreline intersection showed no faulting. Conclusions reached from detailed mapping of the tunnel faults, geophysical veys, borings, and analysis of fault gouge and seepage, as noted in Section 2.5 of the PSAR/FSAR, included:

- faults are generally related (same fault or en echelon)
- faults are confined in Chagrin shale, and are typically limited in lateral and vertical extent
- date of last motion is Pleistocene or older
- motion sense indicates faults originated in northwest directed stress field, approximately 90° from present stress field
- possible mechanisms of nontectonic glacial origin include ice sheet traction, differential downwarp, differential rebound, surficial stress relief ("pop up")
- geologic processes responsible for initiation and latest motion are nontectonic and no longer operative; therefore faults are not capable according to Appendix A of 10 CFR Part 100

BACKGROUND SEISMOLOGIC AND GEOLOGIC CONCLUSIONS

15. Based on past studies and following Appendix A of 10 CFR Part 100, Weston determined at the time of the FSAR that a correlation of earthquakes to a particular fault or series of faults which would be designated as "capable" could not be made. In addition, no "large scale dislocation or distortion" of the earth's crust designated as a "tectonic structure" could be identified to which earthquakes could be correlated. Consequently, earthquakes were identified with a "tectonic province," representative of a region within which there is a relative consistency of geologic structural features.

16. To select the Safe Shutdown Earthquake ("SSE") for the Perry site Weston used a Modified Mercalli Intensity of VII, which was determined to be the maximum intensity earthquake consistent with the geology of the tectonic province. This intensity corresponds to an acceleration value of 0.15 g, based upon a number of developed relationships which relate peak acceleration to earthquake intensity values. The principal relationship was developed by Messrs. Trifunac and Brady (Trifunac, M.D. and Brady, A.G., 1975, On the Correlation of Seismic Intensity Scales with the Peaks of Recorded Strong Ground Motion, Bulletin of the Seismological Society of America, v. 65, No. 1, pp. 139-162). Weston then developed the response spectra representing the SSE by adopting an NRC

Regulatory Guide 1.60 response spectral shape. The design response spectra are shown in Figures 2 and 3.

17. During the review of the FSAR, the NRC Staff requested that site-specific spectra be constructed for the Perry site. In response to this request, Weston constructed a site-specific ground response spectrum using a set of ground motion accelerograms from actual earthquakes of magnitude range 5.3 $\pm$ .5 recorded on rock (to simulate the foundation conditions at Perry) at epicentral distances of 0 to 25 kilometers (see Figure 4). This represents the earthquake "at the site" as required by Appendix A of Part 100.

18. Weston developed the site-specific ground response spectrum on the basis of 11 earthquakes representing 22 components of motion. A subset of records accepted by the NRC Staff as representative of an Anna, Ohio type earthquake had an average magnitude of 5.53 $\pm$ .3 at an average distance of 8.5 miles (13.66 $\pm$ 4.5 kilometers). A smoothed 84th percentile curve of this data set fell below the design response spectrum represented by a Regulatory Guide 1.60 spectral shape set at a maximum ground acceleration of 0.15 g. This site-specific spectrum is representative of free-field data recorded at locations away from the influence of buildings and structures, and is shown in Figure 5.

CURRENT SEISMOLOGIC AND GEOLOGIC STUDIES

19. Based on information collected by the National Earthquake Information Center of the United States Geological Survey (USGS), the 1986 earthquake had a magnitude of 4.96 M_{blg}, a depth presently calculated to be 6 miles (10 kilometers) deep, and a location of 41.640° W and 81.098° N. This location is near the intersection of Highways 86 and 166 in Thompson Township, Geauga County. The location of this earthquake is shown in Figure 6. Earthquakes which have occurred within 200 miles of the plant site in historical times, and those occurring within 50 miles of the plant site, are shown in Figures 7 and 8.

20. Immediately after the occurrence of the 1986 earthquake, Weston undertook a number of geological and seismological investigations at CEI's request to provide a thorough understanding of the earthquake and assess any impact on previous studies performed for the siting and licensing of the Perry Nuclear Power Plant. These investigations were or are being performed under my direction and supervision.

21. Weston installed six portable analog seismographs (Sprengnether Instrument Co. MEG-800) in the epicenter area of the 1986 earthquake during the period from approximately 10 hours to 30 hours after the event. These seismograph stations

are located at the Perry Nuclear Plant and in the communities of Chardon, Chesterland, Middlefield, Hartsgrove, and Thompson. A seventh station was installed on February 4, 1986 in the town of Concord. This spatial distribution of the stations was designed to form a symmetrical array around the preliminary epicental area of the main shock, which was located on the basis of more distant stations. All instruments are operated continuously and all seismograms are recovered and analyzed daily. The purpose of this network is to obtain accurate locations of any recorded aftershocks, to refine the original location of the main shock, and to determine whether or not their occurrence reveals anything about the causative geologic structure.

22. Five other portable instruments integrated into this network are operated by Woodward-Clyde Consultants and deployed in a similar configuration to provide data to Weston seismologists and others on additional locationing capabilities. Five small microearthquakes ("aftershocks") have been detected by this network. The parameters of these earthquakes are shown in Table 1. Preliminary analyses indicate that the focal depths for these microearthquakes range from 2.3 to 8.9 kilometers. The largest of these microearthquakes, a magnitude 2.4 event on February 6, 1986, was the only event physically perceived by the surrounding population. These microearthquake locations

are slightly to the west (about 3 miles) of the preliminary location of the main shock as provided by the National Earthquake Information Center. Based on recent discussions between Weston and USGS personnel, USGS is considering moving the epicenter of the main shock approximately 3 miles to the west to correspond to the location of the microearthquakes. This change, if made, would not affect my conclusions in this Affidavit.

23. Weston personnel are conducting written questionnaire surveys to evaluate the distribution of seismic intensities. These surveys contain general inquiries as to how people experienced the event and accounts of any damage that has been incurred. The questionnaires are being distributed using several parallel approaches to obtain broad coverage of the affected areas.

24. Weston is also conducting personal interviews to compile the observations of people located in the epicentral region who directl, experienced the earthquake. Questionnaires have been distributed at establishments such as fire departments, grocery stores, schools, etc. with instructions to distribute these to persons near the earthquake epicenter.

25. Our preliminary evaluation of returned questionnaires indicates that most of the perceptions in the epicentral area are representative of an Intensity VI on the Modified Mercalli

Scale. Maximum observed or reported effects include a few instances of damaged chimneys above the roof line, cracks in concrete and cinder block walls, cracked or fallen plaster, and a few broken windows. Some disturbances including silting of well water have also been reported.

26. Weston geologists have conducted preliminary reconnaissance of bedrock exposures in the epicentral area to determine whether or not any surface expression resulted from the earthquake. They observed no significant expression of surface disturbance. Although several occurrences of minor rock slides and soil slumps have been documented and photographed, these are not considered unusual, since they occur in unstable, undercut steam banks where they could have been caused by ordinary weathering processes or induced vibratory ground motion from the earthquake.

27. Weston has examined previously mapped fault locations on Paine Creek. We have observed no evidence of recent fault movement. Also, no slumping or sliding of the steep slope was apparent. Weston observed no evidence suggestive of a "capable fault."

CONCLUSIONS REGARDING THE JANUARY 31, 1986 OHIO EARTHQUAKE

28. The 1986 earthquake, both as to magnitude and intensity, is below the maximum earthquake selected to represent the Safe Shutdown Earthquake. The Safe Shutdown Earthquake was selected as intensity VII. The 1986 earthquake is best represented by an intensity VI. The magnitude 4.96 M_{blg} of the January 1986 earthquake is below the SSE magnitude of 5.3 $\pm$ 0.5 used in establishing the site-specific response spectra.

29. Based on the initial data evaluation, it appears that the free-field design response spectra constructed to represent the SSE may have been exceeded. An accelerogram at the foundation level of Unit 1 showed a peak acceleration of 0.18 g at approximately 20 Hz on the north-south component. The duration of the motion associated with this exceedance was less than 0.1 second. Since both the Regulatory Guide 1.60 ground motion and the site-specific spectra represent a smoothed spectra at the 84th percentile for a number of strong motion accelerograms, exceedances above the smoothed spectra are not unexpected.

30. At the high frequency end of the spectra, where the exceedance exists, it is important to look at the other parameters of ground motion. The particle velocity associated with the 0.18 g acceleration at 20 Hz is 0.55 inches-per-second and the displacement is 0.004 inches. This velocity is far

less than the 1 inch-per-second generally accepted by the US Bureau of Mines as the threshold of damage at the 20 Hz frequency; that is, the threshold for concern about cracking of plaster walls, etc. in ordinary (non-engineered) structures. (Siskind, D.E. et al., 1980, Structure Response and Damage Produced by Ground Vibrations from Surface Mine Blasting, Bureau of Mines RI 8507). Structural damage therefore is not a problem.

31. The area and region in which the 1986 earthquake occurred is one of low seismicity. Prior to 1986, the largest earthquake to occur within 50 miles of the site occurred in 1943. The 1986 Ohio earthquake is slightly larger in magnitude (4.9 vs. 4.7) and intensity (VI vs. V) than the 1943 earthquake, which occurred approximately 12 miles west-southwest of the 1986 earthquake. Although somewhat larger than historical earthquakes within 50 miles of the plant site, the 1986 earthquake is smaller than those within 200 miles of the site, as well as those on which the plant design is based. This earthquake is consistent with the seismicity of the area and in my judgment the area and region are still of low seismicity.

32. Based on our geological investigations to date, I conclude that the 1986 earthquake does not change the conclusions in the FSAR on the geology and seismology of the Perry site. In particular, I conclude the following: the 1986 earthquake has not altered the basic understanding of the site and area geology contained in the FSAR; there is no evidence suggestive of a "capable fault" as defined in 10 CFR Part 100, and the investigation has not revealed a cause for any geological concern; there is no reason to alter the use of the tectonic province approach used to select the SSE for Perry; and there is no evidence to support a change in either the SSE or OBE magnitude or intensity used in the design.

Richard J. Holt
RICHARD J. HOLT

Subscribed and sworn to before me this 21st day of February, 1986.

Charlotte M. Pizzuto
Notary Public

My Commission expires: 7-14-90

EXHIBIT A

PROFESSIONAL QUALIFICATIONS OF RICHARD J. HOLT

Education:

Bachelor of Science - Mathematics
Boston College, 1954
Master of Science - Geophysics
Boston College, 1956
Teaching Fellow/Post Graduate Studies
Harvard University, 1956-1957

Background:

1961-present	President, Weston Geophysical Corporation.
1957-present	Vice President and Senior Consulting Geophysicist, Weston Geophysical Engineers, Inc.
1957-1970	Lecturer in theoretical and applied seismology in the Graduate Department of Geophysics, Boston College.
1954-1957	Geophysicist, Gahagan Geophysical Surveys Division; supervision, direction and consultation on geophysical projects.

Founded Weston Geophysical Engineers in 1957 and Weston Geophysical Corporation in 1961.

Registrations:

State of California, Registered Geophysicist,
Certificate No. GP 521
State of Maine, Registered Geologist,
Certificate No. 116
State of Virginia, Registered Geologist,
Certificate No. 531

Societies:

American Geophysical Union
American Institute of Professional Geologists
Boston Society of Civil Engineers
European Association of Exploration Geophysicists
Seismological Society of America
Society of Exploration Geophysicists

Professional Experience:

Completed more than 400 projects involving the application of geophysical exploration techniques, seismic, electrical, electromagnetic, magnetic, and gravity to engineered and non-engineered projects. Evaluations have included both site-specific conditions, such as the engineering characteristics and behavior of foundation materials, and the impact of regional geological and seismological conditions on a site.

Major engineered facilities evaluated include nuclear, fossil fuel, hydroelectric, and pumped storage power-generating facilities; dams; pipelines; highways; tunnels; "hardened" sites such as missile silos; and other land and marine constructed facilities in the United States, Brazil, Taiwan, Italy, Venezuela, and Central America.

Typical nuclear project experience includes:

Boston Edison Pilgrim Nuclear Plant, Plymouth, Massachusetts: Planned and directed regional geological, geophysical, and seismological studies involving six states and extensive off-shore investigations. Site investigations involved the prediction of ground motion from regional earthquakes based on the elastic and static moduli values of the foundation materials.

Washington Public Power Nuclear Plants 1 and 4, Hanford, Washington: Planned and directed studies similar to Boston Edison work in regional and site scope. Scope of studies extended into Canada.

In addition, the following is a selected list of other nuclear plants for which consulting was performed: Maine Yankee, Vermont Yankee, Rowe Yankee, Seabrook, Millstone, Haddam, Hope Creek, Fitzpatrick, Perry, Palisades, Big Rock Point, Clinton, San Onofre, Grand Gulf, Brunswick, and Sequoyah.

Consulting experience on non-nuclear engineering projects includes:

Bear Swamp Pumped Storage Plant of New England Power: Directed field studies for site selection and evaluated the foundation material properties for design.

Bath County Pumped Storage Project of Virginia Electric Power Company: Directed studies to evaluate the dynamic and static properties of the rock tunnels and shafts to determine the effectiveness of an extensive cement grouting program.

Wyman Station Central Maine Power: Planned and directed the design evaluation and testing of a blasting program to excavate a large section of bedrock near an intake structure while the plant continued operation. This plan involved the design of an "air curtain" to reduce water overpressures as well as extensive work on "temporary" depth and multiple delay to reduce ground motion.

Wiscassett Nuclear Plant for Maine Yankee: Designed and planned the blasting of rock adjacent to curing concrete to prevent damage. This involved the determination of the dynamic and static properties of concrete from pouring to 28-day cure time. The vibration levels set were successful and the method still constitutes the state-of-the-art in this area of concrete work.

Baird MaGuire Site in Holbrook, Massachusetts: Directed and planned a geophysical program to detect and trace hazardous waste contamination of ground water.

Sinkhole investigations at Routes 2 and 10 in Puerto Rico: Devised new techniques to delineate in three dimensions the geometry of sinkholes. In addition, the ground-water flow rates into and through these sinkholes was investigated using vertical and horizontal borehole geophysical techniques.

The above are a representative sample of over 400 projects completed for which formal reports were submitted.

Served as a consultant for seismology to the Tennessee Valley Authority (1971-present) and also as a consultant to the electric utilities included in the Nuclear Power Plant Systematic Evaluation Program (SEP) for older power plants; devised new techniques for site dependent response spectra studies for several sites included in this program. Member of the Ad Hoc Power Industry Committe for review of and comments on geology and seismology criteria in siting nuclear power plants (Appendix "A") (1969-1972).

Conducted studies on the effects of underwater and underground blasting, including the measurement and control of the resulting ground vibration levels to prevent damage.

Selected and Representative Publications/Presentations:

Engineering Seismology Applications in Deep Weathered Rock Areas, Murphy, V.J. and Holt, R.J., First Pan American Conference on Soil Mechanics and Foundations Engineering, Mexico, D.F., September 1959.

Characteristics and Properties of Extreme Seismic Events, Air Force Cambridge Research Laboratories, Office of Aerospace Research, 1966.

Seismic Velocities and Elastic Moduli Measurements, Mount Holyoke Range, Massachusetts, U.S.A., Murphy, V.J. and Holt, R.J., Proceedings of the First Congress of International Society of Rock Mechanics, Lisbon, Portugal, 1966.

The In Situ Measurement of Compressional and Shear Wave Velocities for Use in Foundation Design, Murphy, V.J. and Holt, R.J., Dynamic Problems in Engineering Geology, Engineering Geology Division - ASCE-GSA Joint Committee Symposium, November 1969.

Vibration Modulus of Normally Consolidated Clay, Whitman, R.V., Murphy, V.J., and Holt, R.J., Transactions of the American Society of Civil Engineers, January 1969.

Earthquakes and Mafic Plutons: Some Instrumental Data, Leblanc, G. and Holt, R.J., Geotechnology in Massachusetts, March 1980.

Geophysical Studies and Measurements in Eastern Massachusetts, Murphy, V.J. and Simmons, G., Holt, R.J., et al., Geotechnology in Massachustts, March 1980.

Northeastern United States and Eastern Canadian Moderate and Large Earthquake Zones and Their Geophysical Characteristics, Holt, R.J., Klimkiewicz, G.C., Leblanc, G., Imse, J., and Turner, P. Paper presented to the Society of Exploration Geophysicists, October 7, 1985.

TABLE 1

RECENT EARTHQUAKES
IN THE SITE VICINITY

DATE	ORIGIN TIME (1)	LATITUDE	LONGITUDE	PRELIMINARY DEPTH (KM)	MAGNITUDE
22-JANUARY-1983	07:46:57.9	41°51.24'	81°11.46'	5	$2.7M_{bLg}$ (2)
31-JANUARY-1986	16:46:42.3	41°38.84'	81°05.30'	10	$4.9\ M_b$ (3)
01-FEBRUARY-1986	18:54:49.7	41°38.39'	81°09.99'	3.1	--
02-FEBRUARY-1986	03:22:49.1	41°38.37'	81°09.81'	2.3	--
03-FEBRUARY-1986	19:47:19.6	41°39.19'	81°10.27'	9	--
05-FEBRUARY-1986	06:34:02.4	41°39.93'	81°09.11'	6	--
06-FEBRUARY-1986	18:36:22.6	41°38.66'	81°09.80'	5	2.4

(1) UNIVERSAL Time Unless Noted As Local Time

(2) SOURCE: University of Michigan

(3) SOURCE: National Earthquake Information Center (NEIC)

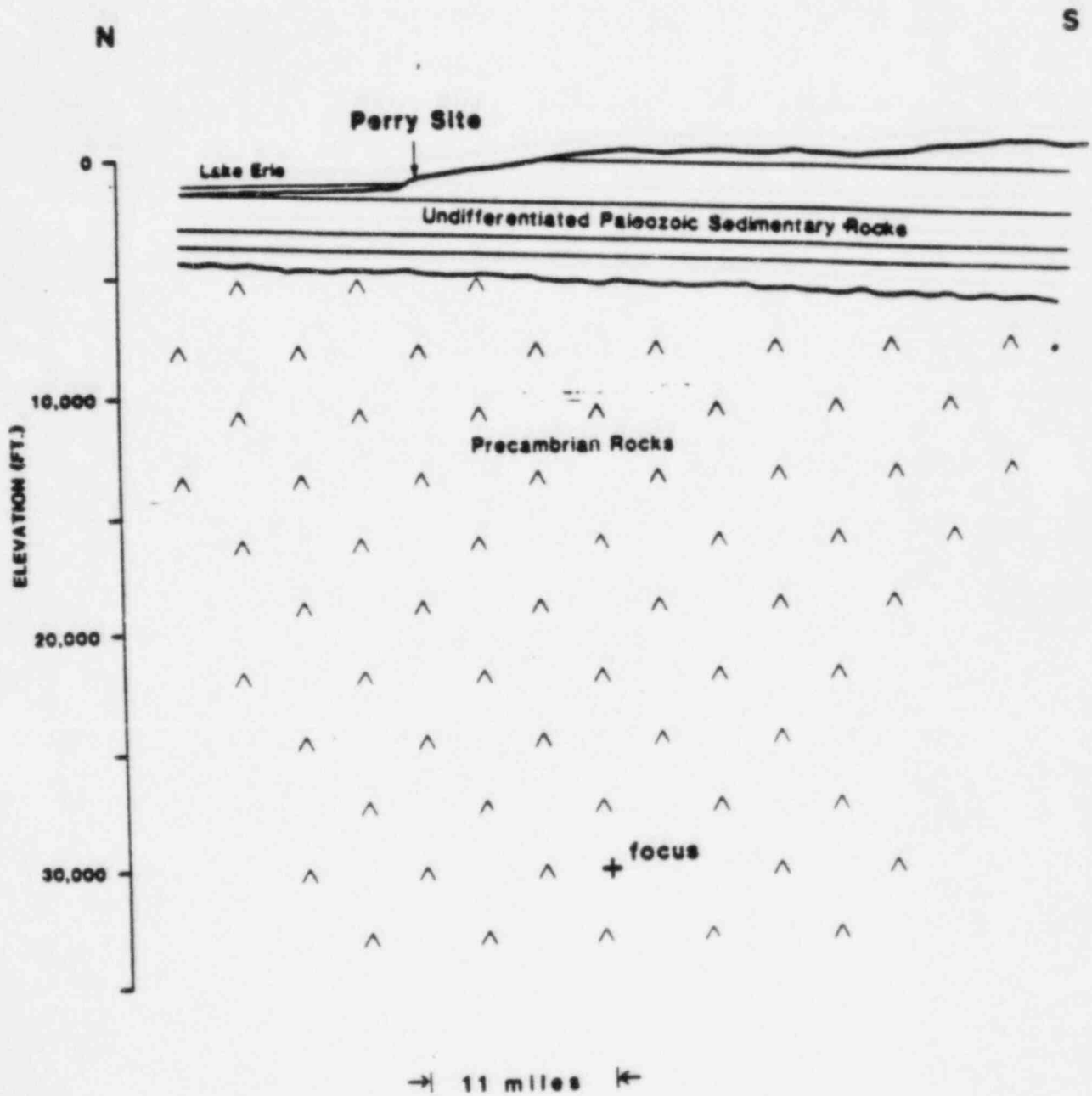

N
S
Perry Site
Lake Erie
Undifferentiated Paleozoic Sedimentary Rocks
0
10,000
20,000
30,000
ELEVATION (FT.)
Precambrian Rocks
focus
11 miles

FIGURE 1

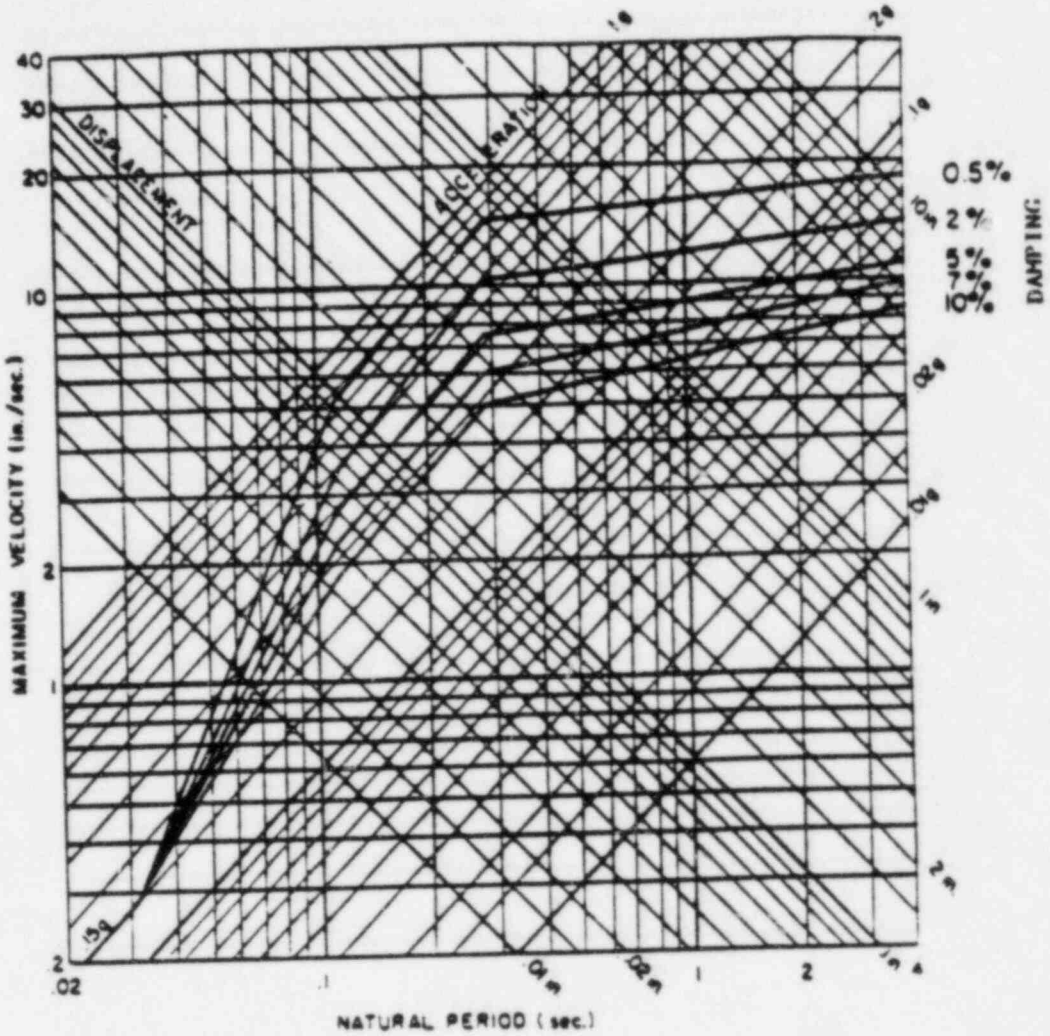


FIGURE 2

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Safe Shutdown Earthquake
Design Response Spectra -
Vertical Motion

Figure 3.7-2

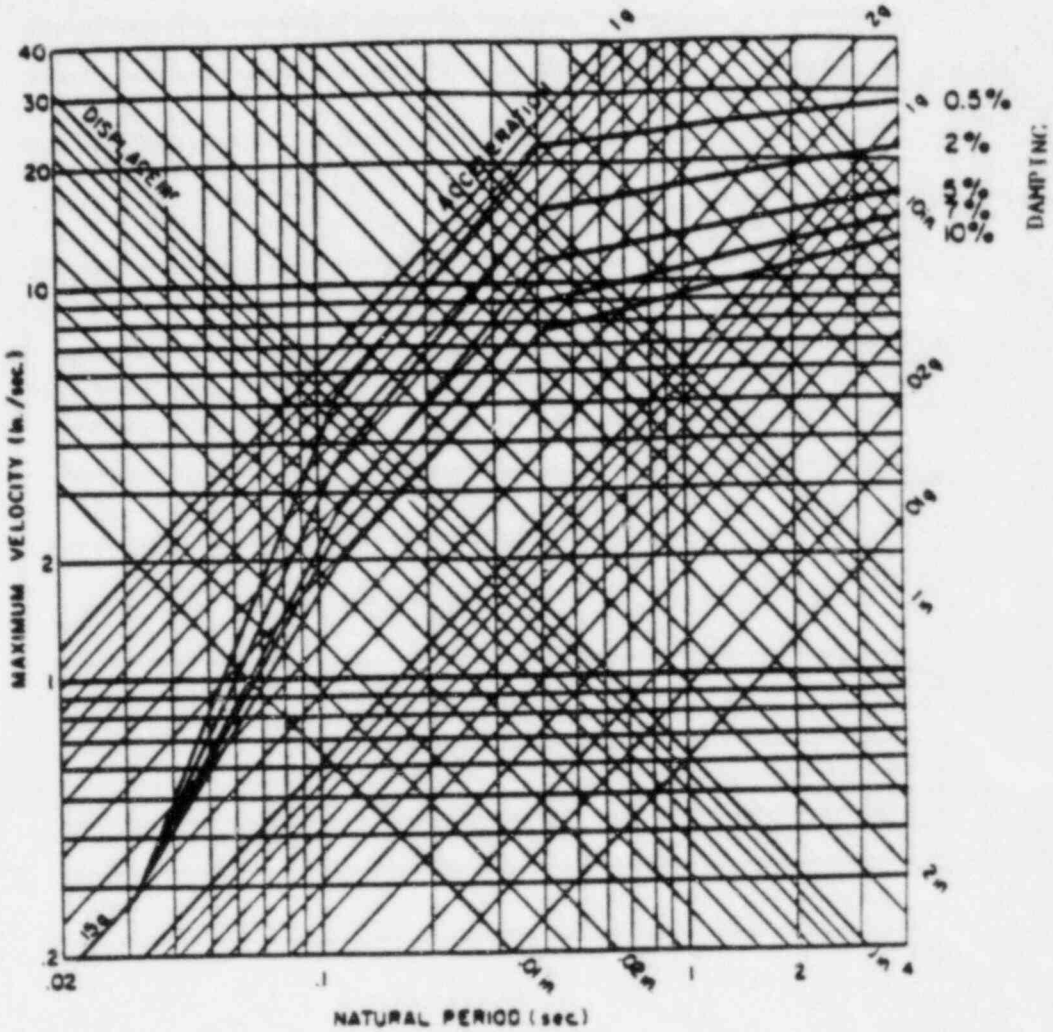
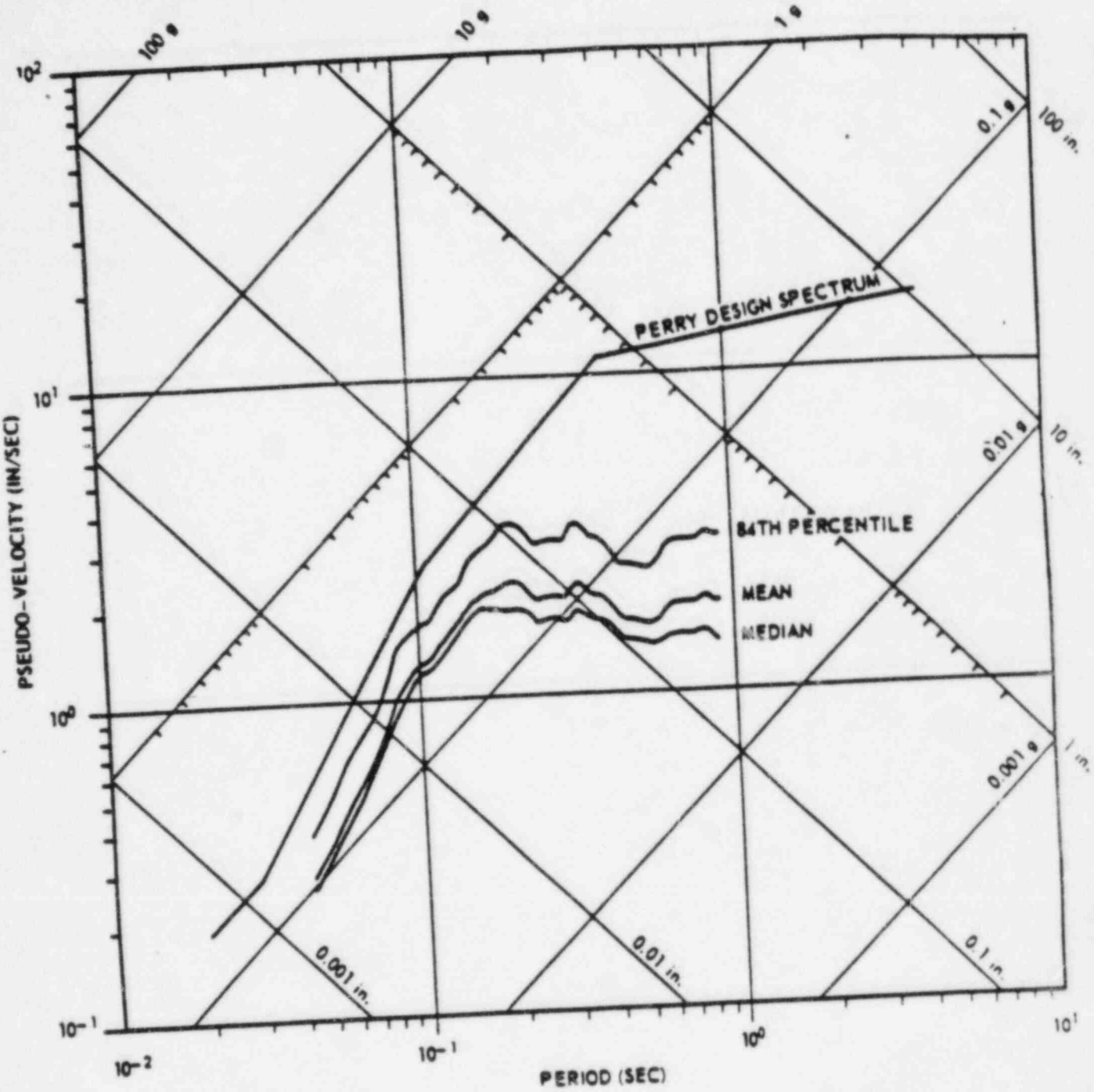


FIGURE 3

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Safe Shutdown Earthquake
Design Response Spectra -
Horizontal Motion

Figure 3.7-1



MEDIAN, MEAN AND 84TH PERCENTILE RESPONSE SPECTRA FOR PERRY (ROCK) SITE. (BASIC SUBSET, 5% DAMPING)

$\beta_{DLG} = 5.3 \pm .5$

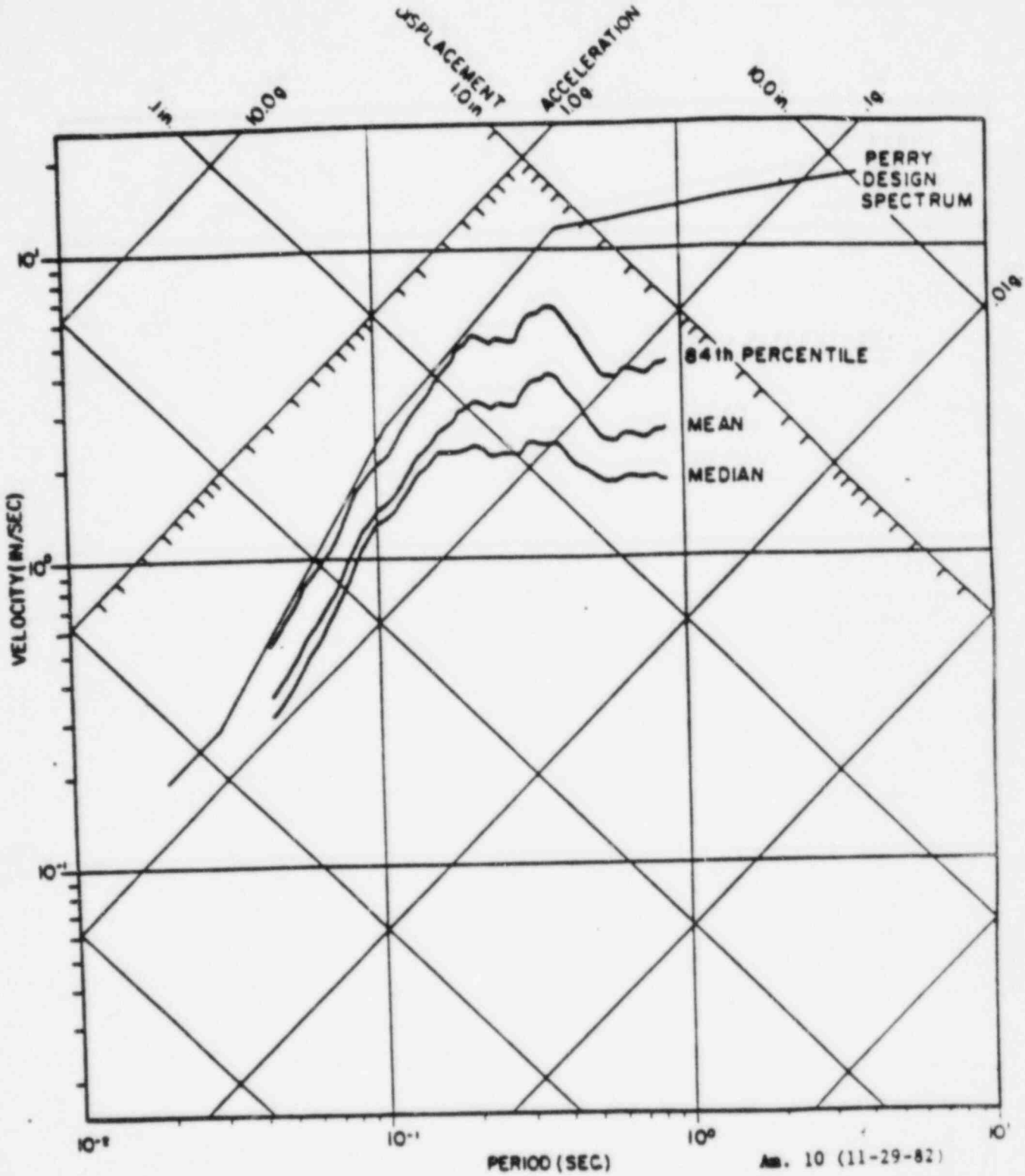
Am. 10 (11-29-82)

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Figure 230.6-2

Q6R 2.5-37

FIGURE 4



MEDIAN, MEAN AND 84TH PERCENTILE
RESPONSE SPECTRA FOR PERRY (ROCK) SITE
(Basic Subset, Parkfield Included, 5% Damping)

m_{bLG} = 5.53 ± .3

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Figure 230.6-5

Q&R 2.5-40

FIGURE 5

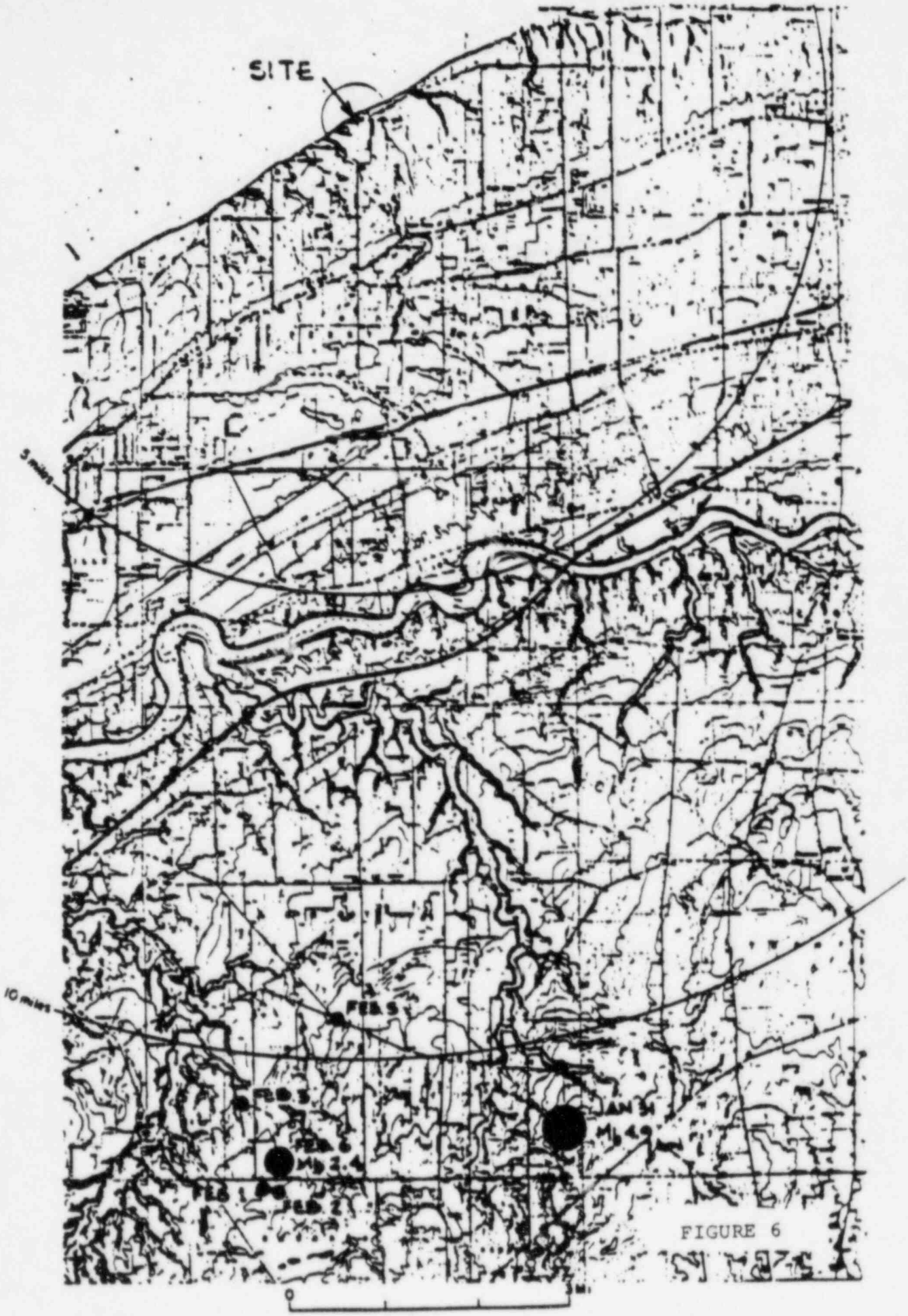
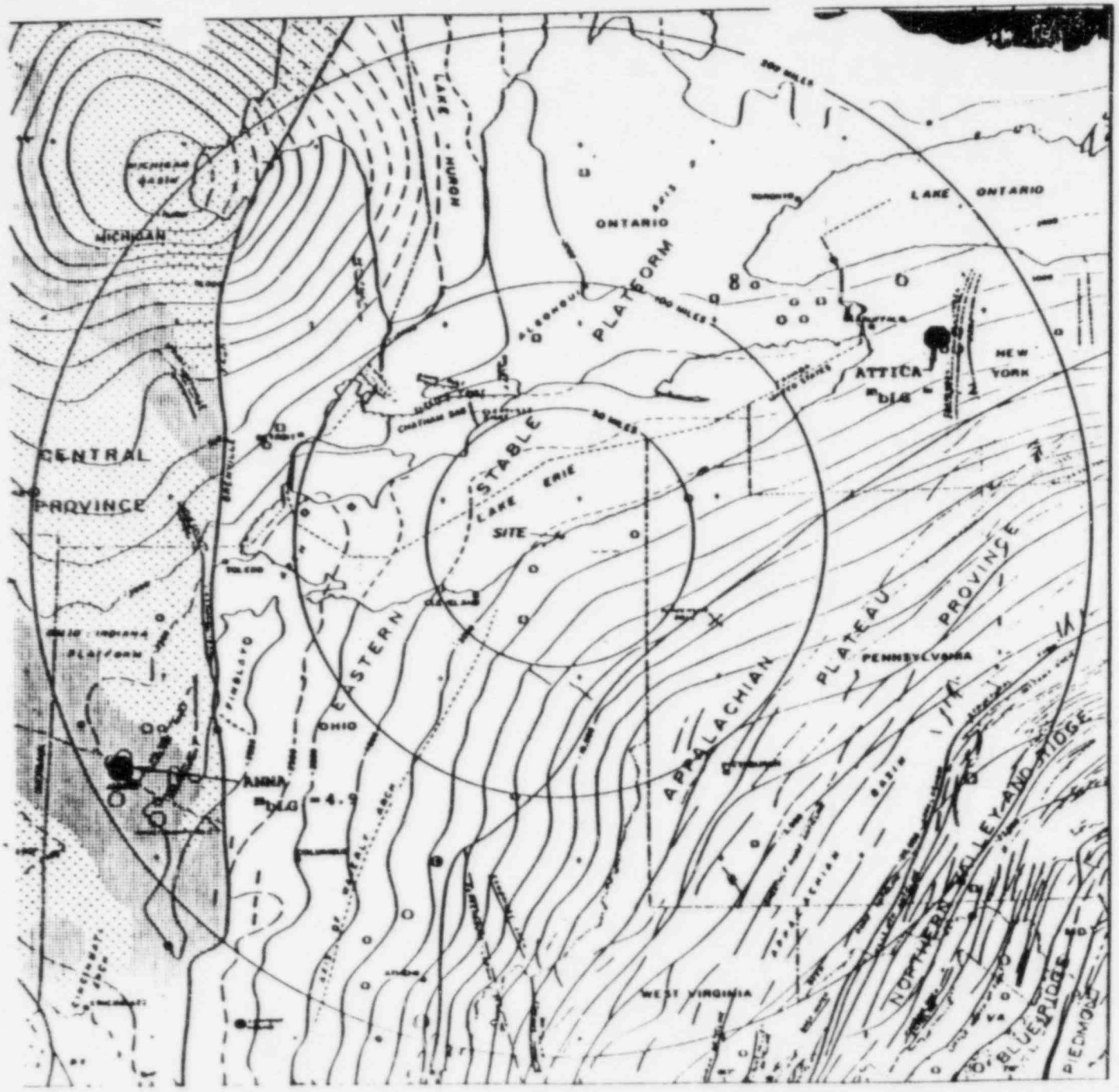


FIGURE 6



REGIONAL TECT ELEMENTS

Grenvillian Basement - Age ... and 950 million years (Shaded: Exposed, Non patterned: Buried)

Keweenawan Basement - Ages around 1100 million yrs

Elsonian Basement - Ages around 1450 million years

Structure contours in feet drawn on the top of Precambrian basement surface

Thrust fault - teeth on upper plate

Normal fault - hatchures on downthrown side

High angle fault

Inferred fault

Anticlinal axis

Synclinal axis

Intensely disturbed "Cryptoexplosive" structure

(Primary basement structure sources: Bayley & Muehlberger, 1968; Hinze et al, 1972; Owens, 1967)

0 50 100 150 200 Kilometers

REGIONAL TECTONIC PROVINCES

PROVINCE BOUNDARY

EARTHQUAKES

MAGNITUDE

INTENSITY

FIGURE 7

Am. 10 (11-29-82)

PERRY NUCLEAR POWER
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Regional Tectonics - Earthquake Tectonic Provinces

Figure 2.5-59

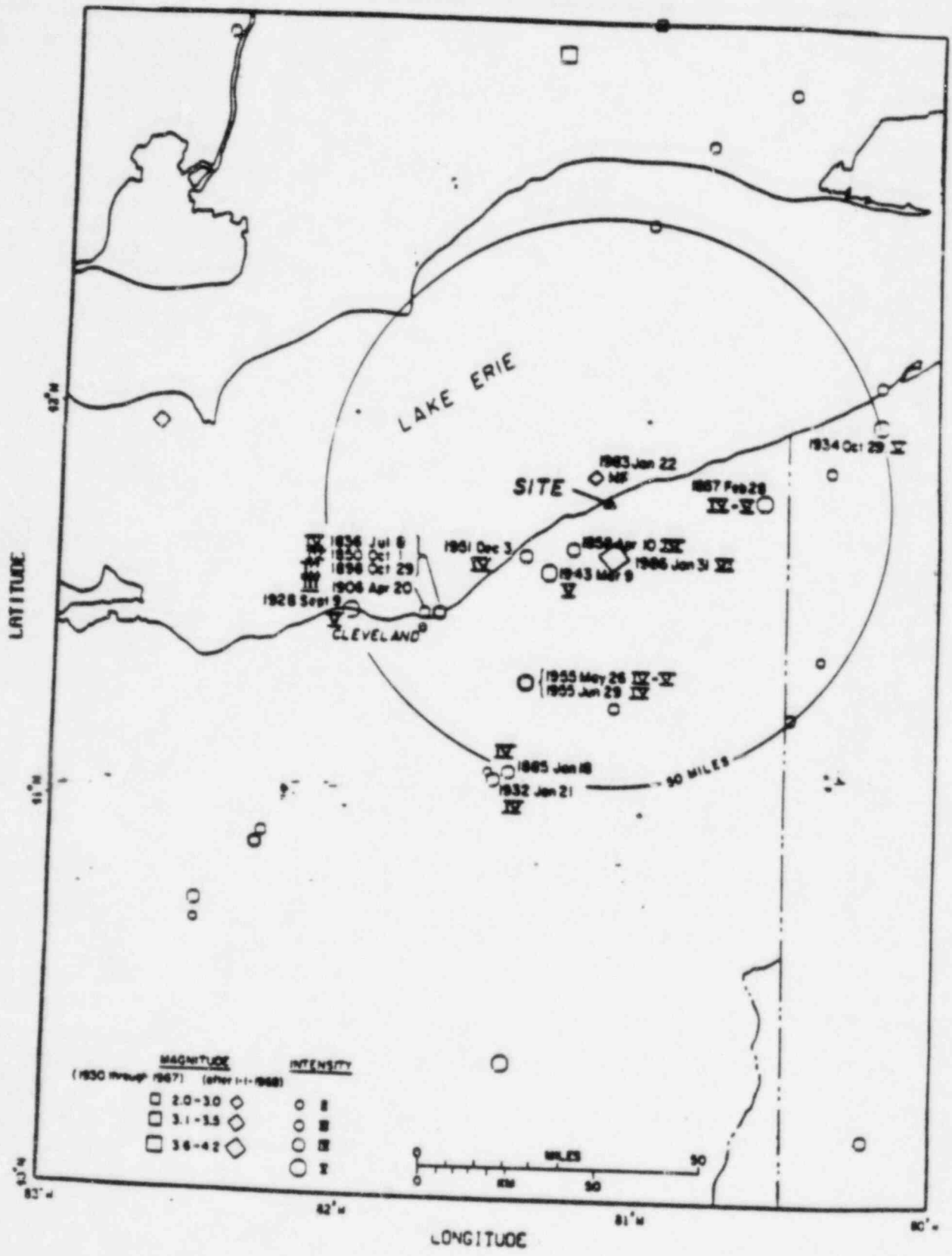

LAKE ERIE
SITE
CLEVELAND
1983 Jan 22
1867 Feb 28
1934 Oct 29
1951 Dec 3
1956 Apr 10
1986 Jan 31
1943 May 9
1955 May 26
1965 Jun 29
1865 Jan 18
1932 Jan 21
1936 Jul 6
1850 Oct
1898 Oct 29
1904 Apr 20
1928 Sept 9
90 MILES
MAGNITUDE
(1930 through 1967) (after 1-1-1968)
2.0-3.0
3.1-3.5
3.6-4.2
INTENSITY
MILES
LATITUDE
LONGITUDE
82°W
81°W
80°W

FIGURE 8

ATTACHMENT 3