UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Appeal Board

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

AFFIDAVIT OF DR. JOHN D. STEVENSON

City of Washington)
: ss:
District of Columbia)

Dr. John D. Stevenson, being duly sworn, deposes and says as follows:

1. I, John D. Stevenson, am President of Stevenson & Associates ("S&A"). My business address is 9217 Midwest Avenue, Cleveland, Ohio 44125. S&A, which I founded in 1981, specializes in design analysis for extreme loads associated with earthquakes, tornados, and other phenomena resulting in high stress. S&A has performed extreme load analysis for over 20 domestic and foreign nuclear power plants.

2. A copy of my professional qualifications is attached hereto as Exhibit "A." As indicated therein, I hold a B.S. degree in Civil Engineering from Virginia Military Institute

(1954), and M.S. (1962) and Ph.D (1968) Civil Engineering degrees from Case Institute of Technology in Cleveland, Ohio. I am a member of numerous professional societies. Among these, I am currently Chairman of the Executive Committee of the Technical Council on Codes and Standards of the American Society of Civil Engineers ("ASCE"), which has over 5000 members. In this position, I have the overall management responsibility for the development of all ASCE codes and standards. In addition, I serve as Chairman of the ASCE Nuclear Standards Committee, which develops all ASCE nuclear standards. In this position, I had overall responsibility for the development of American National Standards Institute Standard N-725 (Design and Analysis of Earth Structures In Nuclear Service). The Committee is currently developing a standard for seismic design and analysis of nuclear safety class structures.

3. In addition to these affiliations, I am currently U.S. representative to International Atomic Energy Agency and International Standards Committee working groups, which have developed international seismic design standards for nuclear power plant facilities.

4. As indicated in Exhibit A hereto, I have authored numerous publications on the subject of seismic design and analysis. These include a number of recent papers discussing seismic design and analysis of nuclear power plant structures and equipment. I have recently served as a consultant to the U.S. Nuclear Regulatory Commission, in development of a

comprehensive report on seismic design of nuclear power plant piping.

5. Following the January 31, 1986 earthquake that occurred in the vicinity of the Perry Nuclear Power Plant, I was asked by the Cleveland Electric Illuminating Company ("CEI") to analyze the data provided by seismic recorders installed at various locations in the Perry plant, and to determine: (1) how the earthquake parameters, as recorded by the instrumentation at the site, compare to those for the Safe Shutdown Earthquake (SSE) and Operating Basis Earthquake (OBE) postulated in the design of the Perry plant's buildings, systems and components; (2) the structural significance of the readings by the seismic recorders at the Perry site during the January 31, 1986 earthquake; and (3) the anticipated impact of the earthquake on the plant's buildings, systems and components.

6. After a physical walkdown of the site, analysis of data recorded by the seismic instrumentation, and discussions with plant technical and operating personnel, I prepared a report of my conclusions regarding the earthquake and its significance for the Perry Plant. A copy of my report ("A Preliminary Evaluation of the Significance of the Seismic Event on January 31, 1986," dated February 10, 1986), is attached hereto as Exhibit "B."

7. As set forth in Exhibit B, the zero period accelerations (ZPA's) recorded during the earthquake in some cases exceeded the design basis ZPA's. However, if the appropriate

adjustment is made to take into account the short duration and low energy of the seismic event, the average elastic response ZPA's are less than SSE ZPA's in all cases, and with one exception equal to or less than one-third of OBE design values (and approximately equal to OBE values in the remaining case). The exceedences are therefore not significant from an engineering standpoint. No damage to safety-related structures, systems and equipment would have been expected from the 1986 earthquake and none has been found. I conclude, therefore, that the 1986 earthquake does not call into question the adequacy of the seismic design of the Perry plant.

8. The information and conclusions set forth in this Affidavit and in the accompanying Exhibits is true and correct to the best of my knowledge and belief.

John D. Stevenson

John D. Stevenson

Subscribed and sworn to before me
this 13th day of February, 1986.

Toryn H. Earwaker

Notary Public

My Commission Expires:

My Commission Expires May 14, 1990

EXHIBIT "A"

JOHN D. STEVENSON

EXPERIENCE:

PRESIDENT - MANAGING PARTNER

Since November 1981, Dr. Stevenson has managed and has served as President and Senior Consultant to Stevenson & Associates. The firm specializes in high technology consulting and forensic engineering associated with failure analysis of structural and mechanical systems; extreme loads; and nonlinear, dynamic, and probabilistic high temperature analyses.

VICE-PRESIDENT - GENERAL MANAGER 1976 - 1981

As Vice-President, Dr. Stevenson managed and served as Senior Engineering Consultant to the Cleveland Offices of Woodward-Clyde Consultants and Structural Mechanics Associates specializing in areas of high technology applicable to the structural-mechanical design and analysis of systems and components. Prior to this time, the consulting group he headed provided similar services as a Division of Davy-McKee Co. Dr. Stevenson also served as Corporate Manager of Engineering Quality Assurance for Davy-McKee Co.

ASSOCIATE PROFESSOR AND PRINCIPAL MANAGER OF EASTERN OPERATIONS 1974 - 1976

Case Western Reserve University, CWRU, and EDAC, Inc., Cleveland, Ohio.

As an Associate Professor at CWRU, Dr. Stevenson served as Director of a program in Design for the Extreme Load Environment and held a joint appointment in the Departments of Civil Engineering and Mechanical Design. He also conducted a number of seminars on Seismic Quality Assurance Scheduling and Manpower Requirements and Mechanical and Electrical Equipment Pipe and Duct Design of Industrial Facilities. Dr. Stevenson was a Principal and managed one of three consulting offices for Engineering Decision Analysis Corp., Palo Alto, California. He was active in marketing and providing consulting services in the area of extreme load, seismic, tornado, high energy systems rupture, and component failure analysis.

CONSULTANT 1973 - 1974

Westinghouse Nuclear Energy Systems, Pittsburgh, Pennsylvania.

As a Consulting Engineer for Westinghouse Nuclear Energy Systems, Dr. Stevenson acted as an advisor to the Technical Director on the Executive Vice-President for Nuclear Power Staff. He performed evaluations of balance of plant requirements associated with nuclear power plant design and constructed and represented Westinghouse on a number of Industry Committees associated with nuclear power.

CONSULTANT
1972 - 1973

Westinghouse Water Reactor Divisions,
Pittsburgh, Pennsylvania.

As an Advisory Engineer for the Westinghouse Standard Plant Project, Dr. Stevenson acted as a consultant to the Manager of the Westinghouse Standard Plant Project. In this capacity he had responsibility for determining interface requirements with site-related design parameters and set envelope requirements for the standard plant design. He was responsible for nuclear island PSAR text developments and AEC licensing requirements associated with the standard plant layout development.

ADJUNCT PROFESSOR
AND PRESIDENT
1970 - 1972

University of Pittsburgh and NSSA Inc.,
Pittsburgh, Pennsylvania.

As a member of the Civil Engineering Facility of the University of Pittsburgh, Dr. Stevenson was particularly active in the areas of structural dynamic response to earthquake, tornado, missile and fluid jet effects as well as reliability and risk analysis and optimum design of structural systems. Dr. Stevenson was responsible for the development of a graduate study program for the study of structural design and analysis for the extreme load environment.

Dr. Stevenson founded and served as President and Managing Director of Nuclear Structural Systems Associates, Inc. During this period, the firm served as consultants to the nuclear power industry, particularly in the areas of structural and mechanical design and licensing of nuclear plant facilities. Dr. Stevenson was active in developing Standard Plant design concepts and also conducted engineering design seminars for the nuclear industry throughout the U.S., Europe and Japan for over 500 representatives of over 150 companies.

MANAGER STRUCTURAL
SYSTEM ENGINEERING
1968 - 1970

Westinghouse PWR Systems Division,
Pittsburgh, Pennsylvania.

Dr. Stevenson had overall responsibility within Westinghouse for the development and approval of structural design criteria and layout used in the design of the six nuclear power stations for which Westinghouse had prime design and construction responsibility for product line management of design and development of support structures for major nuclear components.

LEAD ENGINEER 1966 - 1968	Westinghouse PWR Systems Division, Pittsburgh, Pennsylvania. As Lead Engineer, Dr. Stevenson was responsible for liaison with the various architect-engineer-constructor firms which performed the detailed structural design and construction of turnkey plants, and as such he was responsible for design review and approval. Dr. Stevenson was active in representing Westinghouse structural design policy before the Atomic Energy Commission and Advisory Committee on Reactor Safeguards.
GRADUATE STUDENT 1963 - 1966	Case Institute of Technology, Cleveland, Ohio. Work toward a Ph.D. in Structures with emphasis on computer applications and risk analysis applied to structural design.
RESEARCH ENGINEER 1962 - 1963	I.I.T. Research Institute, Chicago, Illinois. Responsibilities included integrated radiation, structural and operational analysis and minimum cost design of nuclear blast resistant underground structures.
ASSISTANT PROFESSOR 1957 - 1962	Virginia Military Institute, Lexington, Virginia. Courses in structural design of concrete and steel structures were taught to Civil Engineering undergraduates. John Hopkins University, Baltimore, Maryland (Part-Time) Research Assistant. Responsibilities included report editing and research in the location, type quantity and packaging of low level solid atomic wastes.
FIELD ENGINEER 1956 - 1957	McDowell Construction Co., Cleveland, Ohio Field Engineer responsible for Technical Supervision and engineering field modifications to construction of a Sintering Plant for U.S. Steel Corp. Youngstown Works.

Dr. Stevenson has been particularly active in the review and evaluation of design adequacy of structures and equipment in nuclear power plants and other industrial facilities. Particular projects where he personally performed such evaluations include the following:

Nuclear Power Plants:

Indian Point Units 2 & 3
H.B. Robinson
R.E. Ginna
Point Beach
Dresden 2
Monticello
D. C. Cook
Palisades
Oyster Creek
Millstone
South Texas Project
Fessenheim - France
Cordoba - Argentina
Mihama - Japan
Conn. Yankee
Maine Yankee
Midland

Other Industrial Facilities:

Tokamac Fusion Test Facility
Purex Facility Hanford
Rocky Flats Processing Facility
Centrifuge Plant
Granger Soda Ash Plant
LMFBR
Hercules Polypropalene Plant
Shuichang Steel Complex
Touss Oil Fired Power Station
Hanford Coal Fired Power Station
Addy Ferro Silicate Plant
Killen Coal Fired Power Station
LNG Storage Facilities - U.S.

EDUCATION:

B.S. - Civil Engineering - Virginia Military Institute, 1954

AEC Institute on Nuclear Engineering - Purdue University, Summer 1960

M.S. - Civil Engineering - Case Institute of Technology, 1962

Ph.D. - Civil Engineering - Case Institute of Technology, 1968

PROFESSIONAL:	1.	Member:	American Society of Civil Engineers
		Chairman:	Executive Committee Technical Council Codes And Standards
		Chairman:	Nuclear Standards Committee
		Member:	Structural Division Committee on Nuclear Safety
		Member:	Structural Division Committee on Nuclear Structures and Materials
	2.	Member:	American Concrete Institute
		Member:	Joint ACI-ASME Subgroup on Design of Concrete Components in Nuclear Service, ASME BPVC-Section III-Div. 2, Corresponding Consultant ACI 349 Safety Class Concrete Structures
	3.	Member:	American Society of Mechanical Engineers
		Member:	Subgroup on Design of ASME BPVC-Section III-Div. 1 Nuclear Components
		Member:	Subcommittee on Qualification of Mechanical Components in Nuclear Service
	4.	Member:	Nuclear Standards Management Board of ANSI representing ASCE
	5.	Member:	U.S. Respresentative International Standards Committee SC 85/3/7 on Seismic Criteria for Nuclear Plants
	6.	Member:	U.S. Representative International Atomic Energy Agency Working Group on the Development of Seismic Design Standards
	7.	Vice Chairman:	ANS-2, American Nuclear Society Committee on Site Evaluation
		Member:	NUPPSCO, American Nuclear Society Committee on Nuclear Power Plant Codes and Standards
	8.	Member:	AISC, American Institute of Steel Construction Committee on Specifications for Structural Steel in Safety Class Nuclear Structures
	9.	Member:	Earthquake Engineering Research Institute
	10.	Register Professional Engineer: Virginia, Pennsylvania, and Ohio	
	11.	Winner:	Moiseiff Award - ASCE, 1971

PUBLICATIONS:

1. Stevenson, J.D., and Haga, P.G., "Pressurized Water Reactor Containment Structures Design Experience," Journal of the Power Division, ASCE, Vol. 96, No. PO 1, Proc. Paper 7037, January 1970.

2. Moses, F., and Stevenson, J.D. "Reliability Based Structural Design," Journal of the Structural Division, ASCE, Vol. 96, No. ST 2, Proc. Paper 7072, February 1970.

3. Stevenson, J.D., and Moses, F. "Reliability Analysis of Frame Structures," Journal of the Structural Division, ASCE, Vol. 96, No. ST 11, Proc. Paper 7692, November 1970.

4. Stevenson, J.D., "Criteria and Design of Pressurized Water Reactor Coolant System Support Structures - State-of-the-Art," First International Conference on Structural Mechanics in Reactor Technology, Berlin, Germany, September 1971.

5. Stevenson, J.D., and Abrams, J.I., (Editors) "Proceedings of Symposium on Structural Design of Nuclear Power Plant Facilities," University of Pittsburgh, 1972.

6. Stevenson, J.D., "Seismic Design of Small Diameter Pipe and Tubing for Nuclear Power Plants," Proc. 5th World Conference on Earthquake Engineering, Rome, June 1973.

7. Stevenson, J.D., "Containment Structures for Pressurized Water Reactor Systems: Past, Present, and Future State-of-the Art," Proc. 2nd International Conference on Structural Mechanics in Reactor Technology, North Holland Publishing Company, 1973.

8. Stevenson, J.D. (Editor), "Proceedings of Symposium on Structural Design of Nuclear Power Plant Facilities," ASCE Speciality Conference, Chicago, December 1973.

9. Stevenson, J.D. and LaPay, W.S. "Amplification Factors to be Used in Simplified Seismic Dynamic Analysis of Piping Systems," Proc. Pressure Vessel and Piping Conference, ASME, June 1974.

10. Stevenson, J.D. (Editor), "Proceedings of Second ASCE Speciality Conference on Structural Design of Nuclear Power Plant Facilities," New Orleans, December 1975.

11. Stevenson, J.D., "Rational Determination of Operational Basis Earthquake and its Impact on Overall Safety and Cost of Nuclear Facilities," Nuclear Engineering and Design, Vol. 135, North Holland Publishing Company, 1975.

12. Stevenson, J.D. "Survey of Extreme Load Design Regulatory Agency Licensing Requirements for Nuclear Power Plants," Nuclear Engineering and Design, Vol. 36, North Holland Publishing Company, 1976.

13. Stevenson, J.D., "External Hazards in Reliability and Risk Assessment of Nuclear Power Plants," Proceeding 2nd International Conference on Structural Safety and Reliability, Munich, Sept. 1977.

14. Stevenson, J.D., "Preliminary Design of a Containment to Withstand Core Melt for a 1300 MWe LWR System," Nuclear Engineering and Design, Vol. 48, North Holland Publishing Company, June 1978.

15. Stevenson, J.D., "The Economic Effect of Increased Seismic Load on Nuclear Power Plant Design and Construction Costs," Nuclear Engineering and Design, Vol. 48, North Holland Publishing Company, June 1978.

16. Stevenson, J.D., "Research Needs Associated with Seismic Load on Nuclear Power Plants," Nuclear Engineering and Design, Vol. 50, North Holland Publishing Co., October 1978.

17. Stevenson, J.D. (Editor), "International Seminar on Probabilistic and Extreme Load Design of Nuclear Plant Facilities," Presented August 22-24, 1977 by SMIRT 4 and ASCE, March 1979.

18. Stevenson, J.D., "Standards - Status and Development in the Nuclear Industry," Proceedings of ASCE Speciality Conference on Design of Nuclear Plant Facilities, Boston, April 1979.

19. Stevenson, J.D., "Probabilistic Analysis of Nuclear Containment Structures to Resist Seismic Loads," Proceedings of ASCE Speciality Conference on Design of Nuclear Plant Facilities, Boston, April 1979.

20. Bergman, L.A. and Stevenson, J.D., "The Effects of Support Stiffness Upon the Response of Piping Systems," Presented at ASME National Congress on Pressure Vessels and Piping, June 1979.

21. Gorman, M. and Stevenson, J.D., "Probability of Failure of Piping Designed to Seismically Induced Emergency and Faulted Condition Limits," to be Presented 5th SMIRT Conference, Berlin, Germany, August 1979.

22. Stevenson, J.D. Chairman, Editing Board, Structural Analysis and Design of Nuclear Plant Facilities, ASCE Manuals and Reports on Engineering Practice - No. 58, American Society of Civil Engineers, August 1980.

23. Stevenson, J.D., "Structural Damping Values as a Function of Dynamic Response Stress and Deformation Levels," Nuclear Engineering and Design, Vol. 60 No. 2, September 1980.

24. Stevenson, J.D. "Nuclear Standards Applicable to the Civil-Structural Design of Nuclear Power Plants," Proceedings of Speciality Conference on Experience with the Implementation of Construction Practices, Codes Standards, and Regulations in Construction of Power Generating Facilities, Pennsylvania State University, September 1981.

25. Stevenson, J.D. and Thomas, F.A., "Selected Review of Foreign Licensing Practices for Nuclear Power Plants," NUREG/CR-2664, U.S. Nuclear Regulatory Commission, April 1982.

26. Stevenson, J.D. and Thomas, F.A., "Selected Review of Regulatory Standards and Licensing Issues for Nuclear Power Plants," NUREG/CR-3020, U.S. Nuclear Regulatory Commission, November 1982.

27. Stevenson, J.D. and Thomas, F.A., "Selected Review of Foreign Safety Research for Nuclear Power Plants," NUREG/CR-3040, U.S. Nuclear Regulatory Commission, November 1982.

28. Stevenson, J.D., "Use of the Delphi Approach in Seismic Qualification of Existing Electrical and Mechanical Equipment and Distribution Systems in Industrial Facilities," Proceedings of the 6th Japan Earthquake Engineering Symposium - 1982, Tokyo, Japan, December 1982.

29. Stevenson, J.D. and Thomas, F.A., "Selected Review and Evaluation of U.S. Safety Research Vis-a-Vis Foreign Safety Research for Nuclear Power Plants," NUREG/CR-3212, U.S. Nuclear Regulatory Commission, March 1983.

30. Stevenson, J.D., "Seismic Design of Nuclear Plant Facilities at Low Seismicity Sites," Lawrence Livermore Laboratories Sponsored Conference on Seismic Design of Industrial Facilities, San Francisco, May 1983.

31. Hall, W.J., Kennedy, R.P. and Stevenson, J.D., "Nuclear Power Plant Seismic Design - A Review of Selected Topics," Paper K 14/1 Presented at the 7th International Conference on Structural Mechanics in Reactor Technology, Chicago, Ill., August 1983. (Submitted for Publication in Nuclear Engineering and Design)

32. Stevenson, J.D., "Designing for Extreme Loads - The Impact on Cost and Schedule", Nuclear Engineering International, July 1984

33. Stevenson, J.D., "A Review of Procedures Available to Seismically Requalify Operating Nuclear Plant Structures, Equipment and Distribution Systems", Paper K 936 To be Presented at 8th SMIRT, August 1985

34 Stevenson, J.D. "A Summary of Snubber Failure Experience in Nuclear Power Plant Facilities", Paper F1 935, To be Presented at 8th SMIRT, August, 1985

35. Stevenson, J.D., "Rational Seismic Design of Nuclear Power Plant Piping at Low and Moderate Seismicity Sites", Paper K937, To Be Presented at 8th SMIRT, August 1985

EXHIBIT "B"

STEVENSON & ASSOCIATES

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Document Number 861401-1
Revision 0 -- 2/10/86

A PRELIMINARY EVALUATION OF THE SIGNIFICANCE OF THE SEISMIC EVENT ON JANUARY 31, 1986 ON THE PERRY NUCLEAR POWER PLANT

February 10, 1986

Perry Nuclear Power Plant
Cleveland Electric Illuminating Co.
10 Center Road
Perry, Ohio 44080

PREPARED BY:

Stevenson and Associates
9217 Midwest Avenue
Cleveland, Ohio 44125
(216) 587-3805

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1.0 INTRODUCTION

On January 31, 1986, at 11:47 a.m. EST, a brief (approximately 0.75 second strong motion duration) and shallow (10 km focal depth) earthquake with a 4.9 m_b magnitude occurred. Its epicenter was south of Lake Erie, at a distance of approximately eleven (11) miles from the Perry Nuclear Power Plant site at Perry, Ohio.

Stevenson and Associates was retained to analyze the data provided by seismic recorders installed at various locations in the Perry plant, and determine: (1) how the earthquake parameters, as recorded by the instrumentation at the site, compare to those for the Safe Shutdown Earthquake (SSE) and Operating Basis Earthquake (OBE) postulated in the design of the Perry plant's buildings, systems and components; (2) the structural significance of the readings by the seismic recorders at the Perry site during the January 31, 1986 earthquake; and (3) the anticipated impact of the earthquake on the plant's buildings, systems and components.

This report contains Stevenson and Associates' preliminary evaluation of the above-described matters. It is based on a physical walkdown of the site, analysis of data recorded by the seismic instrumentation, and discussions with plant technical and operating personnel. Since some of the evaluations of the earthquake are still underway, this report may be supplemented and/or revised at a later date if new information developed during these ongoing activities so warrants.

A resume of the qualifications and experience of Stevenson and Associates is included as Attachment 1 to this report.

2.0 SEISMIC INSTRUMENTATION AT THE PERRY PLANT

The earthquake motion at the Perry site was recorded by three different types of instrumentation. One type of recorder is the Kinemetrics Model SMA-3 strong motion time history recording accelerograph; this system detects and records the three orthogonal components of acceleration signals over the duration of an earthquake. Another type of instrumentation is the Engdahl PSR 1200-H/V response spectrum recorder, which provides the respons at selected frequencies in three orthogonal directions. The third type of instrumentation is the Engdahl PAR 400 peak accelerograph, which records the three orthogonal components of peak local accelerations produced by the earthquake. The locations and readings taken by these systems will be discussed separately below.

2.1 Locations and Readings by the Kinemetrics SMA-3 Accelerographs

Two Kinemetrics SMA-3 strong motion time history recording accelerographs installed at the Perry plant provided time history data on the earthquake. One system is located on the Unit 1 reactor containment concrete wall at the basemat at Elevation 575', as shown in Figure 1. The second system is attached to the steel containment vessel wall at Elevation 686', 111 feet above the first system and offset by less than one degree in Azimuth. The longitudinal axes of both instruments are in the N-S direction.

The time history motions recorded by these two systems are shown in Figures 2 through 8. A detailed interpretation of the readings from these recorders is contained in Reference 1.[1/]

The lower instrument (Elevation 575') gave a peak acceleration of 0.18g in the N-S direction, 0.10g in the E-W direction, and 0.11g in the vertical direction. The upper instrument (Elevation 686') gave a peak acceleration of 0.55g in the N-S direction, 0.18g in the E-W direction, and 0.30g in the vertical direction. It should be noted that both instruments are installed on cantilever brackets off the wall. While the brackets are quite heavy and relatively rigid, they are attached by four 3/8" diameter bolts, approximately 5 inches on center vertically and 8 inches horizontally. This arrangement may result in amplified bracket motion.

2.2 Locations and Readings of the Engdahl Response Spectra Recorders

There are four Engdahl PSR 1200-H/V triaxial response spectra recorders at the Perry plant. This type of recorder includes twelve reeds of different lengths and weights, one for each

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1/ References are listed at the end of this report.

frequency, fabricated from spring steel. A diamond-tipped stylus is attached to the free end of each reed to inscribe a permanent record of its deflection on one of twelve record plates. The record plates are aluminum, plated with successive layers of nickel, tin, and lead-tin.

The four PSR 1200-H/V recorders at the Perry plant are located as follows (all locations are for Unit 1):

1. <u>Reactor Building Foundation</u>: Elevation 574', Reactor Building foundation mat, Azimuth 210°. This recorder was most recently calibrated on January 14, 1985.

2. <u>Reactor Building Drywell Platform</u>: Inside the drywell platform at Elevation 630', Azimuth 240°, mounted as shown in Figure 9. This recorder was most recently calibrated on January 30, 1986.

3. <u>HPCS Pump Base Mat</u>: In the HPCS Pump Room, in the Auxiliary Building foundation mat, Elevation 574'. The equipment was being calibrated at the time of the earthquake. Previous calibration occurred on January 14, 1985.

4. <u>RCIC Pump Base Mat</u>: In the RCIC Pump Room in the Auxiliary Building foundation mat at Elevation 574'. The equipment was being calibrated at the time of the earthquake. Previous calibration was on January 14, 1985.

The readings taken by these four instruments are discussed in detail in Reference 2. Briefly stated, three of the four instruments provided response spectra which were consistent with each other and which were reasonable in light of the time history readings of the Kinemetrics instruments. The fourth spectra recorder, mounted inside the drywell on the Elevation 630' platform (see Figure 9), indicated vertical acceleration response components of .973g and 1.54g at frequencies of 20.2 and 25.4 Hz, respectively. These readings were 8 to 10 times higher than the corresponding horizontal accelerations at the same frequencies measured by the instrument. See Table 1.[2/]

2.3 Location and Readings of the Engdahl Peak Acceleration Recorders

The Engdahl Model PAR 400 peak acceleration recorder senses and records peak accelerations triaxially. A diamond tipped scriber at the end of an amplifier arm traces a very fine visible permanent record on an aluminum record plate with successive layers of nickel, gold, and burnt gold.

2/ Figure 9 shows the mounting of the Engdahl PSR 1200-H/V instrument on the Elevation 630' platform. The instrument is located approximately 6 feet from the face of the reactor vessel shield wall on an outer beam which provides supports for the platform, recirculation and safety injection piping, and a monorail. Given the highly complex nature of the steel platform and support structure on which the instrument is mounted, it is quite possible the instrument may have measured the acceleration caused by a secondary impact resulting from the earthquake.

The two peak acceleration recorders are located as follows:

1. Reactor Recirculation Pump: Inside the drywell at Elevation 574', on recirculation pump B33-C001A. This instrument was most recently calibrated on December 4, 1985.

2. HPCS Pump Base Mat: In the HPCS Pump Room, in the Auxiliary Building foundation mat at Elevation 574', mounted as shown in Figure 10. This instrument was most recently calibrated on January 30, 1986.

The readings by the Engdahl PAR 400 recorders are discussed in detail in Reference 2.

3.0 COMPARISON AND EVALUATION OF RECORDED ACCELERATIONS AGAINST THOSE ASSUMED FOR THE PERRY SSE AND OBE

Table 2 shows a comparison of the zero period acelerations ("ZPAs"), as recorded by the various instruments, with the corresponding SSE and OBE design accelerations. According to the recorded accelerations, the design basis values of ZPA for the OBE, and in a few instances the SSE, were exceeded during the January 31, 1986 earthquake. As will be discussed below, given the short duration and low energy of the earthquake, the exceedences were not significant from an engineering point of view. This is supported by the apparent lack of damage to plant structures and mechanical and electrical components detected as a result of the earthquake. Moreover, inspection of engineered facilities located near the epicenter and not designed to withstand any earthquake force did not reveal any damage from the earthquake (Reference 3). In order to correlate the short duration, high frequency acceleration that was recorded with the lack of impact on structures and equipment, it is necessary to understand how measured ground acceleration can and should be correlated with design basis accelerations.

In postulating the limiting earthquake conditions for designing nuclear power plant facilities, a key parameter has been the zero period acceleration or Instrumental Peak Acceleration (A_{IP}), which represents the peak acceleration recorded during the entire earthquake motion. As concluded in many studies (References 4 through 11), A_{IP} is a poor indicator of the damage potential of earthquake ground motions. It has been observed that structures performed much better than would have been predicted based on the measured A_{IP} to which the structures were subjected; this phenomenon has been particularly noticeable in connection with short duration, high energy ground motions due to low to moderate magnitude earthquakes, such as the January 31, 1986 earthquake near Perry.[3/] The differences

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3/ Examples of this behavior may be found in the records of the 1966 Parkfield earthquake, the 1971 Pacoima Dam earthquake, the 1972 Ancona earthquake, and the 1972 Melendy Ranch Barn earthquake. These earthquakes showed recorded instrumental peak ground accelerations of between 0.5g and 1.2g, yet only minor damage occurred in the vicinity of the recording sites.

between measured ground motion, assumed design levels, and observed physical behavior is so significant that it cannot be attributed to the safety factors which are utilized in the design and in elastic seismic analyses.

Kennedy (Reference 12), based on the work of others (References 13 through 16) has suggested that it is not appropriate to use just measured A_{IP} to define the characteristics of the SSE and OBE. It is necessary to take also into account, in addition to A_{IP}, the dominant frequency of the strong motion excitation and the duration of the strong motion.[4/] He has proposed the following relationship to develop an equivalent design acceleration for the anchoring elastic spectra:

$$A_D = (K_p)\ (rms),$$

where A_D is the equivalent design acceleration and the other parameters are defined as follows:

$$K_p = \sqrt{2\ \ln\ (2T_D/To)} \geq 2.0$$

T_D = Duration of strong motion (sec.)

4/ Thus, for a high dominant frequency and/or short duration earthquake, the equivalent peak acceleration would be significantly less than that predicted on the basis of A_{IP} measurements alone.

To = Predominant period of motion (sec.)

rms = $\sqrt{P}$

P = $E(T)/T_D$ = earthquake power (average rate of energy input)

$$E_T = \int_{t_o}^{t_o + T_D} a^2(t)dt = \text{total energy}$$

fed into the structure between times to and to + T_D, and

a(t) = instrument acceleration at time t.

Efforts are underway to compute A_D for the January 31, 1986 earthquake. In the meantime and by way of comparison, four earthquakes similar in magnitude and duration to the Perry earthquake have been selected from Tables 1 and 2 of Reference 12. The characteristics of those earthquakes, and those of the one at Perry, are summarized in Table 3. For the four earthquakes listed, an average ZPA of 0.434g is required to cause the same level of response for elastic structures as that postulated by the NRC Reg. Guide 1.60 (Reference 17) spectra for a .20g ground acceleration. This result suggests that a correction factor of 0.20/0.434 = 0.46 should be applied to the accelerations measured during low to moderate magnitude earthquakes (such as the one near Perry) to obtain elastic responses that can be compared to those from the limiting Reg. Guide 1.60 earthquake.

If, in fact, a 0.46 correction factor is applied to the accelerations recorded at Perry and shown in Table 2, accelerations well below the SSE and OBE levels are obtained for all locations except for the readings at the Reactor Building Containment Vessel (Elevation 686'), where the corrected N-S and vertical ZPA are approximately equal to the OBE design value. This is shown in Table 4, where the recorded values of Table 2 have been adjusted by a .46 factor.

4. STRUCTURAL SIGNIFICANCE OF THE PERRY EARTHQUAKE AND ANTICIPATED IMPACT OF EVENT ON THE ADEQUACY OF THE PLANT STRUCTURES, SYSTEMS AND COMPONENTS

Table 4 indicates that if the recorded accelerations from the Perry earthquake are corrected to take into account the short duration and low energy of the event, the average elastic response ZPAs are in all but one instance equal to or less than one-third of the OBE design values, and are approximately equal to the OBE values in the remaining case. In light of these results and the design limits placed on the strength of materials for safety applications (i.e., not to exceed a 0.6 to 0.8 factor of yield during an OBE), all safety-related plant structures, systems and equipment should have remained essentially elastic during an earthquake such as the one experienced on

January 31, 1986, and thus should have emerged undamaged from it. This expectation has been corroborated by physical observation of plant conditions following the earthquake.

Some auxiliary or secondary structural systems, such as suspended ceilings and plaster ceilings and walls, might be expected to sustain some displacement or cracking. One might also expect actuation of instrumentation measuring or sensing changes in liquid levels or the presence of vibration. In addition, one might expect some activation of inertia-sensing relays or switches (fluid or spring loaded), if such controls or instrumentation have not been qualified for seismic operability. If any of these circumstances are determined to have taken place at Perry, their occurrence would only be indicative of the anticipated response of non-seismically qualified structures to moderate earthquake conditions.

TABLE 1 (From Reference 2)

READINGS FROM RESPONSE SPECTRA RECORDER
MPL NUMBER: D51-R170
LOCATION: REACTOR RECIRCULATION
PIPING SUPPORT - DW 630', 240°

REED NUMBER	NOMINAL FREQUENCY (HERTZ)	ACCELERATION(g) North/South 1-31-86	North/South 2-2-86	East/West 1-31-86	East/West 2-2-86	Vertical 1-31-86	Vertical 2-2-86
1	2.00	.047	.048	.049	.051	.007	.007
2	2.52	.082	.082	.086	.084	(*)	.013
3	3.17	.184	.184	.144	.140	.015	.014
4	4.00	.226	.223	.128	.127	.023	.023
5	5.04	.132	.134	.158	.158	.035	.033
6	6.35	.131	.134	.058	.055	.033	.030
7	8.00	.104	.104	.109	.090	(*)	.019
8	10.1	.093	.093	(*)	.052	.093	.085
9	12.7	.188	.182	.166	.080	.198	.199
10	16.0	.194	.204/.167	.348	.312	.490	.500
11	20.2	.152	.152	.191	.175	.973	.973
12	25.4	.114	.091	.155	.158	1.7	1.54

(*) Unreadable

S&A

TABLE 2

COMPARISON OF DESIGN ZPAs (1) VS RECORDED ZPAs (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 Containment Vessel Elevation 686' SMA-3 (Kinemetrics) D51-N111	Reactor Building Platform Elevation 630'-1" Inside Drywell PSR 1200 (Engdahl) D51-R170
	Recorded	.17	.18	.32	.55	.09
NS	SSE	.17	.18	1.06	.40	.48
	OBE	.10	.10	.86	.24	.40
	Recorded	.06	.10	.11	.18	.16
EW	SSE	.20	.18	1.06	.40	.48
	OBE	.10	.10	.86	.24	.40
	Recorded	.03	.11	.05	.30	Note 2
VERT	SSE	.20	.18	.47	.24	.28
	OBE	.10	.10	.38	.15	.16
	Recorded	.18	.23	.34	.65	Note 2
SRSS(3)	SSE	.33	.31	1.57	.62	.73
	OBE	.17	.17	1.27	.37	.59

(1) Zero period acceleration
(2) ZPA indeterminable from available data
(3) Square-root-of-the-sum of the squares

TABLE 3

CHARACTERISTICS AND GROUND ACCELERATION LEVELS REQUIRED TO ACHIEVE EQUAL STRUCTURAL ELASTIC RESPONSE BETWEEN R.G. 1.60 AND SELECTED EARTHQUAKES

Earthquake	Magnitude M_V	Recording Station Epicentral Distance(km)	Peak Inst. Ground Acceleration, g	Strong Motion Duration, sec.	Equiv. ZPGA to the 0.20g R.G. 1.60 Spectra
Parkfield - 1966	5.6	1	0.49	1.4	.3275
Hollister - 1974	5.2	13	0.138	1.1	.4825
Santa Barbara - 1978	5.1	4	0.347	3.0	.2825
Bear Valley-1972	4.7	6	0.520	0.8	.6450
					.434(Average)
Ohio - 1986	4.9	17	(*)	0.75	--

(*) 0.18g in N-S direction, 0.10g in E-W direction, measured at the foundations.

TABLE 4

COMPARISON OF DESIGN ZPAs (1)
VS CORRECTED RECORDED ZPAs
(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 Containment Vessel Elevation 686' SMA-3 (Kinemetrics) D51-N111	Reactor Building Platform Elevation 630'-1" Inside Drywell PSR 1200 (Engdahl) D51-R170
	Recorded	.08	.08	.15	.25	.04
NS	SSE	.17	.18	1.06	.40	.48
	OBE	.10	.10	.86	.24	.40
	Recorded	.03	.05	.06	.08	.07
EW	SSE	.20	.18	1.06	.40	.48
	OBE	.10	.10	.86	.24	.40
	Recorded	.02	.06	.02	.14	Note 2
VERT	SSE	.20	.18	.47	.24	.28
	OBE	.10	.10	.38	.15	.16
	Recorded	.08	.11	.16	.30	Note 2
SRSS(3)	SSE	.33	.31	1.57	.62	.73
	OBE	.17	.17	1.27	.37	.59

(1) Zero period acceleration
(2) ZPA indeterminable from available data
(3) Square-root-of-the-sum of the squares

S&A

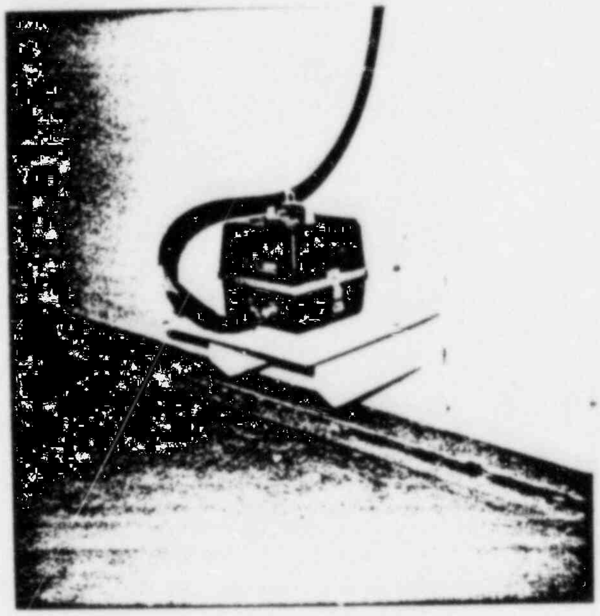

FIGURE 1 - KINEMETRICS SMA-3
ACCELERATION TIME HISTORY RECORDER
SERIAL NO. 165-1, TAG NO. D51-N[illegible]
LOCATED AT BASE OF CONTAINMENT [illegible]
ELEVATION 575.

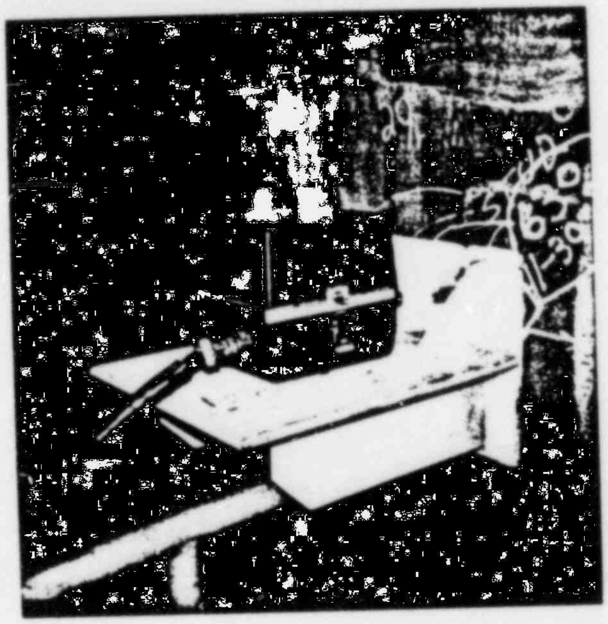

FIGURE 2 - KINEMETRICS SMA-3
ACCELERATION TIME HISTORY RECORDER
SERIAL NO. 165-2, TAG NO. D51-M111
LOCATED ON THE STEEL CONTAINMENT
SHELL AT EL. 682.

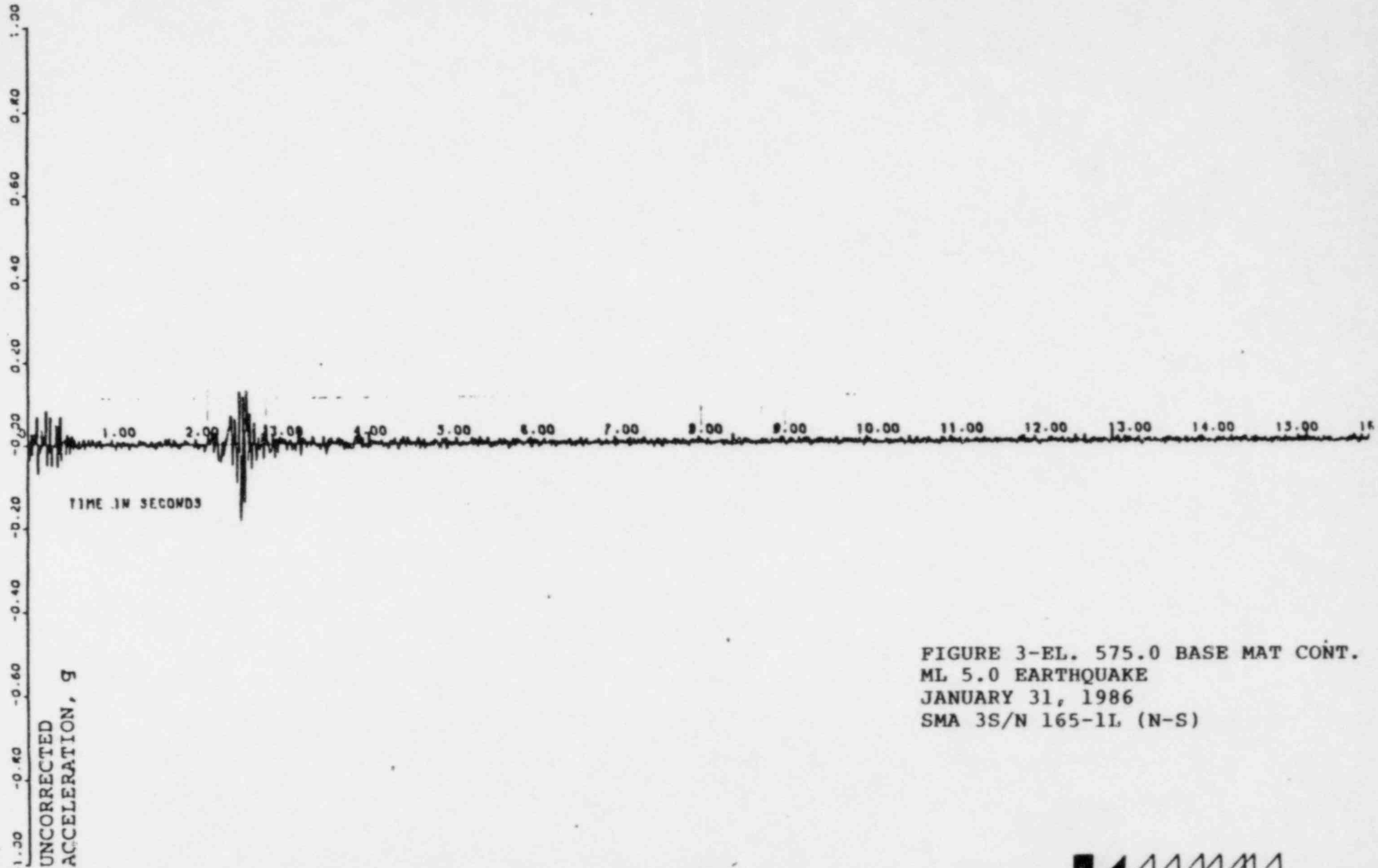

FIGURE 3-EL. 575.0 BASE MAT CONT.
ML 5.0 EARTHQUAKE
JANUARY 31, 1986
SMA 3S/N 165-1L (N-S)

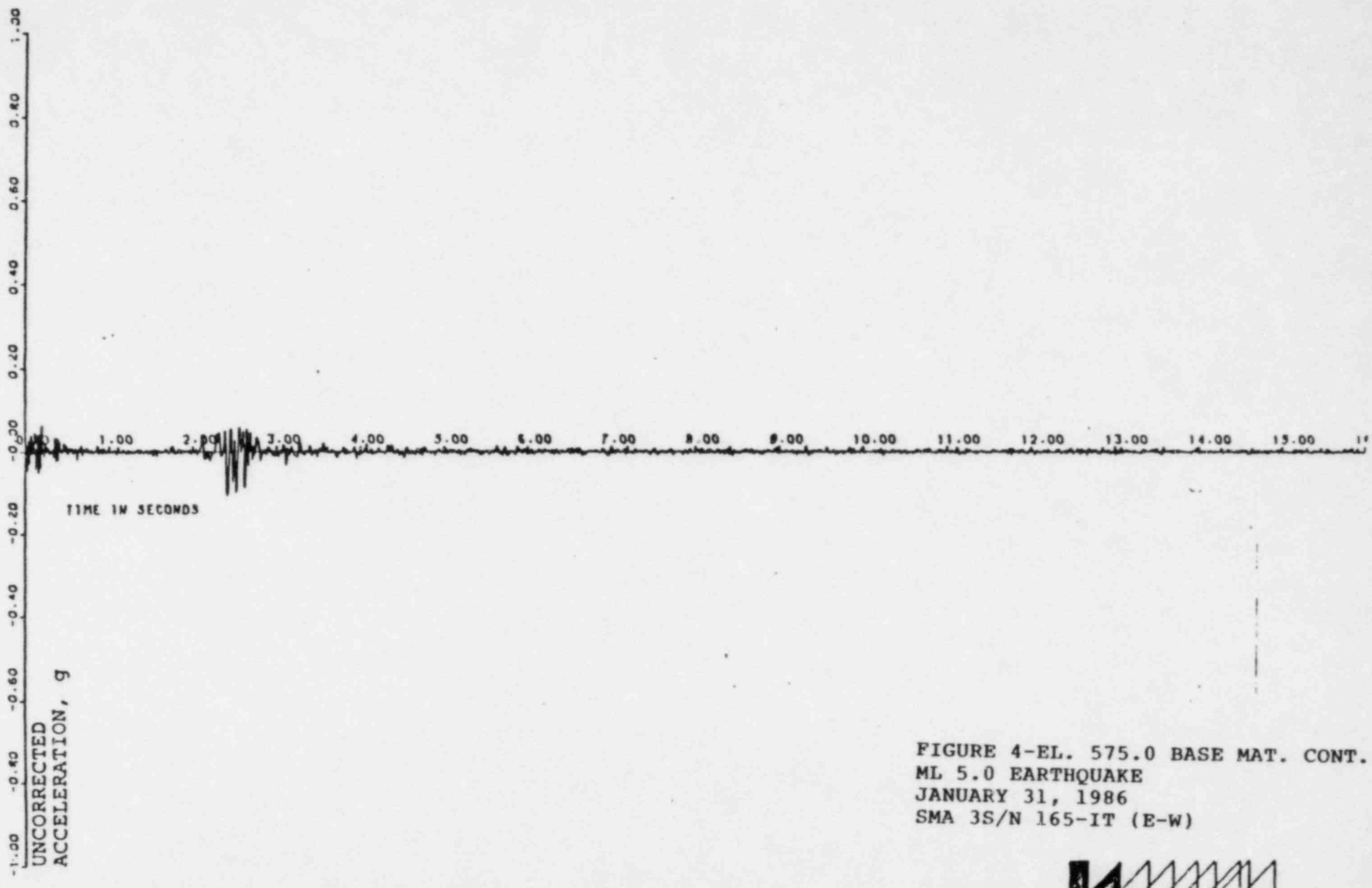

FIGURE 4-EL. 575.0 BASE MAT. CONT.
ML 5.0 EARTHQUAKE
JANUARY 31, 1986
SMA 3S/N 165-IT (E-W)

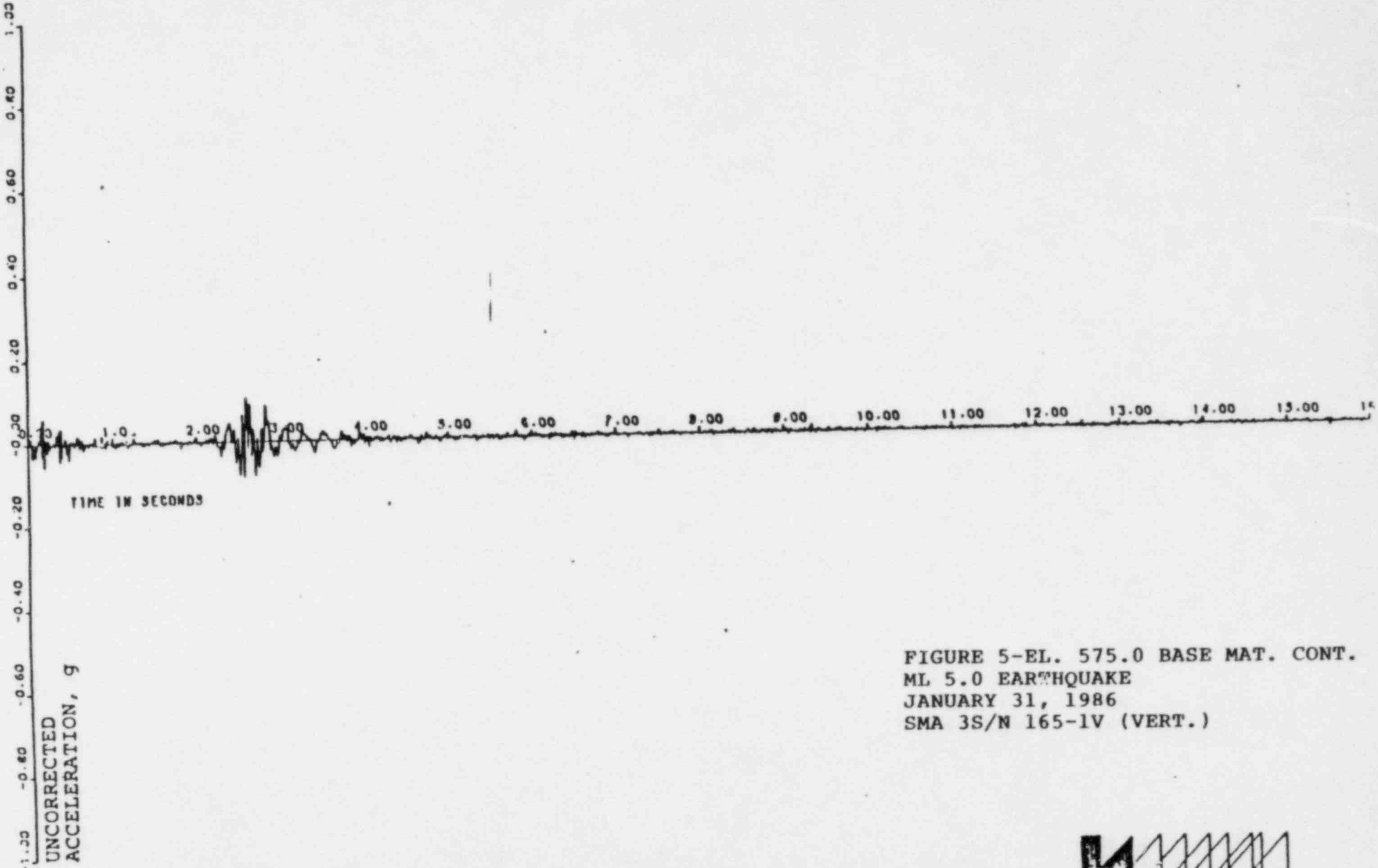

FIGURE 5-EL. 575.0 BASE MAT. CONT.
ML 5.0 EARTHQUAKE
JANUARY 31, 1986
SMA 3S/N 165-1V (VERT.)

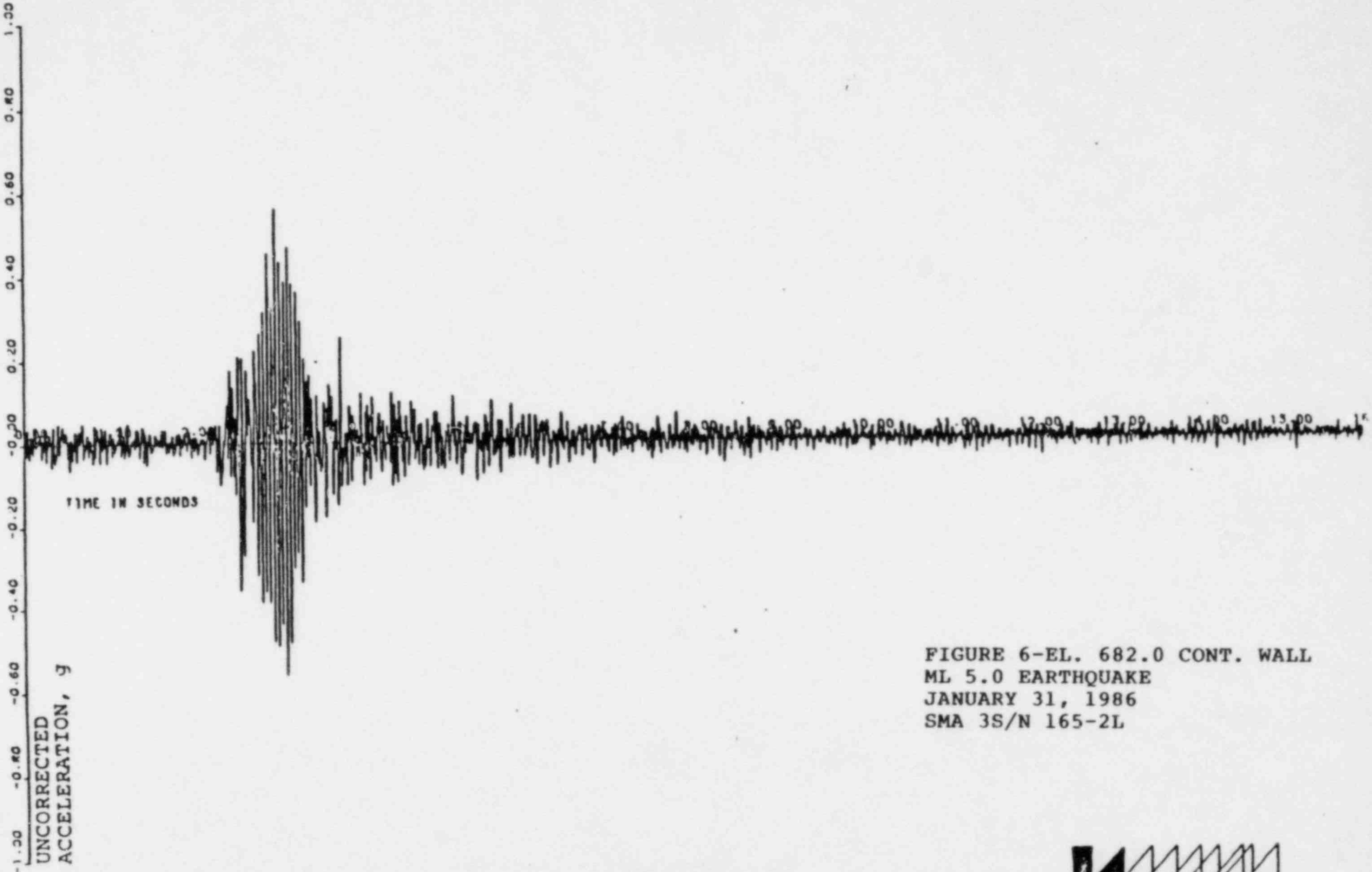

FIGURE 6-EL. 682.0 CONT. WALL
ML 5.0 EARTHQUAKE
JANUARY 31, 1986
SMA 3S/N 165-2L

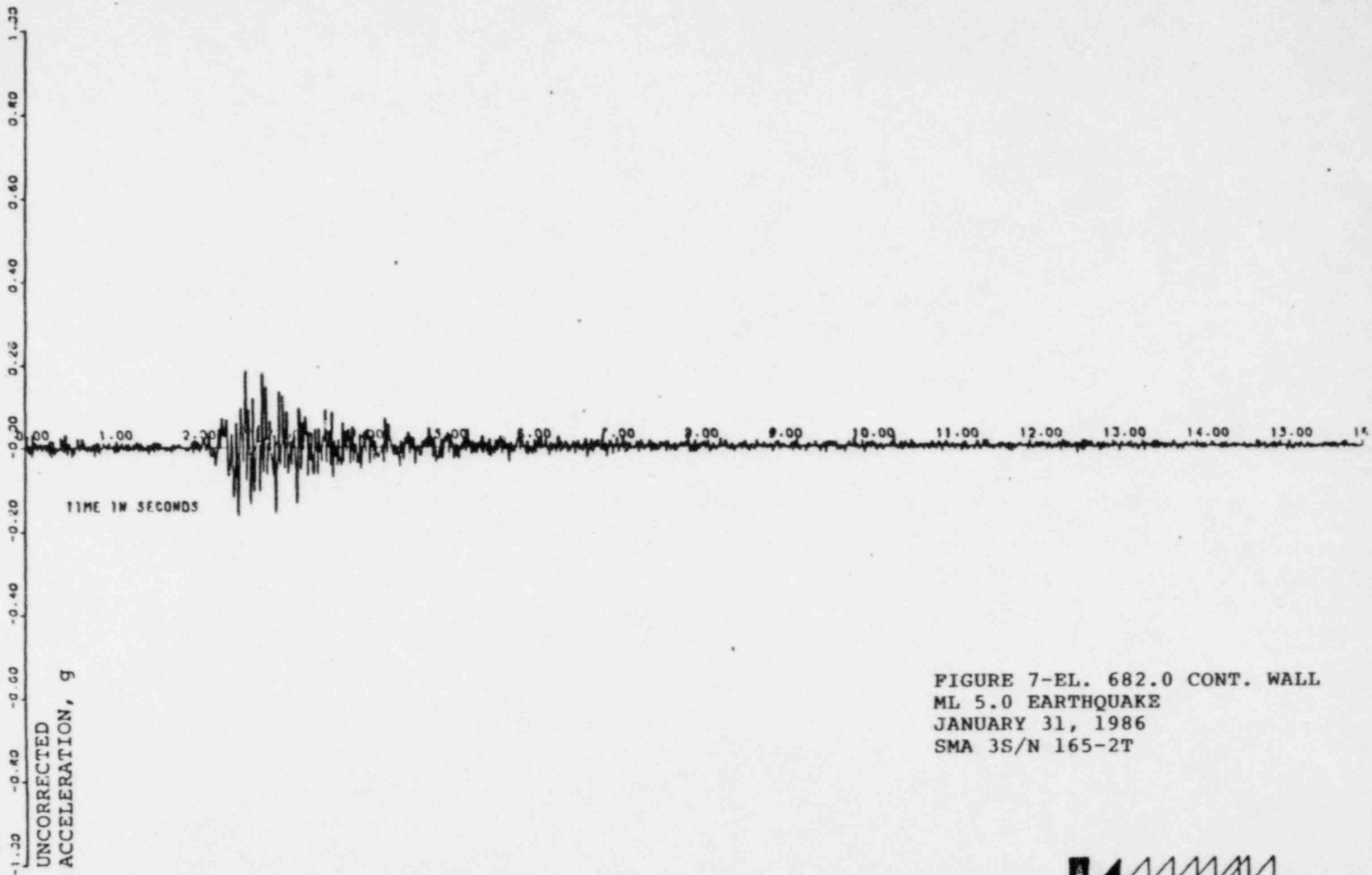

FIGURE 7-EL. 682.0 CONT. WALL
ML 5.0 EARTHQUAKE
JANUARY 31, 1986
SMA 3S/N 165-2T

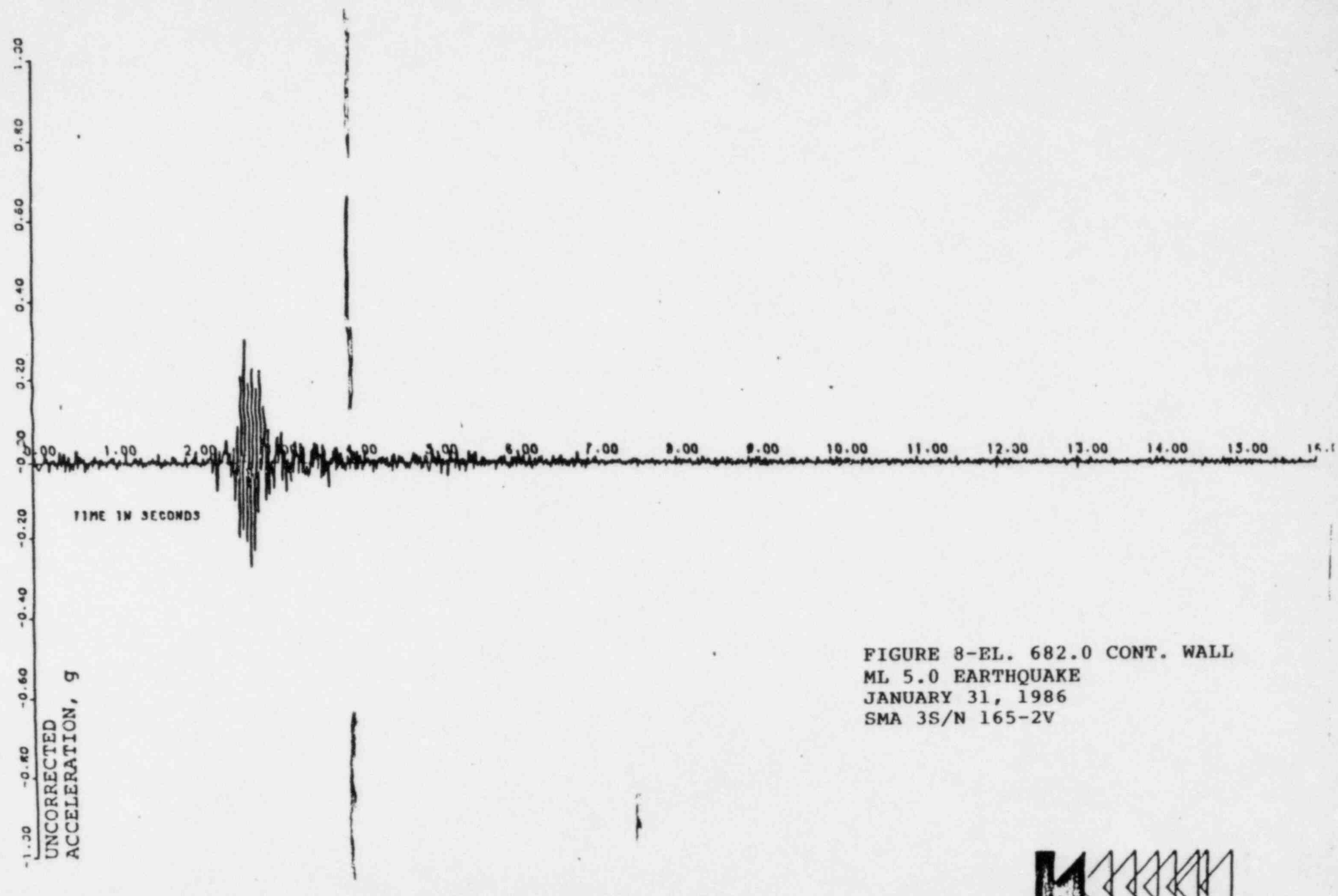

FIGURE 8-EL. 682.0 CONT. WALL
ML 5.0 EARTHQUAKE
JANUARY 31, 1986
SMA 3S/N 165-2V

FIGURE 9 - MOUNTING OF
ENGDAHL PSR 1200-H/V
RECORDER ON THE EL. 630
DRYWELL PLATFORM.

FIGURE 10 - MOUNTING OF
ENGDAHL TYPE PAR 400
RECORDER ON AUXILIARY
BUILDING FOUNDATION MAT
EL. 568.

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(3) Stevenson and Associates, "Reconnaissance Report Prepared for EERI for the Ohio-1986 Earthquake" (In Preparation).

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(5) Schnabel, P.B., and Seed, H.B., "Accelerations in Rock for Earthquakes in the Western United States", Seismol. Soc. America Bull., Vol. 62, April 1973.

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ATTACHMENT 7

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Director, Office of Nuclear Reactor Regulation

In the Matter of	)	
	)	
THE CLEVELAND ELECTRIC	)	Docket Nos. 50-440 OL
ILLUMINATING CO. ET AL.	)	50-441 OL
	)	
(Perry Nuclear Power Plant,	)	
Units 1 and 2)	)	

PETITION FOR ACTION UNDER 10 CFR 2.206

I. INTRODUCTION

At 11:47 AM on Friday, January 31, 1986 an earthquake with a magnitude of 5.0 on the Richter scale struck Northeast Ohio. The epicenter of the earthquake is estimated to be near Thompson, Ohio, less than 10 miles from the Perry Nuclear Power Plant.

While only preliminary information is available on the earthquake at this time, this information strongly indicates that, at a minimum, the FSAR analysis of site area seismicity needs to be redone. The January 31 earthquake clearly shows the conclusions in the FSAR and SER (NUREG-0887) to be erroneous. For example, it is concluded that no capable faults exist in the vicinity of the plant. FSAR Section 2.5.3.6; SER at p. 2-21. The plant site is also said to be an area of low seismicity. FSAR Section 2, Appendix D, p. D-94.

Even more disturbing are news accounts stating that accelerations from the earthquake were estimated to range from 0.19 g to 0.25 g. Perry is designed to withstand 0.15 g (safe shutdown earthquake). FSAR Section 2.5.2.6. This, along with the definition of the operating basis earthquake in 10 CFR 100

Appendix A (an earthquake which could reasonably be expected to affect the plant site during the operating life of the plant), indicates that the SSE and OBE should be more severe than presently postulated, and the seismic capability of safety-related structures, systems, and components at Perry should be upgraded accordingly.

In light of this information, Ohio Citizens for Responsible Energy ("OCRE") has moved to reopen the hearing record in the Perry operating license proceeding, for the purposes of admitting and litigating the following new contention:

> Applicants have not demonstrated that the seismic design of the Perry Nuclear Power Plant is adequate in light of observed local seismicity.

Because fuel loading of Perry Unit 1 is scheduled for sometime this month (perhaps as soon as mid-February), OCRE also finds it necessary to file this action pursuant to 10 CFR 2.206 in order to ensure that licensing does not proceed before this matter has been thoroughly investigated.

II. RELIEF REQUESTED

OCRE requests that fuel loading not be permitted, and that no operating license for any power level be issued, until the following actions have been accomplished:

1. The Perry Nuclear Power Plant has been thoroughly inspected for damage resulting from the January 31 earthquake. This should include the use of nondestructive evaluation techniques as well as visual inspection.

2. Post-earthquake functional testing of all plant systems is completed. These tests should include, but not be limited to, containment integrated leak rate testing and hydrostatic testing of the reactor coolant pressure boundary.

3. Full completion of any corrective actions or repairs found to be necessary as a result of the testing and inspection delineated above.

4. A comprehensive investigation of the January 31 earthquake and a reevaluation of local seismicity by the Cleveland Electric Illuminating Co., the NRC, the Advisory Committee on Reactor Safeguards, the U.S. Geologic Survey, and all other scientific entities studying the earthquake.

5. Completion of the hearing and issuance of a decision on OCRE's seismic design contention (noted above) in the reopened operating license proceeding, should the Appeal Board grant OCRE's motion.

6. Completed installation of any seismic upgrading of Perry that may be required either by the NRC Staff or by the Appeal Board in its decision on OCRE's seismic design contention.

III. CONCLUSION

The January 31 earthquake raises significant questions about the safety of the Perry Nuclear Power Plant. Completion of the above activities is a necessary prerequisite to the resolution of these questions. Because it is imperative that the safety of Perry be firmly resolved before the plant is permitted to operate, the granting of this Petition is manifestly in the public interest.

Respectfully submitted,

Susan L. Hiatt

Susan L. Hiatt
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(216) 255-3158

DATED: FEB. 3, 1986

February 25, 1986

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)	)	

CERTIFICATE OF SERVICE

This is to certify that copies of the foregoing "Applicants' Answer to OCRE Motion to Reopen the Record and to Submit a New Contention" were served by deposit in the United States Mail, First Class, postage prepaid, this 25th day of February, 1986, to all those on the attached Service List.

Harry H. Glasspiegel
HARRY H. GLASSPIEGEL

DATED: February 25, 1986

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. (Perry Nuclear Power Plant, Units 1 and 2)	))))))))	Docket Nos. 50-440 50-441

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