UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
Sheldon J. Wolfe, Chairman
Emmeth A. Luebke
Dr. Jerry Harbour

In the Matter of	)	
	)	
PUBLIC SERVICE COMPANY OF	)	Docket No.(s)
NEW HAMPSHIRE, ET AL.	)	50-443/444-OL-1
(Seabrook Station, Units 1 and 2)	)	On-site EP
	)	October 11, 1988

AFFIDAVIT OF THOMAS G. BOULIANE

I, Thomas G. Bouliane, being under oath, depose and say as follows:

1. I am a Principal Consultant at Cavanaugh Tocci Associates, Inc., an acoustical consulting firm in Sudbury, Massachusetts. A statement of my professional qualifications is attached hereto as Appendix 1. The acoustic analysis set forth in this affidavit was done by me under the guidance and review of Gregory C. Tocci, the president of Cavanaugh Tocci Associates, Inc. A statement of his professional qualifications is attached hereto as Appendix 1a.

2. The purpose of this affidavit it to address issues raised in the September 17, 1988 affidavits of Messrs. Faix,

Keast, Kryter, and Sutherland regarding New Hampshire Yankee's public alert and notification system and its ability to meet the design objectives described in NUREG-0654, FEMA-REP-1, Rev. 1 "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," and FEMA-REP-10 "Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants."

<u>Basis A.1</u>: <u>Siren Coverage</u>
<u>Basis A.8</u>: <u>Sound Irregularities</u>

3. New Hampshire Yankee has described the siren loudspeakers to be employed in the Massachusetts portion of the Seabrook Station EPZ.[1,2]

NOTE: All references are noted in Appendix 2, attached.

4. Mr. Sutherland, describing the performance of these siren loudspeakers, states:

> "No 'gaps in the coverage' of the dual [deletion] sirens are anticipated since, due to rotation, they will eacn be capable of radiating a broad siren tone pattern whose axis of symmetry slowly rotates over 360 degrees ensuring coverage at all angles."[3]

5. Sutherland does, however, indicate that some variation in siren coverage will occur:

> "As the siren <u>rotates</u>, a listener at any point in space will experience a varying sound level ranging from a maximum value that occurs when the siren is pointing generally in his or her direction to a minimum value that occurs when the siren is pointing away."[4] [Emphasis in the original]

6. Wyle Laboratories made rudimentary measurements of this siren loudspeaker to determine its directional characteristics in the horizontal plane.[5] The data from three measurements are shown in Wyle Test Report 88-10(R), Figure 3 and are used in Table 7 [6,7]:

Listen Angle	Siren Angle	DI(Beta)
0.00°	0°	0.0 dB
11.25°	0°	- 4.7 dB
22.50°	0°	-11.3 dB

7. Wyle extended this limited information mathematically to estimate the horizontal distribution of the loudspeaker's siren signal output over angles beyond those measured.[8]

8. Cavanaugh Tocci Associates, Inc. (CTA) illustrates the Wyle loudspeaker directivity estimate in more conventional "polar" form in its Drawing 1.[9, attached hereto as Appendix 3] This drawing sets the loudspeaker's primary output axis to 0° and the maximum output to 0 dB and shows the level variations which occur as the observer moves to either side of the primary axis:

Listener Angle	Relative Level
0.00°	0 dB
11.25°	- 4.7 dB
22.50°	-11.3 dB
33.75°	-16 dB
45.00°	-19 dB
56.25°	-21 dB
67.50°	-23 dB
78.75°	-25 dB
90.00°	-26 dB

9. It is apparent from CTA Drawing 1 that the siren loudspeaker has definite directional characteristics; that the loudspeaker produces its maximum signal output along its primary output axis (0°) and that the loudspeaker's output diminishes as the angular offset from the primary axis increases.

10. New Hampshire Yankee also states that the VANS sirens are to oscillate back and forth through 360° arcs during their operation.[10]

11. Dr. Kryter describes two siren systems[11], one of which Keast confirms[12] is the siren New Hampshire Yankee proposes for use in the (Massachusetts) VANS portion of the public alert and notification system. Kryter's description defines the Massachusetts VANS siren oscillation rate at 2.5 times per minute.

12. The siren levels heard by the Massachusetts populace will be influenced as shown in CTA Drawing 2 [13, attached as Appendix 4] when the sirens are oscillated as described by New Hampshire Yankee and Kryter. This drawing shows the relative signal levels which will be distributed to listeners who are situated at angles offset by 0°, 45°, 90°, 135°, and 180° from the siren's stop position. The maximum signal level the listeners will receive when in alignment with the siren's primary output axis is shown as "REF." The signal level variations over time resulting from the siren's directional output pattern are also shown.

13. New Hampshire Yankee has submitted a map showing the alert and notification system siren coverage they expect in Massachusetts.[14]

14. The 60 dB(C) and 70 dB(C) siren coverage contours shown on the New Hampshire Yankee map are seen to be generally circular. The variations shown relate only to barrier effects caused by changing ground elevations.

15. A siren's signal output can extend to the coverage circles shown on the map only along the siren's primary output axis as shown on CTA Drawing 1. Since the sirens oscillate about 360° arcs, the circular shapes on the map can only represent the siren outputs over <u>all</u> angular positions of oscillation when considered <u>simultaneously</u>. Since the sirens cannot be in all positions at once, the map misrepresents the siren coverage at any given time.

16. The sum of coverage resulting from all VANS sirens operating concurrently will, in fact, vary randomly over time due to the directional characteristics of the loudspeakers in combination with inevitable differences in VANS vehicle orientation and siren stop positions, and the differences in siren starting times and rates of siren oscillation among vehicles. The siren coverage to be expected at any given time is better represented on CTA Drawings 3 and 4.[15,16 attached as Appendices 5 and 6]. These drawings rotate siren primary output axes randomly and superimpose the resulting siren coverage patterns over the New Hampshire Yankee map.

17. Since the 60 dB(C) and 70 dB(C) levels shown as circular patterns on New Hampshire Yankee's map can be achieved only along the siren primary output axes, and since off-axis siren levels diminish by 26 dB during oscillation, it follows that the siren levels heard by listeners will often drop to as little as 34 dB(C) and 44 dB(C) respectively. The sirens will in fact achieve the required 60 dB(C) and 70 dB(C) levels at locations on the map contours only during the brief periods illustrated on CTA Drawing 2 where the curve meets the "REF" level; signal levels will be less at all other times.

18. The public alert and notification system proposed by New Hampshire Yankee for use in Massachusetts appears therefore not to meet the NUREG-0654, FEMA-REP-1, Rev. 1 requirement that "[t]he siren signal shall be a 3 to 5 minute steady signal...."[17]

19. Further, the proposed system appears not to meet the FEMA-REP-10 requirement that "... [t]he expected siren sound pressure level generally exceeds 70 dBC where the population exceeds 2,000 persons per square mile and 60 dBC in other inhabited areas."[18]

Basis A.7: Maximum Permissible Sound Levels

20. Sutherland, the Chief Scientist of Wyle Research and apparently relying on data from various Wyle Laboratories reports, states that:

> "...I have determined that with the siren 25 feet above ground level, the maximum sound level at 5 feet above the ground (i.e., at ear level) is 131 dB(C) which occurs about 90 feet from the siren. With the siren at the normal operating height of 45 feet above ground level, the maximum level at 5 feet above the ground is 124 dB(C) which occurs about 200 feet from the siren."[19]

21. Sutherland reiterates his remarks by saying:

> "As the siren elevates, the sound pressure levels on the ground decrease (e.g., the sound pressure level at 90 feet from the siren decreases from 131 dB(C) to 122 dB(C) and the sound pressure level at 200 feet decreases from 127.5 dB(C) to 124 dB(C)...."[20]

22. Wyle Laboratories acknowledges that only "[a] small amount of data relating to the vertical directivity of the siren is presented..."[21]

23. Notwithstanding the limitations of their measurements, Wyle uses this data and another set of data:

> "...to provide the illustration of the 123dB(C) sound envelope shown in Figure 4 [22] which identifies the contour in a vertical plane of the maximum level to which people near the siren would be exposed."[23]

24. The limited siren loudspeaker information Wyle presents in its test reports, the only information available describing the performance characteristics of New Hampshire Yankee's proposed siren, is insufficient to draw firm conclusions as to its directional properties or the siren levels to which nearby listeners will be exposed. Wyle's presentation is in broad variance with the recommendations of the Audio Engineering Society and the American National

Standards Institute [24, attached as Appendix 7] which describe the requirements for clear, unambiguous reportage of loudspeaker performance.

25. Faix reports that:

> "There are structures located less than 100 feet from each of the two acoustic locations that are co-located at the VAN staging areas. These structures are part of their respective staging areas. Provisions will be made by New Hampshire Yankee to inform people in these structures prior to siren activation."[2_]

26. Faix does not report that the VANS will be parked in close proximity to private residences during their operation:

VANS Location	Nearest Residence (approximate)
VL3	180 ft.
VL4	300 ft.
VL12	250 ft.
VL13	180 ft.
VL16S	150 ft.

I made these approximate measurements when I visited the locations on October 3, 1988.

27. The siren sound which reflects from these buildings will sum with the sound arriving directly from the VANS sirens to elevate the listener levels near the buildings by as much as an additional 3 dB.

28. Based upon Wyle Laboratories' reported maximum siren sound level of 134 dB at 100 ft. and the level losses resulting from geometric spreading alone, I estimate that siren levels in proximity to nearby residences will be as great as 133 dB when building reflection effects are taken into account.

29. Gales, in the Handbook of Noise Control, a standard reference work in the field of acoustics, defines the threshold of listener discomrort caused by sound pressure levels as 120 dB. He further shows that sound levels in the region of 120 dB to 140 dB can be literally felt as tactile sensations.[26] Appendix 8 is Figure 8.2 from Gale's book depicting the discomfort threshold.

30. My estimate of 133 dB listener levels substantially surpasses Gale's 120 dB threshold of discomfort and leads to the conclusion that the public alert and notification system proposed by New Hampshire Yankee for use in Massachusetts will not meet the NUREG-0654, FEMA-REP-1, Rev. 1 requirement that "[t]he maximum sound levels received by any member of the public should be lower than 123 dB, the level which may cause discomfort to individuals."[27]

31. If it is assumed that the sirens should operate at 123 dB at 100 feet, the extent of sound coverage in the Massachusetts EPZ is significantly diminished from that which would occur with New Hampshire Yankee's assumed output of 134 dB at 100 feet. Appendices 9 and 10 are maps depicting the extent of coverage at 123dB at 100 feet for 60 dB and 70 dB coverage, respectively.

32. On July 25, 1988, I visited the Seabrook Station premises and observed the setup procedure of a prototype VANS truck. Appendices 11 and 12 are photographs of the truck with

its outriggers extended and Appendix 13 is a photograph of the instructions for crane operation on the VANS truck prototype.

Thomas G. Bouliane

The above-subscribed Thomas G. Bouliane appeared before me and made oath that he had read the foregoing affidavit and that the statements set forth therein are true to the best of his knowledge.

Notary Public
My Commission Expires:

Bouliane Affidavit Appendices 5, 6, 9, and 10 Contain Information Covered By Protective Order And Have Been Provided Only To The Board, The NRC Staff And The Applicants

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Professional Employment:

1974-1980 Seneca Sound, Inc.
Tonawanda, New York

1980-1982 Audio Contractors, Inc.
Buffalo, New York

1982-1983 Cramer Video, Inc.
Needham Heights, Massachusetts

1983-1988 Sesco, Inc.
Boston, Massachusetts

1988-Pres. Cavanaugh Tocci Associates, Inc.
Sudbury, Massachusetts

Professional Memberships:

National Council of Acoustical Consultants
Acoustical Society of America
Audio Engineering Society
National Sound & Communications Association
Construction Specifications Institute

Professional Papers:

"A Calculator Program for Predicting Sound System Performance," presented at the 70th Convention of the Audio Engineering Society, New York, 1981

"Intelligibility Mapping through Array Perspective Analysis," presented at the 72nd Convention of the Audio Engineering Society, Los Angeles, 1982

Professional Article:

"Calculating Sound System Performance," Sound and Communications, March 1982

Relevent Projects:

Mosque of the Holy Prophet, Medina, Saudi Arabia
Speech reinforcement and minaret sound system

Holy Haram, Mecca, Saudi Arabia
Speech reinforcement and minaret sound system

Appendix 1a

GREGORY C. TOCCI

Education: Tufts University, B.S., 1970
Massachusetts Institute of Technology, M.S., 1973

Professional Affiliations: Member, Acoustical Society of America
Past Chairman, Greater Boston Chapter of the Acoustical Society of America
President, National Council of Acoustical Consultants
Member, Institute of Noise Control Engineering
Member, American Society of Heating, Refrigerating and Air Conditioning Engineers

Editorial Advisory Board, Noise Control Engineering Journal

Registration: Professional Engineer in Massachusetts

Civic: Member, Board of Trustees
Montrose School, Westwood, MA

Faculty Positions: Adjunct Faculty
New England School of Art and Design
1979 - 1987

Guest Lecturer
Harvard School of Public Health
1988 - Present

Experience: Summers 1966, 67, 68
Alonzo B. Reed Inc.
HVAC System Designer/Draftsman

While attending Tufts University, Mr. Tocci worked as an HVAC System Designer/Draftsman and was responsible for the preparation of building project drawings for a number of educational and commercial office buildings.

June 1970 - August 1971
U.S. Army Materials and Mechanics Research Laboratory
Mechanical Engineer

Mr. Tocci was involved with the analysis of the ballistic impact properties of fabrics. His work involved ballistic test design and theoretical and numerical analysis of ballistic/fabric impacts.

September 1971 - February 1973
Massachusetts Institute of Technology
Research Assistant

While earning a Masters of Science Degree at the Massachusetts Institute of Technology, Mr. Tocci was awarded a research assistantship in the Acoustics laboratory of the Mechanical Engineering Department. His research activities were supported by the National Science Foundation and involved exploring the use of geometric acoustics in architectural flanking sound transmission problems and the use of auto correlation for measuring sound absorptive properties of surfaces.

February 1973 - December 1974
Cambridge Collaborative, Inc.
Staff Consultant

While with Cambridge Collaborative, Mr. Tocci assisted in several engineering research projects in the transportation and industrial acoustics areas. Among the programs in which he provided assistance area state-of-the-art evaluation of floating slab techniques for structureborne sound isolation of rail transit lines, assessment of sound radiation from elevated rail structures, and noise control for a commercial newspaper folding machine.

Mr. Tocci's responsibilities included designing and managing acoustical measurement programs and assisting in data analysis and report preparation.

January 1975 - August 1975
Cavanaugh Copley Associates
Staff Consultant

Cavanaugh Copley Associates was a joint venture between two individual consultants. Mr. Tocci was employed to manage all technical and financial aspects of projects awarded to the partnership. Among the projects in which he was involved were the preparation of an environmental impact statement for the Interstate 93 extension through Franconia Notch, NH the environmental impact report for the extension of the MBTA Orange Line to Reading, MA, and mechanical system noise and vibration control for the University of Minnesota Health Science Expansion.

September 1975 - Present
Cavanaugh Tocci Associates, Inc.
President/Principal Consultant

Mr. Tocci and Mr. William J. Cavanaugh, after the disassociation of Cavanaugh Copley Associates, joined together to form Cavanaugh Tocci Associates in September 1975. Since this time, the firm has provided engineering consulting in a wide range of architectural, environmental, and industrial acoustics projects. Besides having full responsibility for all technical aspects and communications concerning projects, Mr. Tocci manages all business matters for Cavanaugh Tocci Associates, Inc. Among the variety of projects which he has managed are the following:

Codex Corporation Headquarters
Canton, MA
(General Office Building, Mechanical System Noise and Vibration Studies)

Animal Research Facilities
Massachusetts Institute of Technology
Cambridge, MA
(Provided construction noise impact assessment for audiogenic seizure prone laboratory animals)

Miscellaneous studies for compliance with HUD Site Acceptability Standards for residential construction

MBTA Track Rehabilitation Program
Boston, MA
(Noise and vibration impact analysis and recommendations for track rehabilitation on 40% of the MBTA system)

Seven Schools Noise Abatement Program
Logan International Airport, Boston, MA
(The development of noise control recommendations and review of design, shop drawings, and installation of glazing and other treatments for schools affected by aircraft noise)

Construction Noise and Vibration Control Studies
MBTA Red Line Extension Northwest, Boston, MA
(Development of recommendations for controlling construction noise as required by the MBTA Construction Noise Control Specification in the project documents)

James River Graphics
Hadley, MA
(Developed recommendations for the control of noise and vibration needed to reduce coating chatter)

Lecture Presentations: Among the presentations he has made to society and corporate groups are the following:

"Fundamentals of Glazing Sound Isolation and Product line Review"
January 27, 1988
Fullerton, CA

"Design Concepts for Sound Isolation Glazing"
California Association of Window Manufacturers
June 12, 1987
Sacramento, CA

"Glazing Products and Sound Isolation Performance"
EFCO Corporation Engineering Staff Seminar
June 11, 1987
Monet, MO

Glazing Sound Transmission Loss Studies
Paper 07, 111th meeting of the Acoustical Society of America
May 14, 1987
Cleveland, OH

"Topics in Rooftop Mechanical System Vibration Isolation"
Boston Chapter/American Society of Heating, Refrigerating and Air Conditioning Engineers
January 28, 1987
Medford, MA

"Concepts in Speech Privacy"
GF Business Equipment National Meeting of General Managers
July 26, 1983
Youngstown, OH

"Open Plan Speech Privacy Analysis"
Philadelphia Electric Company Facilities Department
February 9, 1983
Philadelphia, PA

"Wind Farm Noise"
Paper A8,
101 meeting of the Acoustical Society of America
May 19, 1981
Ottawa, Ontario, Canada

"Protecting Harvard University Buildings from Construction Noise"
Paper JJ10,
99th meeting of the Acoustical Society of America
April 25, 1980
Atlanta, GA

"Construction Noise Control for a Major Urban Rail Rapid Transit Line Extension"
Paper P7,
98th meeting of the Acoustical Society of America
November 29, 1979
Salt Lake City, Utah

General Electric Company Plant Manager Seminar
Harvard School of Public Health
June 28, 1979
Boston, MA 02115

"Acoustic Modeling of 'Close-Proximity' Rail Transit Noise Barriers"
Paper DD8,
94th meeting of the Acoustical Society of America
December 15, 1977
Miami, FL

US Department of Health Education Welfare Program
Tufts University
November 4, 1976
Medford, MA

"Noise Propagation in Corridors"
Paper D9,
83rd Meeting of the Acoustical Society of America
April 9, 1972
Buffalo, NY

Publications: "A Comparison of STC and EWR for Rating Glazing Noise Reduction," Gregory C. Tocci, <u>Sound and Vibration</u>, V.21, No. 10, October 1987.

"Monsanto Acoustical Glazing Design Guide"
Monsanto Polymer and Chemical Co., St. Louis, MO

"Acoustic Performance of a 're-entrant' Axial Fan Intake Silencer"
Gregory C. Tocci and Douglas H. Sturz
<u>Noise Con 83 Proceedings</u>
Cambridge, MA

"A Parametric Evaluation of Wind Turbine Noise"
Gregory C. Tocci and Edward N. Marcus
<u>Internoise 82 Proceedings</u>
San Francisco, CA

"Practical Applications of Outdoor Noise Control Barriers"
Gregory C. Tocci and William H. Pickett
<u>Sound and Vibration</u>, V13, No.6, June 1978
(Selected for the Vibraphonic Award for best paper published in <u>Sound and Vibration</u> in 1978 by Delaware Chapter of the Acoustical Society of America

"Paper Cutting Noise: Source Identification Techniques in Newspaper Folding Machines"
Jeffery Fredberg and Gregory Tocci
Internoise 74 Proceedings
Washington, DC

"Measurement and analysis of noise radiation from a slab on steel beam rapid transit structure"
Gregory Tocci, Jeffery Fredberg, and Nagabhusan Senapati
Internoise 74 Proceedings
Washington, DC

"Ballistic Impact of Textile Structures"
David Roylance, Anthony Wilde, and Gregory Tocci
Textile Research Journal, Volume 43, Number 1, January 1973

Personal: Mr. Tocci resides in Franklin, MA with his wife, Colleen M. (McHugh) Tocci, RN and their four children.

REFERENCES

[1] New Hampshire Yankee FEMA-REP-10 Design Report, pp. 2-14 through 2-16.

[2] Ibid., Table 2-1, pp. 2-31 through 2-33.

[3] Sutherland, Affidavt, September 17, 1988, p. 5.

[4] Ibid., p. 4

[5] Wyle Laboratories Test Report 88-10(R), "Measurement of Speech Intelligibility Range of the WS 4000 Electronic Siren," April 1988, p. 3.

[6] Ibid., "Directivity of WS 4000 Electronic Siren at a Frequency of 550 Hz in the Horizontal Plane," Fig. 3, p. 18.

[7] Ibid., "Coverage of WS 4000 Siren (Dual) for speech at Various Distances and Listener Angles," Table 7, p. 14.

[8] Ibid., "Directivity. . .," Fig. 3, p. 18.

[9] Cavanaugh Toccit Associates, Inc., "Wheland Dual WS 4000 Loudspeaker Horizontal Output Distribution," Drawing 1, September 6, 1988.

[10] New Hampshire Yankee, ibid., p. 2-16.

[11] Kryter, Affidavit, September 17, 1988, pp. 3, 4.

[12] Keast, Affidavit, September 17, 1988, p. 4.

[13] Cavanaugh Toccit Associates, Inc., "Siren Level Variations Due to Rotation," Drawing 2, September 23, 1988.

[14] New Hampshire Yankee, ibid., "Seabrook Station - Siren Coverage for the Public Alert and Notification System in Massachusetts," Fig. 2-2, p. 2-37.

[15] Cavanaugh Tocci Associates, Inc., "Representative Siren Coverage, 60 dB Contours" Drawing 4, October 6, 1988.

[16] Cavanaugh Tocci Associates, Inc., "Representative Siren Coverage, 70 dB Contours" Drawing 4, October 6, 1988.

[17] NUREG-0654, FEMA-REP-1, rEV. 1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," p. 3-12.

[18] FEMA-REP-10, "Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants," November 1985, p. E-8.

[19] Sutherland, ibid., p. 3.

[20] Ibid.

[21] Wyle Research Test Report 88-10(R), ibid., p. 3.

[22] Ibid., "Illustration of the Approximate Envelope of the 123 dB(C) Sound Field for the WS 4000 (Dual) Siren," Figure 4, p. 19.

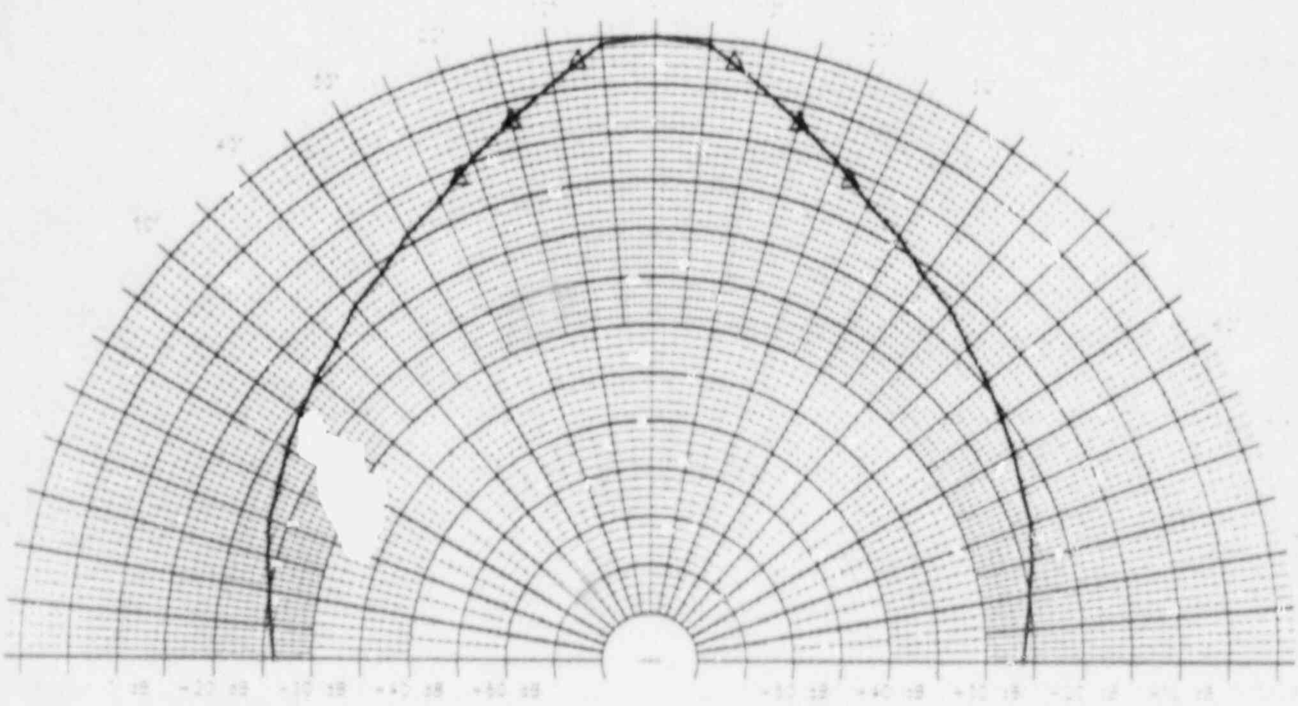
[23] Ibid., p. 4.

[24] Audio Engineering Society, "AES Recommended Practice, Specification of Loudspeaker Components Used in Professional Audio and Sound Reinforcement," AES2-1984 (ANSI S4.26-1984).

[25] Faix, Affidavit, September 17, 1988, p. 4.

[26] R. S. Gales, "Hearing Characteristics," Handbook of Noise Control, ed. C. M. Harris, Second Edition (New York: McGraw-Hill, 1979), "The auditory sensation area," Fig. 8.2, p. 8-4.

[27] NUREG-0654, FEMA-REP-1, Rev. 1, ibid., p. 3-8.



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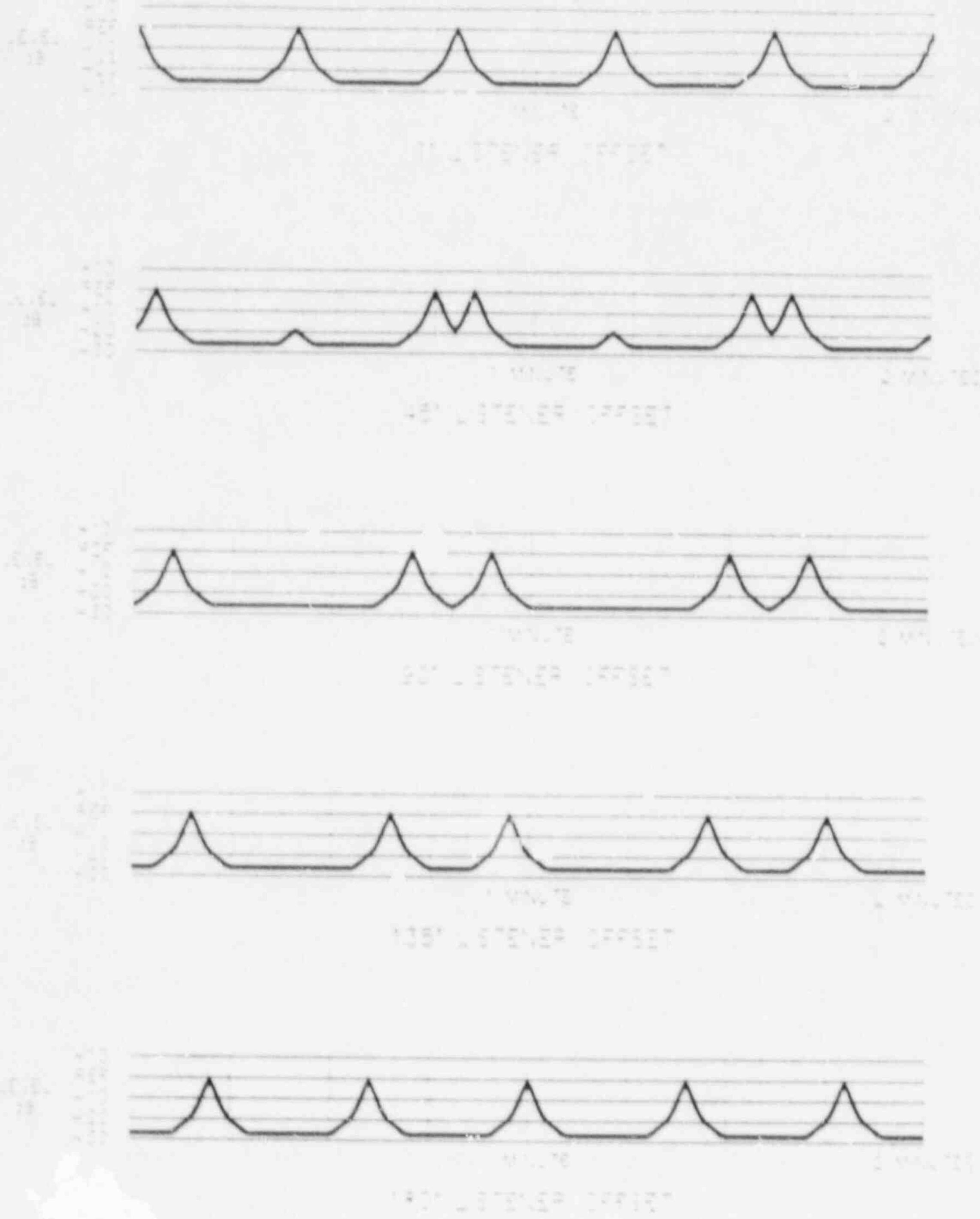

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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OFFICE OF SECRETARY
DOCKETING & SERVICE
BRANCH

In the Matter of PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE, et al. (Seabrook Station, Units 1 and 2)	)	Docket No.(s) 50-443/444-OL-1 (On-site EP)

CERTIFICATE OF SERVICE

I, Stephen A. Jonas, hereby certify that on October 11, 1988, I made service of the within Answer of Massachusetts Attorney General in Opposition to Applicants' Motion for Summary Disposition of Amended Contention on Notification System, Statement of Material Facts in Dispute, and Affidavits of Stephen A. Jonas, Nancy A. Mason, and Thomas G. Bouliane, by first class mail to the parties listed below.

The Affidavits of Nancy A. Mason and Thomas G. Bouliane contain information covered by the Board's Protective Order. Full copies of the affidavits and attachments thereto have been sent to the Board, the Applicants, the NRC Staff, and FEMA. Copies to the remaining individuals on the service list do not include Protective Order information.

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