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ATOMIC SAFETY AND LICENSING BOARD

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Before Administrative Judges:
Peter Bloch, Chairman
Emmeth A. Luebke
Dr. Jerry Harbour

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 April 21, 1989

MASS AG DIRECT TESTIMONY REGARDING PROMPT ALERT AND NOTIFICATION SYSTEM ISSUES

Panel Members: Ruth Kanfer, Professor
University of Minnesota

Karl S. Pearsons, Senior Consultant,
Acentech, Inc.

Charles B. Perrow, Professor
Yale University

Gregory C. Tocci, President,
Cavanaugh Tocci Associates

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I. INTRODUCTION

In its Memorandum and Order (Summary Disposition), LBP-89-09, dated March 3, 1989, the Board ruled that a number of genuine issues of material fact with respect to the Applicants' VANs system remain for hearing. Pursuant to the Board's scheduling order the Applicants filed their Direct Testimony on the remaining issues on April 3, 1989. The testimony of the Mass AG addresses the issues identified by the Board, as well as the Applicants' Direct Testimony.

Section II below addresses the questions designated by the Board as A.1-1 and A.1-2. Section III below addresses the questions designated by the Board as A.1-3 and A.1-4. Section IV below addresses the question designated by the Board as A.5-1. Section V below addresses the questions designated by the Board as A.5-3 and A.5-4.

II. 123 DBC LIMIT/DISCOMFORT STANDARD

The Board in its Memorandum and Order at 9-10, found the following general issues of material fact:

A. 1-1 Whether sound levels in excess of 123 dBC cause enough discomfort so that the Board should not approve the use of sirens at a high level of sound.

A. 1-2 If there is some level higher than 123 dBC that the Board should allow, what is that level?

The Applicants answer the questions by taking the position that the VANS system meets the 123 dBC limit without alteration. This is based principally on two claims: a) that the height of the siren speaker is such that exposure will be less than 123 dBC for normal operation and would only briefly exceed 123 dBC for 25 foot operation; and b) the "discomfort" standard should be viewed in terms of auditory fatigue or temporary threshold shifts and when so viewed the output of the VANS sirens is acceptable.

The purpose here is to demonstrate to the Board that discomfort due to excessive sound levels is a separate phenomenon from auditory fatigue or even hearing damage due to those levels. NUREG-0654 uses the standard of discomfort and sets a limit of less than 123 dBC. There is substantial support for setting the limit at that level as an upper bound of discomfort to individuals, even if no fatigue or damage results.

Sound levels of varying magnitude affect people in a variety of ways. High levels of sound exposure can cause temporary and permanent threshold shifts, either immediately or over a long period of time. At high enough exposure levels, sound can also cause pain or discomfort and create "tickle" or feeling". At lower levels sound can cause annoyance, interfere with speech communication, and disturb sleep. Many of the effects of sounds on people depend both on the frequency content of the sound as well as their duration. However, discomfort and pain do not depend on frequency within the frequency range from 200 to 2000 Hz, and are reported by subjects very soon after the onset of the sound.

Textbooks and articles discussing tolerance to sound have cited levels in the vicinity of 120 dBC as causing discomfort and 140 dBC as causing pain. Although these levels or even lower levels have been cited in many references,[1/] the levels

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1/ References citing 140 dB or lower as thresholds for pain are:

L. Beranek, Acoustics (New York: Acoustical Society of America, 1954, 1986)

L. Doelle, Environmental Acoustics (New York: McGraw-Hill, Inc. 1972) (125 dB)

M. Egan, Architechural Acoustics (New York: McGraw-Hill, Inc. 1988) (130dB)

R. Gales, "Hearing Characteristics, "Handbook of Noise Control, 2d Ed. ed. C. Harris (New York: McGraw-Hill, Inc. 1979)

T. Rossing, The Science of Sound (Reading, MA: Addison-Wesley Publishing Co., Inc. 1982)

A. Peterson and E. Gross, Jr., Handbook of Noise Measurement, 7th Ed (Concord, MA: General Radio, 1963, 1967, 1972)

J. Sataloff and P. Michael, Hearing Conservation (Springfield, IL: Charles C. Thomas, Publisher, 1973)

References citing 120 dB or lower as thresholds for discomfort are:

Beranek (above) (110 dB)

P. Cheremisinoff and P. Cheremisinoff, Industrial Noise Control Handbook (Ann Arbor: Ann Arbor Publishers, Inc., 1977) (115 dB)

(footnote continued)

causing discomfort seem to be based mainly on a study conducted by Silverman, Harrison, and Lane, "Tolerance for Pure Tone and for Speech in Normal and Hard-of-Hearing Ears," (St. Louis: Central Institute for the Deaf, OSRD Report 6303, 1946).

Silverman, et al., investigated tolerance levels for both pure tones and speech in individuals with normal and defective hearing. The study reported "three clearly distinguishable thresholds," identified as follows in the published article:

1. Discomfort threshold, defined as the point at which the subject feels he would cease to listen because the stimulus was uncomfortable.

2. Tickle threshold, defined as the point at which the subject experiences a definite tickling sensation in the ear.

3. Pain threshold, defined as the point at which the subject experiences a definite sensation of sharp pain, as opposed to more discomfort deep in the ear.

Thresholds for discomfort, tickle, and pain, using pure tone and speech, were determined over a 6-week period for 46 normal ears and 46 hard-of-hearing ears. A total of 16,000 observations were made during the course of the investigation. Since the main focus of this review is discomfort, it is

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(footnote continued)

Gales (above)

K. Kryter, The Effects of Noise on Man, 1st Ed. and 2d Ed. (Orlando: Academic Press, Inc. 1985)

A. Petterson and E. Gross, Jr. (above)

instructive to include the actual instructions given to the subjects as follows:

> "You will hear a tone which will get louder and louder. Tell me when you reach the point where the tone is uncomfortable, that is, when you would no longer care to listen or when you feel like removing the earphone from your ear. When the uncomfortable point is reached, say 'uncomfortable' and I will shut off the tone. We shall then repeat the procedure with another tone. Are you ready?"

The signals were presented as "an ascending staircase" with each level being 2 dB higher than the preceding one. The duration at each level was 1.5 seconds with no off time between successive levels.

Average discomfort threshold levels ranged from 110 dBC at the start of the tests to 122 dBC at the end of the final series. There is a slight frequency effect in that a minimum existed in the levels at 1400 to 4000 Hz which was 3 dB below the average at all frequencies tested. However, the levels around 500 Hz were well represented by the average values. Thus, at the beginning of the 6-week test the threshold of discomfort was 110 dBC and at the end the average threshold was 120 dBC. Evidently, people changed their threshold by 10 dB after being exposed to high level sounds. Such an influence was also observed within a test trial. For example, the entire test series was repeated during each test session and the average threshold of discomfort increased by as much as 8 dB in the repeated test. However, at the start of each weekly test session the threshold of discomfort dropped from the final value of the previous week's session.

In summary, the average discomfort level threshold, for people with normal hearing that are unaccustomed to high noise levels, is 110 dBC for sounds lasting 1.5 seconds, the duration of the sounds under test. For individuals with a history of exposure to high noise levels, this threshold might be raised to 120 dBC. An average level for the threshold of discomfort is 115 dBC. This level is also approximately equal to the average discomfort level determined at the start of each weekly session. It should be pointed out that the 115 dBC threshold of discomfort level is an average level. The threshold of discomfort for some individuals would be higher than 115 dBC and lower for others.

One measure of the range of levels across subjects may be expressed as the standard deviation of the threshold levels obtained from the experiment. Unfortunately, values of the standard deviation of threshold levels were not reported by Silverman, et al. For audibility thresholds, a standard deviation of 6.5 dB has been observed for a 500 Hz tone (Dadson and King, "A Determination of the Normal Threshold of Hearing and its Relation to the Standardization of Audiometers," Journal of Laryngology vol. 66, page 366 (1952)). In a test to determine the threshold of "feeling", the standard deviation at 500 Hz can be calculated from reported levels (D. Lierle and S.

Reger, "Threshold of Feeling in the Ear in Relation to Sound Pressures," Arch. Otolaryng, 23:653 (June 1936)) to be 6 dB for 38 ears. Since the threshold of discomfort might exhibit a greater variation in levels, a standard deviation of 8 to 10 dB might be representative. If these values were characteristic of the distribution of threshold levels of discomfort about some average value, then an estimate can be made of the percentage of people whose threshold of discomfort level would be exceeded by a 123 dBC tone at 550 Hz such as generated by a siren. Thus, for a 10 dB standard deviation, the percentage of people whose threshold of discomfort would be exceeded would be 79%. Similarly, for an 8 dB standard deviation, the percentage of people whose threshold of discomfort would be exceeded would be 84%.

In conclusion, the 123 dBC level is already on the high side of the range of discomfort for most individuals. That level represents a sound and appropriate standard for discomfort and should be followed for the VANS sirens.[2/] The actual sound levels likely to be received by members of the public from the VANS speakers is addressed below.

2/ The Mass AG refers the Board to its brief on the relevance of discomfort for an analysis of the legal issues presented by application of the NUREG-0654 standard.

III. SOUND COVERAGE/123 dBC LIMIT

The Board, in its Memorandum and Order at 10, found the following two genuine issues of fact:

> A.1-3. Whether Applicants sirens can provide adequate coverage if used at sound levels that are not unduly uncomfortable.
>
> A.1-4. Whether Applicants' position on the sound level resulting from their sirens is an underestimate because of sound reflection from buildings.

The Applicants have attempted to address these issues in two ways. First, they claim that the vertical directivity pattern of each of the Whelan WS 4000 (Dual) Sirens is such that no bystander could be exposed to sound greater than 123 dBC when the siren is raised to its full height (and would be minimally exposed at the 25 foot height). See Attachment H to Applicants' Direct Testimony. Second, they also claim that while sound reflections from buildings could increase listener exposure by up to 6 dB, this possibility "is of very limited concern" and need not be considered "[f]rom a planning standpoint." Applicants' Direct Testimony at 16-17.

An analysis of these claims begins with a review of Attachment H to the Direct Testimony entitled "Contours of Constant C-Weighted Sound Pressure Level at 550 Hz in Vertical Plane Near Whelen WS 4000 (Dual) Siren Mounted 45 ft. Above the Ground. This figure presents a matrix of sound pressure levels at 5 foot height and 10 foot distance intervals.

The source of these data is not explained, but appears to be a theoretical (or computer driven) estimate. The Audio Engineering Society and American National Standards Institute standards suggest the definition of directivity patterns based on actual sound level measurements. Apparently, no such measurements were taken here.

Moreover, Attachment H appears to ignore the ground reflection of siren sound. The effect of this reflection would be to increase siren sound levels by up to 2dB at 5 feet above the ground surface (ear height) at some locations and reduce sound levels at others to produce a slightly fluctuating sound level as one proceeds away from the siren. This phenomenon would exist over sound reflective surfaces (including pavement, hard ground and short grass surfaces) likely to be predominant in residential or populated areas. The phenomenon would not exist over densely wooded or rough terrain (especially with tall grasses or dense plant growth) areas. In short, Attachment H will underestimate sound levels at ear height for certain common areas by as much as 2dB.

At locations close to buildings, reflections of siren sound can also amplify sound levels by as much as 6dB. See Applicants' Direct Testimony at 16-17. The Applicants discount this as being "of very limited concern" because of the small area potentially effected and the supposed low probability that the recipient would be properly positioned or that necessary atmospheric conditions would exist. In our view this discounting is not appropriate. In fact, increased sound levels due to building reflection can and will occur at a number of areas and under all atmospheric conditions. In particular, several VANS locations have residences between approximately 150 and 300 feet from the acoustic locations. Those distances correspond to the highest sound levels for the listener, according to Attachment H.

The Applicants go on to point to 5 factors which could effect the actual amount of the building reflection increase. See Applicants' Direct Testimony at 17. What they fail to point out, as they should, is that under most circumstances there will be at least a 3dB amplification and under many circumstances the amplification would be even greater. Applicants' factor (5) implies that many building surfaces are sound absorptive. But, in fact most building surfaces are highly sound reflective. With respect to Applicants' factor (3), the relative distances between siren, structure and listener are important. Nevertheless, persons situated in front of building surfaces having line of sight to a siren will experience increased siren sound levels as a result of sound reflecting from building facades. When a siren is lined up perpendicular to a building facade, the area over which sound reflections cause the greatest amplification extends to a distance of approximately 1/2 of the shorter of the building height or width. Therefore, for a 3 story building with a height of 30 feet and a width greater than 30 feet the area of greatest amplification will extend to 15 feet from the building. In short, amplification due to building reflection is not theoretical only and should be addressed by the Board.

Accounting for ground and building reflections, siren sound levels in the vicinity of building surfaces having direct line of sight to sirens would be 3 to 8dB higher (building reflection plus ground reflection) than estimated based on data in Attachment H. If the speaker were at 25 feet above the ground, the sound levels received by members of the public would actually be between 134 dBC and 139 dBC, presuming the accuracy of Attachment H in the absence of either type of reflection. If the speaker were at 50 feet, the sound levels received by members of the public would actually be between 125 dBC and 130 dBC with the same presumption. Put differently, siren sound levels at buildings would need to be shown in Attachment H as less than 115 to 120 dBC (123 dBC at 5 feet above the ground minus 3 to 8 dB) to ensure that the 123 dBC limit is not reached for any particular recipient exposed to siren sound reflections.

Assuming the siren speaker is at 50 feet above the ground, the siren sound level would need to be reduced by 3 to 8 dB or to 126 to 131 dBC at 100 feet on axis. Assuming the speaker is at 25 feet above the ground, the siren sound levels would need to be reduced by 11 to 16 dB or to 118 to 123 dBC at 100 feet on axis.

This could lead to the conclusion that siren sound output should be tailored to account for buildings at (and even their distances from) each VANS acoustic location. Obviously, this would pose significant problems for managing the system. In our view, a prudent conclusion would be to reduce the 100 feet on axis sound levels to 123 dBC for the VANS sirens. We believe that this conclusion is prudent because it accounts for less than maximum likely amplification associated with building reflections and no ground reflections, but calls on the Board to assess sound levels at the 25 foot height which the Applicants should build into their procedure for meeting the 15 minute design objective.

The result of an 11 dB reduction from the 134 dBC level to a 123 dBC level would be to reduce coverage by approximately 63% using calculations consistent with WYLE RESEARCH REPORT WR 88-9, Siren Ranging Model, dated April, 1988. The effect of this reduction is depicted for 60 dBC and 70 dBC siren sound contours in Appendices 9 and 10 to the Affidavit of Thomas G. Bouliane submitted along with the Answer of Massachusetts Attorney General in Opposition to Applicants' Motion for Summary Disposition of Amended Contention on Notification System, dated October 11, 1988. Copies are attached hereto.

IV. DISPATCH TIME/DRIVER RESPONSE

In its Memorandum and Order at 20-21, the Board posed the question: "Over years of plant operation, how likely is it that each of the VANS operators will be actually available and alert (e.g., not in the rest rooms, not away from post on break, not believing that the situation is a false alarm) at the time an alert message is received?" The Board also noted the "Applicants have misinterpreted the requirement for conservative calculations with rspect to dispatch time." The Board questioned both whether the Applicants' repetitious calculations built in a practice bias and whether the tests themselves "where the operators were aware that they would be repeatedly called, are a fair prediction of what would actually happen in an event with no forewarning." Memorandum and Order at 20.

The Applicants' responses to these inquiries appear in Implementing Procedures 2.16, step 5.1.1 as well as pages 21-25 of their Direct Testimony. Their attempt to ensure driver readiness takes the following forms:

(a) training of VANS operators in IP 2.16 and proper use of the equipment;

(b) requiring VANS operators to perform daily non-emergency actions;

(c) 24 hour staffing with shifts of one supervisor, twenty primary VANS operators, and four backup VANS operators;

(d) a rule that VANS operators are not to leave their duty station until relieved;

(e) prioritized dispatch; and

(f) the VACS system.

Notwithstanding the actions taken by the Applicants, the problems alluded to by the Board, as well as similar problems, are real and likely to occur over time. The fundamental issue is that the job of VANS operator is an excessively boring one. Individuals, in similar job circumstances to those here, typically find ways to alleviate their boredom which may well conflict with the objectives of the job. In this case those objectives are to be alert and ready to respond in a timely way. What makes this job particularly problematic is that its most significant function and indeed its very reason for being is to respond to a single signal which has a very low likelihood of occurence. In other words, job performance is ultimately measured by the capacity to respond in a timely fashion to an event of extremely low probability.

This kind of issue has been studied before in different circumstances. Research on vigilance indicates that attention level declines over time in monotonous, monitoring tasks. For example, Bakan found that persons performing a vigilance task were unable to sustain continuous task concentration despite high motivation. (P. Bakan "An Analysis of Retrospective Reports Following An Auditory Vigilance Task," Vigilance: A Symposium, ed. D.N. Buckner, J.J. McGrath (1963)) In this study, over two-thirds of the participants reported lapses in attention and making active attempts to combat drowsiness even when highly motivated to perform the task well. These results, obtained in a brief vigilance task involving signal presentations at a much more frequent rate than that presumed to occur for VANS operators, suggest that VANS operators will engage in activities to counteract boredom with varying degrees of success (e.g. telephone calls, going outside of the staging area, leaving the area altogether). As Bakan indicates, there are substantial individual differences in ability to sustain alertness over time in a monitoring task.

The manifestations of this boredom are likely to be absenteeism problems, engaging in non work-related activities, including leaving the staging areas for extended periods of time for activities which are not work-related. Over time, the routine, repetitive nature of the VANS operators daily duties are likely to result in a reduced desire to attend work relative to the desire to engage in non work activities. Motivation to attend work, motivation to arrive at work on time and motivation to conduct work-related activities only is likely to decline over time relative to the motivation to engage in other activities.

This is complicated and becomes more problematic because of two additional factors. First, there is a single VANS supervisor who is obviously not capable of effectively overseeing the VANS operators for this kind of problem. This limitation on surveillance makes it more likely that off-site activities will occur. Second, the low probability of emergency action translates into a low perceived probability that engaging in non work-related activites will result in negative consequences. Self regulation - in which the VANS operators would forego an immediate pleasing or personally important activity in favor of a long term negative outcome - is substantially weakened when the likelihood that an emergency will occur is extremely low. In addition, the extremely low probability occurrence of a true emergency means that VANS operators may perceive the signal as a false alarm if it does occur, since they have come to expect that such a signal is not likely to occur. In short the boredom of this job coupled with the other factors mentioned above make it unrealistic to expect dispatch times over the life of the VANS system to be consistent with the tested dispatch times presented by the Applicants.

The steps taken by the Applicants will be effective in only limited respects. First, the training of VANS operators in implementing procedures and the proper use of equipment is procedural and cognitive, testing abilities and skills, and is not motivational. In short, it will do nothing to solve these problems. Second, requiring VANS operators to perform daily non emergency actions is helpful. However, the actions as described in Implementing Procedure 2.16 appear to be limited in relation to the total shift time of eight hours and will do little over the life of the system to mitigate these problems. Third, the 24-hour staffing, prioritized dispatch and sophisticated communication system are effective only to the extent that VANS operators remain at the staging areas. They will help to achieve a dispatch time consistent with the Applicants estimate if the VANS operators can be reached by the communications system or can return within 5 minutes (for purposes of a prioritized dispatch). These steps do nothing for VANS operators who come into work late or leave the site during the course of their work, both likely events over the life of the system, as suggested by the Board. Moreover, the assumed dispatch time of 40 seconds is so limited (and in some respects speculative because the staging areas have not been built) that it is doubtful the communications system or the prioritized dispatch will ensure compliance. For example, the prioritized dispatch itself proceeds from the hopeful asumption that not only are all operators at the staging area but all but one operator is in a position to respond immediately. Finally, the Applicants rely on the apparently barren rule that VANS operators remain at the station until they are relieved. It is well settled based on a number of studies of similar jobs that only if there are recognized negative consequences of breaking that rule will it be honored. Nothing filed by the Applicants suggest that that would be the case.

V. NOTIFICATION REQUIREMENT

The Board noted that the "Applicants conclusion that they can complete initial notification in the non-winter months in 14 minutes and 50 seconds does not permit any accommodation for EBS or other instructional messages." Memorandum and Order at 23. The Board goes on to say "there is a genuine issue of fact concerning how much time should be added for this notification function," and significantly notes that a person must hear the signal before tuning in, not all will hear it at the same time, not all will tune in their radio immediately, or tune in at the beginning of a broadcast. As the Board notes, the "question is apparently not simple." Id.

The Applicants hope to satisfy this concern by simultaneous activation of the sirens and the EBS broadcast. Applicants' Direct Testimony at 30-31. They imply that the time to read the EBS message should not "count" for purposes of the 15 minute requirement because of the simultaneous broadcast.

While the procedure of simultaneous activation, three plays of the initial message plus additional repetitions at 15 minute intervals is acceptable, the conclusion the Applicants draw from it, in terms of the 15 minute requirement, is not. The substance of the requirement is to provide an alert signal and an informational and instructional message within 15 minutes. See NUREG-0654 at 3-3. Under their scheme, the Applicants assume that the population is ready at hand to hear the siren, interpret its meaning, has immediate access to a working radio, immediately tunes in to hear the message and hears a full EBS message. This is all supposed to occur for the Massachusetts EPZ population within the three minute alert signal period. It cannot happen.

As an initial matter, unless three of the four conditions occur immediately, an obviously impossible event for all of the population, the population which quickly tunes into the EBS station will do so into the first run of the message, since anyone tuning in after the siren has started will not hear the first full message. The next repetition will not end until at least one minute after the siren sounding is complete, assuming 2 minute EBS messages, as the Applicants do. Therefore, except for the proportion of the population listening to the EBS stations at the time of siren activation, notification will not be complete for members of the population until at least 1 minute after the siren sounding is complete. In fact, an analysis of the four conditions listed above leads to the conlusion that the notification process for a substantial portion of the population will not be complete until after that. It should be noted that these are four conditions that must obtain for the Applicants system to succeed in the time they set forth. One can legitimately question all four, and any one of them can significantly postpone notification for a substantial portion of the population.

Taking each in turn, the first question is whether the sirens will actually be heard. Examples of potential problems are limitless. They all stem from the fact that substantial numbers of the population will be in settings where the siren sound will not reach immediately.

Take the example of two elderly people living a few hundred yards from Unit 2 at Three Mile Island, during the emergency there. They had to sleep in shifts, one awake, the other asleep, because they could not be sure that the plant siren would wake them up. (Edward Walsh, Democracy in the Shadows; Citizen Mobilization in the Wake of the Accident at Three Mile Island, Westport, Greenwood Press, 1988, p. 43. This chapter details the unexpected interactions of small failures during the emergency evacuation.)

The second question is whether the signal will be interpreted correctly. A good deal of psychological research has demonstrated that people place stimuli such as a siren or a warning into a context or "frame;" and the frame, not the signal, determines whether it will be interpreted correctly, or even attended to. This is particularly true for novel, unexpected and potentially ambiguous signals. (See the collection of articles in Daniel Kahneman, Paul Slovic and Amos Tversky, Judgement under Uncertainty; Heuristics and biases, Cambridge, Cambridge University Press, 1982.)

This particular problem is compounded by the fact that residents will likely have experience hearing other sirens (police, fire engine, ambulance, noon siren, air raid tests). The nuclear plant siren is a relatively long one and it is reasonable to expect that those who hear it will eventually distinguish it from others. The point is that one of the means of doing so is the length of the signal. This means that one can expect a substantial portion of the population to properly interpret the signal (and take the necessary subsequent actions), well into (or even after the completion of) the siren.

A question related to that of interpretation is whether the population will act appropriately once the siren is recognized for what it is. It is assumed that the Applicants' public information calendar is completely distributed. The problem is that, particularly over the life of the Seabrook plant, much of the population will forget what to do upon hearing the sirens and will long since have forgotten where the emergency information is.

Next, there is the question of whether the persons hearing the siren have immediate access to a radio. Activities in the area are likely to have many residents away from the house, and most certainly more than an armlength from the radio. If they get back to the house and tune in the radio just three minutes after the siren finishes, they will have missed all three initial broadcasts of the message. Access to the radio (assuming that every necessary radio is working) must be virtually instantaneous to stay within the 15 minute period under the Applicants' assumptions. Ironically, the Applicants allow for VANS operators occasionally to be "indisposed," but never for the public to be so.

Compounding the problematical nature of these steps is the presence of anxiety, fear or panic. Under time pressures that people would be very aware of, we can expect strong psychological reactions that have counter productive consequences. The literature on stress is clear on that, and more limited literature on the role of time pressures in carrying out tasks or making decisions, also suggests that decisions and abilities decay under these pressures.

Under the stress of an emergency, the consequences for decision making by the citizens could be substantial, given the degradation of decision quality under time pressure reported in the literature. (E.g., Dan Zakay and Stuart Wooler, "Time pressure, training and decision effectiveness," Ergonomics, 1984, vol. 27, no. 3, 273-84, who cite six studies to the effect that "under stress, cognitive functioning and decision-making processes deteriorate." Page 275). Time pressures in particular result in suboptimal decision making, and can even remove the advantage of training, as is indicated by three additional studies (cited by Zakey and Wooler. See also the review by Paul Slovic, "Judgment and decision making in emergency situations," Eugene, Ore., Decision Research, February 1988 who cites an additional six studies on time pressures and the decay in optimal decision making.)

The reason for this concern is that unusual stimuli are inherently ambiguous. Sirens are rare, but also used for diverse things, making their meaning on the rare occasion they are heard ambiguous. An emergency sounding may be perceived as "just a test." Even if recognized as emanating from a Seabrook siren the Applicants assume that every message will be interpreted immediately and correctly. If it is acknowledged that there might be errors in the operation of the plant, it should be acknowledged that an untrained population two or ten or twenty years into Seabrook's operation might make errors regarding the sirens. No matter how tighly run nuclear plants may be, daily life is full of errors and delays and minunderstandings. This is particularly evident when unexpected and unfamiliar events occur, and most particularly when they raise expectations of danger.

As can be seen, none of this is capable of precise quantification. It does, however, support the conclusion that a substantial portion of the population will not hear a full EBS message during the siren activation. The Applicants' conclusions, therefore, are erroneous. We suggest that the most prudent way to calculate the time to complete the initial notification is to assume that notification is completed when the initial series of three EBS messages, with at least one full message broadcast after the siren activation is completed, ceases.

MAPS PROVIDED ONLY TO
BOARD, NRC STAFF, AND APPLICANTS

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

'89 APR 24 P3:50

In the Matter of	)	Docket Nos. 50-443-OL-1
	)	50-444-OL-1
PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE, ET AL.	)	
(Seabrook Station, Units 1 and 2)	)	April 21, 1989

CERTIFICATE OF SERVICE

I, Stephen A. Jonas, hereby certify that on April 21, 1989, I made service of the within Mass AG Brief On Relevance Of Discomfort, Mass AG Direct Testimony Regarding Prompt Alert And Notification System Issues, and Mass AG's Supplemental Answer To Applicants' Expert Witness Interrogatories, by First Class Mail, or by Federal Express as indicated by [*], or by Hand Delivery as indicated by [**] to:

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Dated: April 21, 1989