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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of	)	
	)	
CAROLINA POWER & LIGHT COMPANY	)	
and NORTH CAROLINA EASTERN	)	Docket No. 50-400 OL
MUNICIPAL POWER AGENCY	)	
	)	
(Shearon Harris Nuclear Plant	)	
Plant)	)	

APPLICANTS' PROPOSED FINDINGS OF FACT AND  
CONCLUSIONS OF LAW ON REOPENED HEARINGS  
ON EDDLEMAN 57-C-3  
(NIGHT-TIME NOTIFICATION)

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March 18, 1986

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INTRODUCTION AND BACKGROUND

1. The initial evidentiary hearings on Eddleman 57-C-3 were held on November 4 and 5, 1985. Following those hearings, the interested parties submitted proposed findings of fact and conclusions of law,<sup>1/</sup> and the Board

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<sup>1/</sup> See "Applicants' Proposed Findings of Fact and Conclusions of Law on Eddleman 57-C-3 (Night-Time Notification)" (December 9, 1985) (hereinafter "App. PF [paragraph number]"); Wells Eddleman's Proposed Findings and Conclusions on Contention 57-C-3 (Nighttime Alerting and Notification)" (December 16, 1985); "Attorney General's

(Continued next page)

commenced its deliberations. In the course of its deliberations, the Board "discovered gaps and ambiguities in the record" precluding, in its view, the definitive resolution of certain issues presented by the contention. By its January 16, 1986 "Memorandum and Order (Limited Reopening of the Record on Eddleman Contention 57-C-3)" ("January 16 Order"), the Board reopened the record for a further evidentiary hearing in the limited areas described in the order.

2. The Board's January 16 Order emphasized that the record was not being reopened on "informal notification" or on mobile alerting. Nor was the record reopened on actual sound levels in the Harris plume exposure pathway Emergency Planning Zone ("EPZ"). January 16 Order at 1. Rather, as expressed in the January 16 Order, the Board's concerns generally focused on the number of people who would be alerted by the sirens in different parts of the EPZ, depending upon which set of

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(Continued)

Proposed Findings of Fact and Conclusions of Law on Eddleman Contention 57-C-3 (Night-Time Notification)" (December 16, 1985); "NRC Staff/FEMA Proposed Findings of Fact and Conclusions of Law on Eddleman Contention 57-C-3 (Nighttime Notification)" (December 23, 1985) (hereinafter "Staff/FEMA PF [ ]"); and "Applicants' Reply To Other Parties' Proposed Findings of Fact and Conclusions of Law on Eddleman 57-C-3 (Night-Time Notification)" (January 6, 1986).

arousal data is used. In particular, the Board requested testimony on the applicability of a 1962 German study of the effectiveness of sirens in alerting a sleeping population ("the German study" or "Krallmann"). January 16 Order at 9.<sup>2/</sup> Further, relying on the Commission's decision in Final Rule on Emergency Planning, CLI-80-40, 12 N.R.C. 636 (1980) (ruling on a petition for reconsideration of the 15-minute notification requirement), the Board indicated its intention to "make separate findings on the arousal capabilities of the Harris siren system within (1) a 5-mile radius of the plant and (2) the area between 5 and 10 miles of the plant." January 16 Order at 2. The January 16 Order set forth the Board's preliminary computations on siren arousal probabilities for the first 5 miles of the EPZ,<sup>3/</sup> and

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<sup>2/</sup> "Final Report: Studies of the Effects of Waking Signals on Sleepers With Different Depths of Sleep and Dispositions" (Institute for Phonetics and Communications Research, University of Bonn, 1962) (Eddleman Ex. 74). None of the witnesses at the initial hearings were aware of the existence of this report. Indeed, the Board and the parties did not receive translated copies of this study until December 3, 1985.

<sup>3/</sup> The Board's preliminary computations were based on a house count for the first five miles of the EPZ, derived from Applicants' Exhibit 46. That exhibit, which was offered into evidence at the initial hearings, is a map of the Harris EPZ showing siren locations, night-time siren coverage contours, and house locations. It was specially prepared by Applicants to represent for the

(Continued next page)

invited the parties to comment on those calculations. In addition, the Board requested testimony addressed to siren arousal probabilities for the area from the 5-mile radius to the boundary of EPZ. January 16 Order at 6-8. Finally, the Board requested that Applicants provide information on the possibility of a supplemental alerting system within the first 5 miles of the EPZ. January 16 Order at 10. As discussed below, in the interest of the prompt resolution of this issue, Applicants subsequently announced their decision to provide tone alert radios to all households within the first 5 miles of the EPZ.

Tr. 10,269.

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(Continued)

record the much larger maps actually used in performing the analyses described in their initial testimony. When Applicants compared the Board's house count for the first five miles of the EPZ (derived from Exhibit 46) with their own count from the larger maps, the difference appeared to be large and caused them to compare the two maps. As the Board noted in its January 16 Order, Exhibit 46 is marginally legible. That problem, plus some errors Applicants made in plotting house locations on the smaller map, resulted in the discrepancy in house counts. While Applicants determined from their large maps that there are actually many more houses within the first five miles of the EPZ than are depicted on Exhibit 46, analysis reveals that the awakening percentages in the Board's January 16 Order were not sensitive to the house count discrepancy. Nevertheless, in the interest of accuracy, Applicants submitted a revised map (Applicants' Exhibit 46A) in the reopened hearings. January 16 Order; "Additional Testimony of David N. Keast on Eddleman 57-C-3 (Night-time Notification)," ff. Tr. 10,471 (hereinafter "Keast"), at 3-4, 10.

3. The reopened hearings on Eddleman 57-C-3 were convened in Raleigh, North Carolina on March 4 and 5, 1986. The record on Eddleman 57-C-3 includes the written and oral testimony received into evidence, as well as the exhibits received into evidence, at both the initial hearings and the reopened hearings. Appendix A identifies, by witness, the location in the transcript of all written testimony on this contention. Similarly, Appendix B lists all identified exhibits on this contention, and indicates the Board's rulings on any offers of exhibits into evidence.

#### FINDINGS OF FACT

##### I. THE REGULATORY SCHEME

4. In its January 16 Order, the Board advanced its tentative view of the legal standards applicable to emergency public alert and notification systems. January 16 Order at 2-5. Applicants are largely in agreement with the views expressed there, which generally comport with the arguments advanced in "Applicants' Proposed Findings of Fact and Conclusions of Law on Eddleman 57-C-3 (Night-Time Notification)" (December 9, 1985). App. PF 5-8. In particular, Applicants concur in the Board's tentative holding that, by endorsing the three-part

design objective in NUREG-0654/FEMA-REP-1 (Rev. 1),<sup>4/</sup> the Commission recognized a distinction between system performance within five miles of the plant and system performance outside the five-mile radius. Applicants further concur that, by expressly acknowledging that FEMA and the NRC Staff in NUREG-0654 (Rev. 1) had abandoned a 90 percent alerting requirement for the 5 to 10-mile area, the Commission indicated the acceptability of a rate of alerting of less than 90% within that area. See January 16 Order at 2-3, citing Final Rule on Emergency Planning, CLI-80-40, 12 N.R.C. 636 (1980).

5. Any doubt about the legal effect of the Commission's language in CLI-80-40 is removed by the Commission's subsequent action in Duke Power Co. v. NRC, No. 80-2253 (D.C. Cir. Sept. 29, 1981) (per curiam). In that case, Duke Power Company (one of the petitioners in CLI-80-40) pressed its challenge to the 15-minute notification requirement of the Commission's emergency planning regulations. The Court dismissed the challenge as moot, based on the "unequivocal assurance" of the Commission that compliance with the 15-minute notification

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<sup>4/</sup> "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," NUREG-0654/FEMA-REP-1 (Rev. 1, Nov. 1980) (hereinafter "NUREG-0654 (Rev. 1)" or simply "NUREG-0654").



requirement would be judged in accordance with "the standard of performance criteria promulgated in November 1980 jointly by Respondent [NRC] and the Federal Emergency Management Agency" -- NUREG-0654/FEMA-REP-1 (Rev. 1).

6. As the Board has recognized (see, e.g., Tr. 10,458-59), Applicants further maintain that -- where fixed sirens are selected as the means of meeting the Commission's regulations -- the numerical acceptance criteria are quite clear: under average summer daytime conditions, the siren sound level must exceed either 60 or 70 dB (depending upon population density). See generally App. PF 8. These numerical criteria -- established in NUREG-0654 and FEMA-43,<sup>5/</sup> expressly acknowledged by the Commission, and relied upon by FEMA and the NRC Staff in their compliance reviews of siren systems across the country -- served as the basis for Applicants' motion for summary disposition. See App. PF 8; "Applicants' Motion For Summary Disposition of Eddleman 57-C-3" (November 2, 1984).

7. The Board denied Applicants' motion for summary disposition on the ground that the NRC/FEMA numerical criteria were not binding on the Board and the parties.

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<sup>5/</sup> "Standard Guide For The Evaluation of Alert and Notification Systems For Nuclear Power Plants," FEMA-43 (Sept. 1983).

"Memorandum and Order (Ruling on Eleven Summary Disposition Motions)" (February 27, 1985), at 3-4. Based on that ruling, Applicants and the Staff performed detailed analyses of night-time siren sound propagation and arousal probabilities, to demonstrate that the original public alert and notification system for the Harris EPZ provides "the capability to essentially complete the initial notification of the public within the plume exposure pathway Emergency Planning Zone within about 15 minutes" (emphasis supplied). The results of those analyses were presented at the November 4 and 5, 1985 hearings.

8. Subsequently, the Board expressed some doubt as to whether the alerting percentages presented at the initial hearings (using the Lukas and Horonjeff data) constitute "essentially 100%." January 16 Order at 10. In light of the absence of any precise quantitative definition of "essentially 100%," and in the interest of the prompt resolution of this contention, Applicants decided to implement a tone alert radio program within the first five miles of the EPZ (Tr. 10,269), and described that program at the reopened hearings. The proposed findings below accordingly reflect the view that -- particularly in light of the Krallmann data -- Applicants' alert and notification system meets the Commission's regulations, even without the tone alert radios. While not required

for compliance with the Commission's regulations, the tone alert radio program provides an added measure of assurance that those close to the plant would receive prompt notification of any emergency. See ¶¶ 36-37, infra.

## II. THE WITNESSES

9. The evidentiary record on Eddleman 57-C-3 includes the written and oral testimony of the witnesses presented by Applicants and the witnesses presented by the NRC Staff/FEMA, both at the initial hearings and at the reopened hearings on this contention. Mr. Eddleman presented no witnesses at the initial hearings, but offered the "Testimony of Jesse L. Riley Re Alerting and Notification" (Eddleman Ex. 75) at the reopened hearings. Because all but two sentences of Mr. Riley's testimony were excluded as irrelevant and/or beyond the scope of the reopened hearings, all parties stipulated the relevant portion of his testimony into the record, and he was not produced for cross-examination. Tr. 10,685-709.

10. At the initial hearings on Eddleman 57-C-3, the NRC Staff/FEMA presented a distinguished panel of experts: Mr. Thomas F. Carter, Dr. Van M. Lee, Dr. Karl D. Kryter, and Dr. Jiri Nehnevajsa. Their credentials are summarized in App. PF 14-17, and need not be repeated

here. Dr. Kryter also appeared at the reopened hearings. See "Testimony of Karl D. Kryter Concerning Memorandum and Order (Limited Reopening of The Record on Eddleman Contention 57-C-3)," ff. Tr. 10,479 (hereinafter "Kryter II").

11. Applicants also presented a panel of impressive experts at the initial hearings: Mr. David N. Keast, Dr. Dennis S. Miletic, and Mr. Alvin H. Joyner. See "Testimony of David N. Keast, Alvin H. Joyner and Dennis S. Miletic on Eddleman 57-C-3 (Night-time Notification)," ff. Tr. 9375 (hereinafter "Keast et al."). Their professional qualifications are summarized in App. PF 18-20, and are not restated here. In the reopened hearings, Mr. Keast first appeared with Dr. Kryter, with the two testifying "on a roundtable basis" (pursuant to 10 C.F.R. Part 2, Appendix A § V(d)(4)), largely on the several sets of arousal data in the record. In addition, Applicants presented a separate panel of experienced professionals to address the tone alert radio program being implemented within the first five miles of the EPZ. That panel was comprised of Messrs. Keast and Joyner, as well as Mr. H. Ralph Goodwin and Mr. Dewey B. Overman, II.

12. Mr. Goodwin has been employed by Carolina Power & Light Company ("CP&L") since 1981, in the company's Emergency Preparedness Section as a Senior

Specialist-Emergency Preparedness. In that capacity, he is responsible for providing technical support and assistance to CP&L's three nuclear plants in the area of emergency preparedness. His responsibilities include ensuring the adequacy of all emergency response facilities, including communications networks, alert and notification systems, and other equipment necessary during an emergency. He works on a daily basis with emergency preparedness agencies -- including the North Carolina Division of Emergency Management and the Federal Emergency Management Agency -- to ensure effective support and coordination in the event of an emergency at a CP&L plant. Mr. Goodwin has completed numerous training courses in connection with his emergency preparedness responsibilities. His prior experience includes employment at Virginia Electric & Power Company's North Anna Power Station, where his duties included work in the areas of emergency planning and fire protection. "Testimony of H. Ralph Goodwin, Alvin H. Joyner, David N. Keast, and Dewey B. Overman, II on Eddleman Contention 57-C-3 (Night-time Notification)," ff. Tr. 10,723 (hereinafter "Goodwin et al.") at 2, Attachment A.

13. Mr. Overman is employed by CP&L as a Principal Engineer-Telecommunications Engineering, a position he has held since 1977. He received a Bachelor of Science

degree in electrical engineering from North Carolina State University. Since joining CP&L in 1969, he has held a number of engineering positions, all of which have involved the design of communications and electronic control systems. These systems include land-mobile radio systems, microwave systems, and telephone systems. His responsibilities with respect to communications systems include planning, scheduling, preparing specifications, reviewing vendor proposals, systems procurement, design engineering, and consulting. His prior experience includes employment with Texas Instruments, Inc. in the design of communications equipment. Mr. Overman also served as a communications technician in the United States Navy. He is active as an amateur radio hobbyist and holds an Advanced Class amateur radio license.

Goodwin et al. at 3, Attachment B.

### III. THE ALERT/NOTIFICATION SYSTEM FOR THE HARRIS EPZ

#### A. Probability of Alerting: The Krallmann Data

14. At the initial hearings on Eddleman 57-C-3, the NRC Staff/FEMA sleep awakening analysis was based primarily upon a study by Horonjeff and others. App. PF 30; Staff/FEMA PF 58. For reasons discussed above, the Krallmann data were not the subject of cross-examination at the initial hearings. Accordingly,

in its January 16 Order, the Board requested testimony on the psychoacoustic reasons for the differences in arousal probabilities predicted in the original NRC Staff/FEMA testimony as compared with the observed arousals reported by Dr. Krallmann. January 16 Order at 9.

15. On behalf of the NRC Staff/FEMA, Dr. Kryter examined the Krallmann study, comparing it to the Horonjeff data and assessing its validity for predicting awakening by sirens in the Harris EPZ. Tr. 10,480 (Kryter). In the Horonjeff study, fourteen adults (average age 43 years) were exposed over 21 consecutive nights to four different noises at different levels of intensity and two temporal patterns (for each noise and level). One pattern was a steady-state level for 15 minutes and the other was a rising and falling level (2 dB per second), similar to the variation in the level of the signal of a rotating siren. The noises were presented via loudspeakers placed in the bedrooms of the homes of the test subjects. The subjects were instructed to press a switch next to their bed when awakened. Kryter II at 5. Of the four test noises used in the Horonjeff study, Dr. Kryter concluded that the test transmission line noise spectrum was most similar to that of the sirens in the Harris EPZ. Dr. Kryter's initial testimony therefore relied on the test transmission line data as a basis for estimating the arousability of the siren. Kryter II at 8.

16. The subjects in the Krallmann study came from a wide variety of work backgrounds, and were male attendees at a one week course at an air raid protection school in Germany. The subjects slept in individual bedrooms, with provisions for the simultaneous testing of up to twenty-four persons. Krallmann presented a siren signal for 45 seconds once per night -- for 98 test nights -- at a preselected steady level (40, 45, 50, 55 or 60 dBC) and time (midnight to 5:00 a.m., divided into 15 minute segments). The subjects were instructed to arise and push a switch near the bed when awakened. The number (617) and age range (16-70 years, average age 43.88 years) of subjects in the Krallmann study is much greater than in other research studies on sleep. Kryter II at 4-5.

17. In comparing the Krallmann results with the Horonjeff results, it is necessary to account for the differences in sleeping conditions in the two studies (at school vs. home bedrooms). Presumably, the Krallmann subjects were somewhat more easily awakened than they would have been had they been sleeping in their own bedrooms, as were the Horonjeff subjects (just as the sleeping residents of the Harris EPZ would be in their own beds). On the other hand, arousability is dependent upon the stage of sleep and -- although the stages are somewhat cyclic throughout the night -- most of the deepest



sleep periods occur within the first hours of sleep. While the Horonjeff data are averaged over the entire night, the Krallmann data are reported for different clock hours throughout the night. For purposes of awakening analysis, the use of the "deep sleep" (midnight to 1:15 a.m.) Krallmann data generally offsets any over-estimation of arousal in that data due to the sleeping arrangements. Kryter II at 13-14, 15; Tr. 10,550-53, 10,664-65 (Kryter).

18. The Krallmann data for the "deep sleep" period indicate about 17 dB greater effective arousability, for a given SEL, than the Horonjeff test transmission line noise. This difference is attributable to fundamental psychoacoustic perceptual and physiological factors. First, the siren signal is more "salient" or noticeable (and sleep arousing) than the broader spectrum test transmission line noise, even when equally loud. This is consistent with other research findings that the presence of some pure-tone frequency components in a broad-band noise caused that noise to be judged significantly more objectionable or noisy than broad band noises of the same loudness; that is, a pure tone of a given level sounds "noisier" than a broad band sound having the same general center frequency and the same level. Research further indicates that an adjustment of approximately 9 dB should

be added to the dBA level of a 500 Hz siren signal in order to properly predict its judged "noisiness" as compared to that of a broad band noise of the same dBA or PNdB level. The pure-tone components in the 400-500 Hz frequency region of the siren signal thus account for approximately 9 dB of the difference between the results of the Krallmann tests and those of the Horonjeff tests for a given SEL. Kryter II at 8-11, 15; Tr. 10,504-05 (Kryter).

19. The remainder of the difference between the results of the Krallmann tests and the results of the Horonjeff tests are attributable to the phenomenon of "habituation"; that is, when exposed over a number of test nights, subjects may become less likely to be awakened by a given sound level -- they become "habituated" to it. As noted above, in the Horonjeff study, subjects were tested for 21 consecutive nights, whereas in the Krallmann experiment, each subject only participated for up to 4 consecutive nights of sleep (averaged to 2 nights). Research indicates that, had the Krallmann study continued for at least 14 nights (averaged to the seventh night), the arousability percentages would have dropped by approximately 10 percentage points, equivalent to about an 8 dB difference in SEL. Thus, when adjusted for both habituation and the saliency of the siren

signal, the Horonjeff data are consistent with the Krallmann data. Of course, since EPZ residents will not be habituated to sleep arousal by the Harris sirens, it is not necessary to adjust the Krallmann data for purposes of predicting arousal from the Harris sirens.

Kryter II at 9, 11-12, 15; Tr. 10,552-53, 10,561-62 (Kryter).

20. Based on his review of the Krallmann study, Dr. Kryter concluded that the results of that study must be considered applicable for purposes of predicting arousal from sleep by the siren system within the Harris EPZ. Indeed, had the Krallmann report been available to him in the preparation of his initial testimony, he would not have pursued the Horonjeff data. Dr. Kryter considers the Krallmann data to be "several orders of magnitude more relevant" than the Horonjeff data, considering not only the use of a siren source, but also the number of subjects involved and the range of ages.<sup>6/</sup> Accordingly, Dr. Kryter advocated the use of the Krallmann data for the "deep sleep" period to predict awakening by the Harris alert/notification system.

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<sup>6/</sup> These differences are not insubstantial. The Krallmann data indicate at least 20 percentage points more awakening from sirens than the NRC Staff/FEMA predicted on the basis of the Horonjeff data. Tr. 10,480 (Kryter).

Kryter II at 3, 16; Tr. 10,504-05, 10,533-34,  
10,552-54 (Kryter).

21. Similarly, although the awakening analysis in his initial testimony was based upon data summarized in the Lukas Report (Applicants' Ex. 48), Mr. Keast considers the Krallmann data to be most pertinent to the prediction of awakening by sirens. Mr. Keast therefore also endorses the Krallmann study as the "definitive" study on point, and concurs in the use of the Krallmann data for the "deep sleep" period for purposes of predicting arousal from sleep by the alert/notification system for the Harris EPZ.<sup>7/</sup>  
Tr. 10,506, 10,509, 10,554-55 (Keast).

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<sup>7/</sup> The experts thus confirm the Board's tentative view, prior to reopening the record, that the Krallman study is probative of the matters at issue in this contention. January 16 Order at 6.

B. Fixed Sirens, Informal Notification and Mobile Alerting

1. Alerting From the Five-Mile Radius to the Boundary of the EPZ

22. Using the Krallmann "deep sleep" data, Applicants determined the siren arousal frequencies for the area between five miles from the plant and the boundary of the EPZ. First, working from large maps of the EPZ depicting siren locations, night-time siren coverage contours, and house locations, the houses with various sound exposures within five miles of the plant were counted. Subtracting these figures from the original calculations for the full EPZ (Attachment 5 of Keast et al.) produced the number of houses with various sound exposures between five miles and the boundary of the EPZ. A total of 19 nominal outdoor siren sound levels, ranging from 67 to 112 dB, were identified. Keast at 6-8, D-20 to D-38; see generally App. PF 22-24.

23. The analysis also considered the differing attenuation characteristics of different houses. Each of the 19 groups of houses covered by different outdoor siren sound levels was analyzed separately, by dividing it into eight sub-groups<sup>8/</sup> with different siren sound

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<sup>8/</sup> The eight sub-groups are identified and discussed in App. PF 25 n.11. See also Keast at 8, D-20 to D-38.

levels in the bedroom, and with different amounts of siren sound relative to the background noise in the bedroom. The sound attenuation values to indoors for each sub-group of houses were subtracted to determine the indoor sound levels, which were then compared to the appropriate indoor background noise levels. In some cases, at the lower siren sound levels, a signal-to-noise difference of 10 dB or less occurred. The analysis considered the effect of this on the value for the integration over the peak of the siren sound. Keast at 8.

24. Given the determined siren sound levels in the bedroom, the analysis next considered the probability that a sleeper would be awakened by such levels. Adjustments for A-weighting and time duration (based upon 10 minutes of siren operation)<sup>9/</sup> were added to obtain the SEL value. For each SEL value, the fractions awakened for one person were read from the Krallmann "deep sleep" awakening curve.<sup>10/</sup> Next, the fractions for awakening one of 2 people, one of 3 people, and one of 4 people

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<sup>9/</sup> Because the analysis assumes a total siren operating time of 10 minutes, it is conservative in light of the 12 minute operating time planned by the State of North Carolina. Keast et al. at 24-25.

<sup>10/</sup> As directed in the January 16 Order, Mr. Keast's testimony was prepared using Figure 1 of the Board's Order, which is based on the Krallmann "deep sleep" data. January 16 Order at 8; Keast at 7; Kryter II at Figure 1.

were computed. These were then weighted by the U.S. Census data on family sizes for the EPZ to determine awakening probabilities for the census family size mix.<sup>11/</sup>

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<sup>11/</sup> U.S. Census data indicate that 18.5% of the households in the Harris EPZ have one person; 29.5% have two persons; 19.6% have three persons; and the remaining 32.4% have four or more persons. Keast et al. at 23; Nehnevajsa at 25.

In its January 16 Order, the Board performed some computations, using a distribution developed from the initial Staff/FEMA testimony, which was based upon national data for 1978, and which eliminates all persons under the age of 18 as potentially alertable. Even the Staff/FEMA expert sociologist, Dr. Nehnevajsa, considered the EPZ-specific census data used by Applicants more representative than national data for the development of a distribution of alertable persons in the Harris EPZ. Keast at 11; "Testimony of Jiri Nehnevajsa Regarding Eddleman Contention 57-C-3," ff. Tr. 9690 (hereinafter "Nehnevajsa"), at 4-5.

Moreover, in the words of Dr. Nehnevajsa, eliminating all household members under the age of 18 from the alertable population is a "very conservative assumption"; indeed, it is "one of the key conservative limitations" of his results, and it is "not merely conservative, but somewhat unreasonable" to limit the analysis to persons 18 years of age or older. Keast at 12; Nehnevajsa at 10, 23-24; Tr. 9912-13 (Nehnevajsa). Dr. Kryter says only that younger persons may be more difficult to arouse, not that they are impossible to arouse. "Testimony of Karl D. Kryter Regarding Eddleman Contention 57-C-3," ff. Tr. 9690 (hereinafter "Kryter"), at 20.

Dr. Nehnevajsa concluded that all persons over the age of 13 would be able to interpret an alerting signal if aroused. Nehnevajsa at 24. Indeed, it can be expected that even younger children, if aroused, would awaken their parents (or, by their activity, would wake their parents), and then their parents would hear the sirens. Keast at 12.

(Continued next page)

When multiplied by the corresponding fractions of homes in each of the eight sub-groups, the result was the fraction of homes awakened in each class assuming the census family-size distribution. The sum of these eight fractions is the total fraction awakened: the effective awakening probability for the given outdoor siren sound level. This analysis demonstrates that 88.5% of the households from five miles to the boundary of the EPZ would be awakened by the sirens. An additional 1% is added, reflecting households with persons already awake at night, to conclude that about 89.5% of the households in that area would be alerted by the sirens alone. Finally, using Dr. Mileti's method for predicting the rate of facilitated informal notification (Keast et al.

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(Continued)

This difference in assumptions about the number of alertable persons in a household accounts for a 6% to 7% difference between results obtained using Applicants' approach and results obtained using the computational scheme which the Board derived from the initial Staff/FEMA testimony. Applicants' approach to the distribution of arousable persons per household is much more realistic than the wholesale exclusion of all persons under the age of 18 from the potentially alertable population. Keast at 11-12. Nevertheless, in the interest of conservatism (and given the statistical nature of the analysis), the Board could -- if it chose -- divide the difference and adjust the results obtained for fixed sirens using Applicants' approach downward by approximately 3%.



at 39), it is further concluded that greater than 97% of all households in the area between five miles from the plant and the boundary of the EPZ would be alerted by the sirens and by informal notification within 15 minutes. Keast at 6, 8-9, Attachment B.

2. Alerting Within the First Five Miles of the EPZ

25. Using the same methodology and assumptions (including the Krallmann "deep sleep" curve) employed above to predict alerting in the outer portion of the EPZ, Applicants also analyzed alerting for the area within a 5-mile radius of the Harris plant. That analysis demonstrated that 89.6% of the households in that area of the EPZ would be awakened by the sirens. An additional 1% must be added for those already awake at night, to conclude that 90.6% of the households within 5 miles of the plant would be alerted by the sirens alone.<sup>12/</sup> Keast at 6, Attachments E and G. Finally, again using Dr. Mileti's method for predicting the rate of facilitated informal notification, it is further concluded that greater than 97% of all households in the area within 5 miles of the plant would be alerted by the sirens

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<sup>12/</sup> The evidence thus shows relatively uniform alerting from sirens in the two areas of the EPZ. Compare ¶ 24 with ¶ 25, supra.

and by informal notification within 15 minutes. See generally Keast et al. at 39.

### 3. Alerting in the EPZ As A Whole

26. Thus, as the above analyses (using the Krallmann data) demonstrate, greater than 97% of all households throughout the EPZ would be alerted by the fixed sirens and by informal notification within 15 minutes. The mobile alerting system, which was not considered in these quantitative analyses, also can be expected to alert some additional incremental proportion of the population in the same time period. App. PF 37-40, 55. Accordingly, even excluding the tone alert radios being distributed within five miles of the plant, the Harris alert/notification system meets the Commission's regulations, providing "the capability to essentially complete the initial notification of the public within the plume exposure pathway Emergency Planning Zone within about 15 minutes" (emphasis supplied).

#### C. The Tone Alert Radio Program

27. In addition to the three elements of the alert/notification system applicable throughout the EPZ -- the fixed siren system, mobile alerting, and informal notification -- Applicants are distributing tone alert

radios to all residences within 5 miles of the Harris plant, providing additional assurance that households close to the plant would receive prompt notification of a Harris emergency. Goodwin et al. at 4, 7.

28. The tone alert radio system being installed within the five mile radius will be administered by Applicants and the North Carolina Division of Emergency Management, in cooperation with the National Weather Service ("NWS"), which is an agency of the National Oceanic and Atmospheric Administration ("NOAA"). The NWS maintains a radio transmitter system throughout most of the United States which provides continuous weather forecasts and other information about weather conditions. In addition to providing routine weather information, the NWS has the capability to broadcast an alert signal when an emergency weather situation occurs. The tone alert radio receivers to be distributed to residents around the Harris plant are capable of sounding an alarm tone upon receipt of such a signal from the NWS. From its facilities at the Raleigh-Durham Airport, the NWS has the capability to control transmitters in Durham and Fayetteville. Both of these transmitters cover the geographical area surrounding the Harris plant. The NWS has agreed to broadcast radio signals from these transmitters to activate the alert tone of the radio receivers and to

broadcast the EBS message in the event of an emergency at the Harris plant. Goodwin et al. at 15-17.

29. The tone alert radio receivers are capable of operating on both ordinary house current and a standard 9-volt battery as a back-up. If the electrical power supply to the receiver is interrupted for any reason, the receiver automatically shifts to the battery back-up mode and continues to operate. When the radio is in the "alert" standby position it will automatically sound an alarm tone and voice message upon receipt of the radio signal from the NWS. The alarm operates at full volume regardless of the volume control setting for the voice message. The receiver has an "alert lock" feature whereby the alarm sounds continuously until the receiver is manually reset. Goodwin et al. at 10-11.

30. When first activated by an NWS transmission, the receiver produces a relatively high-pitched, piercing tonal sound with a slight frequency warble -- the "initial alert tone." This tone persists as long as the NWS continues to transmit its activation signal -- typically 10 to 15 seconds. A red light on the receiver begins to blink when the transmission begins, and continues to do so until the device is manually reset. When the "alert lock" switch is in the "on" position, the initial alert tone is followed by a somewhat lower-pitched tonal sound,

also with a slight warble -- the "continuous tone." The continuous tone lasts indefinitely, or until the receiver is manually reset. Goodwin et al. at 11.

31. The Krallmann data indicate that 99% of sleeping people will be directly awakened by the combined effect of the two tones within the first 15 minutes after activation. If there are two persons sleeping in the bedroom, the Krallmann data indicate that the probability is 100% that at least one of the two people will be awakened within the first 15 minutes.<sup>13/</sup> U.S. Census data indicate that 68% of EPZ households include married couples. Conservatively assuming, then, that there will be two persons sleeping in 50% of the master bedrooms in the EPZ, it is predicted that the radios will alert 99.5% of the households in which they are installed. Goodwin et al. at 11-12, Attachment D.

32. Applicants plan a comprehensive, ongoing public education and information program to assure the effectiveness of the tone alert radio system. Around the time of the initial distribution of the radio receivers, the Harris Newsletter (distributed approximately three times a year to Harris EPZ residents) will describe the tone

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<sup>13/</sup> The alerting tones of the radio receivers are significantly louder than alarm clocks and clock radios. Goodwin et al. at 13-14.

alert radio program. A news release will also be distributed to media in the area, providing information about the program. In addition, each residence within 5 miles of the plant will receive a letter describing the tone alert radio program and its purpose, and explaining how the radio receivers will be distributed. The initial contact will be made by specially-trained CP&L representatives, who will personally distribute the receivers and meet individually with a responsible adult in each household. The Company representatives will explain the operation of the receiver and give guidance on the optimal placement of the receiver to provide the most effective notification at night. (Generally, the resident will be instructed to place the receiver on a bedstand in the master bedroom). Residents also will be instructed on the importance of maintaining the receivers in operable condition, and of contacting CP&L with any problems or questions about the radio receivers.<sup>14/</sup> Goodwin et al.

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<sup>14/</sup> Intervenors' witness, Mr. Riley, criticized the use of tone alert radios, asserting that they would be activated "only \* \* \* in hopefully rare emergencies." The thrust of Mr. Riley's criticism was that residences will have no means of assuring that their radios are operable in advance of an emergency. Eddleman Ex. 75 at 7 (as modified at Tr. 10,708). Mr. Riley's criticism is unwarranted. The radio receiver itself has three self-test features available to the user. The first feature is a red light that is activated when the radio is

(Continued next page)

at 18-20.

33. Each receiver will have an instructional sticker on the outer case, reminding residents of the importance of proper placement of the receiver in the home, emphasizing the need to keep the radio operable, and explaining how to request service. In addition, operational instructions, in the form of a pamphlet, will be distributed with the radio receivers. The pamphlet will include information on the operation of the receivers, their placement in the home, testing and maintenance programs, and how to contact CP&L to request repairs or receive further information. These pamphlets will be

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(Continued)

operating properly, awaiting the alert tone. The resident only needs to check the radio occasionally to assure that the red light is on. Another means of self-test is for the resident to depress the "weather bar," to hear the weather broadcast, available 24 hours per day. The third test is for the resident to depress the "test bar," to sound the alert tone and verify its operability. Finally, the NWS will activate the tone alert radios as part of a mid-day test conducted once a week. Tr. 10,876-77 (Overman, Goodwin); Goodwin et al. at 11, 20.

Any resident whose receiver fails to operate properly will receive free repair or replacement of the receiver by calling CP&L at a designated telephone number. In addition, each household within a 5-mile radius of the plant will receive a fresh replacement battery annually, including instructions on how to replace the battery, how to ensure proper operation of the receiver, and how to obtain any other needed repairs. Goodwin et al. at 20-21.

redistributed annually, with a letter, to all households within 5 miles of the plant. Further, the Harris Safety Information calendar and the school brochure (distributed annually within the EPZ) are being revised to include information on the purpose of the radios, their operation, their placement within the home, and testing and maintenance programs; and the Harris Newsletter will periodically remind residents of important information about the tone alert radio program. Goodwin et al. at 19.

34. Applicants' aggressive public education and information campaign is designed to maximize the effectiveness of the tone alert radio program. But even if some residents fail to maintain their tone alert radios in operable condition, the overall Harris alert/notification system will still be highly effective. Conservatively assuming that as many as 13.6% of the households<sup>15/</sup> within 5 miles of the plant do not (for whatever reason) have an operable radio in use, it is nevertheless concluded that -- based on the Krallmann data -- 98.3% of all households within 5 miles of the plant would be alerted via the fixed sirens and/or the tone alert radios. Applying Dr. Mileti's method for predicting the rate of

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<sup>15/</sup> In a FEMA-sponsored telephone survey of the population within the Fort St. Vrain EPZ, 13.6% of the survey respondents were not using their tone alert radios properly. Goodwin et al. at 14.



facilitated informal notification, it is concluded that greater than 99.6% of all households within 5 miles of the plant would be alerted by sirens, tone alert radios and informal notification within 15 minutes. The mobile alerting system, which was not considered in the quantitative analyses, also can be expected to alert some additional incremental proportion of the population within the same time period. Goodwin et al. at 14; Tr. 10,725 (Keast); Keast et al. at 39; App. PF 37-40, 55.

#### IV. CONCLUSION

35. The public alert and notification system for the full Harris EPZ is comprised of three elements -- an extensive system of fixed sirens located throughout the EPZ (designed to existing FEMA design objectives and criteria), a comprehensive mobile alerting plan, and the empirically well-established informal notification processes which occur naturally in emergencies. In addition to the three elements of the alert/notification system used throughout the EPZ, Applicants are also distributing tone alert radios to all residences within five miles of the plant.

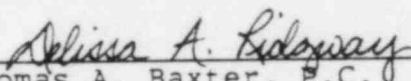
36. Based upon a definitive piece of research on awakening by sirens, endorsed by the acoustic experts of both Applicants and the NRC Staff/FEMA, it is concluded

that the fixed siren system and informal notification processes alone will alert greater than 97% of all EPZ households within 15 minutes. This is true both within five miles of the plant, as well as in the area from the five mile radius to the boundary of the EPZ. (The mobile alerting system, which was not considered in the quantitative analyses, also can be expected to alert some additional incremental proportion of the population in the same time period). Accordingly, even excluding the tone alert radios being distributed within five miles of the plant, the Board concludes that the Harris alert and notification system meets the Commission's regulations, providing "the capability to essentially complete the initial notification of the public within the plume exposure pathway Emergency Planning Zone within about 15 minutes" (emphasis supplied).

37. The research on awakening further indicates that the tone alert radios being distributed within five miles of the plant will alone alert 99.5% of the households in which they are installed. Even assuming, conservatively, that as many as 13.6% of the households within the five mile radius do not have an operable radio in use, it is nevertheless concluded that greater than 99.6% of all households within five miles of the plant would be alerted by sirens, tone alert radios and

informal notification. (Again, the mobile alerting system, which was not considered in the quantitative analyses, can be expected to alert some additional incremental proportion of the population within the same time period). Thus -- while not required for compliance with the Commission's public alert and notification regulations -- Applicants' inclusion of a tone alert radio program as an element of the alert and notification system for the first five miles of the Harris EPZ provides an added measure of assurance that those close to the plant would receive prompt notification of any emergency.

Respectfully submitted,

  
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Counsel for Applicants

Dated: March 18, 1986

APPENDIX A

Written Testimony Received Into Evidence

<u>Witness</u>	<u>Following Transcript Page</u>
<u>Carter</u> , Thomas F. "Testimony of Thomas F. Carter Regarding Eddleman Contention 57-C-3"	9690
<u>Goodwin</u> , H. Ralph "Testimony of H. Ralph Goodwin, Alvin H. Joyner, David N. Keast and Dewey B. Overman, II on Eddleman Contention 57-C-3 (Nighttime Notification)"	10,723
<u>Joyner</u> , Alvin H. "Testimony of David N. Keast, Alvin H. Joyner and Dennis S. Mileti on Eddleman 57-C-3 (Night-time Notification)"	9375
"Testimony of H. Ralph Goodwin, Alvin H. Joyner, David N. Keast and Dewey B. Overman, II on Eddleman Contention 57-C-3 (Nighttime Notification)"	10,723
<u>Keast</u> , David N. "Testimony of David N. Keast, Alvin H. Joyner and Dennis S. Mileti on Eddleman 57-C-3 (Night-time Notification)"	9375
"Additional Testimony of David N. Keast on Eddleman 57-C-3 (Nighttime Notification)"	10,471
"Testimony of H. Ralph Goodwin, Alvin H. Joyner, David N. Keast and Dewey B. Overman, II, On Eddleman Contention 57-C-3 (Nighttime Notification)"	10,723
<u>Kryter</u> , Karl D. "Testimony of Karl D. Kryter Regarding Eddleman Contention 57-C-3"	9690
"Testimony of Karl D. Kryter Concerning Memorandum and Order (Limited Reopening of the Record on Eddleman Contention 57-C-3)"	10,479
<u>Lee</u> , Van M. "Testimony of Van M. Lee Regarding Eddleman Contention 57-C-3"	9690

Mileti, Dennis S. 9375  
"Testimony of David N. Keast,  
Alvin H. Joyner and Dennis S. Mileti  
on Eddleman 57-C-3  
(Night-time Notification)"

Nehnevajsa, Jiri 9690  
"Testimony of Jiri Nehnevajsa  
Regarding Eddleman Contention 57-C-3"

Overman, Dewey B. 10,723  
"Testimony of H. Ralph Goodwin, Alvin H.  
Joyner, David N. Keast and Dewey B. Overman,  
II on Eddleman Contention 57-C-3 (Nighttime  
Notification)"

APPENDIX B

EXHIBITS

<u>Exhibit Number</u>	<u>Description</u>	<u>Identified At Transcript Page</u>	<u>Admitted At Transcript Page</u>
App. Ex. 46	Map of Harris EPZ, showing siren locations, nighttime siren coverage contours and house locations. Prepared by HMM Associates (September 1985)	9369	9372
App. Ex 46-A	Shearon Harris Plume Exposure Pathway map, revised 2/6/86	10468	10471
App. Ex. 47	Map, Revised 60 dBC Coverage Within the EPZ of the Shearon Harris Nuclear Power Plant. Prepared by Acoustic Technology, Inc. (October 1, 1985)	9427-28	9433-34
App. Ex. 48	EPA-600/1-77-010, "Measures of Noise Level: Their Relative Accuracy in Predicting Objective and Subjective Responses to Noise During Sleep," by Jerome S. Lukas (February 1977)	9614-15	9614-15
App. Ex. 49	Excerpts from State and County Emergency Plans, relating to mobile alerting (citations at Tr. 9633-34)	9966-67	9966-67
App. Ex. 53	"Prompt Notification of 100% of People in the EPZ," by M. Reada Bassiouni, reprinted from <u>Power Engineering</u> (September 1983), pages 47-49	10213-14	10225

<u>Exhibit Number</u>	<u>Description</u>	<u>Identified At Transcript Page</u>	<u>Admitted At Transcript Page</u>
WE Ex. 68	First page of data sheet, captioned "Measurement of Acoustic Properties of Homes In the Shearon Harris EPZ," for House #1		Per stipulation memorialized in "Wells Eddleman's Letter re: Exhibit Numbers on Contention 57-C-3," dated 11/26/85
WE Ex. 69	Two tables, "July Monthly Average Meteorological Parameters" at RDU, for 1 a.m. and 4 a.m. (1973-1984)		Per stipulation memorialized in "Wells Eddleman's Letter re: Exhibit Numbers on Contention 57-C-3," dated 11/26/85
WE Ex. 69-B	Table, "CP&L Harris Onsite Meteorological Data For the Period 1973 through 6/30/85, 1 AM through _____ AM, Months of June, July and August (8 pages)		Per stipulation memorialized in "Wells Eddleman's Letter re: Exhibit Numbers on Contention 57-C-3," dated 11/26/85
WE Ex. 70	Kryter, K., <u>The Effects of Noise on Man</u> (Academic Press, New York, 1970), pages 471-83		Per stipulation memorialized in "Wells Eddleman's Letter re: Exhibit Numbers on Contention 57-C-3," dated 11/26/85
WE Ex. 71	Driscoll, D.A., J.P. Dulin, Jr., and D.N. Keast, "Attenuation of Northern Dwellings To A Linear Source of Noise" (presented at 95th Congress of The Acoustical Society of America, Providence, R.I., May 1978)		Per stipulation memorialized in "Wells Eddleman's Letter re: Exhibit Numbers on Contention 57-C-3," dated 11/26/85
WE Ex. 72	Data sheets, captioned "Measurement of Acoustic Properties of Homes In The Shearon Harris EPZ," for Houses #2 - #13  Four data sheets, captioned "Noise Measurement of Window		Marked for Identification Only (per "Wells Eddleman's Letter re: Exhibit Numbers on Contention 57-C-3," dated 11/26/85)

<u>Exhibit Number</u>	<u>Description</u>	<u>Identified At Transcript Page</u>	<u>Admitted At Transcript Page</u>
	Air Conditioner in Bedroom"		
	Anon, "Noise in Urban and Suburban Areas," Report FT/TS-26 (Federal Housing Administration, Department of Housing and Urban Development, March 1968)		
	Anon, "House Noise Reduction Measurements For Use in Studies of Aircraft Flyover Noise," SAE Aerospace Information Report AIR 1081, (Society of Automotive Engineers, New York, October 1971)		
	Three tables, captioned "Housing Units Within Shearon Harris EPZ With Storm Windows," "Distribution of Housing Units By Age and By Window Area Requirements, Shearon Harris EPZ," and "Exterior Material of Yearround Housing Units, 1982, Shearon Harris EPZ"		
	Carter, T.M., S. Kendall, and J.P. Clark, "Household Response to Warnings," <u>International Journal of Mass Emergencies and Disasters</u> , 1, 1:95-104 (1983)		
	Mileti, D., T.E. Drabek, and J.E. Haas, <u>Human Systems in Extreme Environments</u> (Boulder: Institute of Behavioral Science, University of Colorado, 1975), pages 44-45		
	Lindell, M.K. et al., <u>Planning Concepts and Decision Criteria For Sheltering and Evacuation In A Nuclear Power Plant Emergency</u> , AIF/NESP-031 (Washington, D.C. 1985), pages 5-15 through 5-17		
WE Ex. 73	"ATI Review of Pre-filed Testimony, Eddleman Contention 57-C-3, Shearon Harris Nuclear Power Plant Licensing Hearings"	10211-12	10225
WE Ex. 74	"Abschlussbericht: Untersuchungen über die Wirkung von Wecksignalen auf Schäfer verschiedener Schlaftiefen und Disposition," translated: "Final Report: Studies of the Effects of Waking Signals on Sleepers With	10212	10214-15, 10225



<u>Exhibit Number</u>	<u>Description</u>	<u>Identified At Transcript Page</u>	<u>Admitted At Transcript Page</u>
	Different Depths of Sleep and Dispositions" (Institute for Phonetics and Communications Research University of Bonn, 1962)		
WE Ex. 75	"Testimony of Jesse L. Riley Re Alerting and Notification"	10685	10709
WE Ex. 76	Withdrawn portions of Applicants' Testimony of H. Ralph Goodwin, Alvin H. Joyner, David N. Keast and Dewey B. Overman, II on Eddleman Contention 57-C-3 (Nighttime Notification)" relating to telephones.	10709	
WE Ex. 77	"Radio Reception Test, Five Mile Radius, SHNPP" January 7 and 13, 1986	10801-02	10806
WE Ex. 78	"Tone-Alert Radio Alert Tone Test Sound Level versus Time, January 11-12, 1986".	10801-02	1 904

March 18, 1986  
DOCKETED  
USNRC

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

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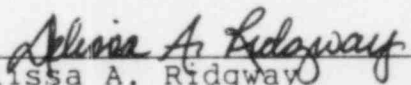
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

OFFICE OF SECRETARY  
DOCKETING & SERVICE  
BRANCH

In the Matter of )  
)  
CAROLINA POWER & LIGHT COMPANY )  
and NORTH CAROLINA EASTERN ) Docket No. 50-400 OL  
MUNICIPAL POWER AGENCY )  
)  
(Shearon Harris Nuclear Power )  
Plant) )

CERTIFICATE OF SERVICE

I hereby certify that copies of "Applicants' Proposed Findings of Fact and Conclusions of Law On Reopened Hearings on Eddleman 57-C-3 (Night-time Notification)" are being served on the 19th day of March, 1986, by hand delivery to those identified with one asterisk, and were served this 18th day of March, 1986, by deposit with Federal Express to those identified with two asterisks, and by deposit in the U.S. mail, first class, postage prepaid, to all others listed on the attached Service List.

  
\_\_\_\_\_  
Delissa A. Ridgway

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of )  
)  
CAROLINA POWER & LIGHT COMPANY )  
and NORTH CAROLINA EASTERN ) Docket No. 50-400 OL  
MUNICIPAL POWER AGENCY )  
)  
(Shearon Harris Nuclear Power )  
Plant) )

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