



UNITED STATES
 NUCLEAR REGULATORY COMMISSION
 ATOMIC SAFETY AND LICENSING BOARD PANEL
 WASHINGTON, D.C. 20555

November 19, 1985

Chairman Nunzio J. Palladino
 Commissioner Thomas M. Roberts
 Commissioner James K. Asselstine
 Commissioner Frederick M. Bernthal
 Commissioner Lando W. Zeck

Dear Mr. Chairman and Commissioners:

We are writing this letter to bring to your attention evidence of possible generic safety problems involving nighttime emergency notification of residents in the plume emergency planning zones surrounding nuclear power plants. It appears that under the acceptance criteria being generally applied by the Federal Emergency Management Agency to nuclear plant siren systems -- criteria which are based on daytime conditions -- substantial numbers of EPZ residents would not be aroused from sleep should an emergency siren notification be necessary between, say, midnight and 6:00 a.m., particularly if bedroom windows were closed.

We are members of the Atomic Safety and Licensing Board presiding over the application of Carolina Power and Light Co., et al. for an operating license for the Shearon Harris facility. We recently conducted an evidentiary hearing in that case on an Intervenor's contention that the Applicants' sirens would not awaken sleeping residents in the EPZ between midnight and 6:00 a.m., particularly those who have closed their windows and turned on their air conditioners. Both the Applicants and the Federal Emergency Management Agency presented extensive testimony and responded to cross-examination on the contention, as reflected in the Shearon Harris transcript. Tr. 9356-9976. The parties will be submitting proposed findings of fact on the siren and another contention during December, and the Board expects to decide those contentions in early 1986. In these circumstances, we as a Licensing Board have not drawn any conclusions about the particular siren contention before us in the Shearon Harris case. In any event, we would have no occasion to write to you about Shearon Harris at this time -- in advance of the normal review process -- because Harris is not, of course, an operating facility. Furthermore, should any deficiencies in nighttime notification emerge from the Shearon Harris record, we could fashion effective measures to deal with them on a site-specific basis. Rather, this letter is prompted by the possible generic implications of certain of the evidence in the Shearon Harris record, and our belief that such evidence should be called to your attention now. Most significantly, you should be aware of the following matters:

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1. The FEMA design criteria provide for siren sound coverage of 10 dB(a) above ambient noise levels or a minimum of 60 dB(c).

2. The "FEMA 43" reviews of siren system designs for operating nuclear facilities are based on summer daytime conditions. Such reviews give no consideration to factors only applicable at night -- i.e., almost everyone is indoors and asleep, many with the windows closed. These factors are not offset by greater sound propagation at night.

3. The testimony is that, for a house with the windows closed (central air conditioning) and an outdoor siren sound level of 60 dB, the probability of arousal from sleep is essentially zero. With the windows open, the probability is 7-8%. (Tr. 9650).

4. The sound levels necessary for high probability of arousal are substantially above the FEMA minimum guidance. For example, a 50% probability of arousal of an individual in a house with the windows closed requires outdoor sound levels of 90-99 decibels (Tr. 9927). The wide range in this estimate reflects the imperfect knowledge of siren arousal capability, since direct tests have not been conducted, at least in the United States.

5. For the Harris assumed summer scenario -- including 36% of the houses in the EPZ with no air conditioning (windows open) -- arousal is estimated as approximately 70%. Assuming the accuracy and acceptability of that estimate, lower probable arousal rates in other climatic areas of the United States nevertheless suggest possible generic safety concerns -- particularly in the winter season, when more of the population may sleep with the windows closed.

6. We further note that overall arousal percentages for an EPZ can mask the fact that, in areas of moderate housing density but with a fair number of houses more than one mile from a siren, a substantial percentage of the houses would have an arousal probability of less than 50%. For example, at siren 70 in the Harris EPZ, about 100 houses of about 160 in that area, or 63%, are in the 70-80 dB area. The probability of arousing an individual in those houses with the windows closed is approximately 30%, and is 55% for household arousal with two residents. If these houses correspond to U.S. averages, 18% would have one resident, 30% would have two residents, and the average probability of arousing the household would be 43%. Thus, although the risk of not being aroused, averaged over the EPZ, may be roughly 30%, in some areas approximately 50% of the houses may have a risk of non-arousal of roughly 57%.

NRC regulations require "early notification" to EPZ residents (10 C.F.R. 50.47(b)(5)), and this has been further defined to mean that the design objective of "the prompt public notification system shall be to have the capability to essentially complete the initial notification of the

public within the plume exposure pathway EPZ within about 15 minutes." 10 C.F.R. Part 50, Appendix E, IV D.3. The evidence we have cited indicates that in EPZs which rely primarily on siren notification (it is our impression that that is the case for most commercial reactors), such notification would not be "essentially complete" under some typical nighttime conditions within 15 minutes. To be sure, emergency notification typically includes "back-up" notification by police, fire and other emergency vehicles driving prearranged routes with sirens sounding. However, as was testified to in the Shearon Harris case, this back-up notification probably would not be accomplished in the 15-minute period. Testimony of Alvin H. Joyner at 42, ff. Tr. 9374. It seems doubtful that such back-up notification could be completed expeditiously if emergency workers had to first be reached and activated between midnight and 6:00 a.m.

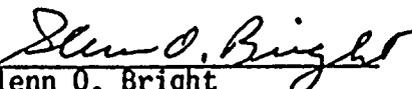
We also are aware that persons who are aroused from sleep might not only arouse their household, but that they would also tend to contact some neighbors, friends and relatives in the EPZ. This process of "informal notification" was testified to at some length in the Shearon Harris hearing, and the Board does not doubt that such informal notification would occur to some degree. However, the phenomenon cannot be controlled like a siren level or a police car route, and its likely effects are difficult to quantify. Therefore, we question whether informal notification should be viewed as a substitute for planned notification.

According to testimony in the Shearon Harris case, the siren systems around operating nuclear plants have not been field-tested to determine what percentage of EPZ residents would actually be aroused by their activation between midnight and six a.m. Tr. 9935-40. We believe that some such testing would be prudent and merits Commission consideration.

Respectfully submitted,


James L. Kelley


Dr. James H. Carpenter


Glenn O. Bright

cc: H. Plaine, General Counsel
S. Chilk, Secretary
Shearon Harris Service List



Federal Emergency Management Agency

Washington, D.C. 20472

DEC 6 1985

MEMORANDUM FOR: Dave Matthews
Chief
Emergency Preparedness Branch
U.S. Nuclear Regulatory Commission

FROM: *Robert S. Wikerson*
Robert S. Wikerson
Chief
Technological Hazards Division

SUBJECT: Nighttime Emergency Notification

This memorandum transmits (see attachment) FEMA's response to the Atomic Safety and Licensing Board's (ASLB) November 19, 1985 memorandum notifying the Commission of possible generic safety problems involving nighttime emergency notification.

PURPOSE:

The members of the ASLB presiding over the application of Carolina Power and Light Co. et al. for an operating license for the Shearon Harris facility informed the Commissioners, in a letter dated November 19, 1985, of "evidence of possible generic safety problems involving nighttime emergency notification of residents in the plume emergency planning zones surrounding nuclear power plants." This discussion presents the Federal Emergency Management Agency's (FEMA's) evaluation of the evidence presented in this letter and its conclusions concerning the existence of a possible generic safety problem.

BACKGROUND:

The Federal Emergency Management Agency (FEMA), as the lead Federal agency in a Memorandum of Understanding (MOU) with the Nuclear Regulatory Commission (NRC), is responsible for evaluating and approving prompt alert and notification systems that are installed around commercial nuclear power plants throughout the United States. These systems have been, or are being, installed within the ten-mile Emergency Planning Zone (EPZ) of each nuclear power plant by cooperative agreements between NRC licensees and State and local governments to provide a mechanism for rapidly alerting the public in the event of an emergency at the nuclear power plant. NRC licensees were mandated by the NRC to have alert and notification systems installed for all operating nuclear power plants by February 1, 1982, (originally July 1, 1981), or face enforcement actions. All nuclear power plants scheduled to go on line after February 1, 1982, must have an alert and notification system in place prior to operation.

10 CFR § 50.47(b) (5) and 44 CFR Part 350 require that "means to provide early notification and clear instruction to the populace within the plume exposure pathway Emergency Planning Zone have been established." 10 CFR Part 50 Appendix E § D.3 requires in addition that "The design objective of the prompt public notification system shall be to have the capability to essentially complete the initial notification of the public within the plume exposure pathway EPZ within about 15 minutes. The use of this notification capability will range from immediate notification of the public (within 15 minutes of the time that State and local officials are notified that a situation exists requiring urgent action) to the more likely events where there is substantial time available for the State and local governmental officials to make a judgment whether or not to activate the public notification system."

In 1980, NRC and FEMA published final guidance 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" which defined in technical terms, how the regulatory requirements in 10 CFR 50 where to be met.

In 1983, FEMA published interim guidance in FEMA-43 "Standard Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants" which organized the acceptance criteria of NUREG-0654/FEMA-REP-1, Rev. 1 into a format that could be used by the utilities to document their alert

and notification systems installations for review and approval under FEMA's 44 CFR 350 process. FEMA-43 did not change the design criteria established in NUREG-0654/FEMA-REP-1, Rev. 1.

To date, over 60 plants have submitted their prompt alert and notification system design plans, as prescribed in FEMA-43, for review by FEMA.

FEMA expects to complete its review of these sites, including findings to the NRC under the MOU, by the end of calendar 1986.

ISSUES:

The ASLB members, in their letter, cited the following evidence as the basis of their concern:

- 1) The FEMA design criteria provide for siren sound coverage of 10dB(a) above ambient noise levels or a minimum of 60dB(c).
- 2) The 'FEMA-43' reviews of siren system designs for operating nuclear facilities are based on summer daytime conditions. Such reviews give no consideration to factors only applicable at night--i.e., almost everyone is indoors and asleep, many with the windows closed. These factors are not offset by greater sound propagation at night.
- 3) The testimony is that, for a house with the windows closed (central air conditioning) and an outdoor siren sound level of 60dB, the probability of arousal from sleep is essentially zero. With the windows open, the probability is 7-8%. (Tr. 9650).
- 4) The sound levels necessary for high probability of arousal are substantially above the FEMA minimum guidance. For example, a 50% probability of arousal of an individual in a house with the windows closed requires outdoor sound levels of 90-99 decibels (Tr. 9927). The wide range in this estimate reflects the imperfect knowledge of siren arousal capability, since direct tests have not been conducted, at least in the United States.
- 5) For the Harris assumed summer scenario--including 36% of the houses in the EPZ with no air conditioning (windows open)--arousal is estimated as approximately 70%. Assuming the accuracy and acceptability of that estimate, lower probable arousal rates in other climatic areas of the United States nevertheless suggest possible generic safety concerns--particularly in the winter season, when more of the population may sleep with the windows closed.

- 6) We further note that overall arousal percentages for an EPZ can mask the fact that, in areas of moderate housing density but with a fair number of houses more than one mile from a siren, a substantial percentage of the houses would have an arousal probability of less than 50%. For example, at siren 70 in the Harris EPZ, about 100 houses of about 160 in that area, or 63%, are in the 70-80dB area. The probability of arousing an individual in those houses with the windows closed is approximately 30%, and is 55% for household arousal with two residents. If these houses correspond to U.S. coverages, 18% would have one resident, 30% would have two residents, and the average probability of arousing the household would be 43%. Thus, although the risk of not being aroused, averaged over the EPZ, may be roughly 30%, in some areas approximately 50% of the houses may have a risk of non-arousal of roughly 57%.
- 7) We also are aware that persons who are aroused from sleep might not only arouse their household, but that they would also tend to contact some neighbors, friends and relatives in the EPZ. This process of "informal notification" was testified to at some length in the Shearon Harris hearing, and the Board does not doubt that such informal notification would occur to some degree. However, the phenomenon cannot be controlled like a siren level or a police car route, and its likely effects are difficult to quantify. Therefore, we question whether informal notification should be viewed as a substitute for planned notification."

FEMA EVALUATION

Issue #1. For acceptance of the licensee's or applicant's siren system, FEMA-43 requires that the design report demonstrate that either "(a) the expected siren sound level generally exceeds 70dBC where the population density exceeds 2,000 persons per square mile and 60dBC in other inhabited areas or (b) the expected siren sound level generally exceeds the average measured daytime ambient sound levels by 10dB." It should be noted that these are minimum requirements and, in fact, cost effective siren system design, which locates sirens within population centers, results in many households being exposed siren sound levels that significantly exceed these minimums. For example, the Shearon Harris siren system, which is not atypical, provides sound levels in excess of 80dBC to almost 60% of the residence in the EPZ, under typical summer nighttime conditions.

Issue #2. The FEMA-43 reviews are based upon summer daytime conditions only to the extent that summer daytime conditions are used to model sound propagation. This approach is taken because siren sound propagation is least effective during these conditions. Therefore an analysis that demonstrates

that the FEMA-43 and NUREG-0654/FEMA-REP-1, Rev. 1 requirements are met under average summer daytime conditions provides reasonable assurance that they will be met in the event of an actual emergency at any time of year. The attenuation of structures, whether windows are open or closed and the need to provide a signal loud enough to alert people was considered in establishing the minimum acceptable sound pressure levels. In particular, as NUREG-0654/FEMA-REP-1, Rev. 1 states:

"The 10dB differential above daytime ambient is intended to provide a distinguishable signal inside of average residential construction under average conditions¹...research has shown that a person is capable of being alerted by such a differential above or below the background ambient in the case of a predominantly narrow band 300 to 800 Hz emitted by large sirens."

Issue #3. The cited testimony is not in agreement with FEMA expert witness testimony which indicates that the probability of arousing an individual from sleep under the circumstances cited with windows closed, is approximately 20% and with windows open is approximately 30%. Using the mix of one and two resident households cited as representative of the U.S. by the board members, this corresponds to an average household probability of direct (i.e., by siren) arousal of 33% for houses with windows closed and 47% for houses with windows open.¹ It should be noted that these direct arousal probabilities are for households at the minimum acceptable sound levels and, under actual circumstances, would be supplemented by informal notification by other alerted residents [see evaluation of issue #7].

Issue #4. Again the cited testimony is not in agreement with FEMA expert witness testimony that indicates that about 85dB would provide a 50% probability of direct arousal of a sleeping individual. Using the mix of one and two resident households cited as representative by the board members, this 85dB sound level would be expected to arouse about 70% of all households. As noted in the discussion of issue 3, this direct arousal would be supplemented by informal notification by other alerted residents.

Issue #5. The arousal estimated cited is for direct arousal only. Both FEMA and applicant expert witnesses testified that the inclusion of informal arousal mechanisms [see response to issue #7] would increase the percentage at the population aroused to approximately 90%.

Issue #6. FEMA agrees with the observation that, if the overall direct arousal percentage for an EPZ is 70% then there will be households for which the direct arousal rate is less than 50%. However, it should be noted that the letter's treatment of multi-resident households is improper since it

¹ Daytime ambient is used because it is higher than nighttime ambient.

ignores the 52% of the households nationwide with three or more residents. If these are treated [conservatively] as two resident households, the correct average probability of arousing the household would be 50.5%. Thus, although FEMA agrees with the general observation that there will be households with direct arousal probabilities lower than 50%, we note that the cited figures do not provide a supporting example.

Issue #7. In disregarding informal alerting mechanisms, the board members are failing to consider a phenomenon which is known to occur and for which quantitative data have been obtained on analogous occasions. The NRC makes predictive findings, often on the basis of engineering judgement, for other phenomena that are known to happen but are not strictly controllable (e.g., accidents). It is FEMA's judgment that consideration of informal alerting mechanisms, based upon quantification of actual experience by disaster sociologists, is appropriate so long as such consideration incorporates suitable conservatism. In addition, FEMA notes that informal notification mechanisms have been recognized by NRC boards in other hearings. See e.g. Duke Power (Catawba Nuclear Station, Units 1 and 2), LBP-84-37, 20 N.R.C. 933, 973 (1984) (Finding 10); Southern California Edison Company (San Onofre Nuclear Generating Station, Units 2 and 3), LBP-82-46, 15 N.R.C. 1531, 1534-35 (1982).

CONCLUSION:

Evaluation of the evidence presented in the November 19, 1985, letter to the Commissioners from the members of the ASLB presiding over the application of Carolina Power and Light Co. et al. for an operating license for the Shearon Harris facility does not indicate that there are possible generic safety problems involving nighttime emergency notification of residents in the plume emergency planning zones surrounding nuclear power plants. The evaluation criteria in NUREG-0654/FEMA-REP-1, Rev. 1 and the acceptance criteria in FEMA-43 are intended to ensure that alert and notification systems that are designed and evaluated in accordance with these criteria meet NRC's 10 CFR 50 Appendix E design objective "to have the capability to essentially complete the initial notification of the public within the plume exposure pathway within about 15 minutes." The siren system for the Shearon Harris Nuclear Power Plant, which is not atypical of the siren systems at other nuclear power plants, was designed, evaluated, and found to be acceptable under these criteria. The conclusion reached in FEMA's study, in response to the hearing contention, that this siren system can be expected to arouse and alert approximately 90% of the EPZ residents during a nighttime emergency serves to confirm FEMA's judgement that siren systems designed and evaluated in accordance with NUREG-0654/FEMA-REP-1, Rev. 1 and FEMA-43 meet the NRC requirements for both daytime and nighttime alerting.

REQUIREMENTS AND GUIDANCE RELATING TO
PUBLIC ALERT AND NOTIFICATION SYSTEMS

The requirement for a public alert and notification system is set forth in 10 C.F.R. §50.47(b)(5) of the Commission's regulations. This regulation requires that: ". . . means to provide early notification and clear instruction to the populace within the plume exposure pathway Emergency Planning Zone have been established." Appendix E to 10 C.F.R. Part 50 establishes the minimum requirements for emergency plans in order to attain an acceptable state of emergency preparedness. 10 C.F.R. Part 50, Appendix E §IV. In addition, the Commission has established a design objective for the prompt public notification system; this design objective is that the system ". . . shall have the capability to essentially complete the initial notification of the public within the plume exposure pathway EPZ within about 15 minutes." 10 C.F.R. Part 50, Appendix E §IV.D.3.

The responsibility for determining the adequacy of offsite emergency plans, including the adequacy of the prompt public notification system, rests with the Federal Emergency Management Agency (FEMA). See, Memorandum of Understanding between NRC and FEMA, 50 Fed. Reg. 15485 (April 18, 1985). FEMA makes its determination of the adequacy of offsite emergency plans by evaluating their compliance with the standards and criteria of 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" (November 1980). NUREG-0654 contains acceptance criteria for a prompt public notification system. NUREG-0654 Appendix 3, §B. The minimum acceptable design objectives for coverage by a prompt public notification system are:

- (a) Capability for providing both an alert signal and an informational or instructional message to the population on an area wide basis throughout the 10-mile EPZ, within 15 minutes.
- (b) The initial notification system will assure direct coverage of essentially 100% of the population within 5 miles of the site.
- (c) Special arrangements will be made to assure 100% coverage within 45 minutes of the population who may not have received the initial notification within the entire plume exposure EPZ.

NUREG-0654, Appendix 3 at 3-3. 1/ The acceptance criteria of NUREG-0654 have been further clarified by FEMA-43, "Standard Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants."

1/ Appendix 3 also contains specific acceptance criteria relating to sirens and siren systems. These criteria are discussed further in the enclosed FEMA response.

NUREG-0654 notes, however, that it is a design objective to meet the criteria of SB of Appendix 3, and that this does not mean that there is a ". . . guarantee that early notification can be provided for everyone with 100% assurance or that the system when tested under actual field conditions will meet the design objective in all cases." NUREG-0654 at 3-1. This statement is consistent with the Commission's view of the effect of the actual operation of such a system. As the Commission stated, "The Commission recognizes that not every individual would necessarily be reached by the actual operation of such a system under all conditions of system use." 45 Fed. Reg. 55402 (August 19, 1980).

