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February 21, 1986

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)	)	

ADDITIONAL TESTIMONY OF
DAVID N. KEAST ON EDDLEMAN 57-C-3
(NIGHT-TIME NOTIFICATION)

D503

Q.1 Please state your name.

A.1 David N. Keast.

Q.2 By whom are you employed, and what is your position?

Q.2 I am a Vice President and Senior Project Manager of HMM Associates, Inc. of Concord, Massachusetts, where I specialize in public warning system studies. HMM has been retained by Carolina Power & Light Company to analyze the Harris siren system in response to Eddleman Contention 57-C-3.

Q.3 Have you testified previously in this proceeding about Eddleman 57-C-3?

A.3 Yes. My direct testimony was filed on October 18, 1985, as a part of Applicants' "Testimony of David N. Keast, Alvin H. Joyner and Dennis S. Mileti on Eddleman 57-C-3 (Night-Time Notification)" (cited herein as "Keast et al."), which is in the record following Tr. 9375. I was cross-examined during the hearing sessions of November 4 and 5, 1985. I have also prepared "Affidavit of David N. Keast Correcting Oral Testimony on Eddleman Contention 57-C-3," which was filed with "Applicants' Supplemental Proposed Transcript Corrections," dated January 2, 1986.

Information on my professional qualifications and experience is already in the record at pages 2 and 3 of, and Attachment 1 to, Keast et al.

Q.4 What is the purpose of this additional testimony?

A.4 My additional testimony responds to the Atomic Safety and Licensing Board's Memorandum and Order (Limited Reopening

of the Record on Eddleman Contention 57-C-3), dated January 16, 1986. In particular, I will provide comment, as the Board invited, on some of the Board's tentative views of the evidence, and I will provide the information specifically requested in Items 1, 3 and 4 (pages 8-10) of the Board's Memorandum and Order.

Q.5 Before we address those subjects, do you have any changes or corrections to provide on the evidence presented at the previous hearing sessions?

A.5 Yes. Applicants' Exhibit 46, which was filed on October 18, 1985 along with Applicants' testimony, is a map of the Harris EPZ showing siren locations, night-time siren coverage contours, and house locations. It was prepared by HMM Associates to represent the maps I used in performing the calculations described in my previous testimony. I actually used a set of maps, which are mounted together on a wall in my firm's offices, four times the size of Applicants' Exhibit 46. While Exhibit 46, which is not a photocopy of the larger map set, was especially prepared to communicate for the record the information I employed in my analysis, I did not use the exhibit, but rather used the larger maps.

When I compared the Board's house count for the first five miles of the EPZ (January 16, 1986 Memorandum and Order, p. 8), derived from Applicants' Exhibit 46, with my own count from the larger maps, the difference appeared to be large and caused me to compare the two maps. The Board noted, at p. 6 of its

Memorandum and Order, that Applicants' Exhibit 46 is marginally legible. This problem, plus some errors made in plotting house locations on the smaller map, resulted in the difference in house counts. As I explain later in my testimony, this difference does not affect the tentative conclusions reached by the Board. Nevertheless, in the interest of accuracy, we have prepared a revised Exhibit 46, Applicants' Exhibit __, which accompanies this testimony. The only changes are to the house location identifiers and the size of the siren designations.

To repeat, this map revision does not affect any of my previous testimony.

Q.6 Mr. Keast, in its Memorandum and Order of January 16, 1986, the Board expressed concern about reliance upon the Lukas study (Applicants' Exhibit 48) because the sounds included there do not have frequency spectra resembling those of the Federal Signal Model 1000 Thunderbolt siren. Do you agree with this concern?

A.6 I understand the Board's desire to assess divergent parts of the testimony. However, differences in frequency spectra between the sounds used in the Lukas study and the Harris sirens provide no technically justifiable basis for discounting the Lukas study. Lukas used the EPNdB rating scale in reporting his results. The principal purpose of the EPNdB rating scale is to provide a common means for estimating human reaction to all types of sounds after applying defined adjustments for the spectral and temporal properties of the sounds

(Keast et al. at 19, A.20). Years of research have gone into the development of the EPNdB rating scale. To the extent that that research has been successful, it is not pertinent whether or not the actual spectra of sounds used for the Lukas study resemble those of sirens because the EPNdB scale provides adjustments for spectral differences.

In addition, a major property of siren sounds is that they are tonal in nature (i.e., their spectra contain one or more pure-tone components). The 22 studies used by Lukas to develop his Figure 2, upon which I relied, include two studies of DC-8 landing noise. This is a tonal sound which is very much like that of a siren. One other study used is of "jet aircraft noise" and two are of "jet flyover noise." These may have included the siren-like sounds of landing jet aircraft. Of course, Lukas also includes a study using an 800 Hz tone (Tr. 9513-14). Thus, there are at least three, and possibly as many as six, studies included in Lukas that were based upon sleep awakening by tonal sounds.

Q.7 Mr. Keast, the Board has asked that Applicants estimate siren arousal frequencies for the 5 to 10 mile area of the EPZ, using both the Horonjeff, et al., data and the Krallmann data. Have you performed such an analysis?

A.7 Yes.

Q.8 What are the results?

A.8 I estimate that, using the Horonjeff data as in Figure 1 of the Board's order, 75% of the households between five

miles from the plant and the boundary of the EPZ would be awakened directly by the sirens. Based upon information noted in my prior direct testimony on people already awake at night (Keast et al. at 9), I have added 3% to this estimate and conclude that about 78% of the households would be directly alerted. Using Dr. Mileti's calculation method for facilitated informal alerting (Keast et al. at 39), I conclude that almost 92% of all households would be alerted by direct and informal means within 15 minutes after the sirens started sounding.

Using the Krallmann data from Figure 1 of the Board's order, I estimate that 88% of the households would be awakened. Adding 1% for those already awake, I conclude that about 89% of the households would be directly alerted by sirens. Again using Dr. Mileti's calculation method, I conclude that about 97% of all households would be alerted by direct and informal means within 15 minutes. The detailed results of my calculations of direct alerting are shown on Attachments A and B.

Q.9 What assumptions have you made to reach these estimates?

A.9 As directed by the Board, I have used the following assumptions in the Board's order of January 16, 1986:

1. Outdoor sound levels are those shown on Exhibit 46, although our work was actually done on the large maps that have been described, rather than with Exhibit 46.

2. The pertinent Horonjeff & Krallmann relationships between Single Event Level (SEL) and % arousal are those shown on the Board's Figure 1, including the nonlinearity of the vertical scale.

I did not use any of the other assumptions or approximations on page 7 of the Board's order. Instead, all of my other assumptions are the same as those made for my original direct testimony.

Q.10 Did you use the EPNdB scale in calculating the results you just gave me?

A.10 No, I did not. The Horonjeff and Krallmann awakening relationships on Figure 1 of the Board's order are in terms of SEL, and I used that scale.

Q.11 Would you describe how you calculated your results?

A.11 Yes. Working from our large maps, we counted the houses with various siren sound exposures within five miles of the plant. By subtraction from our original calculation (Attachment 5 of Keast et al.), this gave us the numbers of houses with various exposures between five miles and the boundary of the EPZ. The specific house counts are shown on Attachment C. I then computed the awakening probabilities (fractions awakened) shown on Attachments A and B for each of the 19 siren sound exposures. These probabilities were computed separately for the Horonjeff and the Krallmann sleep-awakening curves, as provided by the Board. The sum of the products of the number of houses with each sound exposure times the fraction awakened for that exposure is then the total number of households awakened.

The computations of the fractions awakened are included as Attachment D. This consists of a set of 19 tables using

Horonjeff, and another set of 19 using Krallmann. Each table is for a different outdoor sound level.

On each table, the types of house classifications are identified as, Fan = windows open with window fan noise; WAs = Window A/C unit in same room; WAo = Window A/C unit in adjacent room and bedroom door open; CAn = Central A/C in its on cycle; CAf = Central A/C in its off cycle; all in accordance with Attachment 6 of my original testimony. The sound attenuation values to indoors for each class are subtracted to determine the indoor sound levels. These are then compared to the appropriate indoor background noise levels. In some cases at the lower siren sound levels, a signal-to-noise (S/N) difference of 10dB or less occurs. This affects the value for the integration over the peak of the siren sound. I will describe this process when we discuss Item 3 of the Board's order.

Adjustments for A-weighting and time duration (based upon 10 minutes of siren operation) are then added to obtain the SEL value. For each SEL value, the fractions awakened for one person are then read from the appropriate curve on Figure 1 of the Board's order. Next the fractions for awakening one of 2 people, one of 3 people, and one of 4 people are computed. These are then weighted by the U.S. Census data on family sizes for the EPZ (Keast et al. at 23; Nehnevajsa at 25) to determine awakening probabilities for the census family size mix. When multiplied by the corresponding fractions of homes in each of the eight classes, the result is the fraction of houses

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.

Q.12 The Board counted 363 houses within five miles of the plant, and according to your Attachment C you counted 589. How do you explain the difference?

A.12 As I discussed earlier, our work was done with higher legibility maps, four times the area of Exhibit 46, and thus is presumably a more precise count.

Q.13 Could the Board have been misled in its conclusions because it only had Exhibit 46 to count from, and because the Board located so many fewer houses than you did?

A.13 The answer is no. I was concerned about this and did a number of studies to assure myself that the difference in house counts has not significantly affected the Board's computations. The results of my studies are listed on Attachment E.

The first row of Attachment E shows the figures in the Board's Order of January 16, 1986. For the second row, I used all of the Board's assumptions and methods, including the Board's house counts, and repeated the Board's arithmetic. I got the same answers as the Board did using the Board's Krallmann sleep-awakening relationship; but a slightly higher answer using the Board's Horonjeff sleep-awakening relationship. The small difference is not particularly significant, but this calculation serves as a basis for comparison with the subsequent rows in the table.

For my second study, we ourselves counted the houses on the small map (Exhibit 46) and then applied all of the Board's methods and assumptions. Although we found about 17% more houses than the Board did, I still arrived at essentially the same awakening percentages. This suggests that the precision of house counts is not critical to the results being sought.

For my third study, I used our same house counts from the small map (Exhibit 46), but calculated according to methods and assumptions described in my original testimony. My methods and assumptions include a more detailed breakdown of housing types and background noise levels than the Board assumed (see Attachment D), as well as a different distribution of alertable persons within households. My calculation methods and assumptions lead to awakening percentages that are 8 to 10% higher than the Board's, even when the Board's sleep-awakening relationships are applied.

Finally, we counted houses within five miles of the plant on the large maps with which we normally work. We found many more houses, but the awakening percentages computed using my methods and assumptions are not significantly different than those I determined from the small map.

My conclusions from the results tabulated on Attachment E are as follows:

.. Although many more houses are identifiable on the large maps, which we normally work with, essentially the same awakening percentages are obtained from counts on either the large maps or Exhibit 46, when the same computational methods and assumptions are applied.

2. Awakening percentages inside of 5 miles (Attachments E, F, and G), outside of 5 miles (Attachments A and B), and for the entire EPZ (Keast et al. at 9), are all within about 1% of each other when the same computational methods and assumptions are applied.

   Attachments F and G contain the details of my results in the last row of Attachments E, and are directly comparable to Attachments A and B.

3. My computational methods and assumptions lead to awakening percentages 8% to 10% higher than the Board's, even though the Horonjeff or Krallmann sleep-awakening relationships are applied the same way in both cases.

Q.14 Why are the awakening percentages determined by your method 8% to 10% higher than those determined using the assumptions in the Board's order of January 16, 1986?

A.14 The largest single factor, accounting for 6% to 7% of the difference, is the difference in assumptions about the number of alertable persons in a household. The Board (p. 7 of the Order of January 16, 1986) developed a distribution from Table 5 of Nehnevajsa (Nehnevajsa at 31), which in turn is based upon national data for 1978; and which eliminates all persons under the age of 18 as potentially alertable. I used data on family size which were derived from the 1980 census for the EPZ (Keast et al. at 23).

According to Nehnevajsa, the census data from which I selected my household size distribution "are by far the best estimates possible" on the socio-demographic statistics for the EPZ (Nehnevajsa at 4, 5). I agree, and consider these data more representative than national data for the development of a distribution of alertable persons in households for the Shearon Harris EPZ.

More importantly, however, I also agree with Dr. Nehnevajsa that eliminating those household members under the age of 18 from the alertable population is a "very conservative assumption" (Nehnevajsa at 10); indeed, that it is "one of the key conservative limitations" of his results (Nehnevajsa at 23), and that it "is not merely conservative, but somewhat unreasonable" (Nehnevajsa at 24) to limit the analysis to persons 18 years of age or older.

Dr. Nehnevajsa concludes that all persons over the age of 13 would be able to interpret an alerting message if aroused (Nehnevajsa at 24). I would go further and say that even younger children, if aroused, would awaken their parents (or by their activity would lead to the awakening of their parents), and then their parents would hear and interpret the meaning of the sirens. Hence I believe that my distribution of arousable persons per household is much more realistic than that in Table 5 of Nehnevajsa.

The remaining difference between the arousal percentages estimated using the Board's method and those estimated using my method is probably attributable to the greater detail I use in the breakdown of house conditions, as in my Attachment D.

Q.15 Under item 3 of the Board's order, the question is raised as to whether the approximation used by Kryter to determine SEL values from siren peak dBA levels leads to a significant underestimation. The Board illustrates this question with Figure 2 of its order. Do you believe the Kryter approximation leads to underestimating the siren stimulus?

A.15. No. The error resulting from the Kryter approximation in this case is about 0.8dB, and hence negligible. This approximation is generally accepted practice in our field. (See Lee at 28.)

Q.16 How did you come to the conclusion that the error is only 0.8dB?

A.16 I compared the result using Kryter's approximation to the result using my method. My method is close to a true integration of the curve. I will explain this comparison in some detail because it helps illustrate the nature of decibel addition. It may also help resolve questions the Board has about my affidavit of January 2, 1986.

As a siren rotates, the sound level at a location on the ground varies with time. The problem is to determine in decibels the area under the curve of sound pressure vs. time. (Note that I have said sound pressure, not sound pressure level. In acoustics, the word "level" always designates a quantity in decibels.) Mathematicians call this process of determining the area under a curve "integration." To describe the process, let me give a simplified illustration.

Suppose, instead of rotating, the siren is always pointed at us, and can produce 100dBA. If it is on for one minute, then what is the Single Event Level (SEL) of the sound?

Step 1: Convert the level in dB to sound pressure:

SP = 10 exp (dBA/10)

= 10 exp (100/10)

= 10^{10}

Step 2: Multiply by the time duration in seconds. (The curve is now simply a rectangle with its height equal to sound pressure and its base equal to time).

Single-Event Sound Energy (SE) = $10^{10} \times 60$

= 6×10^{11}

Step 3: Convert back to decibels.

SEL = $10 \log_{10} (SE)$

= $10 \log_{10} (6 \times 10^{11})$

= 117.8dB

The process of converting Perceived Noise Level (PNL) to Effective Perceived Noise Level (EPNdB) is analogous for this rectangular example. If the 100dB in our illustration is a Perceived Noise Level, then:

Step 1: Perceived Noise (PN) = 10^{10}

Step 2: Multiply by time in half seconds.

$10^{10} \times 120 = 1.2 \times 10^{12}$

Step 3: EPNdB = $10 \log_{10} (1.2 \times 10^{12})$

= 120.8dB

It is common practice (as in Lukas) to use 1/2 sec. as the

time unit for EPNdB, and 1 sec. for SEL. Hence, for the same starting numbers, the EPNdB value will always be $10 \log_{10} (2) = 3$dB greater than the SEL.

A short-cut approach is often used to simplify the above calculations. For our rectangular example we can say:

EPNdB = PNdb + $10 \log_{10}$ (T/.5), and

SEL = A-weighted level + $10 \log_{10}$ (T/1),

where T is time in seconds. This short-cut approach works because the addition of logarithms is equivalent to multiplication.

For most sounds, the Perceived Noise Level is a complicated function of the sound spectrum. In this particular case where we are working just with a 500 Hz tone, the Perceived Noise Level is equal to the C-weighted sound level plus a 10 dB tone correction.

The actual temporal siren sound pattern at any location varies in accordance with the siren directivity pattern (Attachment H), the speed of siren rotation, and the duration of siren operation.

Attachment I is the worksheet I used to determine the combined effect of these parameters for my original testimony. It is similar to Figure 2 of the Board's Memorandum and Order of January 16, 1986. It shows the sound level from the siren as a function of azimuth over 1/2 of a rotation of the siren. (The other half would be symmetrical.) I divided the peak of the

sound pattern into seven rectangular segments and worked entirely with these. The balance of the pattern makes a negligible contribution to the EPNdB because the levels are so low. Each rectangular segment is 10° wide, and hence accounts for 10/180 (or 20/360) of the exposure for someone on the ground. Thus, a ten-minute siren operation produces a total exposure from each segment of 33.3 sec. (66.6 half seconds).

The speed of siren rotation is unimportant in this case because the sirens operate long enough that all directions receive essentially the same sound exposure duration. (For instance, if the sirens were to rotate twice as fast there would be twice as many sound peaks at any point on the ground, but each would only last half as long. The total duration would be the same.)

The general approach I used to compute the area in decibels (i.e., to integrate) under the sound exposure pattern which consists of many repetitions of Attachment I is as follows:

Step 1) Compute the summed level of the amplitudes of the seven 10° rectangular segments illustrated on Attachment I:

dB	10 exp (dB/10)
0	1
-0.75	0.841
-2.5	0.562
-4.5	0.355
-8	0.158
-11.5	0.071
-14.5	0.035
TOTAL	2.987

$10 \log_{10} (2.987) = 4.8dB$

This is the 5dB factor referred to in my oral testimony (Tr. 9564) and the integration term referred to in my affidavit of January 2, 1986.

Step 2) Add the time duration in decibels of a 10° segment, for 10 min. of siren operation:

$10 \log_{10}$ (66.6 half seconds) = 18.2 dB.

This is the time duration term referred to in my testimony (Tr. 9563) and in my affidavit.

My method is a simple extension of the rectangular example I described above, plus the use of the normal method for adding quantities in decibels. The result is that:

EPNdB = max. PNdB + 23dB

when the indoor siren sound level is well above the background noise level in a bedroom.

The reason I used this approach is that it allowed me to simply drop 10° segments from the calculation as the siren sound level approached the background noise level. For example, if the siren sound level were only 3dB above the background noise, then:

dB	10 exp (dB/10)
0	1
-0.75	0.841
-2.5	0.562
-4.5	x
-8	x
-11.5	x
-14.5	x
TOTAL	2.403

$10 \log_{10} (2.4) = 3.8dB$

This is because the number of 10° segments of sound exposure above the background noise is reduced. The 18dB time duration factor remains unchanged.

Dr. Kryter, in his testimony used the generally-accepted approximation:

$$SEL = \text{max. dBA} + 10 \log_{10} (T/2)$$

where T is the total time of siren operation in seconds between the 10dB down points. From Attachment I, the 10dB down points are at ±50°. Hence, for 10 minutes of siren operation, the duration is:

$50/180 \times 600 = 166.7$ sec.

and $SEL = \text{max. dBA} + 10 \log_{10} (166.7/2)$

$= \text{max. dBA} + 19.2dB$

Recalling that SEL is based upon a 1 second time unit and EPNdB is based on a 1/2 second time unit, the difference between my approach and that in Dr. Kryter's testimony is only 0.8dB

(23-3-19.2). This difference is quite small. It indicates that the difference noted in Item 3 of the Board's Order, and illustrated in Figure 2 attached to the Order, does not significantly alter the calculated acoustic stimulus produced by the siren's functioning.

Q.17 With respect to Item 4 of the Board's order, can you offer any clarification of your January 2, 1986 affidavit?

A.17 Yes. First of all, my error at Tr. 9650 was that I omitted the 18dB time duration term just described.

Secondly, the Board is correct in its conclusion that my reference to Kryter is to his book, The Effects of Noise on Man, identified on p. 20 of my direct testimony. The pertinent portion of this book (pp. 471-483) was sent to Mr. Eddleman on October 22, 1985, was the subject of cross-examination at Tr. 9499-9502, and is in evidence as Eddleman Exhibit 70.

Thirdly, the term "integration" in my Affidavit refers to the term "integrating" on line 9 of Tr. 9564. I hope my use of this term is clarified by my answer to your previous question.

Finally, I would be happy to answer any other questions the Board has about my Affidavit at this time.

ATTACHMENT A

ESTIMATES OF HOUSEHOLDS AWAKENED
BY SIRENS BETWEEN 5 MILES OF
THE SHEARON HARRIS PLANT
AND THE BOUNDARY OF THE EPZ
(using Horonjeff curve from Board Figure 1)

Sound Level Zones	Nominal Siren Sound Level Outdoors	Total # of Houses Exposed (5 mi. to Boundary)	Horonjeff (Board Figure 1) Fraction Awakened	Horonjeff (Board Figure 1) No. of Houses Awakened
>105 dB	112 dB	183	.928	170
100-105	102	154	.886	136
95-100	97	310	.858	266
90-95	92	742	.822	610
2 x 85-90	90	8	.808	6
80-85 + 85-90; 2 x 75-80 + 85-90	88	197	.791	156
85-90	87	1,177	.783	922
2 x 80-85	85	117	.766	90
2 x 75-80 + 80-85	84	10	.755	8
75-80 + 80-85; 3 x 70-75 + 80-85	83	181	.747	135
80-85; 3 x 75-80	82	1,672	.737	1,232
2 x 70-75 + 2 x 75-80	81	5	.728	4
2 x 75-80; 3 x 70-75 + 75-80	80	355	.718	255
2 x 70-75 + 75-80	79	55	.707	39
70-75 + 75-80	78	361	.697	252
75-80; 3 x 70-75	77	379	.684	259
2 x 70-75	75	138	.565	78
70-75	72	232	.532	123
<70	67	62	.434	27
TOTALS:		6,338		4,768

Percentage 75.2%

1162/0644c

ATTACHMENT B

ESTIMATES OF HOUSEHOLDS AWAKENED
BY SIRENS BETWEEN 5 MILES FROM
THE SHEARON HARRIS PLANT
AND THE BOUNDARY OF THE EPZ
(using Krallmann Curve from Board Figure 1)

Sound Level Zones	Nominal Siren Sound Level Outdoors	Total # of Houses Exposed (5 mi. to Boundary)	Krallmann (Board Figure 1) Fraction Awakened	Krallmann (Board Figure 1) No. of Houses Awakened
>105 dB	112 dB	183	.984	180
100-105	102	154	.966	149
95-100	97	310	.951	295
90-95	92	742	.934	693
2 x 85-90	90	8	.927	7
80-85 + 85-90; 2 x 75-80 + 85-90	88	197	.915	180
85-90	87	1,177	.911	1,072
2 x 80-85	85	117	.900	105
2 x 75-80 + 80-85	84	10	.893	9
75-80 + 80-85; 3 x 70-75 + 80-85	83	181	.890	161
80-85; 3 x 75-80	82	1,672	.883	1,476
2 x 70-75 + 2 x 75-80	81	5	.878	4
2 x 75-80; 3 x 70-75 + 75-80	80	355	.869	308
2 x 70-75 + 75-80	79	55	.863	47
70-75 + 75-80	78	361	.857	309
75-80; 3 x 70-75	77	379	.848	321
2 x 70-75	75	138	.704	97
70-75	72	232	.683	158
<70	67	62	.571	35
TOTALS:		6,338		5,606

Percentage 88.5%

1162/0644c

ATTACHMENT C

COUNTS OF HOUSES

WITHIN THE SHEARON HARRIS EPZ

(from large maps)

Sound Level Zones	Nominal Siren Sound Level Outdoors	Houses in EPZ	Houses Within 5 mi.	Houses Outside 5 mi.
>105 dB	112 dB	206	23	183
100-105	102	178	24	154
95-100	97	337	27	310
90-95	92	800	58	742
2 x 85-90	90	8	0	8
80-85 + 85-90; 2 x 75-80 + 85-90	88	199	2	197
85-90	87	1,256	79	1,177
2 x 80-85	85	120	3	117
2 x 75-80 + 80-85	84	10	0	10
75-80 + 80-85; 3 x 70-75 + 80-85	83	221	40	181
80-85; 3 x 75-80	82	1,826	154	1,672
2 x 70-75 + 2 x 75-80	81	5	0	5
2 x 75-80; 3 x 70-75 + 75-80	80	376	21	355
2 x 70-75 + 75-80	79	79	24	55
70-75 + 75-80	78	454	93	361
75-80; 3 x 70-75	77	411	32	379
2 x 70-75	75	146	8	138
70-75	72	233	1	232
<70	67	62	0	62
TOTALS:		6,927	589	6,338

ATTACHMENT D

TABLES SHOWING CALCULATIONS OF AWAKENING FRACTIONS

USING HORONJEFF, AND USING KRALLMANN,

FOR EACH OF THE 19 DIFFERENT

MAXIMUM OUTDOOR SIREN SOUND EXPOSURES

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 112 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	100.0	86.0	86.0	86.0	86.0	82.0	82.0	82.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	104.8	90.8	90.8	90.8	90.8	86.8	86.8	86.8
A-Weighted (-3)	101.8	87.8	87.8	87.8	87.8	83.8	83.8	83.8
Duration (+15.2)	117.0	103.0	103.0	103.0	103.0	99.0	99.0	99.0
SEL, dB	117.0	103.0	103.0	103.0	103.0	99.0	99.0	99.0
Fractions Awakened								
For one	.820	.730	.730	.730	.730	.690	.690	.690
	.968	.927	.927	.927	.927	.904	.904	.904
For 3	.994	.980	.980	.980	.980	.970	.970	.970
For 4	.999	.995	.995	.995	.995	.991	.991	.991
For Census Family	.956	.923	.923	.923	.923	.905	.905	.905
[illegible] FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.340	.148	.033	.024	.054	.096	.072	.160

TOTAL FRACTION AWAKENED = .928

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 102 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	90.0	76.0	76.0	76.0	76.0	72.0	72.0	72.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	94.8	80.8	80.8	80.8	80.8	76.8	76.8	76.8
A-Weighted (-3)	91.8	77.8	77.8	77.8	77.8	73.8	73.8	73.8
Duration (+15.2)	107.0	93.0	93.0	93.0	93.0	89.0	89.0	89.0
SEL, dB	107.0	93.0	93.0	93.0	93.0	89.0	89.0	89.0
Fractions Awakened For one	.760	.630	.630	.630	.630	.580	.580	.580
For 2	.942	.863	.863	.863	.863	.824	.824	.824
For 3	.986	.949	.949	.949	.949	.926	.926	.926
For 4	.997	.981	.981	.981	.981	.969	.969	.969
For Census Family	.935	.875	.875	.875	.875	.846	.846	.846
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.333	.140	.032	.023	.052	.090	.068	.150

TOTAL FRACTION AWAKENED = .886

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 97 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	85.0	71.0	71.0	71.0	71.0	67.0	67.0	67.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	89.8	73.8	75.8	75.8	75.8	71.8	71.8	71.8
A-Weighted (-3)	86.8	72.8	72.8	72.8	72.8	68.8	68.8	68.8
Duration (+15.2)	102.0	88.0	88.0	88.0	88.0	84.0	84.0	84.0
SEL, dB	102.0	88.0	88.0	88.0	88.0	84.0	84.0	84.0
Fractions Awakened For one	.720	.570	.570	.570	.570	.530	.530	.530
For 2	.922	.815	815	.815	.815	.779	.779	.779
For 3	.978	.920	.920	.920	.920	.896	.896	.896
For 4	.994	.966	.966	.966	.966	.951	.951	.951
For Census Family	.919	.839	.839	.839	.839	.812	.812	.812
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.327	.134	.030	.022	.050	.086	.065	.144

TOTAL FRACTION AWAKENED = .858

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 92 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	80.0	66.0	66.0	66.0	66.0	62.0	62.0	62.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	84.8	70.8	70.8	70.8	70.8	66.8	66.8	66.8
A-Weighted (-3)	81.8	67.8	67.8	67.8	67.8	63.8	63.8	63.8
Duration (+15.2)	97.0	83.0	83.0	83.0	83.0	79.0	79.0	79.0
SEL, dB	97.0	83.0	83.0	83.0	83.0	79.0	79.0	79.0
Fractions Awakened								
For one	.670	.520	.520	.520	.520	.470	.470	.470
For 2	.891	.770	.770	.770	.770	.719	.719	.719
For 3	.964	.889	.889	.889	.889	.851	.851	.851
For 4	.988	.947	.947	.947	.947	.921	.921	.921
For Census Family	.896	.804	.804	.804	.804	.764	.764	.764
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.319	.129	.029	.021	.047	.081	.061	.135

TOTAL FRACTION AWAKENED = .822

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 90 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	78.0	64.0	64.0	64.0	64.0	60.0	60.0	60.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	82.8	68.8	68.8	68.8	68.8	64.8	64.8	64.8
A-Weighted (-3)	79.8	65.8	65.8	65.8	65.8	61.8	61.8	61.8
Duration (+15.2)	95.0	81.0	81.0	81.0	81.0	77.0	77.0	77.0
SEL, dB	95.0	81.0	81.0	81.0	81.0	77.0	77.0	77.0
Fractions Awakened For one	.650	.500	.500	.500	.500	.450	.450	.450
For 2	.878	.750	.750	.750	.750	.698	.698	.698
For 3	.957	.875	.875	.875	.875	.834	.834	.834
For 4	.985	.938	.938	.938	.938	.908	.908	.908
For Census Family	.886	.789	.789	.789	.789	.747	.747	.747
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.315	.126	.028	.021	.047	.079	.060	.132

TOTAL FRACTION AWAKENED = .808

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 88 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	76.0	62.0	62.0	62.0	62.0	58.0	58.0	58.0
Background Noise	40	49	37	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	80.8	66.8	66.8	66.8	66.8	62.8	62.8	62.8
A-Weighted (-3)	77.8	63.8	63.8	63.8	63.8	59.8	59.8	59.8
Duration (+15.2)	93.0	79.0	79.0	79.0	79.0	75.0	75.0	75.0
SEL, dB	93.0	79.0	79.0	79.0	79.0	75.0	75.0	75.0
Fractions Awakened								
For one	.630	.470	.470	.470	.470	.430	.430	.430
For 2	.863	.719	.719	.719	.719	.675	.675	.675
For 3	.949	.851	.851	.851	.851	.815	.815	.815
For 4	.981	.921	.921	.921	.921	.894	.894	.894
For Census Family	.875	.764	.764	.764	.764	.728	.728	.728
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.312	.122	.028	.020	.045	.077	.058	.129

TOTAL FRACTION AWAKENED = .791

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 87 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	75.0	61.0	61.0	61.0	61.0	57.0	57.0	57.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	79.8	65.8	65.8	65.8	65.8	61.8	61.8	61.8
A-Weighted (-3)	76.8	62.8	62.8	62.8	62.8	58.8	58.8	58.8
Duration (+15.2)	92.0	78.0	78.0	78.0	78.0	74.0	74.0	74.0
SEL, dB	92.0	78.0	78.0	78.0	78.0	74.0	74.0	74.0
Fractions Awakened								
For one	.620	.460	.460	.460	.460	.420	.420	.420
For 2	.856	.708	.708	.708	.708	.664	.664	.664
For 3	.945	.843	.843	.843	.843	.805	.805	.805
For 4	.979	.915	.915	.915	.915	.887	.887	.887
For Census Family	.870	.756	.756	.756	.756	.719	.719	.719
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.310	.121	.027	.020	.045	.076	.057	.127

TOTAL FRACTION AWAKENED = .783

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 85 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	73.0	59.0	59.0	59.0	59.0	55.0	55.0	55.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	10.0	>10	>10	>10	>10	>10	>10
Integration	77.8	63.6	63.8	63.8	63.8	59.8	59.8	59.8
A-Weighted (-3)	74.8	60.6	60.8	60.8	60.8	56.8	56.8	56.8
Duration (+15.2)	90.0	75.8	76.0	76.0	76.0	72.0	72.0	72.0
SEL, dB	90.0	75.8	76.0	76.0	76.0	72.0	72.0	72.0
Fractions Awakened								
For one	.600	.440	.440	.440	.440	.400	.400	.400
For 2	.840	.686	.686	.686	.686	.640	.640	.640
For 3	.936	.824	.824	.824	.824	.784	.784	.784
For 4	.974	.902	.902	.902	.902	.870	.870	.870
For Census Family	.858	.738	.738	.738	.738	.698	.698	.698
HOUSING FRACTION	.356	.1a	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.305	.118	.027	.019	.044	.074	.056	.124

TOTAL FRACTION AWAKENED = .766

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 84 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	72.0	58.0	58.0	58.0	58.0	54.0	54.0	54.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	9.0	>10	>10	>10	>10	>10	>10
Integration	76.8	62.6	62.8	62.8	62.8	58.8	58.8	58.8
A-Weighted (-3)	73.8	59.6	59.8	59.8	59.8	55.8	55.8	55.8
Duration (+15.2)	89.0	74.8	75.0	75.0	75.0	71.0	71.0	71.0
SEL, dB	89.0	74.8	75.0	75.0	75.0	71.0	71.0	71.0
Fractions Awakened For one	.580	.430	.430	.430	.430	.390	.390	.390
For 2	.824	.675	.675	.675	.675	.628	.628	.628
For 3	.926	.815	.815	.815	.815	.773	.773	.773
For 4	.969	.894	.894	.894	.894	.862	.862	.862
For Census Family	.846	.728	.728	.728	.728	.688	.688	.688
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.301	.117	.026	.019	.043	.073	.055	.122

TOTAL FRACTION AWAKENED = .755

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 83 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	71.0	57.0	57.0	57.0	57.0	53.0	53.0	53.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	8.0	>10	>10	>10	>10	>10	>10
Integration	75.8	61.4	61.8	61.8	61.8	57.8	57.8	57.8
A-Weighted (-3)	72.8	58.4	58.8	58.8	58.8	54.8	54.8	54.8
Duration (+15.2)	88.0	73.6	74.0	74.0	74.0	70.0	70.0	70.0
SEL, dB	88.0	73.6	74.0	74.0	74.0	70.0	70.0	70.0
Fractions Awakened								
For one	.570	.420	.420	.420	.420	.380	.380	.380
For 2	.815	.664	.664	.664	.664	.616	.616	.616
For 3	.920	.805	.805	.805	.805	.762	.762	.762
For 4	.966	.887	.887	.887	.887	.852	.852	.852
For Census Family	.839	.719	.719	.719	.719	.677	.677	.677
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.299	.115	.026	.019	.042	.072	.054	.120

TOTAL FRACTION AWAKENED = .747

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 82 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	70.0	56.0	56.0	56.0	56.0	52.0	52.0	52.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	7.0	>10	>10	>10	>10	>10	>10
[illegible]tion	74.8	60.4	60.8	60.8	60.8	56.8	56.8	56.8
A-Weighted (-3)	71.8	57.4	57.8	57.8	57.8	53.8	53.8	53.8
Duration (+15.2)	87.0	72.6	73.0	73.0	73.0	69.0	69.0	69.0
SEL, dB	87.0	72.6	73.0	73.0	73.0	69.0	69.0	69.0
Fractions Awakened								
For one	.560	.410	.410	.410	.410	.370	.370	.370
For 2	.806	.652	.652	.652	.652	.603	.603	.603
For 3	.915	.795	.795	.795	.795	.750	.750	.750
For 4	.963	.879	.879	.879	.879	.842	.842	.842
For Census Family	.833	.709	.709	.709	.709	.666	.666	.666
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.296	.113	.026	.018	.042	.071	.053	.118

TOTAL FRACTION AWAKENED = .737

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 81 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	69.0	55.0	55.0	55.0	55.0	51.0	51.0	51.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	6.0	>10	>10	>10	>10	>10	>10
Integration	73.8	59.4	59.8	59.8	59.8	55.8	55.8	55.8
A-Weighted (-3)	70.8	56.4	56.8	56.8	56.8	52.8	52.8	52.8
Duration (+15.2)	86.0	71.6	72.0	72.0	72.0	68.0	68.0	68.0
SEL, dB	86.0	71.6	72.0	72.0	72.0	68.0	68.0	68.0
Fractions Awakened								
For one	.550	.400	.400	.400	.400	.360	.360	.360
For 2	.798	.640	.640	.640	.640	.590	.590	.590
For 3	.909	.784	.784	.784	.784	.738	.738	.738
For 4	.959	.870	.870	.870	.870	.832	.832	.832
For Census Family	.826	.698	.698	.698	.698	.655	.655	.655
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.294	.112	.025	.018	.041	.069	.052	.116

TOTAL FRACTION AWAKENED = .728

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 80 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	68.0	54.0	54.0	54.0	54.0	50.0	50.0	50.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	5.0	>10	>10	>10	>10	>10	>10
Integration	72.8	58.4	58.8	58.8	58.8	54.6	54.8	54.8
A-Weighted (-3)	69.8	55.4	55.8	55.8	55.8	51.6	51.8	51.8
Duration (+15.2)	85.0	70.6	71.0	71.0	71.0	66.8	67.0	67.0
SEL, dB	85.0	70.6	71.0	71.0	71.0	66.8	67.0	67.0
Fractions Awakened								
For one	.540	.390	.390	.390	.390	.350	.350	.350
For 2	.788	.628	.628	.628	.628	.577	.577	.577
For 3	.903	.773	.773	.773	.773	.725	.725	.725
For 4	.955	.862	.862	.862	.862	.821	.821	.821
For Census Family	.819	.688	.688	.688	.688	.643	.643	.643
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.292	.110	.025	.018	.041	.068	.051	.114

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 79 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	67.0	53.0	53.0	53.0	53.0	49.0	49.0	49.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	4.0	>10	>10	>10	10.0	>10	>10
Integration	71.8	56.8	57.8	57.8	57.8	53.6	53.8	53.8
A-Weighted (-3)	68.8	53.8	54.8	54.8	54.8	50.6	50.8	50.8
Duration (+15.2)	84.0	69.0	70.0	70.0	70.0	65.8	66.0	66.0
SEL, dB	84.0	69.0	70.0	70.0	70.0	65.8	66.0	66.0
Fractions Awakened								
For one	.530	.370	.380	.380	.380	.340	.340	.340
For 2	.779	.603	.616	.616	.616	.564	.564	.564
For 3	.896	.750	.762	.762	.762	.713	.713	.713
For 4	.951	.842	.852	.852	.852	.810	.810	.810
For Census Family	.812	.666	.677	.677	.677	.632	.632	.632
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.289	.107	.024	.018	.040	.067	.051	.112

TOTAL FRACTION AWAKENED = .707

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 78 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	66.0	52.0	52.0	52.0	52.0	48.0	48.0	48.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	3.0	>10	>10	>10	9.0	>10	>10
Integration	70.8	55.8	56.8	56.8	56.8	52.6	52.8	52.8
A-Weighted (-3)	67.8	52.8	53.8	53.8	53.8	49.6	49.8	49.8
Duration (+15.2)	83.0	68.0	69.0	69.0	69.0	64.8	65.0	65.0
SEL, dB	83.0	68.0	69.0	69.0	69.0	64.8	65.0	65.0
Fractions Awakened								
For one	.520	.360	.370	.370	.370	.330	.330	.330
For 2	.770	.590	.603	.603	.603	.551	.551	.551
For 3	.889	.738	.750	.750	.750	.699	.699	.699
For 4	.947	.832	.842	.842	.842	.798	.798	.798
For Census Family	.804	.655	.666	.666	.666	.619	.619	.619
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.286	.105	.024	.017	.039	.066	.050	.110

TOTAL FRACTION AWAKENED = .697

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 77 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	65.0	51.0	51.0	51.0	51.0	47.0	47.0	47.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	2.0	>10	>10	>10	8.0	>10	>10
Integration	69.8	53.7	55.8	55.8	55.8	51.4	51.8	51.8
A-Weighted (-3)	66.8	50.7	52.8	52.8	52.8	48.4	48.8	48.8
Duration (+15.2)	82.0	65.9	68.0	68.0	68.0	63.6	64.0	64.0
SEL, dB	82.0	65.9	68.0	68.0	68.0	63.6	64.0	64.0
Fractions Awakened								
For one	.510	.340	.360	.360	.360	.320	.320	.320
For 2	.760	.564	.590	.590	.590	.538	.538	.538
For 3	.882	.713	.738	.738	.738	.686	.686	.686
4	.942	.810	.832	.832	.832	.786	.786	.786
For Census Family	.797	.632	.655	.655	.655	.607	.607	.607
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.284	.101	.024	.017	.039	.064	.049	.107

TOTAL FRACTION AWAKENED = .684

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 75 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	63.0	49.0	49.0	49.0	49.0	45.0	45.0	45.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	.0	10.0	>10	>10	6.0	>10	>10
Integration	67.8	.0	53.6	53.8	53.8	49.4	49.8	49.8
A-Weighted (-3)	64.8	.0	50.6	50.8	50.8	46.4	46.8	46.8
Duration (+15.2)	80.0	.0	65.8	66.0	66.0	61.6	62.0	62.0
SEL, dB	80.0	.0	65.8	66.0	66.0	61.6	62.0	62.0
Fractions Awakened								
For one	.490	.000	.340	.340	.340	.300	.300	.300
For 2	.740	.000	.564	.564	.564	.510	.510	.510
For 3	.867	.000	.713	.713	.713	.657	.657	.657
For 4	.932	.000	.810	.810	.810	.760	.760	.760
For Census Family	.781	.000	.632	.632	.632	.581	.581	.581
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.278	.000	.023	.016	.037	.062	.046	.103

TOTAL FRACTION AWAKENED = .565

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 72 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	60.0	46.0	46.0	46.0	46.0	42.0	42.0	42.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	<0	7.0	>10	>10	3.0	>10	>10
Integration	64.8	.0	50.4	50.8	50.8	45.8	46.8	46.8
A-Weighted (-3)	61.8	.0	47.4	47.8	47.8	42.8	43.8	43.8
Duration (+15.2)	77.0	.0	62.6	63.0	63.0	58.0	59.0	59.0
SEL, dB	77.0	.0	62.6	63.0	63.0	58.0	59.0	59.0
Fractions Awakened								
For one	.450	.000	.310	.310	.310	.260	.270	.270
For 2	.698	.000	.524	.524	.524	.452	.467	.467
For 3	.834	.000	.671	.671	.671	.595	.611	.611
For 4	.908	.000	.773	.773	.773	.700	.716	.716
For Census Family	.747	.000	.594	.594	.594	.525	.539	.539
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.266	.000	.021	.015	.035	.056	.043	.095

TOTAL FRACTION AWAKENED = .532

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR HORONJEFF)

OUTDOOR SOUND LEVEL: 67 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	55.0	41.0	41.0	41.0	41.0	37.0	37.0	37.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	<0	2.0	>10	>10	<0	9.0	>10
Integration	59.8	.0	43.7	45.8	45.8	.0	41.6	41.8
A-Weighted (-3)	56.8	.0	40.7	42.8	42.8	.0	38.6	38.8
Duration (+15.2)	72.0	.0	55.9	58.0	58.0	.0	53.8	54.0
SEL, dB	72.0	.0	55.9	58.0	58.0	.0	53.8	54.0
Fractions Awakened For one	.400	.000	.240	.260	.260	.000	.230	.230
For 2	.640	.000	.422	.452	.452	.000	.407	.407
For 3	.784	.000	.561	.595	.595	.000	.543	.543
For 4	.870	.000	.666	.700	.700	.000	.648	.648
For Census Family	.698	.000	.495	.525	.525	.000	.479	.479
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.249	.000	.018	.014	.031	.000	.038	.085

TOTAL FRACTION AWAKENED = .434

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 112 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	100.0	86.0	86.0	86.0	86.0	82.0	82.0	82.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	104.8	90.8	90.8	90.8	90.8	86.8	86.8	86.8
A-Weighted (-3)	101.8	87.8	87.8	87.8	87.8	83.8	83.8	83.8
Duration (+15.2)	117.0	103.0	103.0	103.0	103.0	99.0	99.0	99.0
SEL, dB	117.0	103.0	103.0	103.0	103.0	99.0	99.0	99.0
Fractions Awakened								
For one	.990	.910	.910	.910	.910	.880	.880	.88
0								
For 2	1.000	.992	.992	.992	.992	.986	.986	.98
6								
For 3	1.000	.999	.999	.999	.999	.998	.998	.99
8								
For 4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.00
0								
For Census Family	.998	.981	.981	.981	.981	.973	.973	.97
3								
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.355	.157	.035	.026	.058	.103	.078	.17
2								

TOTAL FRACTION AWAKENED = .984

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 102 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	90.0	76.0	76.0	76.0	76.0	72.0	72.0	72.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	94.8	80.8	80.8	80.8	80.8	76.8	76.8	76.8
A-Weighted (-3)	91.8	77.8	77.8	77.8	77.8	73.8	73.8	73.8
Duration (+15.2)	107.0	93.0	93.0	93.0	93.0	89.0	89.0	89.0
SEL, dB	107.0	93.0	93.0	93.0	93.0	89.0	89.0	89.0
Fractions Awakened								
For one	.940	.830	.830	.830	.830	.800	.800	.80
0								
For 2	.996	.971	.971	.971	.971	.960	.960	.96
0								
For 3	1.000	.995	.995	.995	.995	.992	.992	.99
2								
For 4	1.000	.999	.999	.999	.999	.998	.998	.99
8								
For Census Family	.988	.959	.959	.959	.959	.949	.949	.94
9								
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.352	.153	.035	.025	.057	.101	.076	.16
8								

TOTAL FRACTION AWAKENED = .966

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 97 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	85.0	71.0	71.0	71.0	71.0	67.0	67.0	67.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	89.8	75.8	75.8	75.8	75.8	71.8	71.8	71.8
A-Weighted (-3)	86.8	72.8	72.8	72.8	72.8	68.8	68.8	68.8
Duration (+15.2)	102.0	88.0	88.0	88.0	88.0	84.0	84.0	84.0
SEL, dB	102.0	88.0	88.0	88.0	88.0	84.0	84.0	84.0
Fractions Awakened								
For one	.900	.780	.780	.780	.780	.750	.750	.75
0								
For 2	.990	.952	.952	.952	.952	.938	.938	.93
8								
For 3	.999	.989	.989	.989	.989	.984	.984	.98
4								
For 4	1.000	.998	.998	.998	.998	.996	.996	.99
6								
For Census Family	.978	.942	.942	.942	.942	.931	.931	.93
1								
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.348	.151	.034	.024	.056	.099	.074	.16
5								

TOTAL FRACTION AWAKENED = .951

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 92 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	80.0	66.0	66.0	66.0	66.0	62.0	62.0	62.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	84.8	70.8	70.8	70.8	70.8	66.8	66.8	66.8
A-Weighted (-3)	81.8	67.8	67.8	67.8	67.8	63.8	63.8	63.8
Duration (+15.2)	97.0	83.0	83.0	83.0	83.0	79.0	79.0	79.0
SEL, dB	97.0	83.0	83.0	83.0	83.0	79.0	79.0	79.0
Fractions Awakened								
For one	.860	.740	.740	.740	.740	.690	.690	.69
0								
For 2	.980	.932	.932	.932	.932	.904	.904	.90
4								
For 3	.997	.982	.982	.982	.982	.970	.970	.97
0								
For 4	1.000	.995	.995	.995	.995	.991	.991	.99
1								
For Census Family	.968	.927	.927	.927	.927	.905	.905	.90
5								
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.344	.148	.033	.024	.055	.096	.072	.16
0								

TOTAL FRACTION AWAKENED = .934

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 90 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	78.0	64.0	64.0	64.0	64.0	60.0	60.0	60.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	82.8	68.8	68.8	68.8	68.8	64.8	64.8	64.8
A-Weighted (-3)	79.8	65.8	65.8	65.8	65.8	61.8	61.8	61.8
Duration (+15.2)	95.0	81.0	81.0	81.0	81.0	77.0	77.0	77.0
SEL, dB	95.0	81.0	81.0	81.0	81.0	77.0	77.0	77.0
Fractions Awakened								
For one	.850	.720	.720	.720	.720	.670	.670	.670
For 2	.978	.922	.922	.922	.922	.891	.891	.891
For 3	.997	.978	.978	.978	.978	.964	.964	.964
For 4	.999	.994	.994	.994	.994	.988	.988	.988
For Census Family	.965	.919	.919	.919	.919	.896	.896	.896
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.343	.147	.033	.024	.054	.095	.072	.159

TOTAL FRACTION AWAKENED = .927

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 88 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	76.0	62.0	62.0	62.0	62.0	58.0	58.0	58.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	80.8	66.8	66.8	66.8	66.8	62.8	62.8	62.8
A-Weighted (-3)	77.8	63.8	63.8	63.8	63.8	59.8	59.8	59.8
Duration (+15.2)	93.0	79.0	79.0	79.0	79.0	75.0	75.0	75.0
SEL, dB	93.0	79.0	79.0	79.0	79.0	75.0	75.0	75.0
Fractions Awakened								
For one	.830	.690	.690	.690	.690	.640	.640	.640
	.971	.904	.904	.904	.904	.870	.870	.870
For 3	.995	.970	.970	.970	.970	.953	.953	.953
For 4	.999	.991	.991	.991	.991	.983	.983	.983
For Census Family	.959	.905	.905	.905	.905	.881	.881	.881
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.341	.145	.033	.024	.053	.093	.070	.156

TOTAL FRACTION AWAKENED = .915

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 87 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	75.0	61.0	61.0	61.0	61.0	57.0	57.0	57.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	>10	>10	>10	>10	>10	>10	>10
Integration	79.8	65.8	65.8	65.8	65.8	61.8	61.8	61.8
A-Weighted (-3)	76.8	62.8	62.8	62.8	62.8	58.8	58.8	58.8
Duration (+15.2)	92.0	78.0	78.0	78.0	78.0	74.0	74.0	74.0
SEL, dB	92.0	78.0	78.0	78.0	78.0	74.0	74.0	74.0
Fractions Awakened								
For one	.820	.680	.680	.680	.680	.630	.630	.630
For 2	.968	.898	.898	.898	.898	.863	.863	.863
For 3	.994	.967	.967	.967	.967	.949	.949	.949
For 4	.999	.990	.990	.990	.990	.981	.981	.981
For Census Family	.956	.901	.901	.901	.901	.875	.875	.875
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.340	.144	.032	.023	.053	.093	.070	.155

TOTAL FRACTION AWAKENED = .911

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 85 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	73.0	59.0	59.0	59.0	59.0	55.0	55.0	55.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	10.0	>10	>10	>10	>10	>10	>10
Integration	77.8	63.6	63.8	63.8	63.8	59.8	59.8	59.8
A-Weighted (-3)	74.8	60.6	60.8	60.8	60.8	56.8	56.8	56.8
Duration (+15.2)	90.0	75.8	76.0	76.0	76.0	72.0	72.0	72.0
SEL, dB	90.0	75.8	76.0	76.0	76.0	72.0	72.0	72.0
Fractions Awakened								
For one	.800	.650	.650	.650	.650	.610	.610	.610
For 2	.960	.878	.878	.878	.878	.848	.848	.848
For 3	.992	.957	.957	.957	.957	.941	.941	.941
For 4	.998	.985	.985	.985	.985	.977	.977	.977
For Census Family	.949	.886	.886	.886	.886	.864	.864	.864
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.338	.142	.032	.023	.052	.092	.069	.153

TOTAL FRACTION AWAKENED = .900

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 84 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	72.0	58.0	58.0	58.0	58.0	54.0	54.0	54.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	9.0	>10	>10	>10	>10	>10	>10
Integration	76.8	62.6	62.8	62.8	62.8	58.8	58.8	58.8
A-Weighted (-3)	73.8	59.6	59.8	59.8	59.8	55.8	55.8	55.8
Duration (+15.2)	89.0	74.8	75.0	75.0	75.0	71.0	71.0	71.0
SEL, dB	89.0	74.8	75.0	75.0	75.0	71.0	71.0	71.0
Fractions Awakened								
For one	.790	.640	.640	.640	.640	.590	.590	.590
For 2	.956	.870	.870	.870	.870	.832	.832	.832
For 3	.991	.953	.953	.953	.953	.931	.931	.931
For 4	.998	.983	.983	.983	.983	.972	.972	.972
For Census Family	.946	.881	.881	.881	.881	.852	.852	.852
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.337	.141	.032	.023	.052	.090	.068	.151

TOTAL FRACTION AWAKENED = .893

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 83 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	71.0	57.0	57.0	57.0	57.0	53.0	53.0	53.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	8.0	>10	>10	>10	>10	>10	>10
Integration	75.8	61.4	61.8	61.8	61.8	57.8	57.8	57.8
A-Weighted (-3)	72.8	58.4	58.8	58.8	58.8	54.8	54.8	54.8
Duration (+15.2)	88.0	73.6	74.0	74.0	74.0	70.0	70.0	70.0
SEL, dB	88.0	73.6	74.0	74.0	74.0	70.0	70.0	70.0
Fractions Awakened								
For one	.790	.630	.630	.630	.630	.580	.580	.580
For 2	.956	.863	.863	.863	.863	.824	.824	.824
For 3	.991	.949	.949	.949	.949	.926	.926	.926
For 4	.998	.981	.981	.981	.981	.969	.969	.969
For Census Family	.946	.875	.875	.875	.875	.846	.846	.846
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.337	.140	.032	.023	.052	.090	.068	.150

TOTAL FRACTION AWAKENED = .890

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 82 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	70.0	56.0	56.0	56.0	56.0	52.0	52.0	52.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	7.0	>10	>10	>10	>10	>10	>10
Integration	74.8	60.4	60.8	60.8	60.8	56.8	56.8	56.8
A-Weighted (-3)	71.8	57.4	57.8	57.8	57.8	53.8	53.8	53.8
Duration (+15.2)	87.0	72.6	73.0	73.0	73.0	69.0	69.0	69.0
SEL, dB	87.0	72.6	73.0	73.0	73.0	69.0	69.0	69.0
Fractions Awakened								
For one	.780	.610	.620	.620	.620	.570	.570	.570
For 2	.952	.848	.856	.856	.856	.815	.815	.815
For 3	.989	.941	.945	.945	.945	.920	.920	.920
For 4	.998	.977	.979	.979	.979	.966	.966	.966
For Census Family	.942	.864	.870	.870	.870	.839	.839	.839
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.335	.138	.031	.023	.051	.089	.067	.149

TOTAL FRACTION AWAKENED = .883

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 81 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	69.0	55.0	55.0	55.0	55.0	51.0	51.0	51.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	6.0	>10	>10	>10	>10	>10	>10
Integration	73.8	59.4	59.8	59.8	59.8	55.8	55.8	55.8
A-Weighted (-3)	70.8	56.4	56.8	56.8	56.8	52.8	52.8	52.8
Duration (+15.2)	86.0	71.6	72.0	72.0	72.0	68.0	68.0	68.0
SEL, dB	86.0	71.6	72.0	72.0	72.0	68.0	68.0	68.0
Fractions Awakened								
For one	.770	.600	.610	.610	.610	.560	.560	.560
For 2	.947	.840	.848	.848	.848	.806	.806	.806
For 3	.988	.936	.941	.941	.941	.915	.915	.915
For 4	.997	.974	.977	.977	.977	.963	.963	.963
For Census Family	.939	.858	.864	.864	.864	.833	.833	.833
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.334	.137	.031	.022	.051	.088	.067	.147

TOTAL FRACTION AWAKENED = .878

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 80 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	68.0	54.0	54.0	54.0	54.0	50.0	50.0	50.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	5.0	>10	>10	>10	>10	>10	>10
Integration	72.8	58.4	58.8	58.8	58.8	54.6	54.8	54.8
A-Weighted (-3)	69.8	55.4	55.8	55.8	55.8	51.6	51.8	51.8
Duration (+15.2)	85.0	70.6	71.0	71.0	71.0	66.8	67.0	67.0
SEL, dB	85.0	70.6	71.0	71.0	71.0	66.8	67.0	67.0
Fractions Awakened								
For one	.760	.590	.590	.590	.590	.540	.540	.540
For 2	.942	.832	.832	.832	.832	.788	.788	.788
For 3	.986	.931	.931	.931	.931	.903	.903	.903
For 4	.997	.972	.972	.972	.972	.955	.955	.955
For Census Family	.935	.852	.852	.852	.852	.819	.819	.819
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.333	.136	.031	.022	.050	.087	.066	.145

TOTAL FRACTION AWAKENED = .869

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 79 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	67.0	53.0	53.0	53.0	53.0	49.0	49.0	49.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	4.0	>10	>10	>10	10.0	>10	>10
Integration	71.8	56.8	57.8	57.8	57.8	53.6	53.8	53.8
A-Weighted (-3)	68.8	53.8	54.8	54.8	54.8	50.6	50.8	50.8
Duration (+15.2)	84.0	69.0	70.0	70.0	70.0	65.8	66.0	66.0
SEL, dB	84.0	69.0	70.0	70.0	70.0	65.8	66.0	66.0
Fractions Awakened								
For one	.750	.570	.580	.580	.580	.530	.530	.530
For 2	.938	.815	.824	.824	.824	.779	.779	.779
For 3	.984	.920	.926	.926	.926	.896	.896	.896
For 4	.996	.966	.969	.969	.969	.951	.951	.951
For Census Family	.931	.839	.846	.846	.846	.812	.812	.812
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.331	.134	.030	.022	.050	.086	.065	.144

TOTAL FRACTION AWAKENED = .863

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 78 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	66.0	52.0	52.0	52.0	52.0	48.0	48.0	48.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	3.0	>10	>10	>10	9.0	>10	>10
Integration	70.8	55.8	56.8	56.8	56.8	52.6	52.8	52.8
A-Weighted (-3)	67.8	52.8	53.8	53.8	53.8	49.6	49.8	49.8
Duration (+15.2)	83.0	68.0	69.0	69.0	69.0	64.8	65.0	65.0
SEL, dB	83.0	68.0	69.0	69.0	69.0	64.8	65.0	65.0
Fractions Awakened For one	.740	.560	.570	.570	.570	.520	.520	.520
For 2	.932	.806	.815	.815	.815	.770	.770	.770
For 3	.982	.915	.920	.920	.920	.889	.889	.889
For 4	.995	.963	.966	.966	.966	.947	.947	.947
For Census Family	.927	.833	.839	.839	.839	.804	.804	.804
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.330	.133	.030	.022	.050	.085	.064	.142

TOTAL FRACTION AWAKENED = .857

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 77 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	65.0	51.0	51.0	51.0	51.0	47.0	47.0	47.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	2.0	>10	>10	>10	8.0	>10	>10
Integration	69.8	53.7	55.8	55.8	55.8	51.4	51.8	51.8
A-Weighted (-3)	66.8	50.7	52.8	52.8	52.8	48.4	48.8	48.8
Duration (+15.2)	82.0	65.9	68.0	68.0	68.0	63.6	64.0	64.0
SEL, dB	82.0	65.9	68.0	68.0	68.0	63.6	64.0	64.0
Fractions Awakened								
For one	.730	.530	.560	.560	.560	.500	.510	.510
For 2	.927	.779	.806	.806	.806	.750	.760	.760
For 3	.980	.896	.915	.915	.915	.875	.882	.882
For 4	.995	.951	.963	.963	.963	.938	.942	.942
For Census Family	.923	.812	.833	.833	.833	.789	.797	.797
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.329	.130	.030	.022	.049	.084	.064	.141

TOTAL FRACTION AWAKENED = .848

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 75 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	63.0	49.0	49.0	49.0	49.0	45.0	45.0	45.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	.0	10.0	>10	>10	6.0	>10	>10
Integration	67.8	.0	53.6	53.8	53.8	49.4	49.8	49.8
A-Weighted (-3)	64.8	.0	50.6	50.8	50.8	46.4	46.8	46.8
Duration (+15.2)	80.0	.0	65.8	66.0	66.0	61.6	62.0	62.0
SEL, dB	80.0	.0	65.8	66.0	66.0	61.6	62.0	62.0
Fractions Awakened								
For one	.710	.000	.530	.530	.530	.480	.480	.480
For 2	.916	.000	.779	.779	.779	.730	.730	.730
For 3	.976	.000	.896	.896	.896	.859	.859	.859
For 4	.993	.000	.951	.951	.951	.927	.927	.927
For Census Family	.914	.000	.812	.812	.812	.773	.773	.773
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.326	.000	.029	.021	.048	.082	.062	.137

TOTAL FRACTION AWAKENED = .704

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 72 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	60.0	46.0	46.0	46.0	46.0	42.0	42.0	42.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	<0	7.0	>10	>10	3.0	>10	>10
Integration	64.8	.0	50.4	50.8	50.8	45.8	46.8	46.8
A-Weighted (-3)	61.8	.0	47.4	47.8	47.8	42.8	43.8	43.8
Duration (+15.2)	77.0	.0	62.6	63.0	63.0	58.0	59.0	59.0
SEL, dB	77.0	.0	62.6	63.0	63.0	58.0	59.0	59.0
Fractions Awakened								
For one	.670	.000	.490	.490	.490	.430	.450	.450
For 2	.891	.000	.740	.740	.740	.675	.698	.698
For 3	.964	.000	.867	.867	.867	.815	.834	.834
For 4	.988	.000	.932	.932	.932	.894	.908	.908
For Census Family	.896	.000	.781	.781	.781	.728	.747	.747
HOUSING FRACTION	.356	.16	.036	.026	.039	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.319	.000	.028	.020	.046	.077	.060	.132

TOTAL FRACTION AWAKENED = .683

CALCULATIONS OF SEL AND FRACTIONS AWAKENED

(BASED UPON BOARD FIG. 1 FOR KRALLMANN)

OUTDOOR SOUND LEVEL: 67 DB

Condition	fan	WAs	WAo	CAn	CAf	WAo	CAn	CAf
Loss to indoors	-12	-26	-26	-26	-26	-30	-30	-30
Indoor Level	55.0	41.0	41.0	41.0	41.0	37.0	37.0	37.0
Background Noise	40	49	39	28	13	39	28	13
S/N Difference	>10	<0	2.0	>10	>10	<0	9.0	>10
Integration	59.8	.0	43.7	45.8	45.8	.0	41.6	41.8
A-Weighted (-3)	56.8	.0	40.7	42.8	42.8	.0	38.6	38.8
Duration (+15.2)	72.0	.0	55.9	58.0	58.0	.0	53.8	54.0
SEL, dB	72.0	.0	55.9	58.0	58.0	.0	53.8	54.0
Fract ons Awakened								
For one	.610	.000	.410	.430	.430	.000	.380	.390
For 2	.848	.000	.652	.675	.675	.000	.616	.628
For 3	.941	.000	.795	.815	.815	.000	.762	.773
For 4	.977	.000	.879	.894	.894	.000	.852	.862
For Census Family	.864	.000	.709	.728	.728	.000	.677	.688
HOUSING FRACTION	.356	.16	.036	.026	.059	.106	.08	.177
Fraction of Houses Awakened (Census Family)	.308	.000	.026	.019	.043	.000	.054	.122

TOTAL FRACTION AWAKENED = .571

ATTACHMENT E

VARIOUS ESTIMATES OF HOUSEHOLDS AWAKENED BY SIRENS

WITHIN 5 MILES OF THE SHEARON HARRIS PLANT

(does not include those already awake)

	Total No. of Houses	Percent Awakened		
		Lukas	Horonjeff	Krallmann
Board Order	363	-	62.8%	81.5%
By Applicant				
1. Using Board Count of EX 46 and all of Board Assumptions	363	-	65.5%	81.5%
2. Using Applicant Count of EX 46 and all of Board Assumptions	428	-	66.8%	82.5%
3. Using Applicant Count of EX 46 and Applicant Methods*	428	70.3%	76.6%	90%
4. Using Applicant Count of Large Maps and Applicant Methods*	589	69.4%	75.9%	89.6%

* Except for the use of Horonjeff and Krallmann in place of Lukas where indicated.

1162/0644c

ATTACHMENT F

ESTIMATES OF HOUSEHOLDS AWAKENED BY SIRENS
WITHIN 5 MILES OF THE SHEARON HARRIS PLANT
(using Horonjeff Curve from Board Figure 1)

Sound Level Zones	Nominal Siren Sound Level Outdoors	Total # of Houses Within 5 mi.	Horonjeff (Board Figure 1) Fraction Awakened	Horonjeff (Board Figure 1) No. of Houses Awakened
> 105 dB	112 dB	23	.928	21
100-105	102	24	.886	21
95-100	97	27	.858	23
90-95	92	58	.822	48
2 x 85-90	90	0	.808	0
80-85 + 85-90; 2 x 75-80 + 85-90	88	2	.791	2
85-90	87	79	.783	62
2 x 80-85	85	3	.766	2
2 x 75-80 + 80-85	84	0	.755	0
75-80 + 80-85; 3 x 70-75 + 80-85	83	40	.747	30
80-85; 3 x 75-80	82	154	.737	113
2 x 70-75 + 2 x 75-80	81	0	.728	0
2 x 75-80; 3 x 70-75 + 75-80	80	21	.718	15
2 x 70-75 + 75-80	79	24	.707	17
70-75 + 75-80	78	93	.697	65
75-80; 3 x 70-75	77	32	.684	22
2 x 70-75	75	8	.565	5
70-75	72	1	.532	1
< 70	67	0	.434	0
TOTALS:		589		447
			Percentage	75.9%

1162/0644c

ATTACHMENT G

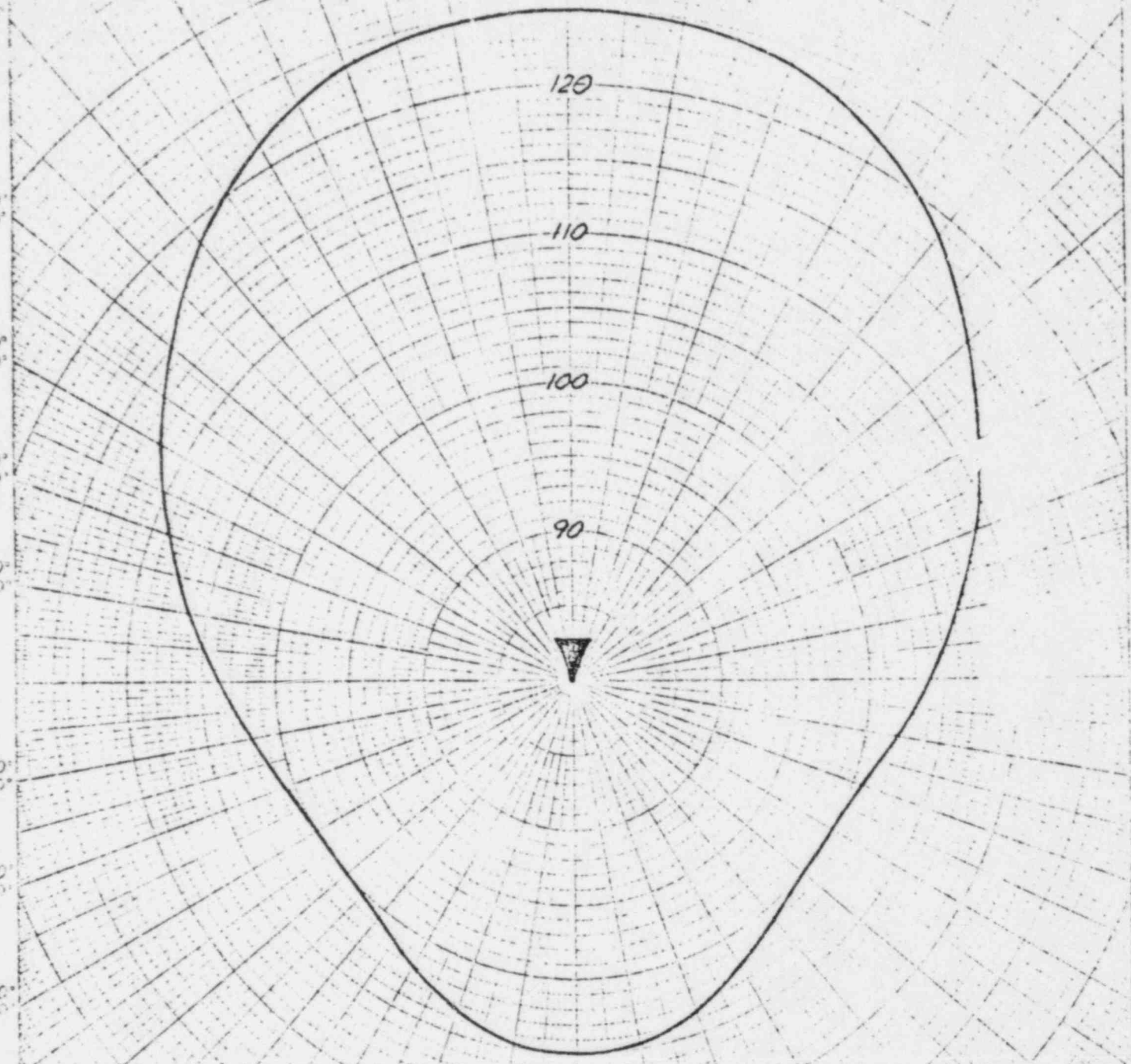
ESTIMATES OF HOUSEHOLDS AWAKENED BY SIRENS
WITHIN 5 MILES OF THE SHEARON HARRIS PLANT
(using Krallmann Curve from Board Figure 1)

Sound Level Zones	Nominal Siren Sound Level Outdoors	Total # of Houses Within 5 mi.	Krallmann (Board Figure 1) Fraction Awakened	Krallmann (Board Figure 1) No. of Houses Awakened
> 105 dB	112 dB	23	.984	23
100-105	102	24	.966	23
95-100	97	27	.951	26
90-95	92	58	.934	54
2 x 85-90	90	0	.927	0
80-85 + 85-90; 2 x 75-80 + 85-90	88	2	.915	2
85-90	87	79	.911	72
2 x 80-85	85	3	.900	3
2 x 75-80 + 80-85	84	0	.893	0
75-80 + 80-85; 3 x 70-75 + 80-85	83	40	.890	36
80-85; 3 x 75-80	82	154	.883	136
2 x 70-75 + 2 x 75-80	81	0	.878	0
2 x 75-80; 3 x 70-75 + 75-80	80	21	.869	18
2 x 70-75 + 75-80	79	24	.863	21
70-75 + 75-80	78	93	.857	80
75-80; 3 x 70-75	77	32	.848	27
2 x 70-75	75	8	.704	6
70-75	72	1	.683	1
< 70	67	0	.571	0
TOTALS:		589		528

Percentage 89.6%

1162/0644c

ATTACHMENT H



THUNDERBOLT SIREN
DIRECTIVITY PATTERN
dBC @ 100 FEET
650 HZ

500 Hz would measurable be broader.

D.K.
9/11/35

GRAPH PAPER ®

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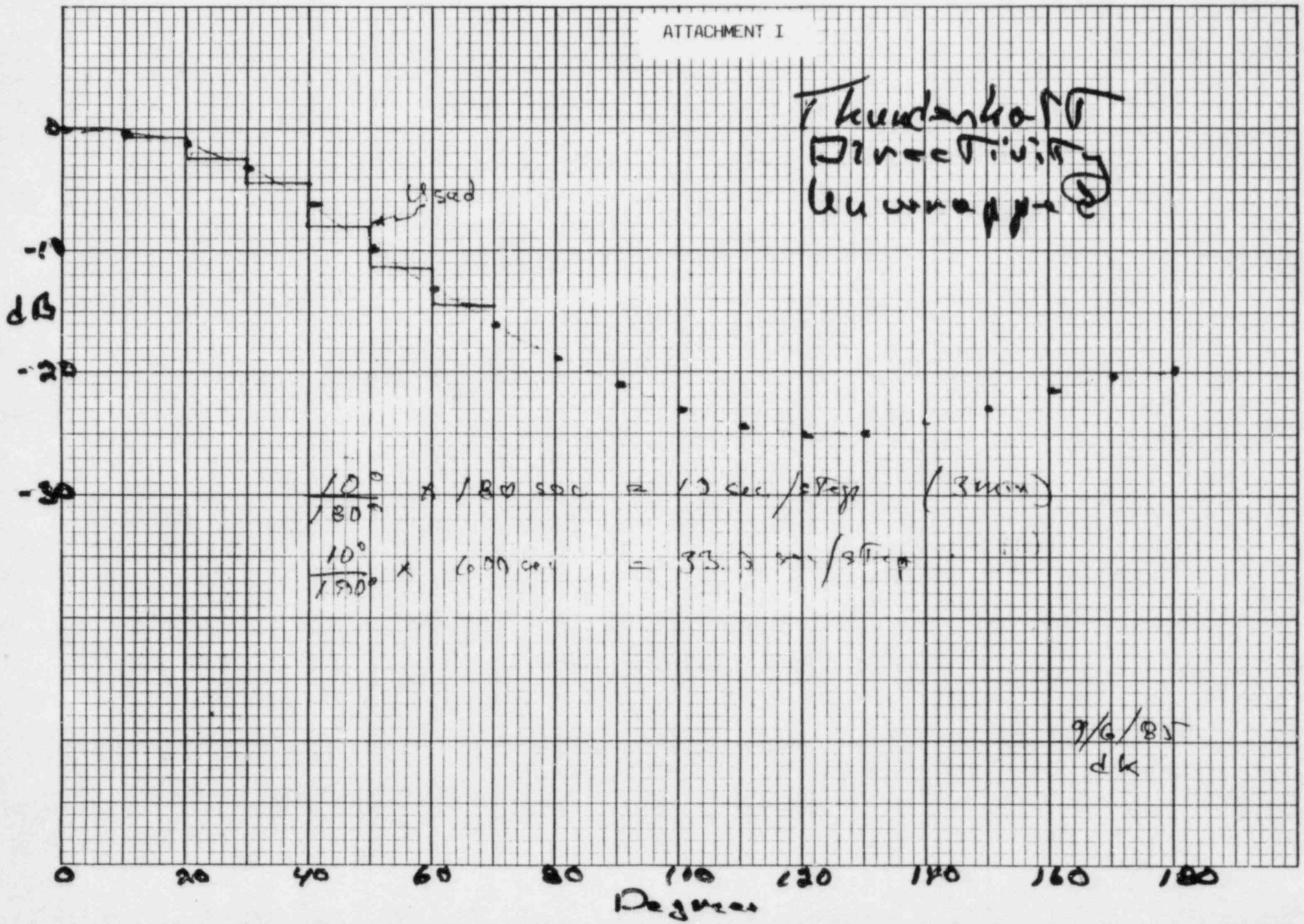
ATTACHMENT I



February 21, 1986

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)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "Additional Testimony of David N. Keast on Eddleman 57-C-3 (Night-Time Notification)" and Applicants' Ex. ____ ("Revised Map, Shearon Harris Plume Exposure Pathway Emergency Planning Zone: Siren Locations, Nighttime Siren Coverage Contours and House Locations") were served this 21st day of February, 1986, by deposit in the U.S. mail, first class, postage prepaid, to the parties on the attached Service List.

Thomas A. Baxter

Thomas A. Baxter, P.C.

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 MUNICIPAL POWER AGENCY	)	Docket Nos. 50-400 OL
	)	
(Shearon Harris Nuclear Power Plant)	)	

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