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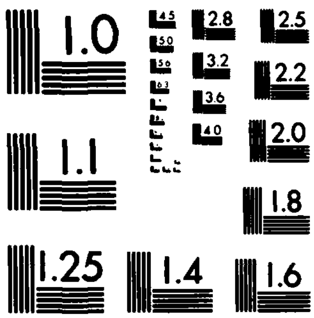

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VARIOUS APPROACHES FOR DETERMINING AND IMPLEMENTING AGE CORRECTION FOR MONETARY COMPENSATION FOR NOISE INDUCED HEARING LOSS

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AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY
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FOR THE COMMANDER

Henning E. von Gierke

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This paper addresses the question of using age corrections when determining compensation for noise induced hearing loss. Using the model currently proposed for the international standard on hearing conservation as the basis for predicting Noise Induced Permanent Threshold Shift, the relative amount of compensation that would be paid for 10 years of noise exposure for different employee age groups is predicted. Some type of age correction is demonstrated to be required in order to prevent very large differences in

compensation due solely to when, in an employee's lifetime, compensation is awarded. While several solutions are proposed, the recommended solution is to test the hearing of a noise exposed worker throughout the worker's lifetime and compensate the worker in proportion both to the amount and the number of years the individual elevated above a specified level.

INTRODUCTION

The question of whether or not there should be an age correction for presbycusis when determining compensation for a noise induced hearing loss is far from resolved. It has been stated that such a correction is not justifiable.[1] This viewpoint came from the belief that "Usually in worker's compensation the entire impairment is compensable as long as an occupational factor in any way increases the impairment caused by the physical condition. It is not clear why hearing loss should be treated differently."[1] Thus an old person whose hearing might be above the "low fence" from presbycusis alone should not be denied compensation if he could have suffered additional loss from some hazardous exposure to occupational noise. The counter argument is that for relatively low noise occupational exposures, those in the range from 80 to 95 dB, much of the hearing loss may come from other than occupational noise. It is an unnecessary burden on industry to pay for all of the problems which occur through aging. At first glance, these arguments may seem to define the key issues with respect to age corrections. Yet, it is my contention that these arguments miss the most essential reason age corrections are necessary. This essential reason is to adjust for the inequities that will occur if compensation is provided based only on the hearing of a young worker. Consider a 30 year old person who has been exposed to enough noise such that his hearing levels are just below the "low fence" for hearing compensation. Current compensation practices in many of the states in the United States usually have a statutory limitation as to when an employee can file a claim. Often the employee must file the claim within 5 years, or even one year, from the termination of the job or noise exposure.[1] Such practices insure that this person will not be compensated. Yet if a person's hearing level is just below the fence at age 30, that person's hearing level can be expected to substantially exceed the fence at age 60.

Hypothetical examples such as this led me to make an in-depth investigation of the expected effects of aging on compensation costs and awards. Specifically, the monetary differences in expected compensation for different age groups is quantified. An underlying philosphy in this article is that equal compensation should be awarded to persons with the same profile of hearing levels through time. An age correction should minimize the monetary differences that result simply because of when in a person's lifetime compensation is paid. A correction may also be made to avoid overcompensation of natural aging, but the need of such a correction is based more on one's moral beliefs than on clear unequivocal evidence.

DATA BASE USED

A detailed report[2] developed as possible supporting material for a standard on hearing loss was used as the basis for most of the tables and figures in this article. The report presents sets of tables that summarize the effects of noise exposure on the hearing threshold levels of an exposed population. Data from reports of Passchier-Vermeer[3], Robinson[4], Baughn[5], Royster and Thomas[6], Robinson and Sutton[7], and the 1960-62 Public Health Survey[8] were incorporated into the tables. One of the measures introduced in this article is the Units of Potential Compensation (UPC). This measure predicts the total number of decibels above a specified low fence that would be expected for 100 people. For example, if a group of 100 people of the same age were given hearing tests and it was found that one person's hearing exceeded the low fence by 8 dB, a second person's hearing exceeded the low fence by 11 dB and the remaining 98 persons had better hearing than the low fence, the Units of Potential Compensation would be 19 dB (8 dB + 11 dB). If compensation of an individual worker is based entirely on the number of decibels above the low fence, then the number of these units will be proportional to the actual money that might be paid to a group of noise exposed employees.

EFFECTS OF AGE ON COMPENSATION

In order to demonstrate the magnitude of the inequality of determining compensation of a relatively young worker, a table of the number of UPCs for groups of different ages for a specific noise exposure has been prepared as Table 1. To further demonstrate that the inequity exists regardless of data base, seven different presbycusis bases from four different studies were used. Table 1 contains the UPCs that could be expected after 10 years of daily exposure to a sound level of 90 decibels. The low fence used was 25 decibels for the average of 500, 1000, 2000, and 3000 Hz audiometric frequencies. By the time the 30 year old group is 60, the hearing levels can be expected to approximate the hearing levels of the group currently 60 years old. However, the amount of compensation paid the two groups will be very dissimilar if compensation is paid at the end of the noise exposure. As shown in Table 1, the exact amount predicted depends somewhat on which presbycusis data were used. But regardless of the data base, the older group will be given considerably more compensation. For example, consider that $500 is given for each decibel above the 25 dB fence. Using Passchier-Vermeer and Robinson's combined data base, 100 people at age 30 would have one decibel of compensation worth $500. This can be interpreted as an average of $5.00 per person, but of course, it really means that only one person out of the 100 is compensated and that person receives $500. Now for 100 people at age 60, 89 dB are lost and this would be worth $44,500 or $445 per person. In this case, 16 people would actually be compensated at an average cost of $44,500/16 or approximately $2600. For our purposes, however, it is more useful to consider the average compensation per group of 100 employees. Now $5.00 per person versus $445 per person is certainly a substantial difference, especially considering the the presbycusis data base in this example used would predict the minimum amount of absolute differences. Using the Public Health Service (PHS) survey of men, for example, would predict $70 per person for the 30 year old group versus $2455 per person for the 60 year old group. The data in Table 1 show the inequity of compensating at the termination of a worker's employment without any age correction. Table 1 also illustrates the importance of the selection of the correct presbycusis base if actual compensation costs are to be predicted for the same fence and compensation rate. Absolute compensation costs predicted by different prebycusis bases may vary by as much as a factor of 5 at age 60 and even 17 at age 30. For this reason, perhaps the better way to illustrate the effects of age on compensation is to find the ratios of UPC at ages 40, 50, and 60 years compared to the UPC at age 30. Such ratios for each presbycusis base are given in Table 2 and these ratios demonstrate that the age at which compensation is determined is a problem common to all presbycusis bases. Dependent on the presbycusis base, anywhere from 20 to 94 times more compensation will be paid to the 60 year old group than the 30 year old group. Even between the 50 and 60 year old groups, the 60 year olds will recieve 1.5 to 7 times more compensation than the 50 year old group.

If the reader concurs with the contention that such differences are inequitable, then some type of correction would seem to be a necessity when simiar occupational noise exposures terminate at different ages. This correction would be in addition to corrections (if any) that would be appropriate to prevent excessive payment for normal aging.

POSSIBLE SOLUTIONS FOR COMPENSATING FOR AGE

While there are many possible approaches to avoid undue compensation for natural aging or presbycusis, I will analyze four fundamental solutions to this problem. These are (1) make all compensation awards at the same age, (2) make compensation awards at equal intervals through a person's lifetime, (3) provide some type of age correction to be added or subtracted to a person's hearing level, or (4) multiply all compensation awards by a factor derived from the risk associated with a worker's lifetime noise exposure. Discussions of each proposed solution and possible variations of the solutions are provided. Solutions 1 and 2 resolve the inequity of compensating at different ages. Solutions 3 and 4 resolve the use of undue compensation for natural aging. As you will see, the solution proposed by the author as best is a combination of 2 and either 3 or 4.

Solution 1 - All Compensation Awards at the Same Age

The approach would be to test every noise exposed worker at one standard age. This age would be relatively late in a person's lifetime such as 55, 60, or 65 years. By definition, this approach would eliminate most of the problems associated with compensation at different ages, although some inequities would still be possible. To illustrate possible inequities, consider some examples that could happen if the standard age selected for testing hearing was 60 years. The 30 year old worker with 10 years of noise exposure would wait 30 years before his/her hearing would be tested for the purposes of determining a compensation payment even if his/her job were terminated. While this would normally be a distinct benefit to the worker in terms of the amount of compensation, 30 years might be viewed as an excessive delay. Further, any payment of compensation would be more advantageous if available when the person is experiencing the handicap.

Another example, although somewhat unlikely, would be a person who starts his first work in a noisy job at an age near 60 and does not retire until 65. Testing at age 60 could miss some or all of the change in hearing levels due to noise. Exceptions could be made in these cases but I would expect that they would be awkward. Interestingly enough, the fact that a person works past 60 would not be much of a problem for the worker who already has at least 10 years of noise exposure since most of the effect of noise will occur in the first 10 years; assuming of course, the noise exposure remains constant from year to year. In addition to the administrative or legal problems that might occur in compensating only at one standard age, there are other considerations. Two different profiles of possible hearing levels through a person's lifetime are plotted in Figure 1. The hearing levels selected are the same as the 10th percentile of the PHS male data. The occupational exposure of one person is 95 dB from age 20 to 30, while the exposure of another person is 95 dB from age 50 to 60. While at age 60 the hearing of both persons is predicted to be similar, it should be obvious that in this scenario the two individuals will have had significantly different hearing loss profiles with respect to time. The person with the exposure early in life crosses the 25 dB fenceat age 38 while the other person crosses at age 52. If one calculates the area between the fence and the actual hearing levels, the early exposed person has approximately 155 decibel years above the fence while the person exposed later has approximately 60 decibel years. In other words, the person exposed early in life has had about 2 1/2 times more insult at age 60. Thus, one might well argue that the person whose hearing was damaged early in life deserves more compensation. But note again that many present compensation practices in the United States will not only not compensate the person who is noise exposed early in life with more compensation, these practices very likely will not compensate that person at all! The subject shown in Figure 1, with an exposure early in life, would not be above the 25 decibel fence by age 31. Yet in many states the subject would have to file a claim by this time because of the requirement to file within 6 months or a year of termination of employment. In addition, the employee is usually required to be away from occupational noise exposure during this time. Compensating both individuals at age 60 would at least insure the person exposed at an early age would be compensated. In summary, compensating all individuals at a specified age would be more equitable than compensating the employee at the termination of employment. The solution, however, is far from perfect and would undoubtedly be difficult to administer.

Solution 2 - Conpensation Awards at Intervals Through a Person's Lifetime

A system of prorating compensation over a person's lifetime effectively avoids the problems associated with deciding when in a person's life compensation is computed. This solution should provide equitable treatment of all workers, regardless of when the noise exposure occurs. To illustrate how this approach might work, again consider the two persons illustrated in Figure 1. If $500 per each decibel above the fence is given at time of termination of employment, the early noise exposed person who terminates employment at age 30 would get nothing and the late exposed person would be given $7500 in compensation. If the compensation is delayed until age 60, then both employees will receive $7500. If instead of giving $500 for each decibel above a 25 decibel fence at age 60, $250 was given for each decibel above the fence at age 30, 40, 50, and 60, then the person exposed to noise early in life would receive nothing at age 30, $250 at age 40, $1750 at age 50, and $3750 at age 60 or a total of $5,750. The person exposed later in life would receive a lesser amount of $3750. The dollar amounts are arbitrary, of course, but in practice the amount paid per decibel could be adjusted so that the total amount distributed remained constant. The only difference would be that the dollars are more equitably distributed. While this procedure is undoubtedly the fairest, it would require more audiometric exams and probably would result in higher administrative costs. This solution still allows for some payment for natural aging or presbycusis.

Solution 3 - Use of Age Corrections

Reasonable age corrections can easily be developed for groups of people and such corrections are developed in this section. But a word of caution is in order when any age correction is used. The data on noise induced hearing loss and on presbycusis are derived from large populations. How statistical parameters of these populations behave can be discussed and compared. Values such as Units of Potential Compensation can be computed and compared as was indeed done in the first part of this paper. Age corrections can be established that make compensation fair between groups of people. But in the final analysis, age corrections for the individual are probably in error the majority of the time. For example, again consider a person of age 30 who had 10 years of noise exposure. Assume also that this person's hearing is 24 dB, or just 1 decibel below the 25 dB fence. On the average one might estimate that this person's hearing will decline another 17 dB to 41 dB by the time this person is 60 years old. This was shown in Figure 1. Yet it is possible that this person's hearing might remain at 24 dB while some other individual might have gone from 10 to 41 dB. Thus use of age corrections, a person who should not have been compensated may be compensated while a person who should have been compensated is ignored. How often this inequity might occur in practice is difficult to determine. Nevertheless, it is a source of error that must be accepted if age corrections are used. Solution 2 avoids this problem because the individual's actual hearing levels are followed through time. Given that a series of age corrections is a reasonable approach, one of the first problems in determining the proper age correction is the decision as to what data base to use. The best data base is the one similiar to the population under investigation. Not having a specific population in mind, the approach taken here was to insure that the correction was reasonable for many different bases. The fundamental issue of any age correction is selecting a logical method for such a correction. One such philosophy, which is being used by some U.S. states, is to deduct from an individual's actual hearing levels a value based on average hearing levels of a nonoccupationally noise exposed population of the same age. Other states use even more arbitrary practices. Use of average hearing levels is very sensitive to the data base used. Unfortunately, there is a very wide variance in the published literature as to what is the average hearing level of the population not subjected to occupational noise exposure. Furthermore, the effect of both aging and noise exposure is to spread out the statistical distribution of hearing levels of a population. Adjusting this distribution by only the average hearing loss will not necessarily threat an older population the same as a younger population in terms of the amount of compensation paid. Therefore, the method that I propose to use is to adjust the hearing level correction so that the same percentage of a noise exposed population would be eligible for compensation regardless of age. For all practical purposes, use of this method would insure that the amount paid to groups of people of different ages would remain constant. Keeping the percentage of people who exceed the fence constant can be accomplished by either adding different age corrections to different age groups or it can be accomplished by varying the height of the "low fence" with age. These two procedures are mathematically equivalent, so I have selected the approach of varying the fence, which is clearer to me. In table 3, the low fence is varied so that equal percentages of the population will be predicted to exceed the low fence at the ages of 30, 40, 50, and 60 years. All of the data used are derived through procedures summarized in reference 2. In Table 3 the results are tabulated for each of the three reference conditions. These are the percentage of population which exceed a 25 dB fence for 1/4(0.5, 1, 2, and 3 KHz) at: (1) 60 years, (2) 50 years, and (3) 40 years. For example, Robinson and Sutton's data indicate that 2% of a non-noise exposed, screened male population will exceed a 25 dB fence at age 50 years. Using the methods shown in Figure 3 of reference 2, this same data base shows that at age 60 a fence of 32.5 dB will also result in 2% of the population exceeding the fence. An age correction of 7.5 dB for the 60 year olds and use of a 25 dB fence would, of course, produce the same result. Note that the values of the desired low fences shown in Table 3 are quite similiar, in spite of the fact that the actual hearing levels of the different data bases vary by a considerable amount. Thus the key result shown in Table 3 is that corrections can be derived that are relatively insensitive to the presbycusis data base used. This insensitivity occurs because it is the percentage that exceeds the 25 dB fence at the reference age that varies greatly with the data base used. For instance, the percentage of males of the PHS survey of 1960-62 that exceed 25 dB at age 50 is 13%. Thus a 33.5 dB low fence is required at age 60 to cause 13% of the PHS male population to exceed the fence. Figure 2, which uses female data from the Public Health Service survey, further illustrates this procedure. If a fence of 25 dB at age 60 years is considered reasonable, then 13% of the population is to be compensated. If 13% of the population is to be compensated at age 30, then the fence should be 9 dB. This value is shown in Table 3 as the required fence at age 30 if compensation is based on a 25 dB fence at age 60.

From looking at the data in Table 3 and just a little trial and error, it appears that for but one exception, a simple correction of 5 dB for each 10 years is all that is required until age 50, at which time a 10 dB correction is needed between 50 and 60 years. The exception is when the 25 dB reference fence is set at age 60, only a 5 dB correction is needed between ages 50 and 60. To assess the accuracy of these simple corrections, Table 4 was constructed using various age correctd fences. The Units of Potential Compensation have been calculated for these fences assuming 10 year occupational noise exposure of 90 dB. Note that the values with respect to different ages are reasonable, especially if all data bases are considered. Certainly there are some errors and the Potential Compensation at some ages differs from others by a factor of 2 or 3, but the accuracy of the Units of Potential Compensation is probably not better than a factor of 2 in the first place. Compared to the very large differences in Table 1, such differences must be considered minor.

What has not been accomplished is the selecting of which references fence to use. That is a value judgement left up to others to make. My concern for the purpose of this article is not the amount of compensation paid, but simply that whatever is paid is fairly paid to all segments of the occupational noise- exposed population.

In summary, if any age correction is used, some reasonable correction procedures would be:

a. Starting with a 10 dB fence at age 30, 0.5 dB per year.

b. Starting with a 15 dB fence at age 30, 0.5 dB per year until age 50, then 1 dB per year thereafter.

c. Starting with a 20 dB fence at age 30, 0.5 dB per year until age 50, then 1 dB per year thereafter.

Solution 4 - Compensation awards by a factor derived from the risk associated with a worker's lifetime noise exposure.

One of the implicit drawbacks of using an age correction, such as proposed in Solution 3, is that no differentiation is made between workers exposed to different levels of occupational noise. A worker exposed to a lifetime of noise at an equivalent level of 100 dB would receive the same consideration as a worker exposed to an equivalent level of 90 dB if the hearing levels of the two workers were identical. Yet it is more likely that the hearing level of the worker subjected to 100 dB is due less to presbycusis than the hearing level of the 90 dB worker. To illustrate this point, a table of units of Potential Compensation from reference 2 is provided as Table 5. The presbycusis data used are the male hearing levels of the 1960-62 Public Health Survey.

The average number of decibels above the 24 dB fence for a 60 year old worker exposed to 40 years of noise is 5.6 dB (556/100) for a 90 dB exposure and 14.5 dB for a 100 dB exposure. A non-noise exposed worker would average 2.7 dB. These numbers provide an index as to the average risk involved for different noise exposures and can be used to derive a reasonable risk factor. Specifically, it is proposed that the number of decibels above a fence due to a noise exposure of X decibels can be corrected for prebycusis by multiplying that number by:

$$1 - \frac{\text{UPC no noise exposure}}{\text{UPC noise exposure of X decibels}}$$

Thus if a 60 year old worker had a 40 year noise exposure of 90 dB and a hearing level for the average of 500, 1000, 2000, or 3000 Hz frequencies of 35 dB, the compensation would be based on:

$$10 \text{ dB} \times \left(1 - \frac{2.7}{5.6}\right) = 5.2 \text{ dB}$$

A similar worker exposed to 100 dB would be compensated on:

$$10 \text{ dB} \times \left(1 - \frac{2.7}{14.5}\right) = 8.1 \text{ dB}$$

A table of correction factors can easily be constructed from Table 5 for various ages and noise exposure deviations. This is done in Table 6.

This method insures that for workers exposed to relatively high levels of noise, little correction for presbycusis is made.

Likewise, workers who at an early age also exceed the fence will receive virtually no correction due to presbycusis. On the other hand, workers who receive only a minimum of noise exposure would be given a substantial reduction in compensation at the older ages.

The drawbacks with this approach, however, are twofold. First, determination of the equivalent lifetime noise exposure is difficult if not impossible. Yet reasonably accurate determination of this level is a necessity if this approach is to be used. Second, this approach is somewhat sensitive to both the fence and the presbycusis base used. For instance, the factor for a 40 year exposure to 90 dB of a 60 year old is 0.9 using Robinson and Passchier-Vermeer's screened population and only 0.51 using the PHS data. Nevertheless, these errors are not nearly as great as the simple use of an age correction based on the average hearing levels of a prebycusis base.

Recommended Solution

The best solution is likely to be a combination of solution 2 and either solution 3 or solution 4. Compensation of a person by using a series of audiometric tests during a person's lifetime resolves the basic issue of undercompensating the young worker. Use of a correction factor based on the worker's noise exposure resolves the problem of paying the worker for natural aging. If the noise exposure of the worker is not available, then compensation can be based on age corrections as suggested by solution 3. Combining solution 2 and either solution 3 or 4 is relatively straight forward. For example, a worker's hearing could be measured every 10 years and incremental compensation paid to the worker based on the worker's hearing loss adjusted by a factor based on the worker's noise exposure. For instance, the worker illustrated in solution 2 would be compensated in the following way if the age correction of solution 3 were used and the base fence was 20 dB at age 30:

Worker 1: (23-20) X 240 = $ 750 at age 30
(26-25) X 250 = $ 250 at age 40
(34-30) X 250 = $1000 at age 50
(40-40) X 250 = 0 at age 60
Worker 2: (40-40) X 250 = $ 0 at age 60

More or less compensation would be given by changing the starting fence at age 30 or by changing the rate ($250 per dB). If a 15 dB fence at age 30 years is used, worker 1 would receive $7000 while worker 2 would obtain $1250. This illustrates the criticial nature of selecting the right parameters, such as the fence, if the compensation is to be reasonable. Using the factors of solution 4, the lifetime compensation of the same two workers would be:

Worker 1: (23-25) X 1 X 250 = $ 0 at age 30
(26-25) X .9 X 250 = $ 250 at age 40
(34-25) X .78 X 250 = $1755 at age 50
(40-25) X .6 X 250 = $2250 at age 60
Worker 2: (40-25) X .6 X 250 = $2250 at age 60

Again, remember that the rate factor can be adjusted so there is not as much difference between solutions 3 or 4. These examples should serve to demonstrate the basic paradigm.

CONCLUSIONS

The overriding concern in the payment of compensation for noise induced hearing loss is the resultant auditory handicap. This paper has presented various mathematical approaches in order to suggest compensation practices which account for the effects of aging and the length of the auditory handicap. If compensation is to be paid at equal intervals through a person's working lifetime, as recommended in solution 2, then this approach might warrant stricter criteria for younger workers to account for (1) the auditory handicap experience at each age interval as a result of the loss, and (2) the time history of the loss (most loss experience during the first 10 years of noise exposure). The current compensation practices do not treat the effect of aging in an equitable manner. If an exployee's present hearing levels are used for compensation, the young noise-exposed employee on the average will be grossly undercompensated, as compared to older workers. An additional important consideration, independent of the mathematic solution, is that hearing loss criteria selected should be appropriate for the age group in question. For instance, a hearing loss may be more socially and economically handicapping for a worker 30 years of age versus 60 years of age. This research might well be advisable to assess the effects of noise in terms of an individual's physical, social, mental, and economic functioning as a function of age and the determination of the most applicable hearing loss criteria. Reduced hearing for a younger person might have more severe and limiting consequnces and these legitimately require more compensation through sensitive criteria. However, the sad fact is that under many present practices and using the same criteria, the older employee may receive as much as 20 to 30 times more monetary compensation for an almost identical lifetime history of hearing level versus age. For this reason, some type of age adjusting procedure is required regardless of whether or not additional age corrections are considered appropriate for the effect of presybcusis. There are many possible approaches and four proposed solutions have been discussed. One solution, the use of numerical age corrections would resolve the problem for groups of people, but is not precise when each individual is concerned nor is it precise for groups with different noise exposure histories. The use of a factor that accounts for the noise exposure of the worker resolves the latter discrepancy, but the noise exposure of the worker is not always known. Use of a standard age for making all compensation awards would resolve the problem for both groups of people and for the individual. This solution, however, would still not account for different time histories of hearing loss. The most equitable solution is to base compensation on a series of audiometric tests during a person's lifetime. This solution should be used whether or not corrections for natural aging are deemed necessary. If correction for natural aging is considered necessary, then compensation based on a lifetime series of audiometric tests and either appropriate age corrections or use of risk factors is the procedure recommended. An audiometric test every 10 years from age 30 would probably be sufficient to truly depict the effect of noise exposure on the individual. This solution will cause somewhat more of an administrative burden, but remember that no method is now known that will allow prediction of an individual's lifetime history of hearing levels from audiometric data at just one point in time. Thus, any lesser solution is nothing more than a guess. As summarized nicely by Mr. Shampan, formerly with the Office of Noise Control Abatement, EPA, in a letter to me, "Hopefully, the discussion of these mathematical approaches will assist in putting researchers and policy makers back on the right track if we are to more fairly compensate individuals without unjust penalties for the effects of aging. The adoption of a policy for periodic compensation payment will provide a more equitable payment schedule for individuals who do not spend all their working lifetime in hazardous noise, provide compensation at a time when the auditory handicap and associated consequences are most serious, and assure that individuals who are forced to live with a loss over their working lifetime are compensated for the duration of the loss, and not penalized years later."

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TABLE 1.

UNITS OF POTENTIAL COMPENSATION PER 100 PEOPLE AFTER 10 YEARS NOISE EXPOSURE AT 90 dB FOR 1/4 (0.5, 1, 2, 3) KHz WITH A 25 dB FENCE

AGE -	30	40	50	60
PHS WOMEN	5	24	92	234
PHS MEN	14	120	234	491
Passchier-Veermeer & Robinson	1	6	24	89
Robinson & Sutton Women	2	7	29	104
Robinson & Sutton Men	2	12	63	180
Royster & Thomas Women	3	16	40	281
Royster & Thomas Men	17	87	237	347

TABLE 2.

RATION OF THE UNITS OF POTENTIAL COMPENSATION FOR VARIOUS AGES TO UNITS OF POTENTIAL COMPENSATION AT AGE 30. DATA FROM TABLE 1.

AGE -	30	40	50	60
PHS WOMEN	1.0	4.8	18.4	46.8
PHS MEN	1.0	8.6	16.7	35.1
Passchier-Vermeer & Robinson	1.0	6.0	24.0	89.0
Robinson & Sutton Women	1.0	3.5	14.5	52.0
Robinson & Sutton Men	1.0	6.0	31.5	90.0
Royster & Thomas Women	1.0	5.3	13.3	93.7
Royster & Thomas Men	1.0	5.1	13.9	20.4

TABLE 3

MAGNITUDE OF FENCE VERSUS AGE THAT IS NECESSARY TO RESULT IN AN EQUAL PERCENTAGE OF THE POPULATION WITH HEARING LEVELS THAT EXCEED THE FENCE. DATA ARE FOR THE AVERAGE OF 500, 1000, 2000, and 3000 Hz.

25 dB FENCE AT 60 YEARS	30	40	50	60
PHS WOMEN	9.0	12.5	18.0	25
PHS MEN	8.5	14.0	19.0	25
Passchier-Vermeer & Robinson	10.0	14.0	18.5	25
Robinson & Sutton Women	10.0	13.0	18.5	25
Robinson & Sutton Men	9.0	12.0	18.5	25
Royster & Thomas Women	9.0	12.0	15.0	25
Royster & Thomas Men	10.5	15.0	21.5	25
Average	9.5	13.3	18.5	25
25 dB FENCE AT 50 YEARS				
PHS WOMEN	13.0	17.5	25	33.5
PHS MEN	11.5	19.5	25	33.5
Passchier-Vermeer & Robinson	15.0	20.0	25	32.0
Robinson & Sutton Women	15.0	19.0	25	33.5
Robinson & Sutton Men	13.0	17.0	25	32.5
Royster & Thomas Women	16.5	20.5	25	46
Royster & Thomas Men	12.5	18.0	25	28.5
Average	13.8	18.8	25	34.2
25 dB FENCE AT 40 YEARS				
PHS WOMEN	19.0	25	36.0	47.0
PHS MEN	15.0	25	31.0	41.0
Passchier-Vermeer & Robinson	20.0	25	30.0	37.0
Robinson & Sutton Women	20.5	25	32.5	42.5
Robinson & Sutton Men	20.0	25	36.0	45.0
Royster & Thomas Women	20.0	25	30.0	56.5
Royster & Thomas Men	17.5	25	34.0	37.5
Average	18.9	25	32.8	43.8

TABLE 4

UNITS OF POTENTIAL COMPENSATION FOR 100 PEOPLE AFTER 10 YEARS OF NOISE EXPOSURE TO 90 dB. FENCE VARIES AS INDICATED 1/4 (0.5, 1, 2, 3 KHz)

DATA BASE	30 (10 dB)	40 (15 dB)	50 (20 dB)	60 (25 dB)
PHS Women	188	155	185	234
PHS Men	279	377	381	491
Passchier-Vermeer & Robinson	113	81	74	89
Robinson & Sutton Women	125	83	78	104
Robinson & Sutton Men	143	108	139	180
Royster & Thomas Women	217	154	111	281
Royster & Thomas Men	313	334	399	347

	30 (15 dB)	40 (20 dB)	50 (25 dB)	60 (35 dB)
PHS Women	71	66	92	69
PHS Men	124	222	234	218
Passchier-Vermeer & Robinson	34	25	24	10
Robinson & Sutton Women	42	28	29	18
Robinson & Sutton Men	52	40	63	42
Royster & Thomas Women	75	55	40	90
Royster & Thomas Men	143	180	237	112

	30 (20 dB)	40 (25 dB)	50 (30 dB)	60 (40 dB)
PHS Women	21	24	42	33
PHS Men	46	120	134	136
Passchier-Vermeer & Robinson	7.6	6.0	6.4	2.3
Robinson & Sutton Women	11	7	9	6
Robinson & Sutton Men	15	12	25	17.5
Royster & Thomas Women	19	16	11.5	40.5
Royster & Thomas Men	54	87	130	57

TABLE 5.

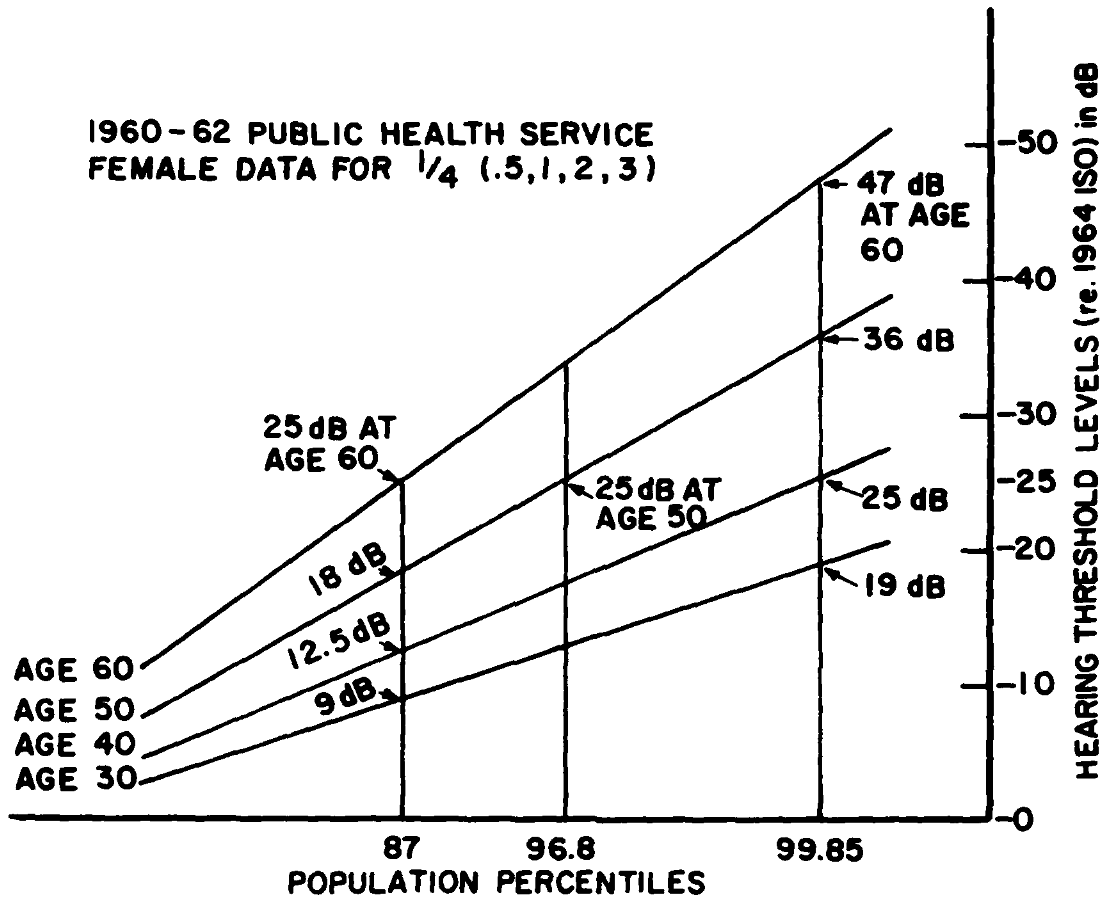
UNITS OF POTENTIAL COMPENSATION. THE NUMBER OF DECIBELS ABOVE 25 dB (RE. 1964 ISO) FOR A HEARING THRESHOLD LEVEL OF AN AVERAGE OF THE FREQUENCIES OF 500, 1000, 2000, and 3000 Hz. DATA BASED ON 100 PEOPLE. THE PRESBYCUSIS DATA USED ARE THE MALE HEARING LEVELS FROM THE 1960-62 PUBLIC HEALTH SURVEY.

Sound Level (dB)	AGE (Yrs) ESPOSURE	30 10	40 10	40 20	50 10	50 20	50 30	60 10	60 20	60 30	60 40
	Presbycusis	0	27	27	84	84	84	272	272	272	272
	75	0	27	27	84	84	84	272	272	272	272
	80	0	39	38	106	106	105	309	309	310	310
	85	2	65	64	151	150	150	377	378	380	381
	90	14	120	131	234	251	273	491	519	549	556
	95	54	224	270	374	436	491	672	753	824	873
	100	170	419	531	616	753	890	961	1132	1304	1449

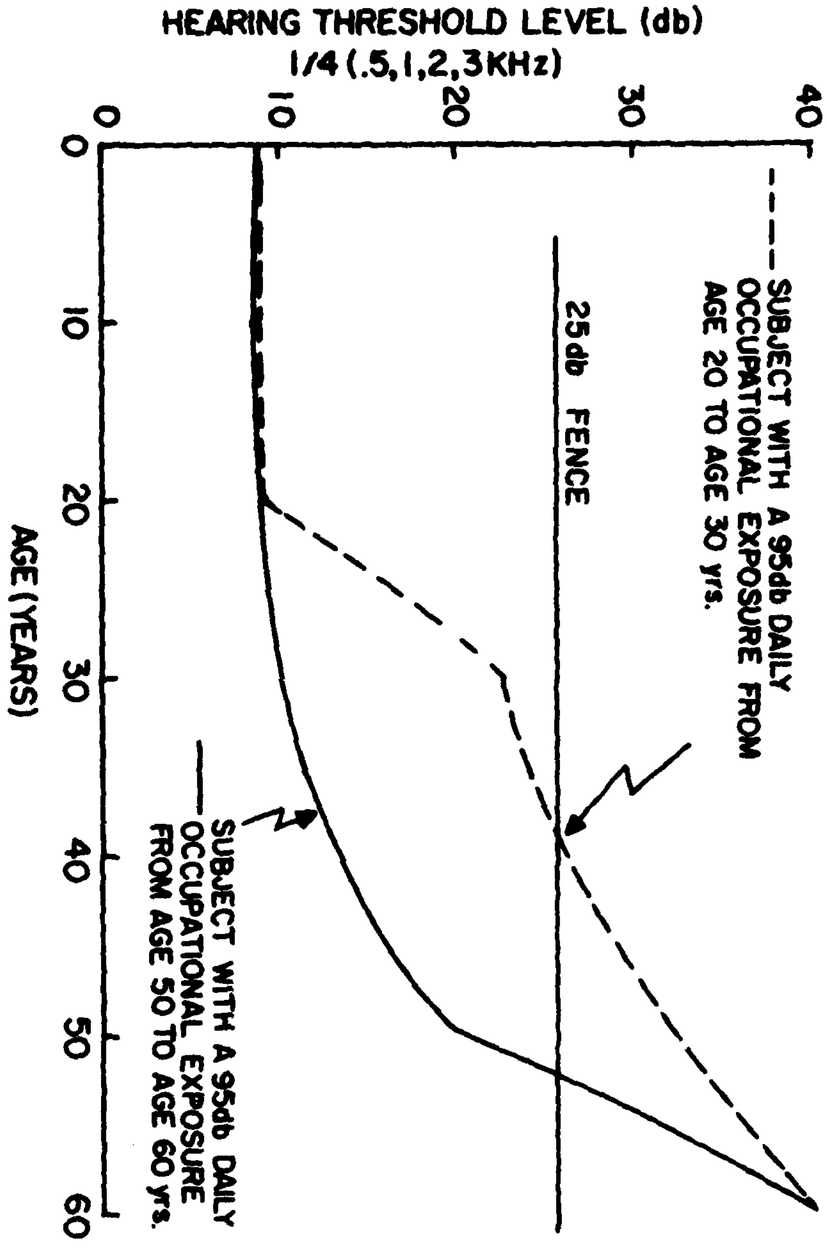
TABLE 6.

CORRECTION FACTORS COMPENSATING HEARING LOSS AS BASED ON DATA OF TABLE 5.

AGE (Yrs)	30	40	40	50	50	50	60	60	60	60
EXPOSURE	10	10	20	10	20	30	10	20	30	40
75	0	0	0	0	0	0	0	0	0	0
80	0	.31	.31	.21	.21	.21	.12	.12	.12	.12
85	1	.58	.58	.44	.44	.44	.28	.28	.28	.29
90	1	.78	.79	.64	.67	.69	.45	.48	.50	.51
95	1	.88	.90	.78	.81	.83	.60	.64	.67	.69
100	1	.94	.94	.86	.89	.91	.72	.76	.79	.81



1960-62 PUBLIC HEALTH SERVICE
FEMALE DATA FOR 1/4 (.5,1,2,3)
AGE 60
AGE 50
AGE 40
AGE 30
25 dB AT AGE 60
18 dB
12.5 dB
9 dB
25 dB AT AGE 50
47 dB AT AGE 60
36 dB
25 dB
19 dB
0
-10
-20
-25
-30
-40
-50
HEARING THRESHOLD LEVELS (re. 1964 ISO) in dB
87
96.8
99.85
POPULATION PERCENTILES



*USGPO:1983-759-106-1310

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