of 100,000 drivers failing over.6 years). By comparing the expected number of hearing-impaired CMV drivers with the number failing the DOT physical due to hearing, one can see that of the 169,000 CMV drivers expected to be hearing-impaired, only an estimated 2,640 (5.5 million X 0.00048) are failing the license renewal over a 5-6 year period because of poor hearing. This represents about 1% of the predicted number of hearing-impaired CMV drivers. This calculation may be slightly understated because some drivers fail the biannual exam for medical masons in addition to hearing impairment.

Surveys on the licensing practices of all 50 states and two foreign countries provided useful information regarding the number of deaf drivers who might be licensed. Arizona, Michigan, and Oregon permitted the intrastate licensure of hearing-impaired individuals, in one form or another, and had information on the number of hearing-impaired drivers licensed in their state. Arizona reported only one, Michigan reported two, and Oregon reported knowledge of four hearing-impaired drivers. Although these drivers were classified as hearing-impaired, the relative looseness of the screening techniques used in these states suggests that they most likely all would be deaf. License examiners may notice only those persons with obvious hearing difficulties.

Considering these data in relation to the total number of licensed CMV drivers in each state (as shown in Table 4-5), the information provided by the states suggests that the number of additional deaf individuals licensed under a rule change would be close to 250. This assessment provides a crude estimate of deaf drivers. However, the numbers predicted agree somewhat with the experience seen in Great Britain, where the rate of licensed deaf drivers for large goods vehicles (LGV) reported was 1 per 100,000 LGV drivers,

Table 4-5. Number of Licensed "Deaf" Drivers Expected if Regulations Were Changed

State	Number Hearing-Impaired CMV Drivers	Population of CMV Drivers	Rate of Hearing-Impaired CMV Drivers	"Deaf" CMV Drivers Expected in U.S.A.
Arizona	1	50,000	5/100,000	250
Michigan	2	130,886	1.5/100,000	75
Oregon	4	86,000	5/100,000	250

Thus. within approximately five years of a program change, the predicted number of additional hearing-impaired drivers added to the license pool with a change in rules is close. to 2,900 persons. The expected number of additional drivers with NJHL being licensed would be about 2640 (the number currently being screened out of the workforce), and the number of deaf drivers beiig licensed would be about 250.

The experience of the states suggests that not all eligible individuals would be expected to apply for interstate licensing immediately after a rule change. It is likely that the majority of drivers who would apply first would be those who are currently driving CMV on an intrastate basis or those existing drivers who have failed their biiual medical examination. The safety risk of both groups of drivers could be low because of their previous experience in driving commercial motor vehicles.

Translating the exposure to hearing-related events into crash risk

Trying to determine the relationship of hearing impairment to crash involvement is, by nature. a difficult task, as hearing is suggested to play a small role in driving performance and crashes are relatively rare events. There has been little research to determine whether hearing-impaired drivers have different accident rates from non-hearing-impaired drivers. The data that do exist have a number of limitations with respect to CMV operation.. However, we will critically evaluate these items sad determine to the best of our judgment, their meaning in terms ofcrsshrisks.

The literature coataias a few case reports of deaf truck drivers who have driven safely for many years. For example, two deaf truck drivers in Massachusetts. each with 33 years of driving experience, were reported to have had no accidents (Woods, Sr. 1978). Another deaf truck driver was reported as having 30 years of driving experience with no major injury-producing accidents (Petersen 1978). Anecdotal reports such as these. though, disclose very little about the extent to which crashes would be likely to occur in a population of drivers.

One study has examined the role of hearing loss in accidents among CMV drivers. Henderson sad Burg (1973) tested the hearing levels of 236 CMV drivers sad examined their driviag records. The results of their study suggest that greater hearing loss was associated with fewer accidents. However, this finding may also reflect the fact that older drivers have more driviag experience (as well as hearing loss), sad the lower risk could be a function of driving experience rather than more cautious behavior associated with hearing impairment The level of heariag impairment present in the CMV drivers also was not severe. AU drivers fulfilled the hearing standards published in 49 CFR 391.41. It is not clear if the same association might be seen in drivers with more serious forms of hearing impairment

With such limited crash sad exposure data, it is difficult to determine what the risk for accidents may he in circumstances where the ability to hear would be important In our searches, we were able to obtaia only general information on the crash experience of trucks with emergency motor vehicles and trains. While not complete, these estimates may indicated the margin for the risk related to hearing impairment.

Emergency motor vehicles — sirens

Earlier we indicated that it is difficult to estimate the frequency of situations in which a truck has to yield the right of way to an emergency vehicle. However, the actual rate of exposure may be inconsequential since data from the General Estimates Survey (GES), a nationally representativve sample of police-reported crashes. indicated that there were no crashes between heavy or medium-sired trucks and emergency vehicles in 1988.1989, or 1990 (personal communication). Given the noise environment of truck cabs, this may indicate that an inability to hear sirens does not contribute to the crash rate for CMV drivers.

Train horns and railwav crossings

It also remains very difficult to estimate how often trucks and buses encounter railway crossings where there is potential for a crash with a train. The GES suggests that crashes with trains are fairly rare events. In 1990, approximately 200 heavy or medium trucks were involved in crashes with trains. Tbis translates to 0.06% of the 324,000 truck crashes reported that year (or six of every 10,000): a small proportion. Data from the Fatal Accident Reporting System (FARS) for 1990 indicated that 25 medium or heavy trucks were involved in fatal crashes with trains (FARS 1991).

A recent study by the Federal Railroad Administration (FRA 1991) on the effects of a nighttime ban on train horns in Florida indicates that hearing could have some role to play in crashes between trains and motor vehicles. In the report, 115 motor vehicle crashes with trains occurred after a nighttime ban on train horns went into effect.. Information from crossings where the ban did not apply and data from a similar time period prior to me ban indicate that 39 crashes would have been expected. Roughly 3 times as many crashes occurred after the ban went into effect than were expected. No differences were seen at these same crossings for crashes occurring during daytime hours, when trains had to sound a horn.

The Florida data suggest that warning signals could play a role in preventing vehicle crashes with trains. However, several factors do oot allow us to draw conclusions about the risk for train crashes among hearing-impaired CMV drivers. Fii the data do not report whether any CMVs were involved in the crashes and, if so, whether their relative risk also increased after the ban. Second, it is not possible to separate the hearing ‘component from other warning components. Third, given the noise levels in truck cabs, it is not clear whether train horns can be heard if sounded, so a hearing impairment may not matter. Finally, hearing-impaired persons, especially deaf persons who have never been able to rely on horns as warning signals, may be able to compensate for their loss and may have different behaviors at rail crossings than normal-hearing drivers.

Total crashes expected due to hearing loss

Estimates of the crash risk related to specific hearing-related circumstances (e.g.. trains, emergency vehicles) describe only limited aspects of the driving task. It is also worthwhile to have data related to the overall driving task. That is. information on crash rates of hearing-impaired drivers relative to normal-hearing drivers. We were able to obtain limited data on this from two sources: individual states and the literature on crashes among deaf automobile drivers.

Estimates from data on intrastate CMV operators

A small set of data was available from a survey we conducted among the 50 states regarding the licensing practices for intrastate CMV operation. Two states out of me 48 that responded had data on the accident history of their licensed drivers known to have hearing impairments. Four hearing-impaired drivers were licensed in Oregon and one in Arizona. It is likely that most, if not all, of these drivers are deaf; certainly they do not account for all hearing-impaired drivers who might be expected in the two states. From 1985 to 1990, a crash rate of

0.67 accidents/ million miles driven was recorded among the four drivers in Oregon. The driver in Arizona had had no crashes in the previous 10 years.

Accident rates for the general CMV operator population are also available, adjusted for mileage driven. Data from the FHWA on the average mileage driven by a CMV operator in the United States (45,000 miles/year) and data on the number of DOT reportable crashes/driver in 1985 suggest a rate of 0.17 crashes/million miles driven. Data on the crash experience of approximately 5,000 CMV drivers employed by two private trucking firms for the years 1989-1991 were also available. These estimates, along with the Oregon and FHWA data, are shown in Table 4-6 below.

Table 4-6 Crash Rate Estimates far CMV Drivers

Hearing-impaired drivers:	0.67 crashes/1,000,000 miles driven	(1985-1990)
General CMV drivers:	0.17 crashes/1,000,000 miles driven'	(1985)
Private trusking firms:	0.93 crashes/1,000,000 miles driven	(1989-1991)
	0.58 crashes/1,000,000 miles driven	(1989-1991)

Comparing the data from Oregon with those from the other sources, we see that the crash risk for drivers with hearing impairment could be estimated to range from 0.72 to 3.94 times greater than that for normal-hearing drivers Several factors, though, affect the validity and reliability of these estimates. The primary limitation is the small sample size upon which the Oregon data are based. It is difficult to draw conclusions on the crash experience of the hearing-impaired population from a sample of fourdrivers. Second, it is likely that the confidence limits surrounding the 0.67 crashes/million miles estimates are quite large. Looking at the Oregon data, it appears that this rate is based upon only one crash. It also remains unclear which of the crash rate estimates for the general population would provide. a relevant comparison. The estimates provided by the two private firms differ substantially from the estimate based upon FHWA estimates. but are more recent.

Estimates from the literature onhearing-impairedautomobile drivers

Info& is also available from the literature to consider the crash risk for hearing-impaired drivers. Nearly all of the reports have focused upon-deaf drivers. The evidence regarding the effects of hearing impairment on accident risk is mixed. Observational studies (Grattan 1968. McFarland 1955. Finesilver 1962b, Norman 1962) suggest that the frequency of accidents related to hearing loss is relatively small in the overall crash scheme. These reports, though, reveal little about the risk for hearing-impaired drivers compared to that for drivers with normal hearing.

Studies evaluating the accident patterns of hearing-impaired drivers and a control group of normal hearing drivers have observed an increased (COppin 1964, Cook 1974), decreased (Wagner 1962, Finesilver 1962b, Ysander 1966, Roydhouse 1967, Schein 1968) and similar (Wolf, unpublished observations) occurrence of collisions. Almost all of the reports, though, were hampered by poor study designs. The majority failed to adjust their results for the influence of other important factors for road crashes, including age, sex, mileage driven, and area of residence. Despite these limitations, none of the reports suggested that the crash risk of hearing-impaired drivers was exceedingly high.

The most comprehensive and best designed study in the Literature was that conducted by Coppin and Peck (1964). In their report, deaf and non-deaf drivers were matched on age, sex, occupation, and mileage driven, and consideration was given to area of residence. The accident rate for deaf men was 80% higher than that for non-deaf men. The crash rate for deaf women was 10% lower than that for non-deaf women.

The observed sex difference holds some interest. If deafness were related to crash records, one would think that disparity between the sexes would not appear. Coppin and Peck hypothesize that the males in their study could have driven more than the females in situations where hearing was important, such as during rush hour and in heavy traffic. However, no data were collected on these factors. It is also possible that the difference was not due to the role of hearing in driving. but to another external factor associated with deafness among men.

There. are several limitations with the study that must be considered in evaluating what we can learn about the relative risk of hearing-impaired CMV drivers. Both the case and control samples were composed of volunteers who may not be representative of their respective populations. Also, different samples of male and female drivers (both deaf and non-deaf) were used in the comparisons. The sample of male drivers used in the analysis was limited to residents of major urban areas (as deaf men in rural areas had significantly fewer crashes than deaf men in urban areas), while the sample of female drivers was based upon both urban and rural drivers.

Perhaps the primary limitation (as it relates to CMV drivers) with Coppin and Peck's study, though, is the period in which it was conducted, The data from this report are now 30 years old. It could be argued that both technology and drivers' training have changed considerably over this time and that the 1962 findings may no longer be relevant.

It is also important to note that a real difference exists between driving an automobile and operating a commercial motor vehicle as an occupation. CMV operation typically involves long hours of driving in varying weather conditions, physical exertion in loading and unloading freight, economic pressures to arrive on schedule, and a series of unique skills necessary to manipulate a large vehicle. Thus, the findings from this study on deaf automobile drivers may not be completely generalizable to a CMV driving population.

Nonetheless, the information from Coppin and Peck remains the best available for considering risk differences between normal and impaired-hearing drivers at this time. If we assume that the data from this report would be similar to the experience for deaf CMV drivers, one might expect that the crash risk for deaf CMV drivers could range from 0.90 to 1.82 times higher than the normal-hearing CMV population. For 250 new deaf drivers, this translates into a possible range of one less crash man would be expected if 250 non-deaf drivers were licensed to about two additional accidents. It is not clear if this risk would be similar for existing drivers who lose their hearing from occupational exposure.

Relative risks of deaf drivers vs. hard-of-hearing drivers

It is not clear if the relative risk for crashes among deaf drivers would be similar to that among drivers who are hard-of-hearing. One might expect it would not be since, for most CMV drivers, hearing impairments (from age or noise-related causes) are correlated with age, age is correlated with driving experience, and experience is negatively correlated with accident rates. On the other hand, deaf drivers may exhibit or be able to develop adequate compensation behaviors to overcome their loss, and their crash experience might not differ from that for the hard of hearing. There ***remains, in any event,*** a need for further information on crashes in both groups of drivers.

Even if we assume that deafness and hearing loss pose approximately the same risks, when making public policy decisions it is important to consider the acceptability of the risk observed. If an increased risk is found for hearing-impaired drivers, one should also consider how this risk might compare to other groups of drivers as age-related and noise-induced hearing loss are correlated with age, and necessarily driving experience. This issue is especially important because we estimate that most drivers affected by any prohibition concerning hearing impairment will be experienced drivers who are hard of hearing. One possible comparison to consider in this context is the rlsk for the experienced, hard-of-hearing drivers and the risk for those drivers who most likely would replace them if they lost their jobs: inexperienced, young drivers.

Sensitivity analysis

Throughout this report we have stressed that our estimates may be uncertain because of the lack of necessary information or potential problems with the studies that the estimates were derived from. In this section, we explicitly consider these uncertainties in order to provide bounds to our estimates. Alternative assumptions may influence our measurement of the number of current CMV drivers with hearing impairment and the numbers of hearing-impaired and deaf drivers expected to he licensed.

Current number of CMV drivers with hearing impairment

We have estimated that there may be. 169.000 existing CMV drivers with heating impairment This figure was based on the report describing the experience of professional drivers in Finland (Backman 1983). Alternatively, one may rely on the data available from the 1989 National Health Interview Survey (Hotchkiss 1989). which found that 4.8% of the population aged 20 to 44 years and 12.8% of the population aged 45 to 64 years reported some form of hearing impairment. Applying these prevalence rates to the CMV licensed population in the manner shown before, the number of CMV drivers with hearing loss of at least 40 db HL would be about 120,000.

This figure is lower for two reasons. Fist, the data are based on self-reported hearing loss and could be biased, as respondents might have been unaware of an existing hearing impairment and reported incorrectly. Second, the rates are based on the population at large, and many persons who do not work in occupations that have a high risk for noise-induced hearing loss are included in the study.

Number of deaf drivers expected to be licensed

Previously, we estimated that about 250 deaf persons would be licensed to drive a CMV within the first 5 years of a rule change eliminating the current restriction. This estimate was based on the data provided by three states on the number of deaf drivers licensed for intrastate commerce. If the number of deaf drivers who would be licensed would be more similar to the number in Great Britain (one per 100,000 licensed drivers), then as few as 55 deaf drivers might be licensed to drive a CMV in interstate commerce, The number of additional accidents expected for these drivers would be. less than one.

It is also possible that the small amount of data available from the states could have led to an underestimate in the number of deaf drivers predicted Without any relevant data, though, it is difficult to characterize the degree to which these data may be underestimated. It also could be reasonable to expect there would be. an increase in the number of deaf persons applying for CMV licenses several years after the existing hearing standards were eliminated This might occur because of changes in social and discriminatory attitudes. as people adjust to them being more job opportunities for deaf persons, and as younger deaf persons are encouraged to take advantage of new-employment choices. However, we have no means of estimating the extent to which such attitudes discourage deaf persons from CMV driving or discriminate against them. Thus, we have no means of reliably estimating the number of deaf persons we might expect to be licensed several years after existing attitudes and pressures have changed.

Number of heating-imoaired persons expected to be licensed

As discussed earlier, there would likely be two major sources of hearing-impaired CMV drivers if the current restrictions were eliminate& deaf persons and experienced CMV drivers who develop hearing impairment. From our contact of 29 private trucking firms, we estimate that approximately 2.640 of the 5.5 million CMV drivers in the United States lose their licenses because of hearing prblems. Few of the companies, though, kept detailed records on the medical condition of their drivers, and variability may be expected in this estimate. Applying a rate based on one standard deviation around the mean number of drivers failing the biannual exam per company (0.89) fmds that the number of CMV drivers in the United States who may lose their license because of hearing impairment could have the following range (near 0 to 4,970 drivers). The small number of drivers failing the exam, though, cause this assumption based upon standard deviations to be unstable.

Conclusions

The data available provide a basis for several general conclusions concerning the risks . associated with licensing hearing-impaired CMV drivers. The literature does suggest a number of situations where hearing impairment may cause problems (e.g., not hearing emergency vehicles and mechanical failures, performing safety checks on vehicles), but more data are needed to describe how these situations affect the crash risk of hearing-impaired drivers. Information on the frequency with which drivers rely on hearing for safe driving practices is needed to understand fully the implications of licensing drivers with hearing loss, as is information on the appropriate level of hearing necessary for the operation of a commercial motor vehicle.

Whether hearing is required for the circumstances listed above. is debatable, as the noise environment in the truck cab may block sounds, and hearing is not the only manner in which drivers can gather relevant information. The noise environment in truck cabs may be sufficiently high to render even a normal hearing driver effectively deaf. Even if sounds can be heard above the background noise, hearing-impaired persons may be able to compensate for their impairment to the extent that their relative accident rate is the same as for normal-hearing persons. This compensation may be in the form of hearing aids, although the relative value of hearing aids in high-noise conditions is questionable. Compensation could also be behavioral, for example, through increased ability to notice vibrations caused by mechanical failure or increased emphasis on vision when attending to railway crossings. There are also several ways that hearing-impaired persons can compensate for decreased communication skills (e.g., by writing or lip-reading).

It appears that most drivers with significant hearing loss are continuing to operate. CMVs. We estimate that currently there are 169.000 CMV drivers with hearing loss exceeding 40 db HL on average at the speech frequencies. We predict that only about 2,640 drivers am screened out every 5 years for reasons related to hearing under the current FHWA standards. This is less than 1% of the drivers estimated to have hearing loss above 40 db. Because of the nature of age-related and noise-induced hearing loss, most of the affected drivers would have at least 10 years of driving experience.

Much uncertainty surrounds the crash risk estimates generated for hearing-impaired drivers. There are few data available to estimate the relative risk for crashes among hearing-impaired CMV drivers. There is no consensus from the available data on whether the relative riak is greater, similar, or smaller for hearing-impaired drivers. Despite this uncertainty, on the basis of the available data, our professional judgment is that the crash risk for a driver with hearing loss is between 0.7 and 2.0 times the crash rate for a normal-hearing driver We cannot rule out that the risk may be below 1. Also, the impression appears from the literature that the crash risk associated with hearing impairment cannot be terribly high, or the studies conducted, inadequate as they are. would have found a consistent result. Determination of the risk related to hearing impairment by the degree of hearing loss is not feasible at this time. Additional data would be helpful to fill in this and many other gaps which currently exist.

If the current- hearing standards were changed to allow waivers for existing inter- or intrastate drivers with hearing impairment, we estimate that the impact could be very small because the current regulations are not strictly enforced. We would expect that there would be only about 2,900 persons nationwide who might request a waiver, depending upon the circumstances of the program. This and other possible modifications to the present hearing standards are discussed in mom detail ‘in the next section.

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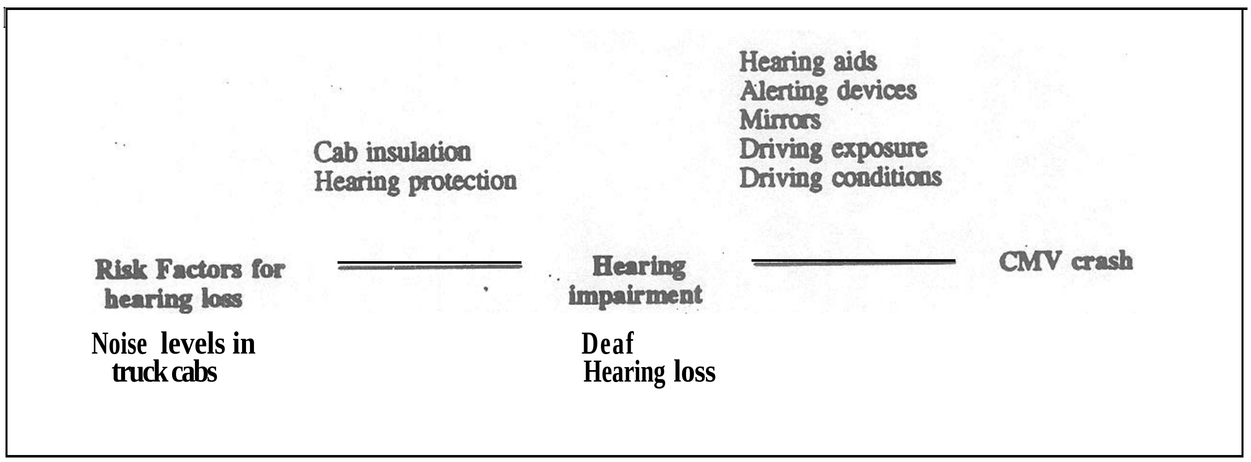
Mechanisms to Reduce the Risk Related to Hearing Impairment

An important area to consider in regulatory evaluation is the ability to minimize excess risk. The estimates presented earlier are based on the assumption that all otherwise qualified hearing-impaired applicants would be licensed. The exposure of these individuals to situations in which hearing would be important, though, may differ. There are no defmitive data, however, that reveal the frequency with which a person may encounter a relevant situation.

A number of approaches might be employed to minimize the risk for hearing-related crashes. They can be characterized as interventions that affect the risk of developing hearing loss. interventions that affect the driving patterns, and interventions that compensate for the loss of hearing. The following model depicts some possible interventions and their position relative to the issue. Intervening on noise levels in the truck cabs, for example, may decrease the number of persons who might develop hearing deficiencies. Interventions to decrease the exposure to driving situations involving hearing may decrease the risk for hearing-related crashes.

Figure 4-3. Interventions to Reduce the Crash Risk of Hearing-Impaired Drivers



Identification of the factors that lead to hearing loss and intervention on them to lower risk levels is one possible. approach for risk minimiition. The major risk factor for hearing loss in this scenario is the noise levels in truck cabs. Interventions could be implemented at the level of the driving environment to lower interior noise levels or at the level of the drivers to protect their hearing (through the use of hearing protection devices). Both types of intervention, though, could decrease. the audibility of sounds originating from outside the vehicle. Newer hearing protection devices decrease all signals linearly and, therefore, maintain the signal-to-noise ratio. Unless the signals are decreased below a person's threshold, the signals remain audible.

Additional restrictions on driving tasks could also be proposed. Such restrictions might focus on decreasing the exposure of drivers with hearing loss to situations in which hearing may be important They could include: (1) not allowing a hearing-impaired driver to operate a vehicle when it has to be backed into a loading dock or into a location where individuals are at risk or (2) not allowing a hearing-impaired driver to operate a CMV on a road with rail crossings that have only passive warning systems. The recommendations could also be more broad, requiring' that a person with unimpaired hearing be in the cab whenever the vehicle is being operated by a hearing-impaired driver.

Recommendations could also involve interventions that address the hearing impairment of the driver. For example, a requirement' that a device which transforms sound in a certain frequency range (such as a siren) into a visual signal be placed in the vehicle. Or a recommendation could include the use of enlarged turn signal indicators and mirrors. A reduction in crash risk could be attained with the use of these devices. However, the possible role of such structural aids in accident prevention is not known.

There are no data to determine the degree to which the interventions listed above may prevent accidents. Thus. it is not possible to say how effective these interventions might be in reducing any crash risk related to hearing impairment.

V. ASSESSMENT OF THE ADEQUACY OF THE PRESENT HEARING STANDARDS

Introduction

We discussed earlier in the literature review and the risk assessment that the role of hearing in the driving task of CMV operators has not been well defined. While the literature suggests that there are four circumstances in which hearing may have an influence in the driving task (detecting sounds during truck inspections, detecting sounds associated with mechanical malfunctions, detecting warning sounds from outside the truck cab, and audibility as part of communication), there are few data on me frequency with which drivers face situations such as these where hearing may be important for averting a crash. Thus, some uncertainty surrounds the determination of crash risks associated with hearing loss.

These underlying issues make it difficult to arrive at definitive recommendations on the adequacy of the present hearing standards [49 CFR 391.41 (b)(11)]. However, by making use of the hearing sciences literature available and other information obtained as part of this contract, we address the adequacy of the current hearing standards to the ability possible.

Does the Standard Address All of the Hearing Requirements of the Job Tasks for CMV Drivers?

It is difficult to consider if the current hearing standards address all of the hearing requirements for the CMV driving tasks because them am so few data available on the job tasks of a CMV operator as they relate to hearing. We know little about what the necessary hearing requirements are for safe operation of a CMV in the four areas listed above. For example, it is not possible, with the data available, even to state that a minimum level of hearing is necessary to detect the sounds of a mechanical problem on the truck. Little is known about how often a driver would encounter this situation, let alone whether a specific level of hearing would be necessary.

Other external factors may obscure the contribution of hearing to the job task of a CMV operator. The high level of noise within the tractor cab, for instance., may mask important warning and emergency sounds. Second, it is not clear that hearing is the only manner in which drivers would get relevant warning and emergency information. This information may also arrive to the driver through visual, vibratory, or olfactory input.

Identifying the level of hearing required in each scenario may be difficult, even in ideal conditions, because crashes are rare events, and many speculate that the four situations described above also occur infrequently. The frequency in which these two phenomenon would interact is, by nature, rather low. Therefore, trying to determine whether or not a standard addresses all of the hearing requirements of a job task may be virtually impossible.

Does the Standard Give Complete. and Adequate Criteria?

The current FHWA standard advises either of two screening procedures for evaluating CMV license applicants and existing drivers: forced-whisper screening or pure-tone screening.

Screening for auditory ability requires that a person be tested for hearing awareness at a specified level (at one frequency or a combination). The individual passes or fails the screening test by the ability either to respond or not respond at this level.

Hearing screening tests are most often used to identify persons with a potential medical problem or hearing impairment. This focus is slightly different from the use of auditory screening in the truck driving population. Here, the implicit aim of the screening tests most often is to identify whether or not individuals are suitable. for CMV driving. Under the current regulations as they am applied, failing the hearing screening has indicated a lack of suitability for the job requirements.

This assumes that hearing impairment has a distinct relationship with CMV driving performance, such that identifying someone as hearing-impaired at a specific level means the person would not be effective in executing the job tasks of CMV driving As we have discussed, though, there are few data available to say whether or not such a relationship actually exists. There are no data to describe how hearing loss above 40 db HL' (or any other specific level of impairment) relates to crash risk. We have only limited information about the experience that might pertain to deaf CMV drivers.

In these circumstances. it is not 'clear that a screening test is even appropriate. Conducting a hearing screening would be an adequate procedure if criteria could be selected (and tested) that differentiate those who can perform a. particular job task from those who **cannot** However, one can argue that no such criteria currently exist. We know nothing about the crash risks of existing drivers with heating impairments due to age or noise, and the risks determined for deaf intrastate CMV operators in Oregon are based upon the driving records of only four drivers.

Establishing hearing criteria also requires some knowledge of the acoustical properties of the sounds judged to be essential for the job task. Because of the numerous variables associated with the listening environment of the CMV operator (noise in the tractor cab, whether the windows are open or closed, whether the radio is on or off, and the distance of the truck from the sound source, etc.), though,. it is extremely difficult to establish what hearing screening criteria would ensure audibility of these signals, without being over-restrictive with regard to hearing ability or specific driving conditions.

If a certain level of hearing is judged to be a requirement for the safe operation of trucks and screening procedure is appropriate, then we must consider if the current screening tests are adequate and complete. The current regulation specifies two choices of hearing screening methods: the forced-whisper test and the audiometric pure tone screening procedure.

As described in Task A, the forced-whisper test may not be. methodologically adequate in identifying persons with hearing impairment in the CMV setting. The major limitation of the forced-whisper test is that it lacks standardization between examiners and the environment in which it is conducted; There is no assurance that each examiner will conduct the forced-whisper

[1] The FHWA defines the requirement when using an audiometer as not having an average hearing loss in the better ear greater than 40 db HL at 500, 1,000 and 2,000 Hz.

test in the same manner. The background noise levels in an examining room could also affect the audibility of a whispered voice.

The pure-tone screening procedure, on the other hand, is widely accepted as the gold standard when testing for hearing impairment. It is conducted in a standardized manner and done in a controlled environment. The American Speech-Language Hearing Association provides standards for both the calibration of ‘audiometers and the method of testing. These standards ensure consistency among results at various testing sites. In this respect, pure-tone screening may be regarded as methodologically adequate.

The present FHWA guidelines for the pure-tone procedure may not be complete with respect to CMV operators because they do not recommend the measurernent of hearing levels at the higher frequencies. The first Indication of NIHL is usually a loss of hearing in the higher frequencies, in the range of 3,000 to 6,000 I-Ix, with a peak loss around 4,000 Hz. Also, it could be possible that some of the sounds deemed essential for driving could have their acoustical impact in this higher-frequency range. There are no data, though, to evaluate the importance of testing in the higher frequencies.

The current regulations are also misleading, and incomplete, when they imply that the individual can pass the pure-tone screening with or without a hearing aid. It is impossible to conduct the described test with a hearing aid. The pure-tone test must be administered with earphones, and one cannot successfully uae hearing aids with earphones pressing against them (there will be resulting feedback and squealing of the heating aids).

Last, one can argue that the current screening procedures are not adequate because they do not identify and eliminate from eligibility many existing hearing-impaired drivers. By surveying the private trucking industry, we found that approximately 99% of existing drivers with meaningful hearing impairment are able to maintain their CMV licenses. This may reflect the improper administration of screening tests, the abiity to pass the forced-whisper test with a hearing aid, or the low level of enforcement placed on the current standards. We are not able to determine which of these reasons may be the most probable cause. While a person may be able to pass the forced-whisper teat with a hearing aid, the use of a heating aid in the tractor cab is questionable because of the noise levels. With the current development of new heating aid circuitry, hearing aid weaners may become more comfortable in noisy environments.

Are Minimum Diagnostic Tests Specified and Adequate?

While minimum diagnostic tests are specified in the current regulations regarding hearing, we come back to the discussion presented earlier about whether or not they ate appropriate or adequate. At this time, testing for a minimum level of hearing ability across frequencies cannot be rigorously supported.

Are There Specific Hearing Problems Which Warrant Disqualification?

Hearing loss may accompany other medical problems and may actually be a symptom of these problems, rather than a discrete disorder. Vertigo, for example, is generally caused by' inner-ear problems and is often accompanied by fluctuating hearing loss. Uncontrolled vertigo can produce a driving hazard. Disqualification from driving should be considered until the vertigo is brought under control by medication or until the individual has been free of seizures for an extended period of time. Specific hearing problems such as this are considered in the present Federal standards. We are unable' to comment on the driving risks related to these conditions.

Do the Present Standards Reflect the Current State of Knowledge in the Hearing Sciences?

Three issues of general awareness in the hearing sciences are relevant to public safety concerns of the motor carrier industry: the method of testing for hearing impairment, hearing conservation programs, and assistive devices for the hearing impaired. We talked earlier about the view of the hearing sciences with respect to the appropriate method of testing for hearing impairment. Discussion of the other two items follows below. Neither is addressed in the current hearing standards. Nor are them any data describing their effectiveness -for adequate performance in the CMV job tasks.

Hearing conservation

The current state of knowledge regarding the permanent influence of excessive noise on hearing sensitivity would suggest that average noise levels in truck cabs are potentially harmful. A hearing conservation program is essential to any industry where workers. are exposed to potentially harmful levels of sound. When implemented properly, a hearing conservation. program can help preserve the hearing ability of workers. Hearing conservation, though, is not sufficiently addressed in the present Federal standards.

A hearing conservation program includes measurement of the baseline hearing thresholds in the employee (as differentiated from hearing screening),. routine retesting to monitor any change in hearing thresholds, modification of the environment to reduce the level of sound, and hearing protection devices:

Hearing protection devices are earplugs and/or earmuffs that reduce the intensity of the sound entering the ear. Modification of the environment with reference to trucks might mean the increased use of soundproofing insulation in tractor cabs. Both hearing protection devices and environmental modifications of this type, though, may also reduce an individual's ability to hear two categories of sound that have been identified as potentially important to driving (emergency sounds and sounds associated with a breakdown). Preserved hearing ability, on the other hand, would assist the truck driver in'two of the categories of sounds that have been identified as potentially important to driving (hearing sounds during truck inspection and hearing in order to communicate after an accident).

Assistive devices

The hearing aid is the most prevalent device used for the correction of hearing impairment. Hearing aids are personal devices fitted to the ear and electronically tuned to amplify specific ranges of frequency depending on the person's hearing loss. The purpose of a hearing aid is to amplify sounds that would not normally be audible to the hearing-impaired individual.

A person's ability to use a hearing aid to enhance communication is dependent on the type of hearing loss, time of onset, degree of loss, age, and individual coping strategies. In practice, most users do not wear their hearing aids in excessively noisy environments, because the noise blares too loudly. It is unlikely that a truck driver would choose to amplify sounds in the noisy environment of the cab. If the truck driver wears a hearing aid, he or she would most likely use it in communication or vehicle inspection situations.

A variety of other devices alert an individual to specific auditory signals (e.g., a flashing light). Such modification would be appropriate if one assumes that alerting one to the sound is important and that the method of alerting (auditory or visual) is not important The alerting device provides a visible warning when it detects noises over a specified sensitivity level. The sensitivity level can be adjusted by the user., If the setting is too sensitive, the alerting signal will go off continually because. of road noises. If the setting is not sensitive enough, though, the alerting device may'not trigger until the emergency vehicle is so close that the driver does not have enough time to react to the situation. The alerting device in this scenario would be ineffective as a warning mechanism.

Summary

With the information accessible, it is our professional judgment that the present hearing standards [49 CFR 391.41 (b)91 1)] are not adequate. The hearing requirements necessary for safe job performance in the motor carrier industry are not clear. Nor is the relationship between hearing impairment and job performance Perhaps the most striking finding regarding the adequacy of me heating standards was the observation that most existing CMV drivers with hearing impairment are not screened out at the biannual medical exam. The current state of knowledge in the hearing sciences indicates that the forced-whisper test is an inadequate method for testing for hearing impairment. This diipline also recommends the use. of hearing conservation programs in noisy environments, as issue which is not presently addressed in the Federal regulations.

VI. PRELIMINARY RECOMMENDATIONS

The current Federal standard regarding hearing in CMV operation (49 CFR 391.41 (11)) states that a person must meet hearing requirements by perceiving a forced whisper at 5 feet in' the better ear, with or without a hearing aid or by meeting specified requirements as measured by a testing device, with or without a hearing aid. The FHWA defines the requirements when using a testing device (audiometer) as not having an average hearing loss in the better ear greater **than 40** db HL at 500, 1,000; and 2,000 Hz.

Determining the relative value of this regulation is the basis for this contract Can persons with hearing impairment operate commercial motor vehicles in a safe manner? Is a specific level of hearing necessary for driving? Are the present hearing standards inadequate? These are just a few of the questions that have been addressed in previous sections. What remains to be discussed are the future actions that may be advised for CMV drivers with hearing impairment. Using the material available from Tasks A, B, and C, we make recommendations for regulating hearing-impaired CMV drivers.

The first major issue for exchange is to determine whether hearing is necessary for CMV driving. From the information available, it is not clear if hearing is or is not necessary for the safe operation of commercial motor vehicles. Evidence from a study on the impact of a nighttime ban on train whistle sounding suggests that hearing plays a role in averting crashes. The noise levels present in truck cabs, though, may mask the emergency and warning sounds that originate from outside the vehicle.

The precise role of hearing in the CMV job tasks remains unknown. Reports in the literature indicate that hearing could be involved in: detecting sounds during vehicle inspections, detecting mechanical problems in the vehicle while driving, detecting emergency and warning sounds from outside the vehicle during operation, and as a factor in effective communication. However, the frequency with which these. situations arise. and the crash risk related to them are not completely known. For this reason, we present a series of recommendations, each prefaced with an assumption that some level of hearing is either necessary or unnecessary for CMV operation.

1: If hearing is judged to be unnecessary for safe CMV operation, then one recommendation may be that there should be no 'Federal hearing standards and no screening for hearing impairment

If hearing is considered to play'little or no part in the safe operation of a commercial motor vehicle, then one may question whether any hearing standards should be maintained. There are some indications in the literature that hearing may be insignificant for driving performance. The noise environment in which drivers function may prevent all persons from hearing emergency and warning sounds. Siiilarly, the increasing use of soundproofing materials in tractor cabs to lower noise levels also decreases the ability to recognize sounds originating from outside the cab for all drivers. Both factors were cited by the Canadian Medical Advisory Board as reasons for recommending no Federal standard for hearing-impaired drivers in Canada.