the deaf population. Individuals from driver improvement programs are also probably not representative of the hearing-impaired population. Persons enrolled in such programs may be either extremely motivated to improve their driving (Finesilver 1962b) or are in the program because of driving errors.

The most accurate approach to gathering a sample of the deaf population has been in the methods described by Schein (1968). He sought to ascertain the entire deaf population in a geographic area by surveying a number of organizations, agencies, schools, informants, and households. This method identified approximately 75% of the resident deaf population. Such an approach, however, requires extensive resources. Strategies for locating and contacting the deaf will differ from those for the general population to the extent that oral communication cannot necessarily be carried out.

Most of the study designs presented below also have failed to adjust for mileage driven in their accident statistics. The accident figures reported, then, may not be entirely accurate. By itself, mileage driven is a significant factor in accident risk. Persons driving more often have mom chances for an accident to occur than a person driving less frequently. Additionally, the annual number of miles driven may differ between the deaf and non-deaf. A survey in California found that the average mileage driven per year was higher for a deaf cohort than for a hearing cohort (Coppin 1964). There also are reported instances where deaf individuals drove to see and visit people because of their inabiity to communicate by telephone before the development of text telephones (known as TTY, TDD, or TT) (Roydhouse 1967. Schein 1968).

1. Accidents Among Hearing-Impaired Drivers

The literature has a number of case reports of deaf truck drivers who have driven safely for many years. For example, two deaf drivers in Massachusetts, each with 33 years of driving experience in trucks, were reported to have had no accidents (Woods 1978). Another driver was noted to have had no accidents in 9 years of driving a truck under 10,000 lbs. (Woods 1977). While a fourth was reported as having 30 years of driving experience with no major injury-producing accidents (Petersen 1978). Case reports, though, disclose very little about the extent to which accidents would be likely to occur in a population of drivers.

Further observational studies have examined large groups of individuals who have had accidents to see if diminished hearing ability may have been connected with any of the events. In a 1955 review, McFarland wrote that no meaningful differences in hearing acuity had been found up to that time between matched groups of accident-free and accident-repeater drivers (McFarland 1955) Finesilver (1962b) writes of a case study that suggests that impaired hearing is a very small factor in automobile accidents. “Out of 127.162 drivers involved in an accident in Virginia in 1959. only 111 were reported to have defective hearing." Similarly, when the physical condition of the drivers involved in accidents in 1959 in the United States was revrewed, only 0.05% of all the drivers involved in an accident had defective hearing (Norman 1962). Another examination of a series of patients admitted to hospitals due to an accident found that the loss of hearing did not have a large effect on accidents among drivers (Grattan 1968). While all of these observations suggest that the frequency of accidents related to hearing loss is likely to be very small in the overall scheme, they reveal very little about the risk for hearing-impaired drivers in comparison with normal-hearing drivers.

Eight studies have examined the accident rate of hearing-impaired drivers in comparison with a control group. Studies evaluating the traffic accident patterns of a group of hearing-impaired drivers and a control group of drivers with normal hearing (Table 2-5 on p. 44) have observed increased (Coppin 1964, Cook 1974), decreased (Wagner 1962, Finesilver 1962b, Ysander 1966, Roydhouse 1967, Schein 1968). and similar (Wolf, unpublished observations) occurrences of collisions among drivers with hearing loss. Almost all of the reports, though, are hampered by poor-study designs. The majority failed to adjust their results by the influence of age, sex, mileage driven, and area of residence. 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, mileage driven, and area of residence. The accident ram for deaf men was 80% higher than that for non-deaf men. No difference was seen between the women in the two groups.

There were limitations in this study, though, that could have influenced the results. For example, the matched study was based on deaf participants who returned a survey on their driving experience and on control participants who agreed to a personal interview. Response rates were markedly lower for the deaf sample.. The deaf drivers surveyed also may not have been representative of the deaf population because they were selected from an organization for the deaf. Scheln (1968) found that only 50% of tbe deaf population belonged to a deaf organization. If the sample examined was different from the deaf population in general, some bias may have been introduced to the study. By all present indications, though, both shortcomings suggest that the accident experience of the deaf population may have been underestimated.

This study raises some important questions about the role of hearing in driving. For example, if deafness were related to driving performance, one would think that it would not be sex-specific. To quote Coppin and Peck, "Wby should deafness affect the driving performance of males but not females?" Coppin and Peck hypothesize that males may drive in more situations where hearing is important than do females, such as during rush hour and in heavy traffic. No data, though, were collected on the type of roads travelled, or the congestion levels present. 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. This study found only that hearing loss was associated with automobile accidents, not that hearing loss was the cause of accidents in deaf men. Prospective studies to evaluate whether the lack of hearing is causally related to automobile accidents have not been conducted, but are critically needed. Last, it is important to point out that these data recorded the. experience of deaf drivers. The results cannot be generalized to persons with lesser degrees of hearing impairment

Some data on the role of hearing loss in accidents among CMV drivers is available for investigation. Henderson and Burg (1973) tested the hearing levels of 236 CMV drivers employed in private interstate commerce and examined the accident records available from their respective companies. Surprlsmgly, they found few significant correlations between hearing loss and CMV driving., Those of signifcance, however, indicated that greater hearing loss was associated with fewer accidents. The level of hearing impairment present in the CMV drivers, though, was not very severe. All fulfilled tbe Federal hearing standards published in 49 CFR 391.41.

This study suggests that hearing may not be important to driving performance above the hearing standards in effect. When considered together with the study by Coppin and Peck, it appears that if heating does play a detrimental role in driving safety, it may occur only among the deaf and extremely hard-of-hearing. However, it could be premature to make such a statement concerning the relationship of hearing to safety on the basis on two studies; one in automobiles and one in CMVs. More research is needed to confirm or refute this implication.

A second set of data concerning commercial motor vehicle drivers came from our survey of the 50 states regarding their licensing practices for intrastate CMV operation. Two states out of the 48 that provided responses bad data on the accident histories of their licensed drivers with hearing impairment. Four hearing-impaired drivers have been licensed in Oregon. From 1985 to 1990, an accident rate of 0.67 accidents/million miles driven was recorded for these four drivers. One hearing-impaired driver has been licensed in Arizina. In the last 10 years, this person has had no accidents.

Summary

The studies completed to date are inconclusive regarding the role of hearing loss in either automobile or CMV accidents. The information available from studies of deaf automobile drivers is generally flawed because independent factors, including mileage driven, age, and area of residence, have not been considered in the analyses. The one study that controlled for mileage driven found that deaf men had significantly more accidents than non-deaf men. No difference in accidents was observed between deaf and non-deaf women. The data from this study, though, are now 30 years old. Motor vehicles. driving habits and drivers' training for deaf individuals have all changed markedly over this period. What was an important factor 30 years ago regarding the role of hearing loss in accidents may not be today.

It remains difficult to extrapolate. findings from automobile drivers to CMV drivers. A real difference exists between driving an automobile and operating a CMV 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. The available data concerning CMV drivers, though, suggest that hearing may play a minimal role in the safe operation of large trucks. Them still remains a great deal to learn about the safety issues related to deafness, hearing impairment, and CMV operation.

The issue of compensation for hearing loss in the hearing-impaired and deaf population is not well documented There is a general belief that other senses such as vision and touch may greatly compensate for an individual's inability to hear. The effects of degree of loss, time of onset, etc. are not well understood at this time.

An in-depth description of the hearing and driving literature follows.

Cook (1974)

This study followed the driving experience of 233 hearing-impaired graduates of Wisconsin schools. Information on how these individuals were identified for study and how

hearing impairment w s defined was not available. One hundred sixty-two of the graduates had driver's licenses, but accident and violation records from the Wisconsin Department of Motor Vehicles were available for only 50% (n=81) of these drivers. The inability to match the school and department records by name and biidate eliminated the other 81 drivers. It is not clear how this low ascertainment rate might affect the results of the study, but a larger sample would have provided more statistical power to the analysis. Records for 99 persons with normal hearing (defined as having no requirement on their license for the use of a hearing aid) were selected randomly from the department files for comparative purposes. These individuals were similar in age to the school graduates. Overall, the hearing-impaired cohort had nearly twice as many department-recorded accidents as the control sample and were more. likely to be. cited for a violation. The period of time over which the accidents and violations occurred, however, was not presented. Nor was there any adjustment for the independent effects of sex, mileage driven, and area of residence.

Coppin and Peck (1964)

Coppin and Peck examined whether or not the driving performance of the deaf driver was different from that of the non-deaf driver in two reports. The deaf cohort in this study was identified from the files of the California Organization for the Deaf. About 50% (n=685) returned a survey on their driving exposure and type of driving. Deafness was defined as "when the sense of hearing was either totally absent or nonfunctional for the ordinary purposes of living." Controls were identified from individuals renewing their licenses and interviewed regarding their driving exposure. No information was presented on participation rate, and no data were collected concerning the type of driving normally done. Accidents for both the cases and controls were determined from the department records of the California Department of Transportation.

Deaf men (n=170) had significantly more accidents than non-deaf men (n=313), after matching for age, mileage, occupation, and living area. However, no difference was seen between these groups regarding moving violation conviction points. Nor was there any differnce noted between deaf (n=140) and non-deaf women (n=140) for accidents and conviction points. Women were evaluated from a slightly different methodological point of view from the men. Only men in Los Angeles and San Francisco were examined, but deaf women from the entire State were compared to non-deaf women from Los Angeles and San Francisco. This did not affect the results significantly. When deaf women from Los Angeles and San Francisco were compared to the non-deaf women from those areas, there still was no significant difference in accident experience, though deaf women had fewer accidents than non-deaf women (0.131 accidents/person vs. 0.157 accidents/person).

Finesilver (1962b)

This report evaluated the driving records of 100 deaf drivers against two groups of 100 hearing drivers in Colorado. The deaf cohort was identified from a list of 128 hearing-impaired participants in a driver improvement program Deaf drivers and those. with minimal hearing were included in the cohort. Those wearing hearing aids were not included. Both control groups were selected at random from the records of the Colorado Department of Motor Vehicles. "The records 'of the deaf drivers were reviewed prior to their attendance at the driver improvement school." The deaf cohort had markedly fewer moving violations than both control group A (54% fewer) and control group B (113 % fewer), as well as significantly fewer accidents (control group

A, 18% fewer; control group B, 31% fewer). The deaf cohort, however, was significantly older than the control froups and had more years of driving experience. Their better driving records, then, could be due to the general finding that older and experienced drivers are safer drivers. Also, no control for driving exposure and sex was included in the study, and it is not clear if the period of record evaluation was similar for the cases and controls.

Henderson and Burp (1973)

Henderson and Burg examined the relationship of hearing loss to CMV accidents among 236 drivers employed by five private trucking and busing companies. Drivers' participation was voluntary and on their own time. Subsequently, a low participation rate was observed. The authors also did not have sufficient data to evaluate if the sample was representative of the driving population. There were no major differences between the truck and bus drivers. The average number of years driving a commercial vehicle was 13.3, years and the average age of the cohort was 40.9 years.

An audiometric test for hearing loss was administered to all participants over a range of frequencies from 250 to 8,000 Hz. Greater hearing loss was evident among the truck drivers. This may have been related to the noisier enviromnents in which they operate, or it could have been a timction of the slightly higher age for the truck drivers. The average hearing loss in the better ear among truck drivers was 10.1 db HL in the frequencies 500-2,000 Hz and 18.1 db HL in the frequencies 500 to 8,000. No driver tested had a hearing loss that exceeded the Federal standards. These audiometric results were compared with the accident records available from the companies during the previous 3 years. Few significant correlations between hearing loss and CMV driving were found. Those of significance, however, indicated that greater hearing loss was associated with fewer accidents. This might suggest that driving experience is more strongly related to accident risk than is bearing loss, as older drivers also had higher degrees of hearing loss.

Schein (1968)

Schein evaluated the driving records of deaf residents in Washington, DC, as one part of a survey into how deafness, per se, affected the lives and lifestyles of the deaf. This study was unique in that it actively sought to identify the entire deaf population in metropolitan. Washington.. A wide variety of sources (deaf organizations, schools for the deaf, deaf informants, churches, vocational rehabilitation departments, and agencies for the deaf) were queried in an attempt to obtain 100% [illegible] of this population. Fifty percent appeared on organization lists,, and 35% appeared on rosters from the schools for the deaf. Approximately 1,132 deaf individuals were identified as residents of metropolitan Washington (Washington, DC, suburban Virginia, and Maryland). This figure likely represents at least 75% of the population. The degree of hearing impairment present in each individual was assessed by the Gallaudet Hearing Scale.

The accident and violation records of both deaf and non-deaf persons listed in the Department of Motor Vehicles of the District of Columbia files were evaluated and compared. Corresponding records for residents of Virginia and Maryland were not examined. Overall, the deaf in Washington, DC, had fewer accidents and fewer violations than the non-deaf. The deaf population, though, differed substantially from the control population by race, age, and SES. Deaf drivers were older, were more likely to be white; and had a higher soci-economic level than the hearing drivers. No adjustment was made for the mileage driven by the cases and

controls. All four independent factors may have seriously biased the a. .dent experience of the deaf cohort.

Roydhouse (1967)

Roydhouse surveyed 2,000 members of the New Zealand League for the Hard of Hearing and other deaf clubs on their driving experience. Only 200 people (10%) responded. Such a poor response rate fatally binders the study. It is likely that only those with good accident histories returned surveys. The level of hearing impairment among the participants was self-reported and ranged from individuals who had difficulty hearing at lectures or in church to individuals who could not hear speech with a hearing aid. The accidents recorded in this study were also self-reported. Twenty-eight hearing impaired drivers reported 34 accidents over 5 years. The authors claim that this number of accidents is 50% fewer than the experience for all drivers in New Zealand, although a control series was not evaluated in this study. Self-reported violations were also substantially lower for the hearing-impaired drivers. Accidents did not vary significantly by level of hearing impairment.

Wagner (1962)

Wagner quotes the report, "Deaf-Mutes Are Safest Motorists on Pennsylvania's Highway System," in the Bulletin of the American Association of Motor Vehicle Administrators, September 1940, pp. 15-16. This account detailed the accident experience of 600 deaf drivers known to the licensing authorities in Pennsylvania Only one minor accident among deaf drivers was observed over a 2-year period. The accident rate among these drivers (1.7 per 1,000 drivers) was substantially lower than that among normal drivers in Pennsylvania (39 per 1.000 drivers). Both figures were not adjusted for the independent influences of mileage driven, age, sex, and area of residence.

Wolf

Wolf reported unpublished and preliminary observations. The risk for motor vehicle injuries was examined in a case-control study of licensed elderly persons who belonged to a health maintenance organization. Cases were licensed drivers, 65 years of age and older, who were residents of the Puget Sound Counties in Washington and were in a crash (as a driver) that required medical attention for injury (n=235). The controls also were licensed elderly drivers from the same area who belonged to the HMO and did not have an accident that resulted in an injury to themselves (n=448). Data on the medical conditions present in both cases and controls were obtained from the medical records of the HMO. Differences between the cases and controls in cognitive and sensory-impaired conditions were evaluated. There was no significant difference between the cases and controls with respect to hearing loss. Hearing impairment was defined by speech reception threshold testing. This study provided no direct proof that the medical conditions examined were causal agents in the accidents reported, just the implication that they were characteristics associated with the accidents reported. More detailed multivariate analysis is underway on this cohort.

Ysander (1966)

Investigated the accident and violation history of 612 drivers with chronic disease. Fifty eight drivers were either deaf or hearing impaired. All were identified either at the time of license application by medical review or through police reports from the licensing bureau of the

Goteberg area and were granted licenses on special conditions. Accidents were defined as all events resulting in damage and repotted to the police. Overall, about five percent of the fearing-impaired cohort was involved in an accident over an average of 4.5 years of follow-up. The exact percentage involvedwas not reported, but 5.3 percent of the drivers with diseases of the sense organs (eyes and ears: n=75) had reportable accidents compared to 7.7 percent in the control series (n=581). Drivers with hearing impairment made up 77% of the cohort with diseases of the sense organs. The control series was matched on age, sex, driving experience and driving exposure (urban/rural, night/day).

Table 2-5. Studies Evaluating Accident and Violation History Among Hearing-Impaired Drivers and a Comparison Group

Study	Time	Type of Impairment	Accidents		Violations		Units	Comments
			HI[1]	Ctl	HI	Ctl		
Wagner, 1962	2 yrs	Deaf-mute	0.17 %	3.90 %	-	-	%	-Identified from licensing agency -Police reported accidents -Not adjusted for driving exposure
Finesilver, 1962b	5+ yrs	Deaf	31	55[2]	79	163[2]	per 100 drivers	-Identified from driver improvement program -Police reported accidents -Not adjusted for age, sex, or driving exposure
Coppin & Peck 1964	3 yrs	Deaf men	46.5	25.6	124[3]	121	per 100 drivers	-Identified from State hearing organization -Controls identified from license renewals -Adjusted for age, driving exposure, residence -Police reported accidents/incidents
	3 yrs	Deaf women	14.3	15.7	51[3]	57	per 100 drivers	
Ysander, 1966	4.7 yrs	Deaf & Impaired	5.3 %	7.7 %	1.4 %	7.6 %	%	-Diseases of the sense organs only -Identified from licensing records -Police reported accidents -Not adjusted for driving exposure
Roydhouse, 1967	5 yrs	Deaf & Impaired	15.5	@31.0	7.3	63.6	per 100 drivers	-Identified from hearing organizations -Low response rate & self-reported accidents -Control groups for accidents not specified -Not adjusted for driving exposure
Schein, 1968	3 yrs	Deaf	0.53	1.7	3.1	6.6	per 100 drivers	-Drivers identified from the deaf population -VA and MD drivers are not included -Police reported accidents -Not adjusted for driving exposure or age
Cook, 1974	?	Impaired	68	37	69 %	48 %	per 100 drivers	-Hearing-impaired graduates of regular schools -No definition of hearing impairment available -Police reported accidents -Not adjusted for driving exposure, sex, residence
Wolf, 1991	2 yrs	?	18 %	15 %	-	-	%	-Evaluated elderly drivers from an HMO[4] -Not adjusted for driving exposure and conditions -Injury producing accidents

[1] HI = hearing-impaired. [2] Average of two samples. [3] Conviction points. [4] HMO = Health Maintenance Organization.

C. Screening Auditory Capabilities

There. are several methods to test the hearing sensitivity of an individual. It is possible, for example, to examine hearing levels with an audiometer, tuning fork, or a free field voice test. Audiometric testing is the accepted standard for measuring hearing levels, but other procedures are often used by medical personnel to identify persons with hearing impairments or hearing disorders.

Testing for hearing perception may take the following forms; testing to determine if a person can hear at a specified hearing level (screening), or testing for a threshold of hearing sensitivity. Screening involves testing for the ability to detect a specified level of sound at various frequencies. An individual either responds or does not respond to the signal. Thus, they pass or fail depending upon their ability to "hear" at this one level. Screening is not an adequate procedure for measuring systematic changes in hearing over time.

A tbreshold procedure, on the other hand, tests hearing capability over a range of sound levels. An individualis tested until the softest sound they are able to hear (50% of the time) at each frequency if identified. While a threshold test provides detailed data on hearing sensitivity that can accurately distinguish changes in hearing over all time (if tested more than once), it is much more time consuming than a screening procedure.

The American Speech-Language Hearing Association (ASHA 1989) has drafted national, screening guidelines for identifying hearing impairments or handicaps in adult and elderly persons. The focus of the proposed screening procedure is to identify persons with potential problems. The aim of the screening procedure. in the truck driving population, though, is to identify persons who fail to meet a defmed job standard. For this purpose; one must be sure that the test (hearing screening) is directly or indirectly testing an ability that is essential. to job function. If criteria can be selected that differentiate those who can perform a task from those who cannot, then screening is an adequate testing procedure.

Types of screening for CMV drivers identified in the literature

The Federal Highway Administration recommends one of two screening procedures for evaluating potential truck drivers. The regulations (49 CFR 391.11) state that the person must meet hearing requirements by perceiving a forced whisper at 5 feet with the better ear, with or without a hearing aid, or meet specified requirements as measured by a testing device, with or without a hearing aid. The FHWA defmes the requirements when using a testing &vice (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. A driver who uses a hearing aid must have it in operation while driving and must carry a spare power source. Thls applies to both new applicants and existing drivers. Existing drivers must pass a physical examination at least every 24 months.

These standards, though, are slightly misleading in stating that a person can pass the pure-tone screening with or without a hearing aid. It is impossible to administer the described test with a hearing aid. The described pure-tone test must be administered under earphones and one cannot successfully use hearing aids with earphones pressing against them (there will be resulting

feedback and squealing of the hearing aids). The screening procedures also consistently indicate that "adequate" hearing is required in only one ear. While an individual may need only one ear to detect a warning signal, it has been empirically demonstrated that two ears are required for adequate sound localization and binaural hearing greatly enhances an individual's ability to understand speech in a noisy environment.

The forced-whisper test

Prior to the availability of audiometers, voice testing was the standard method for measuring hearing ability (Swan 1985). The forced-whisper test is one form of voice testing. In this procedure, a mixture of words, numbers, or letters are spoken by an examiner to a patient in a whispered voice (after the full expiration of air). The examiner evaluates one ear at a time by masking the hearing in the non-test ear" (Swan 1985) and commonly stands to the side or behind a patient while testing to eliminate visual cues. The patient is expected to repeat the words or numbers that are spoken. The percentage of correct responses necessary to pass the test (50% to 100%) varies with tester (Swan and Browning, 1986).

The suitability of the forced-whisper test as a screening instrument for hearing impairment has been questioned because of the possibility that examiner bias may influence the results. For example, the percentage of correct responses necessary to pass the test may differ by examiner, ambient noise and acoustical properties may differ between testing rooms (King 1953). and the distance between the examiner and the patient's ear can be variable. The intensity and frequency of the forced-whisper also can differ between examiners. Wilber (1991) measured "whispers" ranging in sound intensity from 20 to 65 db sound pressure level (SPL) among the examiners tested. King also noted a discrepancy in the opinion as to what constitutes a forced whisper. He reported as much as a 1 to 6 pressure ratio between the quietest and loudest whispered word by an examiner (44 to 60 db). MacPhee.. Crowther, and .McAlpine (1988) reiterated these disadvantages, but acknowledged that the forced-whisper test is still used by many physicians.

The pure-tone screening test

With the availability of audiometers, pure-tone screening has become the standard method for measuring hearing abiity (Swan 1985). The ASHA (1989) recommends a pure-tone stimuli screening, as well as a case history and visual inspection of the outer ear, to identify persons with a hearing impairment. It is also recommended that all audiometric screening programs should be designed, supervised, and/or conducted by a certified audiologist. After appropriate training from an audiologist, support personal can administer screenings. If hearing screenings are to be part of a medical examination, an audiologist can set-up the screening protocol and tram an individual in a physician's office to carry out the test. Screening at discrete frequencies can be a fast procedure when administered by a trained individual to a cooperative patient. A case history, visual inspection, and pure-tone screening under such circumstances can be completed in about ten minutes.

As specific hearing levels and frequencies will vary according to the population being tested, the ASHA guidelines present the following screening recommendations for the general population.

Adults 18-64 years: 25 db HL at 1,000, 2,000, 4,000 Hz (ANSI 1969). The lack of a response to the recommended screening levels at any one frequency shall constitute failure by an individual. A failure in this case indicates that the person tested should be referred for a full diagnostic examination.

Adults 65+ years: 40 db HL and 25 db HL at 1,000 and 2,000 Hz (4,000 Hz is optional). The lack of a response to the 40 db HL pure-tone at any one frequency in either ear shall constitute failure by an individual. Those who pass the 40 db HL screen should be rescreened at 25 db HL.

The audiometers used in hearing screening must meet the ANSI S3.6-1969 requirements and should be calibrated on a regular schedule (ASHA 1985). A daily listening check should be performed by the tester to ensure adequate functioning of the equipment.

Comparing forced-whisper tests with mire-tone screening results

How do the two screening tests relate to each other? Two studies provide evidence to suggest that the forced-whisper test can identify individuals with hearing loss if it is properly administered. A study by Swan and Browning (1986) of 101 middle-aged patients found that every person with an average pure tone threshold worse than 20 db HL at 500, 1,000, and 2,000 Hz failed to hear a whispered voice two feet away from the test ear. The sensitivity of the forced-whisper test in this study was 100% and the specificity was 87%. In layman's terms, this means that every person with hearing impairment (identified and defmed by pure-tone test standards) was recognized as hearing impaired by the forced-whisper test. Eighty-seven percent of the persons with normal hearing (identified and defined by the pure-tone test) were recognized as being without impairment by the forced-whisper test.

MacPhee and colleagues (1988) looked at the relationship between fourlevels of voice tests and pure-tone audiometry. To pass the voice tests, it was necessary to repeat a set of three random numbers presented at each level of loudness (conversational voice at 6 inches and 2 feet from the ear and a whispered voice at 6 inches and 2 feet from the ear). To pass the pure-tone screening test, an individual had to exhibit hearing levels better than 30 db (on average) at 500, 1,000, and 2,000 Hz.. In the voice tests, the examiner stood behind the patient while occluding one of the patient's ears (monaural testing).

Both voice and pure-tone screening tests were administered to 62 elderly patients (124 ears were tested). Results indicated that the failure to hear a whispered voice at 2 feet correlated very strongly with hearing impairment, as defined by the pun-tone screening test. Eighty-one of the 88 ears tested that failed the forced-whisper test at 2 feet also failed the pure-tone screening evaluation. No one was falsely identified as not having a hearing impairment by the forced-whisper test at two feet.

The meaning of the results reported by Swan (1985) and MacPhee (l988) for the truck driving population is not clear. The testing criteria used in both reports differs significantly from that recommended for CMV drivers. For example, pure-tone screening was evaluated at 30 db HL in the studies, while a 40 db HL is recommended for screening truck drivers. Forced-whisper tests were conducted at two feet from the patient's ear, while five feet is the recommended

distance listed by the FHWA. Monaural forced-whisper testing was conducted by MacPhee and colleagues, while binaural testing is possible in the driver screening tests. It is also important to note that the studies reported by Swan and MacPhee were conducted in controlled environments. The experience with forced-whisper testing could be more variable for truck driver screening due to the influence of examiner bias.

It is entirely possible, then, that very different results could be found regarding the eligibility of drivers depending upon whether a forced-whisper or pure-tone screening test was conducted. An obvious example exists for a person with NEIL. Under the current FHWA regulations, a pure-tone screening evaluation at 500, 1,000, and 2,000 Hz may not exclude a number of drivers with NIHL. The regulations state than an individual passes the pure-tone screen if her or her average hearing level at these frequencies is better than 40 db. NEIL, however, is a high frequency, hearing loss phenomenon, with most impairment occurring at 3,000, 4,000, and 6,000 Hz. If a person had a 20 db HL threshold at 500 and 1,000 Hz and a 75 db HL threshold at 2,000 Hz (not unexpected for some-one with NEIL), they would pass the pure-tone screening criteria stated in the Federal regulations. This same person, though, might have a great deal of difficulty in repeating whispered numbers at 5 feet with no visual cues. The detection of whispered words or numbers can be difficult for a person with high frequency hearing loss. In this scenario, the. forced-whisper test may actually exclude more drivers with NIHL than the pure-tone test.

False-wsitives/false-'negatives

A false-positive result on a pure-tone screening test indicates that a person who does not have hearing impairment is identified by the screening test as someone with hearing impairment. A false-negative result means that an individual who is hearing impaired in reality is identified by the test as having normal levels of hearing ability. If it is determined that a certain amount of hearing is necessary for safe truck drlving, then a false-negative result from a screening test may place the driver and other road users at an unnecessary risk. A false-positive result, on the other hand, requires further testing to prove that a person meets the hearing criterion.

The acoustic environment in which the pure-tone screening teat is performed can contribute significantly to the false-negative rate of the test. There are. several special earphones available, however, to control for screening tests conducted in noisier environments. These include audiocups (to create a quiet environment around the ear) and insert earphones (to block out approximately 30 db HL of noise in the enviromnent). These. two types of devices also reduce the problem of poor earphone placement that can produce false-positive results. Problems with earphone placement in aging persons can cause the outer ear canal to collapse, thus creating an erroneous detection of hearing loss during a testing procedure. Insert earphones are ideally suited for avoiding this problem.

The false-negative rate of an adequately administered hearing screening should be very low (ASHA 1985, 1989). Guidelines of allowable ambient noise levels for the screening environment are published (ASHA 1989). Standards also exist to minimize examiner bias in an audiometric evaluation. The individual being tested, for example, sits with his or her back to the audiometer and examiner. In this way, the person beiig tested is given no visual cues about when pure-tones are presented. Appropriate instruction to examiners would advise that the tones

should not be presented in a particular pattern, as the patient can pick up the pattern and keep responding even though he or she is not actually hearing the tone.

There is some indication that rescreening within the same session may reduce the false-positive rate (Schow 1989, Gershel 1985, Frank 1986). In such a situation, the examiner should reposition the earphones and repeat instructions to the individual. As a final point, the ASHA (1989) concludes their recommendations by stating that "a screening failure does not confirm the presence of a hearing impairment, but indicates the need for follow-up diagnostic testing."

Continued evaluation

Hearing is a dynamic function of the human system Our abiity to hear is influenced by our auditory surroundings. Occupational and leisure. activities can influence our abiity to hear. Axelsson (1979) categorizes occupational NIHL in four types: that from continuous noise, that from impulse noise, that from a combination of continuous and impulse noise, and that from acoustic trauma.

A truck driver can be exposed to intense noise over long periods of time. Continued audiometric evaluation is necessary among existing drivers to ensure not only that a driver meets the hearing criteria listed above, but also to examine for any threshold shift due to noise exposure. Noise exposure generally produces hearing loss with a maximum threshold shift between 3,000 and 6.000 Hz. Frequencies below 1500 Hz are not usually influenced. The problem with identifying NIHL in CMV drivers, though, is the lack of reliable baseline data (threshold measures before the person began the noise-related occupation), the influence of age on hearing, and individual susceptibility. The bi-annual medical examinations required for existing CMV driver's focus on hearing screening and provide little data regarding the change that might be occurring in hearing thresholds.

Testing for threshold shift due to noise exposure is mandated and regulated in other industries by OSHA. Monitoring of hearing thresholds (not screening) is part of a hearing conservation program required by OSHA. This program also requires modification of the working environment to produce less noise and the use of hearing protection in a working environment that cannot be. modified. OSHA's guidelines indicate. that, for an 8-hour exposure, the intensity must not exceed 90 db(A) in order for 50% of the exposed population may avoid hearing loss. It is important to keep in mind that, with this standard, 50% of the noise-exposed population can be expected to experience hearing loss.

If a truck driver is exposed to intense sound over long periods of time, it is necessary to monitor hearing in order to assess any threshold shift due to the noise. exposure. This type of testing is mandated and regulated by OSHA (Walsh-Healy Public Contracts Act, 41 USC 3545; Occupational Safety and Health Act of 1970, 29 USC 651-678). A monitoring evaluation (not screening) is part of a hearing conservation program that includes modification of the working environment to produce less noise, use of hearing protection in any working environment that cannot be modified successfully, and education about noise.

The use of hearing protection raises an interesting question in the present discussion. If a certain level of hearing is required for safe truck driving, use of hearing protection (ear plugs) may eliminate this level of hearing for normal and hearing-impaired drivers. On the other hand, if the truck drivers are working in dangerously loud environments, lack of hearing protection would mean that at least some drivers would be diqualified to drive because of the subsequent threshold shift associated with noise exposure.

Any standards of auditory performance should also consider temporary threshold shift (TTS). A person's hearing at any given time is dependent upon the immediately preceding exposure. If an individual has been exposed to continuous high-level sounds, his or her threshold of audibiity will temporarily shift for the worse. A hearing screening conducted at this time could result in the person falsely failing the test. Some precautions should be taken to ensure that the person being tested has been free from such a short-term exposure to high noise levels.

Rationale for screening (predictive value)

Screening hearing ability presumes that being able to hear is essential to adequate job function. If this is true, then one must develop a test that will assess hearing function. Any hearing screening that is used as a component of selection criteria should be designed to predict, directly or indirectly, the audibility of sound for an individual in that particular work environment.

To determine the ability of the hearing screening to predict abiity on the job, one must identify audible signals that, if left unheard, would produce accident and injury and one must determine in what environment these audible signals are presented. It is reasonable to compare the ability of persons who fail the screening to the ability of persons who pass in particular listening environments. One must assume that the' persons who pass did better than those who failed.

How can we test if the CMV driver has necessary auditory cauabilities?

Henderson and Burg (1973) concluded that "conventional audiometric examinations will not necessarily provide the appropriate or adequate measure of the auditory performance capability of a driver within the context of the driving task." After identifying the driving behaviors that require auditory input, one must identify the auditory parameters required for adequate performance and then design a procedure to test these parameters. As long as a person has some hearing and the levels being considered are above his or her threshold, there is no disadvantage regarding detection of auditory warnings. Auditory warning signals are gross sounds that simply need to be detected. Our experience in modem communities allows us to associate the sound with its meaning (e.g., a siren means an emergency vehicle is nearby and traveling quickly). Detecting sounds is very different from understanding a spoken message. Understanding requires more than audibility and cannot be predicted from a pure-tone screening alone. On the other 'hand, we cannot understand a purely auditory (no visual component) signal if it is not audible.

Booher (1978) reported that research results to date are not adequate to establish the auditory requirements for safe driving performance. It appears that, as of 1992, research results

are still not adequate to state that audition actually is a necessary part of safe driving and, if it is, to determine the appropriate screening procedures to ensure an adequate amount of hearing. Any pass-or-fail test presupposes that there are sounds that are necessary for safe driving, that these sounds are audible to the normal-hearing population in the driving environment, and that these sounds cannot be compensated for in some other manner. The literature has mixed results in all of these issues.

D. Summary

The issue that we sought to examine in this review was the role of heating impairment in driving performance and driving safety. Few definitive data were available, however. Research results to date are not adequate either to prove or disprove that hearing is required for safe driving.

The lack of data regarding hearing and driving safety may be due to the fact that hearing, plays only a minor part in the overall driving **task.** Henderson and Burg (1974) have outlined four, non-routine driving situations in which hearing could be important: the audibility of warning sounds from outside the truck (sirens, horns, train whistles), the audibility of warning sounds from within the truck (mechanical failures), the audibility of sounds during vehicle **inpection,** and proper communication in driving.

Very few data exist for each situation to determine, definitively, that hearing is meaningful for safe performance. In fact, most reports suggest that warning sounds may not even be sensed by drivers with no hearing impairments. Noise levels in the tractor cab are sufficiently high to mask **or** hide any warning value that such signals might have when the truck is in operation. While masking is not an issue. when the truck is traveling at slow speeds or is stopped, the safety implications surrounding slower speeds are likely to be quite different from those surrounding trucks traveling at higher speeds. It is also possible that hearing-impaired drivers may be able to compensate for their loss of hearing.

Still, there are data to indicate that an association might exist between hearing and driving safety. The well-designed study of deaf automobile drivers by Coppin and Peck in California found that deaf men had 70% more road crashes than non-deaf men. The recent evaluation of a ban on the nighttime sounding of train whistles in Florida found significantly more accidents at railroad crossings where- the ban was in effect than at crossings where a whistle was sounded. Whether or not these accidents involved any trucks was not disclosed.

Studies among professional drivers indicate that noise-induced hearlng loss is a real consequence of long-term CMV operation. It' is likely a large numbers of CMV drivers have some form of hearing impairment from the long-term exposure to noise in the tractor cab. Each year, we estimate that about 25,000 new cases of NIHL will occur.

Many of these drivers though may not lose their driving privileges. A survey of private trucking **firms** found that very few CMV drivers failed their biannual medical examinations for reasons related to hearing impairment. One reason may be the present form of the Federal hearing standards. Drivers must pass either a forced-whisper or pure-tone screening. Under the **current** regulations, a number of drivers with fairly significant NEIL would be able to **pass** a pure-tone screening set at an average of 40 db I-IL over the frequencies of 500, 1,000, and 2,000 I-Ix. These same drivers might be expected to fail a properly conducted forced-whisper screening. The value of the screening test(s) to identify individuals with hearing impairment, then, comes into question.

Few reports are available to evaluate adequately the relationship between hearing and driving safety. More research is needed to investigate a number of issues. These include, but are not limited to, the following:

1. Investigations into the relationship between hearing loss and CMV accidents. Is hearing loss associated with CMV accidents? Does a point exist on the hearing threshold scale where some drivers would be safe and others would not? Does any safety difference exist between deaf and hearing-impaired drivers?

2. Investigations into the predictive value of hearing screening tests. Investigations into the changes in hearing thresholds over time in CMV operators.

3. Investigations on the impact of the noise environment in truck cabs to the detectability of warning signals. Most of the work done to date has focused on automobiles and was extrapolated to earlier models of trucks. Many individuals have mentioned that later models of trucks have lower interior noise levels and better soundproofmg. Studies are needed to document this and to evaluate the impact of soundproofing on driving safety.

4. Investigations on the relationship between hearing protection devices and driving safety.

5. Investigations on the impact of high noise levels on driver performance in normal-hearing and hearing-impaired individuals. Investigations into the role of temporary threshold shift and permanent noise-induced hearing loss on driver performance.

The safety risk related to hearing-impaired CMV operators are not known. There is no doubt that a number of drlvers with significant hearing impairment already operate CMVs. As will be discussed in the next section, a number of states allow deaf and hearing-impaired CMV drivers on the toad and few existing interstate drivers fail the biannual exam due to hearing. This could indicate that some degree of acceptance of the risks involved with hearing loss already exists.

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III. REVIEW OF EXISTING HEARING-STANDARDS FOR CMV DRIVERS

Our review of the existing hearing standards for CMV drivers focuses on the regulations and rules in effect at State licensing agencies, foreign licensing agencies, and private trucking companies for CMV operation. A description of the hearing standards in use in other transportation-related industries is included as well.

A. State Regulations for CMV Operation

Although drivers with severe hearing impairment are restricted from operating in interstate commerce, the individual states have had the option of licensing hearing-impaired CMV drivers for intrastate commerce in the past. We contacted each state to identify the regulations that they enforce. A list of questions was constructed which examined the current intrastate regulations for hearing-impaired, drivers, the screening techniques used to identify those with hearing impairment. identification of licensed CMV drivers with hearing impairment. and their driving history. This list follows after our discussion.

Part I: Intrastate Regulations for Hearing-Impaired Drivers

Information was obtained from 48 states and the District of Columbia. As shown in Figure 3-1, 71.4% of the responding authorities (n=35) had rules that matched with the Federal regulations regarding hearing and CMV operation. Eleven states, however, allowed drivers with hearing impairments to be licensed under a waiver program. The State of Washington, as an example, allowed licensure if the affected individual passed a driving skill test conducted m a CMV and performed in such a manner that, in the opinion of the examiner, the hearing loss would not affect ability to operate the CMV safely.

Four states with regulations the same as those of the FHWA permitted existing drivers with hearing loss to maintain their CMV licenses under grandfather clauses. Of the remaining 14 states which had not yet conformed to Federal guidelines, five had no specific regulations regarding hearing, and nine had regulations specific to the medical aspects of hearing (e.g., certain hearing levels that were necessary) or to the structure of the vehicle.

In states which allowed drivers who did not pass the Federal medical standards to be licensed under a medical waiver program, the driver generally needed a physician's assessment that he/she was safe to operate a commercial motor vehicle. Some statesalso had medical review boards for this purpose. Structural regulations enforced by the states included requirements for the use of outside mirrors, limitations in the destances which could be traveled by impaired drivers, limitations on the type' of freight that could be hauled, and limitations on the type of industry in which a driver could work.

Figure 3-1. Intrastate Regulations Concerning Hearing

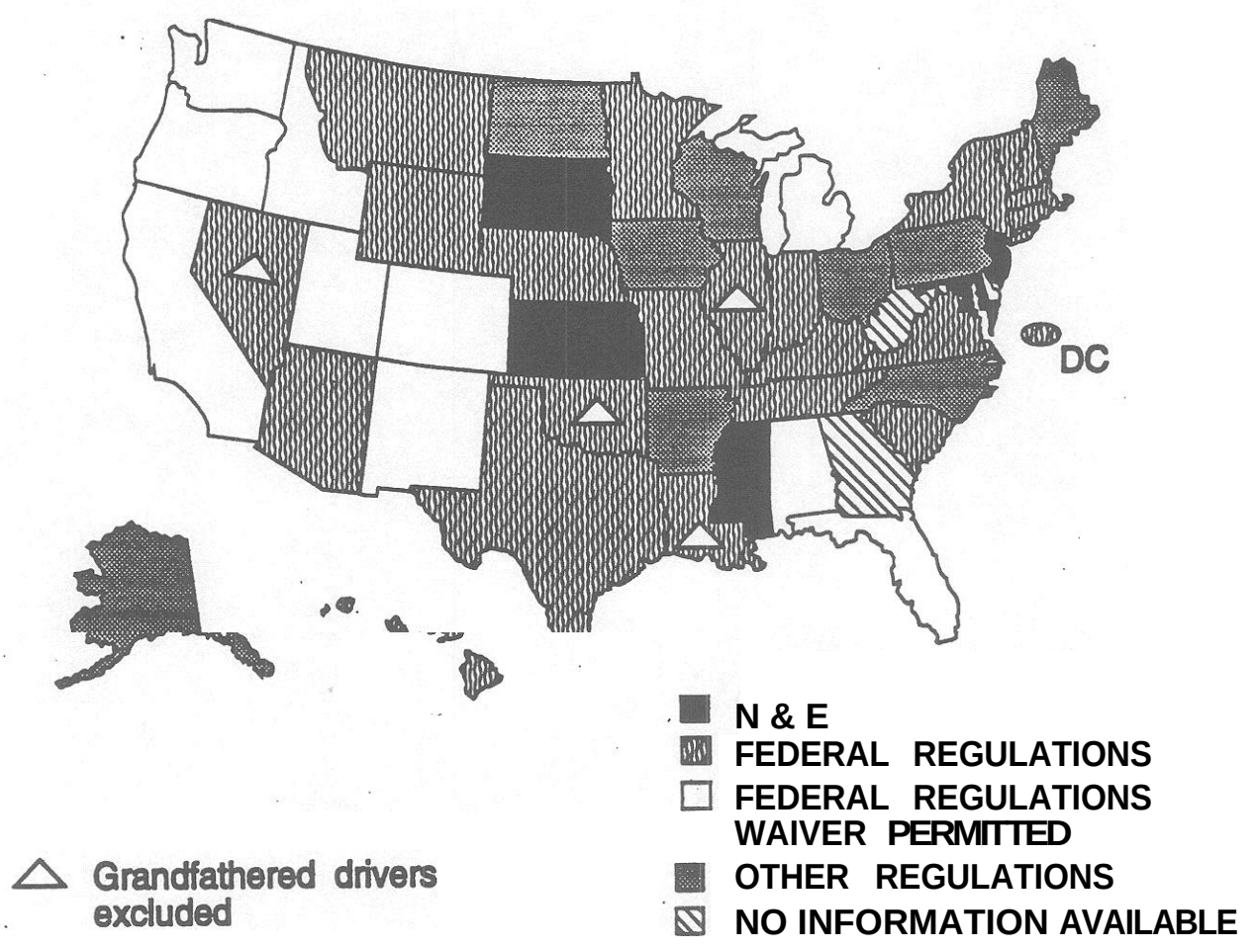


Figure 3-2 portrays the regulations applied for licensing deaf commercial drives. Deaf drivers could. obtain a commercial driver's license hi 26 states. six of which had no special requirements for licensing at the time of the survey. Of the states that licensed deaf drivers under special requirements eight did so under a waiver program and four allowed licenses only if the driver was under the protection of a grandfather clause. IQ the eight other states, restrictions existed on the class of vehicle which could be operated, the type of freight which could be hauled, the distance which could be traveled, or the type of industry in which a deaf driver could be employed. Two outside mirrors were also a common requirement. Deaf drivers could not obtain a license from 23 agencies under any circumstances.

Figure 3-2. Intrastate Licensing of Deaf Drivers

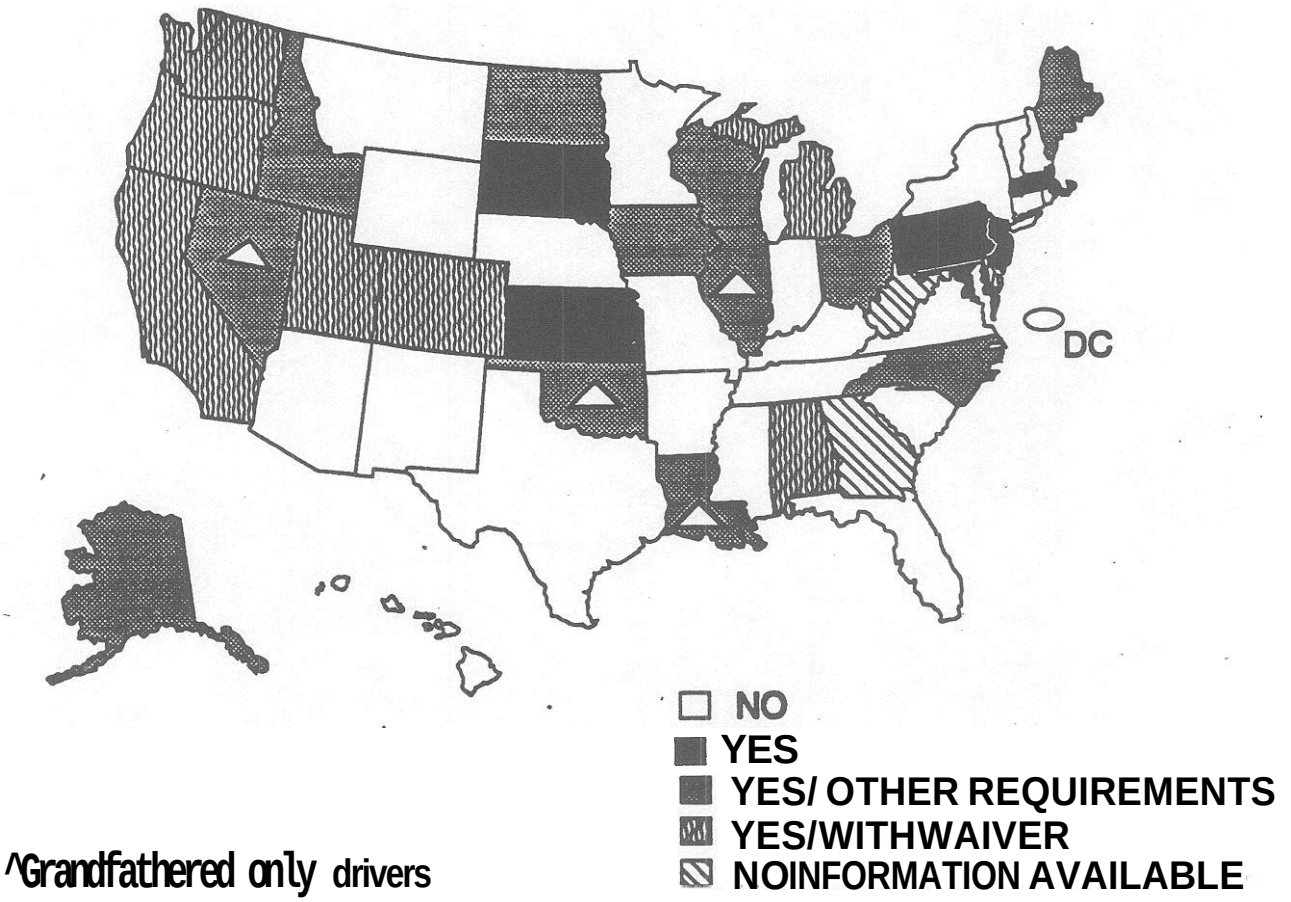
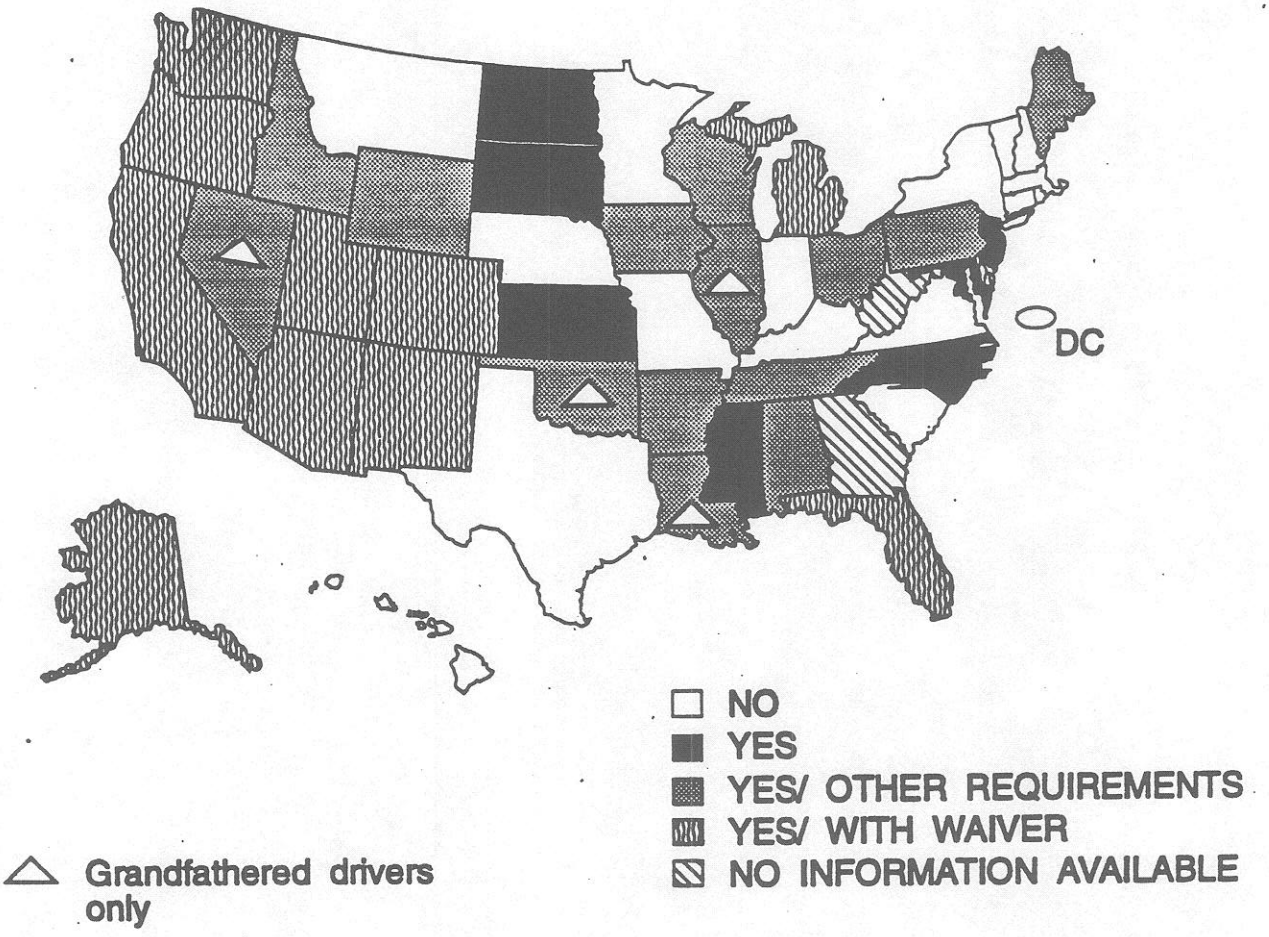


Figure 3-3 depicts the rules applied for hearing-impaired drivers who are not deaf. Seventeen states did not license hearing-impaired drivers who fell below the hearing levels outlined in the Federal gui delines. These states are indicated by a "no" response in the figure. Niie states allowed hearing-impaired drivers to be licensed with no special requirements. Fourteen other states permitted licensure under a waiver program.

Figure 3-3. Intrastate Licensing of Hearing-Impaired Drivers



In reviewing Figures 3-2 and 3-3. it can be seen that drivers who are heating-impaired. but not deaf, cao be licensed in 65.3% of the responding licensing agencies (States and the District of Columbia). while deaf drivers can obtain a license in 53.1% of the agencies. On the basis of the total CMV-licensed population, deaf drivers are allowed to drive CMVs in states whose driving populations comprise 50.7% of the licensed population, and hearing-impaired drivers are allowed to be licensed in states whose driving populations comprise 65.2% of the CMV-licensed population.

Because NIHL may occur among CMV operators after many years of driving, the states were also questioned about the licensing privileges of existing drivers who become hearing-impaired and no longer meet the regulations. Table 3-l presents a summary of the licensing status for these drivers in those states, that require hearing re-examinations (n=23).

Table 3-l. Lii Status of Existing Drivers Who Develop Hearing Impairment

	No Change	License Revoked	License Restrictions	Don't Know
Number of States	3	3	9	8
Percentage of State3	13%	13%	39%	35%

Part II: Hearing Screening Techniques

Information was obtained concerning the screening procedures ‘used by the states to identity applicants and existing drivers with hearing impairments. Overall, there was great variability among the states in the importance assigned to medical examinations in the licensing process. Not all states required that an applicant pass a medical exam before a license could be issued or renewed. Some states relied upon employers to verify that their drivers had passed-the necessary medical criteria for CMV operation. Others had no rules concerning medical examinations at all Table 3-2 presents the breakdown of states regarding the presentation of proof of medical examination before the issuance of a CMV license. States included under the “Exceptions” column include those that require exams only for special drivers. such as hazardous material operators, or states that do not require exams for selected CMV drivers. such as municipal employees or agricultural drivers.

This variability among the states applied to heating examinations as well. Proof of “adequate” hearing was not always necessary before a license was issued in some states. A screening test of hearing ability (as evidenced by a DOT card) might be required, though, before new applicants and existing drivers could drive or find work. In eleven states, it appeared that CMV drivers did not have to undergo any type of testing for hearing ability.

Among those states that had some criteria for hearing screening, the large majority relied upon an external determination of heating ability, most often by a physician of the driver’s choice. Arizona required a determination by an audiologist Two states-Washington and North Dakota reported that they internally “screened” the hearing levels of new applicants.. **Both** determined the heating ability of the applicant on the basis of normal conversation with the license examiner. It was not clear if this was a standard test given to all applicants or an evaluation at the discretion of the examiner. Delaware was the only state contacted that sent applicants to an outside agency to obtain medical certification for commercial driving, including a hearing screening. This center used primarily the forced-whisper test. On occasion (when the employer would pay for it), a complete audiometric evaluation was conducted.

Table 3-2.

Proof of Medical Examination Required to Obtain a License

YES	NO	EXCEPTIONS
Arizona	Alaska	Alabama
California	Arkansas	Colorado
Connecticut	Delaware	Florida
Dist. of Columbii	Iowa	Idaho
Hawaii	Maryland	Kansas
Illinois	Massachusetts	Maine
Indiana	Miieaota	New Jersey
Kentucky	Mississippi	North Dakota
Louisianna	New Hampshire	Virginia
Michigan	New York	
Missouri	North Carolina	
Montana	Oklahoma	
Nebraska	Rhode Island	
Nevada	south Carolina	
New Mexico'	South Dakota	
Ohio	Texas	
Oregon	Wisconsin	
Pennsylvania	Wyoming	
Tennessee		
Utah		
Vermont		
Washington		

Part III: Licensed CMV Drivers With Hearing Impairments

Very few data were available on the number of hearing-impaired drivers in those states which permitted their licensure. There is some indication that the number of deaf drivers who might apply for a CMV license, if the rules were changed, would be small. The State of Washington reported that no deaf drivers had applied for a waiver to drive intrastate. Michigan reported knowledge of 2 deaf drivers who were licensed commercially, both of whom worked for municipalities. Arizona reported having only three hearing-impaired persons apply for licensing; only 1 was licensed. Oregon had knowledge of 4 hearing-impaired drivers, some of whom may have been deaf.

There also were few little data on the driving experience of deaf or hearing-impaired drivers. Arizona and Oregon were the only states that reported accident rates for their hearing impaired drivers. The one licensed driver in Arizona had no accidents in ten years of driving. The four Oregon drivers had a collectiverate of 0.67 accidents per 1 million miles in the period 1985 to 1990.

Summary

It was determined that hearing-impaired drivers can obtain a commercial driver's license for intrastate operation in 50% to 60% of the states. While 32 states followed the same regulatory criteria for intrastate drivers as those for interstate drivers, nine permitted waivers to be granted. Five states did not report any regulations specific to the hearing ability of the driver. This information was collected prior to the 1 April 1992 deadline imposed by the FHWA for states to comply with the Federal regulations on the qualikations of drivers. It is possible that the states which had liberal rules regarding the licensure of hearing-impaired individuals may change to more restrictive rules in the future.

It was evident from the information provided regarding hearing screening practices that very few state agencies actually conducted the screenings themselves. Very little was known by the state agencies about the practices of the outside examiners (many of whom were probably. physicians) who certified a driver as fit to drive on the basis of hearing. Therefore, them could be hearing-impaired drivers (as defmed by the Federal regulations) on the road. In fact, it was speculated by many of the state licensing agencies that there are hearing-impaired commercial drivers who have been licensed, because they were not identified to the agency as "heating-impaired," either due to poor or inadequate screening or no screening at all. Many State agencies reported being highly unsatisfied with the current hearing standards, most notably the forced-whisper method of screening.

Although only two states maintained information on the accident experience of heating-impaired drivers, the accident rates reported are minimal.

Hearing Impairment and Commercial Motor Vehicle Operation

Name: _____ Position: _____

Address: _____

_____

City State Zip Code

Phone Number: _____ Fax Number: _____

The majority of these questions focus on the operation of Commercial Motor Vehicles by drivers with total hearing loss or some form of hearing impairment.

1. How many persons hold a CMV license in your state? _____

   a About what percentage am actively driving? _____ %

2. Is a medical exam required for CMV licenses in your state

   a for new applicants? — Yes — No

   b. for existing drivers? — Yes — No

3. Are. there any regulations regarding hearing standards and commercial motor vehicle operation in your state?

   — yes — No — Don't Know

   a If yes, is any minimum level of hearing required for licensing? (or maximum level of hearing loss allowed)?-

   — yes — No — Don't know

   What is this level? _____

   Does this differ between new and existing drivers? _____ Yes — No

4. Are persons who are totally deaf (i.e. those who have no hearing that contributes to communication) currently allowed to, hold a license to operate commercial motor vehicles in your state?

   _____ Yes — Yes, if special requirements are met _____ No

Special Requirements:

_____

_____

a If yes, is any information available on the existing number of deaf truck drivers licensed in your state?

—— Yes - Number Licensed _____
- NO
—— Don't Know

b. If yes, do you have any information on the accident experience of these drivers?

____ Yes - Accident rate _____
____ No
____ Don't Know

5. Are persons who have some form of hearing impairment, but are not deaf, currently allowed to hold a license to operate commercial motor vehicles in your state?

____ Yes ____ Yes, if special requirements are met -No

Special Requirements:

_____

_____

a. If yes, is any information available on the existing number of **hearing impaired** truck drivers licensed in your state?

-Yes - Number Licensed _____
-No
—— Don't Know

b. If yes, do you have any information on the accident experience of these drivers?

_yes _ Accident rate _____
_no
—— Don't Know

6. Does your state test the hearing levels of new applicants for CMV licenses?

_____ Yes _____ No

a. If you test for hearing, what testing techniques do you use to screen license applicants for hearing impairment?

(1) AUDIOMETRIC TESTING? YES_ NO_

If yes: – Are thresholds obtained? Yes _____ No _____

– Is a screening level used? Yes _____ No _____

What level do you use? _____

– What frequencies are tested? (please circle)

'250 Hz 500 1000 2000 3000 4000 6000 8000 Hz

_Where does the test take place? @lease circle)

a sound booth a quiet room other: _____

(2) FORCED WHISPER? yes_ no_

If yes:

– At what distance is this conducted? _____

(3) ANOTHER TEST? yes_ N O -

Please describe this test? _____

b. If you test for hearing, who conducts the test? (please circle)

certified audiologist technician physician nurse other

7. Are existing drivers required to take hearing tests at any time after receiving a license?

_____ Yes _____ No _____ Don't Know

a If yes, at what time intervals after licensing? _____

b. If yes, what testing techniques do you use?

(1) AUDIOMETRIC TESTING? YES _____ NO _____

If yes: Are thresholds obtained? Yes _____ No _____

- Is a screening level used? Yes _____ N o -

What level do you use? _____

- What frequencies are tested? (please circle)

250 Hz 500 1000 2000 3000 4000 6000 8000 Hz

- Where does the test take place? (please circle)

a sound booth a quiet room other: _____

(2) FORCED WHISPER? : YES _____ No_

If yes:

- At what distance is this conducted7 _____

(3) ANOTHER TEST? yes_ no_

Please describe this test'? _____

c. If you test for hearing, who conducts the test? (please circle)

certified audiologist technician physician nurse other

d. If yes and the test shows that the driver has developed some form of hearing impairment what happens to their driving privileges?

_____ It is revoked _____ No Change _____ Other

other _____

8. Do you requite any form of heating protection for CMV drivers?'

_____ Yes — what do you require? _____

__no

9. Wii there be any change in the hearing regulations for existing drivers in the near future?

_yes __no _____ Don't Know

If yes, what changes are planned and when?

_____

_____

10. Are there any regulations regarding drivers with the following disorders and CMV operation in your state?

	excluded from driving	permitted under special conditions	No Regulations
Epilepsy?	_____	_____	_____
Heart Disease?	_____	_____	_____
History of: Psychiatric Disorders?	_____	_____	_____
Drug Use.?	_____	_____	_____
Alcoholism?	_____	_____	_____

B. Foreign Regulations for CMV Operation

A survey of the existing regulations affecting persons with hearing impairments in several foreign nations was also undertaken. This investigation focused on major, industrialized nations to allow for reasonable comparability of rules and regulations with the United States. Government agencies responsible for transportation in 17 countries (Australia, Austria, Brazil, Canada, Columbia, Denmark, Fiiand, France, Germany, Greece, Japan, Mexico, Norway, Spain, Sweden, Switzerland, and the United Kingdom) were identified from the Europa World Year Book, 1991 edition.

Questionnaires evaluating current regulations, hearing screening, the number of hearing-impaired drivers licensed, and their accident and violation history were distributed to these authorities by mail. This survey instrument was very similar to the questionnaire distributed to the States of the U.S.A. A copy of the questionnaire is included at the end of this section. Nine of the 17 foreign countries contacted returned a completed survey. Details of their responses follow.

Austrailia

Presently, Australia has no Federal regulations regarding hearing impairment and commercial motor vehicle operation. Rules on this issue are left to the discretion of the individual states and territories. The Australian Department of Transport and Communications, though, has published recommendations to medical practitioners for use in determining a person's fitness to drive.' The hearing-specific guidelines advise that commercial vehicle operators should not have a significant hearing loss. "Bus drivers should be able to hear a passenger if he or she speaks. A truck driver should be able to hear above the noise of the engine." Hearing loss of more than 40 db HL at 500, 1,000, and 2.000 Hz in either ear is significant if the applicant is driving a passenger carrying vehicle. The same degree of hearing loss in both ears is significant if the person is driving heavier commercial transport vehicles. Audiometric examination is recommended if the physician suspects any degree of hearing loss in the patient "Commercial vehicle drivers should not have m depend on a hearing aid to bring their hearing to a safe level and their hearing should be evaluated without the use of this aid."

Hearing-specific regulations within the individual Australian States and territories were variable. Information was received from 7. of the 8 Australian States and territories with licensing authority. The Northern Territories did not respond. Three states (Western Australia, South Australia, and Victoria) had hearing regulations identical to the guidelines quoted above. Queensland recommended that physician's follow the published national guidelines when evaluating patients with hearing impairment The determination of the fitness to drive, though, was left to the judgment of the physician. Two states (New South Wales and Tasmania) and one territory (A.C.T.) had no regulations pertaining to hearing; although, Tasmania recommended that drivers should not have a hearing loss of more. than 40 db HL (on average) at 500, 1,000, and 2.000 Hz. Deaf persons are able to obtain a license in these areas.

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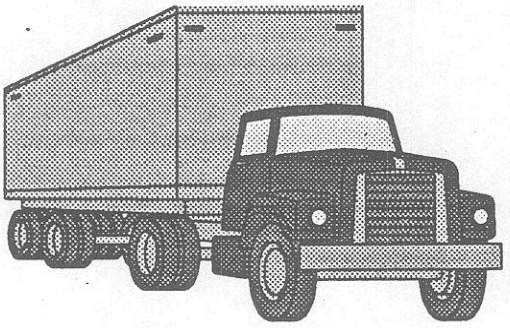
[1] National Guidelines for Medical Practitioners in Determining Fitness to Drive a Motor Vehicle. Australian Department of Transport and Communications, Canberra, Australian Government Publishing Service.

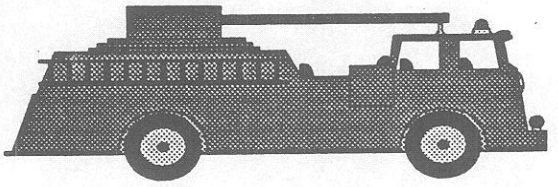
Canada

In the past 2 to 3 years, Canada has m-evaluated the medical requirements for Class 1 drivers (operators of a motor vehicle of any type or size with or without passengers, with a trailer of any sire) (Figure 3-4). Previously, Class 1 drivers were required to meet the same hearing standards as Class 2 and 4 (buses and emergency vehicles) drivers: a corrected hearing loss threshold of no more than 40 db HL averaged at 500, 1,000, and 2,000 Hz. However, after a review by the Canadian Medical Association, the hearing recommendations for Class 1 drivers were revised to state that hearing regulations may not be necessary for large truck operators. According to the recommendation made by the Canadian Medical Association, high noise levels within the truck cabs and the emergence of better soundproofing in response to these levels indicate that hearing probably does not contribute much to the safe operation of commercial motor vehicles.

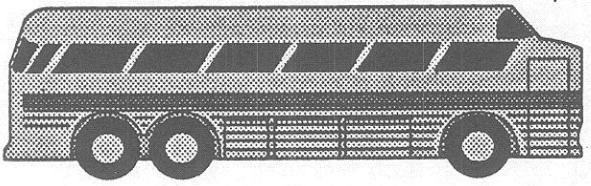
Figure 3-4. Canadian Vehicle Classification



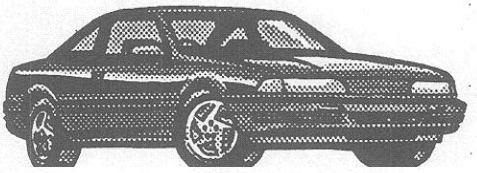
Class 1



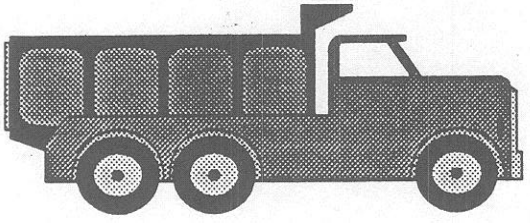
Class 4



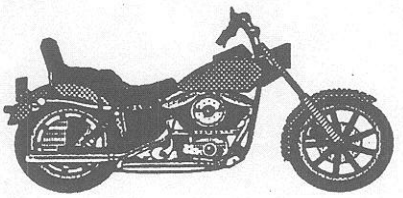
Class 2



Class 5



Class 3



Class 6

The regulation of licenses in Canada is not centralized. Therefore, each province has the prerogative to enforce regulations that may or may not coincide with other provincial regulations. A brief interview of the licensing authorities in the provinces was conducted to identity the existing rules governing CMV drivers, with hearing impairments and to determine if these rules were similar to the recommendations made by the Canadian Medical Association. Managers or supervisors in 9 of the 11 provincial departments in control of licensing of CMV drivers were contacted. Information concerning regulations in Quebec was obtained by a colleague in Montreal.

Table 3-3 describes the hearing-specific regulations in effect for CMV drivers licensed in the respective provinces. The majority of the provinces and territories (seven) had no specific regulations governing drivers with hearing impairments. Four provinces screened applicants and/or drivers for hearing loss and prohibited those persons with an uncorrected hearing level worse than 40 db (averaged over 500, 1,000, and 2,000 Hz) from being licensed. Three of these provinces (New Brunswick, Nova Scotia. and British Columbia), though, offered waiver programs for hearing impaired persons. The rules described above apply to drivers employed in general commercial transport Those drivers who transport hazardous goods, in general, must meet the hearing regulations in place for Class 2 and 4 drivers (corrected hearing loss no more than 40 db HL averaged at 500. 1.000, and 2.000 Hz.

Table 3-3.

Provincial Regulations Regarding Hearing and CMV Driving

No Regulations Specific to Hearing'	Regulations are similar to those in the U.S.A.	Other Regulation?
Manitoba Newfoundland Northwest Territories Ontario Prince Edward Island Quebec Saskatchewan	New Brunswick Nova Scotia Yukon	British Columbia

1 Does not include drivers transporting hazardous goods.
2 A driver should not have uncorrected hearing loss > 40 db HL.
3 A driver should not have uncorrected hearing loss > 55 db HL.

Three provinces that enforce heating regulations reported that new applicants for Class 1 licenses and those existing drivers holding a current Class 1 license are tested for hearing by outside physicians. Although no hearing regulations exist in Saskatchewan, Manitoba. and Newfoundland, these provinces am similar to Yukon, which has hearing standards, in that new applicants and existing drivers of Class 1 licenses are tested under special circumstances, such as when they are seeking permission to transport hazardous materials. No information was available concerning the type of screening used by physicians.

On the basis of these rules, it appears that deaf and hearing-impaired persons are able to obtain a Class 1 license in ten of the eleven provinces questioned; although three provinces. require a medical waiver for drivers who do not meet the necessary hearing standards. Most provinces now follow the viewpoint expressed by the Canadian Medical Association and others: that the lack of hearing does not contribute significantly to the safe operation of CMVs. This is seen quite clearly in the changes made over time to the hearing regulations in Quebec In 1981, drivers with a hearing loss worse than 60 db HL could not obtain a commercial driver license ih Quebec In 1987, the criteria were lowered to screen out drivers with hearing impairments worse than 50 db HL in both ears. Licensing restrictions related to heating were eliminated altogether in 1989. Drivers with any degree of hearing loss are now able to obtain a commercial driver license in Quebec.

Denmark

The response from Denmark was incomplete. Specific details on the hearing requirements for commercial drivers were not indicated. However, it was noted that deaf and hearing-impaired drivers can obtain a commercial driver's license in Denmark if the vehicle they operate is equipped with special external mirrors.

Greece

Commercial driver's licenses in Greece are under the admiitration of the regional departments affiliated with the Ministry of Transport and Communications in Athens. The regulations regarding hearing impairment and commercial motor vehicle operation are unique when compared to the experience reported in other countries. Persons with impairment greater than 35% to 45% on the Sabine or Fowler scales are not permitted to operate vehicles in commercial transport These scales ate no longer used as current audiologic measures. The screening values employed, though, translate into moderate to severe forms of hearing impairment In other words, persons with moderate to severe hearing loss (about 40 db HL on a pure-tone screen) or greater are not permitted to be. licensed. This requirement automatically excludes deaf drivers.

Japan

Police departments in the prefectures of Japan are responsible for licensing CMV drivers. Specific regulations in force for hearing state that a driver must be able to hear 90 phon at a distance of 10 meters. This can be tested by either an audiometric evaluation, a forced-whisper screening, or a horn blown at the driver from 10 meters. 90 phon is approximately equivalent to the intensity of normal conversation. Under these criteria,
deaf persons cannot obtain a commercial license. The National Police Agency had licensed 651 hearing-impaired commercial drivers at the time of the survey.

Mexico

CMV drivers or applicants in Mexico will be disqualified if any of the following hearing-specific conditions are present: unilateral deafness with deep contralateral deafness, bilateral deafness, 'total unilateral or bilateral deafness, hearing loss mom than 40 db HL in the voice frequencies (500 Hz to 4,000 Hz) or if the social usefulness of hearing exceeds 50 db HL. Hearing levels in both existing drivers and new applicants am tested in an audiometric evaluation.

Sweden

Sweden reported a decentralized system, in which each county administrative board is in control of licensing CMV drivers. There is no specific level of hearing required for drivers of large goods vehicles; however, there is a hearing requirement for drivers of commercial passenger vehicles. New applicants for commercial licenses are screened using audiometric evaluations or the forced-whisper test. Irrespective of this testing, deaf and hearing-impaired persons are not restricted from a commercial driver's license in Sweden.

Switzerland

The regulation of commercial driver's licenses in Switzerland is administered by the respective contonal authorities. Existing CMV drivers and new applicants have to demonstrate the abiity to hear a forced whisper at a distance of 3 meters without me use of a hearing aid to pass the screening test. In case of unilateral deafness, the person must be able to detect a forced whisper in the good ear at a distance of 6 meters. Persons with bilateral deafness cannot obtain a commercial driver's license in Switzerland. In some instances, an audiometric evaluation may be substituted in place of the forced-whisper screening.

United Kinedom

In an effort to tit the pattern of European legislation, the United Kingdom has recently altered classifications and regulations for drivers of motor vehicles. Commercial motor vehicles are now defined as large goods vehicles (LGV) with a maximum authorized weight of more than 3.5 tons. Licenses for professional drivers are administered centrally in the UK; all LGV licensing is controlled by the Drivers and Vehicle Licensing Agency in Swansea. Approximately 1 million people in the UK are licensed to drive an LGV.

The hearing regulations for LGV drivers in the UK ate based on the abiity of the driver to communicate with other persons. As part of the required medical examination for licensing, physicians should establish if the driver has any difficulty communicating by phone or any disability that may interfere with the efficient discharge of the driver's duties. The regulations do not specify any hearing threshold that must be met. If a driver has difficulty communicating via telephone, the driver must demonstrate proficiency in using a text communicating terminal, Miicom V, in order to be licensed.

The Minicom V is a portable keyboard that is used with a telephone to communicate via typed conversations. At present, there are some logistical problems with the Minicom V. in that the device lacks a versatility of communicating speeds (bauds), which limits the networks on which Minicom V will work. Nonetheless, the demonstration of proficiency in the use of this device has allowed 10 deaf persons to obtain LGV licenses in the UK.

Summary

The results of the international survey were similar to the results of the U.S.A. intrastate survey. Hearing regulations, restrictions on heating-impaired persons, and screening procedures varied widely across the responding nations. Table 3-4 summarizes the data available on these items from the responding nations, excluding Canada and Australia. The imprtance that licensing authorities place on the role of hearing in driving safety appears to be split evenly between these countries. Still, a rather large percentage of these. authorities viewed hearing impairment as a relatively minor factor in driver safety. Parts of Canada and Australia went so far as to eliminate regulations specific to hearing loss.

Table 3-4.

Regulations, Licensing Restrictions, and Screening Procedures among Responding Nations

	Level of Hearing Required	License Deaf Persons	License Persons with Hearing Loss[1]	Screening Procedure
Denmark	not specified	yes	yes	not specified
Greece	no more than 35% to 45% on Fowler and Sabine scales	no	no	audiometric exam
Japan	no more than 90 phon at 10 meter distance	no	no	pure-tone, forced-whisper, or horn test
Mexico	no more than 40 db HL in the voice range	no	no	pure-tone exam
Sweden	none	yes	yes	pure-tone exam or forced-whisper test
Switzerland	ability to detect forced-whisper at 3 meters	no	no	forced-whisper
UK	dependent on the ability to communicate	yes	yes	physician's judgment or proficiency in theoseofatext terminal

[1] Refers to hearing loss above the national standard.

Name: _____ Position: _____

Address: _____

_____

City Country Postal Code

Phone Number: _____ Fax Number: _____

Hearing Impairment and Commercial Motor Vehicle Operation

These questions focus on the operation of commercial motor vehicles (heavy goods vehicles or trucks weighing over 12,000 kg) by deaf drivers or those with some degree of hearing loss.

1. What department/institute/ministry is in control of licensing commercial motor vehicle drivers in your country?

_____

_____

2 How many persons have a commercial motor vehicle license in your country? _____

3. Is a medical exam required to obtain'a commercial motor vehicle license in your country?

_yes _no _____Don't Know

4. Is any level of hearing required for commercial motor vehicle driving in your country?

_yes _no _____Don't Know

a If yes, what is the minimum level of hearing required (or maximum level of heating loss allowed) for licensing?

_____