review programs for the licensed automobile driver. The studies have assessed the effects of driver medical reexamination programs, medical advisory board reviews, state licensing agency evaluations and state license renewal application programs.

In 1972, Pascarella et al.[41] studied the effects of the North Carolina Driver Medical Evaluation Program upon the accident and violation rates of medically evaluated automobile drivers. Over 4,100 drivers, who were medically evaluated and had their driving privileges restricted, suspended, or unchanged, were studied during a 2-year period. Accidents and selected violation records were collected over a year's time in both retrospective and prospective periods relative to the driver's induction into the evaluation process. In addition, a control group of over 9,400 randomly selected licensed categories included vision. The results of the study indicated that drivers with diagnosed visual defects had improved their driving record (i.e., less accidents/violations after the medical evaluation). However, their accident rates before and after evaluation were still significantly higher than those of the control population.

Another study by Lippman in 1979[42] for the Texas Health Department evaluated the effectiveness of the Texas Medical Advisory Board's (MAB) review of automobile drivers with chronic medical conditions. The study dealt with 19,000 medically impaired driver cases, including the visually impaired, that were reviewed by the MAB for 2 years. In addition, driving records on the reviewed drivers were obtained from the State Department of Public Safety for 1 year prior to MAB review and 1 year thereafter. The number of accidents and moving violations for MAB cases was determined and compared with state average numbers of accidents and moving violations in the entire population of drivers in Texas. The total effect of the MAB review for the visually impaired was a 76 percent reduction in accident rate and a 65 percent improvement in violation rate. The authors noted that the beneficial effects of the MAB action started at about 30 years of age. From age 40 on, the effects of the MAB action were so beneficial that the accident rates were parallel and even better than the statewide average. It seemed that the effects of the MAB action increased proportionally with age.

Popkin et al.[43] reexamined the impact of the North Carolina Driver Medical Evaluation Program on the driving performance of medically impaired automobile drivers entering the program in the early 1980s. Pre- and post-evaluation periods were established for persons who had medical reviews and a sample of move than 6,900 drivers was used. Visual disabilities were included in the categories of medically impaired Results showed that drivers in all of the disability groups experienced a decrease in crash involvement rates after medical program evaluation. Drivers with

certain disabilities, including vision, had post-review crash rates similar to the general driving population Popkin concluded that the medical review program did significantly improve the driving performance of drivers with medically impaired conditions, but that these drivers still had more accidents than the general driving population

These studies demonstrated improvement in the driving safety of medically impaired drivers after intervention by a licensing agency. In general, accident rates of the impaired drivers were significantly reduced after intervention, but were still higher than those of the normal population. Violation rates did not show improvement after intervention and were still higher than those of the normal population.

UNDERLYING STATISTICAL ASSUMPTIONS

The purpose of this section is to present a statistical model that makes explicit some of the major assumptions underlying much of the empirical work previously reviewed The goal of the empirical research has been to establish the nature of the relationship between measures of visual performance and driving safety. The results of this work generally lead to the conclusion that the direct link between visual performance and measures of driver safety, such as history of accidents and citations for moving violations, is weak. When correlations have been found, values have been low and very large numbers of drivers have been needed in the analysis to demonstrate statistical significance. Results such as these have been considered disappointing and an intense effort has been devoted to finding "better" methods of measuring both visual performance and driver adequacy in the hope that more robust relationships will emerge. The brief analysis that follows is an attempt to provide insight into why these generally disappointing results have been obtained. A model of statistical reasoning known as signal detection theory (see Egan[44]) has been adapted to the problem of detecting unsafe drivers within a population of safe drivers on the basis of visual performance. This model has come to be accepted as representing important aspects of a discrimination task. The signal detection model was developed initially in the context of detecting an electronic signal in the presence of noise (defined as anything in the signal domain that is not the signal), and has been applied widely and successfully in the analysis of psychophysical tasks such as those used to test vision.

Figure A.2 illustrates the signal detection paradigm as it applies to the vision and driving problem. The disaimiition task is to identify "bad" drivers on the basis of a visual performance score. In Figure A.2, the distribution of scores obtained on a test of vision (e.g., visual acuity, visual

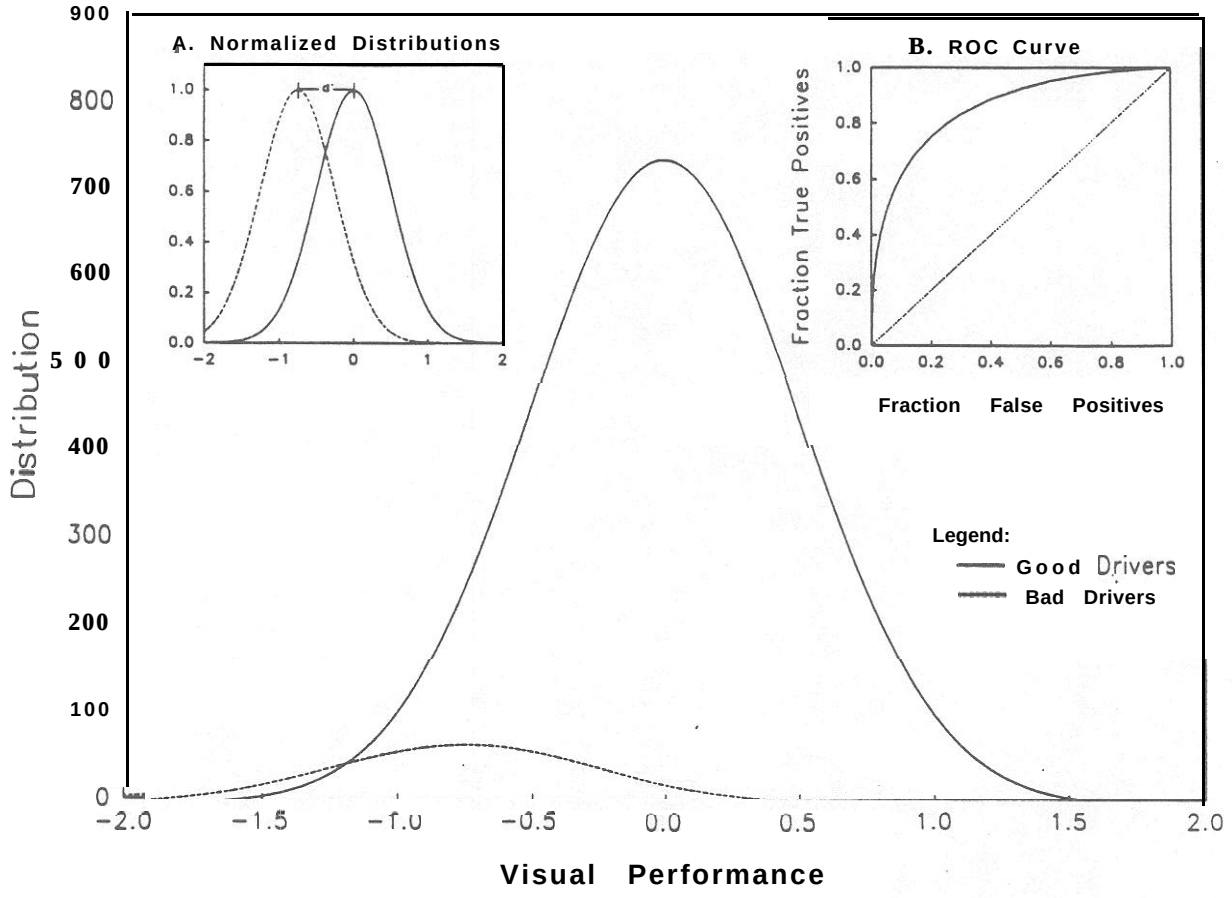

Figure A.2 Distributions of Visual Performance Scores for "Good" and "Bad" Drivers and the Associated ROC Curve

fields, and contrast sensitivity) by good drivers is shown as a solid line. The distribution for the same test for bad drivers is shown as a broken line. The definition of bad drivers is not specified but can be any definition appropriate to the purpose, such as accident rate or moving violations. An important point to notice is tbe overlap in the distributions. In other words, many bad drivers can have good vision and vice versa. This overlap, which is well documented for every measure of visual performance in relation to safe driving, is at the heart of the discrimination problem. The greater the overlap that exists between the good and bad driver populations, the more difficult the discrimination task will be. The heights and areas under the main distribution curves are in rough proportion to the number of good and bad drivers in the population, using statistics derived from a study of 12,483 Pennsylvania drivers done by Decina et al.[37] However, the signal detection scheme

is better understood for groups of equal numbers (normalized distributions) within the population that differ only in the characteristic under study (driving safety in this case). This situation is illustrated in inset A of Figure A.2, where the difference in means for the two driver groups is labeled d'. Larger values of d' correspond to less overlap in the good and bad driver populations and to a better ability of the model to discriminate bad from good drivers at any criterion or cutoff value of tbe visual test. Thus, weak correlations found between vision and driving performance might be explained by extensive overlap between vision scores of good and bad drivers and by correspondingly small d' values and conversely, less overlap will correspond to stronger correlations.

Detailed knowledge of the test score distributions permits quantifying the predictive value for driver performance of any visual test by constructing the receiver operating characteristic (ROC) for the two distributions (good and bad drivers) of the vision scores under study. This is done in inset B of Figure A.2 by counting and then plotting the number of bad drivers (true positives) that occur compared to the number of good drivers (false positives) that occur below different values of the visual performance score. The ROC curve that results is the solid line above the diagonal in inset B. It shows graphically the ratio of true positives to false positives at every value of the test score. In this example, at low test values, the rate of accumulating hits (true positives) exceeds the rate of accumulating false positives and yields a largé value for the slope of the ROC curve up to the point at which the slope is parallel to the diagonal (dashed line from lower left to upper right of the graph). Beyond this point, false positives accumulate more rapidly than hits and the slope of the ROC curve declines. The positive diagonal represents a ROC in which signals cannot be distinguished from noise or the line which corresponds to chance discrimination. This would occur when the distributions for both bad and good drivers overlap to the extent that they are coincident. In general, the area under the ROC between the curve and the diagonal is directly proportional to the ability of the test score to discriminate the target population, in this case, bad drivers. Thus, the area under the ROC curve can be used as an index to measure how well a given test can perform a discrimination. This result is used next to examine data cm the relationship of visual acuity and visual field to driver safety in two sets of data: (1) acuity scores from the 12,483 drivers of the Decina et al. study[37], and (2) visual field scores from the Council and Allen study[30] of 52,000 North Carolina drivers.

Figure A3 shows the distributions of visual acuity by age found in the Decina data set. As shown there is no difference between drivers up to age 54 and after that age, progressively more drivers score below 20/20. This distribution is also notable in that it does not return to zero on the right side. This is an artifact of the testing and recording procedure that assigns every driver with

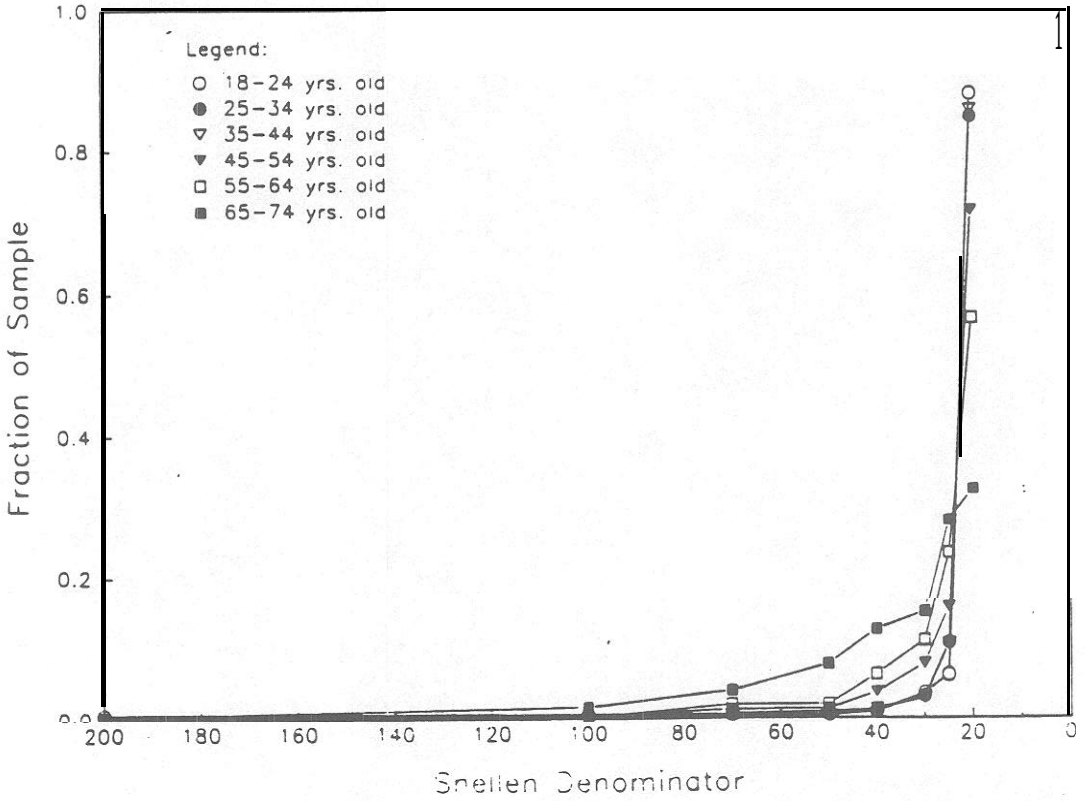

Figure A.3. Distributions of Snellen Visual Acuities at Different Ages

20/20 or better to the 20/20 category. Testing with finer gradients near 20/20 and recording results that are better than 20/20 will show a return to zero frequency at better acuities. However, the distribution will remain sharply peaked near 20/20 and fall off much more rapidly above 20/20 than below (see Hofstetter[27] for examples of acuity distribution shapes). Nevertheless, the distributions can provide a basis for comparison of good and bad drivers since most of the information critical to establishing the nature of the ROC curve is contained in the overlap to the left of 20/20. Figures A.4 and A5 illustrate this point. Figure A.4 plots the visual acuity scores of pooled data for 25 to 44 year olds recorded for both good (open squares) and bad drivers (open triangles) on the same graph. The inset shows an enlarged view of the distributions for scores of 20/40 and below.

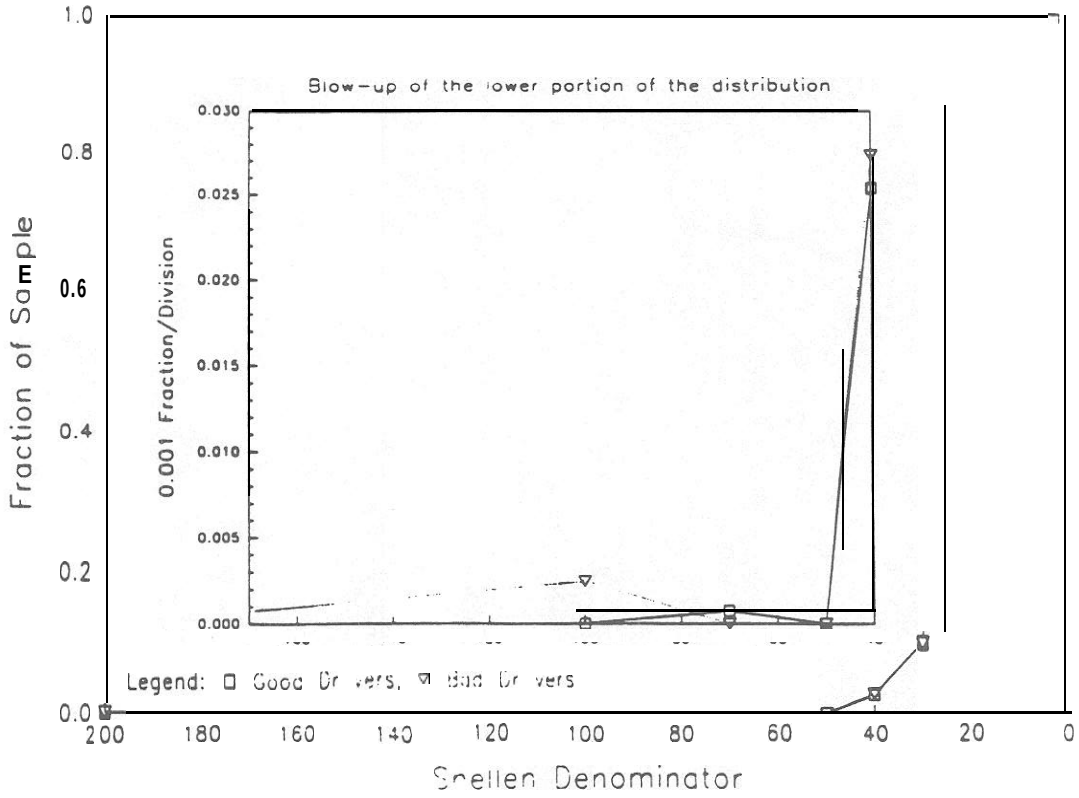

Figure A.4. Acuity Score Distributions for 'Good- and 'Bad" Drivers in the 25 to 44 Age Group

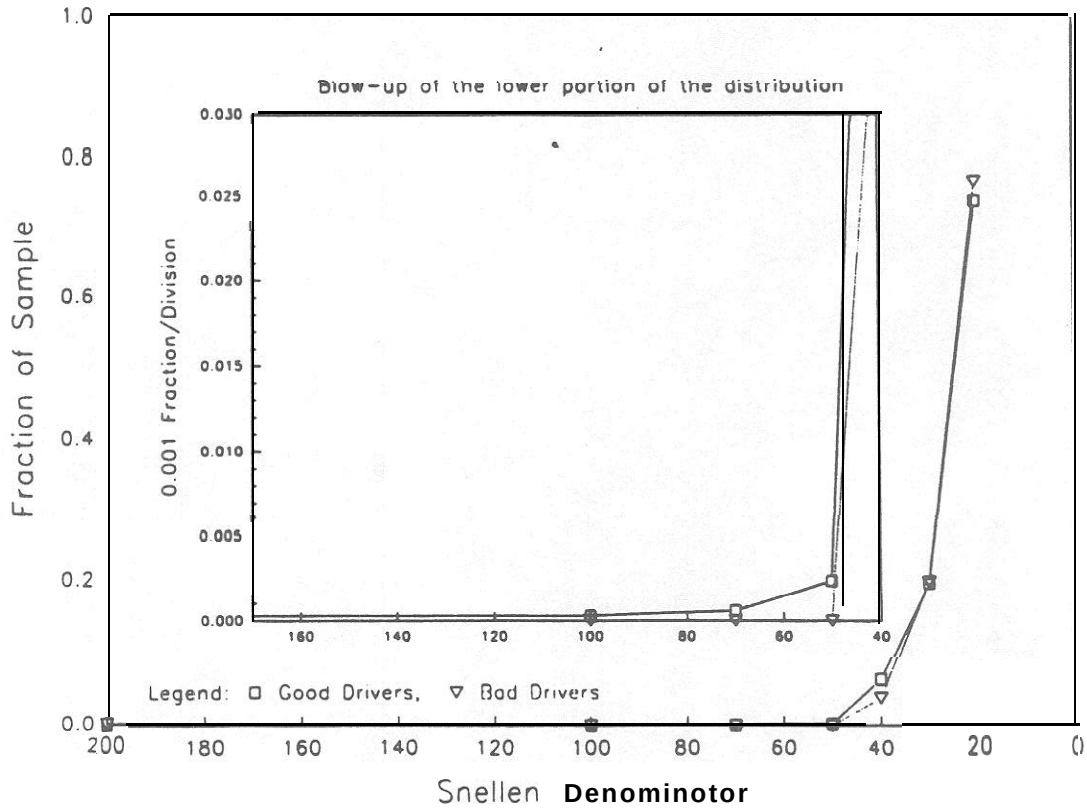

Figure AS. Acuity Distributions for 'Good' and "Bad" Drivers in the 45 to 64 Age Group

Tbe overlap is almost complete, with only a marginal excess of bad drivers over good at 20/100. A similar pattern is seen in Figure AS, which shows data pooled for 45 to 64 year olds. Here, the fraction of bad drivers with 20/20 vision slightly exceeds that of good drivers. The ROC curves corresponding to these distributions are virtually coincident with the positive diagonal. The areas under the ROC curves are .50 and .48 for the two age groups, indicating no discrimination abiity for this test with this population of drivers.

A further analysis is shown in Figures ***Ab, A7,*** and A.8 for visual field scores for the 52,000 drivers of the Council and Allen study[30]. Again, the distributions of the visual field scores for the subgroups of good and bad drivers are almost completely overlapping, and the areas under tbe ROC curves are .50 and .50, again indicating no discrimination power for this variable.

Examination of the score distributions for a test of vision in defined good and bad driver populations provides insight into the problem of predicting driver performance from test scores. The extensive overlap of the well-behaved (relatively smooth) distributions derived from the extensive Decina and Council and Allen data sets indicates that the vision tests administered to

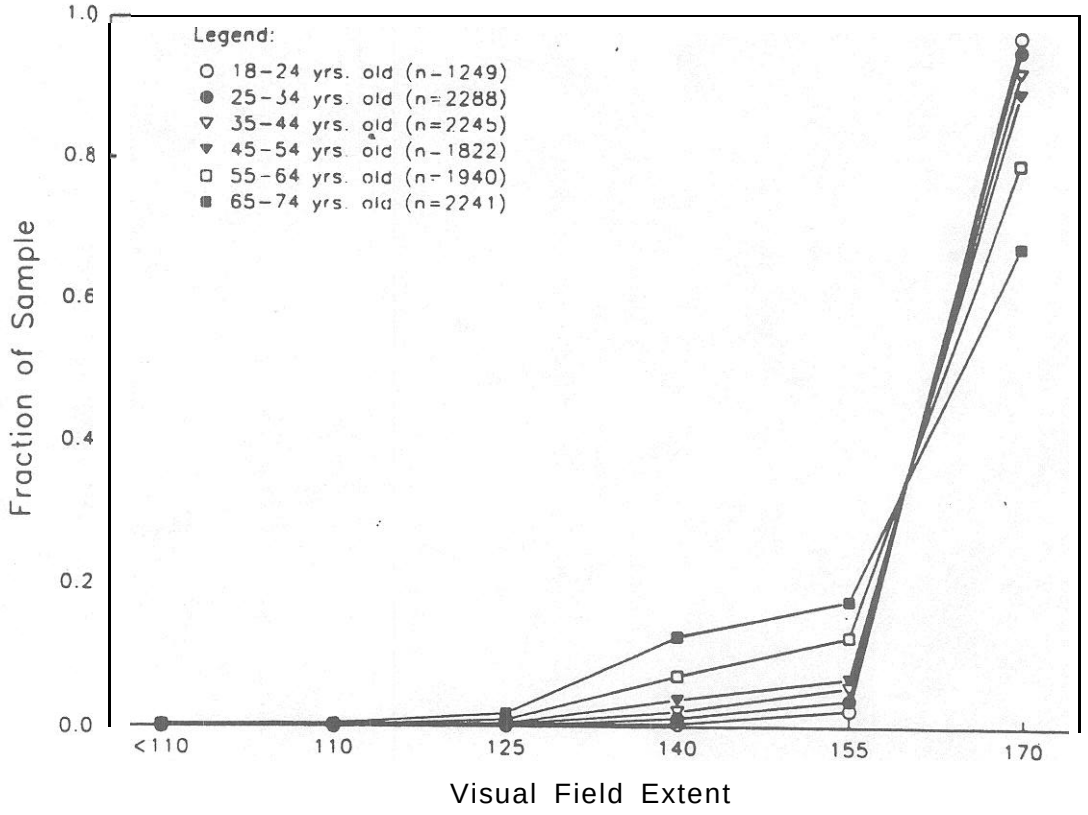

Figure *Ab.* Distributions of Extent of Visual Field

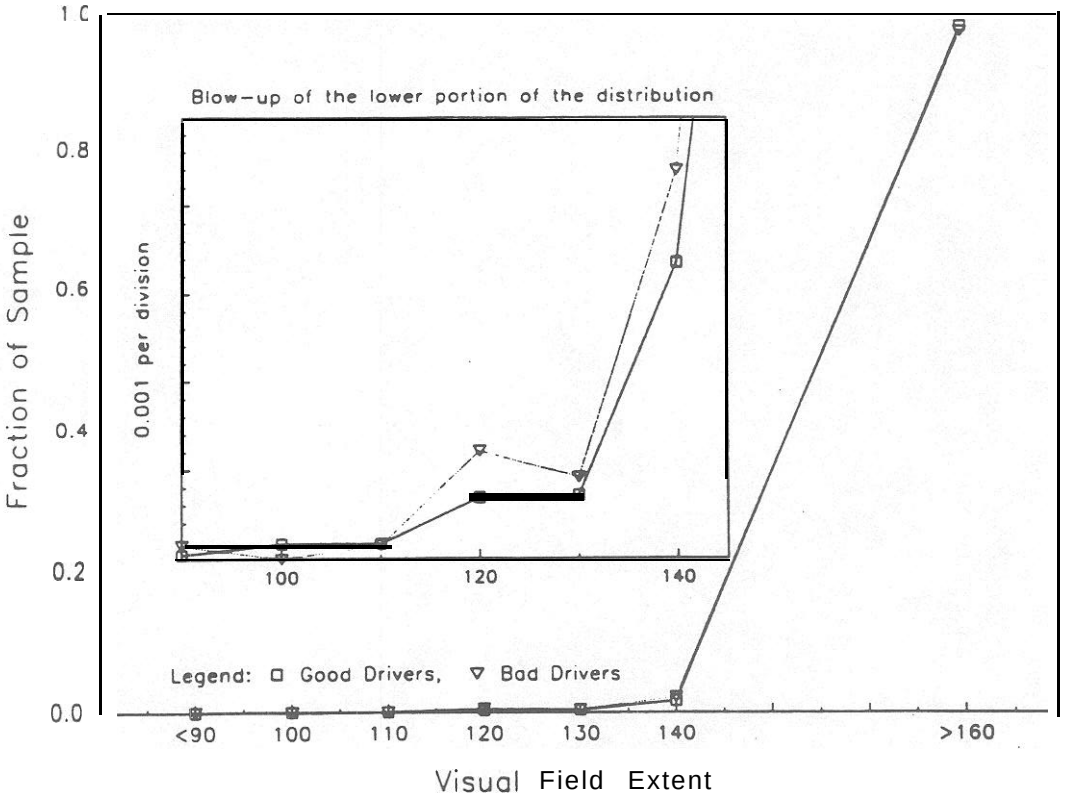

Figure A.7. Visual Field Scores for "Good" and "Bad" Drivers for 26 to 40 Age Group

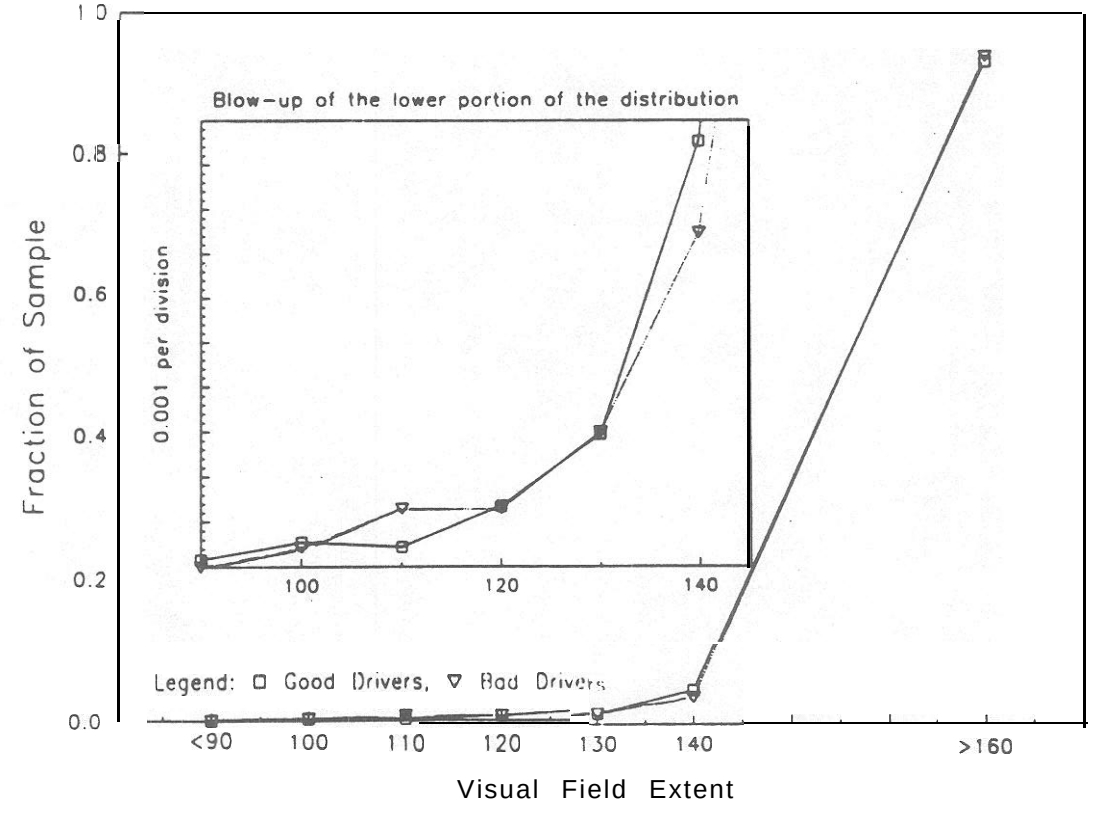

Figure A.8. Visual Field Scores for 'Good- and 'Bad' Drivers for 41 to 60 Age Group

these drivers cannot be used to distinguish reliably between good and bad drivers as they have been defined here. This situation is somewhat more extreme than the one reported by Henderson and Burg,[23] who found significant correlations for both static and dynamic acuity visual test scores. However, it is worth noting that there was no correlation found for visual field and tbe correlation for static acuity was very low.

Do these results mean that visual tests can never be used effectively to screen out poor drivers? Moreover, do these results mean that visual testing is essentially ineffective at maintaining safety on the roads? Several points must be made before answers can be offered for these questions. In particular, a strong argument can be made that the driver populations tested in the Decina and Council and Allen studies, and in most others, do not represent the full range of visual capabilities for potential drivers, nor do they represent the full range of driver capabilities, particularly at the low end of the visual performance scale. Potential drivers with vision below the minimum standard are underrepresented through two mechanisms. First, previously licensed drivers have been prescreened for vision below the standard (for the Pennsylvania drivers of the Decina study, this was only at the time of initial licensing). To the extent that tbc screening exam was accurate and vision remained stable in the intervening time, the driving record of previously licensed drivers reflects performance under conditions of good vision. For drivers falling below the vision standard at the time of retest, it is unclear how much of their driving record should be considered to have occurred under conditions of good vision or under the poorer vision found at the time of retesting. In general, a discrepancy of this kind will favor producing more overlap in tbe distributions. However, this problem is diminished to some extent in the Decina study because only accidents and convictions in the preceding 3-1/2 years were included. Restricting the time horizon for data in this way works in the direction of improving probable correlation of the tested vision with that actually present at the time of the recorded accident or violation. Second, potential new drivers with vision obviously below the standard will be less likely to submit to a driving test which they most likely will fail. These drivers do not accumulate driving records that can be correlated with their vision and are left out of virtually all studies appearing in the literature.

Problems associated with exclusion of drivers with poor vision from the driver database, however, do not seriously weaken the conclusion that tests of visual performance have low power to disaimiite poor or unsafe drivers from safe drivers in those presenting themselves for examination. That visual testing alone cannot disaimiite unsafe drivers, even though vision is necessary to driving, is fundamental to the safe driving problem.

EMERGING TRENDS IN APPLIED VISION RESEARCH

The problems noted previously indicate that, at present, tests of visual performance have low power to discriminate poor or unsafe drivers from safe drivers. One prominent conclusion to be drawn from these data is that factors other than vision must contribute to accidents; tbis is supported by the observation that the same fraction of accident-involved and safe drivers has 20/40 or better vision. A paradigm-the "useful field of view"--for explaining how vision may contribute in conjunction with other factors to produce accidents has been tbe focus of recent investigations by Ball et al.[45] and Sloan, Owsley and Ball.[46] Tbis work has f-d on vision, attention, and elderly driver accident experience, but has obvious applications to the CMV driver assessment problem. An overview of this work is described in a research problem statement prepared by the Basic Research Subcommittee of the TRB Older Driver Task Force (A3T52)[45] and is briefly summarized here.

"Driver inattention" has long been cited as an underlying cause of vehicle crashes in the elderly.[47] In addition, many older adults have deficits in their attentional skills.[48, 49] Three. recent retrospective studies have demonstrated that visual attentional problems are good predictors of poor driving performance in older adults. The first study[50] examined how accident frequency (from state records) in 53 older drivers was related to visual/cognitive capacities at a number of different levels, such as ocular disease, visual sensory function, visual attention, and mental status. The best predictor of accident frequency was a model incorporating a *composite* measure of visual attention (the size of the useful field of view) and mental status, which together accounted for 20 percent of the variance. This model was much stronger than those reported in earlier studies on vision and driving that assessed only visual sensory function, and excluded measures of information processing skills at higher levels.

The useful field of view (UFOV), the best correlate of accident frequency in the aforementioned study, **refers** to the area of the visual field in which information can be rapidly extracted without eye and head movements.[48] It involves the earliest, preattentive (parallel-processing) stage of visual attention which is used to quickly capture and direct attention to highly salient visual events, a skill that seems crucial for effective driving, especially for CMV drivers who require exaggerated lead times for hazard recognition. The UFOV test incorporates measures of

divided attention, selective attention, and speed of visual information processing to arrive at an overall measure of attentional capacity. In this study, the older drivers with restrictions in the size of the useful field of view had *15 times* more intersection accidents than those with normal visual attention.

Obviously, a test of visual attention like the UFOV makes use of information coming through the visual sensory channel. For example, individuals in the previous study who had serious visual field loss also had a serious impairment in the useful field of view. On the other hand, visual sensory field loss was not a necessary and sufficient condition for a constricted UFOV. Many older adults who had impairments in the UFOV bad normal visual fields. Thus, the UFOV depends on the integrity of visual sensory information, and on other processing skills, such as attention. In this sense, it is a more comprehensive measure of information processing ability than visual sensory status alone.

A second and more recent large sample study (over 300 older drivers) by this research group has confirmed that the UFOV is a good predictor of accident problems, with the correlation between accident frequency and UFOV size exceeding $r=0.55$.[51] A correlation of this magnitude between driver capability and crash involvement is virtually unprecedented, underscoring the importance of these findings. This emerging evidence suggests that further research to develop assessment approaches incorporating attentional as well as purely sensory visual capabilities will be a fruitful area of investigation, with a strong potential impact on the evolution of new standards.

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APPENDIX B

RISK ANALYSIS OF A VISUAL ACUITY CRITERION SHIFT

An analytic exercise was conducted in this task to estimate the change in risks associated with shifting the pass/fail criterion for tests of CMV driven' visual acuity. Functional deficits in any of the visual capabilities identified in the previous expert survey as necessary for safe performance could logically be tied to an increased risk of accidents; visual acuity was chosen for the present analysis because. of its prominence in traditional vision test protocols and its high level of face validity to everyday driving tasks. Also, it should be noted that this analysis is specific to a defined operational context, as described below, and necessarily relies upon assumptions in that situation as found in current models of driver response effectiveness.

In particular, this analysis case examines a maneuver/decision response sequence within the more general framework of decision sight distance models.(1) In the present analysis, a safe and effective driver response depends upon sign legibility/comprehension under freeway operating conditions, taking into account the increasing attentional demands for avoiding traffic conflicts and the corresponding decrease in attentional resources available for road sign information processing associated with this situation. A driver unfamiliar with the roadway beii travelled, who must respond to guide sign information to successfully navigate to his/her destination, is also assumed.

The performance context for this analysis is an actual section of highway in southern New Jersey, State Route 130. This highway section has three lanes of travel in each direction; it is a level, tangent section with recorded 1989 average daily traffic (ADT) of 55,860 vehicles' and unobstructed sight distance to the overhead guide signs which are the key visual targets in this analysis. The subject in this analysis is a CMV driver travelling southbound on Route 90 West, the Betsy Ross Bridge leading to Philadelphia. In this case, the exit for NJ Route 90 is from the *left* lane. Two sets of guide signs direct the driver in this situation: an initial pair of overhead signs identifies Route 130 South through lanes and the left exit for Route 90, while a later sign conveys exit information for Route 90 West only. The initial pair of signs is positioned approximately 925 feet (282 meters) upstream of the exit gore; the later exit marker is positioned approximately 125 feet (38 meters) upstream of the exit gore. These highway sign targets are displayed in Figure B.l.

Also shown in Figure B.l is a time/distance scale useful for tracking a driver's approach to the exit point (t_o,d_o), to the extent that a response sequence timeline marking the relative locations of key behavioral events/maneuvers can be defined. The actual vehicle movements required to safely

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✍✍ pcrs. comm., NJDOT Traffic Services Dept., October 9.1991

accomplish the left exit in the situation as described above are straightforward: the CMV driver must change lanes twice—from the far right to the center to the far left lane—in a safe, controlled manner, then exit the highway at the ramp gore.

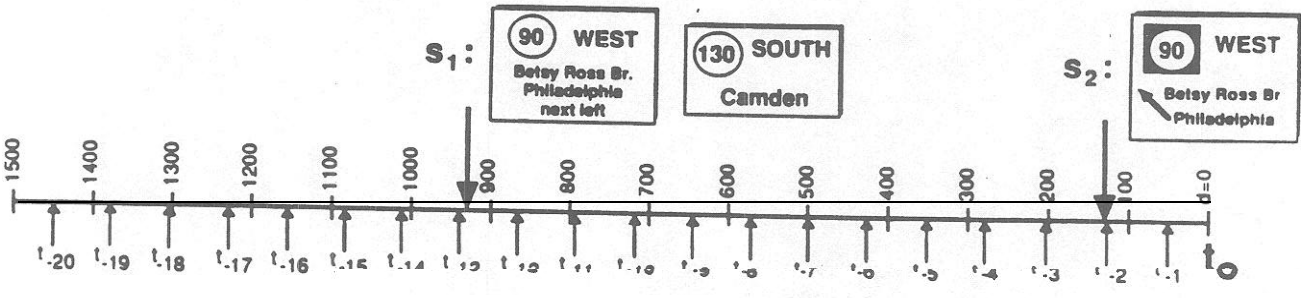
Drivi ask

CMV operator travelling in right lane of 3-lane divided highway must respond to signing information as presented at S, and S_2 to exit from left lane at t_o

Operati

85%-ile speed: 50 mi/h (73 ft/s)

peak volume: headway = 2.5 s
visibility: daytime, clear
highway: dry, level, tangent section



NOTE: 1 ft = .3049 m

Figure B.1. Sign Position Indicated by Time (seconds) and Distance (feet) Upstream of Exit Points ($t_o d_o$)

The perceptual and cognitive components of the driver's behavior as required to effect lane changes in a 'safe, controlled manner" are more problematical. While straightforward to define in a qualitative sense, the precise time requirements and the extent to which such information processing operations can be achieved in parallel are highly dependent upon moment-to-moment traffic conditions and the resulting attentional demands on the driver.

This analysis postulates discrete events in the response sequence timeline. These events include the detection/recognition of the initial overhead sign and the reading/comprehension of its message; the CMV driver's decision (choice reaction time) to initiate a lane change from the right to the center lane; the completion of the first lane change maneuver; the driver's decision (choice RT) to initiate a lane change from the center to the left lane; the completion of the second lane change maneuver; the driver's reading/comprehension of the later sign's message and accompanying decision (choice RT) to initiate an exit maneuver, and the vehicle's actual movement.

To estimate time requirements-and corresponding distances travelled at the 85 percentile speed of 50 miles/hour (73 feet/second)—for each event in the response sequence, current models of driver information processing[1,2] were consulted, supplemented by field observations of CMV lane-change operations on I-95 in the Philadelphia area. Based on the field observations, 5.0 seconds is a representative value for the elapsed time from the instant the left front tire of a CMV cab crosses a lane line until the trailer has completely moved into the adjacent lane at 50 miles/hour. For this analysis, it is assumed that peak volume traffic conditions will not permit a driver to execute both lane changes in a continuous fashion; rather, the first lane change will be completed; then a search for potential conflict vehicles will be performed before initiating the second lane change. Assuming separate vehicle maneuvers, the total time allocated to lane change maneuvers in this response sequence timeline is thus 10.0 seconds.

Another clement of driver behavior to account for in this response sequence is the reading time for the critical information on the initial overhead guide sign (see St in Figure B.l). These critical elements include the route designation (NJ 90), the cardinal direction (WEST), and the guidance information (next left). The name (Betsy Ross Br.) and destination (Philadelphia), which are also likely to be scanned, are not essential to an appropriate vehicle control response in this situation. (It is not the intent in this analysis to demonstrate unrealistically stringent requirements for driver visual capability; this approach suggests using minimum information requirements, translating to minimum reading times and, therefore, minimum required legibility distances.)

The *reading* and comprehension time for this sign (St) is both a function of the driver's expectations and sign content. Since it is assumed that the CMV driver is searching for this guidance information, the sign may be described as a ***search conspicuity*** target.[3] ***This*** heightens the target value of the sign and further supports the logic above, whereby a minimum reading time for the sign is suggested as most appropriate for this analysis. Based on guidelines attributed to Dudek and Forbes reported by Perchonok and Pollack,[4] a range of 25 to as much as 6.0 seconds would be required to read the critical information identified in the preceding paragraph. In consideration of the facilitative effect for processing this test due to the driver's expectation that a sign of this nature will appear-i.e., the search conspicuity target-a minimum reading time of only 2.5 seconds is postulated for this analysis. Again, it is not the intent in this analysis to rely on exaggerated estimates of driver response times that result in unrealistically long reading distance requirements.

Another perspective on this stage of processing is that of "percept&-reaction" time. Because this left exit situation is not commonplace, it is assumed that the driver is *not* expecting to make this maneuver. Therefore, the reading and comprehension time may be estimated fairly using the perception-reaction time of 2.5 seconds which is cited by AASHTO* and is incorporated into serial processing **models** such as the decision sight distance model.[1]

Additional time requirements for the decisions to actually initiate each lane change depend upon the traffic density and the effectiveness with which the CMV driver can use the mirror system on the vehicle. A great deal of variability in this RT component may be introduced by moment-to-moment changes in the traffic flow. Using the most optimistic assumptions about driver visual search efficiency—and further postulating the availability of an acceptable gap under existing operating conditions-a "best-case" estimate of 1.5 seconds for the choice RT to initiate each lane change will be used for this analysis (see *NHTSA Driver Performance* ***Data*** *Book*).

Finally, the reading/comprehension time. for the critical information on the later overhead guide sign (S_2 in Figure B.1) must be taken into account. Again, this may be characterized as a "search conspicuity" target that the driver expects to see. The information contained in this sign also is expected; thus, the component of sign comprehension is reduced to a "yes/no" decision as to

*Handbook on Geometric Design for Highways, American Association of State Highway and Transportation Officials, 1984.

whether the presented information confirms the driver's understanding of the earlier sign's information (S_1). Accordingly, only 15 seconds are allocated to this stage of the exit response sequence-that is, only the minimum time required to read the critical detail on the sign legend: no separate "decision time" is postulated here.

A cumulative estimate of the time/distance necessary to safely perform all the component processes in this response sequence may now be derived, consistent with the assumption and justifications articulated previously. Working *backwards from the* exit gore, identified as t_o and d=O in Figure B.1, the response timeline is as follows:

Driver Performance Requirement	Associated Time Intervals
• Driver initiates exit maneuver in time for cab to leave left lane of highway and move onto ramp at exit gore point.	t_o to $_{f\text{-}1.0}$
• Driver reads critical information on sign S_2.	$t_{-1.0}$ to $t_{-2.5}$
• Driver performs lane change #2 (center lane to left lane).	$t_{-2.5}$ to $t_{-7.5}$
• Choice XT for lane change X2 (visual search, gap judgment, decision to initiate maneuver).	$t_{-7.5}$ to $t_{-9.0}$
• Driver performs lane change Xl (right lane to center lane).	$t_{-9.0}$ to $_{-14.0}$
• Choice RT for lane change Xl (visual search, gap judgment, decision to initiate maneuver).	$t_{-14.0}$ to $t_{-15.5}$
• Driver reads/comprehends critical information on sign S_1.	$t_{-15.5}$ to $t_{-18.0}$
• Driver detects/recognizes sign S_1 and selectively attends to this target	prior to $t_{-18.0}$

Based on this analysis approach, it may thus be argued that safe and effective performance of an exit under these circumstances requires sign S_1 of 320 to 390 feet (98 to 119 meters).

The angular subtense for the Y-inch (lowercase) letters on sign St defines an acuity of 20/20 (Snellen) at 320 feet (98 meters). The conclusion may thus be reached that any reduction of a driver's acuity below 20/20 will result in an increased risk of a conflict in this situation-up to the point where the driver acquires the critical information so late that the required lane-change maneuvers will not be attempted Qualitatively describing the relationship between declining acuity and increasing risk, within this bounded interval, is addressed next.

Missing a required exit from a limited access highway, with the need for additional travel in an unfamiliar area to correct this navigational error, is a potentially costly mistake for a CMV operator. It is, therefore, assumed in this analysis that *some* delay in reading/comprehension of the critical St information will not necessarily result in a driver decision to postpone the required route change, but instead will result in an attempt to accomplish the exit in a shorter time frame than needed for safe performance. Eventually, however, a sufficient delay in reading sign St-given moderate-to-heavy traffic volumes-may be so long that the maneuver will not be attempted For this analysis, the range of St reading distances and associated points in the response sequence timeline shown in Figure B.l will be bounded by the distance at which lowercase text is legible to a driver with 20/20 vision ($t_{-17.0}$ second) and the actual position of the initial overhead sign presenting the exit information of interest ($t_{-12.7}$ second). In other words, it is assumed that a driver who fails to read/comprehend the critical information on sign S, by the time he/she reaches the sign will not attempt the exit maneuver in question in this analysis. The focus of the analysis is to describe a function of relating increasing risk of traffic conflicts/accidents to decreasing St lcgibiity distance resulting from driver visual acuities worse. than 20/20.

With a driver visual acuity of 20/20 in this performance context, it has been argued previously that the available time at 85 percentile operating speed is sufficient for all required components in the response (exit) sequence to be safely accomplished This does not mean that traffic conflict/crash probability is zero under these circumstances, but that a near-zero minimum value is attained As acuity worsens, Icgiiity distance decreases, response time is shortened, and increasing likelihood of conflicts/crashes is a logical prediction.

At best, present understanding of the problem will allow specification of the shape of the function relating the variables described above. Change in legibiity with distance is a linear function; however, factors other than lcgibiity alone influence a driver's decision to proceed (or not to proceed) with the lane-change maneuvers required in this situation. Given the desire to predict

likelihood of a driving behavior, taking decisional/judgmental processes as well as sensory (acuity) processes into account, a normal distribution curve would seem most appropriate. As noted above, the response interval is bounded by the position of the first overhead sign (S_1); it is assumed that a decision to proceed with the lane-change maneuvers needed to accomplish the freeway exit would never occur later than this time/distance on the response sequence timeline in Figure B.l, since the driver would effectively have no advance knowledge of the upcoming exit if the initial sign had not been read. Therefore, it is suggested that the function relating increasing crash risk to decreasing acuity in tbis performance context is best represented by the right half of the normal curve, as shown in Figure B.2. This indicates that a small decrement in acuity would result in only a modest increase in accident risk, but further decrements would result in a dramatic increase in accident risk until some asymptotic level is reached near the cutoff point associated with the position of the initial overhead sign (S_1).

Additional data and analyses are required to calibrate this function and permit the assignment of absolute values to the axis in Figure B.2 indicating accident probability. To limit the values assigned to this function, it may be reasonable to inspect crash data for nighttime clear conditions, nighttime heavy rain conditions, and nighttime fog conditions on the same section of roadway over comparable periods of time. Each of these diminished visibility conditions reduces the preview time of advance sign information to a driver, with increasing reductions in preview time moving from the nighttime clear to the fog conditions. These data may thus serve as a useful analog to the progressive reduction in preview time resulting from lowered acuity in the present analysis case.

In conclusion, shifting the criterion for visual acuity may be expected to result in a measurable increase in probability of a crash whenever a CMV driver's vehicle control decisions depend upon timely comprehension of guidance information presented by highway signing, and moderate-to-heavy traffic conditions increase both the real-time processing load of the driver and the likelihood that sudden or erratic maneuvers will result in conflict with other vehicles. Existing models of driver behavior suggest that the function relating increased accident risk to decreasing acuity (criteria) will mimic the normal probability curve, bat assigning specific values to accident probability will depend upon further analyses of reduced visibility crash data for a given operational situation.

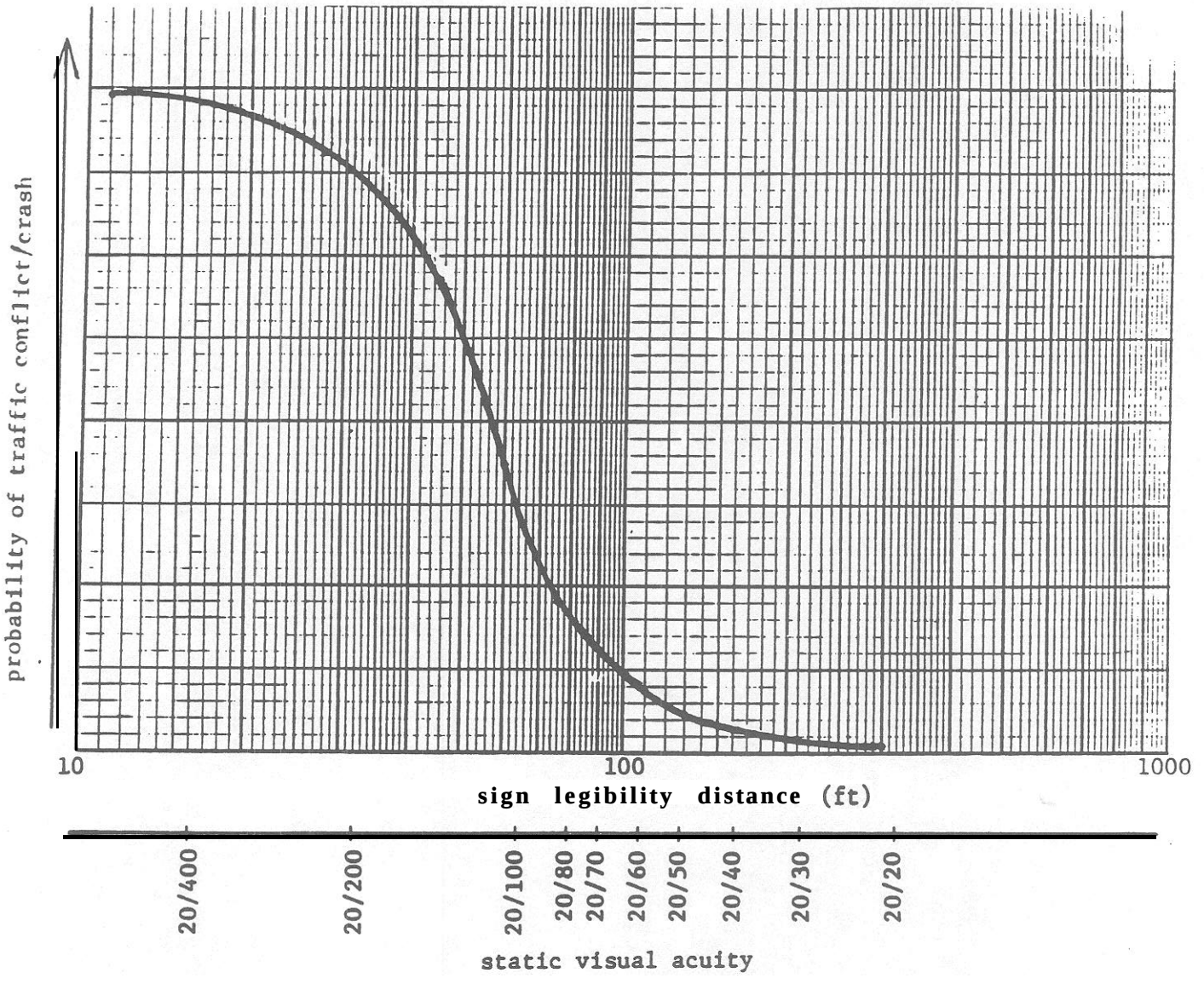


Figure B.2. Candidate Accident Probability Curve for Decreasing Visual Acuity for Present Analysis case.

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APPENDIX C

FEDERAL REGULATIONS FOR PHYSICAL QUALIFICATIONS AND EXAMINATIONS FOR CMV DRIVERS
(49 CFR 391.41 TO 391.49, OCTOBER 1, 1985)

(h) A copy of the certificate required by paragraph (g) of this section shall be given to the person who was examined. The motor carrier shall retain, in the driver qualification file of the person who was examined—

(1) The original, or a copy of, the certificate required by paragraph (g) of this section;

(2) The questions asked on the examination; and

(3) The person's answers to those questions.

[35 FR 19182, Dec. 18, 1970, as amended at 36 FR 223, Jan. 7, 1971; 39 FR 20795, June 14, 1974]

§ 391.37 Equivalent of mitten examination.

(a) In place of, and as equivalent to, the written examination required by § 391.35. . person who seeks to drive . motor vehicle may present, and . motor carrier may accept, a valid certificate written issued p - t to paragraph (g) of that section within the preceding 3 years.

(b) If a motor carrier accepts certificate as equivalent to the written examination, It shall retain . legible COPS of the certificate in its files as Dart Of the driver's qualification file.

(c) A motor carrier may require any person who presents . certificate as equivalent to the written examination to take the written examination prescribed in § 391.35 or participate in any other instructional process designed to acquaint him with the provisions of Parts 390 through 397 of this subchapter.

[35 FR 6460, Apr. 22, 1970, as amended at 35 FR 17420, Nov. 13, 1970]

Subpart E—Physical Qualifications and Examinations

§ 391.41 Physical qualifications for drivers.

(a) A person shall not drive a motor vehicle unless he is physically qualified to do so and, except as provided in § 391.67, has on his person the original, or a photographic copy, of a medical examiner's certificate that he is physically qualified to drive a motor vehicle.

(b) A person is physically qualified to drive a motor vehicle if that person—

(1) Has no loss of a foot, a leg, a hand, or an arm, or has been granted a waiver pursuant to § 391.49;

(2) Has no impairment of:

(i) A hand or finger which interferes with prehension or power grasping; or

(ii) An arm, foot, or leg which interferes with the ability to perform normal tasks associated with operating a motor vehicle; or any other significant limb defect or limitation which interferes with the ability to perform normal tasks associated with operating a motor vehicle; or has been granted a waiver pursuant to § 391.49.

(3) Has no established medical history or clinical diagnosis of diabetes mellitus currently requiring insulin for control;

(4) Has no current clinical diagnosis of myocardial infarction, angina pectoris, coronary insufficiency, thrombosis, or any other cardiovascular disease of a variety known to be accompanied by syncope, dyspnea, collapse, or congestive cardiac failure.

(5) Has no established medical history or clinical diagnosis of a respiratory dysfunction likely to interfere with his ability to control and drive a motor vehicle safely;

(6) Has no current clinical diagnosis of high blood pressure likely to interfere with his ability to operate a motor vehicle safely;

(7) Has no established medical history or clinical diagnosis of rheumatic, arthritic, orthopedic, muscular, neuromuscular, or vascular disease which interferes with his ability to control and operate a motor vehicle safely;

(8) Has no established medical history or clinical diagnosis of epilepsy or any other condition which is likely to cause loss of consciousness or any loss of ability to control a motor vehicle;

(9) Has no mental, nervous, organic, or functional disease or psychiatric disorder likely to interfere with his ability to drive a motor vehicle safely;

(10) Has distant visual acuity of at least 20/40 (Snellen) in each eye without corrective lenses or visual acuity separately corrected to 20/40 (Snellen) or better with corrective lenses, distant binocular acuity of at least 20/40

(Snellen) in both eyes with or without corrective lenses, field of vision of at least 70° in the horizontal Meridian in each eye, and the ability to recognize the colors of traffic signals and devices showing standard red, green, and amber;

(11) First perceives a forced whispered voice in the better ear at not less than 5 feet with or without the use of a hearing aid or, if tested by use of an audiometric device, does not have an average hearing loss in the better ear greater than 40 decibels at 500 Hz, 1,000 Hz, and 2,000 Hz with or without hearing aid when the audiometric device is calibrated to American National Standard (formerly ASA Standard) Z24.5—1951.

(12) Does not use . Schedule I drug or other substance identified in Appendix D to this subchapter.' an amphetamine, . narcotic, or any other habit-forming drug; and

(13) Has no current clinical diagnosis of alcoholism.

[35 FR 6460, Apr. 22, 1970, as unended at 35 FR 17420, Nov. 13, 1970; 36 FR 223, Jan. I. 1971; 36 FR 12857, July 8, 1971; 43 FR 56900, Dec. 5. 1978; 51 FR 17571, May 13. 1986]

§ 391.43 Medical examination; certificate of physical examination.

(a) Except as provided in paragraph (b) of this section, the medical examination shall be performed by a licensed doctor of medicine or osteopathy.

(b) A licensed optometrist may perform so much of the medical examination as pertains to visual acuity, field of vision, and the ability to recognize colors as specified in paragraph (10) of § 391.41(b).

(c) The medical examination shall be performed, and its results shall be recorded, substantially in accordance with the following instructions and examination form:

[1] A copy of the Schedule I drugs and other substances may be obtained by writing to the Director, Bureau of Motor Carrier Safety, Washington, DC 20590, or to any Regional Office of Motor Carrier and Highway Safety of the Federal Highway Administration at the address given in Part 390 of this subchapter.

Instructions for Performing and Recording Physical Examinations

The examining physician should review these instructions before performing the physical examination. Answer each question yes or no where appropriate.

The examining physician should be aware of the rigorous physical demands and mental and emotional responsibilities placed on the driver of a commercial motor vehicle. In the interest of public safety the examining physician is required to certify that the driver does not have any physical, mental, or organic defect of such a nature as to affect the driver's ability to operate safely a commercial motor vehicle.

General information. The purpose of this history and physical examination is to detect the presence of physical, mental, or organic defects of such a character and extent as to affect the applicant's ability to operate a motor vehicle safely. The examination should be made carefully and at least as complete as indicated by the attached form. History of certain defects may be cause for rejection or indicate the need for making certain laboratory tests or a further, and more stringent, examination. Defects may be recorded which do not, because of their character or degree, indicate that certification of physical fitness should be denied. However, these defects should be discussed with the applicant and he should insure correction, particularly of those which, if neglected, might lead to a condition likely to affect his ability to drive safely.

General appearance and development. Note marked overweight. Note any posture defect, perceptible limp, tremor, or other defects that might be caused by alcoholism, thyroid intoxication, or other illnesses. The Federal Motor Carrier Safety Regulations provide that no driver shall use a narcotic or other habit-forming drugs.

Head-eyes. When other than the Snellen chart is used, the results of such test must be expressed in values comparable to the standard Snellen test. If the applicant wears corrective lenses, these should be worn while applicant's visual acuity is being tested. If appropriate, indicate on the Medical Examiner's Certificate by checking the box, "Qualified only when wearing corrective lenses." In recording distance vision use 20 feet as normal. Report all vision as a fraction with 20 as numerator and the smallest type read at 20 feet as denominator. Note ptosis, discharge, visual fields, ocular muscle imbalance, color blindness, corneal scar, exophthalmos, or strabismus, uncorrected by corrective lenses. Monocular drivers are not qualified to operate commercial motor vehicles under existing Federal

Motor Carrier Safety Regulations. If the driver habitually wears contact lenses, or intends to do so while driving, there should be sufficient evidence to indicate that he has good tolerance is well adapted to their use. The use of contact lenses should be noted on the record.

Ears. Note evidence of mastoid or middle ear disease, discharge, symptoms of aural vertigo, or Meniere's Syndrome. When recording hearing, record distance from patient at which a forced whispered voice can first be heard. If audiometer is used to test hearing, record decibel loss at 500 Hz, 1,000 Hz, and 2,000 Hz.

Throat. Note evidence of disease, irremediable deformities of the throat likely to interfere with eating or breathing, or any laryngeal condition which could interfere with the safe operation of a motor vehicle.

Thorax-heart. Stethoscopic examination is required. Note murmurs and arrhythmias, and any past or present history of cardiovascular disease, of a variety known to be accompanied by syncope, dyspnea, collapse, enlarged heart, or congestive heart failures. Electrocardiogram is required when findings so indicate.

Blood pressure. Record with either spring or mercury column type of sphygomomanometer. If the blood pressure is consistently above 160/90 mm. Hg., further tests may be necessary to determine whether the driver is qualified to operate a motor vehicle.

Lungs. If any lung disease is detected, state whether active or arrested; if arrested, your opinion as to how long it has been quiescent.

Gastrointestinal system. Note any diseases of the gastrointestinal system.

Abdomen. Note wounds, injuries, scars, or weakness of muscles of abdominal walls sufficient to interfere with normal function. Any hernia should be noted if present. State how long and if adequately contained by truss.

Abnormal masses. If present, note location, if tender, and whether or not applicant knows how long they have been present. If the diagnosis suggests that the condition might interfere with the control and safe operation of a motor vehicle, more stringent tests must be made before the applicant can be certified.

Tenderness. When noted, state where most pronounced, and suspected cause. If the diagnosis suggests that the condition might interfere with the control and safe operation of a motor vehicle, more stringent tests must be made before the applicant can be certified.

Genito-urinary. Urinalysis is required. Acute infections of the genito-urinary tract, as defined by local and State public health laws, indications from urinalysis of uncontrolled diabetes, symptomatic albumin-urea in the urine, or other findings indicative of health conditions likely to interfere with the control and safe operation of a motor vehicle, will disqualify an applicant from operating a motor vehicle.

Neurological. If positive Romberg is reported, indicate degrees of impairment. Pupillary reflexes should be reported for both light and accommodation. Knee jerks are to be reported absent only when not obtainable upon reinforcement and as increased when foot is actually lifted from the floor following a light blow on the patella, sensory vibratory and positional abnormalities should be noted.

Extremities. Carefully examine upper and lower extremities. Record the loss of impairment of a leg, foot, toe, arm, hand, or fingers. Note any and all deformities, the presence of atrophy, semiparalysis or paralysis, or varicose veins. If a hand or finger deformity exists, determine whether sufficient grasp is present to enable the driver to secure and maintain a grip on the steering wheel. If a leg deformity exists, determine whether sufficient mobility and strength exist to enable the driver to operate pedals properly. Particular attention should be given to and a record should be made of, any impairment or structural defect which may interfere with the driver's ability to operate a motor vehicle safely.

Spine. Note deformities, limitation of motion, or any history of pain, injuries, or disease, past or presently experienced in the cervical or lumbar spine region. If findings so dictate, radiologic and other examinations should be used to diagnose congenital or acquired defects; or spondylolisthesis and scoliosis.

Recto-genital studies. Diseases or conditions causing discomfort should be evaluated carefully to determine the extent to which the condition might be handicapping while lifting, pulling, or during periods of prolonged driving that might be necessary as part of the driver's duties.

Laboratory and other special findings. Urinalysis is required, as well as such other tests as the medical history or findings upon physical examination may indicate are necessary. A serological test is required if the applicant has a history of luetic infection or present physical findings indicate the possibility of latent syphilis. Other studies deemed advisable may be ordered by the examining physician.

Diabetes. If insulin is necessary to control a diabetic condition, the driver is not qualified to operate a motor vehicle. If mild diabetes is noted at the time of examination and it is stabilized by use of a hypoglycemic drug and a diet that can be obtained while the driver is on duty, it should not be considered disqualifying. However, the driver must remain under adequate medical supervision.

The physician must date and sign his findings upon completion of the examination.

EXAMINATION TO DETERMINE PHYSICAL CONDITION OF DRIVERS

Driver's name ——— ☐ New Certification
Address ——— ☐ Recertification
Social Security No. ———
Date of birth ——— Age ——

Yes	No	Health History
☐	☐	Head or spinal injuries.
☐	☐	Seizures, fits, convulsions, or fainting.
☐	☐	Extensive confinement by illness or injury.
☐	☐	Cardiovascular disease.
☐	☐	Tuberculosis.
☐	☐	Syphilis.
☐	☐	Gonorrhea.
☐	☐	Diabetes.
☐	☐	Gastrointestinal ulcer.
☐	☐	Nervous stomach.
☐	☐	Rheumatic fever.
☐	☐	Asthma.
☐	☐	Kidney disease.
☐	☐	Muscular disease.
☐	☐	Suffering from any other disease.
☐	☐	Permanent defect from illness, disease or injury.
☐	☐	Psychiatric disorder.
☐	☐	Any other nervous disorder.

If answer to any of the above is yes, explain:

PHYSICAL EXAMINATION

General appearance and development:
Good —— Fair —— Poor ——
Vision: For distance:
Right 20/ —— Left 20/ ——
☐ Without corrective lenses.
☐ With corrective lenses if worn.
Evidence of disease or injury:
Right —— Left ——
Color Test ——— ———
Horizontal field of vision:
Right ——° Left ——°
Hearing:
Right ear —— Left ear ——
Disease or injury ——— ———
Audiometric Test (complete only if audiometer is used to test hearing) decibel loss at 500 Hz ——, at 1,000 Hz ——, at 2,000 Hz ——
Throat ——— ———
Thorax:
Heart ——— ———
If organic disease is present, is it fully compensated? ———
Blood pressure:
Systolic —— Diastolic ——
Pulse: Before exercise ———
Immediately after exercise ———
Lungs ———
Abdomen:
Scars —— Abnormal masses ——
Tenderness ——
Hernia: Yes —— No ——
If so, where? ———
Is truss worn? ———
Gastrointestinal:
Ulceration or other disease:
Yes —— No ——
Genito-Urinary:
Scars ——— ———
Urethral discharge ——— ———
Reflexes:
Romberg ——— ———
Pupillary —— Light R —— L ——
Accommodation Right —— Left ——
Knee Jerks:
Right:
Normal —— Increased —— Absent ——
Left:
Normal —— Increased —— Absent ——
Remarks ——— ———
Extremities:
Upper ——— ———
Lower ——— ———
Spine ——— ———
Laboratory and other Special Findings:
Urine: Spec. Gr. —— Alb. ——
Sugar ——
Other laboratory data (Serology, etc.)
——— ———
Radiological data ——— ———
Electrocardiograph ——— ———
General comments ——— ———

——— (Date of examination)

——— (Address of examining doctor)

——— (Name of examining doctor (Print))

——— (Signature of examining doctor)

NOTE: This section to be completed only when visual test is conducted by a licensed ophthalmologist or optometrist.

——— (Date of examination)

——— (Address of ophthalmologist or optometrist)

——— (Name of ophthalmologist or optometrist (Print))

(Signature of ophthalmologist or optometrist)

(d) If the medical examiner finds that the person he examined is physically qualified to drive a motor vehicle in accordance with § 391.41(b), he shall complete . certificate in the form prescribed in paragraph (e) of this section and furnish one copy to the person who was examined and one copy to the motor carrier that employs him.

(e) The medical examiner's certificate shall be in accordance with the following form:

MEDICAL EXAMINER'S CERTIFICATE

I certify that I have examined _____ (driver's name (print)) in accordance with the Federal Motor Carrier Safety Regulations (49 CFR 391.41 through 391.49) and with knowledge of his duties, I find him qualified under the regulations.

☐ Qualified only when wearing corrective lenses.

A completed examination form for this person is on file in my office at _____ (Address)

_____ (Date of examination)

_____ (Name of examining doctor (Print))

_____ (Signature of examining doctor)

_____ (Signature of driver)

_____ (Address of driver)

If the driver is qualified only when wearing a hearing aid, the following statement must appear on the medical examiner's certificate: "Qualified only when wearing a hearing aid." If a medical examiner determines a waiver is necessary under § 391.49, the following statement shall appear on the medical examiner's certificate; "medically unqualified unless accompanied by a waiver.

[35 FR 6460, Apr. 22, 1970, as amended at 35 FR 17420, Nov. 13, 1970; 36 FR 8452, May 6, 1971; 36 FR 12857, July 8, 1971; 43 FR 56900, Dec. 5, 1978; 46 FR 53418, Oct. 29, 1981]

§ 391.45 Persons who must be medically examined and certified.

Except as provided in i391.67. the following persons must be medically examined and certified in accordance with § 391.43 as physically qualified to drive a motor vehicle:

(a) Any person who has not been medically examined and certified as physically qualified to drive a motor vehicle;

(b) Any driver who has not been medically examined and certified as qualified to drive a motor vehicle during the preceding 24 months; and

(c) Any driver whose ability to perform his normal duties has been impaired by a physical or mental injury or disease

[35 FR 6460, Apr. 22, 1970, as amended at 36 FR 223, Jan. 7, 1971]

§391.47 Resolution or conflicts of medical evaluation.

(a) *Applications.* Applications for determination of a driver's medical qualifications under standards in this put will only be accepted if they conform to the requirements of this section.

(b) *Content.* Applications will be accepted for consideration only if the following conditions are met.

(1) The application must contain the name and address of the driver, motor carrier, and all physicians involved in the proceeding.

(2) The applicant must submit proof that there is . disagreement between the physician for the driver and the physician for the motor carrier concerning the driver's qualifications.

(3) The applicant must submit a copy of an opinion and report including results of all tests of an impartial medical specialist in the field in which the medical conflict arose. The specialist should be one agreed to by the motor carrier and the driver.

(i) In cases where the driver refuses to agree on . specialist and the applicant is the motor carrier, the applicant must submit . statement of hb agreement to submit the matter to an impartial medical specialist in the field, proof that he has requested the driver to submit to the medical specialist, and the response, if any, of the driver to his request.

(ii) In cases where the motor carrier refuses to agree on a medical specialist, the driver must submit an opinion and test results of an impartial medical specialist, proof that he has requested the motor carrier to agree to submit the matter to the medical specialist and the response, if any, of the motor carrier to his request.

(4) The applicant must include . statement explaining in detail why the decision of the medical specialist identified in paragraph (b)(3) of this section, is unacceptable.

(5) The applicant must submit proof that the medical specialist mentioned in paragraph (b)(3) of this section was provided, prior to his determination, the medical history of the driver and an agreed-upon statement of the work the driver Performs.

(6) The applicant must submit the medical history and statement of work provided to the medical specialist under paragraph (b)(5) of this section.

(7) The applicant must submit all medical records and statements of the physicians who have given opinions on the driver's qualifications.

(8) The applicant must submit a description and . copy of all written and documentary evidence upon which the party making application relies in the form set out in 49 CFR 336.37.

(9) The application must be accompanied by a statement of the driver that he intends to drive in interstate commerce not subject to the commercial zone exemption or. statement Of ths carrier that he has wed or intends to use the driver for such work.

(10) The applicant must submit three copies Of the application and all records.

(c) *Information.* The Director MY request further information from the applicant if he determines that a decidon cannot be made on the evidence submitted. If the applicant fails to submit the information requested, the Director may refuse to issue a determination.

(d)(1) *Action.* Upon receiving a satisfactory ⊘⊘⊘⊘⊘⊘⊘⊘⊘⊘⊘⊘ the Director shall notify the parties (the driver, motor carrier, or any other Interested party) that the application has been accepted and that. determination will be made. A copy of all evidence received shall be attached to the notice.

(2) *Reply.* Any party may submit , reply to the notification within 15 days after service. Such reply must be accompanied by all evidence the party wants the Director to consider in making his determination. Evidence submitted should include all medical records and test results upon which the party relies.

(3) *Parties.* A party for the purposes of this section includes the motor carrier and the driver, or anyone else submitting an application.

(e) *Petitions to review. burden of proof.* The driver or motor carrier may petition to review the Director's determination. Such petition must be submitted in accordance with § 386.13(a) of this chapter. The burden of proof in such a proceeding is on the petitioner.

(f) *Status of driver.* Once an application is submitted to the Director, the driver shall be deemed disqualified until such time as the Director m&es . determination, or until the Director orders otherwise.

(49 U.S.C. 304, 322; 18 U.S.C. 831-835; Pub. L. 93-633, 88 Stat. 8156 (49 U.S.C. 1801, *et seq.*); 49 CFR 1.48, 301.60)

[42 FR 18081, Apr. 5.1971. as amended at 42 FR 53966, Oct. 4.19771

5391.49 Waiver of certain physical de. fects.

(a) A person who is not physically qualified to drive under § 391.41(b) (1) or (2) and who is otherwise qualified to drive a motor vehicle, may drive a motor vehicle, if the Regional Director, Motor Carrier Safety has granted . waiver to that person.

(b) A letter of application for . waiver may be submitted jointly by the person who seeks a waiver Of the physical disqualification (driver applicant) and by the motor carrier that will employ the driver applicant if the application is granted. The application must be addressed to the Regional Director, Motor Carrier Safety for the region in which the coapplicant motor carrier's principal place of business is located. The address for each regional office is listed in § 390.40 of this subchapter. *Exception.* A letter of applica-

tion for . waiver may be submitted unilaterally by a driver applicant. The application must be addressed to the Regional Director. Motor Carrier Safety for the region in which the driver has legal residence. The address of each regional office b listed in § 380.40 of thb subchapter. The driver applicant must comply with all the requirements of paragraph (c) of this section except paragraphs (c)(1) (i) and (iii). The driver applicant shall respond to the requirements of paragraph (c)(2) (i) to (v) of this section, if the information b known.

(c) A letter Of application for a waiver shall contain—

(1) Identification of the applicant(s):

(i) Name and complete address of the motor carrier coapplicant;

(ii) Name and complete address of the driver applicant;

(iii) The Federal Highway Administration Motor Carrier Identification Number. if known; and

(iv) A description of the driver applicant's limb impairment for which waiver b requested

(2) Description of the type of operation the driver will be employed to Perform:

(i) State(s) in which the driver will operate for the motor carrier coapplicant (if more than 10 States, designate general geographic area only);

(ii) Average period of time the driver will be driving and/or on duty. per day;

(iii) Type Of commodities or cargo to be transported;

(iv) Type O f driver operation (i.e. sleeper-team, relay, owner operator, etc.); and

(v) Number of years ∠∠ xpa-knce operating the type of vehicle(s) requested in the letter Of application and total years Of experience operating all types of motor vehicles.

(3) Description of the vehicle(s) the driver applicant intends to drive:

(i) Truck, truck-tractor, or bus make, model, and year (if known);

(ii) Drive train;

(A) Transmission type (automatic or manual—if manual, designate number Of forward speeds);

(B) Auxiliary transmission (if any) and number of forward speeds; and

(C) Rear a x l e (designate single speed, 2 speed, or 3 speed).

(iii) Type of brake system:

(iv) Steering, manual o r power assisted;

(v) Description Of type Of trailer(s) (i.e., van, flat bed. cargo tank. drop frame, lowboy, or pole);

(vi) Number of semitrailers or full trailers to be towed at one time

(vii) For passenger-carrying vehicles. indicate seating capacity of vehicle: and

(viii) Description Of any v e h i c l e modification(s) made for the driver applicant; attach photograph(s) where applicable.

(4) Otherwise qualified:

(i) The coapplicant motor carrier must certify that the driver applicant b otherwise qualified under the regulations Of thb part;

(ii) In the case of. unilateral application, the driver applicant must certify that (s)he b otherwise qualified under the regulations of this part.

(5) Signature Of applicant(s):

(i) Driver applicant's signature and date signed;

(ii) Motor carrier official's signature (if application has a coapplicant), title, and date signed. Dependent upon the motor carrier's organizational structure (corporation, partnership, or proprietorship), thb signer of the application shall *be* an officer, partner, *or* the proprietor.

(d) 'We letter of application for a waiver shall be accompanied by:

(1) A copy of the results of the medical examination performed pursuant to § 391.43;

(2) A copy Of the medical certificate completed pursuant to § 391.43(e);

(3) A medical evaluation summary completed by either a board qualified or board certified physiatrist (doctor o f physical medicine) or orthopedic surgeon;

NOTE The coapplicant motor carrier or the driver applicant shall provide the physiatrist or orthopedic surgeon with . description of the Job tasks the driver applicant will be required to perform.

(i) The medical evaluation summary for a driver applicant disqualified under § 391.41(b)(1) shall Include:

98-184 O—87—15

(A) An assessment 01 the functional capabilities of the driver as they relate to the ability 01 the driver to perform normal tasks associated with operating . motor vehicle. and

(B) A statement by the examiner that ⁄⁄⁄⁄⁄⁄ wllunt is capable 01 demonstrating precision prehension (e.g., manipulating knobs and switches) and power grasp prehension (e.g., holding and maneuvering the steering wheel) with each upper limb separately. This requirement does not apply to an individual who was granted . waiver, absent a prosthetic device. prior to the publication 01 this amendment.

(ii) The medical evaluation summary for a driver applicant disqualified under § 391.41(b)(2) shall Include:

(A) An explanation as to how and why the impairment interferes with the ability 01 the applicant to perform normal tasks associated with operating a commercial motor vehicle:

(B) An assessment and medical opinion 01 whether the condition will likely remain medically stable over the lifetime 01 the driver applicant; and

(C) A statement by the examiner that the applicant is capable of demonstrating precision prehension (e.g., manipulating knobs and switches) and power grasp prehension (e.g., holding and maneuvering the steering wheel) with each upper limb separately. This requirement does not apply to an individual who was granted . waiver, absent an orthotic device, prior to the publication 01 this amendment.

(4) A description 01 the driver applicant's prosthetic or orthotic device worn, if any, by the driver applicant;

(5) Road test:

(i) A COPY 01 the driver⁄⁄⁄ pplIant's' road test administered by the motor carrier coapplicant and the certificate issued pursuant to 1 3 9 1 . 3 1 (b) through (g); or

(ii) A unilateral applicant shall be responsible for having a road test administered by a motor carrier or . person who is competent to administer the test and evaluate its results.

(6) Application for employment:

(i) A copy 01 the driver applicant's application for employment completed pursuant to § 391.21: or

(ii)⁄ A unilateral⁄ ⁄⁄ pplIcult shall be responsible for submitting . copy 01. the last commercial driving position's employment application s/he held If not previously employed as a commercial driver. so state.

(7) A COPY 01 the driver applicant's waiver of certain physical defects issued by the individual State(s), where applicable; and

(8) A COPY of the driver applicant's State Motor Vehicle Driving Record for the Put 3 years from each State in which a motor vehicle driver's license Or permit has been obtained.

(e) *Agreement.* A motor carrier that employs . driver with . waiver agrees to:

(1) We promptly (within 30 days) with the Regional Director, Motor Carrier Safety such documents and information as may be required about driving activities, accidents, arrests. license suspensions, revocations. or withdrawals, and convictions which involve the driver applicant. This applies whether the driver's waiver is a unilateral one or has a coapplicant motor carrier;

(i) A motor carrier who is a coapplicant must file the required documents with the Regional Director, Motor Carrier Safety for the region in which the carrrier's principal place of business is located; or

(ii) A motor carrier who employs ⁄ driver who has been issued . unilateral waiver must file the required documents with the Regional Director, Motor Carrier Safety for the region in which the driver has legal residence.

(2) Evaluate the driver with a road tat using the trailer the motor curler intends the driver to transport or. in lieu of, accept . certificate of a trailer road teat from another motor carrier if the trailer type(s) is similar or accept the trailer rod test done during the Skill Performance Evaluation⁄if⁄⁄⁄⁄is⁄⁄⁄similar⁄⁄⁄⁄⁄⁄⁄⁄⁄type(s)⁄⁄⁄ ⁄⁄⁄⁄⁄⁄⁄⁄⁄⁄⁄⁄prospective⁄motor carrier;

NOTE: Jab tasks, as stated lo paragraph (e)(3) of this section, are not evaluated in the Skill Performance Evalulation.

(3) Evaluate the driver for those nondriving safety-related job tasks associated with whatever type 01 trailer(s) will be used and any other nondriving safety-related or job-relat-

ed tasks unique to the operations of

(4) Use the driver to operate the type Of motor vehicle defined in the waiver only when the driver is in compliance with the conditions and limitations of the waiver.

(f) The driver shall supply each employing motor carrier with a copy of the waiver.

(g) The Regional Director. Motor Carrier Safety may require the driver applicant to demonstrate his or her ability to to safely operate the motor vehicle(s) the driver intends to drive to an went of the Regional Director, Motor Carrier Safety. The waiver form will Identify the power unit (bus, truck, truck-tractor) for which the waiver has been granted. The waiver forms will also identify the trailer type used in the Skill Performance Evaluation; however, the waiver is not limited to that specific trailer type. A driver may use the waiver with other trailer types if a successful trailer road test b completed in accordance with paragraph (e)(2) Of this section. Job tasks, as stated in paragraph (e)(3) of thb section, are not evaluated during the Skill Performance Evaluation.

(h) The Regional Director, Motor Carrier Safety may dew the application for waker or may grant it totally Or in Part end issue the waiver subject to such terms, conditions, and limitations as deemed consistent with the public interest. A waiver b valid for a period not to exceed 2 years from date of issue, and may be renewed 30 days prior to the expiration date.

(i) The waiver renewal application shall be submitted to the Regional Director, Motor Carrier Safety for the region in which the driver has legal residence. If the waiver was issued unilaterally. If the waiver has a coapplicant, then the renewal application b submitted to the Regional Director Motor Carrier Safety for. the region in which the coapplicant motor carrier's principal place of business b located. The waiver renewal application shall contain the following:

(1) Name and complete address of motor carrier currently employing the applicant;

(2) Name and complete address of the driver;

(3) Effective date of the current waiver;

(4) Expiration date of the current waiver;

(5) Total miles driven under the current waiver;

(6) Number of accidents incurred while driving under the current waiver. including date of the accident(s), number of fatalities number Of injuries, and the estimated dollar amount of property damage:

(7) A current medical examination report;

(8) A medical evaluation summary pursuant to paragraph (d)(3) of this section if an unstable medical condition. All handicapped conditions classified under § 391.41(b)(1) are considered unstable.

NOTE: Refer to paragraph (d)(3)(ii) of this section for the condition under § 391.41(b)(2) which may be considered

(9) A COPY Of driver's current State motor vehicle driving record for the period Of time the current waiver has been in effect;

(10) Notification of any change in the type of tractor the driver will operate;

(11) Driver's signature and date signed; and

(12) Motor carrier coapplicant's signature and date signed.

(j) Upon granting a waiver, the Regional Director. Motor Carrier Safety will notify the driver applicant and coapplicant motor carrier (if applicable) by letkr. The terms, conditions, and limitations of the waiver will be set forth. A motor carrier shall maintain a copy of the waiver in its driver qualification file. A copy of the waiver shall be retained in the motor carrier's file for a period Of 3 years after the driver's employment is terminated. The driver applicant shall have the waiver (or a legible copy) in his/her possession whenever on duty.

(k) The Regional Director. Motor Carrier Safety may revoke a waiver after the person to whom It was issued b given notice of the proposed revocation and has been allowed . reasonable opportunity to appeal.

(l) Falsifying information in the letter Of application, the renewal ap-

plication, or falsifying information required by this section by either the applicant or motor carrier is prohibited.

(Approved by the Office of Management and Budget under control number 2125-0080)

[48 FR 38487, Aug. 24, 1983, as amended at 49 FR 38293, Sept. 28, 1984; 50 FR 49851, Dec. 6, 1985; 51 FR 12621, Apr. 14, 1986]

Subpart F—Files and Records

§ 391.51 Driver qualification files.

(a) Each motor carrier shall maintain a driver qualification file for each driver it employs. A driver's qualification file may be combined with his personnel file.

(b) The qualification file for a driver who has been a regularly employed driver of the motor carrier for a continuous period which began before January 1, 1971, must include:

(1) The medical examiner's certificate of his physical qualification to drive a motor vehicle or a legible photographic copy of the certificate;

(2) The Regional Federal Highway Administrator's letter granting a waiver of a physical disqualification, if a waiver was issued under § 391.49;

(3) The note relating to the annual review of his driving record required by § 391.25;

(4) The list or certificate relating to violations of motor vehicle laws and ordinances required by § 391.27; and

(5) Any other matter which relates to the driver's qualifications or ability to drive a motor vehicle safely.

(c) The qualification file for a regularly employed driver who has not been regularly employed by the motor carrier for a continuous period which began before January 1, 1971, must include:

(1) The documents specified in paramph (b) of this section;

(2) The driver's application for employment completed in accordance with § 391.21;

(3) The responses of State agencies and past employers to the motor carrier's inquiries concerning the driver's driving record and employment pursuant to 1391.23;

(4) The certificate of driver's road tat issued to the driver pursuant to § 391.31(e), or a copy of the license or certificate which the motor carrier accepted as equivalent to the driver's road test pursuant to § 391.33; and

(5) The questions asked, the answers the driver gave, and the certificate of written examination issued to him pursuant to § 391.35, or a copy of a certificate which the motor carrier accepted as equivalent to a written examination pursuant to § 391.37.

(d) The qualification file for an intermittent, casual, or occasional driver employed under the rules in § 391.63 must include—

(1) The medical examiner's certificate of his physical qualification to drive a motor vehicle or a legible photographic copy of the certificate;

(2) The certificate of driver's road test issued to the driver pursuant to § 391.31(e), or a copy of the license or certificate which the motor carrier accepted as equivalent to the driver's road test pursuant to § 391.31;

(3) The questions asked, the answers the driver gave, and the certificate of written examination issued to him pursuant to 1391.35, or a copy of a certificate which the motor carrier accepted as equivalent to a written examination pursuant to § 391.37; and

(4) The driver's name, his social security number, and the identification number, type, and issuing State of his motor vehicle operator's license.

(e) A using carrier's qualification file for a driver who is regularly employed by another motor carrier, and who is employed by the using carrier in accordance with § 391.65 of this part, shall include a copy of a certificate, as prescribed by § 391.65(a)(2) of this part, by the regularly employing carrier that the driver is fully qualified to drive a motor vehicle.

(f) Except as provided in paragraphs (g) and (h) of this section, each driver's qualification file shall be kept at the motor carrier's principal place of business for as long as a driver is employed by that motor carrier and for 3 years thereafter.

(g) Upon a written request to, and with the approval of, the Director, Regional Motor Carrier Safety Office, for the region in which a motor carrier has his principal place of business, the carrier may retain one or more of its

APPENDIX D

EXPERT OPINION SURVEY FORMS

INSTRUCTIONS

We have provided a list of seleted driving task'components that are used by commercial motor vehicle operators. For each driving task, identifyby order of importance three visual functions that are necessary for safely performing these driving tasks.

VEHICLE MANEUVER/DRIVING TASK

DRIVING TASK	VISUAL FUNCTION 1	2	3
MAINTAINING SAFE SPEED FOR CODITIONS (HIGHWAY GEOMETRY/WEATHER/VISBILITY)			
MAINTAINING SAFE FOLLOWING DISTANCE			
STAYING IN LANE/STEERING CONTROL			
MERGING/YIELDING IN TRAFFIC CONFLICT SITUATIONS (LANE DROP, RAMP GORE, INTERSECTION OR DRIVEWAY)			
CHANGING LANES AND PASSING			
COMPLYING WITH TRAFFIC CONTROL DEVICES (SIGNS, SIGNALS AND PAVEMENT MARKINGS			
BACKING UP/PARKING OPERATIONS			

0291b/49/Form 1

Panelist Name

INSTRUCTIONS

In this continuation of the expert rating exercise you are asked to provide two kinds of responses. First, the matrix below shows the results of your (collective) judgment with respect to which visual functions are most important for each specified driving task. So far. so good. Now we would like you to identify the minimum acceptable level of performance for each visual function ranked 1, 2. and 3 for each driving task. If, for example, you wish to use the same performance level every time a given function appears in the matrix, just write it in once under that function and leave the other boxes labeled with that function blank. Call Larry Decina or Loren Staplin if you have any questions.

Next, we ask you to provide ratings estimating the relative performance levels to be expected for matched (on age, sex, experience, IQ, etc.) monocular and binocular drivers for each of the seven CMV driving tasks identified below. Please place two marks on each bipolar scale and label them "M" and "B" for monocular and binocular, respectively. Also, please assume that differences in response capability, if any, are due solely to monocular versus binocular status when marking your ratings on each scale; i.e., the same drivers in the same "reasonable worst-case" situation are faced with identical vehicle control demands, and are equally equipped to respond in all capacities except for monocular versus binocular status.

Thank you for your help in completing this expert opinion survey. Please return these pages by mail of fax by July 8, 1991, if possible, and no later than July 15.

1. FILL IN MINIMUM ACCEPTABLE PERFORMANCE LEVELS FOR EACH INDICATED VISUAL FUNCTION

CMV DRIVING TASK	SELECTED VISUAL FUNCTIONS		
	1	2	3
MAINTAINING SAFE SPEED FOR CONDITIONS (HIGHWAY GEOMETRY/WEATHER/VISIBILITY)	Visual Fields	Motion Perception	Contrast Sensitivity
MAINTAINING SAFE FOLLOWING DISTANCE	Depth Perception/Stereopsis	Motion Perception	Visual Fields
STAYING IN LANE/STEERING CONTROL	Visual Fields	Static Visual Acuity	Contrast Sensitivity
MERGING/YIELDING IN TRAFFIC CONFLICT SITUATIONS (LANE DROP, RAMP GORE, INTERSECTION OR DRIVEWAY)	Visual Fields	Visual Search/Attentio..	Motion Perception
CHANGING LANES AND PASSING	Visual Fields	Depth Perception/Stereopsis	Motion Perception
COMPLYING WITH TRAFFIC CONTROL DEVICES (SIGNS, SIGNALS AND PAVEMENT MARKINGS)	Static Visual Acuity	Visual Fields	Contrast Sensitivity
BACKING UP/PARKING OPERATIONS	Depth Perception/Stereopsis	Visual Fields	Contrast Sensitivity

291b/56/Form 3

NAME:_____

2. RELATIVE SAFETY RATINGS FOR MATCHED MONOCULAR AND BINOCULAR DRIVERS (MARK "M" AND "B" ON EACH SCALE)

CMV DRIVING TASK	LIKELIHOOD OF SAFE PERFORMANCE UNDER "REASONABLE WORST-CASE" OPERATING CONDITIONS
EXAMPLE:	unlikely (M or B) (M B) extremely likely 1 2 3 4 5 6 7
Maintaining safe speed for conditions	extremely unlikely 1 2 3 4 5 6 7 extremely likely
Maintaining safe following distance	extremely unlikely 1 2 3 4 5 6 7 extremely likely
Staying in lane/ steering control	extremely unlikely 1 2 3 4 5 6 7 extremely likely
Merging/yielding in traffic conflict situations (e.g., ramps, intersections)	extremely unlikely 1 2 3 4 5 6 7 extremely likely
Changing lanes and passing	extremely unlikely 1 2 3 4 5 6 7 extremely likely
Complying with traffic control devices	extremely unlikely 1 2 3 4 5 6 7 extremely likely
Backing up/parking operations	extremely unlikely 1 2 3 4 5 6 7 extremely likely

RETURN TO: KETRON, INC.
600 Louis Dr., Suite 203
Warminster, PA 18974
ATTN: L. Decina

Phone: 215-957-8013
FAX: 215-957-8099

NAME: _____

PLEASE RETURN BOTH PAGES AT THE SAME TIME

APPENDIX E

PANELISTDIRECTORY

Merrill J. Allen, O.D., Ph.D.
Indiana university, School of optometry
800 East Atwater
Bloomington, IN 47405
812-855-7663

Clifford Anderson
MRS Diagnostics, Inc.
1829 Piie Street
Philadelphia, PA 19103
215-732-9490

Karlene Ball, Ph.D.
Professor of Psychology
Department of Psychology
Western Kentucky University
Bowling Green, KY 42101
502-745-0111

Bernard R. Blais, M.D., Medical Director
Knolls Atomic Power Laboratory
General Electric Corp.
P.O. Box 1072
Building C2, Room 110
Schenectady, N Y 12301
518-395-4235

Raymond P. Briggs, Ph.D.
Research Coordinator
Perceptual Safety and Systems Research
1148 Garfield Avenue
S. Pasadena, CA 91030
818-799-3409

Neill Darmstadter
Senior safety Engineer
American Trucking Associations
2200 Mill Road
Alexandria, VA 22314-4654
703-838-1950

Chris A. Johnson, Ph.D., Adjunct Professor
Department of Ophthalmology
School of Medicine
University of California
Davis, CA 956165224
916-752-1011

Arthur H. Keeney, M.D., D.Sc.
Professor of Ophthalmology and Visual Sciences
Kentucky Lions Eye Research Institute
University of Louisville
Louisville, KY 40292-0001
502-588-5555

A. James McKnight, Ph.D.
President
National Public Services Research Institute
8201 Corporate Drive • Suite 220
Landover, MD 20785
301-731-9891

Cynthia Owsley, Ph.D.
Associate Professor of Ophthalmology
Department of Ophthalmology, School of Medicine
University of Alabama at Birmingham
700 S. 18th Street • Suite 300
Birmingham, AL 35233
205-325-8507

Sandra Z. Salan, M.D.
Office of Medical Evaluation Branch Chief
Neurology and Special Senses
OD/OME SSA
1500 Woodlawn Drive
Baltimore, MD 21241
301-966-1974

Frank Schieber, Ph.D.
Assistant Professor of Psychology
Department of Psychology
Oakland University
Rochester, MI 48309-4401
313-370-2100