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Administration**

DRIVING UNDER THE INFLUENCE:

A REPORT TO CONGRESS ON ALCOHOL LIMITS

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

EXECUTIVE SUMMARY

This is the second of two reports responding to a congressional mandate to "... conduct a study to determine the blood alcohol concentration at or above which an individual when operating any motor vehicle should be deemed to be driving while under the influence of alcohol." That is, the level at which a person should be prevented legally from operating a motor vehicle. The first report was based on a review of scientific literature on the influence of BAC[1] on driver performance and crashes, a review of existing legislation on BAC limits, and data collected on expected institutional responses to alternative BAC limits (0.08, 0.04, and 0.00) for the general driving public.

Since the first report was published, additional information has been collected. This final report integrates the information developed in all phases of the project and presents relevant findings, conclusions, and recommendations.

BACKGROUND

The term "driving under the influence of alcohol" has a technical, legal, and personal interpretation that must be considered in responding to the question posed by the Congress. On the technical question, virtually all of the available literature indicates that alcohol degrades an individual's performance on tasks related to driving and increases crash risk. The same is probably true of many medications and fatigue. The degree of degradation in performance is related to the amount of alcohol, but the effect of a given amount of alcohol or other impairing factors varies among individuals. In the case of alcohol, the amount of alcohol in an individual's system can be measured with a high degree of accuracy. The task of this report, therefore, is to determine what amount of alcohol, recognizing the variation in human responses, should be established and considered a legal bar to driving. This task is complicated by a number of factors:

- There is significant variation in individual response to a given amount of alcohol. Even the same individual can respond in different ways as a result of other factors affecting the individual at a given point in time.

- Impairment increases with the amount of alcohol in the blood stream, but the increase occurs in a rather continuous manner rather than there being a sharp increase in impairment at a particular level.

- Individuals vary in their abilities to drive both with and without alcohol in their blood stream.

- It is legal to consume alcohol and to drive with a quantity of alcohol in the blood stream. Therefore, the selection of a blood level of alcohol representing "driving under the influence" is determined both by scientific findings and societal preferences and enforcement limitations.

- This report addresses the congressional mandate by 1) reviewing the legal status of "driving under the influence," 2) examining the information available on impairment,

[1] In this report, BAC refers to either blood alcohol concentration, stated as grams per 100 milliliters of blood, or breath alcohol concentration, stated as grams per 210 liters of breath.

and 3) examining indications of society's desire to limit driving at different BAC levels.

Current law defines the danger of driving under the influence of alcohol in two ways. First, it is illegal in all states to drive while impaired by alcohol at any BAC level. For example, any person who is observed driving in an unsafe manner and found to have been drinking, can be charged for driving under the influence of alcohol regardless of actual BAC.

In addition, there are basically two types of laws for the driving public that specify BAC limits. "Presumptive"[2] laws state that if an individual is driving at or above a given BAC, it is presumed that the driver is impaired or intoxicated, but the presumption is open to rebuttal in court. "Per se" laws make it illegal by (or in) the act itself to drive if one's BAC is at or over a specified BAC. The per se BAC level is 0.10 in 41 states and the District of Columbia and is 0.08 in 5 states. Four states have only a presumptive limit of 0.10. The laws in some states presume that a person is not impaired if their BAC is 0.05 or below.

A police officer must have a reason to stop someone to determine if he or she is driving under the influence of alcohol. The lower the BAC level, the more difficult is detection from driving behavior or even personal behavior after the driver has been stopped.

In the last decade, a number of national organizations have recommended that states adopt a BAC of 0.08 or lower. The National Safety Council, the National Commission Against Drunk Driving, the Association for the Advancement of Automotive Medicine, and the Surgeon General all have recommended a BAC limit of 0.08. The American Medical Association endorsed a limit of 0.05.

Within the United States and abroad there is a trend to reduce BACs from their current levels. In 1991, 20 states considered legislation to impose lower BAC levels ranging from 0.02 to 0.09. Georgia lowered the per se limit from the 0.12 to 0.10. Kentucky also adopted a 0.10 illegal per se law, changing from the previous law which presumes intoxication at 0.10 BAC. Vermont became the fifth state to enact a BAC limit of 0.08 as a criminal offense. Commercial drivers in the U.S. are now subject to a state and Federally-enforced 0.04 limit, violation of which results in disqualification from operating a commercial vehicle. Similar stringent standards apply to operators in other modes of transportation subject to U.S. Federal jurisdiction. In addition, commercial drivers with any measured or detected BAC are to be placed out of service for a 24-hour period.[3]

A number of countries have BAC limits of 0.08 or below. For example, Austria, Canada, Denmark, France, Italy, New Zealand, Spain, Switzerland, and the United Kingdom have a 0.08 limit, while

[2] In this report, the term "presumptive" refers to both presumptive and prima facie laws which are similar but not identical.

[3] Federal law requires that a commercial driver who is convicted of driving with a BAC of 0.04 percent or more will be disqualified for specified time periods. For the first offense the driver is disqualified for one year, or three years if he is transporting hazardous materials. For the second offense the disqualification is for life; however, under certain conditions the licensing state may elect to reinstate the driver after 10 years. As of April 1, 1992, nearly all states have adopted the 0.04 BAC as part of their Commercial Drivers License (CDL) programs and are enforcing the disqualifications for commercial drivers. In addition, as a condition of participation by a state in the Federal Highway's (FHWA) safety grant program, states are required to enact and enforce the 0.04 BAC limit. So far we understand the process has worked smoothly.

Finland, Iceland, Japan, the Netherlands, and Norway have a 0.05 limit. Sweden recently (1990) lowered its BAC limit to 0.02. Australian states have adopted either .08 or .05 BAC limits.

The personal interpretation of driving under the influence is made regularly by individuals as either drivers or passengers. Some people will drive after drinking because alcohol and automobiles play pervasive roles in American life. People who drink and drive make an informed or uninformed decision about the trade-off between their safety and other factors. This report addresses the messages that should be sent to the public in order to help them make those decisions.

TECHNICAL FINDINGS

1. Effects of Alcohol

A. The scientific literature clearly documents the detrimental effects of alcohol on driver performance. Performance of driving-related tasks decreases as the amount of alcohol in individuals increases. As BAC increases, the effects are greater, more functions are degraded, and more people show the effects.[4]

B. The overwhelming weight of evidence indicates that alcohol is a major causal factor in traffic crashes. Alcohol is involved in half of all fatal crashes.

C. A substantial body of data shows that the probability of a crash increases with higher BAC. This is especially so for more severe crashes. The more alcohol in a driver's bloodstream, the greater the risk of a crash. The exact nature of the increase in crash risk due to alcohol cannot be stated quantitatively with certainty. However, when groups of drivers with similar characteristics (such as age, sex, and drinking habits) are compared, the risk increases as BACs rise.[5]

D. Alcohol degrades driving performance and increases crash risk. The crash risks associated with alcohol increase more rapidly above 0.05 BAC and significantly above 0.08 BAC.

2. BAC Limit Effects on Drivers

E. Because of the variety of factors influencing a person's BAC at a given time (such as a person's sex, weight, fatigue level, and what and how much he or she has eaten), it is difficult for a person to estimate their BAC and its effects accurately.

F. People appear to respond to the concept of a lowered legal BAC limit by changing their drinking driving behavior, but do not seem to use the specific new, lower legal BAC (e.g., 0.08) as a target limit to stay below.

[4] This finding was presented in the interim report to Congress.

[5] This finding was presented in the interim report to Congress.

G. Although 80 percent of the 22,086 alcohol-related fatalities in 1990 involved BACs above .10, 4,500 fatalities occurred at BACs below .10. Lowering the BAC is likely to reduce fatalities at BACs below .10. There is also evidence that lowering BACs, and publicizing the effort, can reduce alcohol-related deaths at all BACs.

3. Enforcement Considerations

H. Enforcement agencies stated in workshops held by the National Highway Traffic Safety Administration (NHTSA) that they would have difficulty enforcing per se BAC below 0.08 as a criminal offense. They argued that in many cases it is difficult to obtain a basis for reasonable suspicion (necessary to stop a motorist) or probable cause (necessary to arrest a motorist for BAC testing). Police agencies might, therefore, be hesitant to enforce what they may perceive as an unpopular law or one without strong scientific or public support. Police agencies were also concerned about overloading the court system.

I. Under present laws and legal constraints, enforcement of BAC limits by police is dependent largely on observable signs of impairment which are less frequently seen at lower BACs. Thus, lowering the per se BAC limit below 0.08 probably would result in only marginal increases in arrests for alcohol offenses.

J. Federal statute requires random and post-accident testing of commercial operators for alcohol without any need for reasonable suspicion. The courts have upheld such testing for drugs and it appears likely that alcohol testing will be similarly upheld.

K. Alcohol testing equipment presents no barrier to enforcement of more stringent BAC standards. Current breath testing devices are capable of detecting and reliably reporting alcohol concentrations of 0.04 and below.

RECOMMENDATIONS

1. States should be encouraged to enact 0.08 as the BAC level at and above which it is a per se criminal offense to drive.

2. States that lower their BAC limit to 0.08 should accompany the change with public information and education.

3. All states should have per se laws that refer to the BACs of drivers. Measurement of alcohol either in breath or blood should be established as a fully acceptable and complete indication of alcohol concentration.

4. The practical issues of implementing and enforcing BAC limits should be the subject of further study with the participation of state, local and national officials.

5. All states have laws prohibiting driving while impaired by alcohol at any BAC. States should actively enforce and publicize these laws.

6. All states should repeal laws that create a presumption that a driver is not under the influence at any BAC above zero.

7. As a safety agency, NHTSA's message to the public will continue to be "don't drink and drive" or "don't drive if you have been drinking."

CHAPTER I. INTRODUCTION

REPORT CONTEXT

This is the second of two reports in response to a congressional mandate to study the alcohol concentration at which a driver should be considered under the influence. The first report (NHTSA, 1991a) described the study approach and the use of an expert panel to provide balance, oversight and objectivity to the study.[6] That report was based on a review of scientific literature on the influence of BAC[7] on driver performance and crashes, a review of existing legislation on BAC limits, and data collected on expected institutional response to alternative BAC limits--0.08, 0.04, and 0.00 for the general driving public.

Since the first (interim) report was published, additional information in these areas has been developed and new information has been collected to help assess the effect of considering different BAC levels as being under the influence. More specifically, this report updates the information on alcohol effects and on the effects of changes that have been made in BAC limits; and presents newly collected information on public and driver attitudes and behavior relevant to BAC limits. In addition, new information is presented regarding system changes that might reduce difficulties in implementing BAC limit changes.

This final report integrates the information developed in all phases of the project and presents relevant findings, conclusions and recommendations.

BACKGROUND

The term "driving under the influence of alcohol" has a technical, a legal, and a personal interpretation that must be considered in responding to the question posed by the Congress. On the technical question, virtually all of the available literature indicates that alcohol degrades an individual's performance on tasks related to driving and increases crash risk. However, at lower BACs some individuals may still perform better than others who have not been drinking.

Current law defines the danger of driving under the influence of alcohol in two ways. First, it is illegal in all states to drive while impaired by alcohol at any BAC level. For example, if a person is observed to be driving in an unsafe manner and is found to have been drinking, he or she can be charged for driving under the influence of alcohol regardless of his or her actual BAC.

In addition, there are basically two types of laws for the driving public that specify BAC limits. "Presumptive" [8] laws say that if an individual is driving at or above a given BAC, it is presumed that the driver is impaired or intoxicated, but the presumption is open to rebuttal in court. Finally, per se laws make it illegal by (or in) the act itself to drive if one's BAC is at or over a specified BAC. The per se BAC level is 0.10 in 41 states and the District of Columbia and is 0.08 in five states. Four states have only a presumptive limit of 0.10. The laws in some states presume that a person is not

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[6] See Appendix A for information about the expert panel.

[7] In this report, BAC refers to either blood alcohol concentration, stated as grams per 100 milliliters of blood, or breath alcohol concentration, stated as grams per 210 liters of breath.

[8] In this report, the term "presumptive" refers to both presumptive and prima facie laws which are similar but not identical.

impaired if their BAC is 0.05 or below. Federal law requires that a commercial driver who is convicted of driving with a BAC of 0.04 percent or more will be disqualified for specified time periods. As of April 1, 1992, nearly all states have adopted the 0.04 BAC as part of their Commercial Drivers License (CDL) programs and are enforcing the disqualifications for commercial drivers. Similar stringent standards apply to operators in other modes of transportation subject to U.S. federal jurisdiction.

A police officer must have a reason to stop someone to determine if he or she is driving under the influence of alcohol. The lower the BAC level, the more difficult is detection from driving behavior or even personal behavior after the driver has been stopped.

The Omnibus Transportation Testing Act of 1991 requires random and post-accident testing of commercial operators for alcohol without any need for reasonable suspicion. The courts have upheld such testing for drugs and it appears likely that alcohol testing will be similarly upheld. Rationale for more stringent requirements on commercial operators includes the notion that licensed professionals should be held to higher standards; and the notion that the greater threat posed by the larger vehicles, the greater number of miles traveled per year and/or the greater number of passengers carried leads to greater overall risk even though the professional drivers are involved in far fewer accidents per mile.

The personal interpretation of driving under the influence is made regularly by individuals as either drivers or passengers. Some people will drive after drinking because alcohol and automobiles play pervasive roles in American life. People who do drink and drive make an informed or uninformed decision about the trade-off between their safety and other factors. This report addresses the messages that should be sent to the public in order to help them make those decisions.

CHAPTER II. ALCOHOL EFFECTS

The first report to Congress reviewed the scientific literature on the influence of BAC on driver performance and the relationship between BAC level and crashes. The evidence from these two areas was integrated to draw a number of conclusions about alcohol effects and BAC levels, especially those below 0.10. Among the major conclusions were:

- There is no threshold for alcohol impairment, i.e, there is no lower level at which impairment starts, or below which no impairment is found.

- The greater the amount of alcohol, the greater the degree of impairment on a given task, the more functions (or different kinds of tasks) that are impaired, and the greater the risk of a crash.

Although there was a wealth of evidence that led to these conclusions, the evidence did not permit precise quantification of the relationship of BAC levels to performance impairment or crash risk. The first report identified the data limitations that precluded quantification of the relationship, but it did not attempt to provide new analyses or data presentations to go beyond what existed. Since then, data from the original scientific reports have been revisited, and further analyses performed, in an attempt to improve the quality of the information and its relevance to the practical issues of concern.

The most relevant information would show driver performance and crash risk for a given individual at given BAC levels compared to the same measures, under the same conditions, at zero BAC. While this is not practical, it is possible to analyze existing data to come closer to this ideal. Reported data from experiments under closely controlled conditions allow one to compare the performance of the same groups of people at different BAC levels and in relation to their performance at zero BAC under the same conditions. Additional work was undertaken to integrate and display the results of such studies.

Reported data from crash case-control studies suffer because the people at different BAC levels are not the same; they appear to differ on important risk factors and this influences the nature of the relationship observed for the whole sample. To the extent that it is possible to desegregate reported data and compare people from similar risk groups at zero and various BAC levels, the relevance of the information to the present issue will be improved.

In this context, some additional analyses of data reported in previous studies were performed and are reported below.

ALCOHOL AND DRIVING PERFORMANCE

Many studies have shown impairment at various BACs, but there has been a tendency during the last two decades for researchers to study BACs at or near 0.10, since this was at or near the prevailing legal limit. Relatively few studies of driving performance provide data on performance at 0.00 BAC and one or more levels below 0.10. (See NHTSA 1991a)

The present analysis of data from prior studies starts with the articles selected by the Transportation Research Board (TRB) (TRB, 1987) as illustrative of performance effects at low BACs. "In general, these studies met the following conditions: the BAC was accurately measured and reported; the time

periods between consumption, experimentation, and BAC testing were controlled and reported; and the study tested for statistical significance" (TRB, 1987, p. 44).

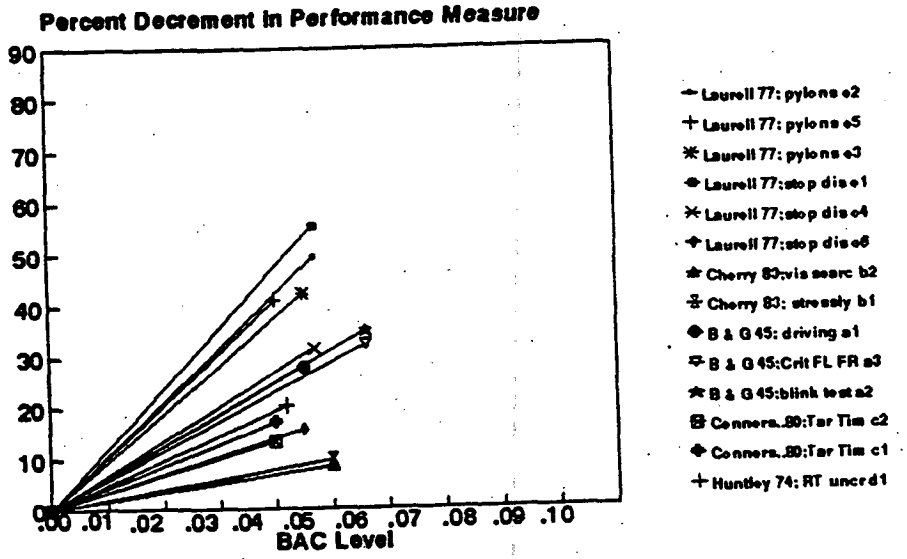


Figure 1. Experimental Studies of Impairment with Zero BAC and One Higher Point

Each of the original articles was reviewed to extract data on performance effects. For 13 of them, it was possible to consider the performance score reported for the zero BAC condition as the baseline or 100 percent. The remaining performance scores for that study were then plotted to show the percent DECREASE in the performance score for each BAC level measured.[9] The results for studies which had one point in addition to zero, are shown in Figure 1. Studies which had two or more points measured in addition to 0.00 are shown in Figure 2.

9 Further details on computation of percent decrements are given in Appendix B.

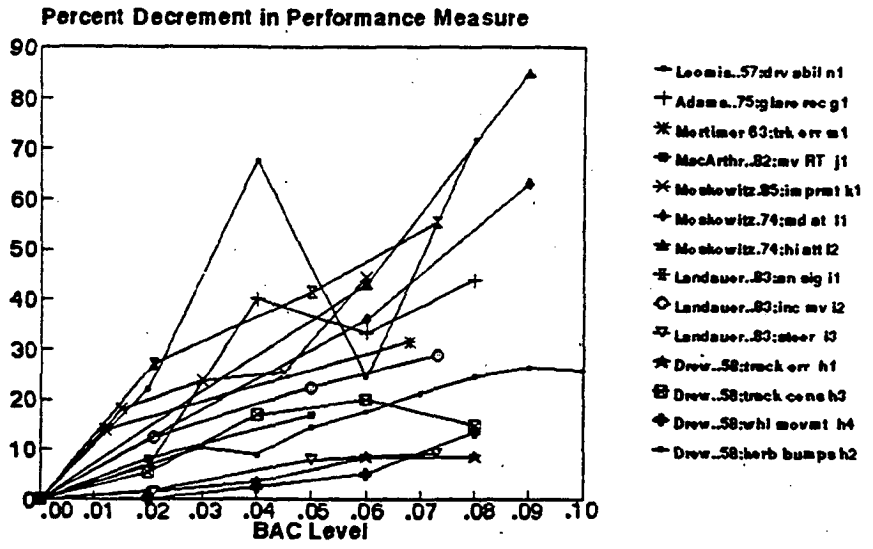


Figure 2. Experimental Studies of Impairment with Zero BAC and Two or More Higher Points

It should be noted that these figures compare a number of studies that differ in many ways including the nature of the performance measured, that they present the decrease in mean or average scores and not scores for a given individual, that subjects were likely to be highly motivated to compensate for alcohol effects in the test situation. Nevertheless, a general pattern appears showing a decrease in performance of a particular task at the lowest BAC level measured by the author and a further decrease in performance with increases in BAC. This may underestimate the overall decrement in performance due to alcohol since it does not take into account the interaction between the different tasks when more than one is required in actual driving.

Most of the data on BAC in crashes comes from blood tests of accident victims. The paucity of real crash data points for low BAC levels in living drivers is not a breath testing equipment limitation. Current breath testing devices are capable of detecting and reliably reporting alochol concentrations of 0.04 alcohol and below. However, the need for reasonable suspicion for a police officer to require private citizens to undergo alcohol testing also applies to post-accident situations.

ADDITIONAL ANALYSES OF BAC AND CRASH RISK

An important point was made in the first report to Congress (NHTSA, 1991a) regarding relative risk estimates that have been reported in the past:

> TRB (1987) in their discussion of this epidemiological research and these relative crash risk estimates suggested that the effect of alcohol at low BACs was masked by other variables in these studies due to heterogeneity of the control group (i.e., they were composed of very

different types of drivers) and the lack of perfect comparability between the crash and noncrash involved drivers.

If it were possible to compare groups of drivers at zero and various BAC levels, who were similar on characteristics associated with crash risk, this problem would be reduced. A review of the data presented in previous studies and contact with the authors of the landmark "Grand Rapids" study (Borkenstein, Crowther, Shumate, Ziel, & Zylman, 1964) failed to secure the raw data that would permit two or more relevant characteristics to be controlled in such an analysis.

However, two useful reanalyses were performed, one as part of this project and one independently in New Zealand (Hurst, Harte and Frith 1991). In both cases, the starting point was the knowledge that the Grand Rapids data permitted the identification of groups of drivers who had different relative crash risks at zero BAC as well as at positive BACs (see Hurst, 1973). Although these groups were identified based on responses to questions about drinking frequency, Hurst (personal communication, 1991) and others believe that this is not the only variable which may account for differences in crash risk for the Grand Rapids drinking groups (hereafter referred to as GRD risk groups). A review of summary data in the Grand Rapids report suggests that higher mileage and middle-aged groups were overrepresented in the higher reported drinking frequency groups studied.

In any event, it has been shown that these GRD risk groups do differ with respect to crash risk and there were different proportions of each GRD risk group in the Grand Rapids samples that were used to compute relative risk at each BAC level. Thus, the relative risk curve generated for Grand Rapids was influenced by the proportion of different GRD risk groups observed in control drivers and crash drivers at each BAC level as well as the effects of that BAC level. Both new analyses attempted to remove this bias from the analysis of Grand Rapids data designed to show BAC effects. These two new analyses are reported below.

Hurst, Harte, and Frith (1991), using Grand Rapids data, computed relative risk at various BAC levels, separating out the effects of risk group. He did this by using a log linear model which is explained further in Appendix C. Figure 3 shows the crash risk due to BAC at various levels below 0.10 using Hurst, et. al.'s (1991) results.

Another analysis using the same reported Grand Rapids data was performed for this report. In this case, the relative risk curves for each GRD risk group were generated by setting the relative risk of 1 as the risk of a crash for members of that GRD group at 0.00 BAC. Thus each GRD risk group was compared to its own sober crash risk. These data were plotted on a log linear scale and are presented in Figure 4.

Figure 4 illustrates that for a given group, regardless of the risk when sober, BAC increases crash risk in a generally similar manner. Still, the risk for some groups appears to build at a much more rapid rate at lower levels than for other groups.

The data presented here lend further support to the conclusions reached in the initial review of research. While precise quantification is still not possible, the figures presented illustrate the nature of the danger to drivers at low levels of BAC.

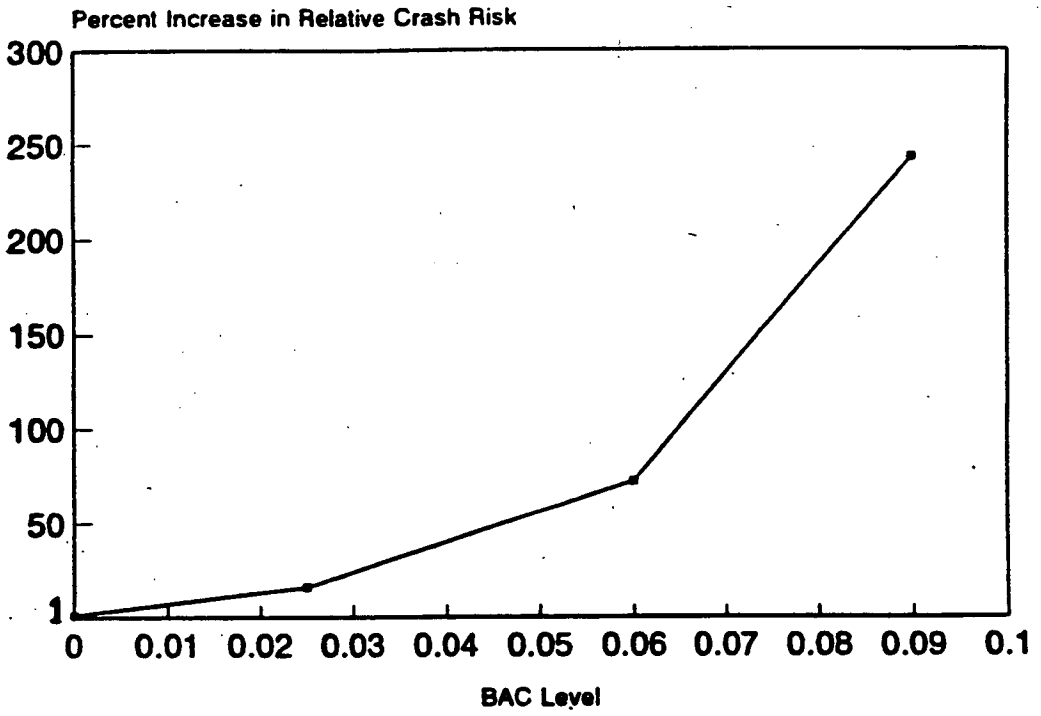


Figure 3. Relative Crash Risk & BAC – Grand Rapids Data Controlled for Drinker Class

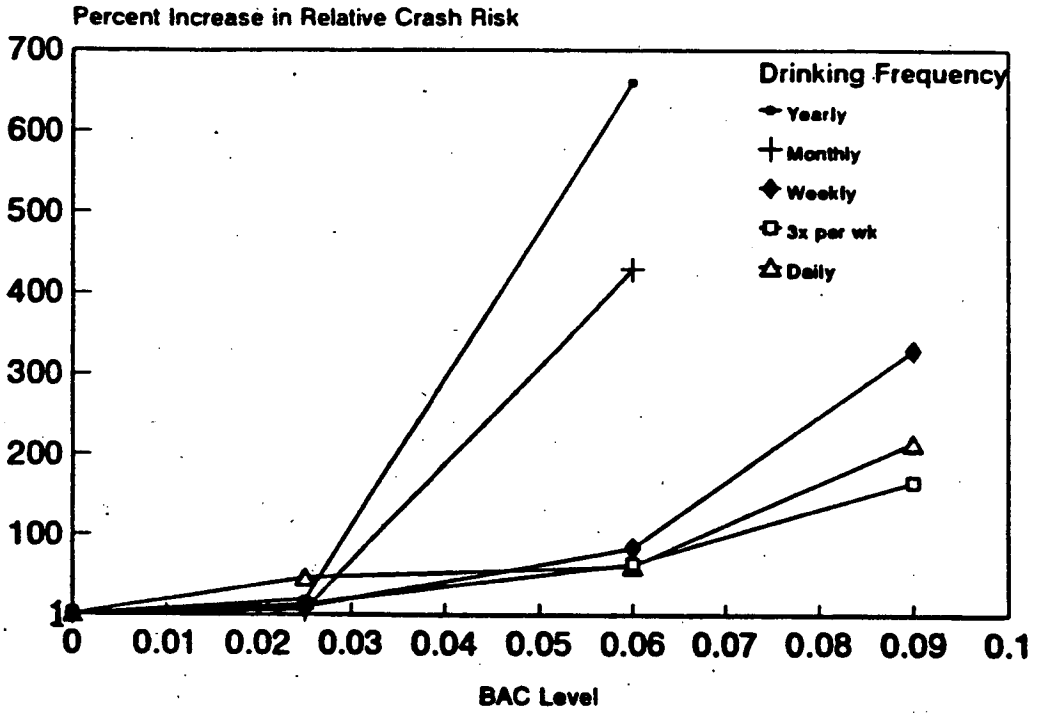


Figure 4. Increase in Crash Risk with BAC for Drinking Driver Groups

CHAPTER III. SAFETY EFFECTS OF LOWER LEGAL BAC LIMITS

In this country and abroad, there have been efforts to lower legal BAC limits. Two issues are typically raised:

1. How much of an effect will a lower BAC limit have? (Is a lower BAC directed at a minor part of the alcohol driving problem because most alcohol-related fatalities are at higher BACs and lower BAC limits would effect only a small proportion?)

2. Who will a lower BAC impact? (Is it the really dangerous drinker-drivers, or others such as those who go out and have a drink with dinner who will be affected?)

This section presents information on the following topics which is relevant to the two questions stated above:

- Results of lowering BAC limits in Australia and California
- Changes in BAC distributions associated with changes in limits
- Relationship between BAC limits, BACs prosecuted and peak BACs
- Relationship between driver BAC and drinker type

Another important and pertinent issue--how drivers can and do make use of the legal limit in influencing their drinking-driving behavior--is treated in the following chapter.

EXPERIENCE WITH LOWER LIMITS

The interim report to Congress noted the difficulty of detecting the influence of BAC legal limits on crash or fatality rates and the paucity of evidence regarding the effect of different BAC limits. The available data suggested positive outcomes from lower limits but the data were quite limited. Since the interim report, there have been two studies that add significantly to the evidence. They are summarized below.

New South Wales, Australia

In December 1980, New South Wales, Australia lowered the legal BAC limit from 0.08 to 0.05. Homel (1991, draft) used time series analysis of daily fatal crashes to assess the impact of the reduction in the BAC limit. The analysis also examined the effect of 13 other traffic safety initiatives, including introduction of Random Breath Testing (RBT) two years after implementation of the 0.05 law, and increases in penalties for drink-driving. The lower BAC limit did not receive extensive publicity and police enforcement levels were no higher than usual.

According to Homel's analysis, of the 14 government initiatives, only the 0.05 law and RBT had a statistically significant effect on the number of fatal crashes. He reports that the lower BAC limit reduced all fatal crashes by 13 percent Saturdays. (If only alcohol-related fatalities were considered, the percent reduction would likely be much greater.) Homel (personal communication November 11, 1991) suggests that this finding may reflect the higher levels of drink-drive law enforcement on Saturday nights.

In any event, his analysis provides support for the expectation that lowering the BAC limit would lead to a reduction in fatalities.

California's Experience with 0.08 BAC and Administrative License Revocation

On January 1, 1990, the legal BAC per se limit in California was reduced from 0.10 to 0.08. This was followed six months later by implementation of an Administrative License Revocation (ALR) law, whereby an arresting officer is allowed to suspend immediately the driving privilege of someone who either refuses to take, or fails, a breath test.

NHTSA (1991b) undertook a study of the effects of these changes. The study provided information on public understanding and behavior change, operational effects in institutions implementing the law as well as changes in alcohol-related crashes and fatalities.[10]

Drivers in five counties were surveyed. Over 80 percent were aware that the blood alcohol concentration level had been reduced and three-quarters believed that the risk of being stopped for driving while impaired had increased. Half of all drivers who drink reported that they were less likely to drive within 2 hours of drinking than they were before the law changes.

Impaired driving arrests increased in each county studied. Alcohol-related crashes statewide were unchanged. Alcohol-related traffic fatalities decreased by 12 percent statewide, while all other traffic fatalities were unchanged.

Police agencies reported only limited changes in their policies and procedures. Courts reported a slight reduction in the blood alcohol level that would be prosecuted as driving while intoxicated (rather than a reduced charge). No changes in guilty pleas, requests for jury trials, convictions, or appeals were reported.

The two laws and their publicity appear to have reduced alcohol-related traffic fatalities by 12 percent in 1990. The study could not quantify the separate effect of each law. The police and courts required only minimal changes to accommodate the 0.08 law.

WHAT BACS AND DRINKER-DRIVERS ARE AFFECTED BY LOWERING LEGAL BAC LIMITS?

It might appear that lowering the BAC limit would affect only drivers at BACs below the previous limit and above the new limit, e.g., if the limit was lowered from 0.10 to 0.08, it would reduce only the number of drivers at 0.09 and 0.08. Various pieces of data, presented here and in the following chapter, indicate that such a "precise correspondence to the limit" (PCTTL) effect is not the case.

In addition, it is often asserted that targeting people with BACs below 0.10 means targeting infrequent or social drinkers who do not reach the most dangerous very high BACs, when one should be using resources to get at "problem drinkers" and others who drink more frequently and to higher BAC levels. The dangers of low BACs having already been treated, this section presents information that indicates that heavier, more frequent drinkers would also be affected by lower BAC limits.

10 Appendix E provides a overview of the project methodology and findings. Results from the study are reported here and in other applicable sections of this report.

Changes in Distribution of BACs in Fatal Crashes

An analysis of the distributions of BACs before and after January 1990 showed little change in the shape of the distribution. A time series analysis, similar to that reported above for the entire BAC range, was performed by BAC groups (0.01-0.04, 0.05-0.09, 0.10-0.14, 0.15-0.19, 0.20+ and 0.08-0.09). No significant change was found for any subgroup. Figure 5 shows the change in alcohol-related fatalities from 1989 to 1990 by BAC groups and illustrates that the effect was not focussed on fatalities in the 0.08 to 0.10 BAC range. Further illustration of the lack of a localized BAC level effect is given by Figure 6 which shows the percent of alcohol-related fatalities by each BAC in 1989 compared with 1990 in California.

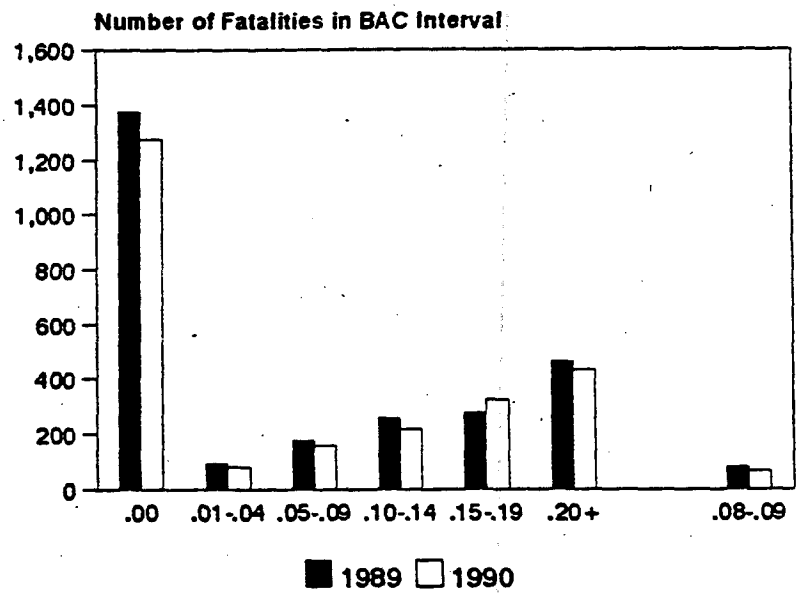


Figure 5. Distribution of BACs for Driver Fatalities in California Before and After 0.08 Limit (Grouped)

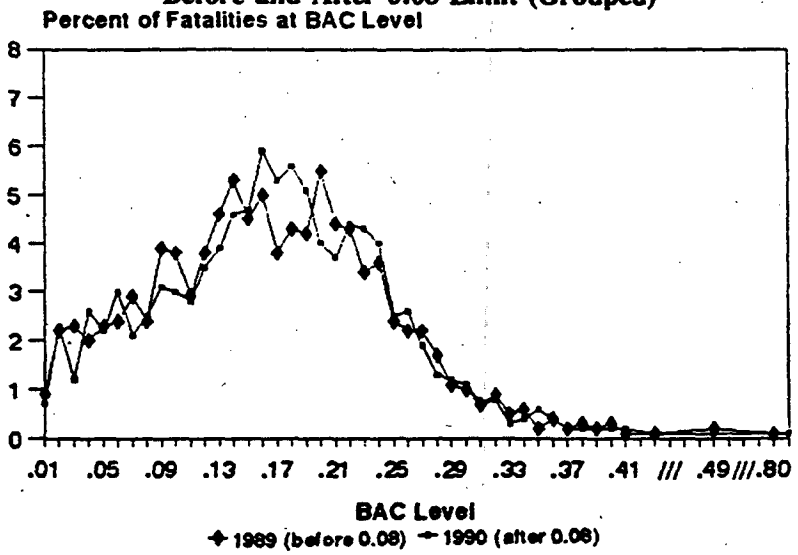


Figure 6. Distribution of BACs for Driver Fatalities in California Before and After 0.08 Limit

Changes in Distribution of BACs of Drivers

In January 1991, the Australian Capital Territory reduced their legal BAC from 0.08 to 0.05. The Federal Office of Road Safety (1991) in Australia analyzed roadside RBT data for 1990 and the first six months of 1991. The results show "a substantial drop in the incidence of high BAC readings in the first half of 1991, compared to the same period in 1990." BACs above 0.15 decreased 39 percent and BACs above 0.20 decreased 61 percent.

Relationship between the Legal Limit, Prosecuted Cases, and Peak BAC

Closer analysis of the legal limit, how it is enforced and the relationship of detected BACs to peak BACs, all provide further reason to expect that a reduction in the legal limit would affect BACs other than those covered by the change in the legal limit.

First, the system that implements the limit builds in some tolerance. Cases with BACs close to the limit may not be prosecuted if evidence other than BAC is not strong. The recent California study (NHTSAb, 1991) suggested that the reduction to a 0.08 per se BAC limit generally lowered from about 0.12 BAC to about 0.10 the point below which cases were plea bargained to a lesser charge.

Second, the measured BAC (either when a person is taken into custody, participates in a roadside survey study or is killed in a crash) is not necessarily the peak BAC that the driver reached during a trip. A driver who is detected at 0.10 may either have recently been drinking and still be absorbing alcohol into the bloodstream, or may have been at a higher level during the trip prior to measurement. Thus, one should not equate measured BAC with peak BAC for the driver. Although there seems to be a tendency to assume that a driver who is measured at a low BAC by the police is an infrequent, light drinker, that driver could be a heavy drinker who was already at or will be at a much higher BAC during his or her trip.

Relationship Between Driver BAC and Drinker Type

It is common to associate low BAC with infrequent social drinkers, and high BACs with frequent and "problem drinkers." However, as noted above, the BAC at the time of measurement is not necessarily the peak BAC. In addition, roadside survey data (Borkenstein, Crowther, Shumate, Ziel, and Zylman, 1964) combined with self-reported drinking frequency (which is likely to be an underestimate) indicate that[11]:

- 92 percent of the self-reported daily drinkers with measurable BACs were at 0.10 or below; 81 percent were at 0.07 or below; 61 percent were at 0.04 or below.
- 25 percent of the drivers with BACs between 0.01 and 0.04 were self-reported daily drinkers; 44 percent reported drinking three times a week or more.

11 Tables developed from the original data are presented in Appendix F.

Thus, the evidence indicates that lower BAC limits would affect a range of drinker-drivers including daily drinkers.

CONCLUSION

Lower BAC limits appear to be associated with a reduction in alcohol-related fatalities, particularly when implemented with publicity and license sanctions. The effect of a lower BAC limit is not restricted to the BACs that are covered by the change in the law; rather it appears to impact on a range of BACs and types of drinkers.

CHAPTER IV. DRIVER USE OF THE MESSAGE SENT BY THE LEGAL LIMIT

A central question is: How would drivers change their drinking-driving behavior in response to different BAC limits? To help provide a basis for responding to this question, this chapter presents data on how drivers currently use BAC limits, their perceptions of how much alcohol is dangerous, and how they behave in jurisdictions with different legal limits. It also considers the ability of drinker-drivers to understand and target BAC levels, and concludes with a discussion of current problems in communicating clear and simple BAC messages to the public.

Since information on most of these subjects was lacking, data were collected through a nationally representative survey (NHTSA, 1991d). The sample consisted of slightly more than 4,000 persons ages 16 and older. Forty-nine percent of these were nondrivers and/or nondrinkers, who were asked a limited number of questions. More extensive questioning was administered to the nearly 2,100 sampled drivers who also drink alcohol (drinker-drivers). For example, drinker-drivers were asked if they had consumed alcohol at a place to which they had driven. About 800 reported not having done so in the past year compared to more than 1200 who did. The latter group then provided information about the last time this occurred. Additionally, more than 800 drinker-drivers provided information about the last time they drove after they thought they had too much to drink; and more than 700 did the same for the last time they did not drive after drinking too much. In both cases, there was no limitation as to how long ago the incident could have occurred. All drinker-drivers were asked questions concerning attitudes and knowledge of BACs and BAC limits.

The major survey results relevant to this chapter are presented below. Readers are cautioned that the percentage figures detailed in the next several pages frequently refer to different subgroups of the total sample, with the groups not necessarily being independent of one another. Thus percentages generally cannot be combined since they are computed from different bases.
An overview of the methodology and additional supporting data are presented in Appendix G.

PRESENT USE AND UNDERSTANDING

BAC Limits as a Factor in Drinking and Driving Decisions

Results of the national survey showed physical symptoms and internal feelings to be far more important than BAC limits in drinking and driving decisions. When asked how they can tell they have had too much to drink and should not drive, more than 60 percent of drinker-drivers cited physical impairments (e.g., vision, speech, motor skills, reflexes) or feeling certain ways (e.g., drowsy, numb, tipsy, ill, dizzy, lightheaded, woozy, off balance). Only 7 percent gauged driving capacity by the amount they drank.

Of the drinker-drivers who drove to a place where they drank during the last year, 41 percent said that they set a limit on the number of drinks they would consume. However, the survey provided evidence that persons typically set drinking limits on the basis of factors other than the legal limit. Table 1 shows that of those who drove to a place to drink and set a limit before drinking, only 2 percent mentioned the BAC limit as the reason for the limit they set.

The survey data further indicated that many persons think about the problems they may have in driving after drinking while they are in the drinking situation. This was particularly true in situations where respondents thought, in hindsight, that they may have had too much alcohol to drive safely (see

Table G2 in Appendix G). Yet the concerns expressed by the respondents, and their reasons for considering adjusting their behavior while in the drinking situation, were once again based on factors other than the BAC limit (see Tables G3 and G4 in Appendix G).

Table 1. Reasons That Persons Give For The Number Of Alcoholic Drinks They Set As A Limit*

Reasons	Percentage
Never Drink More Than That	21
That's My Limit/I Know My Limit	19
Safe Limit/What's Safe To Drive	12
Get Sick/Dizzy/Drunk If I Have More	11
That's All I Want	9
Because I Will Be Driving	8
Past Experience (Unspecified)	8
Length Of Time There	4
Too Expensive	3
Legal Limit/BAC Limit	2
Weight/Height	2
Drunk Driving Laws/Laws	2
Medical Problems/Limitations	1
Other Mentions	3
Don't Know	5

* Percentages are based on the total number of persons who stated that, prior to their entering the drinking situation, they had set a limit to the number of alcoholic drinks they would have. Respondents were referring specifically to the last time they drank at a place to which they had driven. Only persons who had driven to a place to drink in the past year were asked the question. More than one response could be given.

The evidence suggests that a substantial segment of drinker-drivers considers the implications of their driving after drinking, as indicated by establishment of preset drinking limits as well as reported consideration of adjustments in drinking or driving behavior while in risk (i.e., drinking) situations. However, they do not specifically consider the BAC limit in these deliberations.

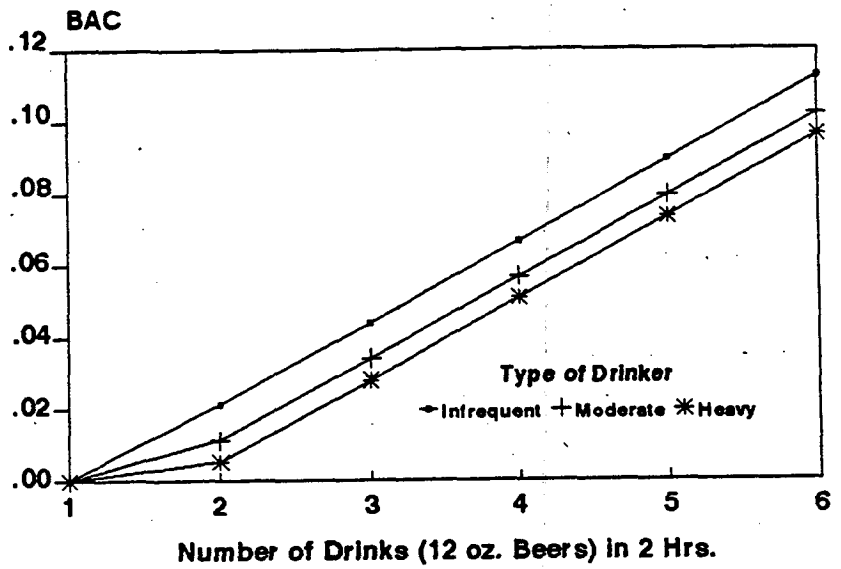
Perception of Dangerous BAC Levels

About one-third of surveyed male drinker-drivers said they could drink four or more 12-ounce beers in a two-hour period and still drive safely; 12 percent did not know while the majority specified 3 or fewer beers. Three beers over two hours equates to approximately a 0.03 BAC for an average weight male. Fewer than 20 percent of female drinker-drivers said they could drink three or more 12-ounce beers in a two-hour period and still drive safely; 22 percent did not know while the majority specified two or fewer. Two beers over two hours equates to approximately a 0.04 BAC for an average weight female. For a similar amount of alcohol contained in liquor (1-1/4 ounce shots), respondents on average felt it would take fewer drinks over a two-hour period to elicit unsafe driving. Although differences in the amount of alcohol specified in the question about wine make it difficult to compare responses, it still was evident that few people thought they could consume any more than three glasses of wine over a two-hour period and still drive safely.

The number of beers a respondent thought he or she could consume in two hours and still drive safely plus data on the respondents' weight and gender were used to compute corresponding BACs at the end of the two-hour period.[12] (Figures 7 & 8 present examples of estimated BACs for the number of beers consumed by a median weight male and female.) The vast majority of respondents thought that their threshold for safe driving was at computed BAC levels well below the legal limit. In fact, only about one-third felt that they would be safe at a BAC level above .04.

12 The estimated BACs reported here are based on the assumption that the respondent is a moderate drinker. Further analysis (not yet available) using reported drinking habits should allow better BAC estimates.

MALE (170 lb.)



FEMALE (137 lb.)

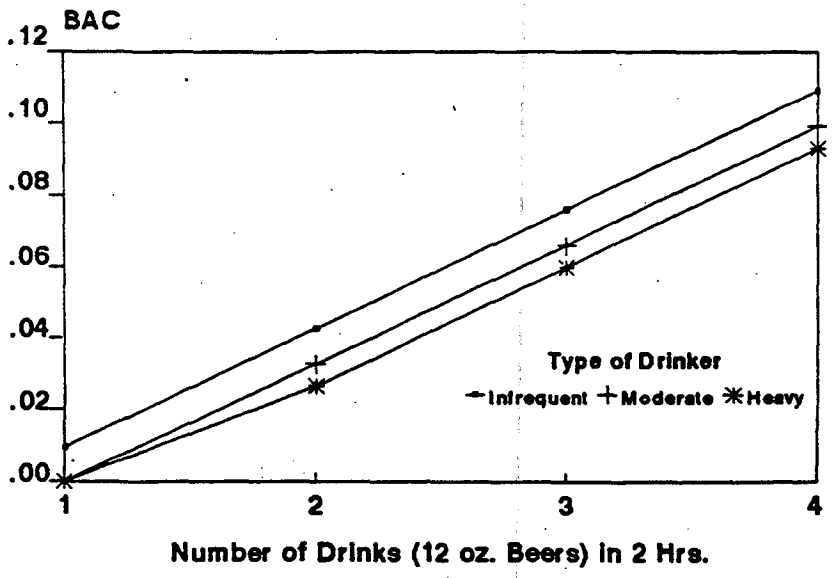
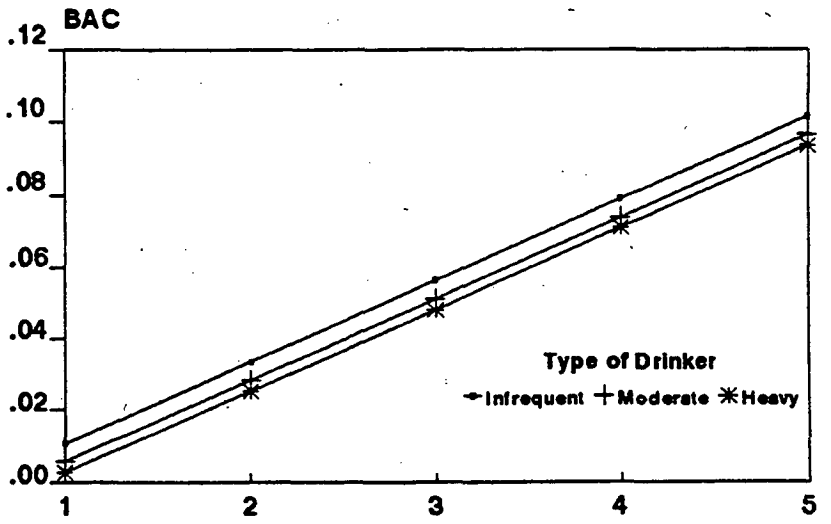


Figure 7. Estimated BACs by Number of Drinks in a Two-Hour Period for a Male and Female Drinker

MALE (170 lb.)



FEMALE (137 lb.)

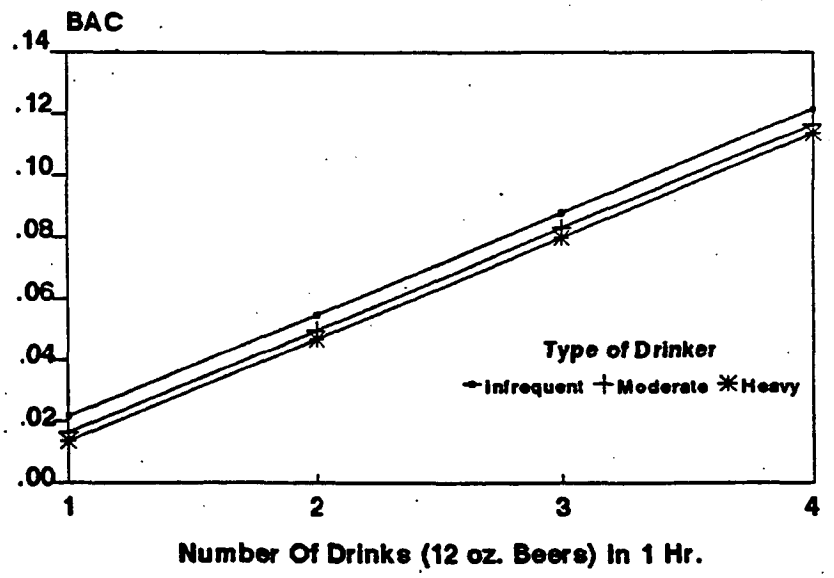


Figure 8. Estimated BACs by Number of Drinks in a One-Hour Period for a Male and Female Drinker

Similar computations were performed for a question asking drinker-drivers what the legal limit should be in terms of numbers of beers. This question was asked only of drinker-drivers who said that there should be a legal limit to the number of drinks before driving. Nonetheless, the results were similar to those for the question about driving safely; the vast majority indicating quantities equivalent to BACs below current per se limits. About 63 percent chose a number of beers equivalent to a BAC of 0.04 or lower and 87 percent chose a quantity equivalent to 0.08 or lower.

Survey data also showed that respondents were more than twice as likely to consider current BAC limits too high than too low. In 0.10 states, 38 percent of males and 41 percent of females felt the 0.10 limit was too high when told how many drinks an average weight male or female would have to consume to reach that level.[13] Fewer than 15 percent of either sex considered it too low. In 0.08 states, 31 percent of males and 39 percent of females considered the 0.08 limit too high, while 11 percent of males and 16 percent of females said it was too low.

When asked how many drivers would actually be dangerous drivers with BAC levels at the legal limit, 30 percent of respondents from 0.10 states said "all" while another 34 percent said "most." In 0.08 states, 25 percent said "all" and 30 percent said "most." Less than 10 percent said "few" and almost none said "none," regardless of it being an 0.08 or 0.10 state.

Other national survey data collected (NHTSA, 1991e) suggests that much of the public is opposed to combining any level of alcohol with driving. The data were obtained from a second telephone survey conducted during the Summer of 1991, one assessing the current status of the public's attitudes toward DWI. The survey questioned respondents (ages 16-64) about their level of agreement with the statement, "people should not be allowed to drive if they have been drinking any alcohol at all." More than one-half (53 percent) strongly agreed that people should not be allowed to drive under these circumstances; another 24 percent somewhat agreed. Fewer than 10 percent registered strong disagreement to the statement.

Returning to the national survey noted earlier, (NHTSA, 1991d) all respondents were presented with one of three hypothetical situations: the BAC limit was reduced to 0.08, 0.04, or to any measurable level. Respondents also were presented with possible penalties for violating the hypothetical legal limits. The survey disclosed only modest differences across the three scenarios in the type of penalty that respondents deemed most appropriate for a first offense (see figure 9). At the lower limits, there emerged a somewhat greater attraction towards small fines and lesser attraction towards license suspensions of 60 days. However, there was little difference across scenarios in the percentages of respondents who chose other options such as larger fines, longer periods of license suspension, vehicle impoundment, or jail. Even at the lower BAC limits, many persons selected these increasingly severe penalties as being appropriate.

13 The number of drinks communicated to respondents was derived from BAC cards that did not differentiate by gender. Data later became available to NHTSA that is considered more accurate in computing BACs (See Appendix I). For males, the number of drinks to reach a specific BAC did not appreciably differ between the BAC card and the new data, indicating no problem with the ranges disclosed to males. However, females were told ranges that the new data suggests were about one drink too high. If the data is accepted, females were responding to a 0.12 BAC rather than a 0.08, and a 0.13 or 0.14 BAC rather than a 0.10. No problem was discerned for a 0.04 BAC. This information should be considered in interpreting results from three questions: (a) whether respondents consider the legal limit too high or too low; (b) the numbers of drivers considered dangerous at the current legal limit; and (c) appropriate penalties if the BAC limit is reduced to 0.08, 0.04, or any measurable level.

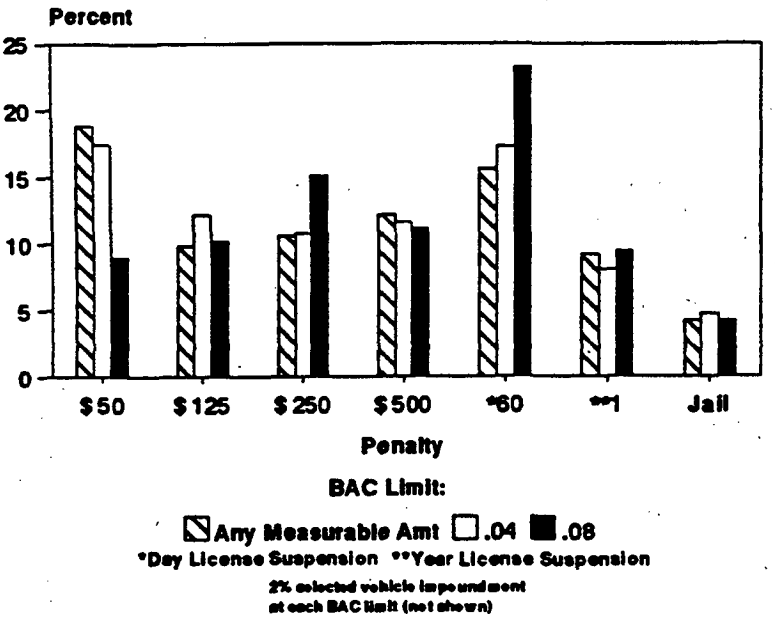


Figure 9. Penalties for Hypothetical BAC Limits

Thus, a majority of the public perceives alcohol concentrations below current per se limits as being dangerous. Most agree that people should not be allowed to drive if they have been drinking any alcohol at all. If lower limits were the law, they would assign penalties similar to what they think the penalties should be for higher levels.

Decision Making and Behavior in 0.08 And 0.10 States

Responses to a number of questions in the national survey were analyzed to determine differences between states that had a 0.10 BAC limit (most states) and those with a 0.08 BAC limit (California contributed most in this category).

Among all drinkers, the average level of alcohol normally consumed per sitting was about the same for the two samples: 2.44 drinks consumed per sitting in 0.08 states and 2.56 in 0.10 states. The average number of times that drinker-drivers had driven within two hours of drinking in the past year was also similar; 6.40 in 0.08 states and 6.99 in 0.10 states.

However, the rates of driving when alcohol-impaired in the past year appear to be lower in 0.08 states. Among drinker-drivers, 6.1 percent in 0.08 states report driving in the past year after having too much to drink, compared to 8.9 percent in 0.10 states. In terms of the most recent occasion where they drank at a place to which they had driven, 2.8 percent in 0.08 states and 4.1 percent in 0.10 states said it resulted in driving after having too much to drink.

There is only a small difference in the number of drinks that drivers who drink think is their safe limit (2.56 beers in two hours in 0.08 states and 2.84 in 0.10 states. For all drivers, the perceived likelihood of being stopped by the police if intoxicated to the point of having trouble handling their vehicle is also similar (37.5 percent in 0.08 states and 39.4 percent in 0.10 states).

81 percent in 0.08 states know there is a specific BAC level at which it is illegal to drive compared to 71 percent in 0.10 states. However, this greater awareness may stem from publicity associated with recent enactment of changes in drunk driving legislation in the largest of the .08 states--California.

Among drivers who reported driving after drinking too much, the average number of drinks consumed was lower in 0.08 states (6.3) compared to 0.10 states (7.7).

Compared to 0.10 states, the pattern of results in 0.08 states is less "driving after drinking too much" and lower levels of consumption when drinking too much, along with better knowledge about BAC testing. From this comparison alone one cannot be sure whether the limit followed the behavior or behavior followed the public's awareness of the law or of a change in the law.

In May 1991, a two-page questionnaire was completed by 1600 respondents at DMV offices in four study sites throughout California as part of the effort to assess the impact of the change in the legal BAC limit from 0.10 to 0.08 (NHTSA, 1991b).

Awareness of the reduction in the BAC limit was high. A large majority (81 percent) of respondents knew that the BAC limit had become stricter and 45 percent were able to correctly write 0.08 as the current limit.

The responses indicated that the incidence of self-reported driving after drinking has decreased substantially since the lower BAC law went into effect. Half of all respondents who drink alcohol reported they are less likely to drive within two hours of drinking now, compared to before the law change.

Forty-four percent of these individuals attributed the change in their behavior to concern about drinking driving laws (both the lower BAC limit and ALR) and penalties. For those individuals who both knew the correct BAC limit and claimed that they have decreased their frequency of driving after drinking too much, 32 percent attributed the change in their behavior to concern about the laws and penalties.

Respondents perceived the risk of being stopped for DUI to be very high. Half of all the respondents felt that they were almost certain or very likely to be stopped by the police if they drove after having had too much to drink. Three-quarters of these individuals felt this risk has increased since the reduction in the BAC limit.

The results of both the national and the California surveys are consistent in suggesting changes in drinking and driving behavior associated with a change in the BAC limit. However it appears that these changes were due to the general perception that the limit was lower and that enforcement was perceived as tougher, rather than due to people using the new legal limit to control the amount of alcohol consumption prior to driving.

Conclusions About Present Use and Understanding

The major conclusions can be summarized as follows:

- While some people in drinking situations become concerned about being stopped by the police when driving afterwards, and many people set a limit on how much they will drink before driving, the legal BAC limit is not the basis for deciding how much they will drink.

- Drivers set drinking limits based on how they feel and react; the number of drinks they think is safe is much below the legal limit, even in 0.08 states. Most drivers feel that most or all drivers are dangerous at the present legal limit.

- Nevertheless, when legal limits have been lowered and publicized, this appears to be associated with reduced frequencies of drinking and driving, and driving "after drinking too much."

POTENTIAL USE OF BAC MESSAGE SENT BY LEGAL LIMIT

The evidence reviewed above shows that in most states the legal BAC limit does not have much effect on drinking driving decision making or behavior. Where it has changed from 0.10 to 0.08, it seems to influence behavior by carrying the message that the acceptable amount of alcohol for drivers has been lowered and that the risk of being caught may be greater. An important issue is whether the legal limit could be more of an influence on drivers, perhaps by steps that would lead drivers to use it in their decision making, or by changing the message that is delivered by the legal limit.

This topic has been given relatively little attention but was raised in the Surgeon General's Workshop on Drunk Driving (Simons-Morton & Simons-Morton, 1988):

> Clear and simple informational messages about drinking/driving need to be established and disseminated. Adolescents, at least, do not know the numbers of drinks that will impair their abilities (Williams, Lund, & Preusser, 1986). Transportation safety advocates have unintentionally added to the confusion by concerning themselves with "drunk driving" rather than drinking and driving, contributing to the misconception that impaired driving occurs only when the driver is inebriated or legally intoxicated, rather than when the driver has ingested relatively low amounts of alcohol.
>
> If we are truly interested in reducing alcohol consumption, we should develop easy-to-understand guidelines about the frequency and amount of drinking for those who drink. Such guidelines, however, are difficult to develop. The effect of alcohol on behavior is a product of a number of factors, most importantly the number of drinks, but also the available blood volume (which varies with body size), the availability of food to impede absorption, drinking experience, and mood. Individuals appear to range in their sensitivity to the effects of alcohol making one drink quite intoxicating to some people yet barely noticeable to others. Further, different alcoholic beverages contain different amounts of alcohol, making simple messages difficult. The inability to develop clear and unambiguous messages about safe levels of consumption is an impediment to public education.

The question is:

> Can clear and simple messages be developed based on, or consistent with, the legal BAC limit such that drivers understand and can readily take appropriate action?

Difficulties In Public Use Of BAC Limits

It has been pointed out above that people use internal and behavioral signs to determine if they have had too much too drink. As a person's BAC decreases, there are fewer symptoms to observe. Calculation of one's BAC based on alcohol consumption is a complex undertaking. At present, there are no practical means for drivers to estimate their BAC levels accurately.

Some of the reasons for this are as follows. First, computations are based on the amount of alcohol consumed. There are differences in the amount of alcohol in different beverages that may appear similar in their package or container. The alcohol content of mixed drinks may vary, both according to recipe and the variation introduced by the mixer of the drink.

> In addition to the difficulty of estimating the amount of alcohol consumed, there are many physiologic parameters (e.g., percent of adipose tissue, skeletal type, sex, height weight, age) which affect the estimate of blood, and other factors (e.g., gastric mobility and stomach contents) which affect the rate of alcohol metabolism [*absorption* - **correction ours**] (Sedman, Wilkinson, Sakmar, Weidler, and Wagner, 1976). This combination of factors can induce substantial uncertainty in the estimate of BAC. ....Obviously, the complex interrelationships among these many factors cannot be more than casually addressed in a nontechnical reference such as a BAC chart (Arstein-Kerslake, 1986).

O'Neill, Williams, and Dubowski (1983) reported great variability in the peak BACs reached by different individuals even though major individual and situational factors known to affect absorption of alcohol were controlled. They concluded that computation of BACs based on mean results from experimental studies was inappropriate to guide the drinking behavior of individuals.

If a driver were tested to determine his or her individual rate of processing alcohol, there may be ways to improve the ability of an individual to compute his or her BAC. However, it remains to be seen if and when a practical means might be available. While it would be possible for a driver to use repeated breath tests to remain under a specified level, this would involve some expense, and may not be worth the time and effort involved to be able to take another drink.

Thus, there are no practical means of computation with sufficient accuracy to permit a driver to drink more than a small amount, with assurance that he or she would not exceed some specified BAC below 0.10.

What should the BAC message be?

The "don't drink and drive" message is consistent with the scientific evidence. This message emphasizes that alcohol degrades driving performance at any measurable level. It also is the only message compatible with the fact that it is illegal in all states to drive while impaired by alcohol at any BAC level.

A per se BAC limit should not confuse this message. A per se limit sends a clear message that it is illegal to drive at BAC levels above the limit. However, some drivers may misinterpret the per se limit to mean that they are not impaired and may legally drive at any BAC level below the limit. It is important that public information contain the "don't drink and drive" message.

CHAPTER V. LOWER BAC IMPLEMENTATION ISSUES

PREVIOUS STUDY

Work on this study that was conducted prior to the first report (NHTSA, 1991a) investigated how the institutions that deal with drinking drivers would react to changes in BAC limits. A series of four workshops were held with personnel from various institutions (e.g., police, courts, legislators and treatment facilities) to determine expected institutional response to alternate BAC limits. The structure for this part of the study was "given that everything stays the same except that the legal BAC limit is changed" what is the expected institutional response for a limit of 0.08, 0.04, 0.00?

The NHTSA report concluded that institutions could adapt to a BAC limit of 0.08 with a minimum of problems. (Recent evidence from the study of 0.08 in California supports this conclusion, see Appendix E.)

Establishing lower limits of 0.04 or 0.00 would result in widespread and continuing attention from the media, the public and public officials. However, the report concluded that:

> A number of problems would limit the number of cases successfully prosecuted at the new lower levels: difficulties in gaining a basis for reasonable suspicion or probable cause, official hesitancy in enforcing what they perceive as an unpopular law or one without strong evidence, concerns about overloading the court system with less important cases. However, there would be an increase in cases and successful prosecutions near or above the previous limit (e.g., 0.10). A larger increase in case load may occur as technology is developed for better detection. Institutions would have great difficulty in effectively implementing a BAC limit of 0.04 or 0.00 for the general driving public without additional changes (p. iv).
>
> The establishment of significantly lower limits (e.g., 0.04 or 0.00) without other changes would exacerbate many present problems in the system that deals with DWI and could lead to difficulties in the proper and efficient handling of cases. However, ways to overcome these problems are in use in some jurisdictions and additional steps have been suggested (p. 62).

It was recommended that further consideration be given to a multilevel system of administrative, civil and criminal penalties or restrictions for drivers who have a BAC as measured in breath at 0.08 and below.

WORKSHOPS ON MULTILEVEL ALCOHOL PENALTY SYSTEMS

To give further consideration to a multilevel system, two workshops were conducted in April 1991, involving people from law enforcement agencies, the court system, motor vehicle departments, treatment centers, and others concerned with drinking and driving behavior. Further details on the participants and methodology are presented in Appendix H.

As a starting point or "strawman," workshop participants were given an initial multilevel system of offenses for BACs at 0.08 and below. The system was defined in terms of BAC level and penalties for initial and repeat offenses. The participants considered the definition of the offense, the penalties to be applied, enforcement approaches and implementation issues. They indicated problems and concerns about these and other aspects, and suggested improvements if such an approach were to be taken. As a result of these suggestions a number of different versions were available for assessment

at the conclusion. Each version was rated on eight factors (including those added by the participants). As a basis for comparison, the "present system" was also rated on the same factors.

WORKSHOP FINDINGS AND CONCLUSIONS

Analysis of the comments and ratings lead to the following conclusions:

- The best such system would be relatively simple in terms of number of levels of offenses and the variations in penalties for repeated offenses. One offense, covering the whole range of 0.08 and below would be better than dividing the range into two offenses (i.e., 0.04 - 0.08 and above 0.00 to below 0.04).

- Of the alternatives considered at the workshops, the most favorably viewed multilevel alcohol penalty system had the following major characteristics[14]:

  - At 0.08 and above (DWI): existing penalties as now applied for exceeding 0.08 or 0.10.

  - At any measurable alcohol to 0.079 (Administrative Any Measurable Alcohol or AAMA):

    - administrative and/or civil (noncriminal) offense.
    - penalty for any offense: recorded on driver record; points and $200 fine.
    - third offense or second offense in two years: administrative license suspension.
    - offense committed while license suspended for alcohol offense is treated as DWI.

- A system incorporating AAMA would be responsive to the concerns regarding loading the court system. Administrative processing should result in a lesser load on the system. AAMA would also have less problems with probable cause than any offense based on a specified BAC because any indication that alcohol had been consumed would be a basis for breath testing.

- A two-level system incorporating AAMA appears to have advantages over the present system in terms of the message sent to the driving public, efficiency in detecting and processing cases, enhancing the detection of alcohol impaired drivers, and reduction of BACs of drivers. Figure H7 shows how workshop participants rated this system compared to the present system.

- A two-level system incorporating AAMA may add costs, have more side effects and not be as practical as the present system. In particular, workshop participants felt that it was not practical to expect legislation of such a system. Figure H8 shows workshop participant ratings on these factors.

14 A more detailed description is given in Appendix H.

The workshop discussions in April, 1991 indicated that law enforcement officials in particular appeared to have the greatest concerns about public (and therefore legislative) rejection of laws that would significantly lower the BAC at which it would be permissible to drive.

The workshop discussions touched on the various operational problems involved in effectively implementing an AAMA component of a two-level system of alcohol offenses. All detailed operational problems existed already in the present system but may be exacerbated if BAC limits were lowered. For most problems, even if widespread now, some participant could suggest a potential solution that was in use in their jurisdiction. However, it was not clear if these solutions would be accepted or could be implemented widely to resolve the problem. Jurisdictions would need to consider how to resolve a number of difficult problems and changes if they were to consider such an approach. Some of these issues are discussed in the following section.

ENFORCEMENT AND LEGISLATIVE PROBLEMS

Under present laws and legal constraints, enforcement of BAC limits by police is largely dependent on observable signs of impairment which are less frequently seen at lower BACs. To enforce BAC laws police rely heavily on observations of deviant driving behavior as cues indicating the driver is likely to be at a high BAC. Many drivers are not likely to exhibit these cues at lower BACs, making police stops unlikely. If a driver at a low BAC has been stopped for other reasons, he or she is unlikely to exhibit gross behavioral cues (e.g., slurred speech) that can give the officer reasonable suspicion to pursue an investigation related to BAC.

Once a driver has been stopped, police need probable cause to arrest a driver and obtain an evidential breath test. Police rely heavily on standard field sobriety tests (SFST) at the roadside to develop probable cause. However, the SFST has been designed to detect BACs at 0.10 and above. The lower the BAC the more difficult it will be to develop effective roadside tests. New methods and procedures will be needed. Use of alcohol measurement through passive alcohol sensors, preliminary breath tests and roadside evidential tests could address the problems that arise after a stop, but they would require equipment, training and in some cases legislation. Thus, lowering the per se BAC limit below 0.08 would result in a smaller proportion of stops, investigations and penalties for lower BAC drivers than for those at BACs above the current limit.

As noted earlier, workshop participants raised the issue of legislative feasibility for lower BAC limits. Only five states have per se limits of 0.08; no state has a per se limit below 0.08; and four states have no per-se limit. Legislators appear to be more receptive to lower limits for special populations (i.e., youth and commercial drivers). Twelve states have lower BAC limits for youth and nearly all states have responded to the Federal requirement of 0.04 for commercial motor vehicle drivers. However, in 1991 state legislative sessions, over 20 states introduced legislation to reduce BAC limits (usually from 0.10 to 0.08) but only one proposal was passed. Thus, it appears that while lower BAC limits for youth and commercial vehicle drivers have been accepted, states are not yet willing to accept lower limits for drivers in general.

CHAPTER VI. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Over the years various legislative bodies have considered what BAC level would be appropriate and acceptable for a driver. In recent years, as the alcohol-highway safety problem has gained wider attention and knowledge has increased, the alcohol levels considered as acceptable by researchers, safety advocates, and legislators have become lower in the United States and in other countries.

There are basically two types of laws for the general driving public that specify BAC limits. Per se laws make it illegal by (or in) the act itself to drive if one's BAC is over a specified BAC limit. "Presumptive"[15] laws say that if an individual is driving over a given BAC, it is presumed that the driver is impaired, but the presumption is open to rebuttal in court.

Forty-six states and the District of Columbia have per se legislation. Twenty-five of these jurisdictions also have presumptive laws. Four states have only presumptive laws specifying an illegal BAC. The laws in some states also presume drivers to be unimpaired if their BAC is 0.05 or below.

Most jurisdictions currently have a 0.10 BAC limit. Forty-two have a per se limit of 0.10. Four states have only a presumptive limit of 0.10. In response to requirements under the Commercial Motor Vehicle Safety Act of 1986, nearly all states adopted a 0.04 per se limit for commercial drivers, violation of which results in disqualification from operating a commercial vehicle. In addition, commercial drivers with any measured or detected BAC are to be placed out of service for a 24-hour period.

In the last decade, a number of national organizations have recommended that states adopt a BAC of 0.08 or lower. The National Safety Council, the National Commission Against Drunk Driving, the Association for the Advancement of Automotive Medicine, the International Association of Chiefs of Police, and the Surgeon General have all recommended a BAC limit of 0.08. The American Medical Association has endorsed a limit of 0.05. Healthy People 2000 (Department of Health and Human Services, 1991) was based on input from a number of organizations and individuals and lists among the health goals for the Nation, the adoption of 0.04 BAC limits for drivers over 21 by 50 states.

Within the United States and abroad, there is a trend towards lower BAC limits. In 1991, 20 states submitted legislation to impose lower BAC levels ranging from 0.02 to 0.09. Georgia lowered their per se limit from the previous 0.12 to 0.10. Kentucky also adopted 0.10 per se, changing from their previous presumptive law. And Vermont became the fifth state to enact a BAC limit of 0.08 as a criminal offense. Commercial drivers in the U.S. are now subject to a state and Federally enforced 0.04 limit.[16] Sweden recently (1990) lowered their BAC limit to 0.02. In Australia, there is a

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15 In this report, the term "presumptive" refers to both presumptive and prima facie laws which are similar but not identical.

16 Federal law requires that a commercial driver who is convicted of driving with a BAC of 0.04 percent or more will be disqualified for specified time periods. For the first offense the driver is disqualified for one year, or three years if he is transporting hazardous materials. For the second offense the disqualification is for life; however, under certain conditions the licensing state may elect to reinstate the driver after 10 years. As of April 1, 1992, nearly all states have adopted the 0.04 BAC as part of their Commercial Drivers License (CDL) programs and are enforcing the disqualifications for commercial drivers. In addition, as a condition of participation by a state in FHWA's safety grant program, states are required to enact and enforce the 0.04 BAC limit. So far we understand the process has worked smoothly.

move by the Federal government to establish a national BAC of 0.05. Currently, four states and one territory within Australia have a 0.05 legal limit while the other two states and one territory have set 0.08 as the limit (Federal Office of Road Safety, 1991).

An observer of the British legislative experience noted that: "The ideal blood concentration in a driver would be zero, but legislators chose a compromise between concentrations at which there is a high risk of having an accident and concentrations that are so low that they would generate too great a workload for police and be unacceptable to the public" (Dunbar, Penttila, & Pikkarainen, 1987). This observation points to the major considerations in BAC level legislation:

- Safety considerations and scientific evidence will support lowering the acceptable level to whatever the legislature chooses, down to any measurable BAC.

- Other considerations fall under two main headings:
  - The effect of the new limit on the enforcement system.
  - The acceptance and response of the public.

This chapter of the report provides conclusions from information provided in this report, and the earlier interim report, as they relate to these major considerations.

SAFETY CONSIDERATIONS

There is no safe alcohol level for all drivers. Setting a lower legal limit will reduce the damage from alcohol-related crashes. Reducing the legal limit below 0.10 is supported by the scientific evidence.

INSTITUTIONAL OR SYSTEM EFFECTS

The police and courts would have difficulties effectively implementing BAC limits below 0.08 without changes in the system. The main areas of concern are (a) that police and court resources may be redirected to deal with a greater percentage of cases that do not yield the greatest benefit and (b) that the court system may become overloaded. The first concern rests on the assumption that cases at lower BACs will affect only the least dangerous drinking drivers. Evidence reviewed here does not support that assumption. With respect to court overload, the use of an administrative noncriminal offense to cover per se offenses at lower levels appears to be a feasible and practical way to effectively and efficiently apply such limits. (c) Drivers at low BACs are unlikely to exhibit deviant driving or gross behavioral cues that can give an officer reasonable suspicion to pursue an investigation. It will be more difficult to develop effective roadside tests that would provide probable cause to arrest a driver and secure a BAC test. New methods and procedures would be needed.

TESTING EQUIPMENT CONSIDERATIONS

There is no equipment limitation to testing for alcohol levels well below 0.08 BAC. Current breath testing devices are capable of detecting and reliably reporting alcohol concentrations of 0.04 and below. Evidential quality breath testing devices on the conforming products list (CPL) meet with NHTSA model specifications [Federal Register, 1986]. While those specifications are centered on testing around the 0.10 alcohol concentration criterion, the agency has been reexamining those devices on the CPL and finds them acceptable for lower BAC ranges as well. There has been recent increased interest in alcohol testing to lower BAC levels because of the federal 0.04 standard for

commercial vehicle drivers, the Omnibus Transportation Testing Act of 1991, and state initiatives to apply a zero alcohol standard to drivers below age 21. To provide for still greater reliability and convenience for testing in the region of 0.04 BAC and below, NHTSA expects to issue additional model specifications in the near future.

PUBLIC SUPPORT AND REACTION

Public officials and safety advocates have expressed concerns that significantly lowering the permissible BAC for drivers would be met with public rejection and perhaps even a backlash against antidrinking-driving enforcement efforts. However, recently collected data shows that about three quarters of the adult population agree that people should not be allowed to drive if they have been drinking any alcohol at all. Also, the half of the population most affected and likely to object--those over 16 years of age who are licensed to drive and sometimes drink alcohol--hold attitudes consistent with enforcement of strong penalties for violation of lower BAC limits (e.g., alcohol consumption that would result in BACs below existing BAC limits is perceived as dangerous; if any measurable alcohol was above the legal limit, they would assign penalties for violation that are similar to those they think are appropriate for violating current limits). Although these supportive attitudes exist, public education regarding the dangers of low levels of alcohol should be undertaken.

CONCLUSIONS

Reducing the BAC at or above which it is a per se criminal offense to drive to 0.08 is consistent with the increased risk of motor vehicle crashes associated with drinking and driving and with current perceptions of public sentiment and judicial and enforcement resources. A BAC level below 0.08 would have safety benefits if it could be implemented effectively. However, a lower BAC might strain judicial and enforcement resources and possibly result in public backlash if these lower limits are viewed as unreasonable. This study has provided some information about these issues, but the nature of public reaction and the burden of regulation at lower levels are still uncertain. Development of better information on these topics and observation of the effects of lower BAC limits seems warranted. Action should be taken now to educate the public and to encourage adoption of 0.08 as a criminal per se offense.

RECOMMENDATIONS

1. States should be encouraged to enact 0.08 as the BAC level at and above which it is a per se criminal offense to drive.

2. States that lower their BAC limit to 0.08 should accompany the change with public information and education.

3. All states should have per se laws that refer to the BACs of drivers. Measurement of alcohol either in breath or blood should be established as a fully acceptable and complete indication of alcohol concentration.

4. The practical issues of implementing and enforcing BAC limits should be the subject of further study with the participation of state, local and national officials..

5. All states have laws prohibiting driving while impaired by alcohol at any BAC. States should actively enforce and publicize these laws.

6. All states should repeal laws that create a presumption that a driver is not under the influence at any BAC above zero.

7. As a safety agency, NHTSA's message to the public will continue to be "don't drink and drive" or "don't drive if you have been drinking."

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APPENDIX A. EXPERT PANEL

NHTSA assembled a panel of experts in all areas affecting drinking and driving to provide balance, oversight, and objectivity to our study. The panel included members of the Transportation Research Board standing Committee on Drugs and Alcohol, the committee that prepared the TRB "Zero Alcohol" study, and other internationally recognized experts in the field. The panel was assembled for the purpose of obtaining the advice of the individual members. They were asked to make recommendations concerning each phase of the study, to recommend individuals to participate in the workshops, to review and assess each phase's results, and to consider the conclusions that could be drawn. The 21 members of the panel are shown below.

Wayne Anderson — Judge Anderson is the Supervising Judge of the Circuit Court in Cook County (Chicago), Illinois. He has had extensive judiciary experience in traffic court, and has spoken on alcohol and other drugs at a recent Lifesavers Conference.

Richard Blomberg — Mr. Blomberg is president of Dunlap and Associates, a research organization dealing with human factors, systems, and applied problems. He has authored numerous papers dealing with alcohol and drug-induced highway safety problems. Mr. Blomberg is an international consultant on human performance in complex task situations. He is currently on the Industrial Safety Panel for NASA.

B. J. Campbell — Dr. Campbell is the longtime Director of the Highway Safety Research Center (HSRC) of the University of North Carolina. He has played a leadership role for many years in one of the leading highway safety research institutes in the United States. Dr. Campbell has well established contacts with the highway safety community both here and abroad. Under his direction, HSRC has been active in the forefront of research on alcohol and highway safety.

Dora Goldstein — Dr. Goldstein, a medical doctor, is Professor of Pharmacology at Stanford University. She has authored numerous papers and articles dealing with alcohol tolerance and withdrawal, and a text entitled, Pharmacology of Alcohol. Dr. Goldstein is a member of and has chaired the VA Merit Review Board on Alcoholism and Drug Dependence.

Harold Holder — Dr. Holder, a sociologist, is with the Prevention Research Center where he has done a considerable amount of work with computer simulation models in the alcohol research area. Other interest areas include content analyses of alcohol themes and community alcohol treatment programs.

Paul Hurst — Dr. Hurst, a psychologist, is well known in the field of epidemiology. He did the classic work leading to the development of relative risk curves which describe the accident risk at various BAC levels relative to the risk associated with sober drivers. Dr. Hurst is retired, but still serves as a consultant to the New Zealand Department of Transportation in the field of alcohol and other drugs.

Richard Jessor Dr. Jessor is Professor of Psychology and Director of the Institute of Behavioral Science at the University of Colorado. His specialty area is problem behavior in youth, with emphasis upon adolescent alcohol use. Dr. Jessor is on the Editorial Board of the journal Alcohol, Drugs and Driving.

Hans Laurell Mr. Laurell, research psychologist, is currently Head, Department of Analysts, in the Swedish Road Safety Administration. He is a member of the TRB committee on Alcohol, Other Drugs, and Transportation.

Adrian K. Lund Dr. Lund is Director, Human and Environmental Factors, for the Insurance Institute for Highway Safety. Dr. Lund is a member of the TRB committee on Alcohol, Other Drugs, and Transportation.

Larry G. Majerus Mr. Majerus was formerly the Administrator of the Montana Division of Motor Vehicles. He is currently with an automotive publishing firm in Detroit, Michigan. Mr. Majerus has been President of Region IV of the American Association of Motor Vehicle Administrators and Chairman of the Driver License Compact Commission. Most recently, he served on the "Zero Alcohol" committee for the National Academy of Sciences.

Kimball I. Maull Dr. Maull, a physician, is Professor and Chairman of the Department of Surgery, University of Tennessee. He has written a number of papers on crash trauma and the relationship between alcohol abuse and vehicle crashes. Dr. Maull is past president of the American Association for Automotive Medicine and Editor-in-Chief of Advances in Trauma. He recently served as a member of the National Academy of Sciences' "Zero Alcohol" committee.

Herbert Moskowitz Dr. Moskowitz, a psychologist, is a noted alcohol researcher. He is a Professor in the Department of Psychology and the Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles. Dr. Moskowitz is editor of the journal Alcohol, Drugs and Driving, and President of the Southern California Research Institute. He is the coauthor of the NHTSA literature review of the effects of low BAC levels on driving impairment. Dr. Moskowitz is a member of the TRB committee on Alcohol, Other Drugs, and Transportation.

Laimutis Nargelanas Major Laimutis Nargelanas, a law enforcement specialist, is currently the Assistant Deputy Director of the Division of Criminal Justice, Illinois State Police. He served as an Illinois State Trooper for five years before joining the staff of the Illinois State Police Academy. He was director of Curriculum Development before becoming the Director of Training for the State Police Department of Law Enforcement Academy in 1979. He progressed through the ranks, achieving the permanent rank of Major in 1983. Prior to his current position, he was Superintendent of the Division of State Troopers, Illinois State Police. He is a member of the International Association of Chiefs of Police and chairman of both the Traffic Law Enforcement and Adjudication Committees for the National Safety Council. Major Nargelanas

recently served as a member of the National Academy of Sciences' "Zero Alcohol" committee.

Olga J. Pendleton Dr. Pendleton, a statistician, is a Program Manager for the Statistical Analysis and Research Program in the Texas Transportation Institute. She has written a number of articles relating to traffic fatalities, including the involvement of alcohol and blood alcohol concentration. Dr. Pendleton was recently a member of the National Academy of Sciences' "Zero Alcohol" committee.

M. W. Perrine Dr. Perrine, a psychologist, is Professor at the Schools of Medicine and Public Health at Boston University and Director of the latter's Alcohol Research Unit. Dr. Perrine recently served as Chairman of the Committee on the Benefits and Costs of Alternate Federal Blood Alcohol Concentration Standards for Commercial Vehicle Operators which produced the "Zero Alcohol and Other Options" report for the National Academy of Sciences. He is also a member of the TRB committee on Alcohol, Other Drugs, and Transportation.

Robert Harry Reeder Mr. Reeder, a lawyer, serves as the General Counsel of the Traffic Institute at Northwestern University and as Executive Director of the National Committee on Uniform Traffic Laws and Ordinances. He received his BA and JD from Washburn University. Before coming to the Traffic Institute as assistant counsel, he began his legal career as a research assistant with the Research Department of the Kansas Legislature. An expert in traffic law, Mr. Reeder has authored and coauthored several books on the subject. He has been Chairman of the National Safety Council and now serves on their Committee on Alcohol and Other Drugs. Recently, he served on the "Zero Alcohol" committee of the National Academy of Sciences.

Kaliste J Saloom, Jr. Judge Saloom is a judge with the City and Juvenile Court of Lafayette, Louisiana. He is an expert in the traffic judiciary area.

Larry N. Thompson Lt. Colonel Thompson is currently the Chairman of the Highway Safety Committee of the International Association of Chiefs of Police. He also holds long-standing tenure on the committee. A staunch advocate of highway safety, Colonel Thompson has promoted training in standardized field sobriety testing for all officers, and has taken a leading role in implementing the Drug Evaluation and Classification program in Arizona. Additionally, he participated in NHTSA's IPA program for many years, and currently details a member of his department to NHTSA's Office of Enforcement and Emergency Services (Police Traffic Services Division).

Chauncey Veatch, III Mr. Chauncey Veatch, III is the President of the National Association of State Alcohol and Drug Abuse Directors. A rehabilitation specialist, he is currently with the Department of Alcohol and Drug Abuse Programs, Sacramento, California. Most recently, Mr. Veatch served as a member of the Treatment Panel in the Surgeon General's Workshop on Drunk Driving.

APPENDIX B. IDENTIFICATION OF FUNCTIONS IN FIGURES 1 AND 2

Study	Dependent Variable	Figure/ Label	Performance Category	Notes
Bjerver & Goldberg 45	critical flick. frequency blink test time to perform driving maneuvers	1, a3 1, a2 1, a1	visual performance general impairment driving skill	Percent change values reported by authors
Cherry et al. 83	visual search mean total time for 3 stressalyser trials	1, b2 1, b1	none stated	Percent change calculated from data in Table 3
Conners & Maisto 80	time on target (undivided attention) time on target (divided attention)	1, c2 1, c1	motor performance motor performance	Percent change calculated from data
Laurell 77	pylons hit (pilot) pylons hit (Exp A) pylons hit (Exp B) stop distance (pilot) stop distance (Exp A) stop distance (Exp B)	1, e2 1, e5 1, e3 1, e1 1, e4 1, e6	driving performance	Percent change calculated
Huntley 74	RT with uncertainty	1, d1	central processing	Percent change value reported by authors
Adams & Brown 75	glare recovery	2, g1	visual performance	Percent change calculated
Drew et al. 58	tracking error kerb bumps tracking consistency steering wheel movement	2, h1 2, h2 2, h3 2, h4	driving-like skill	Percent change calculated
Landauer & Howat 83	anticipated signals wrong direction moves over and under steering	2, i1 2, i2 2, i3	car driving skills	Percent change calculated
MacArthur & Sekuler 82	RT to movement	2, j1	visual function	Percent change calculated
Moskowitz et al. 85	combined: tracking, visual search, rate of information processing	2, k1	impairment	Percent change calculated
Moskowitz & Sharma 74	undetected periph lights (moderate attention) (increased attention)	2, l1 2, l2	central processing	Percent change calculated reported by authors

Study	Dependent Variable	Figure/ Label	Performance Category	Notes
Mortimer 63	tracking error	2, m1	simulated driving	Percent change calculated NG condition only
Loomis & West 57	RT, time on road, time to complete course	2, n1	driving ability	mean of authors reported percent change values at each BAC were calculated

Percent change for the above measures at each BAC level was calculated by dividing the performance measure at zero BAC into the absolute difference between the zero BAC performance and the level tested, and multiplying the result by 100.

APPENDIX C. METHOD USED BY HURST ET AL., 1991 FOR COMPUTING RELATIVE CRASH RISK RATIOS FROM GRAND RAPID'S DATA

Hurst et al., (1991) describe a procedure to estimate the risk ratio of accident involvement given both a BAC level and a risk factor described by frequency of drinking.

Using Grand Rapids (Borkenstein, et al., 1964) alcohol-related crashes and surveys of drivers on the road at previous accident sites, BAC levels and frequency of drinking measures were determined. Therefore, for each of 19 combinations of BAC level and frequency of drinking category, two contingency tables, one representing accident drivers and the second representing control drivers, were developed.

A log linear model in the form of a regression equation was then developed to determine the separate contributions of various BAC levels and frequency of drinking on crash risk. The alcohol- related crashes and exposure data for each combination of BAC level and frequency of drinking were correlated. These correlations yielded a set of weights reflecting the separate contributions of BAC and frequency of drinking for all categories. Once the weights were determined, relative risk ratios were calculated.

Based on the analysis, accident risk appears to increase with increasing blood alcohol levels and generally decreases with increasing frequency of drinking. All nonzero blood alcohol levels have significantly more risk than a zero blood alcohol level at the 95 percent level of statistical significance.

APPENDIX D. LITERATURE UPDATE

In order to determine whether significant new findings regarding low blood alcohol concentration (BAC) levels have become available since the interim report, a literature search was conducted. The search was for articles regarding the effects of alcohol on driver performance and crash risk, as well as studies evaluating lower BAC limits. Few studies specifically examining low BAC levels have been published since the interim report.

One exception was an article addressing the effects of alcohol on pilot performance. Although this study concerned pilots rather than drivers, the results should be noted. The study (Billings, Demosthenes, White, & O'Hara, 1991), examined the performance of four dosed pilots in a Boeing 727 simulator. Each subject acted as pilot on eight simulated flights, of approximately one hour each. The pilots were dosed to target BAC levels of 0.00, 0.025, 0.050, and 0.075. Data was collected from both direct observation and videotapes and was examined for errors committed by the subjects. The researchers found that the total number of errors increased linearly and significantly ($p < 0.05$) as the BAC level increased. Planning and performance errors, procedural errors, and failure of vigilance also increased significantly ($p < 0.05$) as a function of BAC level. In a separate analysis, the number of errors committed at the lowest target BAC level (0.025) were compared to the number of errors at 0.00 BAC. While the increase in total errors was not statistically significant, the increase in number of serious errors was significant ($p < 0.05$). The authors concluded that the pilots' performance was linearly and inversely correlated with BAC level.

Modell and Mountz (1990) also examined the issue of alcohol and pilots' performance. Their review of the literature indicates that performance on specific piloting tasks can be impaired even at relatively low BACs. The authors recommend that the Federal Aviation Regulation 91.17, which applies to all aircraft pilots, be revised to lower the illegal BAC level from 0.04 to a level of no more than 0.01 (there are practical instrument problems in having a limit of 0.00). They also suggest that the "minimum-wait" rule of 8 hours (regarding consumption of alcohol) be extended to 12 hours.

Laurell, McLean, and Kloeden (1990) examined the effect of alcohol on drivers in a night driving situation. The researchers were particularly interested in the possible effects of habituation to alcohol on driving performance. Twenty-four subjects were tested at target BACs of 0.00, 0.05, and 0.10. Half of the subjects were light drinkers and half were heavy drinkers. The results indicate that BAC levels of .10 or more impair nighttime driving performance. A negative effect was also noted on six of the seven performance measures at BACs around 0.05; however, the effect was not statistically significant. There was no evidence of difference in driving performance between the light and heavy drinkers.

Since 1983 nine states have passed laws that lower the legal BAC limit for young drivers. The limits vary between the states, ranging from 0.00 to 0.05 BAC. In an evaluation (Hingson, Heeren, Howland, and Winter, 1991) of these lower limits, researchers compared nighttime fatal crashes in states with lower limits to states without such laws.

The researchers examined changes in both adolescent and adult nighttime fatal crashes. The data from four states that have lower limits for adolescent drivers were compared to data from four comparison states (no lower limit). For the four states that had lower limits, the following results were reported: a 34 percent post-law decline in nighttime fatal crashes among adolescents; a 7 percent decline in nighttime fatal crashes for adults; and as a group, states that had lower BAC limits had statistically significant ($p < 0.05$) greater post-law reductions in nighttime fatal crashes among

adolescents relative to adults than in the comparison states. However, the results are not clear-cut. There was also a 26 percent decline for adolescents in nighttime fatal crashes and a 9 percent decline for adults in those states without lower limits. There was insufficient information in the article to determine whether downward trends in nighttime fatals were already in existence in any of the states, or whether other variables (e.g., increased enforcement levels) could have been partially responsible for the decreases in crashes.

These results provide an indication that lower BAC limits for youths are accompanied by fewer nighttime fatal crashes. However, without further information regarding existing crash trends and possible other intervening variables, one must be cautious in interpreting the results of this study.

NHTSA (1991b) examined the immediate effects of lowering the legal BAC per se limit from 0.10 to 0.08 on DWI enforcement and adjudication in Maine. According to the results, the reduction in the BAC limit was associated with an increase in DWI arrests in Maine. In addition, there appeared to be an increase in case loads for the courts and longer case processing time prior to final adjudication. The study design did not allow for control of other factors that could also have effected arrests and court dispositions. Therefore, the interpretation that the observed effects are due solely or partially to the reduction in the BAC limit must be made with caution.

In December 1980, New South Wales, Australia, lowered the legal BAC limit from 0.08 to 0.05. Homel (1991) used time series analysis to assess the impact of the reduction in the limit on fatal crashes. The analysis also examined the effect of 13 other traffic safety initiatives, including introduction of Random Breath Testing (RBT) two years after implementation of the 0.05 law, and increases in penalties for drink-driving. The lower BAC limit did not receive extensive publicity and police enforcement levels were no higher than usual for the Christmas period. In contrast, the implementation of RBT received extensive media publicity and was enforced in a highly visible manner.

Studies on the effects of BAC changes typically use monthly data figures in the time series analysis. In this study, however, Homel conducted the analysis using the number of daily fatal crashes. According to the results, of the 14 government initiatives, only the 0.05 law and RBT had a statistically significant effect on the number of fatal crashes. The lower BAC limit apparently reduced fatal crashes by 13 percent on Saturdays (there was no statistically significant effect of the 0.05 law on any other day of the week) and RBT corresponded to a 19.5 percent reduction in daily fatal crashes overall, and to a 30 percent reduction during holiday periods. Homel asserts that an 0.05 law can be effective on its own, even with minimal publicity; however, the effects in New South Wales are apparently amplified by RBT. Homel suggests that the laws may have increased drivers' perceived chance of arrest and provided drinkers in group situations an excuse to reduce their consumption level.

Homel's findings differ somewhat from those of Smith's study (cited in Homel, 1991). Smith compared daytime and nighttime accidents (fatal, serious injury, minor injury and property damage only) in New South Wales and Queensland before and after the 0.05 law change. He concluded that hospitalization accidents decreased about 9 percent and fatalities were down about 4 percent, however, the changes in fatalities were not statistically significant. The analysis used by Homel may be more powerful (thus able find more of a difference between fatalities before and after 0.05 implementation) than Smith's as it is based on a long series of data points.

Although the results of the 0.05 law appear limited, with only a reduction of 13 percent in fatal crashes on Saturdays, this reduction may signal a meaningful reduction in the number of fatalities, especially as publicity was limited and there was no special enforcement effort by the police.

Along with New South Wales, three other states and one territory in Australia have adopted 0.05 as the legal BAC limit. The remaining two states and the one territory have set 0.08 as the limit. As a result of Federal road safety directives, there is currently a move within Australia to set a uniform BAC of 0.05. Howat, Sleet, and Smith (1990) conducted a review of experimental and laboratory research to determine whether there was sufficient evidence to support a uniform 0.05 limit. After reviewing studies examining the effects of alcohol on driving performance and related skills, the authors concluded that, on the basis of scientific grounds, there is support for setting the legal BAC limit at 0.05.

The Federal Office of Road Safety (1990) in Australia agrees that the nationwide legal BAC limit should be set at 0.05. This recommendation is based on a number of factors, including: 1) evidence that a move to 0.05 would decrease the number of drivers with high BACs, 2) 0.05 would provide a larger buffer between the legal limit and the level at which crash risk becomes much greater, 3) a lower BAC limit would be consistent with efforts to discourage excessive drinking generally, and 4) 0.05 would result in significant financial saving for communities.

There is no consensus within Australia as to the appropriate level at which the legal BAC should be set. Ryan and Holubowycz (1990) argue that the evidence does not support a move to 0.05 in South Australia (currently at 0.08). The authors note that the vast majority of drinking drivers killed or admitted to hospitals have BACs above 0.08 and that only a small proportion are between 0.05 and 0.08. In addition, it is unlikely that a reduction to 0.05 will substantially effect drivers who reach BACs greater than 0.10. The authors believe that instead of a reduction in the legal BAC limit, effort should be concentrated on targeting young and novice drivers, increasing public education, and employing random breath testing.

APPENDIX E. EFFECTS OF THE REDUCTION IN THE LEGAL BAC PER SE LIMIT IN CALIFORNIA FROM 0.10 TO 0.08

On January 1, 1990, the legal BAC per se limit in California was reduced from 0.10 to 0.08.[1] This was followed six months later by implementation of an Administrative Per Se law[2], whereby an arresting officer is allowed to suspend immediately the driving privilege of someone who either refuses to take, or fails a breath test.

NHTSA (1991b) conducted a study to examine the effects of the reduction in the BAC limit. There were three main components of the study: a survey of the public; an operational analysis of the institutions involved with drinking and driving behavior; and analyses of the change in the number of DUI arrests, alcohol-related crashes, and alcohol-related fatalities.

SURVEY

A survey was conducted at DMV offices in four study sites throughout California. The survey examined the public's awareness of the reduction of the legal BAC limit and implementation of the Administrative Per Se law, reported change in drinking and driving behavior, and perceived risk of being stopped for DUI. Over a one-week period in May 1991, 1600 respondents completed a two-page questionnaire.

Awareness of the reduction in the BAC limit was high. A large majority (81 percent) of respondents knew that the BAC limit had become stricter and 45 percent were able to correctly write 0.08 as the current limit.

The responses indicated that the incidence of self-reported driving after drinking has decreased substantially since the lower BAC law went into effect. Half of all respondents who drink alcohol reported they are less likely to drive within two hours of drinking now, compared to before the law change. Of those individuals who reported a change in their behavior and stated the reason, 44 percent attributed the change to concern about the DUI laws (both the lower BAC limit and Administrative Per Se) and penalties. For those individuals who both knew the correct BAC limit and claimed that they have decreased their frequency of driving after drinking too much, 32 percent attributed the change in their behavior to concern about the laws and penalties.

Respondents perceived the risk of being stopped for DUI to be very high. Half of all the respondents felt that they were almost certain or very likely to be stopped by the police if they drove after having had too much to drink. Three-quarters of all respondents felt this risk has increased since the reduction in the BAC limit.

OPERATIONAL ANALYSIS

The purpose of the operational analysis was to determine how the organizations that deal with drinking and driving behavior (the police, judges, probation departments, DMV) have altered their

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[1] Three states moved toward stricter BAC legislation in 1991. Georgia lowered their per se limit from the previous 0.12 to 0.10. Kentucky also adopted a 0.10 per se, changing from their previous presumptive law. Vermont, which had 0.08 as a civil offense, enacted 0.08 per se as a criminal offense.

[2] Also known as an Administrative License Revocation (ALR) law.

activities as a result of the change in the law. Interviews were conducted with approximately one hundred representatives from organizations within the study sites. The interviews were designed to gather information regarding the effect of the lower BAC limit on the organizations' policies and operations, staffing and finances, and training needs.

Law Enforcement Agencies

- Enforcement of the lower BAC limit did not require new policies or procedures. Many law enforcement agencies had been arresting individuals for DUI below the 0.10 limit before the law change. The major difference is that, in cases where the chemical test indicates a BAC of 0.08 or 0.09, it is no longer necessary for the arresting officer to produce supporting evidence demonstrating the individual is under the influence. This makes it easier to make arrests at these lower BAC levels. The law change has not increased the difficulty of establishing probable cause for arrest.

- The law change did not increase the time involved in making an arrest or filling out the accompanying paperwork once a driver has been stopped. To the extent that the volume of arrests has increased, the time officers spend in court has increased.

- Due to the increase in DUI arrests, the reduced BAC limit has resulted in more jail bookings.

- Law enforcement agencies were not provided with increased funds or additional staff to implement the new law. To the extent that the reduction in the BAC limit has led to more arrests, it has involved more costs and demands on staff time.

- No training was needed regarding the legislative change itself. However, officers' lack of knowledge of how to recognize impaired drivers with BACs below 0.10 is a deterrent to full implementation of the law.

Court System

- The reduction in the BAC limit has had little impact on the way court administrators and judges carry out their jobs. The main impact has been on prosecutors' decisions about whether to file cases and the levels at which they should be prosecuted as DUI. The reduction in the BAC limit generally lowered (from around 0.12 to 0.10) the cutoff point below which cases are plea-bargained to a reduced charge.

- Judges perceive that the number of cases involving BAC levels under 0.10 increased in 1990; however, the relative number remains low. The BAC of the average DUI defendant is still far above the previous legal limit of 0.10.

- No increases were reported in the proportion of DUI defendants pleading guilty, requesting jury trials, receiving convictions or appealing convictions. There has been no impact on the sentencing of those convicted, who generally continue to receive the mandatory minimum sentence.

Probation Departments

- The reduction in the BAC limit has had limited impact on probation departments. Most offenders involved with the probation department are multiple offenders with BAC levels high enough to be unaffected by the law change.

DMV Driver Safety Offices

- The reduction in the BAC limit appears to have had no effect on the number of hearings requested by drivers who refuse to take the chemical test.

ANALYSIS OF ARREST, CRASH, AND FATALITY DATA

Data from each study site, as well as statewide, was examined to determine the impact of the 0.08 law on the number of DUI arrests, alcohol-related crashes, and alcohol-related fatalities.

The data indicate that overall, there was an increase in the number of DUI arrests statewide by the California Highway Patrol (CHP) and in each study site by all arresting agencies combined (this includes sheriff's offices and local police departments). The CHP made 17,661 more DUI arrests statewide from February through October 1990 than in the comparable period the previous year, an increase of 15 percent. The number of misdemeanors in general also rose at each site during the same period, however, the DUI arrests increased at an even higher rate. The number and proportion of arrests with BAC levels below 0.10 remained low.

There was no change in the number of alcohol-related crashes statewide nor in two of the study sites, however, there was an increase in the other two sites. This increase may be due to an actual increase in the number of alcohol-related crashes, or it may reflect increased reporting of alcohol involvement in crashes.

Data from the Fatal Accident Reporting System (FARS) was used to conduct a trend analysis. The purpose of this analysis was to determine the impact of the 0.08 law on the number of alcohol-related fatalities. The analysis indicated 12 percent fewer ($p=0.004$) alcohol-related fatalities statewide than projected following the implementation date of the 0.08 law. There was no change in the number of nonalcohol fatalities in California nor in the number of alcohol-related fatalities nationwide during the same period. This provides further evidence that the BAC legislation was involved in the decline in the number of alcohol-related fatalities.

There was no change in the number of alcohol-related fatalities following the date the Administrative Per Se law went into effect. However, given the advance publicity relating to both the 0.08 and the Administrative Per Se laws, it is difficult to untangle the effects of the two pieces of legislation which occurred so close together. It is possible that effects of the Administrative Per Se law may have taken place earlier than the actual implementation date. In addition, only six months of data were available following implementation of the Administrative Per Se law, making it difficult to assess any change. In summary, a 12 percent reduction in projected alcohol-related fatalities followed implementation of the 0.08 law, but part of this reduction may be due to overlapping activities related to the Administrative Per Se law.

APPENDIX F. ON-THE-ROAD DRIVERS: DRINKING FREQUENCY AND BAC LEVELS

Table F1. Drivers by Drinking Frequency Class Distribution Across BAC Levels

Drinking Frequency Class	Alcohol Class					
	.01-.04	.05-.07	.08-.10	.11-.14	.15+	Total
Abstain	96.2%	3.8%	0%	0%	0%	100%
Yearly	92.5%	5.0%	0%	0%	2.5%	100%
Monthly	85.1%	11.9%	1.5%	1.5%	0%	100%
Weekly	70.4%	17.0%	7.4%	3.5%	1.7%	100%
3x/week	62.1%	19.3%	10.8%	6.0%	1.8%	100%
Daily	61.3%	19.4%	12.2%	4.5%	2.7%	100%

Adapted from Borkenstein et. al., (1964), Table 53.

Table F2. Drivers at Different BAC Levels Distribution by Drinking Frequency Class

Drinking Frequency Class	Alcohol Class				
	.01–.04	.05–.07	.08–.10	.11–.14	.15+
Abstain	9.3%	1.6%	0%	0%	0%
Yearly	6.8%	1.6%	0%	0%	7.1%
Monthly	10.4%	6.3%	1.6%	3.4%	0%
Weekly	29.7%	31.0%	27.0%	27.6%	28.6%
3x/week	18.9%	25.4%	28.6%	34.5%	21.4%
Daily	24.9%	34.1%	42.9%	34.5%	42.9%
Total	100%	100%	100%	100%	100%

Adapted from Borkenstein et. al., (1964), Table 53.

APPENDIX G. INFLUENCE OF BAC LIMITS ON DRINKING AND DRIVING DECISIONS

A national telephone survey (NHTSA, 1991d) conducted as part of this project was designed to collect information on the bases for drinking and driving decisions, and on how the BAC limit fits into this decision-making framework. Some survey findings have already been included in the text of this report. The following summary provides additional information on the procedures and results.

The core of the questionnaire consisted of three scenarios: the last time during the past year respondents drank at a place to which they had driven (random situation), the last time they drove when they thought they had too much to drink to drive (the impaired driving situation), and the last time they did not drive after having too much to drink (the avoidance situation). Interviewers asked respondents if they had ever been in any of these situations. If respondents replied "yes," the interviewers questioned them in detail about the most recent occurrence– starting with any prior preparation for drinking; transcending to behavior, considerations, and perceptions during the drinking situation; and lastly moving to the conclusion of the drinking situation. The questions asked of respondents were largely the same across scenarios. Respondents could go through as many as all three scenarios depending on their past experiences and behavior.

Other survey questions investigated respondents' knowledge and attitudes concerning BAC limits. Items exploring perceptions of enforcement activity and sanctions followed. To segment the sample, the survey included questions on demographics, drinking behavior, problem drinking, and risky behavior.

The telephone survey was administered during June and July 1991 to approximately 4,000 persons drawn from a national probability sample of households selected through a random digit dialing process. The survey oversampled persons 16 through 29 years old in order to obtain sufficient numbers of respondents for analysis of younger age groups, such subgroup analyses being particularly important because of the disproportionately high contribution of younger drivers to the drinking and driving problem. Data were weighted to project national estimates.

The survey estimated that about 8 percent of the population are nondrivers, and 47 percent are nondrinkers (see Table G1). The interviewers asked these groups a relatively small number of selected questions predetermined as appropriate for them. The remainder of the sample, slightly more than 2000 persons, went through the main questionnaire.

Table G1: Drinkers/Drivers***

Total Population Ages 16 And Older	**100%**
*Drivers	92%
**Persons Who Drink	53%
***Drinkers/Drivers	51%
Drinkers/Drivers	**100%**
Drinkers/Drivers In Drinking And Driving Situations****In The Past Year	61%
Drinkers/Drivers Who Have Driven When They Thought They Had Too Much To Drink:	
Ever	40%
Past Year	8%
Drinkers/Drivers Who Have Not Driven When They Thought They Had Too Much To Drink:	
Ever	36%
Past Year	15%

* Persons who indicated they usually drive, or had driven a motor vehicle in the past year.

** Persons who indicated they had consumed some amount of alcohol in the past year.

*** Persons who at least occasionally drive and who consumed some amount of alcohol in the past year.

**** Drinkers/Drivers who drank at a place to which they had driven in the past year.

Some of the findings concerning specific drinking and driving situations are presented in Table G2. The data point to differences between random drinking situations, situations where persons drive after drinking too much, and situations where persons decide not to drive after drinking too much. Moreover, the data suggest that many persons become concerned and think about their ability to drive when drinking alcohol away from home, particularly in situations where they believe they may have consumed too much alcohol. In instances where persons still drove when they thought they may have had too much to drink, 64 percent reported that they considered slowing down or stopping their drinking while there and/or became concerned about problems that might happen if they drove after drinking. Thus, there is evidence that a substantial segment of the population thinks about the implications of their driving after drinking while in risk (i.e., drinking) situations. However, other data indicates that they do not specifically consider the BAC limit in these deliberations (see Tables G3 and G4).

Table G2: Drinking And Driving Situations: Last Reported Incident

	Situation A*	Situation B**	Situation C***
Location:			
Restaurant	34%	8%	12%
Other People's Homes	33%	30%	54%
Bars/taverns	18%	42%	22%
Expected To Be Drinking Alcohol There	75%	87%	84%
Of Those Expecting To Drink: Did Something Before Going To Avoid Problems Driving Home	43%	21%	52%
Average Number Alcoholic Drinks Consumed There	2.8	7.5	7.4
Felt People Expected Them To Drink Alcohol	19%	49%	36%
While There, Considered:			
Slow Down/Stop Drinking	12%	43%	36%
Slow Down Drinking	7%	26%	22%
Stop Drinking	5%	18%	14%
Of Those Who Considered Slow Down/Stop: Percent Who Did Either	90%	84%	86%
While There, Considered: Whether They Should Drive When Leaving (Due To Drinking)	18%	50%	-
Concerned About Specific Problem If They Drove	30%	54%	61%
Upon Leaving, felt:			
Well over legal limit	3%	31%	31%
A little over legal limit	6%	38%	26%
Right at legal limit	2%	2%	2%
Somewhat within limit	11%	15%	12%
Well within limit	74%	8%	22%

* Persons who reported consuming alcohol in the past year at a place to which they had driven.

** Persons who reported an instance in the past where they drove after probably drinking too much.

*** Persons who reported an instance in the past where they did not drive after consuming probably too much alcohol.

Key points to note include the different locations of the varying scenarios; i.e., driving after drinking too much most often originating from bars and taverns while DWI avoidance most often occurring at other people's homes. Also noteworthy--driving after drinking too much was more closely associated with expectations that the respondent would be drinking alcohol, but also associated with lesser prior preparation to avoid any problems driving home. Of great significance, persons who reported that they considered slowing down or stopping their drinking almost invariably reported doing so.

Table G3. Persons Who Considered Slowing Down or Stopping Drinking

	Situation A*	Situation B**	Situation C***
Had To Drive Home, Driving (Unspecified)	36%	33%	20%
Didn't Want To Drink Anymore, Had Enough	19%	13%	17%
Felt Intoxicated/Drunk	10%	24%	19%
Getting Late/Time To Go Home	6%	2%	2%
Felt Lightheaded/Dizzy/Seeing Double/Other Symptoms	6%	9%	14%
Didn't Want Hangover/Feel Bad In Morning	6%	1%	9%
Fear Of Being In Accident/Too Dangerous/Unsafe	5%	4%	5%
Felt Sick	5%	6%	9%
Fear Of Law/DWI/Being Arrested	2%	4%	2

* Persons who reported consuming alcohol in the past year at a place to which they had driven.

** Persons who reported an instance in the past where they drove after probably drinking too much.

*** Persons who reported an instance in the past where they did not drive after consuming probably too much alcohol.

All data above refer to the most recent incident for that person.

Table G4. Persons Concerned About Specific Problems If They Drove

Reported Reasons	Situation A*	Situation B**	Situation C***
Being In An Accident	47%	45%	58%
Being Stopped By Police	36%	40%	33%
Hurting Someone Else	15%	13%	16%
Being Hurt	6%	8%	10%
Hurting Someone In Car With Them	8%	6%	6%
Impaired Reflexes/Driving Skills	4%	3%	3%
Losing Their License	3%	4%	3%
Arrested For DWI	3%	2%	2%

* Persons who reported consuming alcohol in the past year at a place to which they had driven.

** Persons who reported an instance in the past where they drove after probably drinking too much.

*** Persons who reported an instance in the past where they did not drive after consuming probably too much alcohol.

All data above refer to the most recent incident for that person.

Major findings concerning awareness of BAC limits are presented in Table G5. Several basic points may be made from that data. First, a substantial majority of drinkers/drivers have heard of BACs and know that their state has set a BAC level at which it becomes illegal to drive. Second, when persons are asked what the legal limit is, the percentage who can recite the correct BAC limit without prompting drops precipitously. Third, there appeared a somewhat greater level of awareness and knowledge about the BAC limit in the five 0.08 states. Since the largest of these states (California) enacted major drunk driving legislation only a year earlier, and another state (Vermont) enacted a change involving the 0.08 limit just days prior to onset of this survey, the findings may reflect the results of publicity associated with the recent legislative changes. Lastly, 31 percent of drinkers/drivers do not think there should be a legal limit to the number of alcoholic drinks a person can have before driving and another 7 percent are unsure if there should be a legal limit.

Since it was considered unlikely that the public would be able to answer questions about the impairing effects of alcohol according to BAC levels, the survey instead asked drinkers/drivers the numbers of drinks it would take to reach certain points. For example, drinkers/drivers were asked how many beers they could consume in two hours and still drive safely. This information, along with information collected on the respondent's weight and gender, was used to convert the number of drinks into BAC levels (several hundred subjects were lost in the conversion due to lack of all necessary information). The distribution, shown in Figure G1, indicates that fewer than 20 percent of

Table G5. Knowledge Of BAC Limits By Drinkers/Drivers*

	Total	0.08 States**	0.10 States***
Feel There Should Be Legal Limit To Number Of Drinks Before Driving	61%	59%	61%
Heard Of BAC	84%	86%	84%
Of Those Who Heard Of BAC: Percent Who Know State Has Set BAC Limit	87%	94%	86%
Of Those Who Know State Set Limit, Percent Who (Unaided) Said Limit Was:			
.05	4%	1%	4%
.08	11%	56%	2%
.10	35%	12%	39%
Don't Know	39%	24%	42%
Of Those Who Know State Set Limit, Percent Who Learned About It From:			
Newspapers	38%	43%	37%
TV/Radio	24%	31%	22%
Driving Classes/Instruction	13%	19%	12%
Estimated Number Of Drinks To Reach Legal Limit In 2-hour Period (Average):			
12 ounce beers	3.75	3.11	3.86
5 ounce glasses of wine	3.28	2.65	3.39
1 1/4 ounce drinks of liquor	2.80	2.57	2.84

* Persons who at least occasionally drive and who consumed some amount of alcohol in the past year.

** 0.08 States: Respondents from California, Maine, Oregon, Utah, and Vermont

*** 0.10 States: Respondents from the remaining 45 states plus the District of Columbia.

drinkers/drivers felt they could drive safely at a computed BAC of 0.08. A similar question was posed to drinkers/drivers who had said that there should be a legal limit to the number of alcoholic drinks a person can have before driving. It asked them what they thought the legal limit should be for the number of 12-ounce beers a person can drink within two hours before driving. Conversion to BAC levels (Figure G2) showed 87 percent recommending a 0.08 BAC level or lower. Additional information pertinent to this topic may be gleaned from an independent NHTSA survey on attitudes toward DWI, conducted shortly after the BAC limits survey conducted for Congress. The attitude survey included a question that addressed the most basic issue in determining BAC limits--asking respondents their level of agreement with the statement "People should not be allowed to drive if they have been drinking any alcohol at all." As indicated in Figure G3, about three-quarters of the population ages 16-64 agreed with the statement; most professing strong agreement.

Table G6: Attitudes Toward The Current BAC Limit By The Total Population 16 And Older

Think The Legal Limit Is:	0.08 States	0.10 States
Male		
Too High	31%	38%
Far Too High	14%	19%
A Little Too High	17%	18%
About Right	54%	44%
Too Low	11%	12%
A Little Too Low	6%	7%
Far Too Low	5%	5%
Female		
Too High	39%	41%
Far Too High	21%	24%
A Little Too High	18%	17%
About Right	37%	35%
Too Low	16%	13%
A Little Too Low	6%	7%
Far Too Low	10%	6%
Numbers Of Drivers Considered Dangerous At The Current Legal Limit:		
Male		
All	19%	25%
Most	27%	34%
Some	36%	26%
Few	11%	10%
None	*	1%
Female		
All	30%	34%
Most	34%	33%
Some	22%	21%
Few	5%	5%
None	*	*
* = Less than .5%		

Table G7. Penalties Perceived As Appropriate For Lowered BAC Limits

Most Appropriate Sanction	BAC Limit Reduced To:		
	Any Measurable Amount	0.04 Limit	0.08 Limit
Fine of $50	19%	17%	9%
Fine of $125	10%	12%	10%
Fine of $250	11%	11%	15%
Fine of $500	12%	12%	11%
Suspend License 60 Days	16%	17%	23%
Suspend License 1 Year	9%	8%	9%
Jail	4%	5%	4%
Vehicle Impoundment	2%	2%	2%

After surveying drinkers/drivers about their knowledge of BAC limits, the questionnaire collected information concerning attitudes toward the current BAC limit from the total national sample. Interviewers recited the correct BAC limit for DWI to respondents (0.08 or 0.10 depending on state), and equated this to number of drinks consumed over a two-hour period to help respondents interpret the information. Male respondents were told the approximate number of drinks to reach that limit for an average weight male, and female respondents were given information for an average weight female. Table G6 summarizes the results.[1] The Table 6 data indicate that persons are over twice as likely to believe that the current BAC limit is too high as too low. Moreover, 55 percent of persons in 0.08 states, and 63 percent of persons in 0.10 states, believed that most or all drivers would be dangerous if they drove at the legal limit.

Interviewers presented all respondents in the survey with one of three hypothetical situations, where the BAC limit had been reduced either to 0.08, to 0.04, or to any measurable level (persons already in 0.08 states did not receive the 0.08 scenario). They then asked respondents what they felt would be the most appropriate penalty (of several specified) for a person convicted of driving at the limit (first offense). As illustrated in Table G7, responses were for the most part stable across hypothetical BAC limit.

The survey questioned all respondents except nondrivers about perceptions of enforcement. Table G8 summarizes the results. In general, there was evidence that persons in 0.08 states were more likely to expect harsher repercussions from being caught while driving over the legal limit.

[1] The number of drinks communicated to respondents was derived from BAC cards that did not differentiate by gender. Data later became available to NHTSA that is considered more accurate in computing BACs (See Appendix I). For males, the number of drinks to reach a specific BAC did not appreciably differ between the BAC card and the new data, indicating no problem with the ranges disclosed to males. However, females were told ranges that the new data suggests were about one drink too high. If the data is accepted, females were responding to a 0.12 BAC rather than a 0.08, and a 0.13 or 0.14 BAC rather than a 0.10. No problem was discerned for a 0.04 BAC. This information should be considered in interpreting results from three questions: (a) whether respondents consider the legal limit too high or too low, (b) the numbers of drivers considered dangerous at the current legal limit; and (c) appropriate penalties if the BAC limit is reduced to 0.08, 0.04, or any measurable level.

Table G8. Perceptions of Enforcement By Persons Who Drive

Perceived	Total	0.08 States	0.10 States
Chances Out of 100 of Being Stopped by Police if Above BAC Limit And:			
Driving Normally	4.79	5.74	4.64
Driving Erratically	39.11	37.50	39.38
What Police Likely Would Do if They Found Stopped Driver's BAC Was Over Legal Limit:			
Arrest Driver	67%	77%	65%
Give Driver Ticket	11%	7%	12%
Number of DWI Convictions Per 100 Charged Drivers	50.68	56.94	49.64
Know Someone Convicted of DWI/DUI	55%	57%	54%
Personally Convicted of DWI or DUI	4%	7%	4%
Most Likely Consequences of DWI Conviction*:			
First Offense			
Fined Under $500	38%	31%	40%
License Suspended For A Period	29%	30%	29%
Go To Jail	15%	21%	14%
Fined $500 or More	14%	26%	12%
Not Sure	10%	8%	11%
Second Offense			
Fined Under $500	11%	6%	12%
License Suspended For A Period	42%	42%	42%
Go To Jail	30%	39%	28%
Fined $500 or More	26%	33%	25%
Not Sure	17%	15%	17%
Most Serious Consequences Personally If Convicted Of DWI:			
Loss of License	36%	33%	37%
Risk of Jail	27%	28%	27%
Fines	6%	5%	7%
Effectiveness Of Current Laws And Penalties At Reducing Drinking And Driving:			
Effective	63%	68%	62%
Very Effective	13%	17%	12%
Somewhat Effective	50%	51%	49%
Not Effective	34%	30%	35%
Not Too Effective	26%	23%	27%
Not At All Effective	8%	7%	9%

* *Respondents could identify more than one.*

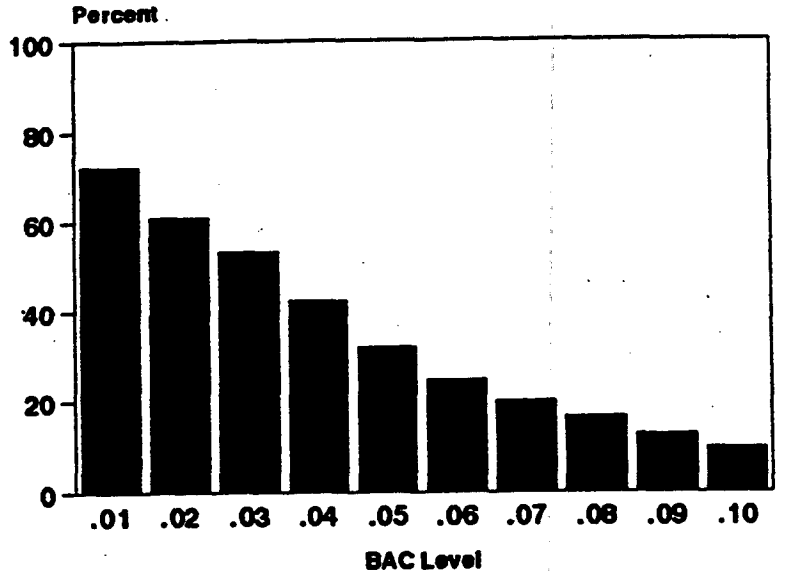
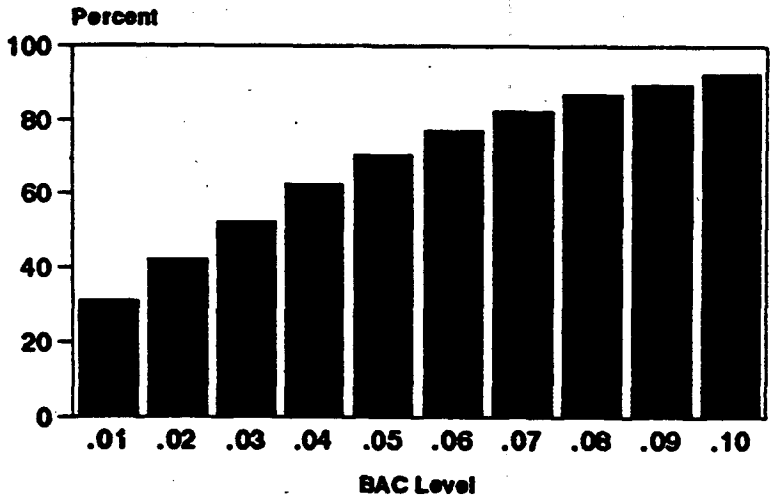


Figure G1. Percent Who Think They Can Drive Safety at Given Alcohol Levels BAC Equivalents of Reported Numbers of Beers by Drinkers/Drivers



***Each bar represents the percent of respondents who felt the legal limit should**

Figure G2. Percent Who Believe Legal Limit Should be at Given BAC or Less* (BAC Equivalents of Reported Numbers of Beers for Drinkers/Drivers Asked of Those Who Felt There Should be a Legal Limit)

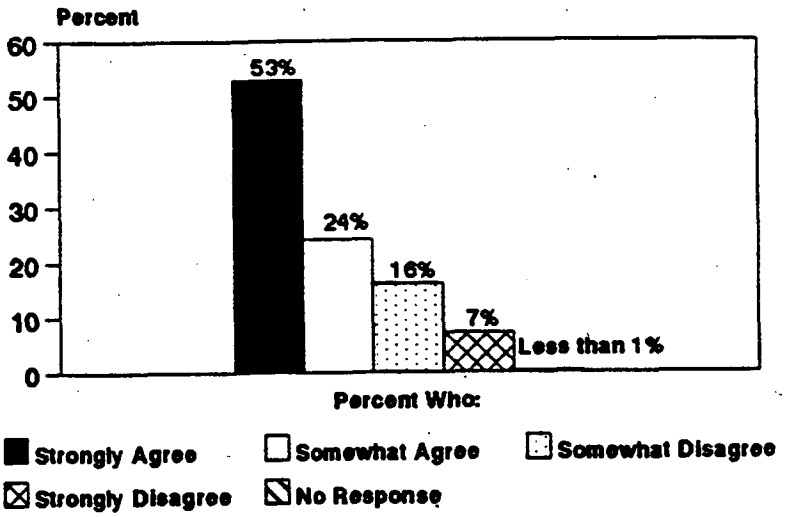


Figure G3. Response to Survey Question: "People should not be allowed to drive if they have drunk any alcohol at all."

APPENDIX H. WORKSHOP METHODOLOGY

This Appendix describes the conduct of two workshops held by the National Highway Traffic Safety Administration (NHTSA) in Belmont, Maryland, in April 1991. The purpose of the workshops was to obtain input from authorities on drinking and driving concerning penalties for driving under the influence of alcohol.

BACKGROUND

The first report to Congress was a multifaceted study that included a review of scientific literature, existing BAC legislation, and expected institutional responses to alternative legal limits on BAC levels for driving. Published in February 1991, the report was entitled *Alcohol Limits for Drivers: A Report on the Effects of Alcohol and Expected Institutional Responses to New Limits.*

As part of its research effort for its first report to Congress, NHTSA conducted four workshops in April 1990 to determine potential responses that institutions, groups, and society in general might have to three BAC limits: 0.08, 0.04, and 0.00 percent. Seventy-seven participants attended the one-day workshops, which were held in Reston, Virginia; San Francisco, California; Kansas City, Kansas; and Atlanta, Georgia. The participants represented local law enforcement agencies and treatment centers, the court system, state legislatures and motor vehicle departments, activist groups, the hospitality industry, and the media.

Through a structured input process, participants in the workshops discussed a comprehensive range of situations that each group represented might experience as a result of each of the three proposed BAC limits for drivers and the type of actions these groups might take in response. The major finding was that effective implementation of lower BAC limits would be very difficult without changes in the system. Participants at the workshops expressed concern about arbitrary enforcement of BAC limits, loss of public support for laws limiting alcohol use for drivers, lack of probable cause in making arrests, court overloading, and jury rejection of offenses resulting from low BAC levels, among other issues. Suggestions to enhance the implementation of lower BAC limits for drivers included a new multilevel system of civil, administrative, and criminal penalties.

WORKSHOPS ON MULTIPLE ALCOHOL PENALTY SYSTEMS

As part of its research effort for its second report to Congress, NHTSA developed a ***multilevel alcohol penalty system (MAPS)*** to address the problems cited in the workshops in implementing lower BAC limits. In developing MAPS, NHTSA identified potential solutions to these problems, incorporating administrative, civil, and criminal penalties or restrictions. The penalties are structured according to the characteristics of the various drinking and driving offenses.

NHTSA then conducted a second series of workshops whose purpose was to obtain input from authorities on drinking and driving concerning penalties for driving under the influence of alcohol. Two separate workshops of 1-1/2 days each were held on April 22 and 23 and April 24 and 25, 1991. The agenda for the workshops is provided at the end of this Appendix.

Thirty-two participants attended the two workshops. In addition, five NHTSA staff and three staff members from a contractor (Walcoff and Associates, Inc.) were present at various times. Walcoff moderated the workshops, and a NHTSA representative led the discussions. Participants represented law enforcement agencies, the court system, motor vehicle departments, treatment centers, and other

groups concerned with drinking and driving behavior. Approximately one-half of the participants had attended the first series of four workshops held in 1990. A list of participants is provided at the end of this Appendix.

Participants were asked to review MAPS and suggest additional approaches to improve the proposed system. The workshops encouraged an open-ended, full policy discussion rather than a consensus process. The results of the two workshop reviews are integrated with findings from other aspects of the overall study and included in this final report to Congress.

Multilevel Alcohol Penalty Systems

Before asking the participants to review MAPS and provide input on enforcing and implementing it, NHTSA presented the following assumptions and principles underlying the system.

Assumptions and principles

NHTSA reviewed two primary findings of its first report to Congress: that alcohol impairs driving ability and that the precise BAC level at which impairment begins has not been determined. Because technical research has not addressed the very low BAC levels, one cannot assume, as has often been the case, that a safe threshold exists below which a person can still drive safely.

As background material, quotations from the Panel on Treatment, in the proceedings of the Surgeon General's Workshop on Drunk Driving were distributed (Table H1).

Table H1. Quotations from the Panel on Treatment, Surgeon General's Workshop on Drunk Driving Proceedings.

"Drinking and driving is a serious social and public health problem. Because of the enormous human and economic costs of drinking and driving on our society, the Panel on Treatment unanimously agrees that prevention and deterrence from drinking and driving are beneficial to all our society.

"To improve traffic safety in the United States, the panel advocates the position that the safest blood alcohol level is 0.0 percent while driving and strongly recommends that the public service message should clearly state:

'If you are going to drive, don't drink.'

"The panel further advises that contrary or different messages, including 'Know your limit' messages, should not be used."

Panel on Treatment
Surgeon General's Workshop
on Drunk Driving Proceedings
Washington, D.C.
December 14–16, 1988

NHTSA then presented a bulleted list of assumptions and principles on which MAPS is based.

Table H2. Assumptions and Principles underlying MAPS.

- Scientific evidence indicates that drinking and driving poses a risk to drivers and society. There is no lower threshold for alcohol effects on performance or increase in crash risk. Thus, people should be discouraged from drinking and driving.
- Public education will be given on the dangers of drinking and driving at any alcohol level. Some aspects of this education will precede and accompany the implementation of MAPS. Implementation of a MAPS will be a part of this education.
- Penalties and enforcement efforts must be suitable to the offense and be acceptable to society. The system needs to be seen as reasonable and fair. Less tolerance is shown for repeated violations and heavy consumption.
- MAPS should overcome or reduce the following potential problems in implementing a DWI alcohol level below 0.08:
    a. Overload of the court system.
    b. Difficulties in gaining reasonable suspicion to investigate or probable cause to arrest.
    c. Official hesitancy in enforcing what is perceived as an unpopular law or as one not based on strong evidence.

After reviewing and reiterating the assumptions and principles, NHTSA distributed MAPS (Table H3). NHTSA noted that the proposed MAPS does not create a criminal offense for BAC levels below 0.08 percent. Additionally, BAC limits on MAPS are *per se* levels. (*Per se* laws make it illegal, by the act itself, to drive with a BAC level over a specified limit. Presumptive laws, in contrast, assume that an individual driving with a given BAC level is impaired, but the presumption is open to refutation in court.) In the first session of Day 1 of the workshop, the participants discussed the structural features of MAPS. This was followed by a discussion of its enforcement aspects in the second session. NHTSA distributed the guidelines in Exhibit H4 for the enforcement discussion. The remainder of the first day was spent on a discussion of schedules for MAPS were it to be implemented.

Participant Assessment of the Multilevel Alcohol Penalty Systems

After the sessions on the first day, NHTSA developed several alternate versions of MAPS. The revised MAPS were based on the comments of the participants in the separate workshops and were distinct for each workshop. On the second day of each of the two workshops, NHTSA distributed the revised MAPS, with the criteria shown in Exhibit H5 for their assessment.

Ratings:

Following the discussions and descriptions of the alternate MAPS for each of the workshops, NHTSA requested that participants rank each of the MAPS developed for their workshop and the original system that NHTSA presented on a scale of 1 to 7 for each of the above criteria. In addition to rating the various MAPS, the participants also rated "their present system" (whatever it might be); this allowed comparisons to be made across alcohol penalty systems. Participants were also requested to write in further narrative suggestions. NHTSA collected and later analyzed the results of the rankings. As a result of these analyses and the comments of the participants, a composite final version of a multilevel alcohol penalty system was derived. This composite is called an administrative "*Any Measurable Alcohol Penalty System*" or Administrative AMAPS (see Table H6). The combined judgements of the workshop participants for this Administrative AMAPS (as compared to their assessment of the "Present System") are shown in the two Tables H7 and H8. Here the eight criterion measures are divided into two sets showing those dimensions on which the Administrative AMAPS was perceived positively relative to present systems (Figure H7), and those for which it was perceived negatively (Figure H8).

Table H7 shows that the Administrative AMAPS is positively perceived as:

- more efficient than present systems
- sending a more powerful alcohol message to the driving public
- enhancing attention to alcohol highway safety, and
- more productive in reducing driver BAC levels.

Table H8 shows the negative perceptions of the participants in seeing the administrative AMAPS as:

- having more side effects
- being less practical to apply
- costing more to implement and operate, and
- having less legislative practicality.

Table H3. Initial Version of Multilevel Alcohol Penalty System (MAPS)

If BAC Is	Offense Is Called	Then
.08 or Higher	*Driving While Intoxicated (DWI)*	Apply existing fines, rules, penalties, and restrictions as currently levied for the .10 BAC level, providing they are greater than their Operating With Alcohol (OWA) and Driving Under the Influence (DUI) counterparts. (If current laws do not embody the two following NHTSA-recommended effective penalties, they should be added: 1) require prompt and certain administrative license revocation or suspension of at least 90 days for persons determined by chemical test to violate the States's BAC limit; and 2) provide for increasingly more severe penalties for repeat offenders, including lengthy license revocation, substantial criminal fines, jail, and/or impoundment or confiscation of license plates or vehicles registered by the offender.)

If BAC Is	Offense Is Called	Treated As	1st Offense Fine Is	2nd Offense Fine Is	2nd Offense Within 2 Years Treated As	2nd Offense Within 3 Years, Penalty Is	Offense Committed While License Suspended Treated As
.04 to .079	*Driving Under the Influence (DUI)*	Civil and administrative offense Akin to moving violation	$125 plus court costs	$175 plus court costs	Criminal Offense: Driving While Intoxicated (DWI)	$250 fine plus court costs License suspended administratively	Criminal Offense: Driving While Intoxicated (DWI)

If BAC Is	Offense Is Called	Treated As	1st Offense Fine Is	2nd Offense Fine Is	3rd Offense Fine Is	3rd Offense Within 1 Year, Penalty Is	4th Offense Penalty Is	5th Offense Penalty Is
.02 to .039	*Operating With Alcohol (OWA)*	Civil and Administrative Offense Akin to Moving Violation	$50 payable through mail	$150 payable through mail	$250 payable through mail	$400 fine, license suspended administratively	$400 fine, license suspended administratively	License suspended administratively DMV hearing on license retention

Table H4. Enforcement Issues for Discussing

Enforcement Approaches

Police observation of observable cues. On patrol and at checkpoints. In essence, present techniques. However, because known observable cues are frequently not present at lower BAC levels, this technique is not expected to be very effective for BAC levels below .08. How effective new cues might be awaits further research.

Given the limitations on direct police observation for detecting lower levels of BAC and the existence of breath test technology established as an evidential tool, a number of approaches can be considered using breath test devices:

- Breath tests as a result of a motor vehicle crash (mandatory?)
- Breath tests as a result of reasonable suspicion of any motor vehicle violation. (nondiscretionary/random)
- Breath tests as a part of an alcohol checkpoint. (nondiscretionary/random)

Resource limitations (time and staff) are factors that must be considered in relation to the enforcement approach.

What about plea bargaining or other ways that a driver with a high BAC level might escape to a lower level offense? Bargaining/reduction to lesser offense?

Table H5. MAPS Assessment Criteria.

Assessment Areas

- Efficiency/effectiveness in handling offenders (offenders caught, appropriate penalty applied).
- Cost to implement and operate.
- Messages given to driving public.
- Enhancement of attention to alcohol-affected highway safety.
- Practicality of application.
- Reduction of driver alcohol levels.
- Side effects.
- Legislative practicality.

Table H6. Final Version of an Administrative "Any Measurable Alcohol Penalty System" (AMAPS)

If BAC is	Offense is called:	Then
.08 or Higher	Driving While Intoxicated (DWI)	Apply existing fines, rules, penalties, and restrictions as currently levied for the .10 BAC level, providing they are greater than the recommended DUI structure. (If current laws do not embody the two following NHTSA-recommended effective penalties, they should be added: 1) require prompt and certain administrative license revocation or suspension of at least 90 days for persons determined by chemical test to violate the State's BAC limit; and 2) provide for increasingly more severe penalties for repeat offenders, including lengthy license revocation, substantial criminal fines, jail, and/or impoundment or confiscation of license plates or vehicles registered by the offender.)

If BAC is	Offense is called	Treated as	Any Offense	2nd Offense within 2 years, penalty is	3rd Offense Below .08, penalty is	Offense committed while license suspended is treated as
>.00 to .079	Driving Under the Influence (DUI)	Civil and/or administrative offense	$200 fine plus points awarded	License suspended administratively	License suspended administratively	Criminal Offense: Driving While Intoxicated (DWI)

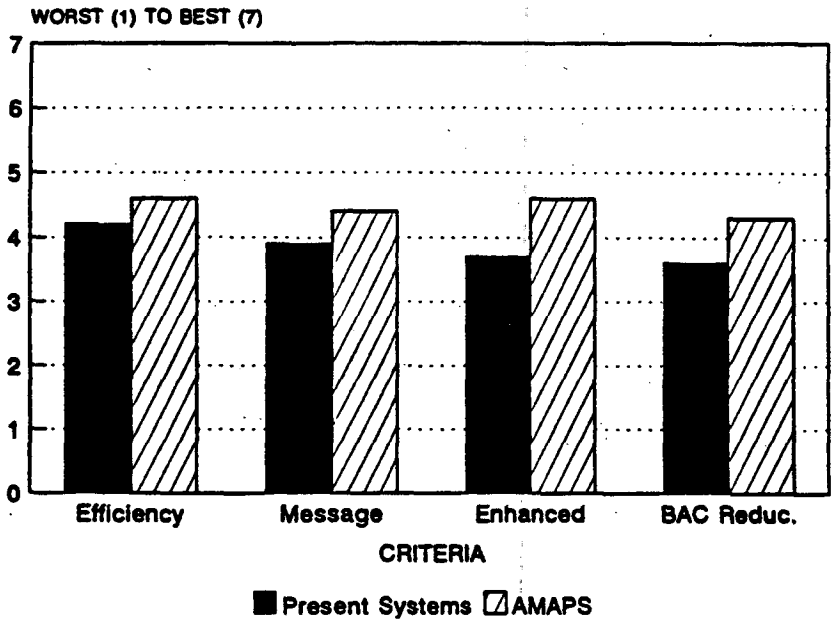


Figure H7. Administrative AMAPS Perceived Safety Benefits

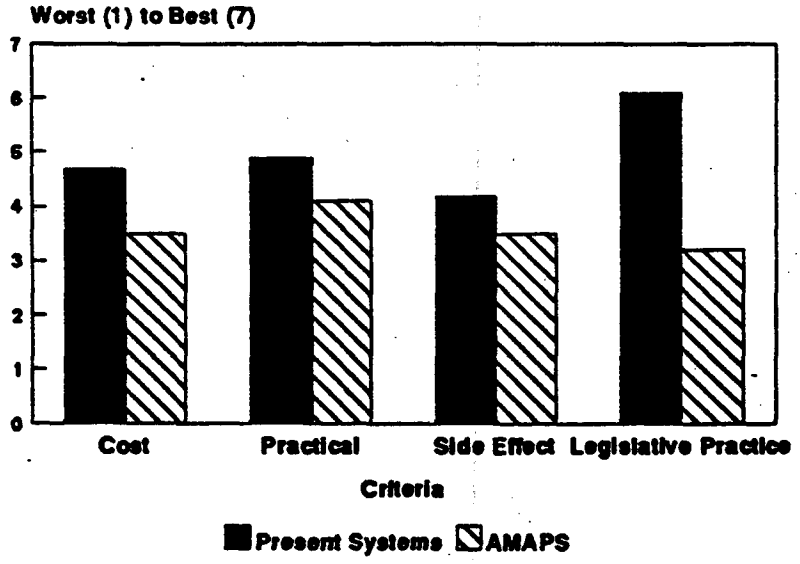


Figure H8. Administrative AMAPS Perceived Cost/Practicality

WORKSHOP AGENDA

DAY 1

SESSION I

9:00–10:10	Welcome, Introductions, Housekeeping, Procedural Ground Rules
	Background and Context
	Project Context—Use of Products
	Report 1 Alcohol Effects
	Report 1 Institutional Response
	Approach to Further Consideration Using Workshops
10:10–10:30	Break
10:30–12:00	MAPS
	Assumptions and Principles
	Offense Definition
	Penalty Structure
	Enforcement Approach
	Implementation Schedule Options
	Penalty Structure Review and Analysis
	Problems and Suggested Improvements
12:00–1:00	Lunch

SESSION II

1:00–3:00	Enforcement Approach Review and Analysis
3:00–3:20	Break
3:20–5:00	Implementation Schedule Options

DAY 2

SESSION III

9:00–10:15	Assessment Criteria/Structure Options to Assess
	Assessment Discussion
10:15–10:30	Break
10:30–11:30	Assessment Notes (to be handed in)

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APPENDIX I. CALCULATION OF BAC ESTIMATES

The basic formula for estimating a person's blood alcohol concentration derives from the work done by Widmark in the early 1930s. Advancements in this technical area have lead to refinements in Widmark's basic calculation formula. The particular formula used in this report incorporates a BAC calculation procedure provided to NHTSA courtesy of Herbert Moskowitz, Ph.D., a noted alcohol researcher. The basis for the calculations are the established physiological facts that alcohol distributes itself in the total water of the body, and that it is disposed of primarily by metabolism in the liver. The procedure takes into account the amount of body water in males and females, and the range of metabolic rates to be found in the population. The procedure, along with a work example, is presented below.

Alcohol concentration is defined in terms of the weight of ethanol (Ethel alcohol) in a volume of blood or breath. In the United States the typical measure is ***grams of ethanol in 100 milliliters of blood or in 210 liters of breath*** and is reported as, for example, .10 percent or .10[1].

The procedure by which one calculates how to convert a dose of alcohol into a probable blood alcohol concentration proceeds in several steps:

1. After absorption, alcohol is eventually distributed in the total water in the body. Begin by calculating the amount of water in the subject. On average, males have 58 percent of their body weight as water and females have 49 percent of their weight as water. To find the amount of water in an individual of given weight, one multiplies the body weight **in kilograms** by the gender percentage and obtains the amount of weight of the water in kilograms. A kilogram of water occupies one liter, one can easily convert from weight to volume of water. For example, consider a 128-pound male of age 25. One hundred and twenty eight pounds divided by 2.2046 converts pounds into 58.06 kilograms, which is his kilogram weight.

2. To find the total body water, multiply the 58.06 kilograms times .58 equals 33.675 kilograms of water which occupies a volume of 33.675 liters or 33,675 milliliters.

3. The next step is to inquire what concentration in water will occur when a given dose of alcohol is administered. Assume that the dose is one ounce of pure alcohol (i.e., 200 proof). One ounce of alcohol equals 29.57 milliliters. Since alcohol has a specific gravity of .79, the 29.57 milliliters will weigh 23.36 grams.

   One ounce of alcohol (i.e., 23.36 grams), absorbed into a 128-pound male's total body water, produces an alcohol concentration in water of 23.36 grams divided by 33,675 milliliters, i.e., .0006937 grams alcohol per milliliter of body water.

4. We now find the alcohol concentration in the blood. On average, blood is composed of 80.6 percent water. Therefore, the .0006937 grams alcohol per milliliter of water is multiplied by

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[1] "Percent" in U.S. toxicological circles means grams per 100 milliliter; this is a weight per volume measure and does not carry the usual meaning of percentage. In this report, BAC is defined as either blood alcohol concentration, stated as grams per 100 milliliters of blood or as breath alcohol concentration, stated as grams per 210 liters of breath, and is reported without a "%" sign.

.806. This results in .000559 grams alcohol per milliliter of blood (this is because each milliliter of blood only has .806 milliliters of water).

5. Since the desired measure is not alcohol per **milliliter** blood but grams alcohol per 100 milliliters, we multiply the .000559 grams alcohol per milliliter blood times 100 milliliters which equals .0559 grams alcohol per 100 milliliter blood. This is also described as grams per deciliter (i.e., per 1/10 liter of blood), or also as .0559.

   It should be noted that our calculations are based on average characteristics for individuals. While .58 is the mean water body weight of males and .49 is the mean water body weight of females, individuals vary with respect to this figure. Younger people have a higher proportion of body water as a fraction of their total weight, and older people have less. Overweight individuals have a smaller proportion of their body weight as water, and lean people have a larger fraction of their body weight as water. In most cases, this variability will produce a small fraction as error in calculating BAC. Another source of variation is the amount of water in the blood. This varies as a function of several factors, including the red blood cell concentration measured by the hemocrit. But again .806 is the average value and deviations typically are small.

   Water body weight percentage is the percentage of total body weight composed of water. This is not the same as Widmark's "R" factor. The "R" factor is a complex empirical measure which takes into account both body water percentage and water concentration in blood.

6. We have calculated the theoretical instantaneous BAC for one ounce of alcohol. To adjust this calculation for the actual content of alcohol in a drink, one multiplies the number of ounces of alcohol in the drink by the figure for **BAC per one ounce alcohol**. An example might be a 12-ounce can of beer drunk by the 128-pound male. Assuming that the concentration of alcohol in the beverage is 4.5 percent by volume, one multiplies the 12 ounces in the beer can times .045 and determines that the can contains .54 ounces of alcohol. Therefore, the theoretically peak instantaneous BAC produced by a single can of beer in our 128-pound male would be .54 times .0559 (the BAC produced by one ounce of alcohol) equalling .0302.

7. The final factor to take into account is the metabolism or burnoff. Alcohol is metabolized from the time that ingestion begins. It takes but a few seconds for alcohol to reach the liver and for metabolism to commence after drinking. Thus, metabolism is occurring during the period that alcohol is being absorbed and distributed throughout the body. To determine the actual blood alcohol level at any given time, we must decrease the theoretical instantaneous peak BAC by the amount of alcohol metabolized from the beginning of drinking. As an example, let us take the 128 pound male who has consumed one can of beer and determine what his likely BAC level would be at the end of one hour. We have already determined that if all the alcohol that he consumed were instantaneously distributed throughout the body, he would have a blood alcohol level of .0302. Now, however, one hour has passed, during which metabolism occurred. There is considerable variation in metabolism rate. Although the average metabolism rate for moderate drinkers produces a .017 per hour decline in BAC level and for heavy drinkers a .02 per hour decline, the range of metabolism rate in the population can go above .40% and below .10%. One can either utilize in the calculation the average metabolism rate, or if one wished to use a very

conservative figure, (which less than 20 percent of the population would exhibit), one could use .012 per hour decline.

If we wish to be sure that we can determine when our blood alcohol concentration level has returned to zero, it might be well to use this very conservative figure. Thus we take the .0302 BAC and subtract .012 for one hour of metabolism and calculate that the estimated BAC at the end of one hour is .0182 for a 128 pound male who has drunk a 12 ounce can of beer containing 4.5 percent alcohol by volume, assuming a conservative metabolic rate of .012 per hour.

Example: Find BAC for 128 lb. male drinking 12 oz. beer (4.5 percent alcohol by volume) in one hour's time.

A. Convert pounds to kilograms: 128LBS/ 2.2046 = 58.06 kg.

B. Find total body water: 58.06 kg. x .58 = 33.675 liters or 33,675 milliliters water

C. Determine the weight in grams of 1 oz. alcohol: 1 oz. alcohol = (29.57) X (.79) = 23.36 grams

D. If we put 1 oz. of alcohol into the S's total body water, we would have grams of alcohol/ml. of water, e.g.,

$$\frac{\text{23.36 grams}}{\text{33,675 milliliter}} = .0006937 \text{ grams alcohol /ml of water}$$

E. We now want to find the alcohol concentration in the blood. Blood is composed of 80.6 percent water; therefore,

.0006937 X .806 = .000559 grams alcohol/milliliter blood

F. Instead of grams alcohol per milliliter we need the figure in terms of grams per 100 milliliter also known as grams percent. Multiply the .000559 grams alcohol milliliter blood by 100, i.e.,

.000559 grams per milliliter X 100 = .0559 grams alcohol per 100 milliliters or .0559.

(This is the BAC which 1 oz. of alcohol would produce in a 128 lb male if there were instantaneous consumption, absorption, and distribution of the alcohol throughout the body.)

G. To adjust for the actual amount of consumed, one multiplies the above figure by the amount of alcohol in the beverage consumed. Thus if the 128 lb. male described above consumed a single 12 oz. can of beer containing 4.5 percent by volume beer, he would have consumed 12 oz. X .045 = .54 oz. of alcohol. Since 1 oz. of alcohol would produce a BAC

of .0559 and .54 oz. of alcohol has been consumed, the actual alcohol level would be:

.0559 x .54 = .0302 BAC for one can of beer

H. In real life, time must pass for the consumption, absorption, and distribution of alcohol throughout the body. Therefore, we calculate what the actual BAC level would be at the end of one hour after consuming the single can of beer. During this period, the body would have disposed of alcohol through metabolism at a rate characteristic of that individual, primarily his recent frequency and quantity of drinking. Utilizing a conservative metabolism rate of .012 per hour, we can calculate the BAC level as .0302 - .012 per hour X 1 hour = .0182 BAC at the end of one hour for our 128 lb. male who drank 1 can of beer. Note that the time of metabolism is calculated from the beginning of drinking, not when the consumption is completed.

.0302 - .012 per hour X 1 hour = .0182 BAC

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