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of Transportation
**National Highway
Traffic Safety
Administration**

Potential for Application of Ignition Interlock Devices to Prohibit Operation of Motor Vehicles By Intoxicated Individuals

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16. Abstract

This report contains a historical overview of the interest in ignition interlock devices and of the early development and research on different types of devices. It provides a description of current technology, its use, the results of some laboratory testing of current devices, a description of current state legislative and judicial activity, a discussion of the problems this technology must overcome, and an assessment of the effectiveness and potential for application in preventing alcohol impaired driving.

The report concludes that the technology is feasible but there is not yet sufficient evidence available to judge the effectiveness of the devices in deterring alcohol impaired driving.

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EXECUTIVE SUMMARY

On behalf of the Secretary of the Department of Transportation, the National Highway Traffic Safety Administration (NHTSA) has prepared this report on the effectiveness and potential for application of ignition interlock devices to prohibit operation of motor vehicles by intoxicated and drugged drivers. The report was undertaken in response to Public Law 100-17, The Highway Safety Act of 1987, Section 203 - Alcohol Traffic Safety Programs, Section 203(c) - Demonstration of Certain Drug And Alcohol Testing Technology.

This report contains a historical overview of the interest in ignition interlock devices and of the early development and research on different types of devices, a description of current technology and its use, the results of some laboratory testing of current devices, a description of current state legislative activity, a discussion of the problems this technology must overcome, and an assessment of their potential for preventing alcohol impaired driving.

SUMMARY

The concept of a car that will not allow a drunk or drugged driver to operate it is an intriguing notion. Over the last couple of decades a variety of approaches have been proposed to accomplish this goal. The primary emphasis of this work has been directed at the drinking driver rather than the drugged driver. As a result, the report focuses on alcohol impaired drivers and devices designed to prevent them from operating a motor vehicle.

There are two basic methods that can be used in vehicles to determine whether an individual is at an illegal BAC and should be prevented from driving. One uses an in-vehicle breath alcohol measurement device to determine the driver's BAC and the other uses a performance test that correlates with BAC.

Early interest in this concept focused on various in-vehicle performance tests that would detect whether an operator was legally intoxicated (i.e., had a BAC above a predetermined level). While several performance tests were identified that appeared promising in being able to discriminate between persons with illegal BACs and those with low or zero BACs, preliminary testing of these devices showed that, although this approach appeared feasible, the devices would require additional development before they reached an acceptable level of performance.

Interest in the application of breath test technology for use in ignition interlock devices received less attention until recently. There were problems with the reliability and accuracy of early electronic breath test devices and concern that they were too susceptible to circumvention or cheating to be practical. There seemed to be a number of ways that a sample of air, that did not come from the driver at the time of the test, could be delivered to the testing device.

In-vehicle alcohol test systems could be implemented in several ways. Different applications may have different requirements that may be best met by different approaches. The range of implementation options includes:

- Individual choice by persons interested in preventing themselves or family members from driving personally owned vehicles while impaired by alcohol (e.g., parents concerned about teenage children);
- Fleet owners interested in reducing accidents and insurance costs;
- Use on commercial and or public transportation vehicles;
- As a sanctioning option for convicted drunk drivers; and
- Installation on all vehicles sold in the U.S.

Similarly, several different approaches have been proposed regarding the action taken after a driver is tested. The two primary approaches that have been investigated are to have a pre-driving test that locks the ignition when the test is failed and a drunk driver warning system that does not prevent the vehicle from being driven but sounds an alarm to indicate an impaired driver. Other approaches include use of a passive sensing system that continuously monitors the driver (either a passive alcohol sensor or the driver's behavior), and systems that are informational only (i.e., no attempt is made to prevent the vehicle from being driven or to sound an alarm).

The ignition interlock approach appeared to present certain problems associated with disabling a car, particularly when the driver might not be intoxicated (e.g., prevention of emergency use, danger to other traffic, and public acceptability). In addition, there was considerable concern about the inconvenience of having to take a test every time the vehicle was started or needed servicing or repairs, and the possibility of erroneously rendering the vehicle inoperable.

Many of the problems with breath alcohol test ignition interlock technology have recently been partially or completely solved. Advances in the state of the art of small electronic breath test devices have resulted in the availability of alcohol sensors that are more reliable and accurate. New interlock devices have been developed that incorporate features designed to prevent or detect many forms of tampering and circumvention. Also, the primary application of this technology has recently focused on persons under the control of the adjudication system (DWI offenders). There is less concern with this special population about possible inconvenience when use of the device is made a condition of probation or to obtain a restricted driving permit.

Three major companies currently manufacture and market these new breath alcohol measurement ignition interlock devices. All three of these alcohol interlock systems are similar in most respects (e.g., they use the same type of alcohol

sensor to determine the amount of alcohol present in the breath sample), with some minor differences primarily in terms of anti-tampering and circumvention techniques.

Recent testing of these new devices by NHTSA has shown them to be reasonably accurate at detecting even low BAC levels and hence preventing persons with even moderate BAC levels from starting the car. These devices are designed and installed in such a fashion that they are apparently fairly resistant to tampering. All electrical connections in the ignition system are sealed and circuitry automatically detects and records attempts to start the vehicle without passing the test (e.g., hot wiring, push starting).

Anti-circumvention techniques have also been designed into these devices. For example, some contain features such as temperature or pressure sensors to detect non-breath air samples, some require a particular breath pulse code to prevent untrained sober persons from blowing into the device, and some shut off the engine after a period of idling (to prevent someone from passing the test, starting the car, and then entering a bar to drink). Another feature requires retesting after a period of time if low levels of alcohol are detected at the initial test (to prevent someone who has ingested alcohol that has not yet entered the bloodstream from starting the car when sober and then driving while intoxicated).

NHTSA tests of some of these anti-circumvention features showed that they have made these devices more difficult to circumvent. However, there are still relatively uncomplicated strategies that can be used to "fool" these devices (methods to use bogus air samples or to filter out the alcohol from a breath sample). Further improvements are possible by combining available anti-circumvention techniques. Whether these particular methods are sufficient to deter all but the most determined individual will be known only through operational experience.

At the end of 1987, five states (California, Oregon, Washington, Texas, and Michigan) had passed legislation authorizing use of certified ignition interlock devices with convicted offenders (some on a test basis). There are more states considering such legislation. For example, in the last legislative session more than half a dozen states had bills introduced or under consideration (Alaska, Florida, Illinois, Massachusetts, Minnesota, New York, New Jersey, Ohio, Tennessee, Virginia and Wisconsin).

In addition, there are a number of local programs across the country that use ignition interlock devices for convicted offenders. These programs are not explicitly authorized by legislation, but function through the exercise of judicial discretion (regarding the imposition of conditions of probation or for a restricted driving permit). There are currently hundreds of offenders using these devices on their vehicles. This number can be expected to grow as additional states pass legislation authorizing use of these devices.

CONCLUSIONS

This report is required to address the following question:

What is the effectiveness and potential for applying ignition interlock technology and devices in preventing drug and alcohol related traffic deaths?

Based on the information available to date, the following general conclusions appear warranted:

- Ignition interlock technology based on breath alcohol test devices for detecting and preventing alcohol impaired driving does appear feasible at this time. Devices that measure a driver's BAC level are currently being marketed and used.

- Laboratory tests have shown the current breath test ignition interlock devices to be relatively accurate in detecting low driver BAC levels (i.e., 0.04% BAC). The accuracy and reliability of these devices under real world conditions is unknown. There is no apparent reason why any operational problems cannot easily be overcome.

- These devices contain anti-tampering and circumvention measures that appear to reduce the likelihood of many forms of tampering and circumvention. Such activity by users is not impossible, but operational experience and testing will indicate the extent to which tampering and circumvention will be a problem.

- Current interest has focused on applying this technology to convicted DWI offenders as a condition of probation or to obtain a restricted driving privilege. Critical information necessary to estimate the potential effectiveness of these devices in this application is lacking. This information includes evidence that the devices function properly under real-world conditions and evidence that persons required to use the devices do not tamper or circumvent their use and do not elect to operate unequipped vehicles when drinking.

- There is not yet enough evidence available to judge how effective these devices will be in deterring alcohol impaired driving and related crashes.

- In the absence of evidence that these devices are effective it is not appropriate for these devices to be used in lieu of other sanctions that have evidence of beneficial effects (e.g., license suspension). Use of this technology as an additional condition of probation or for reinstatement of a restricted driving privilege does appear appropriate.

- The use of these devices with other populations may be feasible (e.g., fleet owners could install them, commercial and public transportation vehicles could be equipped, and individuals interested in this protection could pay for their installation). Widespread use of this type would have to overcome resistance due to the costs, liability issues, and public acceptability issues. Also, considerable research is needed to ascertain the practicality of these uses of the devices.

- Practical performance test based devices (where performance correlates with BAC level) have not yet been developed. However, this approach may be feasible for preventing alcohol impaired driving if performance tests are identified that have high accuracy at low BACs and minimal individual differences in performance so that universal cutoff scores can be used. Such a performance based device might have a collateral benefit of detecting impairment due to causes other than alcohol (e.g., fatigue).

- Ignition interlock technology for detecting and preventing drug impaired driving does not appear feasible at this time. There is no easy or feasible in-vehicle test method currently known to detect the use of drugs. In addition, the cost and complexity of testing for different drugs thought to impair driving skill (including legal as well as illegal drugs) makes such an approach even more impractical.

The most immediate issues outstanding regarding the use of breath test ignition interlock technology with convicted DWI offenders are:

- their operational performance in the real world (i.e., their accuracy, reliability, maintenance and calibration requirements);

- the extent to which the devices are tampered with, circumvented, or non-equipped vehicles are used by persons ordered to only drive cars with ignition interlock devices installed;

- the effectiveness of these devices in reducing alcohol impaired driving; and

- the certification standards adopted by the states authorizing use of the devices.

NHTSA research will help address these needs:

- NHTSA is currently initiating a project to develop model performance guidelines and test procedures that states can use in developing their own certification standards.

- NHTSA is providing grant funds to California to support their ongoing evaluation of their ignition interlock program.

- NHTSA will provide technical assistance to states or local communities interested in evaluating the effectiveness of their ignition interlock programs.

CHAPTER I

INTRODUCTION

PREFACE

On behalf of the Secretary of the Department of Transportation, the National Highway Traffic Safety Administration (NHTSA) has prepared this report on the potential application of ignition interlock devices to prohibit operation of motor vehicles by intoxicated drivers. The report was undertaken in response to Public Law 100-17, The Highway Safety Act of 1987, Section 203 - Alcohol Traffic Safety Programs. Section 203(c) - Demonstration of Certain Drug And Alcohol Testing Technology authorized the Secretary:

> ... (B) to test the application of ignition interlock devices that prohibit the operation of motor vehicles by intoxicated individuals...to determine the potential for applying such technology and devices in preventing drug and alcohol related traffic deaths.

and it directed the Secretary to:

> report to Congress on the effectiveness and the potential for application of the technology and devices...

This report contains a historical overview of the interest in ignition interlock devices and of the early development and research on different types of devices. It provides a description of current technology, its use, the results of some laboratory testing of current devices, a description of current state legislative and judicial activity, a discussion of the problems this technology must overcome, and an assessment of the effectiveness and potential for application in preventing alcohol impaired driving.

REPORT PREPARATION AND ORGANIZATION

This report is based upon currently available information. New data collection was limited to some laboratory tests of new breath test based ignition interlock devices (described in Chapter II).

The report consists of four chapters. Chapter I provides an introduction and historical overview of work to develop ignition interlock devices. Chapter II describes current technology and the results of some testing of the accuracy and resistance to circumvention of three currently marketed devices. Chapter III summarizes current legislative activity regarding state laws authorizing use of these devices, describes judicial programs implementing ignition interlock technology, and reviews current evaluation projects. Chapter IV describes the potential for application of ignition interlock devices, what information is needed to accurately determine their effectiveness in reducing alcohol impaired driving, and summarizes some outstanding issues related to the implementation and operational performance of ignition interlock devices.

HISTORICAL OVERVIEW

The idea of a car that would prevent impaired drivers from operating the vehicle is an intriguing notion. This concept has been discussed and examined for several decades (see Snyder 1984a for a more detailed review). The primary emphasis of this work has been directed at the drinking driver rather than the drugged driver. As a result, this discussion will be directed at alcohol impaired drivers and devices designed to prevent them from operating a motor vehicle. A brief discussion of the particular problems presented by the drugged driver is provided at the end of this chapter.

It has been said that "A car that could sense the capability of its driver and refuse to operate if the driver was not capable of safe performance, provides the most parsimonious approach to the problem of impaired operation" (Voas, 1970). In August of 1968 the Secretary of Transportation submitted a report to Congress on Alcohol and Highway Safety (US DOT, 1968) that stated:

> "Proposed methods have called for the use of devices linked to ignitions to prevent drivers from starting their cars unless some mechanical or other test is passed. ... However, no one has figured out how to ensure that the driver, rather than someone else would 'take' any such test built into the vehicle, or demonstrated that the self-administered tests proposed to date would reliably distinguish between normal and impaired individuals."

In October of 1970, the National Highway Traffic Safety Administration issued a prospectus entitled, "Some Considerations Related to the Development of an Alcohol Safety Interlock System (ASIS)." The purpose was to acquaint commercial and academic organizations with DOT's interest in ignition interlock development, and to ensure that all possible techniques would be considered. The useful responses fell into two basic categories: (1) methods involving the measurement of human performance, and (2) methods using alcohol sensors (Sussman, 1971). These two approaches to determining whether the driver is impaired are covered separately below. The development of performance devices is discussed first, followed by a review of the development of devices using breath tests. This historical overview covers the period 1968 to 1984.

Performance Tests

On the basis of the responses from industry and a review of the pertinent literature, twelve performance-type candidate devices were obtained and examined by DOT. These devices were designed to correlate test performance with blood alcohol level (BAC). Each of the devices required the user to pass a behavioral test involving reaction time, divided attention, short-term memory and/or eye-hand coordination. Ten of the devices were screened in the laboratory to determine the extent to which performance on the task correlated with BAC (Oates & McCay, 1974; McFarland, et al., 1974). The results of the studies indicated that none of the devices tested was acceptable for application at that time (Abernathy & Sussman, 1974). All of the devices failed to eliminate even half of the intoxicated drivers without also eliminating many who were sober.

At about the same time, General Motors' engineering staff investigated this same approach (with a device called the phystester) and reached a similar conclusion (GMC, 1982). Later, GM investigated a different device (that used the Critical Tracking Task or CTT) with more promising results (Tennant & Thompson, 1973).

During the mid 1970's NHTSA funded further laboratory testing of four promising performance testing devices (Oates, 1973). These devices were:

1. Critical Tracking Tester (CTT) - a device that required the driver to keep a pointer centered on a dial (e.g., at the 12 o'clock position) by appropriate movements of the steering wheel. The device generated random movements of the pointer at an increasing rate requiring the driver to make corrective movements at a faster and faster rate. (Developed by Systems Technology, Inc. for the U.S. Air Force and NASA, with modification for automotive application by General Motors staff, see Snyder, 1984a).

2. Reaction Analyzer (RA) - a device that contained two lights, one of which varied randomly in brightness. The driver was required to match the brightness of the other light by turning a knob. The task was made more difficult by reversing the effect of turning the knob after a certain degree of rotation. (Developed by Ratheon Company).

3. Complex Coordinator (CC) - a device that tested motor coordination and reaction time. The display consisted of two pairs of columns of five lights with a different color in each vertical position. One of the lights in the left-hand column of each pair would illuminate in a random sequence, while the driver was required to move one of two levers to illuminate the corresponding light in the right-hand column of each pair. (Developed for NASA and produced by JWM, Inc. - also called the Electronic Programmable Interactive Coordinator or EPIC).

4. Divided Attention Test (DAT) - a device consisting of two tasks. The central tracking task required the subject to keep a randomly moving horizontal bar centered on a vertical line by appropriate movements of the steering wheel. The peripheral task required the subject to simultaneously monitor four display windows for the random appearance of the digits 1 through 4 and to press one of four corresponding push-buttons (Developed by DOT's Transportation System Center for NHTSA, based on work by Moskowitz and Deprey, 1968).

The major findings of this investigation were that, except for the Reaction Analyzer, the devices appeared to offer some ability to discriminate between highly intoxicated (BAC greater than .18%) and sober subjects (BAC = 0.0%). Two of the devices, the Critical Tracking Tester and the Complex Coordinator, were able to detect many intoxicated drivers without penalizing any low BAC drivers (BAC less than 0.10%). However, none of the devices was able to discriminate mid-range BACs (i.e., 0.10% - 0.15%) accurately. For example, in subsequent testing of variations of the DAT device, the optimum scoring strategy resulted in the failure of 77% of the subjects at 0.137% BAC, 46% at

0.1% BAC, and 5% of the sober subjects at 0.00% BAC (Oates, et al., 1975). Overall, the results of this research showed considerable improvement, in comparison to earlier devices, in the ability of the devices to pass low BAC subjects and fail high BAC subjects.

This study appeared to indicate that the concept of a performance test to discriminate between sober and impaired drivers was feasible. However, the results indicated that further refinements of the performance tests, procedures, and scoring methods were needed in order to have a device that would fail almost all subjects with BACs over 0.10% while passing subjects with BACs below that level. Also, the effects of long-term practice on test accuracy was unknown. It appeared that discrimination rates could be improved by the use of individually set passing scores.

In the late 1970's, NHTSA undertook a review of the status of performance based alcohol ignition interlock technology (Snyder, 1984a). No system appeared to be even close to 100% reliable in discriminating sober or low BAC drivers from legally intoxicated drivers. When the scoring was set to ensure that no unimpaired drivers failed the test, then a significant proportion of intoxicated drivers would be able to pass the test. Also, this review concluded that the interlock approach presented disadvantages associated with the disabling of a vehicle, particularly when the driver might not be intoxicated. These included prevention of emergency use, danger to other traffic, and public acceptability.

As a result, research on the ignition interlock concept was deferred. Interest was shifted to use of a warning device that would alert others that the driver had failed to take or pass the test, rather than use of a disabling interlock. It was decided that a field study should be conducted to assess the operational feasibility of the alcohol test device warning system concept.

In 1976 the NHTSA conducted a field test of a Drunk Driver Warning System (DDWS) in California. The device used the CTT as the impairment test component because it was among the best in BAC discrimination and did not require further engineering development in order to be integrated into a vehicle. The DDWS was constructed as a vehicle-mounted system which required the driver to pass a brief test using the steering wheel before the car could be driven in a normal manner. The test had to be passed in order to deactivate alarms consisting of the emergency flasher system and the horn. If the test was not passed, the emergency flashers operated, and if the car was driven above 10 mph the horn honked at one-second intervals. If the test was failed, the driver had to wait 10 minutes before retaking the test.

The DDWS was used with drivers having a history of repeated drunk driving offenses who were under court supervision. The driver's license was restricted to use of the DDWS equipped vehicle. A study of potential legal constraints on the use of mechanical devices to monitor driving restrictions revealed no major legal problems with this approach (Ruschmann et al., 1979). Probationary conditions allowed for regular monitoring of the drivers at which time cassette-recorded data were collected and the vehicles were checked for signs of tampering. Various measures were incorporated into the DDWS to prevent cheating. These included sealing components and cables to prevent or reveal

physical tampering, and using a door and seat sensor to require retesting if the driver left the driver's seat after passing the test.

The results of this pilot study showed that the judges and offenders using the DDWS were generally supportive of the program. Only rarely did any of the offenders attempt to drive after failing or not taking the test. None of the offenders in the study was involved in a subsequent alcohol-related crash or was convicted of a subsequent alcohol-related offense. No obvious attempts were made by the offenders to circumvent the DDWS. A small number of offenders reported driving another vehicle during the period they were restricted to a DDWS equipped vehicle (Allen et al., 1983a, 1983b).

The study did not determine how many possible alcohol impaired trips were deterred by the device, nor even if legally impaired drivers were able to pass the test (drivers whose BAC was over 0.10%). There was evidence that on some occasions drivers who failed the test initially drove after repeating the test until they passed it. In summary, this study showed the feasibility of using technology designed to prevent alcohol-impaired drivers from operating a vehicle while intoxicated in a judicial setting. However, there was no way to know if the DDWS and the CTT test were accurate in discriminating the driver's BAC and effective in preventing alcohol impaired driving.

In the late 1970's, cooperative studies were undertaken with foreign governments (e.g., USSR, Poland, and Australia). NHTSA provided CTT devices to interested agencies for further research and development. Limited information has been available about the Soviet bloc findings from their work with the CTT device. The results we have seen regarding BAC discrimination from the USSR are similar to those found in the U.S. work conducted earlier (Anonymous, 1979).

Some additional testing of the DDWS devices was performed by the Road Traffic Authority of the State of Victoria, Australia. In 1979, NHTSA loaned two DDWS units to this group for evaluation. Their study attempted to further refine the ability of the CTT test to discriminate BAC levels (Bodi, O'Connor & King, 1983). A field trial examined the acceptability, reliability and deterrent effects of the DDWS (RTA, 1987). The laboratory study tried to determine the usefulness of the CTT for discriminating between persons below and above a BAC of 0.05%, the legal Victorian BAC limit. The effects of other factors such as age, drinking history, and practice were also investigated. The primary finding was that the CTT did not adequately discriminate between sober and impaired drivers at a BAC of 0.05%. No significant effects were found for age or drinking history on performance and the effects of practice were unclear. The researchers concluded that this device would not be useful for detecting drivers in violation of the Victorian legal limit.

In the early 1980's the Canadian transportation ministry funded some limited research which compared performance on the CTT with a device called the Tracometer. The Tracometer made use of a psychomotor tracking task which the researchers felt might provide better discrimination of lower BAC levels than did the CTT. The Tracometer task required a subject to align a pointer with one of five targets that were randomly illuminated. The subject must turn a control wheel in the opposite direction of the desired pointer movement.

The results of this work suggested that the Tracometer tracking task provided better discrimination than did the CTT in detecting drivers whose BAC levels were at the legal limit in Canada (0.08% BAC) and in the US (BACs in the range of 0.10 and 0.12%). The researchers concluded that the Tracometer task appeared to be promising, though further development work was necessary before a practical device would be available (Anderson, Salter & Noy, 1985; Grant & Buck, 1986).

In summary, previous research and development work on performance test devices have demonstrated the operational feasibility of this approach (though a useful device does not yet exist). Various performance tests can readily and reliably discriminate sober from highly intoxicated drivers (e.g., BAC above 0.15%). However, the most promising performance devices require extensive individualized user training, so that a pass-fail cutoff score can be set. This means that other persons (including other family members) wishing to operate a car equipped with such a device would also have to be trained to pass the test. Also, these devices are least accurate at moderate BAC levels (0.05% to 0.10% BAC).

These problems can possibly be overcome in time with further development of more promising performance tests. The use of a universal cutoff score that would obviate the need for extensive training of the users will require the identification of a performance test in which individual differences are minimal. It should be readily possible to improve the accuracy of the tests at lower BACs. A successful performance test might well have collateral benefits in that it might detect impairment due to other sources than just alcohol (e.g., fatigue). There is apparently little development work currently being conducted on performance based systems.

Alcohol Sensors

In the early 1970's the concept of measuring directly a driver's breath alcohol level was investigated briefly as part of NHTSA's examination of the feasibility of ignition interlock devices. This concept was not new, though little beyond discussion of this approach had occurred prior to this time (Brown et al., 1973). DOT's Transportation System Center examined several breath test interlock devices based on different types of alcohol sensors but concluded that the breath tester would not be practical as an in-vehicle device for several reasons (Bray & Huntley, 1974; TSC, 1973). Foremost was the fact that it appeared that breath testing devices were too easy to circumvent or cheat. There appeared to be a number of ways that a sample of air, that did not come from the driver at the time of the test, could be delivered to the testing device. For example, the driver could readily circumvent the device by either having a sober person provide the breath sample or by using alcohol-free breath stored for this purpose in a balloon or coming from an air pump.

In addition, the study showed that the alcohol breath test device would have to be inspected quite frequently for recalibration as the available sensors showed erratic calibration drift. These tests were performed at a time when breath test technology was just being developed and refined.

One final problem that delayed development of an interlock device based on direct breath alcohol measurement was the issue of the relationship of BAC to impairment. At that time, few states had per se breath alcohol limits (statutes that make operating a motor vehicle at a specific BAC level illegal in and of itself). Most laws simply prohibited driving while impaired by alcohol. Also, it was well known that some people are impaired at BAC levels below the legal limits, and that the same amount of alcohol can have different effects on different people. These reasons made a performance based test appealing because it is intended to measure impairment.

In the late 1970's and early 1980's interest in the use of breath test devices revived. Nissan in Japan and Mercedes-Benz in Germany are reported to have undertaken some developmental work with breath testing devices during this time period, though nothing beyond the prototype stage was publicly reported (RTA, 1987). DOT funded a small feasibility study (through the DOT small business innovation research program) in 1983 to investigate the development of a sensing device, which would continuously monitor the alcohol content of the breath emitted by the driver. This type of device would not require the active cooperation of the driver but rather simply monitor the air near the driver's face.

This passive sensing method, if feasible, would eliminate many of the ways of circumventing or cheating associated with active breath testing devices (e.g., having a sober person blow into the device and using a prepared breath sample). Unfortunately, this type of continuous monitoring has numerous other potential problems that would be quite difficult to overcome. These include dilution of the alcohol content of the air sampled by crosswinds, contamination of the alcohol sensor by tobacco smoke, after shave, perfumes, gasoline, and possible inaccuracy due to the presence of other sources of alcohol in the air (Young, 1984).

To date, no one has produced and marketed a passive device in the U.S. However, we recently learned of a Chinese passive sensing interlock device manufactured by the Jin Qiu Automobile Repair and Spare Parts Factory in Xian, Shaanxi Province, People's Republic of China (Shaanxi Province, 1987). This device, called the JMD-1 Alcohol Sensitive Cut-off Device, is apparently in use in Shaanxi Province and is now reported to be required in all motor vehicles in the province (except diesel engine vehicles and motorcycles). How this requirement is being implemented is unknown. The manufacturer claims the device is designed to prevent a car from starting when it detects a concentration of alcohol equivalent to 0.02% BAC, and if already operating, it will flash the lights and sound the horn as a warning. No further information about the system or evidence of the effectiveness of this device is currently available. One unit has recently been provided to NHTSA by a import-export firm representing the manufacturer. It will be examined by DOT's Transportation Systems Center.

In the early 1980's a number of firms and inventors contacted NHTSA regarding prototype in-vehicle breath test devices they had or were considering developing. It should be noted that considerable progress had been made by this time in the development of small accurate breath test devices. In 1984,

NHTSA conducted a laboratory evaluation of two of these devices (Frank, 1985). These two units were tested because they had features built into them to determine whether the air sample being provided was a true breath sample blown into the device. They were the SOBERLYZER (developed by Jack Simon of Carmel, California) and the ALCOHOL BREATH IGNITION CONTROLLER (or ABIC developed by Renko, Inc. of Garden City, Michigan). The SOBERLYZER device had a temperature sensor integrated into the unit to determine whether the air sample being introduced into the unit was the same temperature as human breath. In the ABIC device, a pressure switch was incorporated into the system to determine whether the force blowing the air sample into the unit was as strong as a human breath.

The laboratory tests, conducted by the Transportation Systems Center (Frank, 1985), were designed to assess how well each device discriminated between simulated breath samples above and below a set threshold level (0.025% BAC for the SOBERLYZER and 0.10% BAC for the ABIC). Equally important, they were to determine whether the special features incorporated into each device functioned as designed (the temperature and pressure sensors) and to determine whether the systems' sensors could be fooled into responding to a bogus air sample (not a real breath sample) or a filtered air sample (where an air sample containing alcohol is passed through filters to remove the alcohol).

The results showed that the devices were capable of distinguishing 100% of the time between breath samples above or below a threshold value (the actual values were at some variance from those claimed by the manufacturers). The temperature sensor in the SOBERLYZER allowed breath samples to pass in the range of 75-100° F (a requirement fairly easy to meet), while the pressure sensor in the ABIC required a rather strong breath pressure (an average person would have to blow as hard as they could to meet this requirement). The study also showed that bogus, substitute breath samples could be successfully introduced into either device to "fool" the system. These included using a portable vacuum, a portable hair dryer, and a plastic bag or toy balloon with heated air. Also, a number of filtering methods were successfully used to remove alcohol from breath samples (e.g., a home made water pipe, molecular sieve pellets, silica gel, a commercial absorbent, commercial "Drierite" composed of calcium sulphate, and commercially available disposable breath test tubes).

The development of breath test ignition interlock devices has continued and resulted in a new generation of devices that are currently being marketed and used in the U.S. These recent developments are covered in the following chapters of this report.

SUMMARY AND REVIEW OF MAJOR ISSUES

The brief historical review presented above has described efforts at designing an in-vehicle alcohol test device. This work provided valuable knowledge and information that has greatly advanced our understanding of the requirements that an effective interlock device would have to meet.

Efforts were split between attempts to develop a performance based test and a breath alcohol test device. Problems encountered included the accuracy of the

test device, determining what would constitute a failing score, making the device difficult to tamper with or circumvent, and concern regarding the public acceptability of an interlock device (versus a warning system).

To some extent, these issues have become less important through a changed perception of who should be the user of an in-vehicle alcohol test device. The intended user of the device and how is it intended to function will lead to different design requirements for the device. In terms of users there appear to be a number of different types of groups one can define, namely:

- Persons driving under legal restrictions (e.g., convicted DWI offenders driving under a restricted license, or placed on probation);
- Vehicle owners desiring to prevent alcohol-impaired driving of their privately owned vehicles by themselves, family members, or others;
- Fleet owners interested in reducing alcohol-related crashes;
- Commercial vehicles or vehicles used for public transportation (including school buses, transit buses, taxis, rental vehicles, etc.); and
- All vehicles sold or used in the U.S.

The primary focus of current interest is on using in-vehicle test devices with persons under the control of the adjudication system. There is less concern about possible inconvenience (e.g., having to take a test <u>every</u> time the vehicle is started, difficulties in having the vehicle serviced or repaired, and the possibility of erroneously rendering the vehicle inoperable) resulting from the required use of ignition interlock devices with this special population. The accuracy of the device is less of an issue since this population is typically under orders to completely refrain from alcohol use. On the other hand, the need to make the devices relatively difficult to tamper with or circumvent becomes a greater issue.

NHTSA has examined the public's reaction to the concept of an alcohol ignition interlock device (and warning system) installed in all cars or in the cars of convicted offenders as part of a study of the public acceptability of various highway safety countermeasures (see Vayda & Crespi, 1981). This study involved a nationally representative general public telephone survey, focus groups, and interviews with special interest groups in order to gauge public reaction to a variety of highway safety countermeasure programs including in-vehicle test devices. The general reaction was mildly positive, especially with respect to placing these devices on the cars of convicted offenders. There appeared to be a number of concerns held by the public that reduced their enthusiasm for this approach. One was a disbelief that the devices could be made tamper-proof or sufficiently difficult to circumvent. Many respondents felt that the devices would be ineffective in deterring drivers who had been drinking and were determined to drive.

Additional concerns mentioned were the impact on other users of the car, the cost of the devices, and their accuracy. In general, these issues were not felt to be serious problems in the case where the devices were ordered to be used by convicted offenders. There was little support for the idea of equipping cars in general with these devices to reduce the deaths and injuries due to alcohol-impaired driving. They were seen as too intrusive, inconvenient, interfering with individual choice, and not likely to be effective.

Also during the late 1970's, NHTSA undertook a study of the legal feasibility of some proposed highway safety countermeasures, including in-vehicle test devices (Ruschmann et al., 1979). This legal analysis was intended to identify and review potential legal constraints that might impede implementation of the proposed countermeasures. The study only examined use of in-vehicle test devices through the sanctioning process. Other implementation scenarios like the voluntary installation of these devices for purposes such as fleet monitoring or personal use were not considered.

The study concluded that these "countermeasures are neither unconstitutional nor unreasonable means of enforcing driving restrictions, imposed on convicted traffic-law violators as conditions of probation, pretrial diversion, earned charge reduction, or restricted-license schemes" (Ruschmann et al., 1979). Several issues were identified that would have to be considered when implementing use of in-vehicle devices through the sanctioning process. The authors felt care would have to be taken to ensure that drivers were not excluded because of their inability to pay the costs of the program (to avoid violating the constitutional guarantee of equal protection of laws). Also, attempts to compel the installation of a device on a vehicle owned by someone other than the sanctioned driver would violate the constitutional due process of law requirement.

The next two chapters describe the arrival of commercially available breath test devices on the market. First, however, the topic of detecting drug impairment by in-vehicle test devices is briefly reviewed below.

DRUGGED DRIVING

The previous discussion has been restricted to the topic of ignition interlock devices designed to prevent alcohol-impaired driving. The problems presented by the use of drugs other than alcohol are quite different from and more difficult than those associated with alcohol use, and must be treated separately.

One reason is that the extent of alcohol use by drivers can be readily measured by breath alcohol measurement devices. The same is not true for drugs other than alcohol. For reasons too complex to discuss here (e.g., many drugs do not appear in measurable quantities in the breath or breath concentrations do not correlate with blood concentrations), such a breath measurement approach is not currently available for any other drug and may never be feasible for many, if not most, other drugs (Jeffcoat, 1981).

An alternative approach would be to use performance tests to determine whether the driver is too impaired to drive (regardless of the cause of the impairment). A useful performance test should be able to detect impaired driving ability that is related to increased crash rates. Unfortunately, this is not possible at the present time.

As a result, there is no practical way at the present time that an in-vehicle ignition interlock device can be designed to prevent drug impaired drivers from operating a motor vehicle. Accomplishing such a task would require a considerable program of research to better understand the driving task, the critical skills required, and to relate impaired performance on specific tasks to increased crash rates.

CHAPTER II

CURRENT BREATH TEST INTERLOCK TECHNOLOGY

In this chapter a new generation of commercially available breath test ignition interlock devices are described and the results of laboratory tests of the accuracy and ease of circumventing these devices, conducted by NHTSA, are presented.

DESCRIPTION OF CURRENT TECHNOLOGY

In the mid 1980's a number of alcohol ignition interlock devices were developed by private companies and three became commercially available in the United States. These devices are systems designed to prevent drivers whose breath alcohol concentration is above a preset level from starting their cars. They require the driver to pass a breath alcohol test before the car can be started. It should be noted that a similar device, called the Lincoln Co-Driver, was developed and marketed in New Zealand in the early 1980's. Also, a device called the Vehicle Breath Monitor (VBM) was developed in Australia by a group of private companies in 1985. This device is currently being examined by the Victorian provincial agency, the Road Traffic Authority (RTA, 1987).

The new American devices appear to be marketed primarily to traffic courts for use with drivers charged with Driving While Intoxicated (DWI) who may be required to install one of these devices on their car as a condition of probation. The manufacturers also envision a voluntary market for their devices, including such scenarios as parents who want to exercise more control over their inexperienced teenaged driving children, fleet owners, and persons who may want to impose more external control over their own behavior. However, the manufacturers do not appear to be aggressively pursuing such markets at the present time.

The three breath test interlock devices currently available in the U.S. (for sale or lease), and their manufacturers are, in alphabetical order:

- "Autosense", manufactured by Autosense Corp., 3496 Breakwater Court, Hayward, CA 94545
- "Guardian Interlock", manufactured by Guardian Interlock System, Inc., 1009 Grant Street, Denver, CO 80203
- "Safety Interlock", manufactured by Safety Interlock, Inc., P. O. Box 221818, Carmel, CA 93922

These devices are fairly similar. Each is composed of three components, namely, an alcohol breath test unit, an electronic control device, and a connector to the vehicle's ignition and electrical system. The part of each device having the alcohol sensor is a hand-held unit approximately the size of

a CB radio microphone. It is connected by a flexible cable to the electronic unit, which is mounted in or under the dashboard. The driver turns on the device and then blows into the mouthpiece of the alcohol sensor. Depending on the outcome of the breath analysis, the driver can then start the car, or if the amount of alcohol detected is above a preset level, the ignition will be locked.

The three devices use a "Tagucci" cell (manufactured by Figaro Inc.) to sense alcohol in the air sample tested. This semiconductor sensor detects low concentrations of ethyl alcohol, though it requires preheating, is sensitive to temperature and humidity, and has been known to require relatively frequent calibration to maintain its accuracy. On the whole it is a simple form of breath tester, found in some portable preliminary breath testing units used by the police. It is not as sophisticated as the evidential quality breath testers used by the police.

A brief overview of how each device is operated follows (see Appendix A for an illustration of each device):

The AUTOSENSE device is first activated by the user entering a four-digit code into a keyboard, which is part of the hand-held unit. The digital code is not intended as a test to screen out particular users; it only activates the system before each use. Following entry of the code, the user blows into the mouthpiece for approximately 6 seconds to satisfy the requirements of the system. If the BAC exceeds the preset threshold, a user would not be able to start the car. The device provides its user with a digital BAC readout.

In addition, the threshold level at which it will prevent a user from starting a car can be preset with the use of special equipment provided by the manufacturer to the installer . The hand-held unit gives the user additional feedback in the form of (1) a digital "P" or "F" for pass and fail; and (2) a green or red light corresponding to the pass or fail designation.

The AUTOSENSE device also has a pressure sensor that imposes a minimum pressure requirement, and the manufacturer reports plans to incorporate a temperature sensor into the system at later date. The device has circuitry to detect and record attempts to tamper with the system, hot-wire or jump start the car. The device automatically records (for later printout if desired) all attempts to start the car, including date, time, and BAC score for all tests taken.

The GUARDIAN INTERLOCK device is similar in that the user first activates the device and then blows into the mouthpiece for approximately five seconds. The device can be set to lock out BACs from .02% to .05% BAC. Some models give the user a readout of breath alcohol level in terms of a series of lights, two green lights and five red ones. For a device set to lock at a BAC of .03% the light sequence corresponds to the following BAC ranges:

READOUT ON GUARDIAN PANEL	CORRESPONDING BAC RANGE
1 Green light	0.000-0.014 % BAC
2 Green lights	0.015-0.029 "
2 Green lights & 1 Red light	0.030-0.044 "
2 Green lights & 2 Red lights	0.045-0.059 "
2 Green lights & 3 Red lights	0.060-0.074 "
2 Green lights & 4 Red lights	0.075-0.089 "
2 Green lights & 5 Red lights	0.090- and above

An optional feature is a preset breath code that is designed to prevent anyone but the intended driver from starting the vehicle. GUARDIAN calls this feature "Coordinated Breath Pulse Access" ("CPBA"). The CPBA only allows the system to be activated when a user blows a prescribed series of puffs and pauses, properly timed, into the mouthpiece. The GUARDIAN microprocessor allows the CPBA to be set at one of three different difficulty levels. For example, one CPBA difficulty level requires three blows into the mouthpiece, the first for 5 seconds, the second for 1 second and the third also for one second, with the pauses between blows not more than 1 second.

The different difficulty levels vary the length of blows and the interval time between blows, progressively tightening up the demands on the user to attend to the task. The CPBA is intended to be relatively easy for a user to learn, but difficult for a novice to pass on a single trial. It is designed to prevent a user from getting an untrained, sober bystander to start his car if he has too much alcohol on his breath. After three failed attempts to pass the test (CPBA or BAC test) the car will not start for 15 minutes. The GUARDIAN device also has a pressure requirement, but the device does not have a temperature sensor.

The GUARDIAN device includes a feature that will require a retest after 20 minutes if a permissible level of alcohol is detected during the initial test. This feature is intended to catch instances where alcohol has been ingested but not yet fully absorbed into the bloodstream. If the device detects a low level of alcohol during a test, it will permit the car to be started and operated, but will require a retest every 20 minutes. If the driver does not pull over, stop the engine and take the breath test, the car's horn will sound continuously until this requirement is met. If a subsequent test shows the driver's breath alcohol level has reached the prescribed threshold, the ignition is locked and the car can no longer be operated.

Another feature signals the need to bring the device in for maintenance and calibration after a preset interval (e.g., every 60 days), and can only be turned off by a certified technician. Three days before the scheduled due date for calibration and maintenance, a light on the unit begins flashing. For seven days starting on the due date, a series of tones sound in addition to the flashing light. After the seventh day after the due date, the device locks the ignition and prevents the car from being operated until it is serviced.

Also, any attempt to tamper with the electrical circuitry of the vehicle (i.e., interrupt current to the device) or any attempt to start the vehicle without first passing the test (e.g., hot wiring, push starting) will trigger a red light and initiate the requirement to bring the vehicle in for maintenance (otherwise the ignition will be locked). Finally, the device is designed to shut off the engine after a specified period of time that the vehicle is left idling. This feature is designed to prevent someone from passing the test and starting the car before initiating a drinking episode (e.g., entering a bar). If the car stalls after being properly started, the device will allow the car to be restarted without having to retake the test within 1 minute after the car stalls.

The SAFETY INTERLOCK device is activated by the user blowing into the mouthpiece for 4 seconds to activate the system. When the device is ready to use after warm-up, a "Blow" light appears. After the user has blown into the device for the required time (approximately 7 seconds) at the required pressure, another light (red or green) will indicate whether the requirements of the system have been met or not, and whether a user could start his or her car. This device has both a pressure and temperature requirement. The BAC cutoff can be set to any level (it is currently at .03% BAC).

The SAFETY INTERLOCK records a permanent dated and timed record of all attempts to start the vehicle. It stores the date, time, whether the test was passed or failed and the BAC reading. It also detects and records roll starts, attempts at hot wiring, and interruptions of the power supply (e.g., attempts to disconnect the device). The record stored in the device can be read and printed out every few months when the car is brought in for maintenance and recalibration of the device.

Installation of all three devices involves sealing the electrical connections to provide evidence of tampering, if it occurs.

LABORATORY TESTS

During 1987, NHTSA tested the three devices described above to determine their accuracy in distinguishing BACs above and below a given threshold value, to assess how well the pressure and temperature sensors would prevent bogus (non-breath) air samples from passing the test, to determine how easily a simulated alcoholic breath sample could be filtered to remove the alcohol and pass the test, and to determine how easily a naive person could learn the breath code (CPBA) required on the Guardian device.

Two units of each device were evaluated during this study. All the devices were set to a threshold of .03% BAC. BACs at or above this level were supposed to prevent a user from starting the car.

All of the devices prevented a start 100% of the time for breath samples at .04% BAC (except one unit that was obviously out of calibration). Breath samples at .03% BAC prevented a start 0%, 50%, and 100% of the time by the Guardian, Autosense and Safety-Interlock devices, respectively. Breath samples at a .02% BAC prevented a start 0% of the time by the Guardian units, 10% of

the time by the Autosense devices, and 90% of the time by the Safety-Interlock units. None of the devices prevented a start after testing a 0.0% BAC sample. Thus, the three devices all appeared reasonably accurate in detecting low BAC levels and hence preventing persons with even moderate BACs from passing the test. These results are shown in the Table below.

Percentage of Starts Prevented

BAC of Breath Sample	Devices		
	Guardian	Autosense	Safety Interlock
0.00%	0%	0%	0%
0.02%	0%	10%	90%
0.03%	0%	50%	100%
0.04%	100%	100%	100%

Attempts to introduce bogus air samples into the devices met with varying degrees of success depending on the technique used and the anti-circumvention measures contained in the devices. For example, use of a toy rubber balloon and a plastic produce bag (obtained from a grocery store) fooled one of the devices, and a mylar balloon could be used to pass the test in all three devices. The Safety Interlock device, with the temperature sensor, could be fooled by warmed samples in many cases.

The filtering tests were designed to take a simulated breath sample with a BAC ranging from .03% to .10% BAC, filter it through some readily available medium to remove the alcohol, and present it to the devices. Filtering systems were a common styrofoam coffee cup partially filled with warm water and a paper tube packed with a commercial absorbent.

The water filter effectively removed enough of the alcohol from the simulated breath sample to pass two of the devices. It was not possible to generate sufficient pressure blowing through the water filter to satisfy the higher pressure requirement of the Autosense device. Use of paper tubing packed with an absorbent passed all three systems. With the Safety Interlock device (which had a temperature requirement), it was necessary to blow through the tube several times to warm the sample before it would be accepted.

In summary, it appears that there are relatively uncomplicated strategies that can be used to "fool" these devices in spite of their anti-circumvention features. These devices contain features that make circumvention more difficult, and further improvements are possible by combining available techniques.

CHAPTER III

CURRENT STATUS

This chapter reviews recent legislative activity regarding state laws authorizing use of ignition interlock devices, describes some existing programs implementing use of these devices with DWI offenders (programs not legislatively authorized but carried out under judicial authority), reports on current evaluation projects that are underway, and summarizes a workshop held in the Fall of 1987 to review new developments in this technology.

STATE LEGISLATIVE ACTIVITY

By the end of 1987 five states had passed laws permitting use of ignition interlock devices as a condition of probation or for a restricted driving permit for DWI offenders. These states are California, Michigan, Oregon, Texas, and Washington. These state laws are described briefly below (Appendix B contains a comparison of some of the major features of these laws). It should be noted that legislative authority is not necessarily required in all states for judges to order the use of these devices as a condition of probation or for a restricted license, though there are benefits associated with these laws.

California

In 1986, California became the first State to pass legislation authorizing the use of ignition interlock technology with offenders charged with DWI (the Farr-Davis Driver Safety Act of 1986). This law called for a two-year pilot program to study the effectiveness of ignition interlock technology in reducing the rate of repeat drunk driving offenses. The law contains a sunset provision that repeals the provisions of the law at the end of 1989. It allows judges to order the installation of a certified ignition interlock device on the car of a convicted offender as a condition of probation. A recent statute allows for the reduction of a fine to offset the cost of installing and maintaining the device (for those counties participating in the pilot test).

The main features of California's law are:

- Use of an ignition interlock device is not a substitute for other penalties mandated by law (except for a reduced fine in four test counties);
- The costs are paid by the offender;
- It is an offense to rent, lease or loan a vehicle without an interlock to a person required to drive a vehicle with an interlock;

- It is an offense to blow into an ignition interlock device or otherwise start a vehicle equipped with an interlock device for the purpose of providing an operable vehicle to a person whose driving privilege is restricted to use of such a vehicle;

- The offender is required to notify his employer of his restriction; however, he may operate his employer's vehicle without an interlock device with the employer's permission;

- The offender's licensing records must show the mandatory requirement for use of an ignition interlock;

- The manufacturer of the device must report quarterly to the court on the maintenance, calibration and operation of the device;

- The offender must report to the court (or probation officer) at least annually on the operation of the device;

- The California Office of Traffic Safety is directed to conduct a two-year study in four counties for the purpose of determining the effectiveness and reliability of ignition interlock devices;

- California has certified three devices as meeting standards for the operation of ignition interlock devices; and

- The interlock devices are required to prevent anyone with a BAC at or above .03% from starting the vehicle.

Washington

The Washington law provides for the use of an ignition interlock device as a condition of probation (or in deferred prosecution cases). It contains no sunset provision. The law indicates that the ignition interlock device is intended to supplement other punishments. The BAC level at which the device locks the ignition is left to the discretion of the sentencing judge. The question of who bears the cost of the program is not addressed in the legislation. The law calls for the certification of approved devices and contains provisions similar to California's prohibiting other persons from knowingly helping an offender who is restricted to the use of an ignition interlock equipped vehicle to start or operate a vehicle. The law requires a notation on the offender's driving license to indicate the person is restricted to use of an ignition interlock equipped vehicle.

Michigan

The Michigan law gives judges the authority to use ignition interlock devices as a condition of a restricted driving permit. It contains no sunset provision. The law adds the use of ignition interlock devices as an additional condition for issuance of a restricted driving permit. It specifies that approved devices must lock the ignition when a BAC level of 0.02% is detected.

The offender must pay the costs of using the interlock device. The Michigan law calls for the certification of ignition interlock devices, criminalizes tampering with such devices, prohibits anyone from blowing into an ignition interlock device or otherwise starting a vehicle equipped with the device in order to circumvent the law, and calls for a notation on the face of the driver's license to indicate the offender is restricted to the use of an ignition interlock equipped vehicle.

Texas

The Texas law gives judges the discretion to order the use of an ignition interlock device as a condition for obtaining a restricted driving license for a second or subsequent offense. It specifies that approved devices must lock the ignition when any amount of ethyl alcohol is detected by the device. The offender must pay the cost of using the interlock device. The law contains a provision that allows the offender to drive an employer's vehicle without an interlock device as long as the employer has been notified that the offender is otherwise restricted to driving only interlock equipped vehicles. The Texas law calls for the certification of ignition interlock devices, criminalizes tampering with such devices, and prohibits anyone other than the offender from blowing into an ignition interlock device or otherwise starting a vehicle equipped with the device.

Oregon

Oregon's law establishes a one-year pilot program in which judges in participating counties can order use of an ignition interlock device as a condition for a restricted driving permit. The law contains a sunset provision that repeals the bill in June 1989. The Oregon bill does not specify at what BAC level the devices should prevent starting of the vehicle. The cost of using the interlock device is to be paid by the offender unless he or she is indigent. In that case the cost is paid by a state alcohol program fund. The law contains a provision that allows the offender to drive an employer's vehicle without an interlock device as long as the employer has been notified that the offender is otherwise restricted to driving only interlock equipped vehicles. Only ignition interlock devices certified by the state may be used, tampering with ignition interlock devices is criminalized, it is an offense to knowingly furnish a vehicle (rent, lease, or loan) not equipped with an interlock device to someone restricted to driving only vehicles so equipped, and non-offenders are prohibited from blowing into an ignition interlock device or otherwise starting a vehicle equipped with the device. The Motor Vehicle Division is to note the restriction on the offender's driving record.

Two states, Hawaii and Delaware, have passed resolutions to study and evaluate the use of ignition interlock devices. In addition, more than a half dozen other states have bills to authorize use of ignition interlock devices pending or under consideration (Alaska, Florida, Illinois, Massachusetts, Minnesota, New York, New Jersey, Ohio, Tennessee, Virginia and Wisconsin).

JUDICIAL ACTIVITY

Judges traditionally have considerable discretion in setting conditions of probation for convicted offenders as long as they are "reasonable" (i.e., not impossible to carry out, related to the offense, and not unduly restrictive of personal liberty). Under this general judicial authority, judges in a number of states have initiated programs that require use of an ignition interlock device as a condition of probation, in the absence of any specific statutory authorization.

The manufacturers of ignition interlock devices have indicated that there are over 120 judges who have ordered the use of an ignition interlock device as a condition of probation (many of these judges are in the states with laws authorizing use of the devices). These judges are found in twelve different states, namely:

States with Interlock Laws

- California
- Michigan
- Texas
- Washington

States without Interlock Laws

- Colorado
- Florida
- Indiana
- Maryland
- New York
- Ohio
- Pennsylvania
- Virginia

Most of these programs are small, though in a few cases hundreds of offenders have been ordered to use the devices.

EVALUATION

These existing programs are so new that it is too early to have meaningful information about the effectiveness of the ignition interlock devices. A number of evaluation projects are planned or have been recently initiated to examine the impact of the use of ignition interlock devices. California, for example, is required by its legislature to conduct an evaluation of its ignition interlock program to determine the effect on recidivism and the reliability of the devices. Oregon, in its authorizing legislation, is also required to evaluate the impact of its one-year pilot program. In addition, privately sponsored studies are under way in Calvert County, Maryland and in

Hamilton County, Ohio. Results from these studies are not expected to be available for a couple of years.

There are many unanswered questions about the potential benefits that may accrue from the use of this technology. No data that speaks to the effectiveness of these devices in reducing recidivism (or alcohol-impaired driving) are currently available. The operational characteristics of the devices in a real world setting is not known, and a variety of implementation issues will need to be addressed. These topics are discussed briefly below.

If the devices do not work as advertised, it is doubtful that any impact on recidivism will be detected. The issues here are the accuracy and reliability of the devices when placed in cars under real world conditions. The effects of subfreezing or roasting temperatures, high humidity, intense vibration, and accidental misuse (e.g., contaminating the sensor by introducing cigarette smoke into the test chamber) are unknown. Similarly, the maintenance and calibration requirements of the devices in operational settings need to be determined. A malfunctioning device that prevents a sober person from operating their vehicle will not be readily tolerated.

Determining the effectiveness of ignition interlock devices in reducing recidivism will require a comparison of rearrest rates between two groups of offenders, one sentenced to use the devices, and the other group not ordered to use them. This type of research is extremely difficult to implement. Assignment to treatment conditions must be unbiased. Ideally, all other aspects of the treatment of these groups must be equivalent (i.e., the amount of fines, assignment to alcohol treatment programs, the duration of probation, and length of a jail sentence, license suspension, or issuance of a restricted driving permit should be roughly equal).

The current research projects planned to evaluate existing programs will produce some useful information on operational and implementation issues. However, they do not appear to be designed to provide sound information on a number of issues. For example, these studies do not incorporate the necessary features to permit an accurate evaluation of potential effectiveness of the devices. Offenders receiving the ignition interlock devices are either selected at the judge's discretion or through voluntary participation. In both instances, those entering the program are likely to differ in important respects from those who do not. Recidivism rate comparisons between the two groups thus may be very misleading. NHTSA will provide technical assistance to states and local communities so that future evaluations efforts will hopefully provide more useful information.

The effectiveness of the ignition interlock systems may depend upon the type of offender with which they are used. Some of the more obvious characteristics that might be worthwhile investigating are such things as the prior driving record of the offender (e.g., number of prior alcohol-related offenses), BAC at arrest, severity of drinking problem, age, sex, and socioeconomic status.

The extent to which persons with alcohol problems will voluntarily abide by an order to only operate a vehicle with an ignition interlock device installed, after passing the BAC test, is a major question. How much tampering and

circumvention will occur is unknown. Current devices are designed to prevent or record obvious attempts at tampering and circumvention. However, testing conducted for NHTSA has shown that a motivated individual could relatively easily fool the devices.

Finally, there are a variety of implementation issues that will need to be addressed. One is whether the states should try to develop uniform or consistent certification standards and test procedures. Manufacturers are not likely to be able to easily meet 50 different standards in order to market their devices. Also, who will be responsible for installing, maintaining and calibrating the ignition interlock devices must be determined. Options range from having a state agency responsible for this activity, state licensed and certified installers, to manufacturer's agents or dealers (unregulated).

1987 WORKSHOP ON IN-VEHICLE ALCOHOL TEST TECHNOLOGY

On October 14, 1987, NHTSA sponsored a one-day workshop on in-vehicle alcohol test (IVAT) devices to review new developments in the state of the art and to foster the exchange of information about recent developments in State and local applications of this technology. There appears to be considerable interest in IVAT devices, with over 80 persons attending this workshop at their own expense. Speakers and attendees represented a wide array of interests with manufacturers, state legislators, judges, enforcement personnel, researchers, safety advocates, and the general public all being represented. The discussion focused on the breath test devices which are currently being marketed with very little consideration being given to performance devices.

The speakers all appeared to be proponents of this technology, whether manufacturer's representatives, judges, legislators, etc. At a previous NHTSA workshop on the subject (held in 1986), the discussion had focused more on questions of feasibility and practicality of applying this technology (Snyder, 1986), while at this workshop the interest had shifted to implementation and evaluation issues.

The presentations covered a range of topics. The viewpoints presented and the major issues raised are summarized briefly below.

Legislative Issues

- At this time five states have passed legislation authorizing use of ignition interlock devices (some on a test basis) and more than a half dozen other states have bills pending.

- A topic of major concern appeared to be the issue of certification standards and test procedures. State agencies and state laboratories apparently do not have the expertise to undertake this task easily. Several manufacturers vehemently expressed the opinion that they would not undertake the effort and expense of meeting 50 different state standards. There seemed to be a general feeling among attendees that uniform standards would be desirable.

- Concern was expressed regarding the cost of these devices (a one year lease is approximately $400 - $500) and who would pay for them (especially in the case of indigent offenders). There is evidence of judicial reluctance to adopt use of a sanction that is not available to everyone regardless of ability to pay. Oregon's new legislation authorizes use of DWI funds to pay for indigent offenders. Other states currently considering legislation are confronting this issue.

- Another topic of discussion was the relationship between use of these devices and other sanctions. Strong sentiment was expressed by some that these devices should be used in addition to other sanctions or treatment, rather than in lieu of them. Others (the manufacturers and some judges) felt that convicted offenders were already being fined, evaluated, treated, and sanctioned enough. If these devices worked, they should be used in lieu of some of these other less effective measures.

Evaluation

- Many workshop participants wanted hard data showing whether these devices work. Some stressed that the devices had to be accurate and reliable; others stressed that they had to reduce the rate of recidivism and impact deaths and injuries. Several persons doubted that there would be widespread adoption of this technology until evidence was available showing that the ignition interlock devices were more effective than the alternatives.

- A number of evaluation studies are now planned or under way in California, Oregon, Ohio, and Maryland. Results should be available in two years. These studies are not using methods designed to provide unambiguous evidence about the effectiveness of ignition interlock devices in reducing recidivism. Some participants expressed concern that a number of research efforts were being funded by manufacturers, rather than by an independent source (without a vested interest in the outcome).

- Research questions of interest included: the extent to which recidivism is reduced when these devices are used, what criteria should be used to select offenders for use of the devices (e.g., first offenders or multiple offenders, offenders with high arrest BACs), under what conditions would ignition interlock devices work most effectively.

- Recent NHTSA results on the accuracy of these devices and whether they can be circumvented were discussed. The problem of cheating and circumvention remains unresolved. Sentiment appeared to lean toward proceeding with implementation with the belief that excessive tampering and cheating would be revealed by failure of the devices to reduce recidivism rates.

Implementation

- Differing opinions were offered regarding questions about who should be responsible for installing, maintaining and calibrating the devices. Options ranged from a state agency responsible for this activity, to state licensed and certified installers, to unregulated manufacturer's agents or dealers.

- Product liability insurance was again raised as a serious problem due to the cost. Also, California had a great deal of difficulty finding a laboratory that would conduct their certification tests without indemnification from the state for any liability that might result.

- Several manufacturers are now equipping their devices with recorders that log every attempt to start the vehicle (date and time test is taken and test results), as well as recording tampering attempts or incidents when the battery is disconnected. How this information could be used by the courts to revoke probation or a restricted license was discussed.

CHAPTER IV

CONCLUSIONS AND OUTSTANDING ISSUES

Previous chapters of this report have reviewed the history of attempts to develop an in-vehicle test system to prevent the operation of motor vehicles by intoxicated individuals, the recent development of improved ignition interlock technology based on breath alcohol test devices, and the current focus on court ordered use of these devices by DWI offenders as a condition of probation or to obtain a restricted driving permit. This chapter presents some general conclusions about in-vehicle test technology and discusses some outstanding issues related to the operational performance of these devices, their ability to prevent tampering and circumvention, their effectiveness in reducing alcohol impaired driving, and their implementation.

CONCLUSIONS

This report is required to address the following question:

<u>What is the effectiveness and potential for applying ignition interlock technology and devices in preventing drug and alcohol related traffic deaths?</u>

Based on the information available to date, the following general conclusions appear warranted:

- Ignition interlock technology based on breath alcohol test devices for detecting and preventing alcohol impaired driving does appear feasible at this time. Devices that measure a driver's BAC level are currently being marketed and used.

- Laboratory tests have shown the current breath test ignition interlock devices to be relatively accurate in detecting low driver BAC levels (i.e., 0.04% BAC). The accuracy and reliability of these devices under real world conditions is unknown. There is no apparent reason why any operational problems cannot easily be overcome.

- These devices contain anti-tampering and circumvention measures that appear to reduce the likelihood of many forms of tampering and circumvention. Such activity by users is not impossible, but operational experience and testing will indicate the extent to which tampering and circumvention will be a problem.

- Current interest has focused on applying this technology to convicted DWI offenders as a condition of probation or to obtain a restricted driving privilege. Critical information necessary to estimate the potential effectiveness of these devices in this application is lacking. This information includes evidence that the devices function

properly under real-world conditions and evidence that persons required to use the devices do not tamper or circumvent their use and do not elect to operate unequipped vehicles when drinking.

- There is not yet enough evidence available to judge how effective these devices will be in deterring alcohol impaired driving and related crashes.

- In the absence of evidence that these devices are effective it is not appropriate for these devices to be used in lieu of other sanctions that have evidence of beneficial effects (e.g., license suspension). Use of this technology as an additional condition of probation or for reinstatement of a restricted driving privilege does appear appropriate.

- The use of these devices with other populations may be feasible (e.g., fleet owners could install them, commercial and public transportation vehicles could be equipped, and individuals interested in this protection could pay for their installation). Widespread use of this type would have to overcome resistance due to the costs, liability issues, and public acceptability issues. Also, considerable research is needed to ascertain the practicality of these uses of the devices.

- Practical performance test based devices (where performance correlates with BAC level) have not yet been developed. However, this approach may be feasible for preventing alcohol impaired driving if performance tests are identified that have high accuracy at low BACs and minimal individual differences in performance so that universal cutoff scores can be used. Such a performance based device might have a collateral benefit of detecting impairment due to causes other than alcohol (e.g., fatigue).

- Ignition interlock technology for detecting and preventing drug impaired driving does not appear feasible at this time. There is no easy or feasible in-vehicle test method currently known to detect the use of drugs. In addition, the cost and complexity of testing for different drugs thought to impair driving skill (including legal as well as illegal drugs) makes such an approach even more impractical.

OUTSTANDING ISSUES RELATED TO BREATH ALCOHOL MEASUREMENT IGNITION INTERLOCK TECHNOLOGY AND ITS APPLICATION

In order to determine, or even reliably estimate, the effectiveness of ignition interlock technology in reducing alcohol impaired driving some fundamental information is needed. This information falls into three basic areas; namely, the operational performance of the devices, implementation issues, and effectiveness of the devices in preventing alcohol impaired driving. These issues include, but are not limited to:

Operational Performance

- Documented evidence is needed regarding the basic operational characteristics of these devices when used in a real world environment. How accurate and reliable are the BAC test devices when placed in people's cars? The effects of subfreezing and roasting temperatures, high humidity, intense vibration and accidental misuse are unknown. Similarly, the maintenance and calibration requirements of the devices are not known at this time.

Effectiveness in Reducing Alcohol Impaired Driving

- Research is needed to determine how effective ignition interlock devices are in reducing alcohol impaired driving. This information will be needed for the different applications of this technology. Differences in effectiveness may exist depending upon the population using the devices (e.g., convicted DWI offenders, persons with a drinking problem, commercial operators, etc.).

- The extent to which people with alcohol problems will voluntarily abide by an order to operate only a vehicle with an ignition interlock device installed is a major question. How much tampering and circumvention will occur is unknown. Current devices are designed to prevent or record obvious attempts at tampering and circumvention. However, testing conducted for NHTSA has shown that a motivated individual could fool the device. Also, the extent to which offenders violate the conditions of their restricted permission to drive by operating vehicles not equipped with an ignition interlock must be determined.

Implementation Issues

- Prior to use of the devices, States need to set certification standards and test procedures and to determine which devices meet those standards. The certification standards address such issues as the BAC at which the device interlocks, the accuracy of the devices, operation under various environmental conditions, electrical and vehicle safety, operational features (e.g., vehicle restart within one minute after ignition has been turned off, no more than two or three tests permitted within a 60 minute interval), tampering detection and anti-circumvention capability. The widespread implementation of this technology will be facilitated if the states adopt uniform or at least consistent certification standards.

- Responsibility for installing, maintaining and calibrating the devices in person's vehicles needs to be determined. Options range from a state agency responsible for this activity, to state licensed and certified installers, to unregulated manufacturer's agents or dealers.

- Product liability appears to be a serious potential problem. Manufacturers have expressed a concern over the cost, and in at least one state difficulty was encountered finding a laboratory to conduct certification tests without indemnification from the state due to difficulty in obtaining liability insurance.

- The cost of purchasing or leasing the devices has also been raised as an issue. Concern regarding who would pay for use of the devices for convicted offenders (especially in the case of indigent offenders) has been expressed. There is evidence of judicial reluctance to adopt use of a sanction that is not available to everyone regardless of the ability to pay.

- In order to facilitate enforcement of a driving restriction limiting a motorist to operation of an ignition interlock equipped vehicle, the restriction should be clearly stated on the driving license.

DOT Research Plans

The most immediate issues outstanding relate to the operational (real world) performance of the ignition interlock devices (i.e., their accuracy, reliability, maintenance and calibration requirements), their effectiveness in reducing alcohol impaired driving by DWI offenders ordered to use them, and the need for consistency in State certification requirements. To help address these needs NHTSA has planned several efforts. These are described briefly below:

- NHTSA is currently initiating a project to develop performance guidelines and test procedures. These will take the form of model specifications that states can use in developing their own certification standards.

- NHTSA is providing grant funds to California's DMV in support of their ongoing evaluation of their ignition interlock program. These funds will cover the cost of additional work to carefully assess the operational performance of ignition interlock devices.

- NHTSA will provide technical assistance to states or local communities interested in evaluating the effectiveness of their ignition interlock programs.

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APPENDIX A

ILLUSTRATIONS OF CURRENT ALCOHOL IGNITION INTERLOCK DEVICES

SAFETY INTERLOCK, INC.

P.O. Box 221818, Carmel, CA

SAFETY INTERLOCK

PUT AN END TO DRINKING AND DRIVING

HOW THE DEVICE IS USED

The device, the size of a small transistor radio, is either mounted on the dash of a car or kept in the door pocket. It is connected by a flexible cable to a small unit mounted under the dash. The driver turns on the ignition, then must blow into the mouth peice for approximately 7 seconds before the car will start. If the unit detects alcohol above a preset level, the car will not start.

SPECIAL FEATURES

The device is difficult to bypass, since it measures breath temperature and pressure as well as BAC levels. Judicial models additionally feature anti-tamper circuits to detect and prevent circumventing the system. The device records a permanent dated and timed record of all events wihch is read out every three months and sent to the probation department (for judicial devices). This record can also be used to confirm that probationers on restricted licenses are only using their auto during allowed hours.

DETERRENT EFFECT

Although our device will not allow a car to be started if a preset blood alcohol level is detected, Safety Interlock, Inc., does not represent that someone cannot drive while under the influence of alcohol. Recent proposed legislation in several states imposes severe penalties for tampering with or soliciting a non-driver to blow into judicially mandated units. Such legislation has already been passed in California, Washington, Texas, Michigan and Oregon.

ABOUT THE COMPANY

Safety Interlock, Inc., was formed in 1986 by Dr. Ronald Garren, a board certified medical internist, and Mr. Scott Hennessy, a marine biologist, with the intention of adapting modern technology to impact the nationwide problem of alcohol-related injuries and fatalities.

ADVANTAGES OF THE SAFETY INTERLOCK DEVICE

The product is state-of-the-art technology. The **Safety Interlock** device is easy to use and third parties such as mechanics and parking attendants who may need to operate the car can readily be shown how to do so. In case of emergency, any sober driver can use the vehicle.

TECHNOLOGY

The device is computer-controlled interlock system performing 200 tests on each breath. It can be set to detect any level of blood alcohol. Currently the setting is at .03 milligrams percent blood alcohol content (BAC). The device can be calibrated to correspond to blood alcohol limits set by each state.

ORDERING INFORMATION AND WARRANTY

The **Safety Interlock** Device is available through **Safety Interlock, Inc.**, P.O. Box 221818, Carmel, CA 93922. Telephone **408-375-6702.** Call toll free in California 1-800-654-0547, outside California 1-800-992-9931. The unit may be purchased or obtained under a lease plan. A one-year warranty covers parts and labor, exclusive of installation and removal.

PATENT

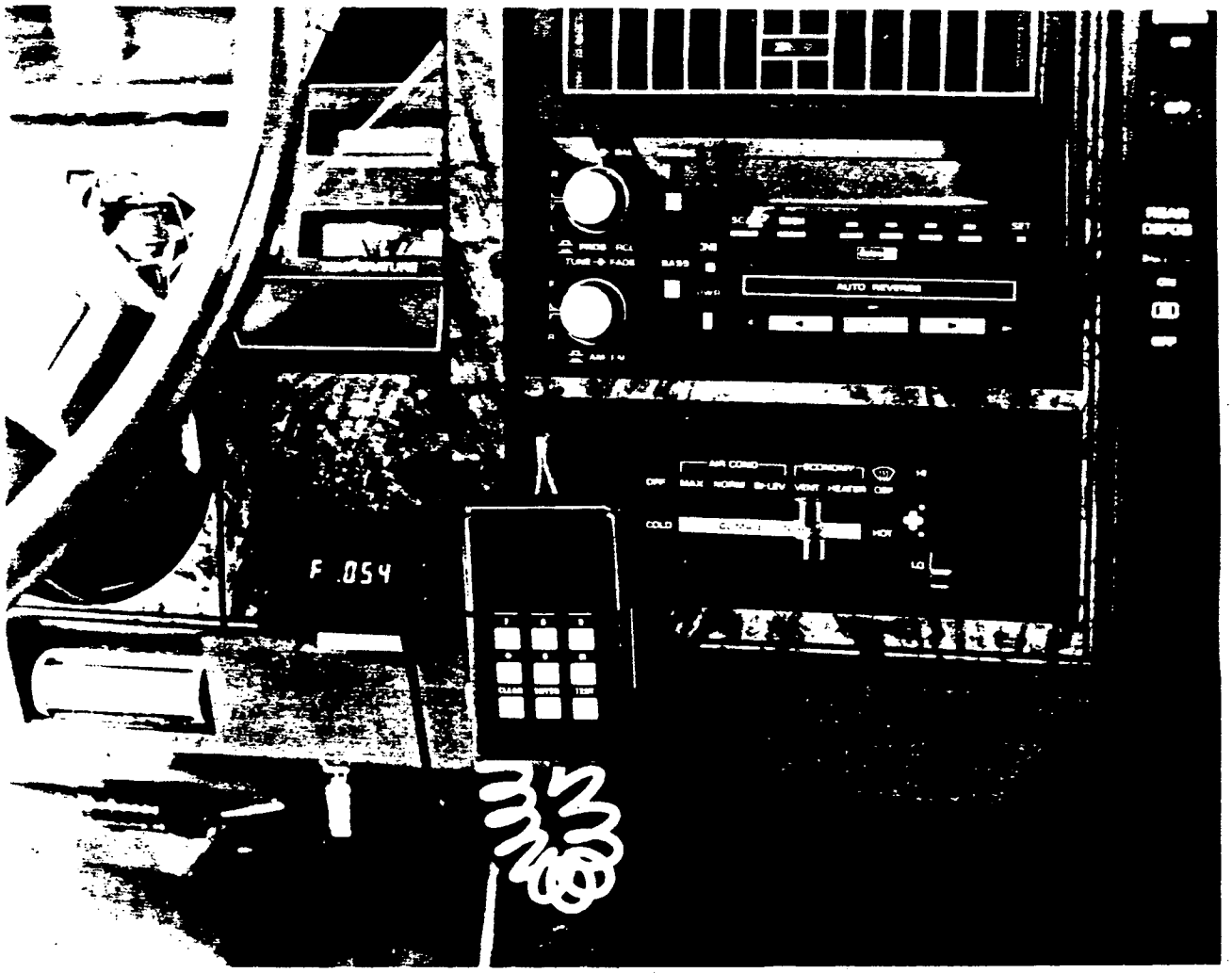
Safety Interlock, Inc., devices are covered by United States Patent Number 4,592,443.

THE SAFETY INTERLOCK DEVICE HAS BEEN CERTIFIED BY THE OFFICE OF TRAFFIC SAFETY IN ACCORD WITH CALIFORNIA VEHICLE CODE SECTION 23244.

CALL TOLL FREE IN CALIFORNIA 1-800-654-0547; OUTSIDE CALIFORNIA 1-800-992-9931

AFFORDABLE . . .

BREATH-TEST SYSTEM FOR IN-THE-CAR USE



Scientifically Accurate and Secure

The AutoSense™ System

is the Quick and Simple Breath Alcohol Analyzer
To Deter Drunk Driving

AUTOSENSE
CORPORATION

Please excuse our redundancy, but we owe new readers an explanation! The Guardian Interlock™ connects a hand-held breath analyzer to a vehicle's ignition. Before a person can start a vehicle equipped with the device, he or she must first blow into the breath analyzer. If the would-be driver's blood alcohol concentration (BAC) meets or exceeds the BAC setting on the device, the car will not start. However, even if a person passes the breath test, he or she must also blow a "breath code" into the analyzer to access the system. This code deters others from trying to start the vehicle for the intended driver. A growing number of judges nationwide are requiring drunken driving offenders to have their vehicles equipped with ignition interlocks as a condition of probation, and to help stop repeat drunken driving offenses.

As a service to the courts, Guardian Interlock Systems launched a program more than a year ago to monitor those sentenced to use the company's product. Called the Guardian Interlock Responsible Driver Program™ the program provides for the installation and calibration of the Guardian Interlock, and it includes scheduled appointments for checking the device for attempted tampering or circumvention

GUARDIAN INTERLOCK SYSTEMS

APPENDIX B

A COMPARISON OF ALCOHOL IGNITION INTERLOCK LAWS

PROVISION	STATE				
	CA[1]	MI[2]	OR[3]	TX[4]	WA[5]
Date Signed	09/24/86	07/10/87	07/16/87	06/24/87	05/05/87
Sunset Provision (Date Rescinded)	Y (01/01/90)	N	Y (06/30/89)	N	N
Eligible Offenders DWI Conviction ($1^{st}/2^{nd}$)	Y/Y	Y/Y	Y/Y	N/Y	Y/Y[6]
Application as a Condition of Probation/Restricted License (P/RL)	P/RL	RL	RL	P/RL	RL
Length of Sentence	up to 3 yrs.	- -	- -	- -	min. 6 mo.
Notification to Licensing Agency	Y	- -	Y	Y	Y
Notation on Drivers License	N	Y	Y	N	Y
Cost paid by Offender	Y	Y	Y[7]	Y	- -
Certification of Devices	Y	Y	Y	Y	Y
BAC level for Ignition Interlock	0.03%	0.02%	N/A[8]	any pos. BAC	- -[9]
Drive Employer's Vehicle w/o Device	Y	N	Y	Y	N
Criminalizes Assisting Offender To Start Car	Y	Y	Y	Y	Y
Replaces Other Sanctions	N[10]	N	N	N	N

1 - see California Vehicle Code § 23240 through Section §2349.4.
2 - see Michigan Code §§257.625, §§257.625b, and §§257.625l.
3 - Oregon HB 2449, enacted in 1987.
4 - see Article 6687b, §§23A(f) & 25(a), Vernon's Texas Civil Statutes, and Article 42.12, §6f(b), Code of Criminal Procedure, also Chapter 38, §38.15 of the Penal Code.
5 - see § 2 of Chapter 247 of the laws of 1987 and § 5 of Chapter 247.
6 - Offenders placed on a deferred prosecution program are also eligible.
7 - Indigent offenders can have the cost of the program paid by the Intoxicated Driver Program Fund.
8 - Not specified.
9 - To be set by the court.
10 - In four test counties the judge may waive a portion of the fine to offset the program cost.

*U.S. Government Printing Office : 1988 - 510-018/80375