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SUMMARY AND EVALUATION OF RESPONSES RECEIVED ON THE ALCOHOL SAFETY INTERLOCK SYSTEM PROSPECTUS

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TECHNICAL MEMORANDUM

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DRIVER PERFORMANCE RESEARCH OFFICE
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16. Abstract

This report summarizes and evaluates devices and suggestions provided by respondents to the DOT Prospectus entitled "Some Considerations Related to the Development of an Alcohol Safety Interlock System (ASIS)". The responses are categorized into: (1) ASIS based on measurement of human performance, (2) ASIS based on personal or vehicle identification, and (3) ASIS based on the detection of alcohol.

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SUMMARY AND EVALUATION OF RESPONSES RECEIVED ON THE ALCOHOL SAFETY INTERLOCK SYSTEM PROSPECTUS

1.0.0 INTRODUCTION

On October 5, 1970, the National Highway and Traffic Safety Administration issued a prospectus entitled "Some Considerations Related to the Development of an Alcohol Safety Interlock System (ASIS)". The prospectus was sent to organizations who have previously expressed an interest in this subject. The prospectus contained a discussion of the needs for an ASIS, the various possible techniques available and the potential problems inherent in the development of an ASIS.

A letter accompanying the prospectus, requested (1) descriptions of potential ASIS, (2) a discussion of the possible solutions to problems mentioned, and (3) a description of the responding firms experience and capabilities in the area of interest.

This report provides a summary and evaluation of those responses to the prospectus which deal with topics (1) and (2) above and a description of actions based on the evaluation of the responses.

Twenty-five firms or institutions provided responses. The Appendix contains a list of all the responding organizations.

In general, these responses contained any or all of the following: A description of an ASIS developed by the respondent, a description of a potential solution or solutions to the ASIS problem, comments on the problems raised in the prospectus and/or an offer to do research and development in the ASIS field.

Section 2.0.0 of this paper contains descriptions, and evaluations of the various solutions suggested by the respondent. The responses fell into three basic catagories: methods or techniques involving the measurement of human performances, methods or techniques involving personal and vehicle identification and

techniques using alcohol sensors. Figure 1 is a matrix of the respondents and the techniques suggested.

2.0.0 SUGGESTED SOLUTIONS

2.1.0 Measurement of Driving Performance

Eight of the responding organizations suggested continuous monitoring of driving performance as an ASIS technique.

They were:

Battelle Memorial Institute
Bendix Corporation
Cornell Aeronautical Laboratory
Exotech Systems Incorporated
Man Factors Incorporated
Stanford Research Institute
Sylvania Electric Products Incorporated
John I. Thompson & Company

2.1.1 Summary

While it was conceded that continuous performance monitoring would be a difficult technique to develop in an ASIS framework, the respondents agreed that a workable ASIS using a continuous monitoring technique would be an ideal solution.

In particular, it would allow operation of the vehicle only when it was driven in a non-erratic and presumably safe manner and would reference passage or failure to the effect of the alcohol on driving performance rather than to the level of alcohol in the bloodstream. Further it would eliminate what may be a major implementation problem-the "Hey, buddy, lend me a hand" situation.

The suggestions for implementation of continuous monitoring technique emphasized automatic sensing of the driver's inputs to the vehicles controls and the resulting changes in the performance of vehicle maneuvers. On the most sophisticated level, it was suggested that a standard profile of the driver's normal

pattern, as reflected in factors such as lateral and linear acceleration, brake applications, and steering wheel inputs be accumulated and that this standard profile be constantly compared with the driver's performance. When the performance showed evidence of significant deterioration in performance (as compared with the standard), the ASIS would be triggered and provide a signal to law enforcement officers. A simpler version of this technique was provided by respondents suggesting the use of the Life Technology Incorporated (LTI) "Owl" or a similar device. The LTI "Owl" is a commercially available device intended to act as an alertness monitor. During a trip, it senses the driver's rate of fine (two degrees) steering wheel reversals and compares this rate to the rate recorded at the beginning of the trip. The fine reversals are taken as an index of control input rate. An observed rate which is considerably lower than that established at the beginning indicates fewer control inputs and lower alertness.

An observed rate which is considerably higher than that established at the beginning indicates more control inputs on an attempt to compensate for worsened road conditions or other factors which increase the "load" on the driver.

2.1.2 Evaluation

In general, the use of continuous monitoring as ASIS technique is limited by the following:

a. The use of continuous monitoring precludes vehicle incapacitation and permits only the use of a signal to warn police officers and/or an in-car violation recorder.

b. If driving performance degradation due to intoxication is not uniform within a population but is idiosyncratic to the driver, it may be necessary to provide a "sober" driving profile. of each driver using the device. This profile would be used as comparison standard for the driver of interest but would have to be modified to allow other drivers to use the vehicle.

Continuous performance monitoring would have the following advantages:

a. Such a test has considerable face validity, as the ASIS purpose is to reduce the number of drivers exhibiting performance degradation and operating their vehicles in an erratic and/or dangerous manner.

b. Such a test need not be referenced to blood alcohol level, which, at best, is an indirect measure of the hazard potential in driving while intoxicated.

c. An ASIS based on continuous monitoring can be extended to degradations caused by other factors such as the use of drugs, carbon monoxide intoxication and fatigue due to prolonged driving or lack of sleep.

d. As noted above, as ASIS based on continuous monitoring could not be defeated by getting a sober individual to start the vehicle.

e. An ASIS based on continuous monitoring would be sensitive to situations where the individual had consumed potentially intoxicating quantities of alcohol immediately before entering his vehicle and was not yet intoxicated when he started the car. It would also be sensitive to intoxication incurred by drinking while driving.

2.2.0 Measurement of Performance on a Divided Attention Task

Seven of the responding organizations suggested that ASIS be based on the measurement of performance on a divided attention task.

They were:

Bendix Corporation
Biospherics Incorporated
Conrac Incorporated
Delco Electronics, Division of General Motors

Nartron Corporation
System Development Corporation
Telluron Incorporated

2.2.1 Summary

It has been demonstrated, under laboratory conditions, that degradation in performance of a two-task, divided attention problem will result under intoxication even though there is no decrease in performance on either of the component tasks when presented separately under intoxication, (Moskowitz & DePry, 1968).

In the response received from Delco Electronics, they describe a candidate ASIS, the "Physiological Tester". This device requires speeded performance on a five digit memory and keyboard entry task which is interrupted by performance of a simple reaction task. Other respondents suggested ASIS using divided attention tasks involving binaural auditory presentation of information necessary to open a "combination type" ignition lock.

2.2.2 Evaluation

While the technique would appear to be of use in discriminating sobriety from intoxication, there is some question as to its practicality. The magnitude of the effect at low BAC levels is small. Moskowitz and DePry reported a 14% increase in error rate over sober performance for a given individual at .07% to .08% BAC.

The response received from the Telluron Incorporated indicates that, in order to reduce the probability of a sober individual failing the ASIS test (Type I error) or passing an intoxicated individual (Type II error), a multiple trial procedure should be used.

Among the other possible disadvantages of an ASIS based on this technique are a possible sensitivity to other variables, such as health, mood, or digit span memory capacity.

Further, the component tasks which make up the divided attention task of necessity are not simple and the complexity of the resulting performance may be beyond the sober ability of those currently driving.

2.3.0 Measurement of Pursuit Tracking Performance

Four respondents proposed measurement of performance on a "Pursuit Performance Tracking Task" as an ASIS technique.

They were:

Cornell Aeronautical Laboratory
Highway Safety Research Institute, University of Michigan
Southwest Research Institute
Universal Information Technology

2.3.1 Summary

The response provided by Cornell discusses a technique under development which requires an individual to visually track a target. In this task, the subject is able to accurately see the target only when there is little or no relative angular motion between his eyes and the target. The device is not discussed in detail in the brochure. The response from the Highway Safety Research Institute discusses the use of a task which combines elements of pursuit tracking and hand steadiness. The subject is required to track a 1/2" wide slot with a metal stylus. The ratio of error time (time the stylus touches the sides) to completion time is described as the most sensitive measure of intoxication.

Universal Information Technology Incorporated describes a more complex approach. The user of the device would be required to align and maintain in alignment a pair of superimposed polarized lenses. The task requires that the user track the moving disc's rotation with the hand controlled disc with sufficient accuracy to see a target through both discs.

The response from Southwest Research Institute describes a proprietary device, CoCort Mk II, which requires an individual to follow a path on a Mylar belt, using a hand control, without mistake for 5-8 seconds. As described in the brochure, the device was in the prototype stage.

2.3.2 Evaluation

Pursuit tracking has long been used as a standard task in Psychomotor assessment programs. Performance on a pursuit tracking task is dependent on the operators hand steadiness control precision and process information allowing prediction of the targets future position.

Laboratory studies described in the response of the Highway Safety Research Institute indicate that significant decrements in performance of a pursuit tracking task occur at BACs as low as .05%.

2.4.0 Measurement of Performance on a Compensatory Tracking Task

2.4.1 Summary

The Bendix Corporation's response suggested an ASIS based on measures of performance on a compensatory tracking task. As described, the task involves keeping a pointer in a null position for a time while a pseudo random forcing function attempts to displace the pointer.

2.4.2 Evaluation

Performance on a compensatory tracking task is dependent on the operators response decision latency, control precision and vigilance. The task is easily learned and has often been used to assess psychomotor performance.

In laboratory studies, degradations in compensatory tracking performance due to alcohol intoxication have been observed (Mortimer 1963, Gibbs, 1966).

2.5.0 Measurement of Performance on a Simple Reaction Time Task

Three respondents suggested that an ASIS could be based on measurement of simple reaction time.

They were:

Battelle Memorial Institute
Nartron Corporation
Robert D. Smith

2.5.1 Summary

Two of these respondents have provided descriptions of working ASIS on this technique.

Nartron's device (Safelock) uses the individual's simple reaction latency to determine whether the user is sober or intoxicated. The assumption is that intoxication will cause an increase in response latency.

The device provided by Robert D. Smith (QuicKey) is somewhat more sophisticated. Here, the individual's performance when taking the test is compared with his previous performance when sober. The device is calibrated to the particular user, and from this calibration a response latency band is established. In use, an individual who responds significantly slower than the calibration score is assumed intoxicated and fails. Responses which are

considerably faster than the calibration are considered evidence of an attempt to circumvent the test by substituting another individual.

2.5.2 Evaluation

The use of simple reaction time performance as an ASIS technique is limited by the high inter- and intra-subject variance accompanying the response which are due to factors other than intoxication. The effect of inter-subject variance may be eliminated using Robert D. Smith's device, but this is not suitable for use on multi-user vehicles. Intra-subject variance effects can be reduced by using a multi-trial average score for determining passage or failure.

Testing of simple reaction time is simple and straightforward, and has good face validity and resulting good public acceptance. Implementation of such a technique could probably be done very economically.

2.6.0 Measurement of Ocular Motion

Three respondents mentioned the measurement of ocular motion as possible ASIS technique:

They were

The Bendix Corporation
Cornell Aeronautical Laboratory
John I. Thompson & Company

2.6.1 Summary

The approach proposed by John I. Thompson & Company involves visual tracking of a moving target and response to a signal presented on the target's surface. It is assumed that intoxication-induced loss of ocular motion control will reduce the ability of the individual to acquire and track visual targets. This will increase the time required to correctly respond to the signal on the target.

Two of the approaches provided by Cornell rely on loss of ocular motion control. The first mentioned above under pursuit tracking requires precise alignment of the eyes with a target. The second utilizes polarized light reflected off the corneal bulge as an indicator of eye movement. Proper placement and alignment of the (eyes) with the sensor is achieved by requiring the individual to perform a simple pursuit tracking task. Little detail was provided regarding the sensor technique to be used.

2.6.2 Evaluation

While there is good evidence for the efficacy of the use of measurements of ocular motion in an ASIS system the present available measurement techniques are expensive, cumbersome and not suited for automatic operation.

2.7.0 Measurement of Steadiness, Dexterity or Control Precision

Three respondents mention changes in hand steadiness, dexterity or control precisions as an ASIS technique.

The respondents are:

A. S. Dwan limited
Man Factors Incorporated
System Development Incorporated

2.7.1 Evaluation

The response provided by Man Factors describes a technique which involves an individual passing a stylus through a series of slots. The technique is reminiscent of that proposed by the Highway Research Institute and discussed above as a pursuit tracking technique. However, the Man Factors technique does not utilize the ratio of time of target to completion time; rather it uses total error time.

System Development Corporation suggests the use of a task which requires the insertion of a tube into or onto a rotating cylinder. The task is to be performed twice; first when starting the vehicle and second after a few minutes of driving. The two stage task is intended to prevent the individual who has been drinking but is not yet intoxicated from passing the test.

A. S. Dwan's response describes a prototype theft resistant lock which requires considerable precision and hand steadiness to fit the key into the lock. The device is described as completely mechanical in operation. As the device is also intended as an anti-theft measure, no override provision is included.

The device can be restarted once the key is inserted, so stalling the vehicle does not require re-passing the ASIS test.

2.8.0 Measurement of Critical Flicker Fusion Frequency

Two respondents suggested that the measurement effects of alcohol on flicker fusion be considered as an ASIS technique.

They were:

Man Factors Incorporated
Creare Incorporated

2.8.1 Summary

Man Factors' submission discusses a "stereo flicker fusion tester". They note that under various stressful conditions, the flashing rate of a pair of stereoscopically arranged stimuli must be increased in order to maintain stereo fusion. Creare Incorporated note that at given flicker rate an increase in brightness is necessary for an individual to perceive flicker when the individual is intoxicated. Creare has designed a device which utilizes this effect to detect intoxication. In practice the

driver is required to indicate whether the target is flickering or steady. If his judgment is incorrect on more than some preset number of trials, he is prevented from starting his vehicle.

2.8.2 Evaluation

The technique has the following disadvantages: Measures of flicker fusion are known to be sensitive to variables other than alcohol such as fatigue and illness. The technique is, however, simple and requires easily learned type of performance by the user.

2.9.0 Measurement of Response Coordination

Two respondents suggested measurements of response coordination as an ASIS technique.

They were:

Man Factors Incorporated
TDL Group of Companies

2.9.1 Summary

Man Factors brochure suggests a task which involves a combination lock. The task requires setting the combination while guiding the key into the lock.

TDL describes a device, the "DDE", which they have developed as a candidate ASIS. In operation, the driver turns a key and follows this response with the depression of the brake pedal. If the brake pedal response is made too slowly or if it precedes or is simultaneous with the key turning, the driver fails the test.

2.9.2 Evaluation

The ASIS described by TDL appears to be simple, very inexpensive, and easily installed in any present vehicle. Insufficient information is available to allow prediction of the utility of the device described as an ASIS.

2.10.0 Measurement of Focus and Lateral Inhibition in the Visual System

2.10.1 Summary

Stanford Research Institute suggested that an ASIS technique involving the automatic sensing of the focus of the driver's eye. They describe a system which indicates the distance at which the eye is focused through measuring the position of a target kept constantly in focus.

2.10.2 Evaluation

The use of such a technique is limited by the following: The measuring device, although not described in detail, would appear complex and so expensive as to make the implementation cost prohibitive. In addition, the technique relies on a hypothetical change in the ability of an individual to focus when intoxicated. While degradations in focus are often reported as symptoms of intoxication, it is not clear whether these degradations result from changes in lens accommodation or changes in lateral phoria with resulting diplopia or from an increase in involuntary eye movements or even from a combination of the above.

The Stanford Research Institute's response also discusses the effect of alcohol on the lateral inhibition in the visual system. The response noted that low levels of blood alcohol

effect lateral inhibition in the visual system of the Limulus (horse shoe crab). They further state effects on lateral inhibition can be measured with instrumentation unique to the Stanford Research Institute. They do note, however, that the effect has never been demonstrated in the human visual system. The use of such a technique in an ASIS would require considerable research and development time.

2.11.0 Personal Identification Techniques

Three respondents suggested an alcohol countermeasure based on or using personal identification.

They were:

The Battelle Memorial Institute
Cornell Aeronautics Laboratory
Universal Information Technology

2.11.1 Summary

The Battelle Memorial Institute suggested that timing information used to set response latency pass-fail thresholds for use in a reaction time task could be read from a magnetic coded card carried by the driver.

The response provided by Cornell suggests the use of large laminated drivers' licenses that fit into a dash board holder. The purpose of this arrangement would be to provide ready access to information on driving restrictions to law enforcement officials. The license would have on it a color picture of the license and coded information regarding restrictions. For instance, the license might have restrictions which prevented the

driver from legally driving at any hour except 7:30-8:30 AM and 4:45-5:45 PM. Substitution of another license would be rendered difficult by the presence of the picture.

2.11.2 Evaluation

The response provided by Universal Information Technology described a personal identification method which while not an ASIS technique could alleviate or eliminate a major difficulty in implementation. The technique involves storing coded fingerprint identification on an identification card. In practice, the ASIS could be operated and the car started only by using a properly coded identification card and a finger with the required print. The card could also be used to set differential pass-fail thresholds for multi-user vehicles or even to override the ASIS automatically for all members but the target individual.

2.12.0 Vehicle Identification Techniques

Two respondents suggested countermeasures based on vehicle identification.

They were:

Exotech Systems Incorporated
Universal Information Technologies Incorporated

2.12.1 Summary

Exotech suggested using an optical license plate reader in combination with a digital computer to monitor violations on time or day driving restrictions placed on drivers convicted of drunken driving. As described, it might also be combined with scoflaw detection and the detection of stolen vehicles.

Universal Information Technologies' response describes a non-powered transponder which is integral with the license plate. In operation, the device detects the 10GHz signal from a police radar and transforms some of the received energy into a 20GHz signal. The 20GHz signal is then picked up by a police receiver.

2.12.2 Evaluation

The Exotech technique would be expensive and difficult to implement during darkness (the most critical period) and would not alleviate the multiple user problem.

The Universal Information technique could easily be defeated by covering the transponder aperture with foil. It would not alleviate the multiple user problem.

2.13.0 Detection of Alcohol

Seven of the responding organizations suggested that an ASIS might be based on the detection of alcohol in body tissues, wastes or breath.

The organizations were:

Battelle Memorial Institute
Bendix Corporation
Cornell Aeronautical Laboratory
Franklin GNO Corporation
Franklin Research Institute
Harold Tombach & Associates
Varian, Inc.

2.13.1 Summary

In general, the suggestions which dealt with tests on tissue or wastes were not detailed or specific. With regard to breath-based tests, two firms suggest devices which are far too expensive to be seriously considered for adoption in a large scale ASIS program. Franklin GNO Corporation describes a device (Plasma Chromatograph) which in its simplest present form has a cost of $19,500. Varian describes a mass spectrometer which, while not given a specific cost, we estimate to cost several thousand dollars.

Cornell Aeronautical Laboratory and Battelle Memorial Institute suggest the use of a catalytic absorbtion or catalytic oxidation type cell as the sensor. The devices can be expected to have a sensitivity in the range of 300 ppm and as such should be suitable for testing alveolar air. The cell type is proposed by Battelle Memorial Institute and is also proposed by Cornell Aeronautical Laboratory. The Cornell approach is provided in somewhat greater detail and provides suggestions and measures to counteract user attempts to defeat the device. In particular, it is suggested that a multi-sensor approach be investigated. This approach would require not only the absence of alcohol, but the presence of the gases normally found in alveolar air (CO_2 and H_2O) in the expected quantities in order to pass the tests.

This is intended to make the substitution of some other air supply difficult.

2.13.2 Evaluation

The following factors would appear to mitigate against the use of a chemical test as an ASIS technique at this time:

1. In order to preclude the ready defeat of the ASIS, it would be necessary to provide it with the ability to not only detect alcohol from a gas sample, but insure that the sample was obtained from a human and that this human was the driver.

2. The device would be sensitive to non-alveolar contaminants including residue from mouth washes, perfume, and possibly windshield washer fluids.

3. Presently "off the shelf" accurate sensing of alveolar alcohol is a multiphase operation requiring a trained operator and an instrument costing between $500.00 and $1,000.00.

An ASIS based on a chemical test would have the following advantage:

The test could be directly related to the blood alcohol level in force in the locality where it was applied.

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Moskowitz, H., DePry, D.: Differential Effect of Alcohol on Auditory Vigilance and Divided Attention Tasks. Quarterly Journal of Studies on Alcohol, 1968, 29, 54-63.

APPENDIX

Battelle Memorial Institute
505 King Avenue
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	Driving Performance (Section 2.1)	Divided Attention Task (2.2)	Pursuit Tracking (2.3)	Compensatory Tracking (2.4)	Simple Reaction Time (2.5)	Ocular Motion (2.6)	Steadiness, Control Precision (2.7)	Critical Flicker Fusion (2.8)	Response Coordination (2.9)	Eye Focus (2.10)	Lateral Inhibition (2.10)	Personal Identification (2.11)	Vehicle Identification (2.12)	Detection of Alcohol (2.13)
Battelle Memorial Institute	X				X							X		X
Bendix Corporation	X	X		X		X								X
Biospherics Incorporated		X												
CONRAC Incorporated		X												
Cornell Aeronautical Laboratory Inc.	X		X			X						X		X
Creare Incorporated								X						
A. S. Dwan Ltd.							X							
Delco Electronics, Division of General Motors		X												
Exotech Systems Incorporated	X												X	
Franklin GNO Incorporated														X
Franklin Research Institute														X
Highway Safety Research Institute			X											
Man Factors Incorporated	X						X	X	X					
Nartron Corporation		X			X									
QuicKey (Robert D. Smith)					X									
Southwest Research Institute			X											
Stanford Research Institute	X									X	X			
System Development Corporation		X					X							
Sylvania Electric Products Incorporated	X													
TDL Group of Companies									X					
Telluron		X												
John I. Thompson & Company	X					X								
Harold Tombach Associates														X
Universal Information Technology			X									X	X	
Varian Incorporated														X

Matrix of Respondents and Suggested ASIS Techniques