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ASSESSMENT OF THE ADEQUACY OF NHTSA'S MOTOR VEHICLE SAFETY RESEARCH PLAN, FINDINGS OF A WORKSHOP

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16. Abstract

A workshop was held to evaluate the adequacy of the safety-related research and development activities planned in support of NHTSA's Five Year Plan for Motor Vehicle Safety and Fuel Economy Rulemaking. This document summarizes the deliberations and findings of that workshop.

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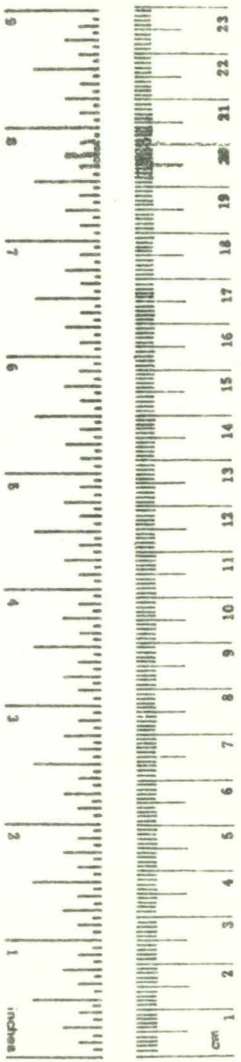
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

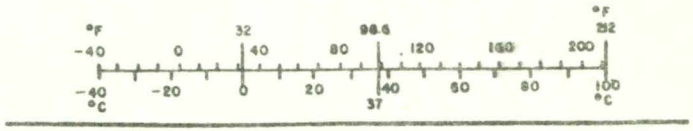
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.96	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



FOREWARD

In 1978, the National Highway Traffic Safety Administration, in a move to streamline its motor vehicle safety rulemaking activities, unveiled a new five-year plan listing four priority areas which offer the most promise for reducing deaths and injuries on the Nation's highways. In the year that followed, the Agency substantially reoriented its research and development program to support this new rulemaking agenda.

In 1979, the Belmont Conference Center was the site of a unique examination of NHTSA's motor vehicle safety research and development program by an impressive cross-section of the motor vehicle safety research community. The panel of experts convened for the workshop was asked to use the Agency's five-year rulemaking plan as the statement of NHTSA's objectives. They evaluated the planned R&D to assess how well it supports those objectives.

This workshop has illustrated the desirability of having greater involvement of the scientific/technical community in the future planning of the research agenda. It also has shown the importance of providing active researchers with greater Agency feedback to assist them in their efforts within the present rulemaking scheme. I assure you it is the intent of the Agency to improve such communications in the future. It is also our intent to consider the recommendations of the workshop panels in the Agency priority-setting, planning process, and in future revisions of the five-year plan.

Special thanks to Len Segel of the Highway Safety Research Institute for chairing and organizing the Conference and to all the participants for their time and contributions.

R. Rhoads Stephenson
Associate administrator for
Research and Development
National Highway Traffic Safety
Administration

TABLE OF CONTENTS

1.0 INTRODUCTION

This document summarizes the deliberations and findings of a workshop organized on behalf of the National Highway Traffic Safety Administration (NHTSA) by the Highway Safety Research Institute (HSRI) of The University of Michigan. The workshop carried the title "Motor Vehicle Safety R & D Program Review" and was charged with the task of analyzing the five-year R & D program that NHTSA had planned in support of its recently published [1] Five Year Plan for Motor Vehicle Safety and Fuel Economy Rulemaking. Specifically, the workshop participants were asked to review only the R & D outlined in support of rulemaking for motor vehicle safety, to "provide ideas and advice on program content and priority and program development and implementation" [2].

The workshop evolved from deliberations within NHTSA leading to the conclusion that the agency should seek out the views of the research community as a means of checking the soundness of its five-year R & D plan. As such, the primary user and beneficiary of the workshop's findings is presumed to be the research and development arm of NHTSA, which reports to the Administrator through the Associate Administrator for R & D.

This document contains five major sections following this Introduction. It appears appropriate to begin with a few words on how the workshop was organized, who the participants were, and what materials were provided for review. Next, the specific findings of the various workshop panels are summarized. These findings speak to the adequacy of the research and development that has been planned in support of proposed rulemaking and, accordingly, this summary is the key section of this report. Subsequent to the presentation of views relative to the adequacy of the R & D plan, the individual views and opinions, expressed by workshop participants regarding NHTSA R & D operations and policies, are summarized. Prior to concluding the report with an assessment of the manner in which the workshop was planned and executed, observations and conclusions, as drawn by the workshop Chairman, are presented.

2.0 METHODOLOGY

Given the objective of the workshop, it seemed rather clear that, to attain a valid and useful output, participants would have to be fairly familiar with (1) NHTSA's current and past research activities and (2) the existing state of knowledge in one, or more, of the research areas supporting the rulemaking activities of the agency. This requirement, plus the desire to hold the workshop to a small group (approximately 15 persons) meant that personnel had to be carefully selected. The selection process involved the informed judgment and background of the workshop Chairman in consultation with NHTSA's Associate Administrator for Research and Development.

Although the primary consideration was that the prospective participant have an in-depth understanding of various fields related to highway safety rulemaking, there was also the feeling that the participants should reflect backgrounds and biases other than those typically found within the research community. For example, in several discussions with NHTSA staff, the question was raised as to whether we should look for participants within the industrial community. Although the decision was in the affirmative, the final outcome of the selection process (involving requests to serve and the acquisition of acceptances) was such that we failed to obtain as a participant anyone who was an employee of, or affiliated with, a motor vehicle manufacturer (see the list of participants given in Table 1). Although this result was deemed by the Chairman to be regrettable, it does appear that the selection process produced a broadly representative spectrum of highly qualified people.

In order to facilitate the workshop's assignment, namely, to assess the adequacy of the five-year R & D plan, each participant was provided with the following documents (as supplied by NHTSA):

1) A draft of the "Five-Year Plan for Motor Vehicle Safety and Fuel Economy Rulemaking" (including three appendices)

2) Fiscal Year 1979 Budget (for Research and Analysis only)

Table 1. Workshop Participants

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Ms. Susan P. Baker, MPH
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Recorder:

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3) Fiscal Year 1980 Budget Estimates (for Research and Analysis only)

4) Draft "Level III" documents, consisting of a detailed problem statement and research task outline for each element in the rulemaking plan

5) A brief description of NHTSA accident data collection systems

6) Accident data support plans for 44 proposed rulemaking actions

7) A tabulation of "R & D Plans for Cost [and Lead-Time] Analysis of Safety Standards"

Examination of this material showed that a five-year R & D plan does not exist as a separate document, but, rather, is defined (in the context of the five-year rulemaking plan) within the total number of Level III documents that are prepared by NHTSA staff in support of each and every contemplated rulemaking action. Accordingly, the Level III documents (containing sections entitled "Problem," "Approach," "Support Requirements," "Summary of Needs [manpower and money]," and "Justification") were the documents that received primary attention per the instructions given to the participants.

In view of the bulk of the material supplied for review, the Chairman elected to group the participants into panels (consisting of three or more people) to review only those Level III documents which dealt with subjects falling into their respective spheres of expertise. Fourteen panels were formed, meaning that each participant was asked to chair one panel, in addition to serving on three additional panels. It should be noted that these fourteen groups, or panels, were organized along lines of common disciplinary interests and qualifications in combination with a logical grouping of rules, for example, accident-avoidance rules as opposed to crash-protection rules.

The titles and the members of these fourteen panels are identified in Figure 1. The first-named panel members served as chairman. This

SUNDAY, APRIL 8	MONDAY, APRIL 9	TUESDAY, APRIL 10	WEDNESDAY, APRIL 11
	Group meetings I A1 - Vision, visibility, signaling (Rockwell, Woodson, Campbell, O'Neill) A5 - Vehicle performance (Segel, Weir, Boulay, Moffatt, Schapery) B1, B2b - Restraint components, pedestrian impact protection (Ward, Melvin, Miller, Friedman, Baker)	General session III Occupant protection research plans Reports of B & F groups	General session VI Modifications to R & D plans based on workshop conclusions
	Group meetings II A2 - Component reliability & inspection, EMI (Friedman, Moffatt, Schapery, Segel) A3 - Controls & displays (Woodson, Rockwell Weir) B2a, B3 - Occupant impact protection, compartment integrity (Boulay, Miller, Melvin, Ward) E3 - Accident data analysis methods (Campbell, Baker, O'Neill)	Group meetings IV E1 - Human impact tolerance (Melvin, Ward, O'Neill) E2 - Accident reconstruction methodologies (Moffatt, Schapery, Boulay, Miller) E4 - Vehicle performance/ accident occurrence relationships (Baker, Friedman, Segel) E5 - Driver performance/ accident occurrence relationships (Weir, Campbell, Rockwell, Woodson)	General session VII Improvement in NHTSA R & D in-house research activities, project definition activities, contract award decision, evaluation of validity of contractors' research findings, dissemination and utilization of research findings
	Group meetings III A4, C1 - Component performance, incl. aftermarket (Schapery, Moffatt, Segel, Weir) D2 - Driver fatigue, seatbelt comfort & convenience (O'Neill, Baker, Campbell, Rockwell, Woodson) F - Advanced occupant impact protection (400 series) (Miller, Boulay, Friedman, Melvin, Ward)	General session IV Data support and research methodologies Reports of E groups	General session VIII Role of R & D with respect to NHTSA's mission: does research lead or follow?
Arrival & registration	General session I Accident avoidance research plans Reports of A groups	Free time or continuation of General session III as needed	Departure
Opening session Remarks by Segel, Stephenson, and Claybrook	General session II Cost analysis methodologies Presentations and discussion	General session V Additional areas of research that should be added to the R & D plan: balance & priorities	

Figure 1. Workshop organization and schedule of sessions.

figure also shows the manner in which the workshop was organized into group-meeting sessions and general sessions. Five of these panels (E1 to E5) were established to consider research needs and methods in general safety-related areas (viz., human tolerance to impact, accident reconstruction methodologies, accident data analysis methods, vehicle performance-accident occurrence relationships, and driver performance-accident occurrence relationships). The nature of the resulting discussions made it reasonable, for the purposes of this report, to incorporate the Human Tolerance (E1) panel's findings with those of the panels concerned with related R & D plans. The findings of the remaining four "E" panels are summarized together under the heading "Accident Data Needs and Methodologies."

Table 2 lists the NHTSA staff members who were present during part, or all, of the workshop sessions to serve either as resource persons or to observe, at first hand, the views and conclusions of the respective participants. By arranging to hold the workshop at the Belmont Conference Center (in Elkridge, Maryland) of the Smithsonian Institution, it was possible for NHTSA staff to both commute and remain on site. In the latter case, it was possible for discussions and dialogue to be continued at the dinner table and into the evening.

Table 2. NHTSA Staff* in Attendance at Workshop

Research and Development

Dr. R. Rhoads Stephenson
Associate Administrator for
Research and Development

Dr. Kennerly H. Digges
Director, Office of Passenger
Vehicle Research

W. Harry Close
Director, Office of Heavy Duty
Vehicle Research

William E. Scott
Director, National Center for
Statistics and Analysis

Dr. P. Robert Knaff
Director, Office of Driver
and Pedestrian Research

Robert L. Carter
Director, Vehicle Research
and Test Center

Rulemaking

Michael M. Finkelstein
Associate Administrator for
Rulemaking

A. C. Malliaris
Director, Office of Vehicle
Safety Standards

Ralph Hitchcock
Chief, Crashworthiness Division

George L. Parker
Chief, Crash Avoidance Division

Plans and Programs

Barry Felrice
Associate Administrator for
Plans and Programs

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*Only primary participants are listed. They were assisted at appropriate group sessions by various members of their staff.

3.0 CONCLUSIONS AND RECOMMENDATIONS FROM THE WORKSHOP PANELS

The findings of the fourteen panels are summarized under four headings to group together related areas of research.

1) Accident-avoidance standards: Driver-vehicle interface research

2) Accident-avoidance standards: Vehicle and component performance research

3) Injury-protection standards: Biomechanics and vehicle structures research

4) Accident data needs and methodologies

The first three sections report findings of panels addressing specific rulemaking/research plans. The fourth is directed at accident data as they may be used to support rulemaking in general. Each section includes a summary of panel conclusions followed by extracts from the panel Chairmen's reports to the workshop Chairman.

3.1 Accident-Avoidance Standards: Driver-Vehicle Interface Research

Three panels discussed research concerned with the driver-vehicle interface (panel chairmen are identified in parentheses):

A1) Vision, visibility, and signaling (Rockwell)

A3) Controls and displays (Woodson)

D2) Driver fatigue, and seat belt comfort and convenience (O'Neill)

Summary of panel conclusions

While vision-related factors cannot easily be identified as "causes" of accidents, the panel agreed they are undoubtedly key factors in many. Accident data bases do not contain sufficient information to be able to show causal relationships, and laboratory studies can only give inferences to the real world. Needed are (1) accident investigation programs specializing in visibility problems and vision errors, (2) controlled field studies to demonstrate the safety benefit (or lack thereof) of

proposed vision-related rules, and (3) a sustained basic research effort, particularly on driver visual search and field-of-view needs. Although several rulemaking actions were thought to be proceeding without adequate research, the panel felt that rear lighting systems could be redesigned based on results from the Washington, D.C., taxicab study.

Arguments for standardizing control/display systems rely on similar inferential evidence, as do justifications for improved visibility. Causal relationships cannot be found using existing mass accident data, and controlled field studies under real stress situations have never been done. The panel agreed that additional funding to support this latter type of research program was needed and that this program should be undertaken very soon, before new configurations proliferate. It was emphasized as well that all types of vehicles need to be incorporated into field studies and rulemaking efforts, not only to reduce commercial-vehicle driver error, but to reduce confusion for drivers switching among different family-owned vehicles and between commercial and private vehicles.

Although standardization is intuitively important, and the fluid nature of current industry designs (e.g., shift to stalk-mounted controls) makes this a good time for rulemaking to occur, there was concern that standardization alone is being pursued without sufficient regard for the functional needs of drivers. One panel member also suggested that certain automobiles (e.g., high performance, single-driver vehicles) be allowed to have systems that are different from and potentially superior to the "aggregated standard."

Although the third panel considered truck ride quality an important issue, it was agreed that a rule could not be justified on the basis of currently existing accident data. Rather, research on this topic should emphasize long-term health effects, just as the proposed rule on interior noise levels is based on protection from hearing loss.

The issue of comfort and convenience of automatic restraint systems is considered of critical importance at this time for consumer acceptance of systems that have already begun to appear. The panel recommended acceleration of research plans in this area. A related

problem is the comfort and convenience of child restraints, for which there is currently no research planned. The panel recommended this issue be addressed.

Comments from panel reports on specific research plans*

•Rear lighting and signalling:

> Enough research exists to begin to redesign taillight systems beginning with separation of function. Whatever system is developed, it must possess instant learning on the part of the population of drivers.

•Motorcycle and moped lighting and signalling:

> A real need exists to improve forward and rear conspicuity of two-wheeled vehicles. Mopeds, in particular, represent a serious problem. Motorists need rapid identification of mopeds, and at the same time they must understand the slow speed of such mopeds and the general inexperience level of the operators involved.

•Improved commercial vehicle conspicuity and signalling:

> The NHTSA study tasks appear to be well directed in this area.

•Fields of direct view:

> There is a need to identify critical targets which lead to accidents in the direct field of view. This involves target path plots over time. Research efforts for target mapping appear to be underfunded. The trend to small cars complicates the direct field of view problem, especially when one considers the taller driver. The argument [that] "front forward blind spots" [contribute significantly to accident occurrence] appears to be less than robust. A-pillar redesign may not be viewed as trivial by the auto manufacturers. Claims for injury reduction are naive and inappropriate for [accident-avoidance] rules.

•Rearview mirror systems--all vehicles; Driver visibility from commercial vehicles:

> The HSRI data and the visibility experts [as cited in the draft Level III document] do not together constitute adequate justification for the proposed rules. Targets need to be identified,

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*These quotations are included not only to convey briefly the opinions of the various panels, but also to give the reader a sense of the spontaneous and frank nature of the workshop discussions. The comments were selected from informal reports addressed to the workshop Chairman. Consequently, some familiarity with the subject at hand is assumed, and reference to the appropriate proposed standard and/or research plan may be necessary. Further details or clarification may be obtained from the individual panel chairmen.

and accident data need to be screened for accidents related to vision errors. Research is warranted on the driver's use of head movements to open up rear field of view and on the extent to which rear mirrors are used for detection and/or decision making. This is a particularly appropriate question for convex mirrors. We also need to ask what the payoff is of a 50% increase in rear target detection. At this moment, a tradeoff between plane mirror size and [the risk of these mirrors striking pedestrians and bicyclists] is needed.

•Headlamp photometrics:

This issue is not believed to be of high priority compared to the topics above.

•Controls and displays--PC, MPV, LT, Vans:

Merely standardizing control-display location without due consideration of how controls operate, how displays are configured, and/or how both are labeled and illuminated may produce only minimal improvement in terms of driver efficiency and ultimate safe performance....Any standards we generate must have a sufficiently sound performance-related basis to allow one to evaluate new functions and make it possible to arrive at satisfactory location and operation decisions that are compatible with what we already have included in the driver station.

•Controls and displays--heavy trucks and buses:

The trucking industry [is already developing] certain standards that appear to vary considerably from similar standards concepts being considered for the private automobile. These standards by the truckers seem to reflect industry consensus (because it is there) rather than being based on any kind of performance-related testing. We may already be too late.

•Controls for the handicapped:

The proposed program is probably appropriate and properly defined. This area should be lower in priority than [conventional] automobile [control] standardization, or even the truck and bus standardization.

There is a need to consider cost and cost/benefit aspects in this rulemaking area. For instance, VA cost and reimbursement limits probably impact current designs, device quality, and performance.

•Truck ride quality:

We recommend that NHTSA put some emphasis on an epidemiological study of the long-term health problems of truck drivers, and

to the extent possible, comparing them with other groups of professional drivers, who have been driving vehicles, such as buses, with considerably better ride quality and less vibration than virtually all heavy trucks. In addition, it has been reported that excessive vibration is a contributing factor in the non-use of seat belts by truck drivers. This latter topic should also be researched as it will provide additional justification and support for the rule.

•Interior noise levels--trucks and buses:

This proposal will basically combine and upgrade present Bureau of Motor Carrier Safety regulations and is intended to protect the health of the drivers, in particular their hearing. There was virtually no research proposed and our group had no comments.

•Seat belt assemblies--comfort and convenience:

There is concern that uncomfortable and inconvenient passive belt systems may encourage many occupants to disconnect them and thus significantly reduce the effectiveness of the standard. In addition, there is another, perhaps even more serious, concern that uncomfortable and inconvenient passive belts could generate sufficient hostility that there could be a consumer backlash and opposition to the [entire] passive restraint standard.

•Child restraint systems upgrade:

Past research has clearly shown that many child restraints are improperly used. For example, in the real world, seats with top tether straps are observed about half the time to not have the strap connected. Our group felt that there is a major problem concerning the convenience and comfort of child restraints.

3.2 Accident-Avoidance Standards: Vehicle and Component Performance Research

Three panels were held on research involving vehicle and component performance (panel chairmen are identified in parentheses):

A5) Vehicle handling and braking performance (Segel)

A4,C1) Component performance (Schapery)

A2) Component reliability and inspectability (Friedman)

Summary of panel conclusions:

Vehicle performance standards are established to reduce the likelihood that accidents will occur. As with the standards addressing visibility, control standardization, and driver environment, actual accident reduction benefits are very difficult to prove. For example, it is assumed that shorter stopping distance is an improvement in braking performance that will lead to an improvement in safety. However, data do not exist that can show a relationship between shorter stopping distance and accident reduction, and it is unlikely that current data collection and analysis procedures will be able to do so. The best way to address this and related problems is to run controlled field experiments. Panel members also emphasized that reasonable vehicle performance standards cannot be developed without consideration of the extent to which the average driver can take advantage of vehicle capabilities in an emergency situation.

Braking and brake system standards make up a large portion of the research plans considered by these panels. The effort to upgrade the heavy-duty vehicle brake standard has understandably been allotted a significant sum of money (approximately $4 million) over a six-year period. Although in-service fleet evaluations are included in the research plan, the panel was concerned that these field studies would emphasize maintainability of brake systems rather than study the actual accident experience of trucks with upgraded and non-upgraded brake systems. Regarding a related proposal, it was suggested that a standard on commercial vehicle retarders would be more appropriate as part of the upgraded heavy-duty vehicle brake standard, or that this problem be dealt with on a state level in regions where downhill braking is important.

The performance requirements for hydraulic brake systems are to be established based on a "sample" of light and heavy trucks. The panel questioned how many might be needed to constitute a statistically valid sample. The panel was also concerned that this limited set of measurements be interpreted with care, taking into account tire traction and load distribution variables. The panel was skeptical that accident data analysis would yield any useful information. Regarding the proposal to double the maintenance-free life of hydraulic brake systems, the panel

doubted its feasibility and was skeptical that a realistic accelerated durability test could be developed.

On motorcycle braking standards, the panel recommended that the emphasis be on the performance of the novice-rider/motorcycle combination. Although there was agreement with the statement in the draft Level III document that the current test procedures are "unenforceable and somewhat inappropriate," the panel questioned whether new test procedures for the old requirements would improve motorcycle safety. Related research to develop advanced motorcycle braking systems was thought to be logically directed at antilock systems. If a cost-effective analysis is to be done, however, the panel recommended that other improved braking systems, as well as the ability of the novice rider to take advantage of these systems, also be considered.

Handling and stability standards are even more difficult to define, test for compliance, and justify with accident data than braking standards. Although opinions differed as to whether a handling standard dealing with sub-limit performance was feasible in the near future, it was agreed that limit handling was in need of fundamental, well-planned, and long-range research. At the same time, it was observed that NHTSA has not taken full advantage of research sponsored by the agency ten years ago. Several statements in the research plan indicate that the problems to be addressed are not well understood, and thus the research itself is not well defined. A policy question arose regarding performance regulation of automobile-trailer combinations assembled in the field. If these vehicles are properly regulated by state governments, then research findings relative to their handling and stability problems should be put in a form that can be used by state agencies.

Testing planned for the development of tire traction requirements should include dry as well as wet surfaces, according to the panel, because wet and dry traction trade off for a given vehicle and passenger tires perform in the opposite manner as truck tires. The panel also doubted that actual accident experience can be related to each level of tire traction. A tire pressure warning indicator was viewed as a potentially valuable accident-avoidance aid, even though the stated justification is based on fuel economy and tire wear arguments.

The panel considering electronic systems compatibility and integrity felt that it was appropriate for the government to assume responsibility for measuring and defining the EMI environment. There was concern, however, that funds were not allocated for developing a basic understanding of the technology and for anticipating problems which may arise with new devices, such as antilock brake controls and airbag electronics.

Comments from panel reports on specific research plans*

•Heavy-duty vehicle brake systems:

> NHTSA tends to see its problems mainly in terms of the performance, availability, and reliability of brake-system hardware. The panel agrees that these are serious matters but would caution that concentration on the hardware aspects of the problem can lead to other important matters being overlooked. For example, NHTSA recognizes the inherent conflict between increasing the deceleration capability of a motor vehicle and simultaneously preserving "lateral stability during braking." However, it goes on to assume that vehicles having increased deceleration capability, while preserving lateral stability with reliable stability augmentation systems, will be safer vehicles and thus will produce an improved accident record. The assumption may be correct, but NHTSA should verify this hypothesis by means of a controlled field experiment. It is recognized that such experiments are costly. However, the proposed upgrading of these brake systems represents a substantial cost to society.

•Retarders for commercial vehicles:

> Whereas the identified problem—future fuel efficient trucks will have less downhill retardation than previous trucks—is on target, the proposed approach to dealing with the problem is...more hardware oriented than appropriate...There is the question of whether the federal government can justify a rule that would apply equally to all commercial vehicles when downhill braking performance is a matter of concern only in certain geographical areas.

•Hydraulic brake systems:

> This panel recommends that NHTSA carefully examine its posture relative to the "problem" of braking. The agency must develop a clearer understanding as to why vehicles exhibit a large variation in wheels-unlocked limit stopping distance behavior—the extent to which these results are tire-traction dependent, brake-energy-absorption-capacity dependent, or torque-distribution dependent. Further, the agency must develop a fuller appreciation of how the average driver is able to utilize the braking capability designed into this vehicle.

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*See footnote, page 10.

•Motorcycle braking systems:

There remains the fundamental question of whether a requirement for a motorcycle to exhibit a specified wheels-unlocked stopping distance on a given surface provides any assurance that a novice, or inexperienced, rider will be able to utilize this capability in an emergency. It follows that additional research is in order to define the properties of a cycle that best satisfy the needs of the rider who is significantly overinvolved in accidents, namely, the novice rider...The cost-effectiveness of an advanced braking system must be judged in terms of the performance gains (and, ultimately, the reduction in accidents) exhibited by novice riders as opposed to expert riders.

•Handling and stability:

NHTSA staff have yet to clearly define the role of rulemaking as a viable countermeasure for attacking the safety problems posed when noncommercial vehicles tow trailers on the highways. In addition, wise decisions on the initiation of handling research concerned with heavy-vehicle combinations require that NHTSA staff understand the limits of their rulemaking authority and recognize that the users of the research may be someone other than the rulemaking arm of the agency. With respect to the research planned to investigate the "limit yaw stability and controllability" of passenger cars, the proposed development of a test procedure and its application to a limited sample of vehicles does not come to grips with the major question, namely, "To what extent does 'spin-out' limit cornering behavior lead to a poorer accident record than does 'plow-out' limit behavior?"... In light of the evidence already accumulated to date showing that combination vehicles are overinvolved in accidents, it seems unnecessary for NHTSA to devote additional time and money to demonstrate this fact again...Heavy-vehicle handling research is needed to establish the levels of instability that can be tolerated by the truck driver as opposed to identifying the "causes of instability."

•Tire selection and rims:

No additions or changes are recommended by the group.

•Aftermarket brakes:

It is believed that the seriousness of the brake shoe and brake pad problem may be greater than indicated in the problem statement considering the possible loss of balance between front and rear brakes with non-uniform braking characteristics. However, the group recognizes the difficulty in meeting specified levels of performance; e.g., the coefficient of friction is very sensitive to manufacturing process variables.

•Long-life hydraulic brake systems:

There is real concern about whether or not a realistic accelerated durability test can be developed. The group also questioned the need for NHTSA's involvement in this project since the extension of brake life may be best left to industry.

•Traction amendment:

The problem statement indicates that the traction performance of truck and bus tires is up to 26 percent below that encountered with passenger car tires. The group believes this reduction is for dry surfaces and is directly related to the high inflation pressures employed; the high pressures produce correspondingly high tire-road contact pressures, which in some cases may provide superior wet traction characteristics compared to car tires. The group also feels that improvements in stopping performance and lateral stability is paced by improvements in braking rather than tire traction, and therefore braking studies are an extremely important part of upgrading the stopping and stability behavior of trucks and buses.

•Vehicle speed control:

No additions or changes are recommended by the group.

•Splash and spray protectors:

The group believes that use of splash and spray protectors is very desirable. Performance criteria and compliance tests may be difficult to establish.

•Coupling devices:

The group felt that this effort should have a low priority, since there is very little evidence that significant benefits would result from the research, and it would seem that defect investigation might pin-point manufacturers whose devices have been failing.

•Battery explosion:

In view of the suggestion that the rule would require minimal (10¢ per battery) costs and consists primarily of a labeling change, the committee made no recommendation.

•Electrical and electronic systems and electromagnetic interference:

This is the only project relating to a major change in automobiles, i.e., the use of electronic devices for fuel economy and emissions controls, driver aids, braking, etc. The group felt that having the government assume responsibility for electromagnetic interference problems with the systems was appropriate.

•Brake system inspectability:

This rule involves little or no money. It was described as involving little or no problem or controversy and requires no recommendation from the group other than to mention that it seems a diversion from higher priority projects.

•Low pressure tire warning indicator:

The group was very interested in such a device since it offers substantial collision avoidance benefit, particularly if the warning is instantaneously available at the driver station. The group expressed interest in encouraging industry and government development of research data on which to base the rulemaking.

3.3 Injury Protection Standards: Biomechanics and Vehicle Structures Research

Four panels were held on research involving human impact protection and vehicle crashworthiness (panel chairmen are identified in parentheses):

B1,B2b) Pedestrian protection, child occupant protection, and helmets (Ward)

B3,B2a) Vehicle structures, automatic restraints, and light truck and van occupant protection (Boulay)

F) Advanced occupant protection - 400 series (Miller)

E1) Human tolerance research needs (Melvin)

Summary of panel conclusions

Significant research advances in biomechanics are needed before several of the planned impact protection rules can be formulated and compliance procedures specified. This is true for side impact protection, pedestrian protection, and the advanced occupant protection or "400 series" standards. In each case, panel members were concerned that, if research does not produce the needed results within the time allotted, rulemaking activities will proceed without them. Particularly critical are the development of advanced test dummies and the improvement of various injury criteria, such as that for non-contact head injury. Both of these research areas are thought to be limited more by time than by money. Further, the estimates for both time and funding in the draft Level III documents were thought to be insufficient.

Panel members agreed that the child had been neglected in the research plan and that efforts should be devoted to improving child injury criteria, collecting child injury data, redesigning child restraints for comfort and convenience, and determining the compatibility of children and child restraints with automatic belts and airbags.

Several existing occupant protection standards are being extended to light trucks and vans. Panel members noted that differences exist between these vehicles and passenger cars in type of crash pulse experienced and in types of occupant injuries. The panel therefore stressed the importance of appropriate vehicle crash tests. It was also suggested that steering wheel/column standards need to be upgraded for all vehicles, and that all interior protection and occupant restraint standards are interrelated and should be considered together. For instance, automatic belt systems may result in an increase in facial impact with the steering wheel, and this problem should receive research attention.

The advanced occupant protection program is considered to be very amitious for the time and resources budgeted, but the goal of the program is agreed to be worthy of the effort. Primary concerns are with regard to (1) limitations of the Abbreviated Injury Scale for the analysis of occupant injury vs. crash severity, (2) trade-offs between crashworthiness and fuel economy, (3) dummy development, (4) crash test conditions that are representative of accident conditions, (5) need for a limited number of compliance tests, (6) necessity for integrated vehicles to be modifications of existing production vehicles, and (7) insufficient utilization of results from the RSV and other past research programs.

Comments from panel reports on specific research plans*

•Pedestrian initial impact protection:

> The research is incomplete in two areas: biomechanics and cost/benefit analysis. The number of cadaver tests [planned] (10 to 15) is not adequate to evaluate the effectiveness of the new structures, given the number of variables to be explored. In the cost analysis, the durability of the proposed soft material should be considered, and replacement costs during the life of the vehicle should be included. The dislocation in the industry and availability of soft durable materials should be seriously considered before enacting the rule.

*See footnote, page 10.

•Pedestrian secondary impact protection:

More research is needed in the biomechanics area. Pedestrian head and neck injuries need additional study. The injury criterion for the head should be upgraded to include recent injury research results and a new injury criterion for the neck should be developed. Neck disections of traffic fatalities are revealing serious injuries. In the pedestrian cases, neck injuries are more severe than head injuries. The effect of the soft hood in preventing serious cervical cord injuries, death and quadrepligia, needs to be examined. Cost of the soft hood is an important consideration. Only a small percentage of automobiles impact pedestrians, and in some impacts, a soft hood will not prevent a fatality. The total cost and manufacturing problems should be weighed against the expected injury reduction. But even an estimate of the injury reduction will require additional injury research and detailed injury data collection.

•Seat belt assemblies--comfort and convenience:

The research program is adequate for adult usage, but the safety of the child using passive restraints should be researched. The torso belt may pass near the child's neck increasing the likelihood of neck injury. Because the geometry of the child is different from the adult, the effect of the inflating airbag on the child's head, face, and neck should be investigated.

•Child restraint systems upgrade:

The effort is adequate for the proposed rule. However, the panel recommends that data on child injuries be collected. The injury criteria for the child also need to be upgraded. The current extrapolation from the adult criterion and the excursion limitations should be investigated and substantiated with factual injury information. Since increased use of child restraints will reduce injuries, a study of the ease and convenience for the mother is suggested. In the new vehicles, belts for anchoring child restraints will be in the rear seat. This may adversely affect usage. The possibility of specifying other anchorage points for child restraint systems should be considered.

The development of injury criteria for the head and chest of children is needed.

•Side impact protection upgrade:

The panel agreed that the dummy and performance criteria development is the key and pacing activity for this program. The panel was concerned that if dummy development lags, NHTSA must have an alternative approach. NHTSA answered that the rulemaking schedule will be met; the alternative to acceptable dummies would be regulation based on interior protection, door velocity criteria, ejection, and similar requirements. The panel pointed

out that criteria for interior padding do not exist so that practical implementation of such countermeasures may be difficult.

Research on side impact to the head should be conducted to develop injury criteria specifically for that type of crash situation. The actual effectiveness of HPR glass in side windows also needs study.

•Motorcycle helmet protection:

Program is adequate.

•Passive restraint research:

Electromagnetic interference in restraint system electronics was discussed. Protection techniques have been developed for other applications and could readily be applied to automotive passive restraints. At least one NHTSA-sponsored demonstration vulnerability test should be conducted in the very near future... The discussion of passive restraint reliability centered on child restraints. Research is needed to resolve problems in meaningful and standardized testing of child restraints and evaluating their use in airbag cars.

•Passive restraint extension to light trucks and vans:

Vans experience a shorter duration and higher level crash pulse than passenger cars and have different steering wheel and steering column performance. Solution of some of these problems, e.g., making the van more crashworthy, may be required before passive restraints can be made effective in vans. Injuries to van passengers differ from those of car passengers, most notably in lower leg injuries. Research must therefore consider such injury mechanisms. If vans are tuned to flat fixed barriers, protection from real-world problems, such as impacting vehicle override, will not be provided. The panel recommended that vehicle/vehicle tests will be required for these reasons.

•Truck rear-end underride protection:

The panel agreed the program should consider weight and performance trade-offs between rigid and energy-absorbing guards. Although underride protection could be provided up to 40 mph, restrained (present technology) and unrestrained occupants probably would not survive at these higher impact speeds. The panel also suggested that research consider the types of vehicles to which underride protection should be applied and the operating constraints that may be imposed by the guards.

The truck underride problem should be viewed strictly as that of geometric incompatibility between the automobile front structure and the rear of the heavy vehicle. The serious injuries that occur to automobile occupants are, for the most part, caused by

severe intrusions into the passenger compartment....Vehicle designs must address this elementary fact and insure reasonable compatibility so that the energy-absorbing structures participate during the collisions. Most heavy vehicles do not satisfy this elementary principle, and a rather obvious solution should immediately be put in place.

•Door lock extension to hatchbacks:

The panel recommended that all-glass rear doors [i.e., without frame structure] be eliminated by regulation. Field data on door lock performance is sparse; adequate pictures of latches and door panels are almost never [obtained at the accident scene]. The panel recommended that the field data acquisition procedures be revised to correct this deficiency.

•Motorcycle leg protection--crash bars:

The need for special leg instrumentation in support of testing and evaluation of crash bars was discussed and not entirely resolved, but the dominant opinion was that such instrumentation is not required. The panel suggested that research consider secondary effects, such as rider post-impact trajectory in motorcycle-auto collisions which could be affected by crash bars. After some discussion, it was agreed that the greatest societal costs [that crash bars might reduce] are from injuries sustained when a sliding motorcycle hits the pavement. Therefore research should concentrate on this fundamental problem.

•Occupant protection interior impact, collapsible steering column, and steering column rearward displacement--extension to light trucks and vans:

There was general agreement that the rulemaking is essentially ready and should proceed as planned. The panel agreed that all these regulations should be upgraded for passenger cars, light trucks and vans. FARS data show that certain body-engine combinations produce significantly higher fatality rates than models which are essentially identical, one model having much greater steering-wheel rearward displacement and a flat wheel option that provides little energy absorption.

•School bus crash protection:

The panel agreed that current NHTSA plans were well thought out and should be implemented.

•Advanced occupant protection - 400 series:

The Abbreviated Injury Scale (AIS) is used almost exclusively in accident data analyses. It is believed that AIS may be too limited to adequately describe various levels of injury. Also, other injury criteria, such as for the neck, should be considered as part of the analysis. Furthermore, other injury data are contained in the files and these should be used to develop a broader understanding of the relationship between occupant injury and crash severity.

The motor vehicle trends and technology analysis should be extended to at least 20 or more years. The standard would take effect in the late 1980's, and many of the affected vehicles will be in operation at the beginning of the century.

Attention should be focused on any possible trade-offs between crash safety and potential fuel economy improvements.

The development of a vehicle crash data base is important to the program. The collection of additional instrumentation data on compliance tests is strongly supported. It is recommended that an attempt be made to get automobile manufacturers to also provide crash test data to this data base.

Within the time constraints, it may not be possible to develop a single dummy; rather, it may be necessary to use a specific type of dummy for each collision test mode.

The panel agrees that present test techniques are not representative of real-world accidents, and progress is definitely needed. Practical constraints may, however, still result in proposed crash test conditions which are not closely representative of accident conditions. Nevertheless, progress in this area is believed to be less critical to the overall project than that required in biomechanics.

Extreme care must be exercised in defining the compliance tests. A complete evaluation might involve 70 or more crash tests for a single vehicle. From a practical viewpoint, it will probably be necessary to limit the tests to not more than five or six. Hence, it would be desirable to develop a methodology which would allow extrapolation of test results to other conditions.

The panel strongly feels that while an integrated vehicle effort similar to the RSV program is essential, the technology must be applied to and demonstrated on vehicles of all types and classes. Specifically, it is felt that with the minicars RSV program, too much effort (resources) was spent in developing a "ground-up" vehicle. Likewise, the Calspan/Chrysler program, although a modification to a production vehicle, spent considerable effort demonstrating producibility. The panel recommends that to maximize industrial transfer, the technology should be applied to a large variety of production vehicles with hardware modifications limited in scope to demonstrate performance at the pre-prototype rather than production level.

The panel feels that the planned 400 Series activities may not have fully taken advantage of the information developed on other programs, particularly the RSV project involving vehicle development activities by both Calspan Corporation and Minicars, Inc. It is recommended that NHTSA conduct a complete review of these programs with special emphasis on how they might support the 400 Series rulemaking.

•Other human tolerance research needs not covered above:

Further consideration should be given to defining the relationship between the mechanical input levels that produce a given type of injury in the cadaver brain and the corresponding levels that produce those injuries in the human.

The mechanism of injury related to surface lacerations and methods for evaluating lacerative potential in crashes should be studied.

3.4 Accident Data Needs and Methodologies

Four panels were held on topics related to accident data needs and methodologies to support the research plan (panel chairmen are identified in parentheses):

E3) Accident data analysis methods (Campbell)

E4) Vehicle performance/accident occurrence relationships (Baker)

E5) Driver performance/accident occurrence relationships (Weir)

E2) Accident reconstruction methodologies (Moffatt)

Summary of panel conclusions

The single most recurring theme during workshop discussions was the inadequacy of currently available accident data for addressing many accident causation, as well as injury occurrence, questions. The focus of these panels was on how the situation might be improved, including new approaches to be taken.

Because of the infrequent nature of many accident events, large numbers of cases are required in order to identify a significant sample of accidents of interest. It was suggested that state records which include certain minimum elements (e.g., VIN, accident severity, injury severity, belt usage, etc.) could be aggregated to yield a million accident records per year. Although less detailed and reliable than NASS, this data bank could be used for different purposes due to the large numbers.

The information collected in routine accident investigations could also be augmented to include some vehicle performance indications, such as jackknifing; but it was agreed that most precrash performance data is difficult to obtain. Panel members made strong recommendations that NHTSA consider the use of crash recorders in vehicles participating in controlled fleet experiments.

With sufficiently large data banks, certain accident-avoidance characteristics of vehicles might be addressed. This task could be done by identifying vehicle models that are similar except in the one variable of interest. Examples might be different control layouts, brake configurations, or handling characteristics. This approach has already been successfully used to reveal differences in occupant protection performance.

Even if accident data files are upgraded and enlarged as suggested, panel members recognize that a signficant number of questions will remain unanswerable. It was therefore emphasized that resources must be spent on other methods. Among alternative accident research approaches, the most frequently mentioned was the controlled field evaluation of modified fleets. Although costly and potentially problematical from the liability standpoint, the larger costs and problems resulting from insufficiently justified rules could be avoided. Another approach to identifying vehicle characteristics with accident causation is the case-control study comparing crash-involved vehicles with vehicles similarly exposed but not involved in crashes.

Accident reconstruction augments field data collection by determining quantities that are not directly observable but that can be derived from measured data. Several of the research plans require accident reconstruction capabilities that go beyond those currently available. Examples are the detection of wheel locking, wet-brake fade, trailer swing, tire traction effects, precrash vehicle motions, and tire underinflation. Impact speed determinations for the proposed motorcycle crash bar rule and reconstruction of underride collisions are also not presently possible. Rollover accidents are difficult to reconstruct because of the third dimension of motion. The panel recommended that standard reconstruction methods be developed for this type of accident that could

be used by skilled investigators in different locations. The upgrade of the side impact standard will require the determination of impact speeds and ΔV as well as the division of ΔV into its longitudinal and lateral components. The panel saw these determinations as possible with NCSS data and the development of a methodology for dealing specifically with side impacts.

The panel emphasized that automated accident reconstruction is possible to a point, but it soon becomes very difficult and certainly cannot be done on a mass basis. As the crash becomes more unusual, a higher level of expertise is needed to reconstruct it. Requirements in the research plan for specialized reconstructions will have to be met by careful field identification of accidents of interest followed by reconstruction by a few qualified experts. As reconstructions become more complex, the need for a data bank of physical and dynamic properties of a wide range of vehicles becomes important. The panel strongly recommended efforts in this direction.

Comments from panel reports*

•Mass accident data files:

> Repeated references are made to accident data support being sought from files like FARS, NASS, etc. The panel believes that in many instances such files will not be responsive because the sample size is too small. We suggest that, in addition to NASS, data from 6 to 8 states be accumulated, such that an input rate of 1,000,000 accidents per year be achieved. The prospects for collecting these data, harmonizing them to some extent, and upgrading their quality seems at least hopeful enough to warrant a modest effort to examine the possibilities.

•Accident data collection improvement:

> Existing files of accident data often lack crucial data items related to vehicle performance. Some, such as jackknife, rollover, and other indications of crash dynamics, could and should be added to standard accident reports.

•Crash recorders:

> The panel felt that NHTSA interest in crash recorders should not be dropped. We feel that significant knowledge gaps could still be addressed by a test fleet equipped with such devices.

*See footnote, page 10.

•Potential accident data analysis designs:

Given the differences in the wetting and wet fade properties of the front drum and disc brakes employed on motorcycles, one could seek trends in the accident data generated by larger sized motorcycles which are distinguished largely by differences in front brake design (disc vs. drum). It is recognized, however, that motorcycle data are difficult to obtain, and that this hampers the potential for such analysis.

If two or three general truck designs can be identified as having consistently different ride qualities,...then it could be very feasible to seek ride-related trends in the accident data.

In the sub-limit directional control area, it was noted that handling parameters (e.g., gain and yaw time constant) have been identified that correlate with both avoidance maneuver performance and subjective ratings of handling "qualities." It is likely that vehicles could be identified that differ in these performance characteristics but are otherwise similar (appearance, price, use, etc.). Differences could be sought in the accident data that would likely reflect handling and crash-avoidance properties.

•Accident data limitations:

The panel made the point that, even if all foreseeable data sources are developed, there will nevertheless be many questions that simply will not be addressable through accident data. Such questions seem likely to fall more in the accident causation area. In view of this, one should be very practical and realistic about deciding which problems lend themselves to use of accident data.

•Alternative accident research designs:

In view of the limitations of retrospective analyses of accident data, greater use should be made of other research designs, such as comparisons of crash-involved vehicles with other vehicles traveling in the same direction past the accident site, on the same day of the week and at the same time of day. Another powerful research tool is the field trial, in which part of a fleet is modified and subsequent accident experience compared with the remainder of the fleet.

•Accident reconstruction methodologies:

Delta V has historically been considered as a one-dimensional quantity, but for standard 214 it will be important to distinguish the frontal and lateral components of the delta V vector. This appears to be possible using currently available reconstruction techniques and the measured damage profiles obtained in the NCSS.

There appear to be several requirements in the five-year plan for specialized accident reconstructions of uncommon crashes. The panel supported an approach that NHTSA has used for special studies in the past. That approach is to develop methodologies for the mass accident data collection teams that allow them to uniformly detect cases in which the effect of interest may be a factor. These cases would then be reconstructed by specialists whose expertise could not feasibly be available in every team.

An essential underpinning of all quantitative reconstructions is the physical properties of vehicles: their dimensions, their mass and mass distributions, their crush stiffnesses, and their tire properties. The panel highly recommends efforts toward gathering this information and toward establishing ways of scaling these dynamic quantities among comparable vehicles. As NHTSA moves from what have been essentially one-dimensional reconstructions giving a scalar delta V value, to two-dimensional side impact and handling reconstructions, and to three-dimensional rollover reconstructions, accurate knowledge of vehicle dynamics properties will become more critical.

4.0 NHTSA R & D PROGRAMS, OPERATIONS AND POLICIES: VIEWS OF INDIVIDUAL PARTICIPANTS

As indicated in Figure 1, four workshop sessions were devoted to obtaining comments of individual participants with respect to

1) areas of research that should be added to the R & D plan,

2) modifications to be made to the present plan,

3) improvements that could and should be made in the research and development process, and

4) the role of R & D in fulfilling NHTSA's mission.

The views expressed in these sessions are summarized below under two general headings, viz., "Procurement, management and utilization of research" and "Recommendations for changes and additions to the motor vehicle safety research program."

4.1 Procurement, Management and Utilization of Research

Several participants pointed out that the procurement process suffers from unwarranted delays that stem not only from problems in the Contracts and Procurement Office, but also from disputes between R & D and Rulemaking staff who have not resolved their differences before issuing the RFP. Although contractors are held to deadlines, they themselves have been subjected to procurement delays of as much as twelve months. Some qualified researchers choose not to bid on NHTSA contracts for these reasons. NHTSA should consider what this is costing the agency and the public in terms of lost time and expertise and make the necessary adjustments in staffing and procedures.

RFP's need to include level-of-effort indications in terms of manpower and money. Other agencies within DOT currently follow this practice. The suggestion was also made that RFP's not specify the methodology to be used but rather leave this up to the bidder. If this were done, the level of effort expected would be necessary information.

Several researchers encouraged NHTSA to accept unsolicited proposals, even though it was recognized that these do not have a place in

the R & D plan as currently structured. Another comment concerned the tendency of NHTSA to put researchers in "pigeon holes" regarding their areas of expertise.

Once the contract is awarded, good communication between the researchers and the CTM is critical but often found to be lacking. Contractors need to know how their particular project fits into NHTSA's overall goals and expectations. The creation of "draft standards" was suggested as one way of guiding the direction of research. Communication would also be facilitated by the provision of more travel funds to get researchers and CTM's together at critical points in the project.

Although researchers in different fields have apparently had quite different experiences, there was nevertheless a significant amount of concern about the quality of CTM's. These concerns ranged from administrative to technical issues. Several researchers felt that CTM's are not adequately trained to perform their managerial assignments. Others questioned the ability of some CTM's to evaluate research results presented to them. On the other hand, situations occur in which the CTM is most qualified, but the qualifications of the research contractor leave much to be desired. This state of affairs reflects, of course, on the adequacy of the process used by NHTSA in selecting research contractors.

Occasionally it becomes apparent in mid-contract that the direction or scope of the project needs changing. NHTSA needs the flexibility to allow these changes to be made so that resources are not wasted on unnecessary programs.

Research results are of little value unless someone knows about them and uses them, either in the short or the long term. It was the general contention of the group that findings from NHTSA contracts are difficult to obtain through formal channels. Even the authors of a report, who must provide the agency with the camera copy, do not routinely receive copies of the final printed edition. Several suggestions were made to improve the situation. At a minimum, copies of final reports should be automatically distributed to all researchers receiving the RFP's for those programs as well as to other researchers in the field. NHTSA should also encourage and provide funds for reporting research results in

professional, refereed journals when appropriate. This would have the added advantage of providing NHTSA with external evaluations of the research it sponsors. A regular newsletter containing digests of on-going as well as recently completed projects would benefit safety researchers.

The foregoing has been concerned with research dissemination to and utilization by the research community outside NHTSA. Also at issue is the use by the agency of its own sponsored research. There seems to be no formal evaluation procedure that results in feedback to the contractor concerning the work he has done. It is often obvious that findings are not incorporated into policies or rulemaking actions, but the reasons are not known. Test devices are sometimes used for purposes not intended by the contractor that developed them, but he may not be consulted.

During many workshop discussions, the point arose that past research results have been lost or ignored, or that NHTSA does not fully comprehend the research findings from which it has to draw. The result is that, when new rulemaking actions are planned, research tends to be repeated. A formal evaluation and feedback procedure would not only allow the contractor to learn if his research missed the target but would allow him the opportunity to explain his findings if agency staff misinterpreted them.

Several comments were made about the general problem of conducting research and maintaining high quality staff without the assurance of funding continuity. This is a problem particularly for academic organizations, who would like to promise support to graduate students over a multi-year period, and for small companies, who must maintain an income to stay in business.

One participant observed that NHTSA could benefit from better cooperation with other government agencies in the planning and sharing of research. Another recommended that issues addressed at this session be discussed again next year to see what improvements have been made.

4.2 Recommendations for Changes and Additions to the Motor Vehicle Safety Research Program

The remarks and statements presented below are not verbatim quotes, but are based on the notes taken by the workshop recorder. For the sake of conciseness and brevity, these remarks are presented in a highly condensed form.

Accident data:

- NHTSA's expectations regarding the ability of accident data to prove the value of accident-avoidance measures are overly optimistic.
- Nevertheless, accident data banks should be viewed as an "investment" which may pay off at a later date in response to unanticipated needs.
- The evaluation of accident-avoidance countermeasures by means of accident data is very difficult; accordingly, controlled field studies should be used to an increasing extent with a corresponding reduction in retrospective data analysis.

Crash protection:

- Improved means are needed for providing occupant protection to the handicapped in autos and buses and to children being transported to day-care centers.
- NHTSA should encourage cooperation with the medical community and provide funding for trauma research.
- Child protection and injury criteria are being neglected.
- Crash test and biomechanics data obtained by various organizations should be collected, organized and shared.
- The 400-series program is too ambitious; there is a need to (1) expedite dummy research, (2) evaluate past research, (3) set specific goals, and (4) identify problems.
- The findings of the RSV program should be reviewed to anticipate potential problems in the development of rules to be based on the 400-series research program.

Accident avoidance:

- Driver performance measures are needed to advance our understanding of the accident-avoidance process.
- The schedule for (1) promulgating control-display standards and (2) conducting the necessary supporting research should be accelerated to "head off" further complications.
- The influence of long-term vibration on driver sensitivity to motion and relative motion cues should be studied.
- A better understanding of the "standard" driver is needed; NHTSA needs a data base defining
  - -visual targets used for directional and longitudinal control
  - -head movements, visual search patterns, and average dwell times used by the driver in gathering information
  - -factors influencing driver attention and lack of same.
- Field studies should be conducted during night hours to determine the extent to which degraded visibility is a function of vehicle design or maintenance activities.

General remarks:

- NHTSA should recognize that its motor vehicle safety research program has utility to users other than the rulemaking arm of the agency; it should identify these additional users and should determine the best way of disseminating its research findings to the identified parties.
- Anthropomorphic dummies should be used as a design tool as well as a crash-testing tool.
- The emphasis on supporting rulemaking frequently leads to test procedures getting developed without comparable attention being given to the development of performance requirements; the latter task is the more difficult and its execution is frequently squeezed by tight research budgets.

- Stated differently, there is a tendency to concentrate on the development of tools and test procedures with the bona fide research issues getting short shrift.
- NHTSA should engage in more dialogue with the motor vehicle industry.
- There is need for research being directed towards defining and alleviating a highway safety problem, rather than to a rule, per se.
- NHTSA should beware of doing testing for its own sake; more analysis should be performed to complement the test effort.
- Although modeling is a tool that is equally important as test, it must be used realistically and with caution. Where possible, modeling should be coordinated with test activities.
- A national consumer panel should be created to identify concerns about restraint systems, vision, and other aspects of vehicle design relating to safety.

5.0 OBSERVATIONS AND CONCLUSIONS: FROM THE PERSPECTIVE OF THE WORKSHOP CHAIRMAN

The Chairman was asked by NHTSA to exercise his perogatives in preparing this report, namely, to speak out on topics that he deems to be important. Although the observations presented below have been prompted by the recent workshop and are based, in part, on what transpired therein, it should be acknowledged that the Chairman has long been an observer of NHTSA's research activities in support of safety standards and consequently has had ample opportunity to develop biases which presumably influence his ability to be a completely neutral observer. Nevertheless, every effort is made below to be as objective and as fair as it is humanly possible to do so.

In order to (1) discuss NHTSA's research enterprise in support of motor vehicle safety rulemaking and (2) critique same in a highly substantive way, it is necessary to observe that NHTSA does not do research for research's sake, that is, merely to expand knowledge and understanding. One of the primary functions of this agency (as it interprets its mission from its enabling statute [3]) is the development of motor vehicle safety standards. To the degree that the agency must consider whether a proposed standard is "reasonable, practicable, and appropriate," the agency is authorized to conduct research. Given that the agency's primary product is safety standards, its research centers around (1) the identification of the need for a standard, (2) the determination of the minimum performance levels to be met by new production vehicles, and (3) the establishment of the test procedures by which the motor vehicle industry and the government can determine that the requirements of the standard have been met. Not only is the agency's research program highly circumscribed, it is also viewed as being only a means to an end, where the "end" is an objective, certifiable standard. Thus, when one chooses to consider whether NHTSA's R & D enterprise is sound and well conceived and whether it is being wise to use a rulemaking plan for structuring its R & D program, this consideration must, a priori, acknowledge the particular thrust and purpose of NHTSA's R & D function.

Within these constraints, observations are offered below with respect to

1) how well NHTSA is conducting and managing its research activities, and

2) the advantages and disadvantages of using a "rulemaking plan" to define an R & D program in support of rulemaking.

Recommendations will also be offered with respect to the adoption of internal actions and policies which, hopefully, would advance the effectiveness of the agency in attaining its research and development goals.

5.1 Is NHTSA'S R & D Enterprise Soundly Conceived, Managed and Executed?

Endeavoring to answer this question is, admittedly, a presumptuous undertaking. As with anything else, it would be a serious mistake to generalize. Consequently, it should be recognized that my observations do not derive from a balanced exposure to each facet of the agency's program.

To begin, my primary impression of the agency's R & D activities is that, more often than not, it seeks to gather information and data which support a previously adopted position. Clearly, a research posture of this kind can produce difficulties and inefficiencies relative to the short-term goal of completing a project to the agency's satisfaction. More important, however, are the consequences for the long term—specifically, this research posture can result in "negative" findings being forgotten over the long term such that instead of accumulating a steadily increasing body of knowledge, the agency finds itself supporting a program with limited short-term goals characterized by projects which may involve dubious hypotheses and dubious assumptions. Under these circumstances, the research program will likely reflect the personal idiosyncracies of agency staff members instead of reflecting a careful and deliberate implementation of the scientific method.

The above remark is serious, indeed. It derives, in part, from a personal familiarity with only a portion of the research activities pursued by NHTSA over a twelve-year period. In particular, I am reacting

to (1) requests for proposals that the agency has issued, (2) the quality of the research that has been performed under contract, and (3) the extent to which projects have exhibited continuity and have reflected objectives relevant to rulemaking goals. Admittedly, my remarks involve a judgment which is open to debate. However, this observer would contend that there is considerable evidence to show that NHTSA has permitted its zealousness on behalf of highway safety to outweigh considerations pertinent to making wise decisions vis a vis its research program.

Certainly, there are those who would say the opposite—namely, that the agency hasn't been zealous enough in its efforts to carry out its mandate. I would only repeat that, in the eyes of one who is committed to the scientific method, the agency's apparent research posture is not that of proving/disproving a hypothesis, but rather that of supporting a preconceived position. I say "apparent" because the appearance may, in fact, disguise what is real. In either case, there is substantial basis for concluding that the short-range character of the majority of research projects funded by NHTSA leads to findings that tend to be obscured with the passage of time.

A second impression is that NHTSA errs in putting too much faith in agency structure and its procedures as a means of generating a viable and sound R & D program. In essence, the management of the agency seems to feel that if you establish the right kind of process, work output will be acceptable in quality, and on target as well. This observer would contend, however, that no matter how rigorous the process and no matter how qualified the people who hold management responsibilities, the work output will be less than satisfactory if people at the working level are limited in their qualifications or capabilities. If working-level weaknesses are also accompanied by inadequacies at certain levels of supervision, the "process" is even more likely to be defeated in achieving its goals.

Notwithstanding the evidence that there are staff inadequacies which result in the "process" being frustrated and, on occasion, defeated, a more serious problem, in this observer's opinion, is the failure of some managers to manage and of some supervisors to supervise. This statement is difficult to document, but the quality of the writing and the arguments frequently set forth in Level III documents and in RFP's speak volumes as

to the lack of attention given by senior staff to work output of their subordinates. The question naturally arises as to why this state of affairs exists and whether this lack of quality control is unique to NHTSA or common to many, or all, government agencies. Frankly, I don't know the answer, but I suspect that one of the reasons that NHTSA managers and supervisors do not uniformly attend to their management and supervisory responsibilities is that they become preoccupied with assignments and chores that derive from the limelight and the pressures surrounding the agency as it performs its mission.

A final impression of this observer relative to the soundness of NHTSA's R & D enterprise is that progress is hindered by a tendency to discount the findings and knowledge produced by researchers who did not do their work under NHTSA sponsorship. It can be speculated that such discounting (to the degree that it occurs) derives from a lack of self-confidence on the part of NHTSA staff to evaluate work which they did not personally monitor. This writer has seen instances in which it was necessary to do work under a NHTSA contract before it was possible for NHTSA staff to accept and feel comfortable with facts already established. This observation suggests that, in certain cases, NHTSA R & D staff need to improve their lines of communication with the outside research community. As matters stand now, it appears that efforts to establish communication with various members of the research community are inhibited by NHTSA's concern for preserving the integrity of its procurement process. The net result is some R & D staff members do seek advice and information when it is needed, but others do not. The irony of the situation is that, on the one hand, a contract is deemed necessary to obtain findings that possess credibility but, on the other hand, such findings are not always fully comprehended by agency staff, either with respect to meaning or implications.

5.2 The Pros and Cons of Using a Rulemaking Plan to Structure NHTSA'S R & D Program

In 1974, the General Accounting Office (GAO), at the request of Congress, examined the manner in which the Safety Administration plans and uses its motor vehicle safety research. The recommendations submitted by GAO [4] were as follows:

The Safety Administration should:

--Develop a coordinated program plan for establishing safety standards which delineates the research requirements for each standard and periodically update the plan.

--Monitor the plan's implementation and resolve any differences that may arise between the offices responsible for research and rulemaking.

--Critically evaluate research findings and determine the extent to which they can be used for rulemaking.

--Insure that the Motor Vehicle Program Office promptly (1) uses contractors' research findings, if determined to be feasible and desirable, to develop safety standards or (2) obtains any additional research needed on a priority basis to support rulemaking.

Clearly, the first of the above recommendations calls for a "coordinated program plan" which, to all intents and purposes, is not too dissimilar from the rulemaking plan that exists today. Whether the reasons for generating the current plan are the same as those outlined in the GAO report are not clear, since the stated objectives of the current plan [1] are:

1) to provide policy guidance for use within NHTSA for the development and issuance of motor vehicle safety standards

2) to provide the public with information on proposed future activities and priorities, and permit the industry to anticipate potential requirements in its long-range planning.

Although a reading of the above-stated objectives does not suggest that NHTSA's rationale for developing the plan is exactly the same as that underlying the earlier GAO recommendations, statements were made at the workshop by NHTSA staff to indicate that the five-year rulemaking plan serves as an instrument by which the agency is able to identify the total resources (money and manpower) required to implement the research effort supporting a time-phased rulemaking plan. It was also stated that the purpose of the Level III documents is to define the research that must be done in support of a proposed rulemaking action. Thus, the verbal

statements made at the workshop harmonize with the rationale expounded by GAO some 4 1/2 years earlier on the need for a "coordinated program plan" whereas the written statement [1] does not identify research planning as an objective of the five-year rulemaking plan.

Given that the development of safety standards is seen as one of the major functions of the agency and that the research dollars available in support of their development are limited, it follows that the agency wants to maximize the "bang that it gets for the buck." (In this context, "bang" must be interpreted as rules or standards.) Accordingly, the goals used to define and structure the R & D program consists of specific proposed rulemaking actions which, in turn, require the establishment of (a) performance limits and (b) applicable test procedures as opposed to the more general goal of acquiring knowledge applicable to the improvement of the traffic-safety record.

This observer would ask whether the above-described process does more good than harm. Although I am convinced that a good case can be made, in theory, for using a rulemaking plan to define the R & D in support of that plan, I am not convinced that, in practice, the process works as well as desired. The major problem, as I see it, is that, protestation to the contrary, the rulemaking plan is not seen merely as a mechanism for defining research but is also seen as a collection of future rulemaking actions which NHTSA would like to complete. In the Washington environment, these proposed rules, which, in theory, are supposed to stand or fall on the basis of the supporting research, tend to become sacred cows. No matter how hard the agency tries to remember the true purpose of the process, the staff is likely to fail, as evidenced by the stated objectives of the rulemaking plan and the tone of the Level III documents that provide the backup detail.

To the degree that proposed rules become sacred cows and rulemaking, per se, is the activity that provides the agency with its primary sense of accomplishment, it is difficult to see how R & D staff can avoid taking positions, as opposed to being fully open to discovery. In a research environment that is highly focused towards producing findings, data, and procedures applicable to rulemaking, it is likely that there will not be any great interest in serendipitous discoveries or findings.

I hesitate to generalize, but I suspect that given the organizational structure of NHTSA, the rulemakers are inclined to ask R & D staff a rather single-minded question, namely, "What have you done for us lately?"

In concluding this section, I would add that all comments have been purposely constrained to deal with reality, namely, that the rulemaking arm of NHTSA is viewed as the sole user of the motor vehicle safety research conducted by the R & D arm of the agency. This is not entirely true, but for the purposes of this workshop, motor vehicle safety research is defined by the Level III documents provided to the participants. In every case, these documents are keyed to proposed rules.

5.3 Specific Recommendations

It appears that many of the problems that were examined earlier by GAO in regard to the ability of rulemaking and R & D to work together in a constructive manner have been alleviated, if not corrected altogether, judging from observations made at the workshop. Nevertheless, this observer has indicated above that certain problems remain. The most difficult question is "What should and can be done to eliminate the problems that remain?"

First, it is recommended that the managers of NHTSA's R & D enterprise give serious attention to quality control matters. In particular, these managers should make every attempt to obtain higher standards of performance on the part of their subordinates by means of setting an example. Where the quality of work is deemed to be inadequate, each manager and supervisor needs to become an instructor to advise his subordinates of what must be done to attain a higher standard of quality. The issue is not one of "shaping up" but rather that of developing an attitude wherein striving to do his/her task at the highest professional level possible is the order of the day.

Second, it is recommended that R & D managers and supervisors adopt a more realistic view of their capabilities and those of their subordinates. A lack of experience, ability and judgment will not necessarily compromise the accomplishments of the research and development arm of the agency, if the agency is completely honest with itself, to

the point of recognizing what it can do (in terms of defining the research needs and objectives of the agency) and what it cannot do (in terms of defining the best way of attaining these objectives). In other words, a little humility can go a long way towards making up for staffing inadequacies.

Third, the current procedure of having the research contractor present a final briefing on the completion of his study should, in no way, relieve the R & D staff of reporting to supervision and management their in-depth evaluation of the research efforts and its findings. This should be done in such a manner that the agency clearly understands the R & D progress achieved in terms of whichever criteria it chooses to apply. (This observer, however, would argue that R & D progress in support of a proposed rule should be only one of several applicable criteria.) Most importantly, this evaluation should be sent to the research contractor to provide the researcher with feedback that, at present, is absent. To the extent that the researcher does not see eye-to-eye with NHTSA's evaluation of the project, the opportunity arises for (1) clarification and (2) the initiation of a dialogue that should be helpful to NHTSA as well as to the research parties involved.

A recommendation, related to the above recommendation, is that NHTSA staff should seek every opportunity to engage in dialogue with the research community. NHTSA management should strive to indoctrinate the R & D staff with respect to the benefits of good communication. Agency staff should be encouraged to seek opinions and advice of persons outside of government with the understanding that they would be expected to weigh all inputs as a professional individual who, in the last analysis, must decide or conclude as best he can.

Finally, the agency should do whatever it can to clarify the role of a rulemaking plan. It should differentiate between such purposes as expounded in the introduction to the current five-year plan and purposes as were identified in the GAO report and as expounded verbally by NHTSA staff. To state one thing but mean something else caused workshop participants some considerable difficulty in knowing how to treat or view a given Level III document. More important, however, is the need for those who set policy to choose their words more precisely so that working-level staff can avoid the natural tendency of a highly mission-oriented and socially-conscious agency to adopt rulemaking positions which R & D would be expected to defend and support.

6.0 A RETROSPECTIVE ASSESSMENT OF WORKSHOP PLANNING AND EXECUTION

The subject workshop was the first of its kind, namely, a workshop to assess NHTSA's motor vehicle safety R & D program in its totality, as opposed to a workshop which addresses a much narrower topic. In addition to novelty, a second basic feature of this workshop was the decision made early on to conduct it with a small number of participants. The broad scope of the workshop, together with the limited number of experts that could be invited, meant that it was not possible for participants to concentrate exclusively on topics falling within their area of expertise. Consequently, the specific R & D plans did not get as much individualized expert attention as would have been possible if the workshop had been organized differently. On the other hand, the small number of participants, together with the senior NHTSA staff in attendance, led to the establishment of a coterie which (1) possessed an excellent esprit de corps and (2) dedicated itself seriously to the task at hand.

In addition to assessing how well this particular workshop performed its assigned mission (on the grounds that such an assessment would aid in the planning of future workshops), a more basic question would be "Was this workshop given, in the first instance, a mission whose execution leads to output having maximal benefit to NHTSA?" In this regard, there were several participants who felt that the workshop occurred too far "downstream" in the planning activities of the agency. In other words, there were participants who felt that NHTSA would benefit more from seeking advice from the research community during the formulation of NHTSA's R & D program than from asking the research community whether the agency had developed R & D plans that were adequate for supporting the planned (proposed) rulemaking. Thus some participants had mixed feelings at the workshop: they were most pleased to see NHTSA embark on this venture, but they also regretted that they had not been asked for their comments and advice at an earlier stage in the proceedings.

The Chairman's personal observations relative to the planning and execution of this workshop, as charged, are the following:

1) The efficiency of the various panels would have been increased by having the organizer exercise more discretion over the material that was distributed and, in particular, designating those Level III documents which should have been given a low priority.

2) More instructions should have been provided by the organizer to the participants that chaired panels on various research needs and methods.

3) More attention should have been given towards providing NHTSA staff with background material and instructions comparable to that given to the workshop participants. NHTSA staff serving as resource persons during the workshop were nonuniformly instructed beforehand as to the role that they were expected to play.

4) Given the basic conflict between a broad scope and a small number of participants, it is felt that the workshop was able to address the questions placed before it. Whether the insights, comments, and recommendations deriving from the workshop's deliberations were of sufficient substance and utility as to encourage NHTSA to hold this kind of a workshop on a repeating basis is a decision for NHTSA to make. However, the participants felt that the workshop was worthwhile and expressed themselves in this vein in letters to the Chairman.

5) It is believed that some benefits of a workshop (of the kind held at Belmont) are difficult to evaluate. In addition to the findings documented in this report, there are the possible benefits that derive from (a) senior NHTSA staff having the opportunity to engage in dialogue with each other away from their offices, (b) the requirement for NHTSA staff to think about their R & D plans in the presence of persons from outside the agency, and (c) the establishment of relationships that could lead to easier and more frequent contacts between agency staff and members of the research community.

REFERENCES

1. Department of Transportation "Five-Year Plan for Motor Vehicle Safety and Fuel Economy Rulemaking", Federal Register, Vol. 44, No. 82, April 26, 1979, p. 2459.

2. Contract DOT-HS-9-02101 "Motor Vehicle Safety R & D Program Review Workshop".

3. National Traffic and Motor Vehicle Safety Act of 1966; Public Law 89-563, 89th Congress, S.3005.

4. Comptroller General's Report to the Committee on Commerce, United States Senate, "Improvements needed in planning and using motor vehicle safety research", Sept. 16, 1974.