REPORT OF THE
VIRGINIA TRANSPORTATION RESEARCH COUNCIL
FOR THE DEPARTMENT OF MOTOR VEHICLES ON

Deceleration Lights on Trucks

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

SENATE DOCUMENT NO. 14

COMMONWEALTH OF VIRGINIA
RICHMOND
1994

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Department of Motor Vehicles
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December 10, 1993

TO: The Honorable L. Douglas Wilder
Governor of Virginia

and

The General Assembly of Virginia

Senate Joint Resolution 247 of the 1993 General Assembly requested that the Department of Motor Vehicles, in cooperation with the Center for Innovative Technology, the Motor Carrier Division of the State Corporation Commission and the Department of State Police study the desirability of allowing deceleration lights on trucks in the Commonwealth, the types of lights which currently exist and the appropriate standards which should dictate their use.

On behalf of the Departments of Motor Vehicles and State Police, the Center for Innovative Technology and the Motor Carrier Division of the State Corporation Commission, it is my privilege to transmit the report of the findings and recommendations of the requested study.

Respectfully submitted,

Donald E. Williams
Commissioner

DECELERATION LIGHTS ON TRUCKS

A REPORT TO THE GOVERNOR AND GENERAL ASSEMBLY OF VIRGINIA IN RESPONSE TO SENATE JOINT RESOLUTION NO. 247, 1993 LEGISLATIVE SESSION

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the
Virginia Department of Transportation and
the University of Virginia)

Charlottesville, Virginia

November 1993

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PREFACE

Senate Joint Resolution No. 247, agreed to by the Virginia General Assembly in February of 1993, requested that the Virginia Department of Motor Vehicles, the Center for Innovative Technology, the Motor Carrier Division of the State Corporation Commission, and the Department of State Police conduct a study of the desirability of allowing deceleration lights on trucks in the Commonwealth, the types of deceleration lights that currently exist, and the appropriate standards that should dictate their use. Legislative action was taken as a result of the efforts of a Virginia company to gain approval for the sale or testing in the Commonwealth of a patented deceleration warning light. The device, patented by Mr. Emory L. Lariscy of Stuart, Virginia, consists of two rectangular amber-colored lights mounted to the rear of a semi-trailer or straight truck and a switching mechanism adapted to the throttle linkage of the attached power unit. The warning lamps are illuminated whenever the accelerator of the vehicle is not depressed, with the purpose that such lights might warn following motorists of nonbraking deceleration by trucks and thereby prevent rear-end collisions.

Mr. Lariscy's deceleration warning system has not been approved for use in the Commonwealth: first, because in order for the Superintendent of State Police to approve an item of motor vehicle equipment for use on state highways it must be tested against a recognized standard, and second, because the State Police were doubtful that such a warning light system would truly improve highway safety. At present, state participation in standard setting for motor vehicle safety equipment is limited by the absence of a mechanism for such participation. At the same time, no provision is made under Virginia law for on-road testing of motor vehicle safety equipment. Thus, Mr. Lariscy has been halted by the absence of a standard against which to test his invention and must look outside his home state for a forum in which he can try to prove the worth of his device.

The impasse reached by the state and the inventor over the use of this device is largely the result of a catch in the law, a good law that has benefitted the safety interests of the Commonwealth for many years. The requirement that motor vehicle lighting equipment measure up to recognized standards before it is allowed on the highway enables the State Police to protect the integrity of signaling systems that are critical to highway safety. The problem with the law is that new ideas may be rejected even though they offer a potential for improved highway safety.

SJR 247, sponsored by the Honorable Virgil H. Goode, Jr., in the Senate and the Honorable W. Roscoe Reynolds in the House, addresses this problem for one category of motor vehicle lighting equipment: deceleration lights. The Virginia Transportation Research Council became involved in the study requested by SJR 247 at the request of the Virginia Department of Motor Vehicles. This study was conducted in such a way as to answer the questions put directly by the General Assembly. Over the course of this study, the authors also tried to develop recommendations responsive to the larger issues raised by the impasse over deceleration lights.

The Virginia Transportation Research Council is pleased to submit this report to the Governor and General Assembly of the Commonwealth of Virginia in appreciation of their long-standing interest in highway safety.

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EXECUTIVE SUMMARY

History has shown that innovations in motor vehicle safety equipment can significantly improve highway safety. At the same time, the uniformity of signaling systems and the need for appropriate standards to regulate those systems are factors that are critically important to highway safety. The balancing of these two interests is the subject of extensive state and federal regulation. Ideally, the goal of that regulation should be to foster innovation without sacrificing highway safety.

This, it seems, is the larger issue raised by Senate Joint Resolution No. 247, requesting from the Department of Motor Vehicles, the Center for Innovative Technology, the Motor Carrier Division of the State Corporation Commission, and the Department of State Police a study of (1) the desirability of allowing deceleration lights on trucks in the Commonwealth, (2) the types of deceleration lights that currently exist, and (3) the appropriate standards that should govern their use. This study answers the specific questions raised by the General Assembly and in the process offers a solution for the larger issue. It is likely that these questions would never have come before the legislature had a mechanism been in place to resolve the dispute between the proponents of innovation, in this case Mr. Emory Lariscy and his associates, and the state officials charged with protecting highway safety, the State Police. Hopefully, this study will accomplish more than a resolution of the dispute with respect to deceleration lights on trucks. Hopefully, it will initiate the development of a mechanism for dealing with similar disputes in the future.

The steps taken in pursuance of this study included (1) the assembly of a steering committee, (2) an extensive literature survey, (3) a visit to the company that is seeking to market Mr. Lariscy's system in Virginia, (4) analysis of the problem that deceleration warning systems on trucks propose to cure, (5) research into the state and federal law regulating and establishing standards for motor vehicle safety equipment, and (6) analysis of the assembled information in order to answer the three questions posed by the General Assembly.

In answer to the first question, what types of deceleration lights currently exist, it was discovered that a great variety of systems have been developed and tested. The most common type of system, and the category that includes Mr. Lariscy's system, is the accelerator position signal. The principal function of these systems is to signal to the following motorist that the driver of the leading vehicle has lifted his or her foot from the accelerator. A second category of deceleration warning systems includes enhanced brake signaling (EBS) and true deceleration signaling (TDS) systems. These systems use signal lamps to communicate the severity of braking or actual deceleration of the vehicle.

A third category of deceleration warning systems includes systems, including Jake Brake lights, that operate to warn the following motorist of the use by the leading vehicle of a Jake Brake or some other alternative braking system. The final category of deceleration warning systems is the pre-brake signal or advance braking light device (ABLD), a refinement of the accelerator position signal that operates not on the basis of the release of the accelerator but according to the speed at which the accelerator is released.

It was also discovered that there are enhancements available to augment standard signaling and safety systems that may accomplish the same purpose as a deceleration warning system. These enhancements include fast-rise brake lamps, which shorten the time it takes for brake lights to reach effective luminescence, and conspicuity treatments, which use reflectorized materials to make trucks more conspicuous.

Statistical analysis of the extent of the problem that deceleration warning systems on trucks propose to cure (i.e., car-into-truck rear-end collisions) yielded an estimate of the costs to the Commonwealth in terms of crashes and lives lost that amounted to 1,000 crashes and more than 20 deaths each year. This suggests that car-into-truck rear-end collisions are not the most serious highway safety problem in the Commonwealth but are a problem that is certainly worth thinking about.

Motor vehicle safety equipment is heavily regulated under both federal and state law. This is an important consideration for both the question of desirability and the question of appropriate standards. Deceleration warning systems are not explicitly covered by federal regulation, which leaves it to the states to regulate and establish standards for their use. The states are, however, constrained by the federal requirement that supplementary lighting equipment not impair the effectiveness of federally mandated lighting equipment. The National Highway Traffic Safety Administration (NHTSA) has interpreted that requirement to mean that Virginia could permit the use of deceleration warning systems so long as the signal lamps used are red or amber and operate in a steady burning mode. The Federal Highway Administration (FHWA) has added a prohibition against amber signals on the rear of commercial vehicles.

Virginia law states that unless a lighting device is required by federal law or required or permitted in the Code of Virginia it must be approved before use by the Superintendent of State Police. The Superintendent is required, before approving the use of a lighting device, to see that the device complies with recognized testing standards. No recognized standard for deceleration warning lights exists, which forces the developers of deceleration warning systems either to go outside the Commonwealth to develop their systems and generate information that could serve as a basis for appropriate, recognized standards or to seek tacit approval for their systems in the Code of Virginia. There is little doubt that highway safety in Virginia is benefitted by the requirement that all lighting devices on motor vehicles comply with recognized standards. Unfortunately, Virginia loses inasmuch as there is currently no mechanism providing for the Commonwealth's involvement in the development and revision of those standards.

Seven other states make reference to deceleration warning systems in their regulations or codes. California and Washington are the states that have gone to the greatest effort, including in their regulations technical standards for the systems they have allowed. Even though allowable under the laws of these states, deceleration warning systems have failed to achieve even nominal use. And, at this point, many of the state regulations are in conflict with positions recently adopted by NHTSA and FHWA.

The second question posed by the General Assembly, whether it would be desirable to allow the use of deceleration lights on trucks, is more tenuous than the first. Relying on past studies and the observations of motor vehicle safety researchers and administrators, a compilation of the factors weighing in the consideration of desirability has been constructed. These factors include the need for signaling systems to deliver a familiar, consistent message and to do so without generating ambiguous or false signals. Systems must also comply with legal barriers intended to protect the effectiveness of required lighting and signaling systems. Systems should not be prone to problems in installation and adjustment that would alter the nature of the signals they deliver. And finally, systems should be uniform in the message they deliver, which emphasizes the need for recognized standards and suggests the need to avoid having a great variety of systems in use.

Because this study specifically addresses the desirability of allowing deceleration lights on trucks, as opposed to all vehicles, it was important to consider the ways in which trucks are particularly desirable or undesirable vehicles for the use of such lights. It is apparent that trucks are more likely than a passenger vehicle to obstruct the view of a following motorist of the traffic ahead. Trucks give fewer cues of the severity of their braking than a passenger vehicle. And the lighting systems on the rear of trucks, in particular straight trucks, are in many cases substantially inferior to what is typical on passenger vehicles. These factors argue that trucks are a relatively desirable platform for deceleration lights.

Alternatively, performance differences between trucks and passenger vehicles suggest that car-into-truck rear-end collisions are principally a product of human error and may not be solved by additional signals on trucks. Trucks are also working vehicles, and the wide-ranging differences in configuration among trucks may complicate the need for uniformity in mounting and placement of signal lamps. A great number of trucks are engaged in interstate commerce, and systems approved for use in Virginia may be illegal in other states. Finally, the FHWA position on amber lamps on the rear of commercial vehicles limits most trucks to using red lamps as deceleration warning signals. These considerations undermine the desirability of allowing deceleration lights specifically on trucks to a great extent.

Accelerator position signals (APS), including the Lariscy system, were analyzed according to the factors noted above and were found, despite their intuitive merit, to be undesirable. Prior studies have shown that APSs will not consistently convey useful information to a following motorist and that, in fact, when they do convey useful information the following motorist is likely to be unresponsive to that information as a result of the false or meaningless signals that have previously been given. One study suggested that APSs tend to create visual noise that could lead to disturbances in traffic flow. The APSs may also pull the concentration of the following motorist away from the leading vehicle's brake lights. Refinements have been made to APS systems to reduce their propensity to generate false signals, but in certain cases these refinements eliminate a greater part of the systems' usefulness. In the end, APSs are not a desirable type of deceleration warning light to allow for use on trucks in the Commonwealth.

Enhanced brake signaling (EBS) systems and true deceleration signaling (TDS) systems, although they avoid the false signals given by APSs, are similarly undesirable. These systems communicate the severity of a vehicle's deceleration based on one of two reliable indicators: braking force or actual deceleration. These systems were tested, with what appeared to be great success, in a study conducted in California in the early 1970s using a fleet of taxicabs. The results of this study are called into question, however, by concerns on the part of the California Highway Patrol that the reduction in collisions may not in fact have been due to the enhanced signal on the cabs but instead to the excessive brightness of the signal, and by a later study that showed identical results for vehicles using enhanced signals and vehicles using standard signals. The evidence in favor of EBS and TDS systems, therefore, is not convincing. The usefulness of EBS and TDS systems is further called into doubt by the evidence from prior studies that most car-into-truck rear-end collisions occur not in emergency braking situations, where an enhanced signal might be useful, but in situations where a truck is moving slowly or is stopped in traffic. And flashing signals, on which many of these systems rely, are not allowable under NHTSA's recent interpretation of the relevant federal regulations.

Jake Brake lights and other deceleration warning systems that indicate to the following motorist that an alternative form of braking is being employed by the leading vehicle are desirable. Jake Brakes are widely used by operators of large diesel trucks and may in some instances supplant friction brakes as the primary means of braking used by truck drivers. These types of systems are allowable under NHTSA's recent interpretation of the relevant federal regulations and suggest few problems in terms of false signals or inconsistent messages. Instead, they would provide a useful signal that a braking device is engaged and the driver intends to decelerate the vehicle.

ABLDs face both the false signal problems of the APS systems, and the limited usefulness of EBS and TDS systems, and are therefore undesirable. The study that was conducted of an ABLD suggested that the system was susceptible to adjustment problems, and these devices may, in any case, be prohibited by NHTSA's position on flashing lights.

Fast-rise brake lamps are in themselves not a deceleration warning system, but a potential enhancement to existing brake light systems. As such, they seem desirable. In shortening the time it takes for brake lamps to reach effective luminescence, they would not alter the existing signal but instead would get it there faster. The value of that improvement in terms of crashes prevented and lives saved is unknown. But fast-rise brake lamps certainly deserve further investigation.

NHTSA has been active in adopting or revising federal regulations over the last 10 to 15 years in ways that bear directly on the desirability of any action Virginia might take with respect to deceleration lights on trucks. The agency has addressed the same problem addressed by this study in three important ways: (1) by revising the regulations concerning rear underride guards on truck trailers, (2) by adopting new rules relating to conspicuity treatments on trucks, and (3) by requiring the use of center high-mounted stoplamps (CHMSL) on passenger vehicles and light trucks. Each of these actions suggests that as a result there is less for the states to do, and over time there should be less of a problem. With particular regard to the CHMSL, NHTSA's success with that device has lessened the chances that deceleration warning signals will ever be allowable on passenger vehicles or light trucks.

The one implication that arises from this that encourages state action is the fact that it takes an immense amount of time, and often the support of the states, to accommodate innovation in motor vehicle safety equipment at the federal level. It is for that reason that this study, in answering the General Assembly's third question, what are the appropriate standards that should govern the use of deceleration warning lights, has developed two proposals that would go hand-in-hand in creating a mechanism for state involvement in standard setting and innovation for motor vehicle safety equipment. The first of those proposals suggests that Virginia should work together with other states to reestablish and fund the Vehicle Equipment Safety Commission (VESC) as a standard-setting organization for items of motor vehicle safety equipment that fall into the "no-man's land" outside of the federal motor vehicle safety standards. The second proposal suggests that Virginia should consider adding a provision to the Code of Virginia that would allow for experimental testing of motor vehicle safety equipment on the highways of the Commonwealth through a permit system administered by the State Police.

These recommendations are intended both to answer the questions put by the General Assembly and to suggest means by which the Commonwealth might accomplish the dual goals of providing for innovation in the future while maintaining highway safety today.

FINAL REPORT

DECELERATION LIGHTS ON TRUCKS

A REPORT TO THE GOVERNOR AND GENERAL ASSEMBLY OF VIRGINIA IN RESPONSE TO SENATE JOINT RESOLUTION NO. 247, 1993 LEGISLATIVE SESSION

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INTRODUCTION

The people of Virginia spend countless hours each year plying the streets and highways of the Commonwealth in pursuit of business, education, and recreation. Vehicles that are vastly different in shape and size share the road in a daily ritual of the motoring age, taking us to work, to school, and to play. And they do so with relatively few mishaps.

When collisions do occur, there is a tendency to write them off to human failure. Drivers are seen as the weak link in an otherwise reliable machine. In fact, the great majority of accidents can be identified as a product of human error, whether it be inattention, impairment, recklessness, or misperception. Mechanical failures, on the other hand, are rare.

The problem of motor vehicle collisions is not quite that simple, however; the mechanical and human factors that combine to create traffic accidents are inseparably intertwined. Motor vehicle safety is a product not merely of error-free driving but also of humans interacting with machines in such a way that the risk of human failure is reduced, or at least its consequences are minimized.

Innovations developed by motor vehicle researchers and manufacturers have significantly improved the capacity of vehicles to protect their occupants from harm in the event of a collision. Nowhere has the push for innovation come from more diverse sectors than where motor vehicle lighting and signaling systems are concerned. Some of the most novel ideas have arisen not from scientific research or vehicle engineering, but from the everyday experiences of ordinary motorists who conceive of a new and potentially better way for vehicles to communicate through lights and signals. Some of the most interesting ideas seem to reappear every few years in a new configuration or under a slightly different name. And yet, vehicle lighting systems have remained fundamentally unchanged since before the midpoint of this century.

PURPOSE AND SCOPE

This study addresses three questions put by the Virginia General Assembly in SJR 247 (Appendix A) with respect to deceleration warning systems:

1. What types of deceleration lights currently exist?

2. How desirable would it be to allow the use of deceleration lights on trucks in the Commonwealth?[1]

3. What are the appropriate standards that should govern their use?

Deceleration warning systems have been around for many years and have existed in numerous forms. The different forms taken share a similar purpose: alerting following motorists to the deceleration of a leading vehicle and potentially providing a pre-brake or enhanced brake signal in emergency situations. This study answers the question of what currently exists by discussing both systems that are currently available for purchase, which are very few, and systems that exist only conceptually at this point, whether they represent past attempts at innovation or ideas for the future.

Desirability is a more complicated issue. At its base, the desirability of allowing deceleration lights on trucks rests on two factors: (1) the extent of the problem that deceleration warning systems propose to solve, and (2) the demonstrated or estimable effectiveness of those systems at actually solving the problem. Because the General Assembly is concerned with allowing, as opposed to mandating, deceleration lights, cost-benefit analysis in terms of dollars spent on systems versus dollars saved as a result of their use is something that may comfortably be left to the market for such systems and thus is not addressed herein. Of greater concern to the Commonwealth is the question of whether these systems offer a net safety benefit that would justify their use. Accordingly, that was the critical analysis engaged in by this study.

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1. This study focuses on medium and heavy trucks, which are defined by the National Highway Traffic Safety Administration to mean "motor vehicle[s] with a gross vehicle weight rating (GVWR) greater than 10,000 pounds (buses, motor homes, and farm and construction equipment other than trucks are excluded)." National Highway Traffic Safety Administration. *Summary of Medium & Heavy Truck Crashes in 1990.* Report No. DOT-HS-807-953, Washington, D.C., 1993, p. 55. Nevertheless, there is reason to believe that most of the conclusions reached in this study would prove equally applicable to automobiles and light trucks.

In fact, the second and third questions, desirability and appropriate standards, are so closely tied together that they must be answered concurrently. The ability of a state to adopt appropriate standards governing the use of deceleration lights is essential to their desirability, and issues such as federal preemption and the overarching desire to achieve uniformity among states complicate any attempt by a state to be pioneering in a particular area of motor vehicle safety equipment.

The question of appropriate standards necessitated extensive research into the intersection of state and federal law regulating motor vehicle safety equipment. One of the more interesting questions raised by this study was the role that is left to the states in this area under the pervasive framework of federal regulation that currently exists. The National Highway Traffic Safety Administration (NHTSA) has been active in revising the federal standards to achieve greater safety, particularly where lights and signals on motor vehicles are concerned. Even so, gray areas seem to exist where the federal rules are either inapplicable or unenforced, and where well-conceived state action may hold substantial promise for enhancing highway safety.

The Commonwealth of Virginia has long taken an active role in promoting highway and motor vehicle safety. Prior to the enactment of the National Traffic and Motor Vehicle Safety Act of 1966, the juncture at which the federal government assumed the lead in the regulation of motor vehicle safety equipment, Virginia was prominent among the states in the nationwide effort to establish uniform and effective motor vehicle safety standards. It seemed appropriate, therefore, to consider what role the Commonwealth can continue to play in establishing appropriate standards not only for deceleration lights but for all forms of motor vehicle safety equipment.

METHODS

The following steps were taken in an effort to answer the questions put by the General Assembly.

1. *A steering committee was assembled to help direct the research effort and to assist in defining issues of concern to motor vehicle administrators, innovators, owners, and operators.* This committee included representatives of each of the agencies named in SJR 247 and representatives of the trucking industry, truck drivers, and the American Association of Motor Vehicle Administrators.

2. *An extensive survey of the technical literature on deceleration warning systems and motor vehicle signaling systems was conducted to discover what types of deceleration warning systems currently exist and what effectiveness such systems have demonstrated in the past.* A number of libraries and elec-

tronic databases, including the U.S. patent files, were searched as a part of this effort. A visit was made to Harris Brothers Enterprises, Inc., the Woolwine, Virginia, company that has sought approval for the marketing of Mr. Lariscy's patented system, in order to observe the operation of that particular system first hand.

3. *Analysis was made of the extent of the problem that deceleration warning systems on trucks propose to cure.* This step involved the collection and analysis of both state and national crash statistics. The analysis also involved research into the literature concerning truck crashes. From the collected information, statistics were approximated in order to provide a best guess estimate of the number of crashes annually that are relevant to deceleration warning systems on trucks in Virginia.

4. *Research was conducted into state and federal law regulating motor vehicle safety equipment* to determine (1) what sorts of deceleration warning systems are allowable under the current regulatory framework, and (2) whether appropriate standards could be adopted to ensure that deceleration warning systems would complement, rather than detract from, the effectiveness of currently mandated systems. This research involved not only reference to published codes and regulations, but also the seeking of interpretive opinions and conversations with individuals from the governing agencies concerning points of the law that were unclear.

5. *Careful analysis was made of the information assembled through the prior steps to assess the desirability of allowing the use of each type of deceleration warning system on trucks in the Commonwealth.*

6. *Further analysis of the assembled information was made to discover what constraints on Virginia's ability to adopt appropriate standards exist relating to deceleration warning systems and other items of aftermarket motor vehicle safety equipment.* Recommendations were then formulated in an effort to suggest a means for overcoming some of those limitations.

RESULTS

Types of Deceleration Warning Systems That Currently Exist[2]

Deceleration warning systems have been around as a concept for many years. Brake lights, of course, have long been standard equipment on every motor vehicle and trailer. For nearly as long, inventors and motor vehicle equipment manufacturers have been suggesting improvements to the simple system

2. For purposes of this study, "currently exists" is defined to include systems that are both currently available for purchase, which are very few, and that exist only conceptually at this point, whether they represent past attempts at innovation or ideas for the future.

of rear signaling that brake lights offer. Listed here are some of the numerous paths their ideas have taken. Similar concepts are grouped together and presented without comment as to their legality, demonstrated effectiveness, or overall desirability.

Accelerator Position Signals

The first and most commonly revisited type of deceleration warning system is the accelerator position signal (APS). As early as 1948, the U.S. Patent Office had issued a patent on a "signal control adapted to be operated by a portion of a motor vehicle fuel feeding control."[3] The theory behind this and other APSs is that by indicating to the following motorist that the driver of the leading vehicle has lifted his or her foot from the accelerator, the motorist will be better able to anticipate and respond to subsequent deceleration by the leading vehicle. Proponents of such devices claim that this extra margin of anticipatory warning, even if amounting to only a split second, could be particularly helpful in preventing rear-end collisions in emergency situations where the leading driver is moving quickly from the accelerator to the brake.

Most applications of the APS concept have used a lamp or lamps on the rear of the vehicle to signal the release of the accelerator to the following motorist. The use of existing and supplementary lighting equipment has been a matter of creativity, however. One early design simply energized the brake lights whenever the throttle was released.[4] Another substituted a yellow bulb for the original equipment's white bulb in the backup lamp and used that lamp as an APS.[5] Deceleration warning systems have almost always originated as applications for use on automobiles, often with auxiliary lamps centrally mounted between the brake lights or directly in front of the rear window glass. With the exception of Mr. Lariscy, few inventors have adapted their ideas specifically to straight trucks or tractor-trailers. The application of existing deceleration warning systems to trucks seems mechanically feasible but is complicated by the great variety of rear-end configurations that exist among working vehicles, which includes most medium and heavy trucks.

APSs have appeared in many forms over the years. One of the simplest versions is that represented by Mr. Lariscy's patented "Deceleration Warning Light."[6] The system currently available from Mr. Lariscy and his associates consists of a switching mechanism that is positioned in relation to a truck's throttle linkage such that when the accelerator is not depressed the switch is closed, allowing current to run to a pair of 3-inch x 8-inch steady burning amber lamps mounted on the rear of the truck. This system is designed so that

3. U.S. Patent No. 2,452,762 (November 2, 1948).
4. U.S. Patent No. 3,411,134 (November 12, 1968).
5. Denial of Petition for Rulemaking, 50 Fed. Reg. 11,212 (1985).
6. U.S. Patent No. 4,924,207 (May 8, 1990).

the deceleration warning lamps are lit any time the driver's foot is off the accelerator.

Other versions of the APS work in much the same way but provide additional features that limit the situations where the signal is lit. These concepts include systems, often referred to as coasting lights, that switch off the deceleration lights when the brake lights are energized. One patented system includes a second switch operated by the clutch pedal in order to prevent the warning lamp from being illuminated "each time the clutch is operated during a gear change."[7] More recent developments in computer technology have made feasible any number of variations on this theme. One concept that has been suggested is a speed-sensitive deceleration warning system that operates only when the vehicle is traveling above a specified speed.[8] And as early as 1973, radar and "infra-red sensing units" were being suggested as promising technologies for application to deceleration warning systems.[9] If the proper impetus existed, it would not be unrealistic to anticipate the future development of systems that would be sensitive to road or traffic conditions or that could interact with intelligent vehicle highway systems.

One recurring variation on the APS theme is the green to yellow to red signal, green indicating acceleration (accelerator depressed), yellow indicating coasting (neither pedal depressed), and red indicating braking. This concept has been tested both in laboratory studies and on city buses in Portland, Oregon; Seattle, Washington; and Washington, D.C. Experimental use of these types of signals has been made in a traffic light—like configuration.[10] In the studies using city buses, a green lamp was mounted between two amber lamps near the vertical centerline of the vehicles, with the standard brake lights providing the braking signal.

Enhanced Brake Signaling and True Deceleration Signaling Systems

The second major category of deceleration warning systems includes enhanced brake signaling (EBS) and true deceleration signaling (TDS) systems. EBS systems represent attempts at communicating to the following motorist the severity of a leading vehicle's braking, and thus the rate at which it is decelerating. With traditional, steady-burning brake lights, a following motorist's only clues as to the severity of a leading vehicle's braking are the observed changes in the rate of closure with the vehicle and the forward-leaning dip the vehicle makes as its brakes are applied. One researcher pointed out that with big

7. U.S. Patent No. 3,414,879 (December 3, 1968).

8. Denial of Petition for Rulemaking, 50 Fed. Reg. 11,212 (1985).

9. California Highway Patrol. Business & Transportation Agency. 1973. *Report to the Legislature of the State of California: Deceleration Signal System Study (as required by AB 1260, 1972 Legislative Session)*. Sacramento (commonly referred to as the "Cyberlite report").

10. Mortimer, R. G., and Sturgis, S. P. 1975. *Evaluations of Automobile Rear Lighting and Signaling Systems in Driving Simulator and Road Tests.* Report No. UM-HRSI-HF-72-12. Ann Arbor: University of Michigan Transportation Research Institute.

trucks, that telltale dip is not present as a signal.[11] EBS systems monitor pressure in the braking system or brake pedal position and adjust their signals to the following motorist accordingly.

TDS systems are similar to EBS systems except that instead of regulating their signals according to braking force or pedal position, they react to actual deceleration force. A number of means have been used to measure and respond to deceleration, and these vary considerably in cost and sophistication. The first and costliest of these is the accelerometer. Modern accelerometers using piezoelectric devices are capable of taking accurate measurements of deceleration.[12] Combined with sophisticated computer technologies, accelerometers theoretically could form the basis for complex and finely tuned deceleration signaling systems. Tilt switches and acceleration sensing switches represent simpler and less expensive options.[13] Unlike accelerometers, these devices are not capable of measuring deceleration. Instead, they can be designed to switch on or off at a predetermined threshold level of deceleration and likely would be more than accurate enough for most TDS systems.

Most of the prior research with respect to EBS and TDS systems has involved systems that used variable rate flashing amber lights to signal deceleration, with flash rates increasing exponentially with brake pressure or deceleration force. One such system, called the Cyberlite, went through extensive testing on taxicabs in San Francisco and Sacramento, California.[14] In fact, systems using variable rate flashing lights have been tested in a variety of forms, reflecting a diversity of opinion on issues such as flash rates, colors, and lamp configuration.

An alternative means of signaling for EBS or TDS systems is a row or bar of lights running across the back of a motor vehicle, with the number of illuminated lights varying according to brake pressure or deceleration force. One such system involved a bar of red lights across the rear of a vehicle, with the two outermost lamps lit at all times, and a progressively greater number of lamps lighting in a pattern that worked toward the center as braking force increased.

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11. Voevodsky, J. 1974. *Rear-End Collisions Reduced: A Large-Scale Experiment Under Natural Conditions.* Paper read at the West Coast Meeting of the Society of Automotive Engineers, August 12-16, Anaheim, California, p. 2.

12. Piezoelectric devices operate through the use of a beam of piezoelectric metal, cantilevered from a fixed point, that when subjected to acceleration forces will bend. As the beam bends, voltage is generated, and by measuring the voltage generated, accurate measurements of the acceleration forces acting on the beam can be calculated.

13. Tilt switches consist of a saucer-shaped bowl of electrical contacts with a contact ball of mercury inside; they can monitor acceleration along a number of axes. Acceleration sensing switches consist of a contact or contacts along an axis and a second contact moving against resistance along that axis.

14. California Highway Patrol, *supra* note 9.

Proponents of EBS and TDS systems have argued that by observing changes in brightness, flash rate, or the number of lamps illuminated, the following motorist is better able to differentiate between normal and emergency braking situations. More important, they hope that the following motorist's natural response to such changes in intensity or pattern will be the response necessary to avoid a rear-end collision.

A third category of deceleration warning systems includes those concepts that involve deceleration-inducing systems in addition to traditional friction brakes. Friction brakes are not likely to be outmoded soon, but many new concepts for vehicle braking exist and a few are finding increasing usage.

One such system, technically a compression retarder but commonly referred to as a Jake Brake, is currently in use on about 50% of all diesel-powered trucks east of the Mississippi and 85% to 90% of the diesel trucks west of the Mississippi.[15] Invented by Clessy Cummins in the 1950s, compression retarders work by retiming the opening of the exhaust valves on a diesel engine, which causes the engine to operate as an air pump and slows the truck through the driveline. Compression retarders have proven to be an effective means of slowing heavy diesel trucks, or enabling them to maintain a constant speed on downward grades, without the use of the truck's friction brakes. And yet, within the current scheme of rear signaling, no signal is given to the following motorist that a Jake Brake is being used.

In 1955, the Jacobs Company marketed a switch that provided for the brake lights to be lit any time a truck's Jake Brake was in service.[16] Jacobs no longer offers such a switch, but systems of this type continue to be suggested as a potential enhancement to the safe operation of big trucks.

Deceleration-inducing devices similar to compression retarders have been tried on gasoline engines, but these devices (referred to as exhaust retarders) are substantially less effective at slowing a vehicle than a Jake Brake. However, a number of promising alternatives exist, either as operating systems or in developmental stages. Prominent among these are electromagnetic braking systems and hydraulic energy recovery brakes. Each of these systems operates as a brake on the driveline of a vehicle and can generate significant deceleration forces in the absence of friction braking. An additional idea that is likely to become more important as electric vehicles become more common on our highways are systems that take the kinetic energy of a vehicle in motion and use that energy to generate storable electric power. For efficiency reasons, electric

15. From a telephone conversation with Edward Purcell of Truck Parts East in Charlottesville, Virginia, a distributor for the Jacobs Company, a manufacturer of compression retarders (and source of the name "Jake Brake"), in Virginia, West Virginia, and North Carolina, in September of 1993.

16. This switch was referred to in company literature as "Stop Light Control Kit, Group 2012," and is described in Jacobs Company Service Letter #56, dated June 3, 1955.

vehicle manufacturers are likely to derive as much braking as possible from this generating process while leaving little braking activity to wasteful friction braking.

The problems unconventional braking systems pose for vehicle signaling are mostly due to the fact that they do not fit into the conventional signaling system. Allowances need to be made for technological development in alternative braking systems. And when alternative braking systems are capable of generating substantial braking forces, it seems appropriate to provide some indication of their operation to the following motorist.

Advance Braking Light Devices

The final type of deceleration warning system addressed by this study has been called both a pre-brake signal and an advance braking light device (ABLD).[17] This concept seems to be a refinement of the APS, where, instead of lighting because the accelerator is released, the signal lights because of the speed at which the accelerator is released. Pre-brake signals use a treadle to gauge the speed at which the accelerator on a vehicle is released. Then, if that speed exceeds a certain value, the system operates to flash the brake lamps. The theory behind pre-brake signals is that in cases where the accelerator is released at a greater than normal rate, hard braking is likely to follow. By energizing the brake lights in those situations at the moment the accelerator is released, inventors have tried to capture the time lapse between the release of the accelerator and the application of the brakes.

Lighting or Signaling Systems

To complete the picture, it seems appropriate to take note of lighting or signaling systems that may offer viable alternatives to deceleration warning systems.

One recent study has suggested that safety could be enhanced within the existing system of rear signaling through the use of a fast-rise brake lamp system. In that study, the observation was made that with a standard brake signaling system, there is a measurable delay between the application of the brakes and the time the brake lamps reach 90% of full luminescence.[18] Using a patented fast-rise vehicle stop lamp system to eliminate a portion of that delay,[19] the authors suggested that reaction times to vehicle braking could be

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17. Olson, P. 1988. *An Evaluation of the Advance Braking Light Device.* Report No. UMTRI-88-21, Ann Arbor: University of Michigan Transportation Research Institute.

18. Sivak, M., and Flannagan, M. 1993. *Fast-Rise Brake Lamp as a Collision-Prevention Device.* Report No. UMTRI-93-5, Ann Arbor: University of Michigan Transportation Research Institute. Conventional tungsten-filament brake lamps take approximately 0.250 second to reach 90% of asymptotic luminous intensity.

19. Flannagan, M., and Sivak, M. 1988. *Vehicle stop lamp system* (U.S. Patent No. 4,791,399). Washington, D.C.: U.S. Patent and Trademark Office ["utilizes conventional tungsten-filament bulbs, coupled with continuous preheating of the filament at approximately 2 V (below visible) and a brief overvoltage at the time of the application of the brakes"].

significantly reduced with potential benefits in the reduction of rear-end collisions.

A number of studies have noted that the greatest number of rear-end collisions, whether involving trucks or other types of vehicles, occur when the struck vehicle is moving slowly or is stopped in traffic.[20] Crash data taken from these studies suggest that signals or markings that make slow-moving or stopped vehicles more obvious to approaching motorists might be more important than an additional signal to warn of impending deceleration. One possible solution to this problem is the addition of conspicuity treatments to the scheme of vehicle lighting and signaling. In December of 1992, NHTSA finalized a new set of regulations with respect to conspicuity treatments for medium and heavy trucks.[21] Conspicuity is enhanced under the federal rules through the use of retroreflective sheeting or reflex reflectors to outline the dimensions of a vehicle.

With NHTSA having already adopted regulations pertaining to conspicuity treatments, the question now becomes whether, in addition to passive systems such as conspicuity treatments, an active signaling system has been or might be developed that could further enhance driver awareness of slow-moving or stopped vehicles. Certainly, technology exists that could facilitate the development of electronic speed monitoring systems or enhanced slow-moving signals or position signals for vehicles.

Extent of the Problem That Deceleration Warning Systems on Trucks Propose to Cure

In 1992 there were 204,456 medium and heavy trucks registered in Virginia, comprising 4.0% of the state's total vehicle population.[22] In the same year, trucks were involved in 8,888 crashes, or 7.2% of the crashes reported in 1992. This suggests that trucks are overrepresented in traffic crashes, but the figures are somewhat deceptive. When the crash data are considered on the basis of vehicle miles traveled (VMT), straight trucks averaged 0.24 million VMT per crash in 1990, and tractor-trailers averaged 1.66 million VMT per crash, compared to 0.32 million VMT per crash during the same year for automobiles.[23]

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20. Mortimer, R. G. 1981. *Field Test Evaluation of Rear Lighting Deceleration Signals: II—Field Test.* Report No. DOT- HS-806-125. Champaign: University of Illinois; Burger et al. 1981. *Improved Commercial Vehicle Conspicuity and Signalling Systems. Task I: Accident Analysis and Functional Requirements.* Report No. DOT-HS-806-100. Santa Monica, Calif.: Vector Enterprises, Inc.

21. 57 Fed. Reg. 58,406 (1992) (to be codified at 49 C.F.R. pt. 571).

22. Virginia Department of Motor Vehicles, unpublished data, 1933.

23. The number of trucks and passenger vehicles, as well as the number of crashes, was taken from the Virginia Department of Motor Vehicles's *1990 Virginia Traffic Crash Facts.* The average annual vehicle miles of travel figures used to calculate VMT for each vehicle type were taken from the National Highway Traffic Safety Administration's *Summary of Medium & Heavy Truck Crashes in 1990*; 1990 was chosen as an example because it is the last year for which complete state and federal data are available.

These differences in crash rates can be attributed to several factors. Specifically, trucks are markedly different from automobiles both in performance and in their ordinary use. Straight trucks, for example, are likely to record fewer miles of travel annually than tractor-trailers but record a greater share of those miles in relatively hazardous urban traffic. Tractor-trailers are likely to cover a significantly greater number of miles but record most of that mileage on rural interstates. Automobiles, meanwhile, vary greatly in usage but on average are more likely to split their time between urban and rural travel. Also, many crashes may be attributable to the performance limitations of trucks as compared to automobiles. Performance limitations may be offset, however, by the fact that trucks are often in the hands of experienced, professional drivers.

The experience of the Commonwealth in terms of crashes involving medium and heavy trucks for the past 5 years is summarized in Table 1. The figures show an encouraging trend: a 38% reduction in truck crashes from 1988 to 1992 while the number of trucks registered in the Commonwealth stayed about the same.[24] In 1992, there were 5,340 fewer truck crashes than in 1988; 87.6% of the change was attributable to a decline in the number of straight truck-crashes and 12.4% of the change was attributable to a decline in the number of tractor-trailer crashes. However, even with this recent decline, truck crashes still represent a substantial human and economic loss to the Commonwealth each year.

One thing that is known both intuitively and empirically is that when a crash involves a truck, that crash is more likely to result in a fatality than a collision between passenger vehicles. National figures from 1990 show that trucks comprised 8% of all vehicles involved in fatal crashes but only 2% to 3% of the vehicles in injury and property-damage-only crashes.[25] Virginia's recent experience is even more striking. From 1988 through 1992, the rate at which trucks were involved in fatal crashes hovered between 13% and 16%. These figures make intuitive sense considering the impact that size and weight disparity have on the dynamics of a crash. If nothing else, they suggest that although trucks may not be any more likely to be involved in a crash on a per mile basis, the severity of crashes involving big trucks warrants special consideration.

The data in Table 1 also reflect an additional disparity, the nearly 5 to 1 ratio of fatalities suffered by nontruck occupants to fatalities suffered by truck occupants. Once again, the dangers posed by trucks seem to be inherent to their size and weight, factors that offer safety advantages to truck occupants while creating a hazard for other motorists.

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24. Virginia Department of Motor Vehicles. 1986 (fiscal year). *Truck Trailer Survey*. Richmond; Virginia Department of Motor Vehicles. 1992 (fiscal year). *Truck Trailer Survey*. Richmond.

25. National Highway Traffic Safety Administration, *Summary of Medium & Heavy Truck Crashes in 1990*, p. 6.

Table 1. Crashes Involving Trucks in Virginia, 1988-1992, by Truck Type, Number of Fatalities, and Number of Non-Truck Occupant Fatalities

Year	Straight Trucks	Tractor-Trailers	Totals
1992			
Total Crashes	5,514	3,374	8,888
Fatalities	57	79	136
Non-Truck Occupant Fatalities	51	64	115
1991			
Total Crashes	6,098	3,236	9,334
Fatalities	61	65	126
Non-Truck Occupant Fatalities	50	53	103
1990			
Total Crashes	8,107	3,444	11,551
Fatalities	70	94	164
Non-Truck Occupant Fatalities	58	73	131
1989			
Total Crashes	9,568	3,836	13,404
Fatalities	73	68	141
Non-Truck Occupant Fatalities	56	54	110
1988			
Total Crashes	10,193	4,035	14,228
Fatalities	63	101	164
Non-Truck Occupant Fatalities	48	87	135

Source: Virginia Department of Motor Vehicles, *Virginia Traffic Crash Facts*, 1988-1992. Richmond.

Steps have been taken to reduce the hazards particular to the size and configuration of trucks. Federal regulations mandate the use of rear underride guards and were recently revised to include standards pertaining to conspicuity treatments for trucks.[26] This study addresses a more specific problem, that is, whether enhancements to the mandatory rear signaling systems on trucks could further reduce the number of truck-related crashes. Counting the number of crashes involving trucks is a straightforward task. Using crash data to estimate the number of situations where a deceleration warning system might have been able to save a life, or prevent injuries or property damage, is substantially more complicated.

One way to attack the problem is to separate the crash data for trucks into narrower categories: first, by looking for the subset of collisions where trucks have been rear-ended, and beyond that for the situations where a crash might have been averted if the following motorist had been better informed of the leading truck's position or deceleration. Unfortunately, no state or national

26. Supplementary Notice of Proposed Rulemaking, 57 Fed. Reg. 252 (1992); 57 Fed. Reg. 58,406 (1992) (to be codified at 49 C.F.R. pt. 571).

collection of crash data maintains the level of specificity necessary for this sort of analysis. Working from the statistics that are available, and relying on prior studies of rear-end collisions involving trucks, the relevant figures for Virginia were developed as approximations.

Table 2 summarizes the national statistics for multivehicle crashes according to vehicle type and crash severity. From 1988 through 1990, national truck crash statistics show that as a percentage of all truck crashes property damage crashes declined from 71.9% to 68.0%, personal injury crashes increased from 26.6% to 30.5%, and fatal crashes remained constant at 1.5%. Over the same 3 years, there has been little change in the percentages of passenger vehicle property damage crashes (68.8% to 68.4%) and personal injury crashes (30.8% to 31.3%) and no change in the percentage of fatal crashes. These data show the similarity in the percentage of truck and passenger vehicle crashes that resulted in property damage and personal injury, especially in 1990. The data also show the greater proclivity for truck crashes to result in a fatality, with a fatality occurring in 1.5% of all truck crashes, but in only about 0.3% of passenger vehicle crashes.

Table 2. Multivehicle Crashes by Vehicle Type and Crash Severity for All States

Year	Fatal	Injury	Property Damage Only	Total
No. of Trucks[a]				
1990	3,471	70,000	156,000	~229,500
% of total	1.5%	30.5%	68.0%	100%
1989	3,539	69,000	168,500	~241,000
% of total	1.5%	28.6%	69.9%	100%
1988	3,712	65,000	175,500	~244,000
% of total	1.5%	26.6%	71.9%	100%
No. of PV[b]				
1990	15,058	1,348,500	2,945,000	~4,308,500
% of total	0.3%	31.3%	68.4%	100%
1989	15,623	1,360,000	3,003,000	~4,378,500
% of total	0.4%	31.1%	68.6%	100%
1988	15,901	1,406,000	3,137,000	~4,559,000
% of total	0.3%	30.8%	68.8%	100%

[a]Trucks = medium and heavy trucks.
[b]PV = passenger vehicles.

Sources: National Highway Traffic Safety Administration, *Summary of Medium & Heavy Truck Crashes in 1990*, *Summary of Medium & Heavy Truck Crashes in 1989*, and *A Summary of Fatal and Nonfatal Crashes Involving Medium and Heavy Trucks in 1988*, Washington, D.C.

Table 3. Rear-End Collisions as a Percentage of Total Collisions by Vehicle Type and Crash Severity for all States

Year	% of Fatal Crashes	% of Injury Crashes	% of Property-Damage-Only Crashes
Trucks[a]			
1990	22%	35%	25%
1989	22%	38%	30%
1988	23%	40%	29%
1988-1990 Average	22.3%	37.7%	28%
PV[b]			
1990	12%	38%	34%
1989	11%	38%	36%
1988	11%	38%	35%
1988-1990 Average	11.3%	38%	35%

[a]Trucks = medium and heavy trucks.
[b]PV = passenger vehicles.

Sources: National Highway Traffic Safety Administration, *Summary of Medium & Heavy Truck Crashes in 1990, Summary of Medium & Heavy Truck Crashes in 1989*, and *A Summary of Fatal and Nonfatal Crashes Involving Medium and Heavy Trucks in 1988.* Washington, D.C.

The data in Table 3 show rear-end collisions as a percentage of total collisions by crash severity for 1988 through 1990. A 3-year average has also been computed. For trucks, the percentage of property damage crashes has varied from 25.0% (1990) to 30.0% (1989) and personal injury crashes have varied from 35.0% (1990) to 40% (1988), while fatal crashes have remained stable at 22.0%/23.0%. For passenger vehicles, the property damage (34.0% to 36.0%), personal injury (38.0%), and fatal crash rates (11.0% to 12.0%) have been remarkably stable over these 3 years. When the 3-year average is considered, trucks have a lower property damage rate (28.0% v. 35.0%), nearly the same personal injury rate (38.0%), and a significantly higher fatal crash rate (23.3% v. 11.3%).

One question raised over the course of this study was whether it is more likely that a truck will rear-end a car than a car will rear-end a truck. Passenger vehicles offer braking and handling performance superior to that of medium and heavy trucks. The question suggests that it might be more useful to have a deceleration warning signal on automobiles than on trucks. In fact, this suspicion is at least partially correct.

The data in Table 4 show the national number of rear-end collisions according to crash severity, vehicle type, and vehicle role. When the 3-year average is considered on the basis of the striking and struck vehicle, the data show that the truck was the striking vehicle in 64.0% of all crashes and 68.0% of the property damage, 56.7% of the personal injury, and 24.3% of the fatal

Table 4. Rear-End Collisions Involving Trucks
by Crash Severity, Vehicle Type, and Vehicle Role for All States

Year	Fatal	Injury	Property Damage Only	Total
1990				
Passenger Vehicle Striking Truck[a]	382 (76%)	8,000 (46%)	11,000 (35%)	~19,500 (40%)
Truck Striking Passenger Vehicle	122 (24%)	9,500 (54%)	20,000 (65%)	~29,500 (60%)
1989				
Passenger Vehicle Striking Truck	398 (77%)	7,000 (40%)	12,500 (32%)	20,000 (34%)
Truck Striking Passenger Vehicle	117 (23%)	10,500 (60%)	27,500 (68%)	38,000 (66%)
1988				
Passenger Vehicle Striking Truck	359 (74%)	7,500 (44%)	12,000 (29%)	20,000 (34%)
Truck Striking Passenger Vehicle	127 (26%)	9,500 (56%)	29,000 (71%)	38,500 (66%)
1988-1990 Averages				
Passenger Vehicle Striking Truck	75.7%	43.3%	32%	36%
Truck Striking Passenger Vehicle	24.3%	56.7%	68%	64%

[a]Trucks = medium and heavy trucks.

Sources: National Highway Traffic Safety Administration, *Summary of Medium & Heavy Truck Crashes in 1990, Summary of Medium & Heavy Truck Crashes in 1989*, and *A Summary of Fatal and Nonfatal Crashes Involving Medium and Heavy Trucks in 1988.* Washington, D.C.

crashes. The 3-year average data show that the passenger vehicle was the striking vehicle in 36.0% of all crashes and 32.0% of the property damage, 43.3% of the personal injury, and 75.7% of the fatal crashes. The data also show that in 1990 it was 1.5 times more likely that a truck would rear-end a passenger vehicle than a passenger vehicle would rear-end a truck. In 1988 and 1989, it was almost twice as likely that a truck would strike a passenger vehicle.[27] And yet, the number of fatalities resulting from cars rear-ending

27. The Federal Highway Administration came up with similar results in a long-term study of urban freeway accidents involving trucks. In that study, rear-end collisions accounted for 28.5% of all accidents, with 66.9% of those being truck-into-car collisions. Bowman, B., and Hummer, J. 1989. *Examination of Truck Accidents on Urban Freeways.* Report No. FHWA-RD-89-201. Southfield, Mich.: Goodell-Grivas, Inc.

trucks has consistently been 3 times as great as the number from trucks rear-ending cars. The greatest number of rear-end collisions result in property damage only, which, although costly, does not seem as significant as the loss of life suffered in the fewer number of collisions. It does seem clear that if there is any life-saving potential to the use of deceleration warning systems, the greater part of that potential would be captured by using those systems on trucks.

Table 5 provides estimates[28] of the number of rear-end collisions involving a passenger vehicle striking a truck in Virginia for the years 1988 through 1992. These figures offer a best guess at the extent of the problem deceleration warning systems propose to cure. The data show that the cost to the Commonwealth each year from car-into-truck rear-end collisions is approximately 1,000 crashes, and in excess of 20 lives. Clearly, these collisions are not the most serious highway safety problem in the Commonwealth;[29] but 1,000 crashes and more than 20 lives lost each year make it a problem that is certainly worth thinking about.

Table 5. Estimated Number of Rear-End Collisions
With a Passenger Vehicle Striking a Truck by Crash Severity in Virginia

Year	Fatal	Injury	Property Damage Only	Total
1992	23	498	482	1003
1991	21	494	522	1037
1990	28	619	640	1287
1989	23	695	753	1471
1988	28	733	804	1565

Source: *Virginia Traffic Crash Facts* for 1986-1992.

28. The figures in Table 5 are approximated from the crash rates shown in Tables 3 and 4. Averaging the figures presented in Table 3, a probability that any particular crash was a rear-end collision was assigned to each category of crashes (fatal crashes, injury crashes, and property-damage-only crashes). Of all truck crashes resulting in a fatality, 22.3% were rear-end collisions. Of all truck crashes resulting in injury or property damage only, 37.7% and 28% of those crashes, respectively, were rear-end collisions. The next step in the analysis was to compute the probability for each category of crashes that a rear-end collision was a car-into-truck rather than a truck-into-car collision. This was done by averaging the figures from Table 4. Fatal crashes were car-into-truck collisions 75.7% of the time. And injury and property-damage-only crashes were car-into-truck collisions 43.3% and 32% of the time, respectively. Applying these percentages to the data available in the *Virginia Traffic Crash Facts* for 1988-1992, the figures shown in Table 5 were derived.

29. By way of comparison, 379 persons died in alcohol-related crashes in 1992. Virginia Department of Motor Vehicles, unpublished data, 1993.

Legal Issues Pertaining to Deceleration Warning Systems and Appropriate Standards for Their Use

Federal Law

Congress first entered into the business of establishing national standards for motor vehicles and motor vehicle safety equipment under the National Traffic and Motor Vehicle Safety Act of 1966 (the "Safety Act").[30] The purpose of the Safety Act, as stated therein, was to "reduce traffic accidents and deaths and injuries to persons resulting from traffic accidents."[31] Prior to the Safety Act, the regulation of motor vehicle safety equipment had been left almost exclusively to the police powers of the various states.[32] What has developed, subsequent to the Safety Act, is a complex scheme of regulation that relies on the collective efforts of state and federal governments in both standard setting and enforcement.

Congress understood that in adopting the Safety Act it was encroaching upon what had historically been state territory and therefore took pains to clarify the preemptive effects of the Safety Act in Section 1392(d):

> Whenever a Federal motor vehicle safety standard established under this title is in effect, no State or political subdivision of a State shall have any authority either to establish, or to continue in effect, with respect to any motor vehicle or item of motor vehicle equipment any safety standard applicable to the same aspect of performance of such vehicle or item of equipment which is not identical to the Federal standard.[33]

Clearly, under Section 1392(d), federal standards control where state and federal standards conflict. Controversy arises, however, in determining whether or not standards actually conflict. It seems that the phrase "same aspect of performance" in Section 1392(d) is open to a variety of interpretations and has required the attention of the courts.

Two early cases, *Chrysler Corporation v. Rhodes* and *Chrysler Corporation v. Tofany*, set out to define the limits of federal preemption under the Safety Act

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30. 15 U.S.C. § 1381 *et seq.*

31. *Id.*

32. *Chrysler Corporation v. Rhodes*, 416 F.2d 319, 321 (1st Cir. 1969). The limits to state police powers in the regulation of motor vehicle equipment were defined, prior to the Safety Act, by the powers of Congress under the Commerce Clause of the United States Constitution. U.S. Const. art. I, § 8. One example of a conflict between these powers was the case of *Bibb v. Navajo Freight Lines, Inc.*, 359 U.S. 520 (1959), where the Supreme Court ruled that Illinois could not require contoured mudguards on trucks when such a requirement would interfere with interstate commerce.

33. 15 U.S.C. § 1392(d).

by defining the breadth of the phrase "aspect of performance."[34] These cases point out that, under Section 1391(2) of the Safety Act, federal standards are to be "minimum standard[s] for motor vehicle performance, or motor vehicle equipment performance."[35] One possible interpretation of this language suggests that a separate authority, which heretofore had belonged to the states, continues to play a role in regulating equipment that goes beyond the minimum requirements. Whether or not clearly intended by Congress, this is the result reached by the courts in their effort to accomplish the purpose of the Safety Act.

The reasoning behind the courts' decisions can be explained as follows. Federal Motor Vehicle Safety Standard No. 108 specifies requirements for "lamps, reflective devices, and associated equipment."[36] The substance of these requirements is that all new cars and trucks must come equipped with certain items of lighting equipment and that required items of equipment must conform to specified performance standards.[37] As detailed as they are, the requirements of Standard No. 108 do not extend to all categories of lighting equipment. Fog lamps, for example, are not mentioned; neither are deceleration warning systems. What the courts noticed in *Rhodes* and *Tofany* was that where Standard No. 108 fails to touch upon a particular item of motor vehicle lighting equipment, federal preemption broadly interpreted leaves no effective control over the use of such equipment.[38] Thus, if "same aspect of performance" is interpreted in its broadest sense, the danger arises that lighting equipment will be inadequately regulated and accidents may be caused by a new category of equipment that the states would be powerless to regulate.[39] Given that the purpose of the Safety Act was to reduce accidents, the courts avoided this result by holding that simply because requirements have been formulated for the most common categories of lighting equipment, that "does not mean that all other kinds of lights are covered."[40] Rather than leave certain items of motor vehicle equipment unregulated, the courts left the authority to fill in the gaps to the states,

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34. *Chrysler Corp. v. Rhodes*, 416 F.2d 319, 323 (1st Cir. 1969); *Chrysler Corp. v. Tofany*, 419 F.2d 499, 506 (2nd Cir. 1969). Both courts adopted a narrow reading of Section 1392(d)'s "aspect of performance" language, agreeing that "Superlite," an additional headlamp offered as optional equipment by Chrysler on certain of its 1969 model vehicles, was not covered by Federal Motor Vehicle Safety Standard No. 108 and therefore remained subject to state regulation.

35. *Tofany*, 419 F.2d at 505.

36. Federal Motor Vehicle Safety Standard No. 108, 49 C.F.R. _571.108 (1992).

37. *Tofany*, 419 F.2d at 506. Standard No. 108 in its current form makes reference exclusively to performance standards announced by the Society of Automotive Engineers (SAE). The SAE has adopted performance standards not only with respect to required items of motor vehicle equipment, but also with respect to many nonstandard items of equipment. However, at this point, they have not adopted a standard with respect to deceleration warning lights.

38. *Id.* at 509-10. "To hold that the mere promulgation of a general purpose sought to be achieved by a federal safety standard would preempt all state regulation in a vaguely described area would result in a 'no man's' land with respect to categories of equipment which the federal standard does not yet seek to regulate."

39. *Id.* at 506-7.

40. *Rhodes*, 416 F.2d at 323.

which, in any event, "are better situated to act promptly in this field than is the federal government under the present regulatory scheme."[41]

What, then, are the guiding principles for state regulation of nonmandatory motor vehicle equipment, and are there any preset limits to what states may allow? Section 1397(a)(2)(A) of the Safety Act offers a starting point on these questions:

> No manufacturer, distributor, dealer, or motor vehicle repair business shall knowingly render inoperative, in whole or in part, any device or element of design installed on or in a motor vehicle or item of motor vehicle equipment in compliance with an applicable Federal motor vehicle safety standard.[42]

Although not as clear as the prohibition against adopting nonidentical standards with respect to required motor vehicle equipment, this section suggests that states should refrain from adopting standards that would allow for required equipment to be rendered inoperative in any foreseeable way. This suggestion is made mandatory with respect to lighting equipment under Standard No. 108, where it provides that

> No additional lamp, reflective device or other motor vehicle equipment shall be installed that impairs the effectiveness of lighting equipment required by this standard.[43]

The test, then, is whether the nonmandatory equipment the state would allow impairs the effectiveness of other, required lighting systems.

As is the case with every federal motor vehicle safety standard, for enforcement purposes at the federal level, the manufacturer, distributor, dealer, or professional installer of the nonmandatory equipment makes the initial determination under Standard No. 108 whether effectiveness is impaired. The individual or business that is later found to have been wrong with respect to that determination is subject to the recall provisions of the Safety Act,[44] civil penalties arising under the Safety Act,[45] and any common law liability that

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41. *Tofany*, 419 F.2d at 507. The great irony of the court's decisions in these early cases is that the pervasive, though incomplete, nature of the federal regulations has subsequently led to the demise of a state institution that was designed to accomplish precisely the function reserved by the courts to the states. Before the first federal standards went into effect, a number of states, including Virginia, combined their efforts to form a nationally recognized standard-setting organization. The Vehicle Equipment Safety Commission (VESC), established by compact in 1962, was an official interstate agency empowered to recommend rules, regulations, or codes embodying performance requirements or restrictions for items of motor vehicle equipment in order to encourage the prompt adoption of uniform standards among the states.

42. 15 U.S.C. § 1397(a)(2)(A).

43. 49 C.F.R. § 571.108, S5.1.3.

44. 15 U.S.C. § 1400.

45. 15 U.S.C. § 1398.

arises out of that determination. These are, however, *ex post* cures. Many states remain silent and allow the federal rules to operate after a problem arises. Others, including Virginia, have chosen to act in an *ex ante* manner, restricting allowable motor vehicle safety equipment essentially to that which is required under the federal standards. Either way, states are bound by the language of Section 1392(d) to adopt identical standards, if any, and that provision extends to the requirement under Standard No. 108 that supplemental lamps or equipment not impair the effectiveness of required lighting equipment.

Wishing to have an official interpretation of the situations where a deceleration warning signal might impair the effectiveness of required lighting equipment, an opinion was requested from the Chief Counsel's Office of NHTSA, the federal agency responsible for the administration of the Safety Act. In its response, NHTSA stated that it has interpreted Section 5.5.10(d) of Standard No. 108 to mean that "unless otherwise provided by Section 5.5.10, all original motor vehicle lighting equipment, whether or not required by Standard No. 108, must be steady burning in use."[46] In ruling on an earlier case, NHTSA determined that the simultaneous use of flashing and steady-burning lamps is a potential source of confusion for a following motorist and is thus an impairment to the effectiveness of required lighting equipment within the meaning of Section 5.1.3. The conclusion reached by NHTSA in response to this study was that

> Virginia could permit the use of a red or amber original equipment deceleration warning system operating in a steady burning mode through either original equipment lamps or supplementary ones.[47]

Thus, within the limits described in its opinion letter, NHTSA does not suppose that a deceleration warning light will necessarily impair the effectiveness of other, federally required lighting equipment. At the same time, two points are worth noting. First, NHTSA's allowance of deceleration warning systems, so long as they meet certain conditions, does not constitute an endorsement of the idea.[48] Second, should NHTSA later decide, *ex post*, that a state-approved deceleration warning system does impair the effectiveness of required lighting equipment, its letter suggesting that Virginia could permit certain deceleration lights would be inconsequential for the developers, manufacturers, and installers of deceleration warning systems.

Through Standard No. 108, NHTSA prescribed in considerable detail the lighting equipment required on every type of motor vehicle on the nation's high-

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46. National Highway Traffic Safety Administration. Interpretive letter, dated July 30, 1993, to the Virginia Transportation Research Council.

47. *Id.*

48. In fact, NHTSA has declined to establish standards explicitly allowing for the use of deceleration warning systems. See, *e.g.*, Denial of Petition for Rulemaking, 50 Fed. Reg. 11,212 (1985).

ways. Nevertheless, because the great majority of medium and heavy trucks that are the subject of this study are commercial vehicles, Virginia must additionally look to the regulations adopted by the Federal Highway Administration (FHWA) with respect to lighting devices on commercial vehicles. Fortunately, FHWA has adopted Standard No. 108 as the law pertaining to lighting devices on commercial vehicles.[49] Unfortunately, this has not resulted in complete agreement between the agencies as to the correct interpretation of the provisions of Standard No. 108.

FHWA regulations, under Section 393, echo the Safety Act in allowing the use of additional equipment and accessories "provided such equipment and accessories do not decrease the safety of operation of the motor vehicles on which they are used."[50] FHWA adds force to the Section 393 standards by providing that "no employer shall operate a commercial motor vehicle, or cause or permit it to be operated, unless it is equipped in accordance with the requirements and specifications of this part."[51] Section 393 supports NHTSA's recent interpretation with respect to deceleration warning lamps by requiring, under Section 393.25(e), that, with specified exceptions, "all exterior lighting devices shall be of the steady-burning type."[52] On all of these issues, NHTSA and FHWA seem to be of like mind.

What has emerged as a point of disagreement is the question of what colors are permissible for deceleration warning lamps on the rear of commercial vehicles. NHTSA, in its interpretation, said that either red or amber lamps would be allowable.[53] In the same letter, NHTSA suggested that inquiry be made into the views of FHWA "to determine whether that agency's regulations affect trucks with deceleration lights."[54] Such an inquiry was made, and the response from FHWA was that, with certain exceptions not including deceleration warning lamps, the use of amber lamps on the rear of commercial vehicles is prohibited by Section 393.[55]

Clearly, this prohibition amounts to an outright disallowance of deceleration warning systems that rely on an amber signal to communicate nonbraking

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49. 49 C.F.R. § 393.11 (1992).
50. 49 C.F.R. § 393.3.
51. 49 C.F.R. § 393.1.
52. 49 C.F.R. § 393.25(e).
53. National Highway Traffic Safety Administration, *supra* note 45.
54. *Id.*
55. Federal Highway Administration. Interpretive letter, dated August 30, 1993, to the Virginia Transportation Research Council. The actual language of the letter states that "amber tailamps" are prohibited. Because the word "tailamp" is strictly defined under Section 393.11 to mean lamps that are "illuminated when tractor headlamps are illuminated," inquiry was made subsequent to receipt of the letter as to whether FHWA's use of the word "tailamp" in this case extended to include deceleration warning lamps. The response obtained in a telephone conversation with an attorney at the FHWA Office of Motor Carrier Standards suggested that the use of the word "tailamp" in the letter extended to all categories of lamps on the rear of commercial vehicles.

deceleration. And yet, there are good reasons to suppose that FHWA's response is appropriate within the overall scheme of Section 393. One reason that seems particularly significant is that under Section 393.11, the required lighting equipment on commercial vehicles creates a color scheme that identifies the direction of travel of commercial vehicles. Within Table 1 of Section 393.11, white and amber lamps are required for the front of each vehicle, amber lamps and reflectors identify the sides, and red lamps and reflectors are required on the rear and rear sides of each vehicle. It may be that FHWA, by prohibiting amber deceleration lamps, is simply trying to prevent any confusion of this color scheme.

It has been suggested, however, that FHWA is either wrong in its interpretation of Standard No. 108 as it applies to commercial vehicles through Section 393.11 or has overstepped its bounds in creating a safety standard additional to those announced by NHTSA. Because FHWA's prohibition against amber deceleration lamps on commercial vehicles significantly limits the choices available to the Commonwealth with respect to deceleration warning systems on trucks, the problem has once again been submitted to NHTSA, along with a copy of the correspondence received from FHWA, in the hope that these agencies might come together and reach a common position on the issue.

Virginia Law

Section 46.2-1010 *et seq.* of the Code of Virginia sets forth the lighting and signaling equipment required on every vehicle "driven or moved on a highway within the Commonwealth." Section 46.2-1014 requires that brake lights automatically exhibit "a red or amber light . . . when the brake is applied." Section 46.2-1014.1 similarly requires that supplemental high-mount stop lights "shall be actuated only in conjunction with [a] vehicle's brake lights and hazard lights."

Under the title "Other permissible lights —," Section 46.2- 1020 provides that

> Unless such lighting device is both covered and unlit, no motor vehicle which is equipped with any lighting device other than lights required or permitted in this article, required or approved by the Superintendent, or required by the federal Department of Transportation shall be operated on any highway in the Commonwealth.

As deceleration warning lights are not currently covered by Section 46.2, and as they have not been required by the U.S. Department of Transportation, the only way they can legally be used in Virginia is by gaining the approval of the Superintendent of State Police.

The procedure for approval of motor vehicle lighting equipment is set forth in Section 46.2-1005 of the Code. That section requires that, in the procedure for approval adopted by the Superintendent, evidence must be submitted that the device for which approval is sought complies either with the provisions of Section 46.2 or with "recognized testing standards which the Superintendent is hereby authorized to adopt." Such approval may be waived by the Superintendent, but only in cases where the device or equipment required to be approved

> is identified as complying with the standards and specifications of the Society of Automotive Engineers, the American National Standards Institute, Incorporated, or the regulations of the federal Department of Transportation (46.2-1005).

Because the Society of Automotive Engineers (SAE) is the only organization currently engaged in developing new standards for motor vehicle lighting equipment, this leaves the inventor of a new lighting system with few alternatives in Virginia. He or she can work with SAE to establish a new standard relating to that particular category of motor vehicle equipment, or he or she can seek legislation revising Section 46.2.

That is not to say that the current scheme of regulation in Virginia is without merit. The operation of the Virginia system has received praise for its ability to keep distracting or hazardous lighting systems (bad ideas) off the highways of the Commonwealth.[56] It is possible, however, that in the balance between caution and the no holds barred acceptance of new vehicle lighting systems, Virginia has taken too cautious a line. Based on a review of practices adopted by other states, the conclusion has been reached that Virginia may be able to do more to encourage the development of improved safety related systems without sacrificing the high level of highway safety the state currently enjoys.[57]

Other States

Other states have wrestled with the same issues Virginia is presently considering. The great majority of states make no mention of deceleration warning systems in their laws governing motor vehicle lighting equipment. In contrast to Virginia, however, the absence of tacit state approval or recognized standards for deceleration lights does not preclude their use in many of those states.

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56. From a telephone conversation with George E. Walton, Director of Safety Equipment Services, American Association of Motor Vehicle Administrators, on May 26, 1993.

57. A proposal for the amendment of Section 46.2 of the Code of Virginia to allow for experimental testing of motor vehicle safety equipment on the highways of the Commonwealth is included in this report.

Seven states make specific mention of deceleration warning systems in their state regulations or codes. In Missouri, state law simply authorizes the Director of Public Safety to approve or disapprove the use of such systems.[58] Florida law provides that lights may light or flash during deceleration but requires that deceleration signals be amber in color.[59]

Other states are more specific with respect to the types of systems their regulations envision. The State of Idaho authorizes the use of accelerator position signals incorporating green and amber lamps.[60] Arizona makes specific reference to the Cyberlite in its statutory language.[61] Wisconsin differentiates between vehicle types in its regulations concerning deceleration warning systems, authorizing the use of either steady or pulsing lamps on buses, but only pulsing lamps on all other types of vehicles.[62]

California and Washington are the two states that have gone to the most trouble in regulating deceleration warning systems. Each state permits the use of two different types of deceleration signal, but they differ in their choices. Both states have chosen to authorize the use of EBS systems that "communicate a component of deceleration" by varying the flashing rate of signal lamps with deceleration or when the brakes are applied.[63] The second type of deceleration light allowable under Washington state regulations is a three-compartment green and amber accelerator position signal.[64] California, meanwhile, has approved the use of prebrake signals that operate to flash a pair of supplementary amber lamps or the vehicle's brake lamps upon the sudden release of the accelerator.[65]

California and Washington have made up for the lack of any nationally recognized standards for deceleration warning systems by incorporating into their state regulations the technical standards with which approved systems must comply. Included in their state regulations are standards for the mounting of lamps, the mechanical operation of systems, flash rates, colors, photometrics, reduced nighttime brightness, and durability.[66] The two states' standards relating to EBS systems are identical. They are to a large extent a product of the California Highway Patrol's (CHiP) involvement in the Cyberlite

58. Mo. Rev. Stat. § 307.030 (1972).
59. Fla. Stat. §§ 316.224, 316.235 (1986 & Supp. 1992).
60. Idaho Code § 49-921 (1988).
61. Ariz. Rev. Stat. Ann. §§ 28-927, 28-939, 28-947, 28-952 (1989).
62. Wis. Stat. § 347.145 (Supp. 1990).
63. Wash. Admin. Code § 204-62-060 (1976); Cal. Veh. Code § 25,251.5 (West Supp. 1993).
64. Wash. Admin. Code § 204-62-050 (1976).
65. Cal. Veh. Code §§ 25,251.5. and 24,603(f) (West Supp. 1993).
66. Wash. Admin. Code §§ 204-62-050 and 204-62-060 (1976); Cal. Code Regs. tit. 13, § 730-36 (1991).

study that took place in San Francisco in 1973.[67] Washington appears to have adopted the California standards when it considered the problem in 1976.

Although statutes and regulations are still on the books of the seven states mentioned, the age of these statutes and regulations is telling. Many of the systems specifically adopted into state law in years past are now contrary to the positions of the controlling federal agencies as expressed in recent interpretations. The fact that these conflicts have been of little practical importance is indicative of the history of deceleration warning systems. Systems approved in the past by states have either not been used or have been used in such limited quantities that they have failed to attract the notice of the federal agencies.

Summary

The Commonwealth of Virginia is not preempted from permitting the use of deceleration warning systems on trucks. This assertion is subject to numerous qualifications, however. First and foremost, Virginia must take care that the lamps it approves do not impair the effectiveness of federally required lighting equipment. NHTSA and FHWA have offered two indications as to how that might be avoided: (1) by allowing only steady-burning lamps to be used as a part of deceleration warning systems, and (2) by not allowing the use of amber lamps as a part of deceleration warning systems. Second, so long as recognized performance standards for deceleration warning systems do not exist, approval of any deceleration warning system would necessitate a revision of Section 46.2 of the Code of Virginia.

Desirability Analysis

In SJR 247, the General Assembly requested a study of the desirability of permitting deceleration lights on trucks.[68] Desirability is not something that is quantifiable. Neither are there established standards for weighing the factors that affect the desirability of deceleration lights. The following is a discussion of both the benefits promised by deceleration warning systems and the concerns and conflicts that could result from the use of those systems. The discussion touches upon deceleration warning systems in all their various forms. This analysis is categorized according to points of general application and points relating to particular systems or types of systems.

General Observations Relating to Deceleration Warning Systems

Motorists have grown accustomed to the standard system of signaling required on every vehicle. One of the most important considerations in sanc-

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67. California Highway Patrol, *supra* note 9.

68. Senate Joint Resolution No. 247, 1993 Legislative Session, Virginia General Assembly.

tioning a new signaling system, therefore, is the need for that system to deliver a familiar, consistent message.[69] Any system approved for use in the Commonwealth will appear on the state's highways only in limited numbers, at least in the early stages of use. Therefore, unless the message of a particular system can be easily understood by a first-time observer, it should not be approved for general use in Virginia.

The ability of a signaling system to operate without generating false or ambiguous signals is crucial to its effectiveness as a safety device. Deceleration warning systems generate a false signal any time the signal is lit without corresponding noticeable deceleration by the leading vehicle. One early study found that a coasting signal would lose much of its effectiveness unless braking followed the onset of the signal about 80% of the time.[70]

Federal law raises significant barriers to the use of supplemental lighting equipment on motor vehicles. These legal barriers are designed to protect the effectiveness of signaling systems required under the Federal Motor Vehicle Safety Standards. As a practical matter, compliance with the law is a critical ingredient in the weighing of desirability. It is worthwhile, however, to adhere to the principle behind the rule and recognize that any system that tends to impair the effectiveness of mandatory safety equipment is surely less desirable because of it.

One criticism leveled at the results of a past study was that the claimed effectiveness of the studied system may have been largely attributable to the excessive brightness of the signal lamps the system used.[71] While the study showed a significant reduction in the number of crashes involving test vehicles, angry letters from the public demanded an accounting of the number of crashes caused by the blinding effects of the supplementary lamps. In fact, the brightness of a proposed deceleration warning signal may contribute to its desirability in many cases by compensating for the poor quality of the existing brake signal lights on many trucks. The problem with using supplementary signal lamps to improve the conspicuity of trucks and reduce the likelihood of running into the back of a truck is that they may, if excessively bright, cause a following motorist to take unusual risks to escape from behind vehicles equipped with such lights or may keep the motorist from observing other important signals on the highway.

Section 46.2-1025 of the Code of Virginia sets forth detailed regulations concerning the use of flashing amber warning lights. The vehicles authorized to use such lights are almost exclusively emergency, law enforcement, or service

69. National Highway Traffic Safety Administration. Final Ruling on Center High-Mounted Stoplamps, 48 Fed. Reg. 48,235 (1983) (codified at 49 C.F.R. _ 571.108).

70. Mortimer, R. G., and Sturgis, S. P. 1976. *Evaluation of an Accelerator Position Signal.* Report No. TRR 600. Washington, D.C.: Transportation Research Board.

71. California Highway Patrol, *supra* note 9.

vehicles.[72] One concern expressed in an earlier study was that the use of amber deceleration warning lamps could result in a "sea of flashing lights," particularly where traffic is stopped or congested.[73] Such a situation could impair the effectiveness of authorized warning lights and detract from the safety of emergency and law enforcement vehicles.

Installation and adjustment can be problematic for even the simplest of deceleration warning systems. For the most part, these are aftermarket systems, and many are likely to be installed by truck owners or mechanics unfamiliar with such systems. Furthermore, any approved system would have to be adapted to a great variety of vehicles. Obtaining the proper adjustment between system components (the activating switch and the throttle linkage, for example) is an important factor in the signals that are given at the back end of the truck. The problem this presents is that motorists may come to rely on a particular signal from a warning light on one vehicle only to find a substantially different message from a similar system on another vehicle. Some systems seem relatively better suited to avoiding this problem than others, but it is a problem that is worth considering.

Like any other item of motor vehicle signaling equipment, deceleration warning systems would require regular maintenance to keep them in proper operating condition. The state's role in making sure such maintenance took place would be effected through the annual vehicle inspection process. State inspection, supervised by the State Police, currently involves the inspection of 21 general component areas of motor vehicle safety equipment. Permitting the use of a deceleration warning system would certainly require the addition of another step to the inspection process.

Under the current statutes, rules, and regulations in Virginia, any authorization for the use of a deceleration warning system would require an act of the General Assembly. This is an important consideration in thinking about desirability because of the role standard setting organizations have played, historically, in the Commonwealth's procedure for the approval of equipment. No nationally recognized standard for deceleration warning systems exists. The standards adopted into law by the states of California and Washington, meanwhile, have been trumped by the rulemaking of NHTSA and FHWA. It is suggested that before Virginia goes against its traditional approach, and approves a deceleration warning system under an independently developed standard, there should be no question as to that system's worth as a safety device. The proper basis for such a decision might be a proven safety benefit demonstrated in long-term studies of substantial proportions. Obviously, this would put a tremendous burden of proof on the developer of any new safety device. Two possible solutions to this problem are discussed later. Under those solutions, Virginia

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72. Va. Code Ann. § 46.2-1025 (Michie 1992).
73. California Highway Patrol, *supra* note 9, at 27.

could maintain its strict adherence to a procedure that requires recognized standards while, at the same time, enjoy the benefits of a system that promotes the testing of, and the development of standards for, promising new ideas in highway safety.

One final consideration is the fine balance the General Assembly would need to strike in choosing to adopt a particular system for use in the Commonwealth. First, the need for uniformity suggests that if any type of system is going to be approved, there should be only one type of system approved rather than several. At the same time, the General Assembly should not preclude the acceptance of better ideas that might arise in the future. A number of concepts discussed in this report have been around for many years. Modern technologies offer significant refinement to those concepts, to the point that a concept that may not seem desirable now may very well be the best alternative in years to come. The point here is that Virginia may not want to draw up formal standards relating to deceleration warning systems if those standards would impede the development of more desirable concepts in the future.

Observations Specific to Medium and Heavy Trucks

Most deceleration warning systems have originated as systems applicable to passenger vehicles. The following observations point out ways in which narrowing the inquiry to the desirability of allowing deceleration lights on trucks, as opposed to on all vehicles, makes a difference in the analysis.

As mentioned before, without signal lamps, one of the few signals available to a following motorist that a vehicle is slowing is the front end dip that the leading vehicle makes under braking. That signal is less likely to be present when the leading vehicle is a truck, implying a greater need for signaling systems on trucks than on other vehicles.

Another important source of information for the following motorist is the view he or she gets through or over the leading vehicle at traffic ahead. While the drivers of medium and heavy trucks have an advantage in being able to see over the top of most other vehicles, trucks often dominate the field of vision of a following motorist and rarely offer any sort of visibility through the vehicle.[74] Once again, this implies a greater need for signaling systems on trucks than on other vehicles.

Researchers have found that one of the most significant improvements that can be made to signaling systems is the separation of functions of the systems into separate lamps.[75] While most automobile manufacturers seem to have taken advantage of these findings, many trucks, particularly many straight

74. Burger et al., *supra* note 20, at 4-26.
75. Mortimer, *Evaluations of Automobile Rear Lighting and Signaling Systems in Driving Simulator and Road Tests.*

trucks, carry two relatively small lamps that incorporate tail lights, brake lights, turn signals, and backup lights in a single unit. If for no other reason than that they would serve to enhance the conspicuity of such trucks, deceleration lights might prove to be more desirable on trucks than on other vehicles.

Medium and heavy trucks are substantially inferior to most passenger vehicles in both braking and acceleration performance. This implies that in the absence of driver error, a passenger vehicle should almost always be able to stop short of a braking truck, even in an emergency situation. Therefore, unless the primary attribute of a deceleration warning system is its effectiveness in preventing human error, it is less likely to be useful on trucks than on other vehicles.

Because trucks are for the most part working vehicles, their configuration is determined by function rather than aerodynamics or style. What has resulted is a great variety of rear-end configurations for trucks, some of which are less amenable to the mounting of a new set of signal lights than others. This would suggest that if uniformity of mounting for signal lamps is a consideration, applying the system to trucks would be more problematic than for other vehicle types.

Many trucks are engaged in transporting goods not just within but among states. The problem this poses is that deceleration warning lights approved for use in Virginia might not be legal in other states. Because the enforcement of state laws with respect to motor vehicle lighting equipment is a legitimate safety interest of the states, there is little doubt that Virginia truckers could be cited and fined for carrying an unapproved lighting system in another state. This suggests that trucks might be a comparatively undesirable vehicle type for the approval of nonstandard vehicle lighting systems.

Finally, the great majority of medium and heavy trucks are commercial vehicles that fall under the jurisdiction of FHWA. As noted, FHWA has advised that the use of amber lamps on the rear of a commercial vehicle is, with certain exceptions, prohibited under Part 393 of the Federal Motor Carrier Safety Regulations.[76] These regulations severely limit the options available to motor carriers in terms of allowable deceleration warning systems. While systems using red lamps remain an alternative for motor carriers, those systems may in many cases be less desirable than the same systems using an amber lamp, again suggesting that it may be less desirable to have these systems on trucks than on other sorts of vehicles.

Accelerator Position Signals

APSs are the oldest and most frequently revisited idea in deceleration warning systems. It is important to note that APSs are not true deceleration signals. Instead, they operate on the assumption that vehicles will tend to

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76. Federal Highway Administration, *supra* note 54.

decelerate any time their accelerator is released. Of course, physical forces acting on a vehicle may contradict this assumption in some situations, but this is probably a fair assumption in the majority of situations.

Does that mean that APSs will convey useful information to a following motorist in most driving situations? It is doubtful that they will. Prior research into rear signaling systems found that "coasting durations are generally short and therefore involve a minor reduction in vehicle speed."[77] This suggests that the release of the accelerator in and of itself will rarely result in deceleration significant enough that it might contribute to a rear-end collision.

What about the claim that an APS could provide an early warning to a following motorist of impending braking in emergency situations? If true, this might imply a substantial benefit to highway safety. The problem is that frequent operation of the signals without any subsequent braking or significant deceleration by the lead vehicle would tend to dampen the responsiveness of a following motorist and erase the benefit of early warning when an emergency situation did arise. Laboratory and field tests of a simple APS, conducted by R.G. Mortimer of the Highway Safety Research Institute, showed none of the anticipated improvement in car-following behavior. In fact, the research showed that after growing accustomed to the signal, drivers maintained the same amount of headway with the leading vehicle whether the signal was given or not.[78]

The chance that drivers might simply ignore the signals provided by an APS does not in itself create a safety hazard. Mortimer's study made an additional point, however, in finding that

> there was some evidence obtained in the subjective evaluation test, in which accelerator releases and brake applications of the following-car driver were also measured, that the [accelerator position signal] encouraged more than usual releases of the accelerator on the part of the following driver. This effect would create visual noise in the driver's environment, and potentially lead to disturbances in traffic flow in a stream of vehicles, if each driver in the stream responded as was found in the two-car evaluation.[79]

In addition to Mortimer's findings, the danger also arises that an APS might pull the concentration of a following motorist away from the leading vehicle's brake lights. In any case, there do seem to be legitimate safety concerns in allowing supplementary signaling systems on motor vehicles.

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77. Mortimer, *Evaluation of an Accelerator Position Signal*, p. 33. Results indicated that in 90% of coasting events the vehicle slowed less than 4 mph.

78. Mortimer, *Evaluations of Automobile Rear Lighting and Signaling Systems in Driving Simulator and Road Tests*, p. 100.

79. *Id.* at p. 133.

Without additional evidence, it is impossible to know whether more technically advanced APSs would offer a greater benefit than the simpler ones. Theoretically, if the false signals generated by APSs could be eliminated, the resulting message would be much more effective. One observation made upon seeing the Lariscy system in operation was that the simplicity of its design and function (in its currently existing form) may be one of its greatest attributes. With the Lariscy system, the point of the message may be mistaken by a following motorist, but the message itself comes across loud and clear, that is, for whatever it's worth, "the driver's foot is off the gas!"[80]

Coasting lights and staged green to yellow to red lights may partially solve the problem of distracting motorists from the brake lights but may at the same time result in a more distracting display of signals than the Lariscy system. One of the earliest concerns with the Lariscy system was the likelihood that the warning lamps would light when the driver was upshifting in the process of accelerating. Additional controls have been developed in an attempt to refine the system to eliminate false signals of this kind. Nevertheless, as the system becomes more complicated in an effort to eliminate false signals, the question arises whether the initial appeal of the APS concept is diluted to the point that it loses all of its usefulness.

An example of how added complexity could limit the usefulness of a simple device is provided by the concept for speed-sensitive systems. These systems limit the use of the signal to situations where the truck is moving above a certain threshold speed and therefore creates fewer false signals. Accepting that the greatest number of rear-end collisions involving trucks occur not on rural interstates at high speed but on urban roadways with the truck moving slowly or stopped,[81] such a refinement is undesirable because it would eliminate the greater part of the system's usefulness.

One of the most telling indicators of the desirability of APSs is the fact that they have been around for so long, have been tried on numerous occasions in the past, but have never gained wide acceptance as an supplement to standard motor vehicle signaling systems. In the 1970s, municipal bus companies in Oregon, Washington, and Washington, D.C., equipped buses with combina-

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80. Two other notes with respect to the Lariscy system that were observed upon seeing it in operation:

1. The brightness of the APS lamps far outshone the brightness of the other lamps on the vehicle, and in particular the brake lamps. While this certainly adds to the conspicuity of the trucks on which they were mounted (particularly at night and in inclement weather), they could cause a problem if they were to significantly diminish a following motorist's perception of brake lights and turn signals operating at the same time.

2. The proper adjustment of the system's switching mechanism in relation to the trucks' throttle linkage is critical to the accuracy of the message delivered by the warning lamps. The operation of the system was observed on two different trucks, and a substantial difference was noticeable in the message delivered by each because the switching mechanism on one of the trucks had slipped out of proper adjustment.

81. Burger et al., *supra* note 20, at 3-37.

tion green and yellow APSs. In Oregon, the signals were installed as part of a six-month study by Tri-Met in Portland. The results showed a 60% reduction in the number of rear-end collisions with the use of the lights.[82] (Effectiveness data from Washington and Washington, D.C., were unavailable.) Although a positive result was found, the lights have not continued to be used. In at least one case, the lamps were replaced with a center high-mounted stop lamp. It has been suggested that as the novelty of any new signal wears off, its effectiveness diminishes. This seems to have been the case for the federally mandated center high-mounted stoplamp (CHMSL), for which initial studies suggested a potential 50% reduction in rear-end collisions. Subsequent experience has shown an actual reduction of 17%, which is a significant safety benefit but nowhere near what was projected.[83] In speaking to state and municipal officials who remember the green/yellow APSs on buses, no one was found who still endorsed the idea.

Although it did not come up as an issue in the 1970s, it does seem inappropriate to have green lamps on the rear ends of motor vehicles. One can only imagine the potential conflicts (and potential liability) that might arise out of using the same color on a vehicle that is used to signal "GO" by every stoplight. The American Association of Motor Vehicle Administrators (AAMVA) has for many years taken a position against using green lamps on vehicles. And NHTSA's interpretation letter limited Virginia's color choices for deceleration warning signals to red and amber. As a result, it appears that the day of the green to yellow to red APS is effectively over.

What promise APSs did have to offer, at least for trucks, has for the most part been preempted by FHWA's position against the use of amber lamps on the rear of commercial vehicles. Certainly, APSs could be designed to operate through red lamps on trucks. But doing so would be much less desirable for two reasons: first, because a steady-burning amber light would provide a more readily distinguishable warning signal, and second, because a red accelerator position signal might significantly impair the effectiveness of the standard brake lights.

In the final analysis, APSs are an idea that has intuitive merit but, within the framework of what is currently allowable under the federal regulations, would not be a desirable addition to the existing lights, reflectors, and signaling systems on the back of trucks. Also, it seems unproductive to try to overcome the deficiencies inherent in the concept: first, because the concept may be at its best in its simplest form, and second, because, even outside of what is currently allowable, there is little evidence to suggest a safety benefit from the use of APSs. Perhaps more important, findings made by Mortimer in his study of an APS suggest that APSs have two "undesirable characteristics":

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82. Burger et al., *supra* note 20, at 5-39.

83. From a telephone conversation with Richard Van Iderstine, Engineer at NHTSA, on June 11, 1993.

(a) an increase in the frequency of accelerator releases by following car drivers and (b) a frequently appearing signal on the rear of a vehicle that on most occasions provides no useful information to the drivers of following vehicles.[84]

Weighing these negatives against only a slight potential benefit, it does not seem desirable that APSs be approved for use in Virginia.

Enhanced Brake Signaling Systems and True Deceleration Signaling Systems

EBS and TDS systems are also ideas with intuitive appeal. But unlike APSs, these systems do not rely on an ambiguous indicator of deceleration, the position of the accelerator, as the basis for their operation. Instead, these systems propose to communicate the severity of a vehicle's deceleration based on one of two more reliable indicators: braking force or actual deceleration. This means, with one very important exception, that EBS and TDS systems are much less likely than APSs to generate false signals.

The exception relates specifically to EBS systems. CHiP stated in its report on the Cyberlite study that one of the most common complaints about the Cyberlite derived from cab drivers riding their brakes and causing the signal lamp to flash continually for blocks at a time.[85] Although this continual flashing might help to prevent rear-end collisions with the taxicab, it can hardly be seen as a proper function of the warning system. Even so, the important point is that, other than teaching drivers not to ride their brakes, EBS and TDS systems do not require any substantial refinements or elaborate technology to minimize the generation of false signals.

Standard brake lights deliver a multitude of messages with exactly the same signal. Researchers have suggested that by enhancing that signal it is possible to compensate for a driver's inadequacy at detecting the acceleration or deceleration of visual targets.[86] John Voevodsky developed the Cyberlite and similar systems in the 1960s and 1970s after extensive research into human visual perception. He dismissed the idea of using a system where brake light intensity increased proportionally to applied brake pressure, stating that "light intensity depends on separation distance and on atmospheric and lens conditions" and "distorted information" would be presented by such a system.[87] He also dismissed the usefulness of APSs because they offer no additional information to the following motorist once braking begins. Instead, he proposed to take advantage of the "neural response generated by a pulsed light which causes focusing of attention" and developed the Cyberlite.[88]

84. Mortimer, *Evaluation of an Accelerator Position Signal,* p. 34.
85. California Highway Patrol, *supra* note 9, at 26.
86. Burger et al., *supra* note 20, at 4-34; Voevodsky, *supra* note 11, at 2.
87. Voevodsky, *supra* note 11, at 7.
88. *Id.*

The Cyberlite system as described by CHiP, lights and flashes upon application of the brakes at a "rate which increases exponentially with the brake pressure."[89] The results of the Cyberlite experiment in San Francisco in 1972 and 1973 convinced CHiP to approve the "principle" of the Cyberlite system. The experiment resulted in 60% fewer "rear-of-cab" collisions over the course of the study for Cyberlite-equipped cabs than for nonequipped cabs.[90] But the Cyberlite report also addressed the numerous complaints the experiment generated. The brake-riding problem was already mentioned. More serious than that seems to have been the excessive (some said "blinding") brightness of the flashing signal lamps, particularly at night. Other complaints listed by CHiP in their report included:

- Difficulty maintaining peripheral vision at night.
- Irritating at night on downhill streets.
- Distracting in congested traffic.
- Traffic hazard—causes lane switching.
- Annoying, confusing, misleading, troublesome.
- Hazardous in foggy weather.
- Deceiving, similar to emergency or street maintenance vehicles.
- Stimulus overload.[91]

As successful as the Cyberlite seems to have been at preventing rear-end collisions, CHiP had important reservations about the implications that could be drawn from the study. Principal among their concerns were (1) that the system might have a tendency to lose effectiveness as it became less of a novelty, and (2) that the high brightness of the lamp might in fact have been the "main feature of the signal."[92]

In his own account of the Cyberlite experiment, Voevodsky described his signaling system in a way that seems to conflict with what CHiP reported. In Voevodsky's description, the lighting of the warning lamp was initiated by the application of the brakes. The flash rate, however, was regulated not according to brake pressure as CHiP described it, but according to actual deceleration as measured by an "inertial pendulum" (an accelerometer) rigidly attached to the vehicle.[93] This discrepancy is of little practical importance, except that it gives

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89. California Highway Patrol, *supra* note 9, at 5.

90. *Id.* at 11.

91. *Id.* at 19-20.

92. *Id.* at 18. This was a concern of CHiP because the number of rear-end collisions involving Cyberlite-equipped cabs increased during the month that electrical problems reduced the intensity of the lamps.

93. Voevodsky, *supra* note 11, at 8.

reason to consider the advantages and disadvantages of both EBS and TDS systems.

TDS systems, using accelerometers, tilt switches, or acceleration sensing switches, offer the advantage of regulating the flash rate independently of any mechanical adjustments on the vehicle.[94] Although it was not the case with Voevodsky's application, TDS systems could circumvent the brake-riding problem by operating in complete isolation from the braking system. By operating independently of the braking system, TDS systems would provide a useful signal in situations where a vehicle experiences significant deceleration without the brakes ever being applied. Such situations are rare, however, and Voevodsky may have struck an appropriate balance in having the lamps illuminated whenever the brakes were in service. That way they would have the additional value of helping to accentuate the presence of a vehicle when it is stopped or moving slowly in traffic, which is when the crash data suggest that the greatest number of rear-end collisions occur.

A follow-up study, sponsored by NHTSA and conducted by Rudolf Mortimer, took place in San Francisco and Sacramento, California, in 1980-81.[95] Again using taxicabs, Mortimer tested three different systems.

> In system 1, the lamp flashed at 2.5 Hz whenever the brakes were depressed. In system 2, the lamp flashed at 1.5 to 7.0 Hz, in four discrete steps of flash rate proportional to the deceleration. In system 3, the added lamp burned steadily.[96]

After almost 41 million miles of testing, Mortimer found that the differences in accident rates among the three systems were not enough to be statistically significant.[97] He also found that in the great majority of cases (somewhere between 73% and 80%), collisions involved a cab that was stationary in traffic.[98] Thus, the situations where a coded deceleration signal might be of value to a following motorist did not account for a substantial proportion of the rear-end collisions.

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94. The independence of signaling systems from mechanical systems on vehicles is an important factor in ensuring the uniformity of signals between vehicles. The relationship between brake pressure and deceleration, for example, differs widely among vehicle models. Independent systems, on the other hand, could be adapted to any vehicle with uniform results.

95. Mortimer, *Field Test Evaluation of Rear Lighting Deceleration Signals: II—Field Test.*

96. *Id.* Each of the systems used a supplemental lamp mounted in the center of the vehicle just behind the rear window, and only the additional lamp exhibited the coded deceleration signal. System 2 functioned much like Voevodsky's Cyberlite, except that the Cyberlite used seven different flash rates.

97. The actual rates were 5.24 collisions per million miles for system 1 (constant flashing), 4.91 collisions per million miles for system 2 (variable flashing), and 4.4 collisions per million miles for system 3 (steady burning). *Id.* at p. 9.

98. *Id.* at p. 13.

It was previously noted that flashing deceleration signals are not allowable under NHTSA's current interpretation of Standard No. 108. If the indications of the 1980-81 study are correct, there is little reason to think that flashing lights would offer any safety advantage over similarly situated steady-burning lamps. Much of what Mortimer learned in the 1980-81 study has since been put into practice by NHTSA in the form of CHMSLs on passenger vehicles and light trucks. The CHMSL concept is not easily adaptable to medium and heavy trucks because of the diversity that exists in truck and trailer configurations. Nevertheless, it can be argued that the principle behind CHMSLs holds true as much for trucks as for passenger vehicles. That is, if an effective brake lamp is provided near eye level and of sufficient brightness, it will be equally as effective at preventing rear-end collisions as a system that purports to communicate the rate of deceleration.

Previous research leads to the assumption that an EBS or a TDS system would have only a limited chance of reducing the number of rear-end collisions in Virginia.[99] It is believed that a majority of the car-into-truck rear-end collisions in Virginia occur when the truck is either stopped or moving slowly, and not when the truck is decelerating rapidly. Therefore, even if they were allowable under the federal regulations, it would be undesirable to permit the use of nonstandard and potentially confusing EBS or TDS systems for a chance to solve a part of the problem that really does not amount to much. Perhaps it would be wiser to do as Mortimer suggests and think about developing a signal "specifically devoted to informing drivers that a vehicle ahead is stopped in traffic or moving very slowly."[100]

Jake Brake Lights

Unfortunately, no prior research with respect to Jake Brake warning lights was discovered in the course of the literature review. As mentioned before, the concept has been around for nearly 40 years but seems to have come and gone as a result of opposition in a few states and an absence of popular demand. Meanwhile, the popularity of compression retarders has grown to the point that they are now in use on more than half of all large diesel trucks nationwide.

A major concern with compression retarders is that, despite their widespread use and effectiveness as a braking mechanism for trucks, vehicle signaling systems offer no visual indication to a following motorist of their application.[101] This is true despite the fact that trucks have on occasion been

99. Clearly, studies conducted in San Francisco are not going to be precisely indicative of the results one might expect in Virginia.

100. Mortimer, *Field Test Evaluation of Rear Lighting Deceleration Signals: II—Field Test*, p. 22.

101. One does occasionally notice the characteristic audible signal a Jake Brake can make. The claim has been made, however, that one hears the Jake Brake only on trucks that are out of compliance with applicable laws governing engine exhaust systems.

observed to use Jake Brakes as their primary means of braking, saving the friction brakes for emergency stops or the last few feet before an intersection.[102]

The Jake Brake signal idea may not have taken off in the past, but NHTSA recently paved the way for its reconsideration. In a letter to The Flxible Corporation, dated April 10, 1992, NHTSA interpreted Section 5.5.4 of Standard No. 108, which provides that "the stop lamps on each vehicle shall be activated upon application of the service brakes" to allow for the lighting of a vehicle's brake lights in conjunction with the application of an alternative deceleration-inducing system.[103]

If it is true that many truck drivers are using Jake Brakes in lieu of their friction or "service" brakes, then it is suggested that the brake lights could be wired to operate whenever the Jake Brake is applied. No data are available on the number of rear-end collisions that result from the use of Jake Brakes. It is impossible, therefore, to predict the reduction in rear-end collisions that would result from using brake lights to signal the application of a Jake Brake. It is suggested, however, that the lighting of the brake lights in conjunction with the use of a Jake Brake achieves a closer approximation of the familiar, consistent message motorists have come to expect from a vehicle's brake lights than the situation where the leading vehicle undergoes substantial, braking deceleration without a brake light ever being lit.

The mechanics of the Jake Brake are also an appropriate basis for the generation of a warning signal. The modern compression retarder is operated by means of an electric solenoid acting upon the valve train of a diesel motor. The solenoid is actuated only upon the concurrence of three events: the control switch must be in the "on" position, the clutch must be fully engaged, and the accelerator must be fully released. This provides for a braking system that is either on or off, eliminating the possibility of generating false signals akin to "riding the brake." Switching power to the brake lights in a similar manner should offer an unmistakable message. Because at least a marginal benefit and no apparent negative effects are perceived in the adoption of this concept, the concept is one that would be a desirable addition to the existing signaling systems in use on trucks in the Commonwealth of Virginia.

Experience with respect to alternative braking devices such as electromagnetic braking systems and hydraulic energy recovery brakes is much more limited. But as these alternatives become more prevalent, the same reasoning that applies to the use of brake lights to signal the use of Jake Brakes applies to these systems as well. If alternative deceleration-inducing devices generate significant enough deceleration that they may frequently be used in place of fric-

102. From a telephone conversation with Richard Van Iderstine, Engineer at NHTSA, on June 11, 1993.

103. National Highway Traffic Safety Administration. Interpretive letter, dated April 10, 1992, to The Flxible Corporation.

tion brakes, a following motorist should be given an indication that those systems are in use.

Pre-Brake Signals and Advance Braking Light Devices

The pre-brake signal, or ABLD, is one of the more recently developed types of systems for warning a following motorist of impending emergency braking. In 1988, a study was made of an ABLD by Paul Olson of the University of Michigan Transportation Research Institute.[104] Olson collected data from the operation of the device on three test vehicles: a full-size station wagon with an automatic transmission, a mid-size 4-door sedan with an automatic transmission, and a mid-size 2-door sedan with a manual transmission. Through the evaluation of driver reaction times under test conditions, Olson calculated what he felt to be a "conservative estimate of the typical improvement in warning to following drivers achieved through use of the ABLD under emergency conditions" of about 0.20 second.[105] Olson then proceeded to estimate the potential reduction in rear-end collisions that could result from an additional 0.20-second warning. This second calculation, which suggested that upwards of 1 million crashes could potentially be avoided and hundreds of millions of dollars in property damage saved, was based on crash reduction assumptions drawn from the earlier studies of CHMSLs.[106] But the results Olson reached seem suspect in many ways.

It does seem that the device might be effective in those few situations where a truck is rear-ended upon braking suddenly in response to emergency conditions. The device does nothing, however, to enhance the safety of a truck that is stopped or moving slowly in traffic, the situation where studies have indicated most car-into-truck rear-end collisions occur. In support of the concept, Olson found only a limited number of occasions where the ABLD lit without subsequent braking by the test vehicle (what he referred to as "false alarms").[107] He further suggested that the occasional false alarm results in only a "minor addition to the number of short-duration brake light activations that are already part of the driving scene."[108] Of greater concern is the fact that

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104. Olson, *supra* note 17.

105. *Id.* at p. 9.

106. Olson suggested that using the ABLD by itself could potentially result in a 34% to 50% reduction in rear-end collisions (meaning 1.1 to 1.7 million fewer collisions and monetary savings of $500 to $730 million) and using the ABLD in conjunction with a CHMSL could result in an additional 1% to 25% reduction in rear-end collisions beyond that offered by the CHMSL (or an additional savings of 1,000 to 550,000 collisions or $20 to $365 million). These estimates are suspect because (1) the original projections for the effectiveness of the CHMSL have proven to be greatly exaggerated; (2) the effectiveness of the CHMSL at reducing rear-end collisions is in large part a product of its conspicuity and not, as the author assumes, its ability to shorten response times; and (3) the great majority of situations where the CHMSL works to prevent rear-end collisions would not involve the lighting of an ABLD even if the vehicle were so equipped. *Id.* at pp. 11-12.

107. *Id.* at p. 9.

108. *Id.* at p. 10.

the frequency of operation of the ABLD varied considerably between the test vehicles for no obvious reason.[109] This may suggest that considerable work would be required to adapt the device to different vehicles in order for them to provide a consistent, familiar message.

It is unclear whether NHTSA's interpretation letter prohibiting flashing deceleration warning lamps would apply to a system that lights with a duration of 1 second. In any case, prior estimates of the effectiveness of the device seem greatly exaggerated and would not support approval of the device for general use on trucks in the Commonwealth.

Fast-Rise Brake Lamps

Fast-rise brake lamps were introduced in a recent study conducted by the developers of the lamps to try to determine their potential benefits.[110] The concept pursued by these researchers was to develop at minimal cost a signal lamp that would obtain the greater part of its luminous intensity in significantly less time than a conventional tungsten-filament brake lamp. Laboratory tests suggested that a 0.115-second reduction in mean reaction time could be obtained through the use of a fast-rise brake lamp when compared to conventional lamps.[111] Using two methods of analysis, the researchers concluded that a 0.115-second reduction in driver reaction times could lead to a 15% reduction in rear-end collisions.

These figures may or may not be reliable. It matters very little. The developers of the fast-rise brake lamp do not propose to alter the message sent by traditional brake lights but simply to get it there faster. If this can be done at a reasonable cost (which is actually a question for the marketplace), there is no reason the concept should not be embraced as a benefit to highway safety. Furthermore, no action is required on the part of the state to allow for the use of fast-rise brake lamps on Virginia's highways.

Recent Federal Actions with an Impact on Desirability

For more than 50 years, federal agencies have concerned themselves with the problems addressed by this study: the occurrence and severity of rear-end collisions involving trucks. Even so, safety advocates, systems developers, and state administrators have argued that the federal agencies, and NHTSA in particular, are slow to act or are unresponsive to recent "advances" in motor vehicle safety equipment. More than anything else, this "slowness" at the federal level seems to be a product of two overriding concerns. The first is the need for uniformity among motor vehicle signaling systems. The second is the perception that, because the federal role is to establish minimum standards applicable to

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109. *Id.* at p. 6.
110. Sivak, *supra* note 18.
111. *Id.* at 2.

all vehicles, the cost-effectiveness and desirability of any additional item of motor vehicle safety equipment should be clearly demonstrated before it is mandated for use. Despite these substantial barriers to change in the federal rules, three important steps have been taken in the 1980s and 1990s to address the problem of rear-end collisions.

In 1953, the Bureau of Motor Carriers of the Interstate Commerce Commission (presently the Office of Motor Carrier Safety of FHWA) adopted the first federal regulations addressing the problem of rear underride in collisions involving trucks.[112] "Rear underride" occurs when the front of a smaller vehicle slides under the rear-end of a larger vehicle. Recognizing that rear underride continues to be an important factor in fatal car-into-truck collisions, the U.S. Department of Transportation has considered the need for a federal motor vehicle safety standard, issued by NHTSA, on underride protection. In 1981, NHTSA proposed the adoption of more stringent rules relating to the strength and configuration of underride guards.[113] This proposal has more recently been revised to accommodate the potentially harmful economic impact the new rules could have on small manufacturers of trailers.[114] Rulemaking, in this case, has been a long, drawn out process. Nevertheless, the proposal illustrates the fact that these federal agencies continue to grapple with the problem of fatalities resulting from car-into-truck rear-end collisions.

A second example of federal initiative in addressing the car-into-truck crash problem is NHTSA's recent activity with respect to "conspicuity treatments" on tractor-trailers. Pursuant to this rule, any trailer manufactured after December 1, 1993, with an overall width of 80 inches or more and a gross vehicle weight rating of more than 10,000 pounds must be equipped on its sides and rear with "means for increasing [its] conspicuity."[115] Trailer manufacturers are given the option of installing either retroreflective sheeting or reflex reflectors to accomplish this purpose.

For many years, NHTSA has concerned itself with the need to reduce the number and severity of collisions with tractor-trailers during conditions of darkness or reduced visibility.[116] Conspicuity treatments demonstrated their worth as a solution to the problem in a fleet study conducted by NHTSA between 1980 and 1985. Over the course of the study, tractor-trailer combinations equipped with conspicuity enhancing materials were involved in 15% fewer collisions

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112. Supplemental Notice of Proposed Rulemaking, 57 Fed. Reg. 252 (1992). The 1953 regulation, which is still in effect, provides that the ground clearance of the underride guard shall not exceed 30 inches when the vehicle is empty. The device must be located not more than 24 inches forward of the extreme rear of the vehicle, and must be sufficiently wide so that the guard's ends are not more than 18 inches inboard from either side. [And further requires that the device be] substantially constructed and firmly attached.

113. Supplemental Notice of Proposed Rulemaking, 46 Fed. Reg. 2,136 (1981).

114. Supplemental Notice of Proposed Rulemaking, 57 Fed. Reg. 252 (1992).

115. 57 Fed. Reg. 58,406 (1992) (to be codified at 49 C.F.R. pt. 571).

116. *Id.*

than nonequipped combinations.[117] Congress responded to the study results by directing the Secretary of Transportation to "initiate a rulemaking proceeding on the need to adopt methods for making trucks . . . more visible to motorists."[118] The end result of that process was a revision of Standard No. 108 to include the aforementioned conspicuity treatments for large trailers, which was adopted in final form in December of 1992.

There was one action taken by NHTSA in the 1980s that, although it may never extend to medium and heavy trucks directly, is critically important to the analysis pursued by this study: that is, the amendment in October, 1983, of Standard No. 108 to require a "single center, high-mounted stoplamp" on passenger cars.[119] This new rule was "the culmination of many years of NHTSA and industry-funded research on vehicle rear lighting systems."[120] Early studies had suggested to NHTSA that reaction times to rear signals could be reduced by the separation of rear lamps and signals and the high mounting of lamps. Subsequent testing with CHMSLs suggested that a 50% or greater reduction in rear-end collisions might be obtainable with their use.[121] Meanwhile, NHTSA estimated that consumer costs for the lamps would amount to between $4 and $7 each, a relatively cost-effective means of achieving a significant reduction in rear-end collisions. Under the new rule, CHMSLs have been required on every passenger car manufactured on or after September 1, 1985.

At the time the final rule was announced in October of 1983, NHTSA suggested that "[o]ther types of lamps or added functions such as deceleration warning signals may be desirable and should be investigated."[122] For better or worse, NHTSA's position on the matter has become significantly more conservative since then. In March of 1985, NHTSA turned down a petition that requested approval for the use of an APS, stating that because all of the studies known to them had shown that a "deceleration signal will not have the promised effectiveness," they did not believe that rulemaking should be conducted regarding deceleration warning systems."[123] In July and August of 1991, NHTSA turned away two separate petitions to allow for multiple or alternate uses of the CHMSL, explaining that

> the agency is loath to alter any aspect of the CHMSL. While numerous requests for interpretations have been received which describe schemes for altering the CHMSL performance, in every case, the basis for negative agency response was the same: The CHMSL must present an unambiguous "brake" signal which is activated

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117. *Id.*
118. *Id.*
119. 48 Fed. Reg. 48,235 (1983) (codified at 49 C.F.R. pt. 571).
120. *Id.*
121. *Id.*
122. *Id.*
123. Denial of Petition for Rulemaking, 50 Fed. Reg. 11,212 (1985).

during service brake application. The agency has been unwavering on this most basic safety aspect of the CHMSL.[124]

NHTSA estimates that the CHMSL has been responsible for a 17% reduction in crashes since its introduction on passenger cars in 1985.[125] Although this is far short of the 50% reduction projected by numerous fleet studies, the CHMSL has nevertheless been an exceptionally cost-effective addition to Standard No. 108.[126]

Because new federal motor vehicle safety standards relate only to newly manufactured motor vehicles or trailers, it could be years before the new rules concerning rear underride guards, conspicuity treatments, and CHMSLs achieve full effectiveness. Nevertheless, they each present important considerations for the desirability of permitting deceleration warning systems on trucks. Updated standards for rear underride guards propose to reduce the number of fatalities and serious injuries resulting from car-into-truck rear-end collisions. Conspicuity treatments present a viable answer to one of the most vexing problems for deceleration warning systems: their ineffectiveness at preventing collisions involving slow-moving or stopped trucks. NHTSA's adoption of the CHMSL strikes at the heart of the desirability issue for deceleration warning systems on two counts. First, if the results of Mortimer's 1980-81 taxicab study are correct, and steady-burning lamps will yield an equivalent reduction in rear-end collisions as enhanced or flashing signals,[127] then the CHMSL is already accomplishing much of the purpose of having a deceleration warning system. Second, NHTSA's elevation of the CHMSL to inviolability means that any deceleration warning system approved for use on medium and heavy trucks is unlikely to ever make its way onto passenger vehicles or light trucks. If for no other reason, these recent changes in the Federal Motor Vehicle Safety Standards are relevant to the desirability analysis because they demonstrate that at least one other authority has considered the problem.

STANDARD SETTING AND THE ROLE OF THE STATES IN REACHING APPROPRIATE STANDARDS: TWO PROPOSALS

The Vehicle Equipment Safety Commission as a Mechanism for State Involvement in the Development of Motor Vehicle Safety Standards

One issue previously raised in this report is the growth, subsequent to the enactment of the Safety Act, of a "no-man's land" with respect to the regulation

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124. Denial of Petition for Rulemaking, 56 Fed Reg. 33,239 (1991); Denial of Petition for Rulemaking, 56 Fed. Reg. 42,307 (1991).

125. From a telephone conversation with Richard Van Iderstine, Engineer at NHTSA, on June 11, 1993.

126. *Id.* The CHMSL has been effective enough that NHTSA has expanded the application of the rule, effective September 1, 1993, to include light trucks.

127. Mortimer, *Field Test Evaluation of Rear Lighting Deceleration Signals: II—Field Test.*

of certain items of motor vehicle equipment. Because the Federal Motor Vehicle Safety Standards are minimum standards, applicable only to required equipment on newly manufactured motor vehicles, they rely on outside authorities, principally the states, to establish performance standards with respect to additional items of motor vehicle equipment. This the states have for the most part ceased to do, but that has not always been the case.

For 20 years, states worked together through an official interstate agency known as the Vehicle Equipment Safety Commission (VESC) to formulate "rules, regulations or codes embodying performance requirements or restrictions" for items of motor vehicle equipment.[128] This was done, prior to the Safety Act, to encourage the "prompt adoption of uniform standards."[129] The coming of the Safety Act was not intended to make the VESC redundant, however. In fact, the continued existence of the VESC was envisioned as an integral part of the federal scheme. Section 1392(f) of the Safety Act provides that

> In prescribing standards under this section, the Secretary shall— . . . (2) consult with the Vehicle Equipment Safety Commission, and such other State or interstate agencies (including legislative committees) as he deems appropriate.[130]

The disappearance of the VESC in 1983, due to long-term funding problems, created a gap that no other organization has been able to fill.

The American Association of Motor Vehicle Administrators (AAMVA) offers to the states and to motor vehicle equipment manufacturers a mechanism for proving compliance with existing performance standards for motor vehicle equipment. But the AAMVA is not in the business of establishing or revising standards relating to new or changing items of equipment. Meanwhile, industry groups such as SAE establish technical standards for a great variety of motor vehicle equipment but are not in a position politically to make recommendations concerning the desirability of adopting a particular standard. It has also been observed that, while the federal requirements do change in response to developments in highway safety equipment, those requirements change very slowly and only after a substantial benefit from the modification has been clearly demonstrated.

AAMVA has for many years maintained a hope that VESC could one day be reactivated. The old files of VESC are in the possession of AAMVA, and many of the old standards developed by VESC continue to be important to AAMVA's compliance testing of motor vehicle equipment. But gray areas exist where there are no recognized standards with respect to certain categories of equip-

128. The Council of State Governments. 1962. *Interstate Compacts for Traffic Safety: The Driver License Compact and The Vehicle Equipment Safety Compact.* Chicago, p. 6.
129. *Id.*
130. 15 USC § 1392(f).

ment. One such category of equipment is the subject of this report. There needs to be an organization responsible for the adoption of standards relating to those categories of equipment. It is important that that organization be more responsive to current developments in motor vehicle safety equipment than is possible for NHTSA. And it is important that the organization possess the authority to adopt uniform standards acceptable to all the states.

Amendment of Section 46.2 of the Code of Virginia to Allow for Experimental Testing of Motor Vehicle Safety Equipment

At various places in this report, it has been suggested that certain items of motor vehicle lighting equipment should not be approved for "general" use on the highways of the Commonwealth. The word "general" has been included to allow for the possibility of special or specifically authorized use of equipment that, although its desirability is either unclear or unsubstantiated, could actually prove beneficial to highway safety. As a part of a forward-looking approach to highway safety, it is recommended that the General Assembly adopt into Section 46.2 of the Code of Virginia a provision that would allow for the use of such equipment as experimental safety equipment on motor vehicles through a permit system administered by the State Police.

There are two reasons that argue in favor of adopting such a system. First, by allowing for experimental testing, new ideas that hold substantial promise for improved highway safety may develop and be implemented where they otherwise would not. Many of the studies referenced in this report involved the testing of equipment under such a permit system. Experience in highway testing is typically a better indicator of the value of a proposed system than laboratory tests. Certainly, that is one reason NHTSA requires long-term fleet studies of proposed systems before adopting regulations with respect to such systems. Second, in making provision for experimental testing, Virginia could promote the economic interests of inventors, system developers, and manufacturers in the Commonwealth. In the contest among the states for high-technology and manufacturing businesses, the opportunity to test recent developments in limited applications on the highway might be a factor that would attract those sorts of businesses to Virginia.

The State of California has maintained a permit-based system for the approval of experimental testing for many years. The legislative authorization for the system is simple; Section 26106 of the California Vehicle Code provides that

> The department may issue a permit for the use of equipment for experimental purposes. The use of such equipment under the permit is not a violation of this code.[131]

The specific requirements of the permit system have been established through the administrative practice of CHiP. The principal requirements under which a permit may be issued in California are:

1. The device shows promise of contributing to safety on the highway.

2. The device is a type that would be practical for installation on a vehicle.

3. Tests on highways of other states where permitted, or on private test areas, have shown a measured improvement in effectiveness over current systems.

4. A proposed research program is submitted for approval detailing how the applicant plans to measure accidents occurring to vehicles equipped with the experimental device for comparison against a similar control group of vehicles not so equipped.

5. Periodic reports on the data accumulated during the experiment will be made available to the Department for monitoring the conduct of the program and the statistical significance of the results.[132]

Conversations with an officer of CHiP have suggested that there is not a great deal of demand in California for experimental testing permits.[133] CHiP has a policy of being strict in its issuance of permits, and frivolous inquiries tend to disappear once CHiP has explained the procedures involved. When a formal request is made, a panel of officers evaluate the claims of the applicant and issue or decline to issue a permit according to the provisions listed above. Appendix B is the CHiP Application for an Experimental Equipment Permit.

A system similar to that of the State of California should be adopted by Virginia, with one significant revision. The principal reason for having an experimental testing program is to foster innovation. However, this must be done without compromising current highway safety. The Department of State Police has the expertise necessary to make determinations with respect to the approval or denial of requests for experimental testing permits. It has been suggested, however, that before a permit is issued by the State Police, a technical advisory committee be assembled (through procedures adopted by the Superintendent of State Police) to evaluate the determination of the State Police and to establish parameters for the proposed test. This would serve two purposes. First, it would help to insulate the State Police (and individual officers) against

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131. Cal. Veh. Code § 26,106 (West Supp. 1993).

132. Taken from a letter, dated October 26, 1981, from CHiP to C & A Manufacturing, describing the conditions under which an experimental device permit may be issued.

133. From a telephone conversation with Kyle Larsen, an officer in the Commercial and Technical Services Section of CHiP, on July 27, 1993.

liability claims that might arise out of the testing of experimental equipment. Second, it should contribute to the safety and effectiveness of the program by establishing appropriate technical guidelines for authorized experiments. The limited demand for such permits in California suggests that the administrative costs of having such a program would not be burdensome.

CONCLUSIONS

A variety of deceleration warning systems exist, but there are few recognized standards against which these systems can be tested. Allowing the use of deceleration warning systems on trucks in the Commonwealth would, therefore, in most cases require revision of the Virginia state law requirement that systems be tested against a recognized standard before approval for use by the Superintendent of State Police.

Virginia is preempted by federal regulation from permitting the use of most types of deceleration warning systems on trucks. NHTSA has interpreted Federal Motor Vehicle Safety Standard No. 108 in a way that limits deceleration warning systems to the use of steady burning red or amber lamps. FHWA, meanwhile, prohibits the use of amber lamps as deceleration warning signals on the rear of commercial vehicles.

Even if Virginia were not preempted from allowing such systems, the balance of the evidence suggests that it would be undesirable for Virginia to permit the use on trucks in the Commonwealth of (1) accelerator position signals, (2) enhanced brake signaling systems, (3) true deceleration signaling systems, or (4) pre-brake signals. This does not mean that these types of systems are without merit. It simply means that the potential costs of allowing such systems, in terms of false signals, impairment of mandatory signals, and confusion, outweigh the safety benefits of such systems to the extent those benefits are estimable or have been demonstrated.

Alternatively, the evidence does suggest that it would be desirable for Virginia to permit the use of (1) Jake Brake lights and (2) fast-rise brake lamps. These systems appear to offer potential safety benefits with few or no offsetting safety costs. Furthermore, these two types of systems would be allowable in Virginia without any revision to state law.

Virginia is currently without any mechanism for developing appropriate standards for innovative items of motor vehicle safety equipment. Because the State Police were unable to draw upon recognized standards from outside the Commonwealth with respect to deceleration warning systems, the absence of a mechanism for developing appropriate standards came to the fore in this case.

Working with other states to reestablish the VESC and facilitating experimental testing of motor vehicle safety equipment are two steps the Commonwealth could take to rectify this problem.

RECOMMENDATIONS

1. *Virginia should not allow the use on a nonexperimental basis of (1) accelerator position signals, including Lariscy's patented deceleration warning light, (2) enhanced brake signaling systems, (3) true deceleration signaling systems, or (4) pre-brake signals on trucks in the Commonwealth unless or until subsequent research demonstrates a reliable safety benefit from the use of such systems and appropriate standards for their use are available.*

2. *Virginia should allow the use of Jake Brake lights and other alternative brake-related deceleration warning systems that use a vehicle's brake lights to communicate that a retarder or alternative brake is in use. Virginia should also allow the use of fast-rise brake lamps as a performance enhancement to traditional signaling systems.* No change in state law would be required for these systems to be used in the Commonwealth, but the General Assembly should consider the ways in which it could encourage the use of such systems. It might be worthwhile, for example, to contract with the developers of the fast-rise brake lamp to conduct a fleet study of the effectiveness of that device in Virginia.

3. *Virginia should work together with other states to reestablish and fund the VESC as a standard-setting organization for items of motor vehicle safety equipment that fall outside the Federal Motor Vehicle Safety Standards.*

4. *Virginia should consider amending Section 46.2 of the Code of Virginia to allow for experimental testing of motor vehicle safety equipment on the highways of the Commonwealth through a permit system administered by the State Police.* So long as the funding requirements for such a program are met, and State Police officers given responsibility for granting experimental testing permits can be shielded from liability, Virginia should incorporate such a system into state law.

5. *Virginia should encourage compliance with Section 46.2-1014 of the Code of Virginia, which requires that brake lights be visible from 500 feet.* Existing signaling systems on trucks may not be very good, even if they are legal. Many suffer from neglect. The state should encourage truck owners and drivers to keep signal lamps and reflectors clean and in good repair in order to take full advantage of the provisions that have already been made for highway safety in state and federal law.

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Appendix A

SENATE JOINT RESOLUTION NO. 247

LD9408665

SENATE JOINT RESOLUTION NO. 247
AMENDMENT IN THE NATURE OF A SUBSTITUTE
(Proposed by the House Committee on Rules
on February 19, 1993)
(Patron Prior to Substitute—Senator Goode)

Requesting the Department of Motor Vehicles, in cooperation with the Center for Innovative Technology, the Motor Carrier Division of the State Corporation Commission, and the State Police, to study the use of deacceleration lights on trucks in the Commonwealth.

WHEREAS, trucks often deaccelerate without use of brakes, such as when traveling uphill; and

WHEREAS, such deacceleration can pose a hazard to following traffic which is given no warning of the deacceleration; and

WHEREAS, deacceleration lights on trucks may provide an appropriate warning to following traffic; and

WHEREAS, such deacceleration lights are not currently permitted in the Commonwealth; and

WHEREAS, the Commonwealth should study the desirability of permitting deacceleration lights on trucks; and

WHEREAS, if the Commonwealth decides to allow such deacceleration lights on trucks, appropriate standards should be developed to dictate their use; now, therefore, be it

RESOLVED by the Senate, the House of Delegates concurring, That the Department of Motor Vehicles, in cooperation with the Center for Innovative Technology, the Motor Carrier Division of the State Corporation Commission, and the State Police, be requested to study the desirability of allowing deacceleration lights on trucks in the Commonwealth, the types of deacceleration lights which currently exist, and the appropriate standards which should dictate their use.

The Department shall complete its work in time to submit its findings and recommendations to the Governor and the 1994 Session of the General Assembly as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents.

Official Use By Clerks

Agreed to By The Senate		Agreed to By The House of Delegates	
without amendment	☐	without amendment	☐
with amendment	☐	with amendment	☐
substitute	☐	substitute	☐
substitute w/amdt	☐	substitute w/amdt	☐

Date: ______________ Date: ______________

______________ Clerk of the Senate ______________ Clerk of the House of Delegates

Appendix B

CALIFORNIA HIGHWAY PATROL—APPLICATION/ AUTHORIZATION FOR EXPERIMENTAL EQUIPMENT PERMIT

DEPARTMENT OF CALIFORNIA HIGHWAY PATROL

APPLICATION/AUTHORIZATION FOR EXPERIMENTAL EQUIPMENT PERMIT	INSTRUCTIONS: COMPLETE AND SUBMIT THIS FORM IN TRIPLICATE	DATE Feb. 1, 1972
TO: ENGINEERING SECTION CALIFORNIA HIGHWAY PATROL P. O. BOX 898 SACRAMENTO, CALIFORNIA, 95804	OWNER OF VEHICLE: Yellow Cab Company ADDRESS: 695 - 8th Street San Francisco, Ca. 94103	

FROM (Name and Address of Applicant)	MAKE OF VEHICLE
Yellow Cab Company 695 - 8th Street San Francisco, Ca. 94103	*
	VEH. YEAR: * — LICENSE NUMBER: *
	TYPE OF EXPERIMENTAL EQUIPMENT: Variable Flashing Deceleration Lamp

PURPOSES FOR WHICH PERMIT IS REQUESTED

The purpose of this permit is to determine the effectiveness in reducing rear end collisions using a lamp with a flashing rate which varies in relation to the deceleration of a vehicle. The experimental lamp shall be amber in color, be mounted on the rear of the vehicle at the centerline above the bumper, and have a maximum intensity not exceeding 900 candlepower.

*Approved for 500 Yellow Cabs in San Francisco and adjacent areas. 1 copy of this form will be carried in each vehicle equipped with the experimental lamp.

NOTICE TO APPLICANT: THIS EXPERIMENTAL PERMIT IS NOT TRANSFERABLE AND MUST BE CARRIED AT ALL TIMES IN THE VEHICLE DESCRIBED

AUTHORIZATION *(SECTION 26118 OF CVC)*

APPROVED *(with following changes)*	PERMIT NO. 72-6
	DATE PERMIT EXPIRES 3/1/73
SIGNATURE OF APPROVING OFFICIAL	TITLE Commander Engineering Section