

**THE UNSAFE DRIVING ACTS OF MOTORISTS
IN THE VICINITY OF LARGE TRUCKS**

Conducted For

U.S. DEPARTMENT OF TRANSPORTATION
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<p>This study identified the unsafe driving acts of motorists that contribute to collisions between passenger vehicles and large trucks. The project comprised several research tasks, including 1) review and analysis of statistical crash data; 2) interviews with truck drivers, collision investigators, and other experts; 3) review and analysis of collision investigation reports; and, 4) a systematic rating of the unsafe driving acts by a sample of experts. More than 50 subject matter experts participated in the study.</p> <p>The systematic rating of the unsafe driving acts (UDAs) resulted in 23 UDAs that were recommended to be included in training materials developed for law enforcement officers. The purpose of the materials would be to sensitize the officers to the dangers associated with the UDAs. Study results also might be useful to the developers of training programs for truck drivers and novice operators of passenger vehicles. An Unsafe Driving Acts Detection Guide and a draft script for a training video intended for law enforcement officers were prepared, based on study results.</p> <p>In addition to recommending the development of training materials, it was recommended that a request be submitted to the National Committee on Uniform Traffic Laws and Ordinances to modify the Uniform Vehicle Code and Model Traffic Ordinance to include the UDAs as violations, or to modify the Uniform Vehicle Code to assign special consideration or penalties to UDAs that already are violations, when they are committed in the vicinity of a large truck. Special consideration or penalties are warranted because of the greater possibility of serious injury or death resulting from collisions between passenger vehicles and large trucks, compared to collisions between passenger vehicles.</p>			
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INTRODUCTION

This report documents research conducted for the Federal Highway Administration's Office of Motor Carriers (OMC). The purpose of the research is to identify the unsafe driving acts (UDAs) of motorists in the vicinity of large trucks.¹ Additional objectives include the development of recommendations for training materials and possible changes to the Uniform Vehicle Code and Model Traffic Ordinance.

BACKGROUND

The number of fatal crashes involving large trucks has declined significantly during the past decade, from more than 4 per 100 million miles driven during the 1980s to about 2.5 fatal crashes per 100 million miles now. Despite these improvements, there were nearly 400,000 crashes involving large trucks in the US during 1996, according to the US Department of Transportation (FARS 96). Of that number, 4,398 crashes (involving 4,740 trucks) resulted in 5,126 fatalities—a four percent increase from the previous year.

Trucks composed eight percent of all vehicles involved in fatal crashes in 1996, however, truck-involved crashes resulted in twelve percent of the total number of lives lost on the nation's roads and highways. The disproportionate involvement of trucks in fatal crashes is a reflection of a fundamental law of physics, which is expressed by the following equation.

$$\text{Kinetic Energy} = .5 \times \text{mass} \times (\text{velocity})^2$$

Kinetic energy is dissipated in a collision by friction, heat, and the deformation of mass. Generally, the more kinetic energy to be dissipated in a collision, the greater the potential for injury to vehicle occupants. Trucks typically weigh 20 to 30 times as much as passenger vehicles. The structural properties and greater mass of trucks better absorb the kinetic energy generated by collisions, which places the occupants of smaller vehicles at a considerable disadvantage. Largely as a consequence of differential mass, the occupants of large trucks compose only 14 percent of the fatalities resulting from fatal truck crashes; 86 percent of the fatalities occur outside the truck, to pedestrians, cyclists, and, primarily, the occupants of passenger vehicles.

The disadvantage to smaller vehicles that results from differential mass is compounded by speed. Because kinetic energy is determined by the square of the vehicle's speed, rather than by speed alone, the probability of injury, and the severity of injuries that occur in a crash, increase exponentially with vehicle speed. For example, a 30 percent increase in speed (e.g., from 50 to 65 mph [80.5 to 104.6 kmh]) results in a 69 percent increase in the kinetic energy of a vehicle.

¹ Unsafe Driving Acts (UDAs) are defined as motorist behaviors that have been found to contribute to collisions.

The relationships among vehicle mass, speed, and crash severity are unequivocal and can be calculated with precision. What is not understood, however, are the driving behaviors that lead to collisions between passenger vehicles and large trucks. A systematic identification of the driving behaviors is necessary before countermeasures can be developed. The development of countermeasures to specific causal factors is a proven means to further reduce the incidence and severity of crashes. For example, detection guides and training materials to assist law enforcement personnel have been among the most effective countermeasures to alcohol-impaired driving. The OMC initiative to identify, then target, unsafe driving acts in the vicinity of large trucks is consistent with this approach to improving traffic safety.

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METHODS AND RESULTS

This section describes all tasks that were performed during the study. The technical approach to the research consisted of seven major project tasks, as illustrated by Figure 1 and summarized in the following pages.

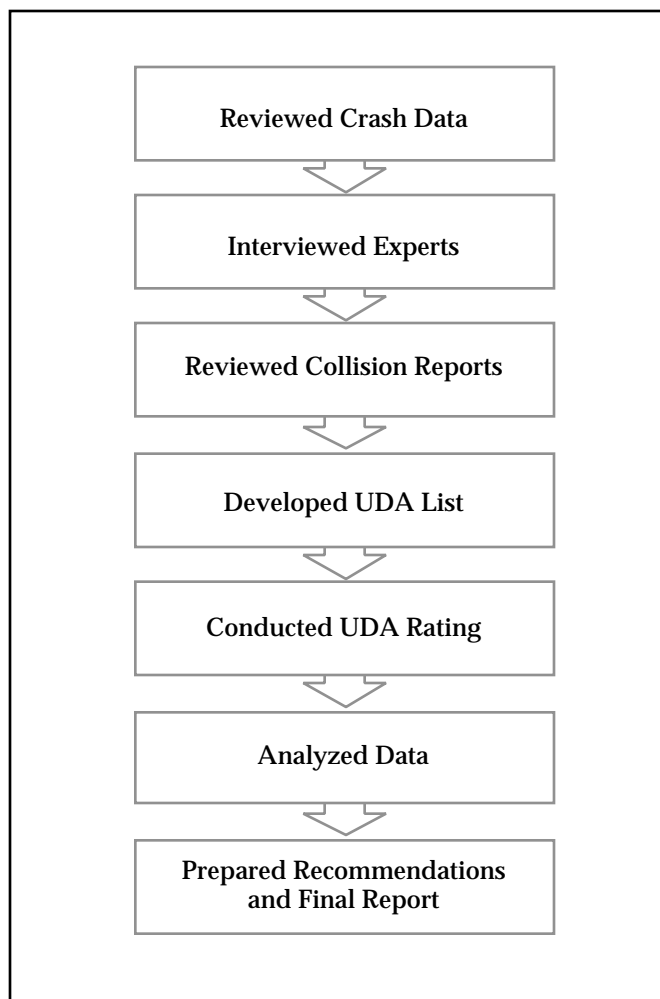


Figure 1. Summary of major project tasks.

REVIEWED CRASH DATA

Statistical summaries of crash data were reviewed to identify the types of trucks and roadways that are most involved in fatal collisions. Several sources were consulted, including the *Truck Crash Profile* (published by the Federal Highway Administration's Office of Motor Carriers), the *Truck and Bus Crash Factbook* (published by the Center for National Truck Statistics), and *Fatality Facts* (published by the Insurance Institute for Highway Safety). The primary source of data used during this project task was the U.S. Department of Transportation's Fatality Analysis Reporting System (FARS). FARS data were obtained for the year 1995, the most recent complete year available at the time of the analysis. A summary of relevant FARS data is presented in Table 1.

TABLE 1
FATAL CRASHES BY TRUCK AND ROADWAY TYPE FOR 1995

Roadway Type	Single		One-Trailer		Multi-Trailer		Total	
	n	%	n	%	n	%	n	%
Interstate/Urban	110	7.4	306	10.4	19	10.4	435	9.4
Interstate/Rural	78	5.2	486	16.5	38	20.8	602	13.0
Maj. Arterial/Urban	243	16.3	395	13.4	13	7.1	652	14.1
Maj. Arterial/Rural	460	30.8	1268	43.0	81	44.3	1810	39.1
Other Urban	315	21.1	201	6.8	12	6.6	529	11.4
Other Rural	246	16.5	217	7.4	15	8.2	478	10.3
Unknown	43	2.9	77	2.6	5	2.7	125	2.7
Total	1495		2950		183		4631	

FARS Data

Table 1 shows that most fatal truck crashes in 1995 involved a truck that was pulling one trailer; 2,950 of the 4,631 fatal crashes, accounting for 64 percent of the total, involved trucks of this type. Single-unit trucks (i.e., trucks with no trailers) were involved in 1,495, or 32 percent, of the fatal crashes. Multi-trailer vehicles were involved in only 183 fatal crashes, representing fewer than four percent of all fatal truck crashes in 1995.

Table 1 also shows that major rural arterial roadways were the scenes of the greatest proportion of fatal truck crashes in 1995; 1,810 fatal crashes occurred on major rural arterials, accounting for more than 39 percent of all fatal truck crashes. Rural arterials had the highest frequencies of crashes for all categories of trucks. The data presented in the table clearly illustrate the higher crash risk in rural than urban environments. Excluding crashes on interstate highways, rural roadways accounted for 49.4 percent of the fatal crashes in 1995, while 25.5 of the fatal crashes occurred on urban roadways.

The relative safety of the Interstate system also is evident from the data. FARS estimated that 40 percent of all truck miles were driven on Interstate highways, but only 23.4 percent of the fatal truck crashes occurred on the interstates. A further review of FARS data found that 56.5 percent of all fatal truck crashes occurred on undivided roadways, and another 31.8 percent on divided highways without barriers. Only 10.4 percent of all fatal truck crashes occurred on divided highways with barriers (FARS 96).

Additional data were reviewed in an attempt to better understand the types of precipitating events to collisions between large trucks and passenger vehicles. Table 2 presents a summary of FARS data that clearly shows collisions with other motor vehicles as the most frequent precipitating event, accounting for 78.9 percent of all fatal truck crashes.

TABLE 2
LARGE TRUCKS INVOLVED IN FATAL CRASHES BY FIRST HARMFUL EVENT

First Event	Percent
Collision with vehicle in transport	78.9
Collision with pedestrian	6.4
Collision with fixed object	6.1
Overturn (Rollover)	4.1
Collision with pedacycle	1.2
Collision with train	0.5
Collision with animal	0.3
Collision with other object	0.7
Other	1.0

FARS Data

Table 3 lists the initial impact areas for fatal and non-fatal collisions involving large trucks. The table shows that the front of the truck is the initial impact area in nearly 62 percent of all fatal truck crashes and in nearly 28 percent of the non-fatal crashes. The rear of the truck is the location of initial impact in about 16 percent of both fatal and non-fatal collisions, according to these data.

TABLE 3
LARGE TRUCKS INVOLVED IN CRASHES BY INITIAL IMPACT AREA

Impact Area	Fatal	Non-Fatal
Front	61.7	27.9
Rear	15.8	16.2
Left Side	9.1	20.0
Right Side	5.7	27.3
Non Collision	2.9	7.4
Other/Unknown	5.0	1.1
Total	4,740	390,000

FARS Data & GES Data
from OMC 1997

Recent analyses by Dan Blower at the University of Michigan Transportation Research Institute (UMTRI) have contributed additional insight into the driver acts that lead to collisions between passenger vehicles and large trucks (Blower, 1998). Table 4 summarizes data from UMTRI's Trucks Involved In Fatal Accidents (TIFA) file for the years 1994 and 1995. The table is based on the meticulous review and coding of actual collision investigation reports. The method provides a detailed accounting of collision events, which permits, in most cases, an identification of precipitating driver behaviors that is independent of the accounts of witnesses or crash survivors. The FARS and TIFA data are consistent, however, the TIFA data presented, in Table 4, provide greater detail concerning collision type. In particular,

Table 3 shows the front of the truck to be the initial impact area in 61.7 percent of all fatal truck crashes (including single vehicle crashes). Table 4 lists five collision types in which the front of the truck clearly is the area of initial impact; the five collision types account for 55 percent of all fatal crashes between large trucks and passenger vehicles and include the two leading fatal collision types, Head-on in truck's lane and Straight path, truck into passenger vehicle.

TABLE 4
LARGE TRUCKS INVOLVED IN CRASHES WITH PASSENGER VEHICLES BY COLLISION TYPE

Collision Type	Fatal Crashes	
	n	%
Head-on in truck's lane*	1,236	22.7
Straight path, truck into passenger vehicle*	925	17.0
Rear end, passenger vehicle striking	649	11.9
Other crash type	506	9.3
Passenger Vehicle turned across path*	496	9.1
Sideswipe, opposite direction passenger vehicle encroaches	386	7.1
Straight path, passenger vehicle into truck	296	5.4
Truck turned across path	223	4.1
Rear end, truck striking*	175	3.2
Head-on in passenger vehicle lane*	156	2.9
Unknown	127	2.3
Sideswipe, same direction, pass vehicle encroaches	120	2.2
Sideswipe, opposite direction truck encroaches	67	1.2
Sideswipe, same direction truck encroaches	49	0.9
Other turning-related	32	0.6
Truck backed into passenger vehicle	8	0.1
Other backed into truck	2	0.0
Total	5,453	100.0

TIFA File data *Front of truck is area of initial impact

Finally, FARS data were reviewed to obtain information about the driver-related crash factors that contribute to collisions between passenger vehicles and large trucks. Crash factors are recorded by law enforcement officers in the course of their collision investigations. The FARS database includes 98 separate driver-related crash factors, and coders assign as many as three factors for each driver involved in a crash. Truck driver-related factors were recorded by officers in 29 percent of fatal truck crashes involving passenger vehicles. In contrast, officers recorded crash factors for 67 percent of the drivers of passenger vehicles who were involved in fatal collisions with large trucks. Blower's independent assessment of crash factors found the FARS coding to be generally accurate, especially for head-on and rear end collisions (Blower, 1998). Table 5 presents the proportions of all crash factors assigned by officers on the scene to truck drivers and the operators of passenger vehicles involved in fatal collisions. Only the 12 most frequently-recorded crash factors are included in the table.

TABLE 5
DRIVER-RELATED FACTORS IN FATAL CRASHES
BETWEEN PASSENGER VEHICLES AND LARGE TRUCKS

Driver-Related Factors	Passenger Vehicles	Large Trucks
Ran Off Road/Lane	19.9	5.1
Failure to Yield Right of Way	14.4	4.6
Unsafe Speed	14.1	5.9
Driving Inattentively	8.7	2.9
Failure to Obey Traffic Devices	8.4	3.2
Erratic/Reckless Driving	4.3	2.1
Driving into Opposing Traffic	3.9	0.8
Ice, Water, Snow on Road	2.8	0.9
Following Too Closely	2.7	2.1
Vision Obscured by Weather	2.1	1.8
Manslaughter/Homicide	1.3	2.7
Vehicle in Road	1.0	1.0

FARS Data

Table 5 shows the most frequent crash factors assigned to the drivers of passenger vehicles to be, Ran Off Road/Lane, Failure to Yield Right of Way, Unsafe Speed, Driving Inattentively, and Failure to Obey Traffic Devices (e.g., traffic lights, stop signs, and other warnings). Unsafe Speed, Ran Off Road/Lane, and Failure to Yield Right of Way, were the leading factors assigned to the operators of large trucks in fatal collisions with passenger vehicles. For the drivers of both passenger vehicles and large trucks, running off the road or lane might be a result of some other factor or an attempt to avoid a collision within a traffic lane.

The data presented in Tables 1 through 5 show that nearly all fatal truck crashes occur as a consequence of a collision with another vehicle. Most of the fatal collisions involve a truck pulling a single trailer that either strikes or is struck by another vehicle. The front of the truck is the initial impact area in at least 55 percent of crashes with other vehicles; the rear and sides of the truck receive the impact in six to 16 percent of fatal crashes. The primary driver-related factors include running off the road or lane, failure to yield the right of way (e.g., unsafe turning, crossing, and passing headways), unsafe speed, driving inattentively, and failure to obey traffic control devices (e.g., stop signs and traffic lights). Although the crash data are instructive, they provide only a limited understanding of the specific driver behaviors that contribute to collisions between passenger vehicles and large trucks.

INTERVIEWED EXPERTS

Open-ended interviews were conducted with subject matter experts to identify the specific unsafe driving acts of motorists that lead to collisions with large trucks. The experts interviewed during the study are listed in Table 6. The behaviors mentioned by the experts are presented in Table 7, in descending order of frequency.

TABLE 6
SUBJECT MATTER EXPERTS INTERVIEWED CONCERNING
THE UNSAFE DRIVING ACTS OF MOTORISTS IN THE VICINITY OF LARGE TRUCKS

Collision Investigators

- Cpl. Ron R. Baade, Supervisor, Collision Analysis & Reconstruction Unit, Pennsylvania State Police
- Sgt. Dan Bates, Supervisor, Collision Investigation Unit, New York State Police
- M/Sgt. Keith Brown, Traffic Crash Reconstruction Unit, Illinois State Police
- Investigator Tim Byrnes, Motor Carrier Division, Michigan State Police
- MC Investigator Rick Dill, Motor Carrier Division, Michigan State Police
- Ofcr. Doug English, Collision Investigator, San Diego Police Department
- Sgt. Bill Esmay, Central Division MAIT, California Highway Patrol
- MC Investigator Cathy Fisher, Motor Carrier Division, Michigan State Police
- Lt. Mike Fryar, Coordinator/Instructor, Collision Investigations, Florida Highway Patrol
- TFC Brad Harrold, Crash Team, Maryland State Police
- Sgt. John Ivarsson, Accident Reconstructionist, Florida Highway Patrol
- Trooper Alan Jacobs, Traffic Crash Reconstruction Unit, Illinois State Police
- Sgt. Richard Kuemichel, Collision Investigator, Oregon State Police
- Lt. Charles Kunz, Uniformed Support Division, Los Angeles Police Department
- Ofcr. Dane Lobb, Instructor, California Highway Patrol Academy
- Ofcr. Bob Maddox, Collision Investigator, San Francisco Police Department
- Trooper Gary Metroka, Commercial Motor Vehicle Division, Indiana State Police
- Capt. Paul McClellan, Commander, Licensing and Standards, Ohio Highway Patrol
- Sgt. Steve McKinzie, Critical Highway Accident Response Team, Kansas Highway Patrol
- Sgt. Doug Myers, Collision Investigator, Los Angeles Police Department
- TFC Glenn Saltsman, Crash Team, Maryland State Police
- Sgt. Nathan Shigemura, Supervisor, Traffic Crash Reconstruction Unit, Illinois State Police
- Sgt. Charles Seale, Coordinator, State Accident Team, Texas Highway Patrol
- Sgt. Dennis Smith, Homicide Investigator, Florida Highway Patrol
- Master Trooper James R. Todd, Critical Highway Accident Response Team, Kansas Highway Patrol
- Lt. Leonard Zimmerer, Homicide Investigator, Florida Highway Patrol

Other Subject Matter Experts

- Ron Hoffman, Office of Motor Carriers, California
- Bob Ketenheim, Office of Motor Carriers, Maryland
- Fred McGraw, Office of Motor Carriers, Kansas
- Ralph Limon, Trucking Safety Consultant and former CHP Captain
- Ron Huesser, Collision Reconstruction Consultant and former NTSB staff member
- Dan Blower, University of Michigan Traffic Safety Research Institute

Truck Drivers

Name	Home	Years Experience	Hauls
• David Jones	Bedford, IN	30	bottle caps west; produce east
• David Jones, Jr.	Bedford, IN	10	bottle caps west; produce east
• Duane Pieper	St. Paul, MN	29	boxed cereal west; computers east
• Judy Pieper	St. Paul, MN	10	boxed cereal west; computers east
• Robert Carston	Pecktonville, MD	44	soda machines west; lettuce east
• Eric Gainer	Meterie, LA	26	chickens west; lettuce east
• John Horn	Goleta, CA	25	top soil and gravel, locally
• Audrey Gullas	Santa Barbara, CA	15	top soil and gravel, locally
• Rich Havicon	Oxnard, CA	15	general freight delivery
• Louis Vallejo	Santa Barbara, CA	15	building supplies
• Jim Meinhart	Ontario, CA	28	appliances

TABLE 7
UNSAFE DRIVING ACTS IN THE VICINITY OF LARGE TRUCKS: EXPERT INTERVIEWS

Frequency	Unsafe Driving Act
17	Driving in the “no zones” (left rear quarter, right front quarter, and directly behind)
16	Changing lanes abruptly in front of a truck
16	Driving inattentively (e.g., reading, talking on phone, fatigue-induced inattention)
13	Following too closely
12	Failure to stop for a stop sign or light (also, early or late through a signal)
10	Changing lanes in front of a truck, then braking (for traffic, obstacle, toll gate, etc.)
10	Unsafe turning, primarily turning with insufficient headway
9	Unsafe passing, primarily passing with insufficient headway
8	Unsafe speed (e.g., approaching too fast from the rear/misjudging truck’s acceleration or speed)
7	Failure to slow down in a construction zone
6	Failure to slow down in response to environmental conditions (e.g., fog, smoke, rain, bright sun)
6	Misjudging an approaching truck’s speed at an intersection (i.e., pulling out in front of a truck)
5	Driving while impaired by alcohol or other drug
5	Maneuvering to the right of a truck that is making a right turn (the “right turn squeeze”)
4	Merging improperly into traffic, causing a truck to maneuver or brake quickly
4	Striking an unattended or parked truck at roadside
4	Driving left of center
4	Failure to slow down or speed up when a truck begins to change lanes or merge
3	Pulling into traffic from roadside in front of a truck without accelerating sufficiently
3	Changing lanes in front of a truck traveling on an onramp or offramp
3	Striking the front or rear of a truck or trailer while changing lanes
3	Passing a truck, then being blown out of lane position by cross wind or turbulence
3	Assuming that a turn signal is sufficient to ensure a safe lane change or merge
2	Changing lanes into a truck (i.e., the trailer)
2	Driving in the spray generated by a truck on wet pavement (not necessarily in no-zone)
2	Driving between large trucks
2	Operating at dawn or dusk without headlights
2	Failure to discern that the trailer of a maneuvering truck is blocking the roadway (this occurs primarily during pre-dawn hours, when the truck’s headlights, far from the trailer, are interpreted by a motorist, as evidence that the obstacle has passed)

The 28 unsafe driving acts (UDAs) listed in Table 7 were described by the collision investigators and other trucking experts during open-ended telephone interviews. The durations of the interviews ranged from 25 and 55 minutes. All of the experts contacted were extremely cooperative and interested in the study.

The sample of collision investigators was assembled to reflect the geographic and operational diversity of commercial motor vehicle operation; that is, the intention was to include in the sample at least one investigator from each of the states with the greatest numbers of fatal truck crashes, as well as investigators from states with fewer crashes. The sample includes investigators from state police agencies, highway patrols, and municipal police departments, to ensure coverage of

operational differences (i.e., city vs. highway conditions). Figure 2 illustrates the geographic representation of the collision investigators who were interviewed during the current study.

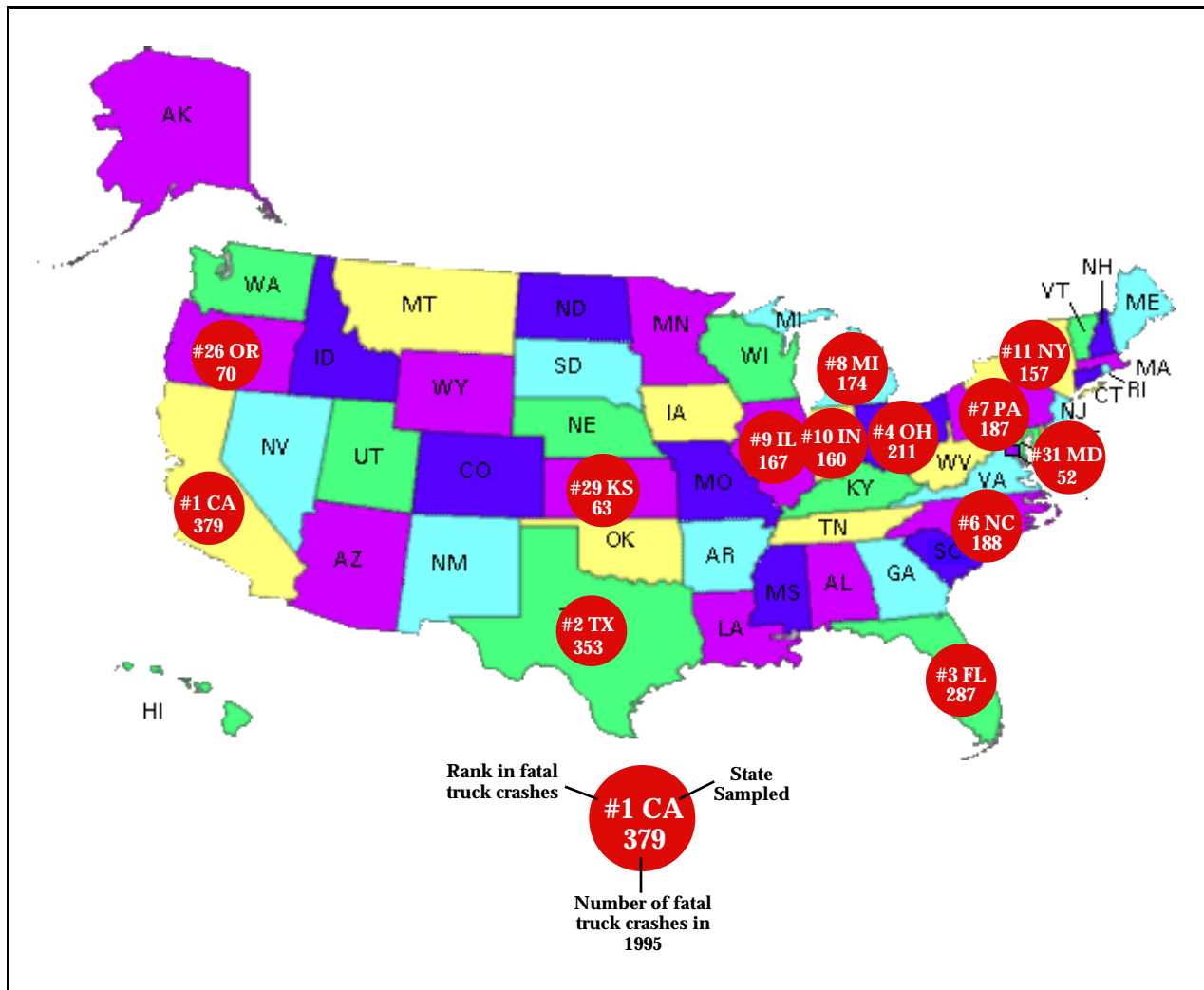


Figure 2. States represented by collision investigators who were interviewed during the study.

The frequencies reported in Table 7 are the results of simple tabulations from interview notes. The UDAs most frequently reported by the experts are, Driving in the “no zones,” Changing lanes abruptly in front of a truck, and Driving inattentively. Some regional differences were evident, for example, Failure to slow down in response to environmental conditions was mentioned by investigators from states with areas subject to heavy fog and icy roads. Operational differences also were evident, in particular, highway patrol officers reported that they rarely encounter the “right turn squeeze,” which is one of the most frequent types of truck collision investigated by officers from municipal police departments. Similarly, officers from rural areas reported far more experience with head-on collisions than their colleagues from urban areas.

The results of the interviews with operators of large trucks are presented in Table 8. All of the interviews with truck drivers were open-ended and conducted in person. The long-haul operators were interviewed in the parking lot of a truck stop; the in-town operators were interviewed at delivery sites. All of the truck operators interviewed were cooperative and grateful that the government was studying the issues that render their work dangerous and stressful.

TABLE 8
UNSAFE DRIVING ACTS IN THE VICINITY OF LARGE TRUCKS: TRUCKER INTERVIEWS

Frequency	Unsafe Driving Act
6	Changing lanes abruptly in front of a truck
5	Changing lanes abruptly in front of a truck to make an exit
3	Driving inattentively (e.g., reading, talking on phone, fatigue-induced inattention)
3	Merging improperly into traffic, causing a truck to maneuver or brake quickly
2	Changing lanes frequently
2	Maneuvering to the right of a truck that is making a right turn (the “right turn squeeze”)
2	Following too closely
2	Failure to yield to merging truck
2	Failure to yield to backing truck (in town)
2	Car speeds up when truck attempts to pass or change lanes to the right
1	Driving slowly in fast lane (requiring truck to pass on right)
1	Unsafe passing, primarily passing with insufficient headway
1	Failure to signal lane change

The UDAs identified during the interviews with truck drivers generally were consistent with those described by the other experts. The truck drivers, however, emphasized the lane changing and merging behaviors of motorists when listing unsafe driving acts. Particularly distressing to the truckers is the practice of passing a truck, quickly cutting in front of it, then exiting the highway. Many of the drivers reported extreme frustration with motorists for their lack of courtesy and understanding of the performance constraints imposed by large trucks. All of the drivers reported similar experiences in which motorists pass their trucks yelling obscenities, but the truck driver is clueless regarding what he or she might have done to provoke the outburst. In the words of a trucker, “The toughest part of my job is being a courteous, defensive driver when no one else is.”

In addition to identifying specific unsafe driving acts, the open-ended interviews with truck drivers and other subject matter experts also contributed to an understanding of why the behaviors occur, or at least, what some of the conditions are that lead to the unsafe driving acts. These “conditions” include,

- Aggressive or self-centered attitudes;
- Inattentiveness;
- Incompetence;
- Fatigue; and,
- Ignorance.

The experts reported that the condition most common in collisions involving passenger vehicles and large trucks is ignorance of the performance limitations and capabilities of large trucks. It appears that most drivers are unaware of the limited acceleration, braking, and visibility of large trucks, and of the relationship between mass and velocity, and the potential consequences of that relationship to safety.

REVIEWED COLLISION INVESTIGATION REPORTS

Collision investigation reports provided by law enforcement agencies from California, Delaware, Florida, Indiana, Maryland, Pennsylvania, and Washington were reviewed and the primary collision factors tabulated for collisions in which the driver of the passenger vehicle contributed to the crash. Table 9 presents the results of this project task.

TABLE 9
UNSAFE DRIVING ACTS IN THE VICINITY OF LARGE TRUCKS: COLLISION REPORTS

Frequency	Unsafe Driving Act
115	Unsafe speed (e.g., approaching too fast from the rear/misjudging truck's speed)
97	Driving left of center or into opposing traffic
72	Unsafe turning, primarily turning with insufficient headway
69	Driving inattentively (e.g., reading, talking on phone, fatigue-induced inattention)
65	Failure to stop for a stop sign or light (also, early or late through a signal)
33	Unsafe crossing, primarily crossing traffic with insufficient headway
31	Following too closely
28	Striking the side of a truck or trailer while passing in the same direction (e.g., curve, rain)
27	Driving in the "no zones" (left rear quarter, right front quarter, and directly behind)
24	Merging improperly into traffic, causing a truck to maneuver or brake quickly
23	Striking the rear of a truck or trailer that is stopped or moving slowly in traffic
15	Changing lanes in front of a truck, then braking (for traffic, obstacle, toll gate, etc.)
14	Striking a truck while passing in oncoming lane
11	Changing lanes into a truck (i.e., the trailer)
10	Changing lanes abruptly in front of a truck
10	Driving while impaired by alcohol or other drug
7	Pulling into traffic from roadside in front of a truck without accelerating sufficiently
7	Failure to discern that the trailer of a maneuvering truck is blocking the roadway
6	Striking the front or rear of a truck or trailer while changing lanes
5	Unsafe passing, primarily passing with insufficient headway
3	Abandoned vehicle in travel lane or impeding traffic
2	Driving between large trucks
2	Failure to slow down in a construction zone
2	Failure to slow down in response to environmental conditions (e.g., fog, smoke, rain, bright sun)
2	Maneuvering to the right of a truck that is making a right turn (the "right turn squeeze")
2	Changing lanes (U-turn) in toll booth area/interchange
1	Operating at dawn or dusk without headlights

More than 1,000 collision investigation reports from seven states were reviewed and the primary collision factors recorded. Included in the review were reports of fatal collisions involving a large truck and at least one passenger vehicle, in which the behavior of a passenger vehicle driver was determined to be a contributing factor to the collision. Crashes in which the truck driver was determined to be at fault (approximately 24 percent of all reports reviewed), and collisions in which a passenger vehicle crashed into a truck legally parked at roadside, were excluded.

The results of the review of collision investigation reports are generally consistent with the results of the statistical review and the interviews with experts. The statistical summaries from FARS and the TIFA File (both sources derived from collision reports) and the collision reports reviewed as part of the current project, indicate greater salience for head-on collisions and collisions resulting from right of way violations than the interview data. During interviews, the experts tended to emphasize lane position, lane changing, and merging behaviors as particularly dangerous. All sources of information implicate unsafe speed as a major contributing factor to crashes involving passenger vehicles and large trucks. In short, driving into opposing traffic, turning and crossing in the paths of oncoming trucks, unsafe speed, driving inattentively, and merging and lane changing behavior have emerged as leading unsafe driving acts of motorists from all sources of inquiry.²

CONDUCTED UDA RATING BY EXPERTS

The lists of unsafe driving acts resulting from the statistical reviews, interviews with experts, and the review of collision investigation reports were used to develop a final UDA list. Some of the UDAs from the collision reports are descriptions of collisions, which precludes the utility of the behaviors as driving acts that could be observed by an officer and used as motivation to make an enforcement stop. In other words, some of the UDAs from the collision reports are descriptions of collision types that were caused by other, precursor UDAs. For this reason, the descriptions of five of the UDAs listed in Table 9 were changed for use in the final UDA list. For example, Striking the side of a truck or trailer while passing in the same direction became, Crossing a lane line near the side of a truck or trailer while passing. Similarly, Changing lanes into a truck was combined with Striking the front or rear of a truck or trailer while changing lanes, to become, Nearly striking the front or rear of a truck or trailer while changing lanes; Striking the rear of a truck or trailer that is stopped or moving slowly in traffic became, Nearly striking the rear of a truck or trailer that is stopped or moving slowly in traffic. Striking a truck while passing in the oncoming lane was eliminated because the precursor behaviors were addressed by the UDAs, Driving left of center or into opposing traffic and Unsafe passing. Changing lanes in a toll both area also was excluded from the final UDA list because the behavior was described by two other UDAs, Changing lanes abruptly in front of a truck and Changing lanes in front of a truck, then braking for traffic, obstacle, toll gate, etc.

² Data concerning unsafe driving acts by the operators of large trucks are summarized in Appendix A.

Two UDAs that were not included in the list that was derived from collision reports were added to the final list. Nearly striking an unattended or parked truck at roadside was added in response to the large number of collisions reviewed in which drivers drifted out of their lane and into a truck parked legally at the side of the roadway. And, Failure to permit a truck to merge was added to the final list because it was mentioned during the interviews with truck drivers.

The final list of UDAs was reviewed by OMC personnel, then prepared as a rating instrument, or form, to permit experts to assign values to each UDA. The 26 UDAs were presented in four categories: Speed-Related, Right-of-Way-Related, Judgment Problems, and Lane Change/Lane Position-Related. Each of the UDAs was presented in a box along with two, 10-point scales, as shown in Figure 3. The first scale asked the respondents to estimate the danger of the act, which was defined as a combination of the probability and severity of a collision when committed by a motorist in the vicinity of a large truck. The second scale asked the respondents to estimate the frequency that the driving act occurs. Respondents were instructed to circle the numbers on both scales that best reflect their subjective estimates concerning the driving act listed at the top of the box.

Following too closely

How dangerous is this?

Not Dangerously Moderately Dangerous Extremely Dangerous

1 ---- 2 ---- 3 ---- 4 ---- 5 ---- 6 ---- 7 ---- 8 ---- 9 ---- 10

How frequently does this occur?

Hardly Ever Moderate Frequency Very Frequently

1 ---- 2 ---- 3 ---- 4 ---- 5 ---- 6 ---- 7 ---- 8 ---- 9 ---- 10

Figure 3. Example of one UDA from the rating form.

The following admonition was included in the instructions to respondents.

Sometimes there is a tendency to use only the center of the scale when responding to questions like these. Please consider each statement separately--without regard to your previous answers--and do not hesitate to use the extremes of the scales when you believe those responses to best reflect your opinions.

Rating forms were sent to 25 subject matter experts from across the U.S. The sample included many of the collision investigators who were interviewed earlier in the study and other experts who were identified later. Completed forms were returned by 21 of the experts. Data were entered and mean values were calculated. Table 10 presents the UDAs listed in descending order of their Danger and Table 11 presents the UDAs in order of their Frequency, as determined by the experts' rating. Table 12 presents the UDAs in order of a composite measure, defined as Criticality.

TABLE 10
UNSAFE DRIVING ACTS: EXPERTS' RATING OF DANGER

Mean Score: Danger	Unsafe Driving Act
9.67	Driving left of center or into opposing traffic
9.62	Unsafe passing, primarily passing with insufficient headway
9.52	Driving while impaired by alcohol or other drug
9.14	Failure to stop for a stop sign or light (also, early or late through a signal)
8.95	Failure to discern that the trailer of a maneuvering truck is blocking the roadway
8.90	Unsafe crossing, primarily crossing traffic with insufficient headway
8.76	Driving inattentively (e.g., reading, talking on phone, fatigue-induced inattention)
8.76	Merging improperly into traffic, causing a truck to maneuver or brake quickly
8.76	Pulling into traffic from roadside in front of a truck without accelerating sufficiently
8.71	Unsafe turning, primarily turning with insufficient headway
8.57	Failure to slow down in a construction zone
8.57	Changing lanes abruptly in front of a truck
8.38	Failure to slow down in response to environmental conditions (e.g., fog, smoke, rain, bright sun)
8.19	Changing lanes in front of a truck, then braking (for traffic, obstacle, toll gate, etc.)
8.05	Unsafe speed (e.g., approaching too fast from the rear/misjudging truck's speed)
8.05	Abandoning vehicle in travel lane or impeding traffic
7.90	Following too closely
7.70	Nearly striking an unattended or parked truck at roadside
7.67	Driving in the "no zones" (left rear quarter, right front quarter, and directly behind)
7.57	Maneuvering to the right of a truck that is making a right turn (the "right turn squeeze")
7.50	Nearly striking the front or rear of a truck or trailer while changing lanes
7.43	Failure to permit a truck to merge
7.33	Operating at dawn or dusk without headlights
7.19	Crossing a lane line near the side of a truck or trailer while passing
6.67	Driving between large trucks
6.67	Nearly striking the rear of a truck or trailer that is stopped or moving slowly in traffic

Standard deviations from the mean were calculated for all UDAs. This procedure found considerable agreement among the experts concerning the relative danger of the UDAs. For example, 17 of the 21 experts assigned the maximum score to Driving left of center or into opposing traffic, and 14 experts gave the maximum score to Unsafe passing (six gave it a "9" and one gave it an "8"). Low standard deviations and high mean scores for these and most of the other UDAs on the list reflect a lack of variance in this measure. Responses to a few of the UDAs, however, showed somewhat less agreement among the experts. In particular, the UDAs that involved nearly striking a truck (i.e., stopped or moving slowly, parked at roadside, or while changing lanes) received broader ranges of responses than other driving behaviors because the word "nearly" implied to some respondents that much of the danger had been averted.

TABLE 11
UNSAFE DRIVING ACTS: EXPERTS' RATING OF FREQUENCY

Mean Score: Frequency	Unsafe Driving Act
8.05	Following too closely
8.00	Unsafe speed (e.g., approaching too fast from the rear/misjudging truck's speed)
7.90	Driving inattentively (e.g., reading, talking on phone, fatigue-induced inattention)
7.76	Driving in the "no zones" (left rear quarter, right front quarter, and directly behind)
7.67	Merging improperly into traffic, causing a truck to maneuver or brake quickly
7.62	Failure to slow down in a construction zone
7.48	Failure to slow down in response to environmental conditions (e.g., fog, smoke, rain, bright sun)
7.10	Failure to stop for a stop sign or light (also, early or late through a signal)
7.10	Changing lanes abruptly in front of a truck
6.71	Changing lanes in front of a truck, then braking (for traffic, obstacle, toll gate, etc.)
6.57	Unsafe turning, primarily turning with insufficient headway
6.52	Pulling into traffic from roadside in front of a truck without accelerating sufficiently
6.19	Failure to permit a truck to merge
5.76	Unsafe crossing, primarily crossing traffic with insufficient headway
5.76	Driving between large trucks
5.67	Unsafe passing, primarily passing with insufficient headway
5.65	Nearly striking the front or rear of a truck or trailer while changing lanes
5.52	Maneuvering to the right of a truck that is making a right turn (the "right turn squeeze")
5.52	Operating at dawn or dusk without headlights
5.48	Driving while impaired by alcohol or other drug
5.35	Nearly striking the rear of a truck or trailer that is stopped or moving slowly in traffic
5.29	Crossing a lane line near the side of a truck or trailer while passing
4.90	Driving left of center or into opposing traffic
4.24	Failure to discern that the trailer of a maneuvering truck is blocking the roadway
4.05	Nearly striking an unattended or parked truck at roadside
3.33	Abandoning vehicle in travel lane or impeding traffic

The experts' ratings of the frequency of the UDAs were in less agreement than their ratings of danger. Greater variance concerning the frequency of specific UDAs was expected because the experts were instructed to base their responses on their personal and professional experiences. Regional and operational differences were intentionally included in the sample; those differences are reflected in the variance of responses to the question of frequency of occurrence. For example, Maneuvering to the right of a truck that is making a right turn received frequency scores ranging from a low of "1" to a high of "10." Also, it is interesting to note that the two UDAs with the greatest agreement among the experts concerning danger (Unsafe passing and Driving while impaired) received the greatest variance in responses concerning frequency, as measured by standard deviation from the mean.

TABLE 12
UNSAFE DRIVING ACTS: EXPERTS' RATING OF CRITICALITY
(DANGER + FREQUENCY)

Combined Mean Scores	Unsafe Driving Act
16.67	Driving inattentively (e.g., reading, talking on phone, fatigue-induced inattention)
16.43	Merging improperly into traffic, causing a truck to maneuver or brake quickly
16.24	Failure to stop for a stop sign or light (also, early or late through a signal)
16.19	Failure to slow down in a construction zone
16.05	Unsafe speed (e.g., approaching too fast from the rear/misjudging truck's speed)
15.95	Following too closely
15.86	Failure to slow down in response to environmental conditions (e.g., fog, smoke, rain, bright sun)
15.67	Changing lanes abruptly in front of a truck
15.43	Driving in the "no zones" (left rear quarter, right front quarter, and directly behind)
15.29	Unsafe passing, primarily passing with insufficient headway
15.29	Unsafe turning, primarily turning with insufficient headway
15.29	Pulling into traffic from roadside in front of a truck without accelerating sufficiently
15.00	Driving while impaired by alcohol or other drug
14.90	Changing lanes in front of a truck, then braking (for traffic, obstacle, toll gate, etc.)
14.67	Unsafe crossing, primarily crossing traffic with insufficient headway
14.57	Driving left of center or into opposing traffic
13.62	Failure to permit a truck to merge
13.19	Failure to discern that the trailer of a maneuvering truck is blocking the roadway
13.15	Nearly striking the front or rear of a truck or trailer while changing lanes
13.10	Maneuvering to the right of a truck that is making a right turn (the "right turn squeeze")
12.86	Operating at dawn or dusk without headlights
12.48	Crossing a lane line near the side of a truck or trailer while passing
12.43	Driving between large trucks
12.02	Nearly striking the rear of a truck or trailer that is stopped or moving slowly in traffic
11.75	Nearly striking an unattended or parked truck at roadside
11.33	Abandoning vehicle in travel lane or impeding traffic

Combining the mean scores for each UDA places equal weight on the experts' ratings of Danger and Frequency of occurrence to create a separate metric, labeled Criticality. As composite scores, the Criticality values reflect both the relative danger and the relative frequency of the UDAs. In this way, driving behaviors that are considered to be extremely dangerous, but infrequent, reasonably can be compared to UDAs that are only moderately dangerous, but extremely frequent. For example, Driving left of center or into opposing traffic was rated by the experts as the most dangerous of the UDAs, but one of the least frequent (23rd out of 26); the composite score places Driving left of center as the 16th highest-ranked UDA in overall Criticality.

Similarly, Following too closely was rated by the experts as the most frequent of the UDAs, but 17th in terms of danger; the composite score places Following too closely as the seventh UDA on the Criticality list. As a final example, Driving inattentively was rated by the experts as the seventh most dangerous UDA and the third most frequent; the combined danger and frequency values place Driving inattentively at the top of the Criticality list.

The internal validity of the Criticality ratings can be assessed by comparing the rank-orders of the UDAs in Table 12 to the rank-orders of corresponding UDAs in Table 7 (Expert Interviews) and Table 9 (Collision Reports). For example, Driving inattentively, which received the highest Criticality score, previously was the second most-frequently mentioned UDA during interviews and the fourth most frequent contributing factor recorded in the collision reports. Similarly, Unsafe speed received the fifth-highest Criticality score, was the eighth most frequently-mentioned UDA by the experts interviewed, and the most frequently cited contributing factor in the collision reports. Comparisons such as these, and the systematic procedures that led to the final UDA list, support the use of the criticality values as the most appropriate means for assigning relative importance to the unsafe driving acts of motorists in the vicinity of large trucks.

IMPLICATIONS

As stated in the Introduction to this report, the purpose of the current research is to identify the unsafe driving acts of motorists in the vicinity of large trucks. This objective has been achieved by reviewing relevant statistical summaries, interviewing a representative sample of subject matter experts, recording contributing factors from a large sample of collision investigation reports, and conducting a systematic rating procedure. These research tasks have resulted in an ordered list of the unsafe driving acts of motorists that contribute to collisions with large trucks. The following paragraphs discuss the implications of the research results to the project's secondary objectives, the development of recommendations for training materials and possible changes to the Uniform Vehicle Code and Model Traffic Ordinance.

IMPLICATIONS FOR THE DEVELOPMENT OF TRAINING MATERIALS

The disproportionate number of fatalities resulting from truck collisions, and the disproportionate representation of passenger vehicle operators among those fatalities, creates the perception among many motorists and some law enforcement officers that truck drivers must be disproportionately at fault. Analyses conducted during the current study, and other recent work that has focused on this issue, indicate that the drivers of passenger vehicles, rather than truck drivers, are disproportionately responsible for crashes involving passenger vehicles and large trucks. Further, ignorance of the performance limitations of large trucks appears to be a contributing factor to many of the unsafe driving acts of motorists.

The results of the current study could be applied to the development of separate training materials intended for, 1) truck drivers, 2) drivers of passenger vehicles, and 3) law enforcement officers, as summarized below.

Training For Truck Drivers

Most operators of commercial motor vehicles receive formal training, but most of the training they receive is devoted to technical issues rather than driving style or technique. Accordingly, many truck drivers develop a driving style that is shaped by operational conditions. Those conditions include, for some drivers, a system of payment that encourages faster vehicle speeds and more hours of operation than advisable, and unrealistic schedules and expectations of trucking company managers that encourage truck drivers to hurry, despite the risks involved. The conditions also include sharing the road with motorists who are inattentive, fatigued, unskilled, aggressive, self-centered, and/or ignorant of the performance limitations of large trucks.

Most operators of large trucks probably develop a defensive approach to driving as a rational, survival mechanism. It is safe to assume that truckers who do not drive defensively (i.e., anticipate the errors and encroachment of others on the road) are more likely to be involved in crashes than those who drive defensively, because motorists routinely drive unsafely in the vicinity of large trucks.

It is likely that most truck drivers already are painfully aware of the unsafe driving acts of motorists that lead to dangerous entanglements, and it is likely that most truckers already are aware of defensive driving techniques. However, knowing about the benefits of defensive driving and actually practicing defensive driving techniques can be quite separate in some individuals; also, lapses in defensive driving practices are not uncommon, even among the safest drivers. For these reasons, it is possible that the list of UDAs that has resulted from the current study might be useful to the developers of training programs for truck drivers. At the very least, the list presented in Table 12 could serve as a checklist of the motorist behaviors for which truck drivers must remain vigilant when on the road.

Training For the Drivers of Passenger Vehicles

It might be extremely difficult to change drivers' attitudes, attentiveness, and general competence, or to prevent drivers from driving while fatigued or impaired. However, it might be possible to at least partially remedy widespread ignorance about the performance characteristics of large trucks by programs designed to inform motorists that commercial motor vehicles are not just "large cars." The Office of Motor Carriers' No Zone Program is a good example of this approach. Additional public information and education programs could be developed to illustrate the acceleration, braking, and turning limitations of large trucks. Motorists probably would be less inclined to drive dangerously in the vicinity of large trucks if they were better informed about the trucks' limitations and capabilities.

Another approach to educating motorists is to develop materials to be included in driver training programs. A model curriculum could be developed based on the results of the current study to warn novice motorists of the driving behaviors that contribute to collisions; presenting the behaviors in categories of similar UDAs would be particularly appropriate. The model curriculum also should inform the novice drivers of the fundamental performance differences between large trucks and passenger vehicles. And, the curriculum should include explanations of the physical processes that render the occupants of passenger vehicles extremely vulnerable to serious injury or death in any collision with a large truck.

The principal investigator found reviewing reports of collisions between passenger vehicles and large trucks to be a particularly sad task. The narrative and diagrammatic descriptions of crashes are written with clinical objectivity, but the reader automatically fills in the story elements from other sections of the collision report. A simple "T-bone" collision at an intersection thus becomes a young, single mother who, late for work and distracted by children in the back seat, pulls out into the path of an oncoming dump truck. It is impossible to be unmoved by collision reports such as this. After reviewing only a few reports readers are struck by the realization of how fortunate they are not to have had their momentary lapses of perception or judgment penalized with such grim consequences. Perhaps the model curriculum should include a few collision investigation reports for novice drivers to read. It might encourage them to be more careful.


Training For Law Enforcement Officers

A third training approach to mitigating the unsafe driving acts of motorists is to develop training materials to sensitize law enforcement officers to the hazards of unsafe driving acts in the vicinity of large trucks. It is recommended that a training program, based on study results, be developed for law enforcement officers. The training program should be composed of a UDA detection guide, training booklet, and video, suitable for roll call training. An example of the proposed detection guide is presented as Figure 4.

Unsafe Driving Acts in the Vicinity of Large Trucks

Research conducted for the Federal Highway Administration's Office of Motor Carriers (OMC) has found the following driving behaviors to be primary causes of collisions with large trucks.

- Driving inattentively (e.g., reading, talking on phone, fatigue)
- Merging improperly into traffic or failing to permit a truck to merge
- Changing lanes abruptly in front of a truck
- Driving in the “no zones”
- Unsafe passing, primarily passing with insufficient headway
- Unsafe turning, primarily turning with insufficient headway
- Pulling into traffic in front of a truck without accelerating sufficiently
- Changing lanes in front of a truck, then braking (for traffic, toll gate, exit, etc.)
- Unsafe crossing (i.e., pulling out in front of an approaching truck)
- Maneuvering to the right of a turning truck
- Crossing a lane line near the side of a truck (while passing or changing lanes)
- Driving between large trucks
- Failure to discern that the trailer of a turning truck is blocking the roadway
- Nearly striking the rear of a slowly moving, stopped, or parked truck




Front

Unsafe Driving Acts in the Vicinity of Large Trucks

Research conducted for the Federal Highway Administration's Office of Motor Carriers (OMC) has found the following vehicle code violations to be primary causes of collisions with large trucks.

- Failure to stop for a stop sign or light (also, early or late through a signal)
- Failure to slow down in a construction zone
- Failure to slow down in response to environmental conditions (e.g., fog, smoke, rain, bright sunlight)
- Unsafe speed (e.g., approaching too fast from the rear)
- Following too closely
- Driving While Impaired
- Driving left of center or into opposing traffic
- Operating at dawn or dusk without headlights
- Abandoning a vehicle in the traffic lane or impeding traffic



Back

Figure 4. Proposed UDA detection guide.

The training materials developed for law enforcement officers should distinguish between the driving acts that are vehicle code violations, such as Following too closely, and those that are unsafe, but not illegal, such as Driving in the No Zones. The training booklet and video should provide narrative and graphic illustrations of the unsafe driving acts, as well as information about the performance characteristics of large trucks and a brief tutorial on the physical laws that determine the consequences of collisions between smaller and larger vehicles. A draft of the proposed training video script is included as Appendix B to this report.

IMPLICATIONS FOR CHANGES TO THE UNIFORM VEHICLE CODE AND MODEL TRAFFIC ORDINANCE

One of the objectives of the current study is to explore the possibility of implementing changes to vehicle codes that would permit officers to cite drivers for unsafe driving practices that presently are not vehicle code violations. The recommended method for encouraging changes to vehicle codes is to propose that the changes be made to the Uniform Vehicle Code (UVC) and Model Traffic Ordinance. The UVC is administered by the National Committee on Uniform Traffic Laws and Ordinances (NCUTLO).

The procedure for changing the UVC begins with a letter to the Chairman of NCUTLO's standing Task Force on UVC Revisions. The letter must briefly describe the proposed changes and be accompanied by relevant supporting information. Issues that are proposed for consideration by the Task Force are posted on the NCUTLO web site for comments by members of the organization.

The Task Force on UVC Revisions meets in October and March of each year to review requests for changes to the Uniform Vehicle Code. Task Force reviews find that some proposed changes are warranted, while others are determined to be impractical; some are found already to be covered in sections of the UVC; and, in other cases, it is found that changes to existing language in the UVC are justified. NCUTLO attorneys draft the modifications to the UVC if the members of the Task Force authorize the change. The entire process takes about one year to complete.

It is recommended that the Associate Administrator of the Office of Motor Carriers and Highway Safety submit a letter to the Chairman of NCUTLO's standing Task Force on UVC Revisions. The letter should request that the Task Force consider changes to the UVC that would include the unsafe driving acts, listed below, as vehicle code violations. The letter should request that any unsafe driving act that is found already to be covered by the UVC, be considered for special language in the UVC, or greater penalties, when committed in the vicinity of a large truck. Special language and greater penalties are warranted because of the greater probability of serious injury or death resulting from collisions between passenger vehicles and large trucks, compared to collisions between passenger vehicles. The current Chairman of NCUTLO's Task Force on UVC Revisions is Mr. Ray Pusey (BDR & Associates, 45 West Fairfield Drive, Dover, DE 19901). A copy of the letter also should be sent to Ms Leila Osina, Executive Vice President of NCUTLO (107 S. West Street, #110, Alexandria, VA 22314). Copies of this report should accompany both letters.

**UNSAFE DRIVING ACTS OF MOTORISTS IN THE VICINITY OF LARGE TRUCKS
THAT ARE RECOMMENDED FOR CHANGES TO VEHICLE CODE VIOLATIONS
IN THE UNIFORM VEHICLE CODE (UVC) AND MODEL TRAFFIC ORDINANCE**

- Driving inattentively (e.g., reading, talking on phone, fatigue)
- Changing lanes in front of a truck, then braking (for traffic, toll gate, exit, etc.)
- Changing lanes abruptly in front of a truck
- Driving in the “no zones”
- Unsafe passing, primarily passing with insufficient headway
- Unsafe turning, primarily turning with insufficient headway
- Unsafe crossing (i.e., pulling out in front of an approaching truck)
- Merging improperly into traffic or failing to permit a truck to merge
- Pulling into traffic in front of a truck without accelerating sufficiently
- Maneuvering to the right of a turning truck
- Crossing a lane line near the side of a truck (while passing or changing lanes)
- Driving between large trucks
- Failure to discern that the trailer of a turning truck is blocking the roadway
- Nearly striking the rear of a slowly moving, stopped, or parked truck

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APPENDIX A

**SUMMARY OF DATA COLLECTED
CONCERNING UNSAFE DRIVING ACTS
BY THE OPERATORS OF LARGE TRUCKS**

UNSAFE DRIVING ACTS OF OPERATORS OF LARGE TRUCKS

The focus of the current study is the unsafe driving acts of motorists, which are responsible for approximately 75 percent of fatal collisions that involve passenger vehicles and large trucks. However, interview and collision report data also were collected concerning the driving actions of the operators of large trucks that contribute to collisions with passenger vehicles. These data are presented in this appendix to preserve the focus and continuity of the report.

Table A1 presents the list of UDAs reported in interviews with collision investigators and Table A2 presents the driving acts of truck operators that contributed to fatal collisions with passenger vehicles, as indicated on a sample of collision reports obtained from the Maryland State Police, the Kansas Highway Patrol, and the California Highway Patrol.

TABLE A1
UNSAFE DRIVING ACTS OF OPERATORS OF LARGE TRUCKS: INTERVIEWS

Frequency	Unsafe Driving Act
11	Following too closely
8	Driving inattentively (e.g., fatigue-induced inattention)
7	Unsafe speed
5	Equipment problems (i.e., bad brakes)
3	Failure to slow down in response to environmental conditions (e.g., fog, smoke, rain, bright sun)
2	Failure to stop for a stop sign or light

TABLE A2
UNSAFE DRIVING ACTS OF OPERATORS OF LARGE TRUCKS: COLLISION REPORTS

Frequency	Unsafe Driving Act
55	Unsafe speed
28	Unsafe turning, primarily turning with insufficient headway
26	Driving inattentively (e.g., fatigue-induced inattention)
20	Failure to stop for a stop sign or light
14	Changing lanes improperly
14	Driving left of center or into opposing traffic
10	Unsafe crossing, primarily crossing traffic with insufficient headway
5	Unsafe passing
2	Merging improperly into traffic
1	Failure to slow down in response to environmental conditions (e.g., fog, smoke, rain, bright sun)
1	Backing improperly
1	Following too closely

APPENDIX B
DRAFT TRAINING VIDEO SCRIPT

THE UNSAFE DRIVING ACTS OF MOTORISTS IN THE VICINITY OF LARGE TRUCKS

Training Video Script

(Scenes of trucks on the highway; title rolls; Narrator begins voice-over)

Narrator: The number of fatal crashes involving large trucks has declined significantly during the past decade, from more than 4 per 100 million miles driven during the 1980s to about 2.5 fatal crashes per 100 million miles now. Despite these improvements, there are nearly 400,000 crashes involving large trucks in the US each year. Of that number, more than 4,000 crashes result in about 5,000 fatalities.

(Scenes of truck crashes from news sources, voice-over)

Narrator: Trucks compose about eight percent of all vehicles involved in fatal crashes, however, truck-involved crashes result in twelve percent of the total number of lives lost on the nation's roads and highways. The disproportionate involvement of trucks in fatal crashes is a reflection of a fundamental law of physics, which is expressed by the equation,

(Dissolve to graphic, equation is "teletyped" on the screen)

$$\text{Kinetic Energy} = .5 \times \text{mass} \times (\text{velocity})^2$$

(Scenes from collision investigations or test crashes, provided by DoT, voice-over)

Narrator: Kinetic energy is dissipated in a collision by friction, heat, and the deformation of mass. Generally, the more kinetic energy to be dissipated in a collision, the greater the potential for injury to vehicle occupants. Trucks typically weigh 20 to 30 times as much as passenger vehicles. The structural properties and greater mass of trucks better absorb the kinetic energy generated by a collision, which places the occupants of the smaller vehicles at a considerable disadvantage. Largely as a consequence of differential mass, the occupants of large trucks compose only 14 percent of the fatalities resulting from fatal truck crashes; 86 percent of the fatalities occur outside the truck, to pedestrians, cyclists, and, primarily, the occupants of passenger vehicles.

(More scenes of test crashes, showing greater speed, voice-over)

Narrator: The disadvantage to smaller vehicles that results from differential mass is compounded by speed. Because kinetic energy is determined by the square of the vehicle's speed, rather than by speed alone, the probability of injury, and the severity of injuries that occur in a crash, increase exponentially with vehicle speed. For example, a 30 percent increase in speed (e.g., from 50 to 65 mph [80.5 to 104.6 kmh]) results in a 69 percent increase in the kinetic energy of a vehicle.

(Truck inspector standing in front of a large truck, then cut to close-ups of wheels and brake systems as he points out the features, voice-over)

Truck Inspector: Most people believe that because trucks are big, they must have terrific brakes. Well, they do, but they cannot stop a large truck nearly as quickly as a passenger vehicle can stop. When a trucker slams on his or her brakes, air must travel through a hose for about 40 feet to reach a valve that releases more air under pressure to operate the mechanical portion of the brake system. The pneumatic and mechanical lag results in a delay of more than two seconds, compared to the nearly instantaneous hydraulic connection in a passenger vehicle. For example, a car traveling at 55 miles per hour can stop in about 225 feet, but a large truck traveling at the same speed can take more than 400 feet to stop.

(Scenes of truck crashes from news sources, voice-over)

Narrator: The disproportionate number of fatalities resulting from truck collisions, and the disproportionate representation of passenger vehicle operators among those fatalities, creates the perception among many motorists, and some law enforcement officers, that truck drivers must be disproportionately at fault. However, analyses of large numbers of collision reports have found that the drivers of passenger vehicles, rather than truck drivers, are disproportionately responsible for crashes involving passenger vehicles and large trucks. Ignorance of the performance limitations of large trucks appears to be a contributing factor to many of the unsafe driving acts of motorists.

(Uniformed officer standing)

Officer 1: The Federal Highway Administration's Office of Motor Carriers sponsored research to identify the driving behaviors that lead to collisions between passenger vehicles and large trucks. The researchers interviewed truck drivers, collision investigators, and other experts from across the country, and they reviewed thousands of collision reports. The study found 23 unsafe driving acts committed by motorists to be the primary causes of crashes between passenger vehicles and large trucks. The unsafe driving acts are presented in four categories: Judgment Problems, Speed-Related Behaviors, Right-of-Way or Headway-Related Behaviors, and Lane Change or Lane Position Problems (Title slides are displayed on the screen as each one is mentioned)

(Title Slide: Judgment Problems, dissolve to uniformed officer, traffic in background)

Officer 2: The research found Driving inattentively to be the leading contributing factor to collisions between passenger vehicles and large trucks. (Driving Inattentively appears on the screen as we cut to scenes of inattentive driving: talking on cell phone, applying make up, adjusting radio.) We have all seen this before. Unfortunately, a momentary lapse of judgment in the vicinity of a large truck can be fatal.

Officer 2: (Failure to stop for a stop sign or light appears on the screen as we cut to the scene of the black truck plowing into the pickup truck) Failure to stop for a stop sign or light is another killer. You've probably seen this example before. Something like this happens every day.

Officer 2: (Driving While Impaired appears on the screen as we cut to a scene from the DWI detection video) Driving while impaired by alcohol or other drugs is another judgment problem that contributes to collisions of all types, but you already know that.

Officer 2: (Failure to discern that the trailer of a maneuvering truck is blocking the roadway appears on the screen as we cut to a scene of a truck blocking the lane in semi-darkness) You might not know about this problem. It occurs primarily during pre-dawn hours, when the truck's headlights, far from the trailer, are interpreted by a motorist, as evidence that the obstacle has passed. Similarly, Operating at dawn or dusk without headlights also contributes to collisions between passenger vehicles and large trucks. (Operating at dawn or dusk without headlights appears on the screen).

Officer 2: (Maneuvering to the right of a truck that is making a right turn appears on the screen as we cut to a scene of a truck turning right as a car zips in on the right) Maneuvering to the right of a truck that is making a right turn is called the "right turn squeeze." Some people just don't realize that a large truck cannot turn right from the right turn lane, so they slip in on the truck's right and either prevent the turn, if they are lucky, or cause a crash, if they are not. Some folks know what the truck driver is doing, but they are impatient and insist on getting through, even if it means delaying everyone else.

Officer 2: (Nearly striking the rear of a truck or trailer that is stopped or moving slowly in traffic and Nearly striking an unattended or parked truck at roadside appear on the screen as we cut to a scene of a car approaching the rear of a truck that is stopped in the lane) Crashing into the rear of a truck or trailer that is stopped or moving slowly in traffic is another way that motorists die as a result of judgment problems. The drivers were traveling too fast for the conditions, they misjudged the speed of the truck, or they looked away from the road for a moment. A related driving act is striking an unattended or parked truck at roadside.

(Title Slide: Speed-Related Behaviors, dissolve to uniformed officer, traffic in background)

Officer 3: The research found Unsafe speed to be one of the leading contributors to crashes between passenger vehicles and large trucks. Faster vehicle speeds mean less time for a driver to react to the movements of other vehicles, including slower trucks. Speed also contributes to the severity of a crash by generating kinetic energy.

Officer 3: (Failure to slow down in a construction zone appears on the screen as we cut to a scene of a vehicle speeding into a construction zone with trucks around) Related unsafe driving behaviors are Failure to slow down in a construction zone, and Failure to slow down in response to environmental conditions, for example fog, smoke, rain, or bright sunlight (scenes of examples from news video of big pileup near Bakersfield). It is difficult to understand why people continue to drive at highway speeds when they can't see more than a few feet in front of their vehicles.

(Title Slide: Right of Way/Headway-Related Behaviors, dissolve to uniformed officer, traffic in background)

Officer 4: One of the most frequent unsafe driving acts is Following too closely (cut to scene of car tailgating a large truck). Tailgating always is dangerous, but it is especially dangerous to follow a truck too closely. Debris can fall from a truck or be kicked up by its tires. Driving that close to a truck greatly restricts visibility, and there is no time to react to an emergency. Everyone knows that following too closely is dangerous, but you see it every day.

(Driving between large trucks appears on the screen as we cut to a scene from a freeway overpass, then to news tape of a crash scene) Here's a behavior that makes Following too closely even more dangerous--Driving between large trucks.

Officer 4: There are three, closely-related unsafe driving acts that involve a driver accepting an unsafe headway. Headway is the distance from one vehicle to another that is approaching. (Unsafe Passing appears on the screen as we cut to scenes of a car passing a truck). Some drivers become frustrated or impatient when their progress is impeded by traffic, and some take chances when attempting to pass. Unsafe passing usually involves passing with an insufficient headway, or distance to the oncoming traffic. Sometimes the oncoming traffic is a large truck and there is no escape.

(Unsafe Turning appears on the screen as we cut to a scene of a car waiting to turn left on a highway with oncoming traffic) Unsafe turning and Unsafe crossing result in many fatalities each year. (Unsafe Crossing appears on the screen as we cut to a scene of a car waiting to cross a busy highway) Some drivers are fooled by a truck's size into thinking it is moving slower than it is; others are willing to take a chance, believing the truck can slow down in time to avoid a collision. Whatever the motivation, the passenger vehicle will lose in a right of way conflict with a large truck.

The final unsafe driving act in this category is Driving left of center or into opposing traffic (Driving Left of Center appears on the screen as we cut to a scene of an undivided highway with vehicles passing slower trucks) This cue was found to be the most dangerous of all of the unsafe driving acts. Sometimes, the motorist's reason for being left of center is to pass another vehicle, but the research found a large proportion of cases to have no clear explanation. One analysis found passenger vehicles to be hit head-on in the trucks' lane in 23 percent of all fatal collisions between large trucks and passenger vehicles.

(Title Slide: Lane Change/Lane Position-Related Behaviors, dissolve to uniformed officer, traffic in background)

Officer 5: The research found several driving behaviors related to lane changes and lane position to be contributing factors in collisions between passenger vehicles and large trucks. (Pulling into traffic from roadside appears on the screen as we cut to highway scenes illustrating the UDAs, officer's voice over) Pulling into traffic from

roadside without accelerating sufficiently, and Merging improperly, that is, in a manner that causes a truck to maneuver or brake quickly, are particularly dangerous, because of the response lag in the braking systems of trucks. It is not safe to assume that the driver of an oncoming truck can slow down or stop the rig in the same distance as a passenger vehicle. Similarly, Failure to permit a truck to merge is not just rude driving behavior, its dangerous.

(Changing lanes in front of a truck appears on the screen as we cut to scenes of lane changing) Changing lanes abruptly in front of a truck, and Changing lanes in front of a truck, then braking for whatever reason, also are very dangerous. Cutting into the open space in front of a truck to reach a highway exit is very aggravating to truck drivers. Motorists should slow down and exit behind the truck--it only takes a few more seconds. Similarly, cutting in front of a truck to beat it to a single-lane construction zone places everyone around, including the road workers, in great jeopardy by reducing the truck driver's ability to stop safely.

(Return to officer, then Driving in the No Zones appears on the screen as we cut to scenes of the UDA) Finally, one of the most unsafe things a motorist can do is to ride along in a truck driver's blind spots. The areas immediately behind and to the left and right of a truck are called the No Zones, and for good reason. Vehicles in those zones cannot be seen by the truck driver and if the truck must maneuver quickly, well, you've probably seen what can happen.

Narrator: (Voice-over scenes of trucks at a truck stop, making deliveries, etc.) Nearly every possession we own and nearly all of the food we eat are transported to us, at least part of the way, by trucks. Sometimes it is difficult to appreciate what trucks do for us, but it is important for all motorists to remember that trucks are not "large cars"--they accelerate and stop slower than passenger vehicles, and the truck driver's ability to see other vehicles in the vicinity is limited. When you see the unsafe driving acts described in this video, stop the motorist and explain why their behavior is dangerous. You just might save their life.

To summarize, the unsafe driving acts that lead to collisions with large trucks are:

(Title Slide: Judgment Problems; Scenes from each of the UDA segments appear in sequence, with the UDA teletyped onto the screen, Narrator's voice reads the UDA)

(Title Slide: Speed-Related Behaviors; same summary treatment)

(Title Slide: Right of Way/Headway-Related Behaviors; same summary treatment)

(Title Slide: Lane Change/Lane Position-Related Behaviors; same summary treatment)

(Credits roll; music over)

(Fade to OMC logo; Fade to black)
