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COMPARISON OF CERTAIN VARIABLES IN THE LARGE TRUCK CRASH CAUSATION STUDY WITH VARIABLES CODED IN A REVIEW OF THE TRUCKS INVOLVED IN FATAL ACCIDENTS CASE MATERIALS

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Comparison of Certain Variables in the Large Truck Crash Causation Study With Variables Coded in a Review of the Trucks Involved In Fatal Accidents Case Materials

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16. Abstract

The Large Truck Crash Causation Study (LTCCS) is the largest and most ambitious effort to date to collect data on medium and heavy truck crashes. The purpose of the LTCCS is to identify and understand the factors that contribute to truck crashes in order to develop crash countermeasures that will be effective in reducing the number and severity of truck crashes. The University of Michigan's (UMTRI) Trucks Involved in Fatal Accidents (TIFA) survey covers all medium and heavy trucks involved in a fatal crash. Nominally, all fatal crashes in LTCCS should appear in TIFA.

LTCCS fatal crashes were matched to TIFA cases. Then the TIFA cases were re-examined independently, using the police report and any other information available, to attempt to code certain central crash variables in the LTCCS. The purpose was to determine the extent to which the central LTCCS variables could be coded using only the materials available in the TIFA survey.

The results were mixed. At the highest level, agreement was quite good. Critical reason category agreed in 90.1 percent of the matched cases for which critical reason could be determined. Critical event category agreed in 86.1 percent of cases. However, there were higher rates of disagreement between LTCCS and TIFA at finer levels of detail and missing data rates were higher in the TIFA review cases. This result is not surprising in light of the much greater resources devoted to each case in the LTCCS project.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
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1 Introduction

The Large Truck Crash Causation Study (LTCCS) is the largest and most ambitious effort to date to collect data on medium and heavy truck crashes. The purpose of the LTCCS is to identify and understand the factors that contribute to truck crashes in order to develop crash countermeasures that will be effective in reducing the number and severity of truck crashes. The LTCCS was conceived by the Federal Motor Carrier Safety Administration (FMCSA), and conducted in cooperation with the National Highway Traffic Safety Administration (NHTSA), employing NHTSA crash investigators and using a sampling frame developed by NHTSA for its own crash databases.

Certain LTCCS variables are central to the LTCCS methodology. These variables capture the critical event, the reason for the critical event, the crash type, pre-event maneuver, avoidance maneuver, and right of way for each vehicle. In addition, a set of associated factors was collected, identifying conditions that may be correlated with increased crash risk.

The LTCCS project utilized extensive resources to collect an unprecedented amount of information about each crash. The study was conducted over three years, and involved investigation teams at 24 locations around the country. Each crash was investigated by an experienced crash investigator and an experienced truck inspector, who was responsible for performing the post-crash truck inspection. Each case underwent multiple reviews and additional information—the assessments that are the subject of this review—was coded at a central location. The materials collected include the in-depth investigation, truck inspections, on-site investigation including photographs and crash diagrams, access to relevant administrative files such as driver history files and carrier records, and the ability to conduct interviews with participants, all directed specifically toward establishing the details of the crash event.

The University of Michigan Transportation Research Institute's (UMTRI) Trucks Involved in Fatal Accidents project, in contrast, is a telephone survey of all medium and heavy trucks involved in a fatal crash in the United States. Data collected include a detailed description of the truck and its cargo at the time of the crash, the type of company operating the vehicle, the type of trip the truck was on, how many hours the driver had been at the wheel at the time of the crash, and some details about the truck's role in the crash. Police reports are acquired on all crashes and are used to contact the owner, driver, or any other person with knowledge about the crash and the truck at the time of the crash. The TIFA survey collects the crash type, structured in the same way as the crash type variable in the LTCCS, but none of the other LTCCS variables that describe the crash are determined as part of the survey.

However, since police reports are acquired from the states for each crash, UMTRI has access to all the information contained on the police reports, which often includes details about the crash beyond what is captured in the crash type variable. Almost all police reports include crash diagrams and a narrative of the events. Some also include witness statements, statements from the participants, and even crash reconstructions and vehicle inspections in a few cases.

The purpose of the present project is to use the materials collected as part of the TIFA survey to determine if it is feasible to collect some of the variables about crash events that are part of the LTCCS data. The variables collected include pre-crash maneuver, critical event, critical reason, crash avoidance maneuver, and right of way. The method is to identify the fatal LTCCS crashes in the TIFA data, and independently code the variables for those cases. We then compare the results with the results from the LTCCS team to determine how accurately the data can be collected using only the information available from the TIFA survey.

2 Matching TIFA and LTCCS cases

The first step in the process is to identify the relevant fatal crashes in the TIFA file. We used all crashes determined by the LTCCS researcher to include a fatality. There were 261 such cases with nonzero weights, i.e., that were sampled after the pilot phase of the LTCCS. These 261 were the initial target in the TIFA data.

Since there are no case identifiers in common between the TIFA and LTCCS files, it was necessary to develop an algorithm to match the LTCCS cases in the TIFA files. To do this, we identified variables in common that established the location of the crash, the time of the crash, and that would identify specific vehicles and drivers within a crash.

The LTCCS data has been “sanitized” to prevent identification of specific vehicles in specific crashes, but that is precisely what was necessary to match cases with the corresponding records in TIFA. Both location and time are masked in LTCCS. The locations of the primary sampling units (PSU) are not publicly released, but knowing those locations is necessary to determine the county of the crash. The day of the crash is also censored by setting all crash days to the first day of the month in which the crash occurred. NHTSA very kindly provided the locations of the PSUs and the exact dates of the crash. In addition to state, county, and crash date, we used the hour and minute to identify the crash in time and space. To identify specific vehicles within the crash, we used vehicle descriptors such as make, model year, and vehicle identification number (VIN), and for the driver, date of birth or age at the time of the crash.

Matching was done using computer algorithms. Cases that were not matched using the algorithms were matched by hand. Hand-matching involves dumping all the records that occur in a state on a particular day and searching for the crash and vehicle by identifying cases that might plausibly match but escape the computer match. For example, the crash may have occurred in a neighboring county, or the age may vary by a year, or the VIN may have a typographical error.

The result of the match effort was to identify 245 of the 261 LTCCS cases in the TIFA data. This left 16 unmatched cases.

We then searched the "parent" FARS file. Nominally all trucks in FARS should be in the TIFA file, and in fact TIFA includes some trucks that are not identified as trucks in FARS. The TIFA protocol searches the FARS file to identify cases that are inconsistently coded in FARS (e.g., a gross vehicle weight rating over 10,000 pounds, but identified as a light vehicle) to identify trucks. But it is possible that the vehicle is identified in such a way that it is not caught by the TIFA filter. Accordingly, for each of the 16 unmatched cases, we examined by hand all of the possible cases in FARS. For example, we examined all of the fatal crashes occurring on a given date in the state. Of the 16 unmatched cases, we could not find ten at all in FARS. There was no crash that occurred on the LTCCS crash date that plausibly match. Of the remaining six, the crash was in FARS, but either the LTCCS vehicle was not included or it could not be determined if the LTCCS vehicle was included. In either event—in fact for all of the 16—the relevant record was not in TIFA, so we did not have any of the TIFA materials (primarily police report) to review and code.

3 Assessment Method

With the 245 matched TIFA cases in hand, a data collection method was developed using Microsoft Access. Figure 1 shows a screen-shot of the interface. Data collected included pre-crash maneuver, critical event, critical reason, right of way, crash type, and a set of factors coded if present. In addition, there was a comment field to record any observations about the crash to clarify the coders reasoning for the assessments.

There were two independent reviewers for each case. The reviewers both have long experience in examining police reports, and coding supplemental data. The reviewers include the present writer, who has been involved in the LTCCS from near the beginning. He has over 20 years of experience in dealing with crash data; helped develop the coding scheme for the LTCCS, served on an LTCCS review committee, and has applied similar schemes for other projects. The second reviewer, Robert Pichler, also has extensive experience in reviewing police reports and coding crash events. He coded similar information for the Michigan Fatal Accident Complaint Team (FACT) project. The FACT project captured many variables that also are in the LTCCS, including right of way, sequence of events, crash type, and critical event, for a set of fatal truck crashes in Michigan. The crash type and critical event variables were modeled on the variables in NASS GES and CDS programs, from which the LTCCS variables were taken. Bob has also coded similar information from police reports for other projects.

After each reviewer completed all cases, the results for each case were compared to identify inconsistencies in coding between the two reviewers. For each case in which differences were identified, the two reviewers discussed and reconciled the differences. This procedure ensures inter-coder reliability and reduces the probability of coding errors.

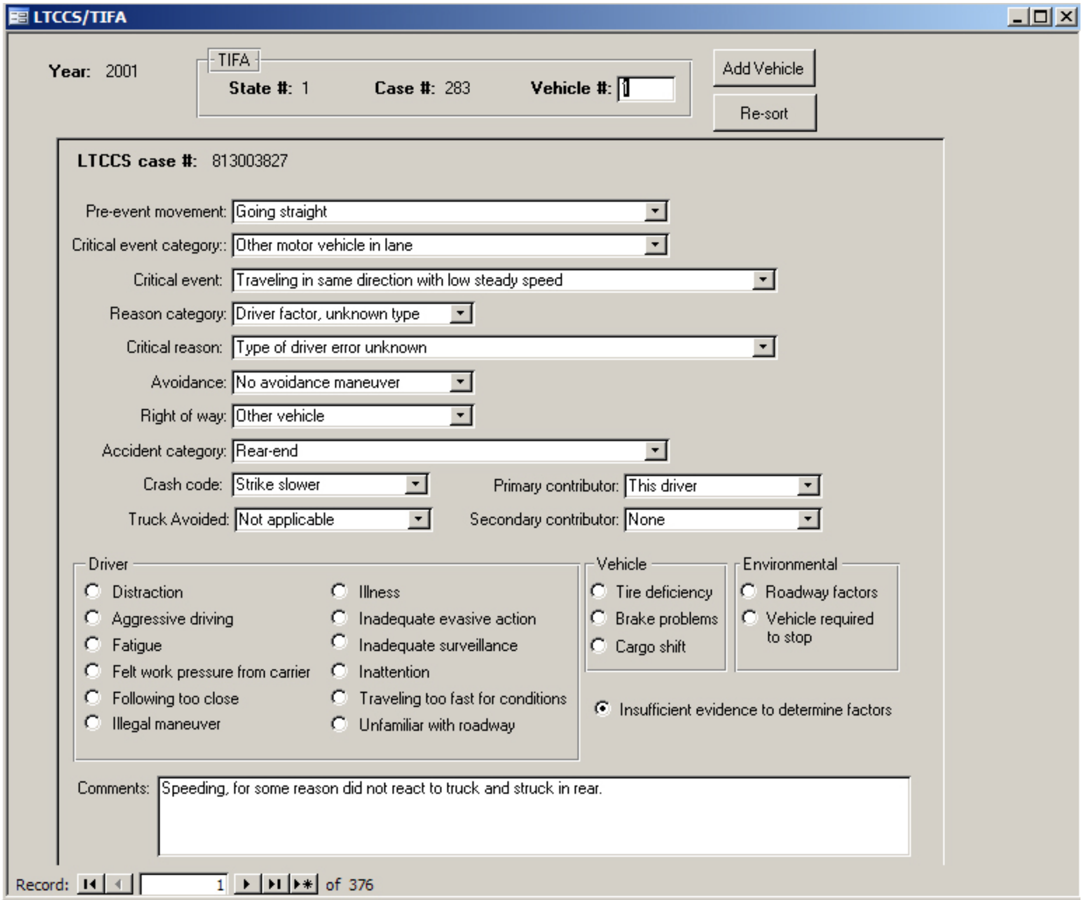

Figure 1 Data-collection Interface

4 Limitations of the method

The information available for the review of TIFA materials is limited primarily to police reports only, or in some cases, supplemental information such as post-crash truck inspections and crash reconstructions that the state may have supplied when sending UMTRI the police report. Most states do not include crash reconstructions—California often includes reconstructions, but most states do not. The usefulness of police reports for the purpose of coding critical event and critical reason data varies from state to state. For example, police reports in large metropolitan areas can be less detailed than those completed by officers primarily focused on traffic safety. The LTCCS protocol included an investigator on-site, who could conduct interviews with all parties, and examine physical evidence at the scene, as well as the police report. In addition, all trucks involved were subject to a Level 1 inspection.

The TIFA survey as currently structured is focused on the vehicle, company, trip, and driver hours driving. In coding critical event and critical reason, the UMTRI reviewers were limited to the information available from a survey not explicitly focused on identifying the critical event in the crash or the critical reason for that event. In this way, the present comparison is a retrospective study, or a meta-study. It is possible that the outcome would be different if the pertinent questions were available at the time of the survey, rather than collected after the fact. Of course, the scale of resources available for the LTCCS and the TIFA projects are radically different.

Finally, UMTRI is dependent on the states to send police reports. In each data year, typically one or two states fails to supply the reports. The states vary from year to year, though one state does not as a matter of state policy. Unfortunately, two of the LTCCS PSUs were located in two states that, for periods during the LTCCS, failed to supply police reports to UMTRI. There were thirteen matched LTCCS cases for which UMTRI did not receive a police report. Accordingly, these thirteen cases could not be coded.

5 Results

The following sections present the results of the attempt to code certain LTCCS variables using only the materials available in the TIFA survey. First, we present the overall results and distributions, comparing them with the corresponding variables in the LTCCS. In the next section, the results are compared on a case by case basis, to identify instances where the results of the TIFA review conflicted with the LTCCS team's determination. Then we describe the results of the attempt to identify the presence of selected driver, vehicle, and environmental factors. Finally, we compare the information on the critical event and critical reason variables with the driver-related and vehicle-related factors variables in FARS.

5.1 Comparison of distributions

This section will provide results of comparison of overall distributions for the most important variables. A later section will provide results of the case-by-case comparison. Comparison of the overall distributions gives a top-level comparison of the results of the two different approaches. The comparison at the case level can show whether a difference in the type and depth of research materials available can make a difference, not just in terms of details but also whether the additional details might actually make a fundamental difference in the evaluation of a case, e.g., change a critical reason from a driver to a vehicle factor, or even change the vehicle assigned the critical reason.

We begin with critical reason because the variable is central to the approach of the LTCCS in evaluating the contribution to crashes. In the LTCCS methodology, adopted by the UMTRI team, the critical reason is coded to the vehicle whose movement immediately precipitated the crash. Critical reasons can be coded to driver actions or failure, vehicle failures, or highway/weather conditions. Where another vehicle in the collision precipitated the crash, critical reason was assigned "not coded to this vehicle."

Table 1 shows the distribution of critical reason category for both the UMTRI review and the LTCCS coding.[1] The table compares the distribution of codes assigned by the UMTRI review team and the LTCCS team. For each team, the number of cases and the percentage of the total for each critical reason category is shown. The UMTRI team had a significantly larger number of cases left unknown than the LTCCS team. The larger number of unknowns for the review of LTCCS cases using TIFA materials is primarily due to the much greater resources employed in the LTCCS study. The table also includes a column that adjusts for the high number of unknowns in the TIFA review, by excluding them from the calculation of percentages.

Table 1 Critical Reason Category as Coded in UMTRI Review and LTCCS

	Review			LTCCS	
Critical reason category	N	%	% excluding unknown	N	%
Not coded to this vehicle	150	61.2	69.8	166	67.8
Driver factors					
Non-performance	4	1.6	1.9	7	2.9
Recognition	9	3.7	4.2	23	9.4
Decision	7	2.9	3.3	19	7.8
Performance	1	0.4	0.5	4	1.6
Driver factor, unk. type	35	14.3	16.3	10	4.1
Vehicle factor	7	2.9	3.3	10	4.1
Highway/weather factor	2	0.8	0.9	3	1.2
Unknown	30	12.2		3	1.2
Total	245	100.0	100.0	245	100.0

Overall, the distribution of critical reason category is reasonably similar. The percentage of cases "not coded to this vehicle" is almost the same between the two files. Similarly, both teams coded a similar, low percentage of cases in which the critical reason was coded to a vehicle factor or a highway/weather (environmental) factor. There are large differences in the details of the driver reason. In the critical reason variable, four general categories are defined: Non-performance (asleep or other incapacitation); recognition (e.g., distraction or looked but failed to see); decision (e.g., misjudgment of gap or too fast for conditions); and performance (e.g., overcompensation or freezing). Often the review team, using only the materials available from the TIFA file, primarily the police report and associated materials, was unable to distinguish a recognition error from a decision error. There simply was not enough information, for example,

[1] Coding of critical reason category in the LTCCS required some correction before comparing with the TIFA review data. In the LTCCS data, critical reason category is a derived variable. That is, it is derived from the codes in the full critical reason variable. The full critical reason variable includes a level for "driver factor, unknown type," but the critical reason category variable does not. It appears that in generating the critical reason category variable, all cases coded "driver factor, unknown type" were assigned the "performance" code in the critical reason category variable. Accordingly, we corrected this error before comparing the variable with the results from the review of TIFA materials.

to determine if the reason a driver pulled out at an intersection was because he failed to see approaching traffic or he misjudged the gap available. In these instances, the UMTRI team chose "driver factor, unknown type," which accounted for 14.3 percent of all cases in the TIFA review and only 4.1 percent of the LTCCS cases. However, if all types of driver factors are summed, including the unknown types, the percentage of driver factors is reasonably close. The LTCCS coded 25.7 percent of the cases to a driver factor. Excluding the unknowns, the UMTRI team coded 26.0 percent. Thus, the overall distributions between the two approaches are quite similar, with the caution that the LTCCS produced more detail, and the TIFA review left a larger number of cases unknown.

Table 2 shows the distribution of the critical event category from the review of TIFA cases and the LTCCS team. Critical event captures the event that immediately precipitated the crash, and is coded for all vehicles in the crash, though vehicles that are not involved in the first harmful event are all assigned "not in first harmful event," regardless of how they became involved. The top level categories are shown, and, just as in Table 1, there is a column that shows the percentage distribution of critical event category calculated after excluding the unknowns. As in the case of most of the variables coded in the review, there was a relatively high number of unknowns, in part because some police reports could not be obtained, and in part because not enough information was available from the TIFA survey to determine the coding.

Table 2 Critical Event Category as Coded in UMTRI Review and LTCCS

	UMTRI			LTCCS	
Critical event category	N	%	% excluding unknown	N	%
This vehicle loss of control	18	7.3	8.1	17	6.9
This vehicle traveling	30	12.2	13.5	32	13.1
Other motor vehicle in lane	52	21.2	23.3	57	23.3
Other motor vehicle encroaching	60	24.5	26.9	64	26.1
Nonmotorist	14	5.7	6.3	19	7.8
Object or animal	0	0.0	0.0	1	0.4
Other	4	1.6	1.8	5	2.0
Not in first harmful event	45	18.4	20.2	50	20.4
Unknown	22	9.0		0	0.0
Total	245	100.0	100.0	245	100.0

Yet it is striking how similar the distribution of critical event category coded in the UMTRI review is to critical event coded by the LTCCS team, after adjusting for the unknowns. The biggest difference is in the percentage of cases coded "non-motorist," the category for non-motorists in or approaching the roadway, and that is a difference of only 6.3 percent for the UMTRI review and 7.8 percent for the LTCCS cases. The percentages for the most common critical event categories differ between the two efforts only by trivial amounts.

Right of way was also coded by both the LTCCS team and the UMTRI review of TIFA cases. There were significant differences in the approach to the variable. In the UMTRI review, right of way was coded for every vehicle at the time of the critical event, attempting to apply the legal rules of the road. The LTCCS team, however, coded many cases “not applicable,” apparently meaning that right of way was not relevant to the crash. How relevance was determined is not entirely clear, and the UMTRI team was not confident that it could reproduce the standards within the scope of the project. UMTRI instead determined for each vehicle within the context of the collision which vehicle had the right of way. This approach follows that used by the UMTRI team in the FACT project for the Michigan State Police. In that project, right of way was coded for nearly all vehicles, and was validated in ambiguous cases by reviewing with an experienced officer of the State Patrol.

However, the high proportion of “not applicable” coded by the LTCCS prevents valid comparisons of the overall distribution of right of way. The LTCCS found right of way not applicable in almost half of the cases reviewed here. This is not analogous to the problem of missing data, since it is reasonable to assume that there is no bias relevant to the crashes to which police reports could not be obtained, while the choice of “not applicable” for right of way flows directly from the nature of the crash. Of more interest will be the comparison of coding right of way on a case-by-case basis, which directly shows the extent of agreement. This will be discussed more specifically below, but here it may be noted that the teams differed in only five cases where a specific right of way was assigned.

Table 3 Right of Way, as Coded in UMTRI Review and LTCCS

	Review		LTCCS	
Right of way	N	%	N	%
This vehicle	157	64.1	106	43.3
Other vehicle	50	20.4	21	8.6
Not applicable	9	3.7	117	47.8
Unknown	29	11.8	1	0.4
Total	245	100.0	245	100.0

The distributions of crash type category coded by the two efforts is reasonably similar, particularly when adjusted for the number of cases for which the UMTRI review could not acquire the necessary police report. (Table 4) The LTCCS effort classified a higher proportion of cases in the “miscellaneous” category, essentially an “other” category for cases that do not fit into any of the other categories. This category also includes the large number of cases in which the truck was not involved in the first harmful event. UMTRI identified 47 such cases, and the TIFA review included a separate category to identify them, while the LTCCS team included them in the “other” category. Note that 28.2 percent of the LTCCS are coded “miscellaneous” compared with a combined 19.6 percent of the review cases, combining miscellaneous and not in the first harmful event.

Table 4 Crash Type Category as Coded in UMTRI Review and LTCCS

Crash type category	Review N	Review %	Review % excluding unknown	LTCCS N	LTCCS %
Single driver					
Right roadside departure	12	4.9	5.3	9	3.7
Left roadside departure	12	4.9	5.3	14	5.7
Single vehicle, forward impact	16	6.5	7.1	20	8.2
Same trafficway, same direction					
Rear-end	45	18.4	20.0	50	20.4
Sideswipe, same direction	15	6.1	6.7	11	4.5
Same trafficway, forward impact	2	0.8	0.9	0	0.0
Same trafficway, opposite direction					
Head-on	23	9.4	10.2	21	8.6
Sideswipe, opposite direction	14	5.7	6.2	10	4.1
Same trafficway/opposite direction	2	0.8	0.9	3	1.2
Change trafficway, vehicle turning					
Turn across path	16	6.5	7.1	12	4.9
Turn into path	4	1.6	1.8	7	2.9
Intersection paths, both straight					
Straight paths	16	6.5	7.1	19	7.8
Miscellaneous					
Backing, etc.;	1	0.4	0.4	69	28.2
Not in first harmful event	47	19.2	20.9	0	0.0
Unknown	20	8.2		0	0.0
Total	245	100.0	100.0	245	100.0

It may be the somewhat paradoxical case that the additional information on crash events available to the LTCCS team accounts for the higher percent of "other" cases. The additional information resulting from site visits, crash reconstructions, and focused interviews with participants and witnesses, may have resulted in more information that made the defined categories less suitable. On the other hand, the UMTRI team, working from primarily police reports, had a somewhat simpler picture and so, based on the information available, was able to assign a specific category.

Pre-event movement describes the movement of the vehicle prior to the "critical crash envelope," (CCE) essentially prior to the initiation of the crash sequence. Timing considerations can be important in defining the boundaries of the CCE. In addition, there can be close calls in trying to distinguish between some of the categories. For example, it may be difficult to determine if a vehicle is stopped, decelerating, or starting when crashes occur in stop-and-go traffic. The UMTRI team also found that some curves depicted in police diagrams were so gradual as make it ambiguous whether the truck was negotiating a curve or going straight. The overall distribution of pre-event movement from the TIFA review is reasonably close to that of the LTCCS team, as adjusted for missing data, but there are some differences. The TIFA review produced a higher percentage of cases “going straight” and a lower proportion of “negotiating a curve.” The LTCCS team also found more trucks “stopped” and fewer with a “successful avoidance” maneuver to a previous critical event. Differences in the type and amount of resources available to the two teams, and genuine uncertainties in making close calls, likely explain the variations.

Table 5 Pre-event Movement as Coded in UMTRI Review and LTCCS

	Review			LTCCS	
Pre-event movement	N	%	% excluding unknown	N	%
No driver	1	0.4	0.5	2	0.8
Going straight	138	56.3	62.4	141	57.6
Decelerating	7	2.9	3.2	6	2.4
Accelerating	0	0.0	0.0	5	2.0
Starting	4	1.6	1.8	2	0.8
Stopped	23	9.4	10.4	35	14.3
Passing	0	0.0	0.0	1	0.4
Disabled/parked in lane	3	1.2	1.4	1	0.4
Turning right	3	1.2	1.4	1	0.4
Turning left	8	3.3	3.6	2	0.8
U-turn	1	0.4	0.5	0	0.0
Backing	1	0.4	0.5	2	0.8
Negotiating curve	21	8.6	9.5	34	13.9
Changing lanes	0	0.0	0.0	7	2.9
Merging	3	1.2	1.4	1	0.4
Successful avoidance	8	3.3	3.6	5	2.0
Unknown	24	9.8		0	0.0
Total	245	100.0	100.0	245	100.0

Avoidance maneuver is similarly difficult to code. The variable includes not just the top level maneuvers (braking, steering, and accelerating), but also selected combinations of them, and whether there was lockup of the brakes as well. Table 6 shows the distribution of avoidance maneuver for the two teams, along with the distribution of the TIFA review adjusted for unknown cases. Note that the TIFA review team was unable to assign an avoidance maneuver in over 30 percent of the cases, compared with less than three percent in LTCCS. The distributions from the two teams overall have the same shape, but there are differences in detail. LTCCS found no avoidance in about half of the cases, while the review of TIFA materials found no avoidance in almost 60 percent. The TIFA team also found that it was difficult to determine if there was lockup and skidding in the avoidance maneuver, so the TIFA review resulted in a higher proportion of cases coded “braking, unknown lockup,” compared with LTCCS. The LTCCS was unable to determine lockup in only one case, compared with eight cases in the TIFA review. But remember that the LTCCS investigators were able to visit and photograph the scene, and frequently performed a reconstruction. Overall, both teams had about the same percentage of cases with braking as part of the avoidance maneuver.

Table 6 Avoidance as Coded in UMTRI Review and LTCCS

	Review			LTCCS	
Avoidance maneuver	N	%	% excluding unknown	N	%
No driver	2	0.8	1.2	2	0.8
No avoidance	101	41.2	59.1	122	49.8
Brake, no lockup	2	0.8	1.2	14	5.7
Brake, lockup	16	6.5	9.4	32	13.1
Brake, unknown lockup	8	3.3	4.7	1	0.4
Steer left	5	2.0	2.9	6	2.4
Steer right	5	2.0	2.9	10	4.1
Brake & steer left	16	6.5	9.4	10	4.1
Brake & steer right	15	6.1	8.8	21	8.6
Accelerate	0	0.0	0.0	2	0.8
Other action	1	0.4	0.6	18	7.3
Unknown	74	30.2		7	2.9
Total	245	100.0	100.0	245	100.0

5.2 Case-level Comparison of Primary Variables

This section provides results of comparing the coding of the variables on a case-by-case basis. The previous section compared the overall distribution of the variables between the two files. A case-by-case comparison will show the extent to which the two approaches (review of TIFA materials and the LTCCS in-depth investigation) can result in conflicts on specific data items. We compare the results where both teams were able to code the variable, i.e., excluding unknowns.

Critical reason category is a central variable in the LTCCS methodology to determine crash contribution, and so we will begin with that variable. There were 213 cases that were not unknown in both files. Of these, the two teams agreed in 192 cases, or 90.1 percent of the time in which both teams had enough information to make an assignment. The level of agreement was helped considerably by the large number of cases where critical reason was coded to the other vehicle by both teams. Coding the case to the other vehicle does not require all the information to identify a specific reason for the vehicle or driver.

In addition, we also counted all cases in which the UMTRI review team identified a driver-related reason, but did not have enough information to be more specific (driver factor, unknown type) as in agreement with the LTCCS determination if the LTCCS team also chose one of the driver factors. The LTCCS team had substantially more information available to make a more detailed assessment of the driver error, while the UMTRI review team had access only to police reports, some of which had some detail, including witness statements and crash reconstructions. But many simply did not provide sufficient information, in the judgment of the UMTRI team, to make a more detailed determination; accordingly, the team coded driver factor, unknown type, in those instances. Table 7 shows the percentage of agreement for each critical reason category. In the table, it is counted as a conflict if LTCCS shows a recognition factor and the TIFA review shows a decision factor, even though both selected a driver critical reason. The breakdown of the types of driver reasons somewhat overstates the level of conflict in coding between the UMTRI review and the LTCCS team. If all driver reasons are added together, about 77 percent of cases in which the UMTRI review assigned the critical reason to a driver category were also assigned a driver category by the LTCCS team.

Table 7 Agreement Between Review and LTCCS Coding of Critical Reason Category

Critical reason category	N	% agreement
Not this vehicle	150	97.3
Non-performance	4	50.0
Recognition	7	55.6
Decision	7	71.4
Performance	1	0.0
Driver, unknown type	35	74.3
Vehicle	7	71.4
Highway	2	50.0

On right of way, there were 216 cases in which both teams were able to code the variable (i.e., did not leave it unknown). Right of way was not in conflict in 97.3 percent of the cases; in five cases, right of way was coded in conflicting ways. In four of the conflicts, the LTCCS teams coded right of way to the truck and the UMTRI team coded it to the other vehicle, and in the other case, LTCCS coded right of way to the other vehicle and UMTRI coded it to the truck. The large fraction of cases in which right of way was coded not applicable by the LTCCS complicates the comparison, but only somewhat. LTCCS coding rules specified coding not applicable when right of way was not deemed relevant in the crash (almost half the cases; see Table 3 above), while the UMTRI teamed attempted to code right of way in all instances, only using the not applicable code for cases such as single-vehicle road departures not involving any other vehicle or road user. However, overall there appears to be good agreement on the coding of right of way, with only five instances in which the two teams differed.

Critical event is another crucial variable in understanding the contributions of different roles and conditions in a crash, though it is important to repeat that the critical event is in no sense the “cause” of the crash. Rather, the critical event is the event that precipitated the crash. After the critical event, the crash or collision was unavoidable. For this comparison, we compare the higher level *category* of the critical event, rather than the more fine-grained subcategories. The critical event categories are the stems for more detailed branches. For example, the “this vehicle traveling” stem has ten branches, including over the lane line on the left side of travel, off the edge of the road on the left side, turning left at intersection, and so on. The review of the materials available in the TIFA survey—primarily the police report—are themselves not sufficiently in-depth to expect the review to provide as much detail as the LTCCS study, with its much greater resources. However, it is reasonable to compare results at the higher category level, which captures the basic structure of the crash and contributes substantially to the overall understanding of the crash. Overall, the UMTRI review and the LTCCS team chose the same critical event category in 87.4 percent of the 223 cases for which both were able to assign a critical event.

Table 8 shows the number of trucks assigned to the different categories by the review of TIFA materials, and the percentage of each with the same category in the LTCCS data. For the most common categories, the percentage of agreement is relatively high. Cases coded “Not in the first harmful event” by UMTRI had the same code 97.8 percent of the time. “Other motor vehicle encroaching” agreed in 91.7 percent. “This vehicle traveling” cases agreed in only about 73.3 percent, however. And only two-thirds of the cases coded by UMTRI as “loss of control” as the precipitating event were coded the same way in LTCCS. It is likely that the supplementary investigation, scene examination, and witness interviews included in the LTCCS allowed better discrimination as to whether the loss of control led to the crash or was precipitated by avoidance maneuvers.

Table 8 Agreement Between Review and LTCCS Coding of Critical Event Category

Critical event category	N	% agreement
Loss of control	18	66.7
This vehicle traveling	30	73.3
Other motor vehicle in lane	52	86.5
Other motor vehicle encroaching	60	91.7
Nonmotorist	14	100.0
Other	4	75.0
Not in first harmful event	45	97.8

Comparison of the coding of pre-event movement and crash avoidance maneuver also showed somewhat mixed results. For pre-event movement, pre-event movement was not unknown for 221 cases. The UMTRI review and the LTCCS team selected the same pre-event movement in 77.8 percent of those cases. The largest number of conflicts were cases in which the review coded going straight and the LTCCS team coded negotiating a curve. In both categories, the driver could be considered to be primarily engaged in lane-keeping, rather than in an active maneuver. And in the UMTRI review, it was noted in a number of cases that the curves depicted in the police diagrams were fairly subtle. In other words, in some instances the curves were so gradual that there was disagreement between the coders as to whether the road was essentially curved or essentially straight. Eventually, the convention was adopted that if the road was detectibly curved it would be coded as curved. There were also some cases in which it was not clear whether the vehicle had come to a complete stop or was still just stopping before the critical event. Crashes in stop-and-go traffic are particularly problematic. Minor factors such as these can result in conflicts in the coding.

Crash avoidance maneuver also showed a relatively high level of inconsistency between the UMTRI review and the LTCCS team. Coding avoidance maneuver was often quite difficult for the UMTRI review team. The variable is fairly detailed, including braking, whether the brakes locked, steering, direction of steer, and acceleration as avoidance maneuvers, including combinations of the maneuvers. For example, a reviewer could code braking with no lockup, braking with lockup, steering right, braking and steering right, or some other action. This amount of detail is somewhat challenging, given the range of information available on police reports. Overall, there were only 167 cases in which both teams assigned an avoidance maneuver. The LTCCS team left only seven cases unknown, thanks to the resources available, but the UMTRI team had insufficient information to make a determination in 74 cases, only 13 of which were explained by the lack of a police report. Of the 167 cases in common, the same avoidance maneuver was coded in 62.3 percent of the cases. However, considering only the binary classification—was there an avoidance maneuver or not—the two teams agreed in 85 percent of the cases.

5.3 Additional factors

The TIFA review team also included coding of a set of driver, vehicle, and environmental factors. In addition to these items, a catchall item was added after reviewing a few cases: insufficient evidence to determine factors.

Table 9 Additional Factors Coded

Driver	Vehicle	Environmental
Distraction	Tire deficiency	Roadway
Aggressive driving	Brake problems	Vehicle required to stop
Fatigue	Cargo shift	
Felt work pressure from carrier		
Following too close		
Illegal maneuver		
Illness		
Inadequate evasive action		
Inadequate surveillance		
Inattention		
Traveling too fast for conditions		
Unfamiliar with roadway		

The experience of the team reviewing the TIFA materials was that these items were very difficult to identify with confidence. Items such as speeding and roadway condition were mentioned in the police reports if the officer felt they affected the crash. Fatigue was mentioned if the nature of the crash was consistent with the driver being asleep. But matters related to the carrier ("work pressure") or familiarity with the roadway are seldom mentioned, whether they were present or not. It cannot be expected that reporting officers would specifically address those questions, unless a driver raised it himself. In a similar way, it was typically not possible to distinguish distraction from inattention or surveillance factors, in the narratives and diagrams, unless explicitly mentioned, so those factors were rarely checked. Only three cases were coded with distraction, six with inattention, seven for inadequate surveillance. Such items are only picked up if the crash narrative identifies them as part of the critical reason. In the end, the TIFA review team felt there was insufficient evidence to reasonably evaluate the presence of the factors in 87.4 percent of the cases.

Analysis of the factors was not pursued further at this time because of the limited time available within the scope of the project.

6 Comparison with Driver and Vehicle Factors Variables in the Fatality Analysis Reporting System files

The Fatality Analysis Reporting System (FARS) file, annually compiled by the NHTSA is the primary file for fatal motor vehicle traffic crashes. The TIFA serves as a supplement to the FARS file, in that TIFA identifies medium and heavy trucks in the FARS file and collects additional information on the truck, driver, crash, trip, and carrier through a telephone survey. All TIFA cases are ultimately found in FARS.

The FARS file consists of data collected by analysts based in the 50 states and the District of Columbia. These analysts collect a standard set of data about each crash, vehicle, and person involved in a traffic accident in which at least one person was fatally injured. The analysts use a broad range of documentation to compile the data, including police reports and any investigation that enforcement authorities may choose to conduct, coroner's reports, and administrative data such as driver and vehicle registration files. FARS analysts do not do any independent investigation of their own, but draw on information that is collected by other entities for their own purposes. FARS is the most comprehensive and detailed database for fatal crashes. All the LTCCS fatal crashes should also appear in FARS.

As part of the FARS record, analysts code two sets of variables that are of particular interest here. The first is the "driver-related factors" variables. Driver-related factors records driving errors and conditions, for each involved driver. Up to four responses can be recorded for each driver, allowing the coding of up to four mistakes or conditions that may have contributed to the crash. The second set of variables is the analogous "vehicle-related" factors, which records pre-existing vehicle conditions or failures that are recorded on the police report. Most of the vehicle-related codes relate to the mechanical condition of the vehicle, but there are also some that identify special conditions that further identify the use of the vehicle. Up to two vehicle-related factors may be coded.

FARS analysts draw up the police report to code driver-related factors. The instruction in the coding manual used by the analysts is to “code information provided in the narrative by the investigation officer. It is the officer’s assessment.” The same is true for vehicle-related factors. Thus, the information in the variables does not record the analysts’ assessments, nor is it truly a record of the “presence” of conditions, errors, and so on. Both variables can probably be understood as recording the officer’s assessment of factors that contributed to the crash. In that way, they probably are closest to the critical reason variable, in terms of identifying items that contributed, in the officer’s judgment, to the crash. Though clearly they are in no way substitutes for the LTCCS variables.

Table 10 shows the comparison of the FARS coding of driver-related factors and the assignment of the category of critical reason from the review of TIFA materials. For the purposes of this table, specific driver-related factors were aggregated to indicate whether a factor was coded or not. Overall, driver factors were recorded by FARS in 40.4 percent of the cases reviewed for this effort. The percentage columns show the percentage with a driver-related factor for each critical reason category.

Table 10 Comparison of Critical Reason Category and FARS Driver-Related Factors

	Driver-related factor coded						Total
	Yes		None		Unknown		
Critical reason category	N	%*	N	%	N	%	N
Not coded to this vehicle	22	14.7	128	85.3	0	0.0	150
Non-performance	4	100.0	0	0.0	0	0.0	4
Recognition	8	88.9	1	11.1	0	0.0	9
Decision	7	100.0	0	0.0	0	0.0	7
Performance	1	100.0	0	0.0	0	0.0	1
Driver factor, unk. type	32	91.4	2	5.7	1	2.9	35
Vehicle factor	7	100.0	0	0.0	0	0.0	7
Highway/weather factor	2	100.0	0	0.0	0	0.0	2
Unknown	16	53.3	12	40.0	2	6.7	30
Total	99	40.4	143	58.4	3	1.2	245

*Row percentages for each category of critical reason

In general, there is some relationship between the critical reason and driver factors. In 85.3 percent of cases in which the TIFA review assigned the critical reason to another vehicle, no driver factors were recorded for the truck driver. And in virtually all cases where the critical reason category was assigned to a driver factor, at least one driver factor was recorded in FARS. But driver factors were also recorded when the critical reason category was assigned to a vehicle failure or highway/weather conditions. The close association between the two variables is expected, since both ultimately rely on police reports and both approach driver contribution, albeit from quite different perspectives.

The FARS vehicle-related factors is more problematic, and not only because it is also used to record special uses of the vehicle involved. Identifying vehicle conditions that may have contributed to a crash is typically very difficult for police officers. Only the most egregious problems can usually be detected, such as brake failures or tire blowouts. Short of a catastrophic failure, officers do not have the training or responsibility to determine the contribution of mechanical factors to crashes. In Table 11, all vehicle factors are aggregated to identify trucks with any coded vehicle defects. The “none” category means that no condition was coded, and the special column identifies cases where the variable was used to record a special condition (such as hit-and-run vehicle or used in highway construction) for the vehicle. One would expect that trucks for which the critical reason category was a vehicle factor would also have vehicle-related defects recorded in the FARS file. And in fact, that critical reason category had the highest percentage of vehicles with a FARS-recorded vehicle defect. However, only 42.9 percent of the trucks had a vehicle problem identified in FARS, and an equal percentage had a special vehicle item set. Overall, only 5.7 percent of the trucks had a mechanical problem recorded.

Table 11 Comparison of Critical Reason Category and FARS Vehicle-Related Factors

	Vehicle-related factor coded								Total
	Yes		None		Special		Unk.		
Critical reason category	N	%*	N	%	N	%	N	%	N
Not coded to this vehicle	6	4.0	140	93.3	3	2.0	1	0.7	150
Non-performance	0	0.0	3	75.0	1	25.0	0	0.0	4
Recognition	0	0.0	8	88.9	1	11.1	0	0.0	9
Decision	1	14.3	6	85.7	0	0.0	0	0.0	7
Performance	0	0.0	1	100.0	0	0.0	0	0.0	1
Driver factor, unk. type	1	2.9	31	88.6	0	0.0	3	8.6	35
Vehicle factor	3	42.9	1	14.3	3	42.9	0	0.0	7
Highway/weather factor	0	0.0	2	100.0	0	0.0	0	0.0	2
Unknown	3	10.0	25	83.3	1	3.3	1	3.3	30
Total	14	5.7	217	88.6	9	3.7	5	2.0	245

* Row percentages for each category of critical reason.

7 Summary

All fatal crashes, as determined by the researcher, were extracted from the LTCCS weighted cases, i.e., those occurring after the pilot phase. An effort was made to match the trucks to the corresponding records in UMTRI’s TIFA file. The two files do not use the same case identifiers so it was necessary to match on other factors. The matching process used variables that identified geographical location (state and county), specific day and time of day, and vehicle and driver characteristics, such as vehicle identification number, make, model year, and driver age. A total of 261 trucks were subset from the LTCCS data; 245 were matched to TIFA records and the other 16 could not be matched. The next phase of the effort focused on the 245 matched cases.

In the second phase of the work, two experienced crash analysts independently coded a set of the variables central to the LTCCS methodology. The variables captured the critical event and critical reason for the critical event, pre-crash maneuver and avoidance maneuver, right of way, and a selected set of driver, vehicle, and environmental factors. After each reviewer coded every case, the results for each variable were compared and any inconsistencies were discussed and corrected. Overall, agreement between the two reviewers was good.

The purpose of the coding effort was to determine if certain LTCCS variables could be reasonably captured using materials available in the TIFA project. The LTCCS, of course, was a major undertaking with very extensive resources deployed over a number of years to collect massive amounts of information about a limited set of truck crashes. Each case had at least one researcher and a truck inspector to evaluate the mechanical condition of the truck. Cases were reviewed in the field and then forwarded to two central offices to code additional data, using the materials collected by the field investigator and truck inspector. Resources for the LTCCS team included on-site visits, sometimes on-scene investigation, extensive photography of the vehicles and location, interviews with all participants and witnesses, interviews with the motor carrier, and access to a number of administrative files to collect driver, vehicle, and company information.

In contrast, the TIFA survey is a telephone survey conducted on all trucks (GVWR greater than 10,000 pounds) involved in a fatal accident in the United States. Police reports for each crash are acquired by UMTRI and used to locate respondents knowledgeable about the vehicle. The survey collects information about the configuration and loading of the truck at the time of the crash, the type of carrier operating the vehicle, the type of trip, the driver’s time at the wheel prior to the crash, and the crash type. The TIFA materials available for this project include primarily the police report. In some cases, the police report is fairly extensive and includes crash reconstructions and witness statements. Others are fairly cursory, even though the crashes are fatal. Unfortunately, the LTCCS sample included two states that declined to supply police reports for some years during the years the LTCCS was underway. This is a bit of bad luck, because in most years no more than one or two states refuse to supply police reports. This fact drove up missing data higher than it would be if all TIFA cases were examined.

Comparing the results produced by the LTCCS and by the review of TIFA materials gives a somewhat mixed picture. There was reasonably good agreement in coding the overall structure of the crash itself. In terms of the critical event category, the distribution of TIFA results was quite close to that in the LTCCS. At the case level, the codes were in agreement for 86.1 percent of the cases where the variable was not unknown. Similarly for the critical reason category variable, the overall distributions were in good agreement (with one exception to be discussed shortly), and 90.1 percent of cases were coded the same.

There was less agreement for more detailed variables. For example, both pre-crash event and avoidance maneuver are fairly fine-grained, with only subtle (in the context of a crash) differences between code levels in some cases. For example, when the crash took place in stop-and-go traffic, it was often difficult to determine if the vehicle was stopping, stopped, or starting in traffic immediately prior to the initiation of the crash sequence. Similarly, without access to more than the police report, it might be possible to determine that the vehicle was braking, but not whether lockup occurred. Capturing finer details of crash events and conditions was in many instances not feasible from the TIFA materials.

Agreement was fairly good—remarkably good, in fact, when considering differences in the scale of resources devoted—for the critical reason category. But this level of agreement was arrived at by essentially lumping all the driver reasons together. Driver reasons fall into four general categories: Non-performance, recognition, decision, and performance. Without consistent access to witnesses, drivers, other investigators, and the scene, it was very difficult to judge whether the crash was produced by a decision or a recognition error. Accordingly, “driver factor, unknown type” was selected much more often in the TIFA review than by the LTCCS team. Similarly, the two efforts agreed reasonably well on the critical event at the category level, but not at the more fine-grained level.

This was made very clear to the UMTRI reviewers as they struggled to code driver, vehicle, and environmental factors. Some were straightforward in some cases. When a vehicle inspection was included, it was possible to identify vehicle factors. But unless they played a critical role in the crash that was noted by the officer, in most cases it was simply not possible to determine the condition of the vehicle. The same was true for the driver factors items. In over 87 percent of the cases, the reviewers did not feel there was sufficient information in the police report to determine the presence or absence of the factors.

It is possible to code reliably the basic structure of the crash using materials available in the TIFA survey. This includes right of way, critical event category, and critical reason category. More detailed information about the crash, such as the full critical event variable or the full critical reason variable, is not feasible within the scope of the materials available in the TIFA survey. Associated events and factors are not captured on police reports reliably and routinely enough to permit them to be coded with confidence that they have been identified when present and not identified when absent. The in-depth investigation of the LTCCS is more suited to collect the more detailed information about the nature of the crashes.