

Evaluation of North Carolina Crash Data Reported to MCMIS Crash File

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MCMIS Crash File Evaluation**

Anne Matteson

Daniel Blower

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**Center for National Truck and Bus Statistics
University of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, Michigan 48109-2150**

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16. Abstract <p>This document is part of a series of reports evaluating the data reported to the Motor Carrier Management Information System (MCMIS) Crash file undertaken by the Center for National Truck and Bus Statistics at the University of Michigan Transportation Research Institute. Earlier studies showed that reporting to the MCMIS Crash file was significantly incomplete in other states. This report examines the sources of underreporting for the state of North Carolina.</p> <p>MCMIS Crash file records were matched to the North Carolina Police Accident Report (PAR) file to determine the nature and extent of reporting. Overall, North Carolina submitted 48.2% of its reportable crash involvements to the MCMIS Crash File in 2003. Reporting rates varied by vehicle type, crash severity, and reporting agency. Reporting rates are 63.3% for fatal crashes, 49.4% for injury cases, and 47.1% for tow/disabled accidents. Two-axle trucks are reported only 15.7% of the time, while tractor semitrailers and truck tractors each have reporting rates over 81%. Buses are only reported 9.9% of the time. Interstate vehicles were reported at a rate of 73.6%, compared with 40.3% for vehicles with instate license plates. The highway patrol reported 58.2% of cases they covered compared with 35.4% for the local police.</p> <p>Although North Carolina's data collection system is comprehensive, it appears that issues connected with identifying the target vehicle as a commercial motor vehicle (CMV) is preventing all MCMIS-eligible vehicles from being identified. Officers are less likely to recognize smaller vehicles and those operating in state as CMVs, and thus do not record the CMV variables for these cases. Evidence suggests that failure to fill out the CMV section of the PAR form results in such cases not being submitted to the MCMIS Crash file.</p>					
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Evaluation of North Carolina Crash Data Reported to MCMIS Crash File

1. Introduction

Complete reporting of truck and bus involvements is essential in assessing the magnitude and characteristics of motor carrier crashes, so that effective safety measures can be designed. For this purpose, the Motor Carrier Management Information System (MCMIS) Crash file was developed by the Federal Motor Carrier Safety Administration (FMCSA) to serve as a census file of traffic crashes involving trucks and buses. Its utility is dependent upon individual states to transmit a standard set of data items on all trucks and buses involved in traffic crashes that meet a specific severity threshold. However, the MCMIS Crash file is known to be incomplete. Nationally, only about two-thirds of qualifying truck involvements are reported. The reporting rate for buses is even lower, at about 40%. [1] (See references at the end of the report.) Reporting is more complete for severe crashes, with about 90% of truck fatal involvements and 65% of bus fatal involvements appearing in the file, but rates are much lower for less severe crashes.

Since the states are responsible for reporting qualifying crashes, the solution for underreporting must ultimately reside with the individual states. This report is part of a series of evaluations of reporting from each state. Previous reports on Ohio, Missouri, Michigan, Florida, and California showed substantial underreporting due in large part to problems police officers experience in interpreting and applying the reporting criteria [2, 3, 4, 5, 6]. The problems were more severe in large jurisdictions and police departments. Each state also had problems specific to the nature of its system. Both Missouri and Ohio also had substantial overreporting of cases, often due to technical problems with duplicate records.

In this report, we focus on MCMIS Crash file reporting by North Carolina. In recent years North Carolina has ranked among the top 15% of states with the greatest number of truck and bus fatal involvements. Accordingly, improving reporting to the MCMIS Crash file from this state would contribute significantly to the goal of making that entire file complete and accurate.

The method employed in this study is similar to previous studies:

1. The complete police accident report file (PAR file hereafter) from North Carolina was obtained for the most recent year available, 2003. This file was processed to identify all cases that qualified for reporting to the MCMIS Crash file.
2. All cases in the North Carolina PAR file—those that qualified for reporting to the Crash file as well as those that did not—were matched to the cases actually reported to the MCMIS Crash file from North Carolina.

3. Cases that should have been reported, but were not, were compared with those that were reported to identify the sources of underreporting.
4. Cases that did not qualify but which were reported were examined to identify the extent and nature of overreporting.

Police accident report (PAR) data recorded in North Carolina's statewide files as of September 7, 2004 were used in this analysis. The 2003 PAR file contains the computerized records of 513,943 "units" involved in 285,135 crashes that occurred in North Carolina during 2003. Units include vehicles, pedestrians and others. Excluding pedestrians, the North Carolina PAR data had records on 511,172 vehicles.

2. Data Preparation

The North Carolina PAR file and MCMIS Crash file each required some preparation before the North Carolina records in the MCMIS Crash file could be matched to the North Carolina PAR file. In the case of the MCMIS Crash file, the only processing necessary was to extract records reported from North Carolina and to eliminate duplicate records. The North Carolina PAR file required more extensive work, primarily to develop means of identifying cases that should have been reported to the MCMIS Crash file. This section discusses the methods used to prepare each file and some of the problems uncovered.

2.1 MCMIS Crash File

Initially, the 2003 MCMIS Crash file as of April 27, 2004 was used to identify records submitted from North Carolina. However, only three months of 2003 data from North Carolina (1,056 cases) had been submitted by that date. All cases are required to be reported within 90 days of the event, so an April file date should have contained all 2003 North Carolina cases. Since so few records were in the April file, it was decided to obtain a more current MCMIS file, anticipating that the data year would then be complete. Indeed, for calendar year 2003 there were 4,493 North Carolina cases in the MCMIS file dated March 14, 2005. An analysis file was constructed using all variables in the file.

The file was then examined for duplicate records (those involvements where more than one record was submitted for the same vehicle in the same crash; i.e., the report number and sequence number were identical). Only three pairs of such duplicate records were found. In each pair, all variables were identical except for accident day or accident time. It appeared that duplicates were generated in two of the pairs due to accident day differing by one day. In the other pair of duplicate records accident time varied by two hours. In each instance, the record that did not appear in the PAR file was excluded. In addition, records were examined for identical values for accident date, time, crash county, crash city, officer badge number, vehicle identification number, and driver's date of birth, even though their case numbers were perhaps

different. One would not expect all of these variables to be identical between two cases. No duplicates were found. After excluding the three duplicate records previously identified, the resulting MCMIS file contained 4,490 records.

2.2 North Carolina PAR File

The North Carolina PAR file for 2003 (dated September 7, 2004) was obtained from the state of North Carolina. This file contains records for 285,135 crashes involving 511,172 vehicles. Data for the PAR file are coded from the North Carolina Crash Report Form DMV-349 completed by police officers [10].

When duplicates were defined as records with identical report numbers and vehicle numbers, no instances were found. In addition, inspection of report numbers verified that they were consistently recorded in the same format, so there was no reason to suspect duplicate records based on similar, but not identical, report numbers (such as 100804143 and 1008-4143, for example). However, cases were also examined to determine if there were any records that contained identical time, place and vehicle/driver variables, even though their case numbers were perhaps different. Two cases would not be expected to be identical on all variables. To investigate this possibility, records were examined for duplicate occurrences based on the variables accident date/time, county, crash road number (8-digit), vehicle identification number (17-digit VIN), and driver date of birth. (City was not included as a location variable, as it was unrecorded in 30% of the cases). A total of 52 duplicate instances were found, representing 104 individual records.

Duplicate pairs were examined more closely for any patterns that might explain why they were occurring. These records could be grouped into two categories: those where Crash_ID differed, and those where Crash_ID were identical. In the first group, where crash time, location, VIN and driver date of birth was the same but Crash_ID differed, one explanation could be that a vehicle was involved in two accidents at the same place and virtually at the same time. But according to the North Carolina Crash Report Instruction Manual, “a reportable motor vehicle traffic crash must occur on a trafficway or occur after the motor vehicle runs off the roadway but before events are stabilized.”¹ Thus, once events are stabilized, subsequent crashes are reported as new crashes. If a vehicle is reported as being in a second crash after the first one has stabilized, one would expect accident date, location, vehicle and driver information to be identical, but accident

¹ North Carolina Department of Transportation Division of Motor Vehicles, *North Carolina Crash Report Instruction Manual*, September, 1999, p. 1.

time to vary by a couple of minutes or longer. However, in the case of these records, accident hour and minute are identical, suggesting they are in fact duplicate records.

The second group of cases were identical on crash time, location, VIN, and driver date of birth, and also had identical Crash_IDs. In some instances vehicle number differed, suggesting the possibility that these could be two different vehicles in the same accident. However, with VIN and driver date of birth both recorded and identical among the two records, this is unlikely. These cases were also designated as duplicate records.

Thus, the 52 pairs identified above were considered to be duplicates and one member of the pair was excluded. Since there was no variable indicating a date the record was updated or processed, the first member of each pair was excluded and the second was kept. The resulting PAR file has 511,120 records.

The next step in data preparation is to identify records that qualified for reporting to the MCMIS Crash file. It was necessary to develop a set of criteria using the variables in the North Carolina PAR file to identify records that should have been reported. The purpose of the criteria is to approximate as closely as possible the reporting threshold of the MCMIS file. The MCMIS criteria for a reportable crash involving a qualifying vehicle are shown in Table 1.

Table 1. Vehicle and Crash Severity Threshold for MCMIS Crash File

Vehicle	Truck with GVWR over 10,000 or GCWR over 10,000, or Bus with seating for at least nine, including the driver, or Vehicle displaying a hazardous materials placard.
Accident	Fatality, or Injury transported to a medical facility for immediate medical attention, or Vehicle towed due to disabling damage.

Variables available in the North Carolina PAR data permit the MCMIS Crash file criteria to be applied reasonably well. Although gross vehicle weight rating (GVWR) was essentially unrecorded, the vehicle style (type) variable appeared to be sufficient for identifying eligible trucks and buses. Since there was no further explanation of the meanings of these vehicle codes, codes were interpreted for their typical meaning. Vehicle type was unknown in only 4.1% of cases. In all of these instances, cargo body type was also unknown.

Variables pertaining to transporting hazardous materials were only included in the “Commercial Motor Vehicle (CMV): Hazardous Materials Involvement” section on page 2 of the crash form [10]. However, the third definition of a CMV, according to the crash form instructions [9], was expanded to include vehicles *of any size*, if used to transport hazardous materials. This brings it into conformity with the MCMIS criteria. If the CMV definition was applied in the strictest sense, then variables in this CMV section should be recorded for vehicles less than 10,001 lbs.

with a hazardous materials placard. For this study, placarded vehicles were then identified using the Hazmat Placard Indicator variable from this area of the crash report.

It is also possible that some other vehicles, such as vans, could qualify as buses. They would qualify if they have seats for nine or more passengers and are used for transporting passengers, and not personal transport. However, since number of seats and a description of vehicle use are not available, the decision was made not to include any other vehicles as qualifying buses since many are used for personal transport. Appendix A includes a complete discussion of the variables used to identify qualifying vehicles.

Eligible vehicles were thus selected based on the codes in Table 2, excluding parked vehicles.

Table 2. North Carolina PAR File Codes Used to Identify Eligible Vehicles

Vehicle style (type) code	Description
Truck	
10	Single unit truck (2-axle, 6 tire)
11	Single unit truck (3 or more axles)
12	Truck/trailer
13	Truck tractor (i.e. bobtail)
14	Truck tractor (semi-trailer)
15	Tractor/doubles
16	Unknown heavy truck
Bus	
6	Commercial bus
7	School bus
8	Activity bus
9	Other bus
Hazardous placarded vehicle	
Haz-mat placard indicator =1	

In total, there were 19,788 vehicles meeting the vehicle criteria in the North Carolina PAR file (Table 3). These represented 3.9% of all vehicles in the PAR file, which was within the range of corresponding percentages for other states that have thus far been evaluated (ranging from 2.6% to 6.1%).

Table 3. Vehicles Meeting MCMIS Vehicle Criteria, North Carolina PAR File, 2003

Vehicle type	N	%
Trucks	17,468	88.3%
Buses	2,318	11.7%
Non-trucks with hazmat placard	2	<0.1%
Total	19,788	100.0%

Of these vehicles, those in a crash involving a fatality, an injury transported for medical treatment, or a vehicle towed due to disabling damage should have been reported to the MCMIS Crash file. Injuries can be readily identified in the North Carolina PAR file. The PAR occupant file, which represents passengers as well as non-passengers such as pedestrians and pedalcyclists,

includes the usual crash injury severity variable identifying fatal, A type (disabling), B type (evident), and C type (possible injury). There were also “no injury” and “unknown” code levels. Additionally, 42 cases were coded as 7 or 8. These code levels do not exist in the instruction manual, nor are they in the PAR form instructions. However, since there were separate codes to indicate “no injury” or “unknown,” codes 7 and 8 were considered to be “injury” codes. This is conservative since they are likely to be wild codes.

In addition, the PAR file includes treatment facility name and city (designated on the crash report as Injured taken to by EMS: _____ (treatment facility and city or town.) This variable appeared to be well-recorded, although it did contain some random comments. The following entries were not considered to be valid facility names: “not transported,” “treated at scene,” “no transport,” “N/A,” “NA,” “refused,” “refused transport,” “did not transport.” A person was considered to be transported if facility name was valid or if facility name was unrecorded, but facility city was valid (not equal to unrecorded or “not transported”).

Thus, it was possible to directly identify injured persons who were transported for medical care. Injured, transported persons were defined as those who had an injury code of A, B, C, No injury, unknown, 7 or 8 and were transported. It was assumed the individuals designated “no injury,” “unknown,” and codes 7 or 8 (including only 19 eligible vehicles in total) suffered some degree of injury since they were transported for medical care. Based on the above definition, an injured/transported variable was created at the accident level to indicate if any person in the crash was injured and also transported for care.

The last MCMIS criterion specifies “vehicles towed due to disabling damage.” The North Carolina PAR file contains three vehicle-level variables that could be used to determine tow/disabled status: Vehicle_drivable, Towed_by, and Towed_to. The PAR Vehicle_drivable variable is coded as no (0), yes (1), or unknown (2). All of the North Carolina data had a value of either yes (1) or missing. The manual states that a “no” response means that the vehicle was disabled by damage severe enough to prevent driving it [9]. The Towed_by and Towed_to instructions state that the officer is supposed to record where the vehicle was towed, followed by the name of the business responsible for towing [9].

A vehicle was considered “towed due to disabling damage” if the Vehicle_drivable variable was not “yes” and any of the following apply:

- a. Towed_by and Towed_to are both recorded
- b. Towed_by is blank, but Towed_to is recorded
- c. Towed_by is recorded, but Towed_to is blank
- d. Towed_by is “not towed,” but Towed_to is recorded

Based on the above algorithm, an accident-level tow_disabled variable was created to identify crashes with at least one vehicle towed due to disabling damage. Appendix A provides further

details and discussion of the variables and code levels used to identify MCMIS-reportable cases for the interested reader.

Thus, the subset of PAR cases that can be identified as reportable to MCMIS included the trucks, buses, and vehicles with a hazardous materials placard defined above, in conjunction with one of the following conditions: fatal accident, accident involving an injured/transported person, or accident including a vehicle towed due to disabling damage. Table 4 shows the distribution of eligible vehicles by accident criteria, and the number of those vehicles reportable to the MCMIS Crash File. As a pattern one would reasonably expect, 88.6% of A injuries, 71.2% of B injuries, and only 38.9% of C injuries were transported for medical care.

Table 4. Vehicles and Crashes Meeting MCMIS Criteria, North Carolina PAR File, 2003

Accident severity	Eligible vehicles				Reportable cases
	Transported		Not transported		
	towed *	not towed	towed *	not towed	
Fatal	87	1	74	18	180
A injury	207	18	19	10	244
B injury	941	78	299	114	1,318
C injury	1,073	330	1,242	959	2,645
No injury	10	6	4,074	10,068	4,090
Unknown	1	2	37	120	40
Total	2,319	435	5,745	11,289	8,517

* towed means "towed due to disabling damage"

Note: shaded areas represent reportable cases

Based on these criteria, 8,517 records in the North Carolina PAR file should have been reported to the MCMIS Crash file. Table 5 shows the distribution of cases identified in the North Carolina PAR file that met the reporting criteria thus defined, along with the distribution of records actually reported.

Table 5. Reportable Records in the North Carolina PAR File by Crash Severity, 2003

Crash severity	Reportable records in North Carolina PAR file	%	Actually reported	% Reported
Fatal	180	2.1	114	63.3
Transported injury	2,666	31.3	1,318	49.4
Tow, disabled	5,671	66.6	2,673	47.1
Total	8,517	100.0	4,105	48.2

3. Matching Process

The next step involved matching records from the North Carolina PAR file to corresponding records from the MCMIS file. After removing duplicates, there were 4,490 North Carolina records from the MCMIS file available for matching, and 511,120 records from the North Carolina PAR file. All records from the North Carolina PAR data file were used in the match,

even those that were not reportable to the MCMIS Crash file. This allowed the identification of cases in the MCMIS Crash file that should not have been reported.

Matching records in the two files requires finding common variables that match at the accident level as well as identifying specific vehicles within an accident. Crash_ID, which is the crash identifier used to uniquely specify a crash in the North Carolina PAR data, corresponds to Report Number in the MCMIS Crash file, and is an obvious first choice. Crash_ID in the North Carolina PAR file is a nine-digit numeric value, while in the MCMIS Crash file, Report Number is stored as a 12-character alphanumeric value, a combination of alphabetic characters and numbers. It appears that the report number in the MCMIS Crash file is constructed as follows: The first two columns contain the state abbreviation (NC, in this case), followed by a zero, then by nine digits that correspond to the police report number.

Examination of PAR and corresponding MCMIS records showed that for most cases the PAR report number was among the digits of the MCMIS report number, allowing a value corresponding to the North Carolina Crash_ID to be extracted and used in the match. Other variables that were available for matching at the accident level included crash month, day, hour, minute, and crash county. A variable designating “city” could not be used, as the PAR file contained a numeric code, but city code on the MCMIS file was unrecorded. Another variable often used for matching at the accident level, officer badge number, appeared on the MCMIS file, but no corresponding variable was present on the PAR file.

Variables in the MCMIS file that could distinguish one vehicle from another within the same accident included vehicle license plate number, driver license number, vehicle identification number (VIN), driver date of birth, and driver last name. However, only vehicle identification number (VIN) and driver date of birth were available on the PAR file.

Three separate matches were performed using the available variables. In each match step, records in either file with duplicate values on the match variables were excluded, along with records that were missing values on the match variables. The first match included the variables Crash_ID, crash month, day, hour, minute, crash county, driver birthdate, and VIN. The subsequent match step eliminated birthdate. The third match step included birthdate, but eliminated VIN. See Table 6 for the variables used in each match step along with the number of records matched at each step.

Table 6. Variables Used in MCMIS-North Carolina PAR File Match, 2003

Match step	Matching variables	Cases matched
Match 1	Crash_ID, crash month, day, hour, minute, crash county, driver birthdate, and VIN	4,229
Match 2	Crash_ID, crash month, day, hour, minute, crash county, and VIN	91
Match 3	Crash_ID, crash month, day, hour, minute, crash county, and driver birthdate	71
Total cases matched		4,391

Matched records were verified on other variables common to the MCMIS and PAR file as a final check to ensure the match was valid. The above procedure resulted in 4,391 matches, representing 97.8% of the 4,490 non-duplicate records reported to MCMIS.

Figure 1 shows the case flow during the match. There were 99 (2.2%) MCMIS records that could not be matched to the North Carolina PAR file. Of the 8,517 reportable cases in the North Carolina PAR data, only 4,105 were actually reported, along with 286 cases that were not reportable, but nevertheless were reported. Thus, the reporting rate for reportable cases was $4,105/8,517=48.2\%$. Approximately 48% of crash involvements that qualified for reporting to the 2003 MCMIS Crash file were actually reported.

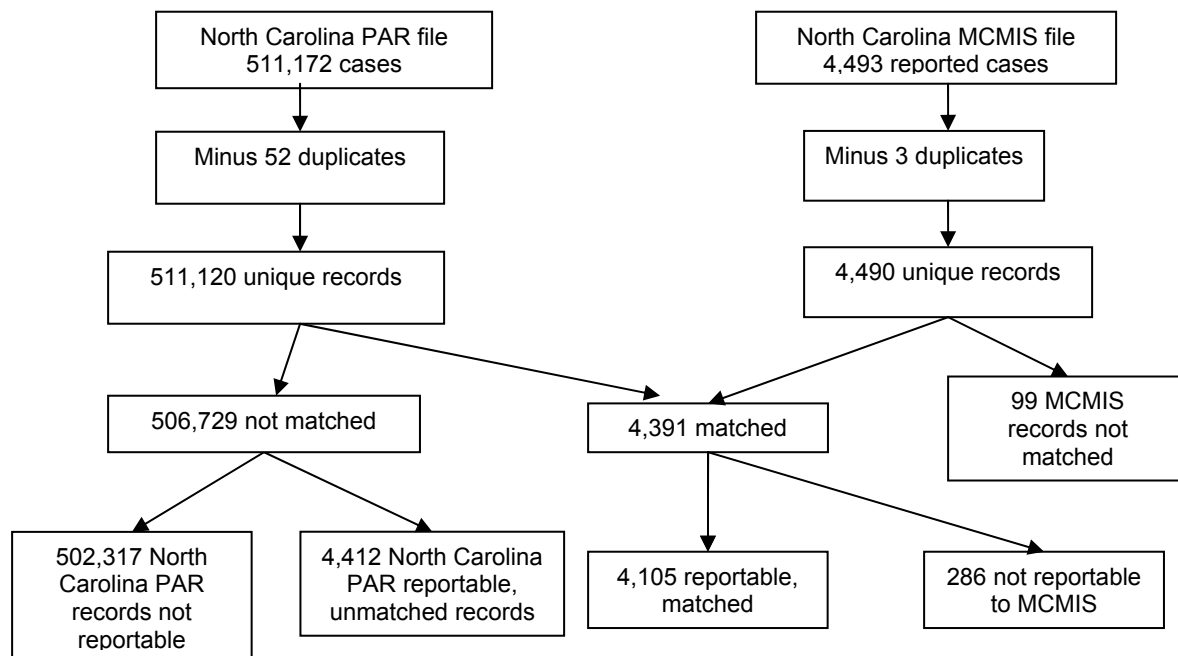


Figure 1. Results of MCMIS-North Carolina PAR File Match, 2003

In addition, 286, or 6.4%, of reported cases should not have been reported. They did not qualify

as reportable because they did not involve either qualifying vehicles or qualifying severity. Table 7 shows why these cases did not meet the reporting criteria. Almost half of the cases, 137, were trucks or buses, and even though all were injury cases, none of them involved a person transported for medical care, or a vehicle towed due to disabling damage.

Table 7. Distribution of Non-Reportable Cases in MCMIS by Reporting Criteria, North Carolina PAR File, 2003

Vehicle type	Crash severity				Total
	Fatal	Transported injury	Tow/disabled	Other crash severity	
Truck	0	0	0	135	135
Bus	0	0	0	2	2
Other vehicle (not transporting hazmat)	6	39	95	9	149
Total	6	39	95	146	286

An additional 140 (6+39+95) cases were involvements in which the crash met the severity test, but they were not trucks, buses, or a vehicle transporting hazmat. Finally, nine cases were neither serious enough nor did they involve qualifying vehicles.

Omitting the 99 cases that could not be matched and the 286 MCMIS cases not considered reportable in the PAR file, 4,105 reportable MCMIS records were matched to the PAR file, or 48.2% of the 8,517 cases that should have been reported. The analysis that follows will investigate why the remaining 51.8% of cases were not reported.

4. Sources of Underreporting

This section explores the sources of underreporting to the MCMIS Crash file. The approach is to compare reported and unreported cases across several dimensions to search for patterns that might suggest why some cases were reported and others were not. All tables include only matched, reportable cases. Therefore, they exclude the 286 MCMIS cases not considered reportable in the PAR file and the 99 MCMIS cases that could not be matched to the PAR file. The reporting rate shown in the following tables is the number of reported cases per 100 reportable cases.

There are two primary ways states may identify eligible cases for MCMIS: (1) The officer is expected to understand the MCMIS reporting criteria and, for cases that qualify, is instructed to fill out a separate form or a designated area on the crash report itself. (2) All criteria are incorporated into the crash report form, so that state officials can then determine which cases should be submitted to the MCMIS Crash file. Unlike several other states, North Carolina does not have a separate form that the officer is expected to fill out if the crash meets the MCMIS criteria. Instead, there is a commercial motor vehicle (CMV) box on the main form to capture information about a commercial vehicle involved in the crash, and the accident-level crash severity criteria are found elsewhere on the form. Thus, in North Carolina it appears that the state makes the final determination of which cases are submitted to the MCMIS Crash file.

North Carolina's instructions for filling out the crash report form makes a specific reference to the Safetynet initiative stating:

[T]he reporting of motor vehicle crashes involving CMV's has been incorporated into the DMV-349. All of the data requirements to meet the Office of Motor Carrier, Federal Highway Administration requirements for SAFETYNET, and the seven motor carrier specific data elements recommended by the National Governor's Association have been addressed.¹

The officer is supposed to complete the crash report form for crashes meeting at least one of the following criteria:

- (1) the crash resulted in a fatality
- (2) the crash resulted in a non-fatal personal injury, or
- (3) the crash resulted in total property damage amounting to \$1000 or more, or
- (4) the crash resulted in property damage of any amount to a vehicle seized.

In addition, if the crash involves a commercial motor vehicle, the officer is instructed to complete the CMV section of the crash report which contains information about the carrier and the vehicle, and to fillout a separate box pertaining to hazardous materials involvement, if applicable. North Carolina defines a CMV as follows:

Commercial Motor Vehicle (CMV) is defined as a motor vehicle or combination of motor vehicles **used in commerce** to transport passengers or property if the motor vehicle:
(a) Has a gross combination weight rating of **10,001 or more pounds** inclusive of a towed unit; or
(b) is designed to transport **16 or more passengers**, including the driver; or
(c) is of any size and is used in the **transportation of materials found to be hazardous** for the purposes of the Hazardous Materials Transportation Act and **which require the motor vehicle to be placarded** under the Hazardous Materials Regulations (49 CFR Part 172, Subpart F).²

Failure to complete the CMV box in page 1 of the crash form may result in a case not being submitted to MCMIS. To test this hypothesis, recording of nine variables located in the CMV section of the crash form were examined. Of the following sixteen CMV variables on the crash form, only the first nine were included in the PAR file (carrier city, state, zip, registered state, state number, cargo body type, source, axles, GVWR, carrier name, same address as owner, US

¹ North Carolina Department of Transportation Division of Motor Vehicles, *North Carolina Crash Report Instruction Manual*, September, 1999, p. 45.

² North Carolina Department of Transportation Division of Motor Vehicles, *North Carolina Crash Report Instruction Manual*, September, 1999, p. 45. (emphasis in original)

DOT number, ICC MC number, International Fuel Tax Agreement Number, Federal Employee Id Number, and fleet number.)

Table 8 reveals that recording of variables in the CMV section of the crash report is clearly related to whether or not the case is submitted to the MCMIS Crash file. For submitted cases, all but one had at least one CMV variable recorded. However, for cases that were reportable, but not reported, only 256 out of 4,412 (5.8%) had CMV variables recorded.

Table 8. Reportable Cases Submission Status by Number of CMV Variables Recorded, North Carolina PAR File, 2003

Number of CMV variables recorded	Case Submitted?				All Reportable Cases	
	Yes		No			
	No.	%	No.	%	No.	%
0	1	0.0	4,156	>99.9	4,157	100.0
1	0	0.0	1	100.0	1	100.0
6	346	93.5	24	6.5	370	100.0
7	1,545	95.0	81	5.0	1,626	100.0
8	1,659	93.7	111	6.3	1,770	100.0
9	554	93.4	39	6.6	593	100.0
Total	4,105	48.2	4,412	51.8	8,517	100.0

Reportable cases fall into two distinct groups: those with CMV variables not recorded, and those with CMV variables recorded. Table 9 shows the percentage of cases submitted to the MCMIS Crash file by recording of CMV variables for injury severity, agency type, vehicle type and license plate state. Regardless of the dimension used to stratify cases, it is clear that cases otherwise eligible but without data in the CMV section are not reported to MCMIS. Although reporting rates are known to vary by these factors, there is no variance in reporting rates where the CMV information is filled out.

Table 9. Reporting to MCMIS Crash File by Recording of CMV Variables, North Carolina PAR File, 2003

CMV variables recorded?	Accident severity		
	Fatal	Inj/trans	Tow/disab
no	0.0	0.0	0.0
yes	92.7	93.9	94.3
total	63.3	49.4	47.1

CMV variables recorded?	Reporting agency		
	NCHP	Police	Other
no	0.1	0.0	0.0
yes	94.4	93.8	89.7
total	58.2	35.4	40.6

CMV variables recorded?	Vehicle type				
	SUT	Trk/trlr	Trac/trlr	Bus	Other
no	0.0	0.0	0.0	0.0	0.0
yes	93.7	93.2	94.6	97.3	91.5
total	25.4	60.2	81.4	9.9	37.5

CMV variables recorded?	License plate state *	
	NC	Out-state
no	0.0	0.0
yes	94.7	93.2
total	40.3	73.6

* The 770 reportable cases that did not have license plate state recorded were excluded from this table.

Thus, filling out the CMV section of the crash report is a necessary event for a MCMIS case to be ultimately reported. Although officers record the vehicle type variable, used here to define eligible vehicles, in many instances they determine that the vehicle does not meet the CMV definition, and thus do not complete the variables in that section of the crash form.

North Carolina officials do not have to rely on recording of variables in the CMV section to determine if a case should be submitted. Variables used to determine if a case qualifies for MCMIS submission (i.e. vehicle type, injury, and towed status) reside elsewhere on the crash form. However, since the CMV variables are among those required by MCMIS, not completing this section results in missing data elements in the Crash file.

Beyond entering information accurately on the crash report, and extracting the appropriate cases, incompleteness of the MCMIS Crash file could be due to delays in transmitting cases. The next section will explore this issue.

4.1 Case Processing

The time lag in extracting and submitting reports to the MCMIS Crash file might explain some portion of the unreported cases. All reportable crash involvements for a calendar year are required to be transmitted to the MCMIS Crash file within 90 days of the date of the crash. Since there had been only one quarter of data submitted to the older 2003 Crash file dated April 27, 2004, timely submission appears to be a problem for North Carolina. Theoretically, all cases should have been submitted by that date. If that file had been used in this evaluation, there would have been a huge number of unreported cases.

The MCMIS file used in this evaluation was dated March 14, 2005, so all 2003 cases should definitely have been reported by that date. An examination of reporting by accident month (see

Table 10) shows that 43.1% to 55.2% of reportable cases are submitted in any given month, with a clear downward trend from the beginning to the end of the year.

Table 10. Reporting to MCMIS Crash File by Accident Month, North Carolina PAR File, 2003

Crash month	Reportable cases	Reporting rate	Unreported cases	% of unreported cases
January	743	55.2	333	7.5
February	581	52.2	278	6.3
March	654	50.9	321	7.3
April	686	53.8	317	7.2
May	768	43.1	437	9.9
June	643	50.5	318	7.2
July	696	49.3	353	8.0
August	766	47.0	406	9.2
September	739	44.0	414	9.4
October	817	44.4	454	10.3
November	708	45.3	387	8.8
December	716	45.0	394	8.9
Total	8,517	48.2	4,412	100.0

To further investigate the magnitude of this problem, data submitted to the crash file used in this study (March 14, 2005) were examined on a month-by-month basis. Table 11 shows the average latency in case submission by month, where latency is the number of days between crash date and the date the case was uploaded to the MCMIS Crash file. Indeed, when looking at the various dates that 2003 cases were uploaded, 97.7% were uploaded on August 23, 2004, which explains the pattern observed in the table. Allowing for the 90-day grace period, the typical case was submitted 333 days late.

Table 11. Average Latency (in days) in Reporting to the MCMIS Crash File, North Carolina Reported Cases, 2003

Crash month (in 2003)	Avg. latency (in days) * for reported cases
January	490
February	466
March	436
April	408
May	376
June	346
July	317
August	286
September	253
October	224
November	195
December	165
Total	333

* Latency calculation allows for the 90-day grace period.

4.2 Reporting Criteria

From the evidence presented above, North Carolina determines MCMIS-eligible vehicles by whether or not the CMV data are present. This section will examine reporting rates by vehicle type, to determine if officers are reporting certain configurations more consistently than others.

North Carolina's overall reporting rate for trucks is 51.8%, with larger trucks more likely to be reported than smaller trucks (Table 12). Two-axle trucks are only reported 15.7% of the time, while tractor semitrailers and tractor doubles are reported at rates of 81.3% and 85.7%, respectively. Improving reporting rates for two-axle trucks would have a large impact on the total number of unreported cases. It should also be noted that buses have very low reporting rates, averaging only 9.9%. School buses are reported less frequently than other bus types, with a reporting rate of less than 6%.

Table 12. Reporting to MCMIS Crash File by Vehicle Type, North Carolina PAR File, 2003

Vehicle type	Reportable cases	Reporting rate	Unreported cases	% of total unreported cases
2-axle truck	2,482	15.7	2,092	47.4
3-axle truck	979	49.8	491	11.1
Truck trailer	1,076	60.2	428	9.7
Truck tractor (bobtail)	175	58.3	73	1.7
Tractor/semitrailer	2,858	81.3	535	12.1
Tractor/doubles	77	85.7	11	0.2
School bus	454	5.9	427	9.7
Other bus	276	16.3	231	5.2
Other vehicle (hazmat placard)	2	50.0	1	0.0
Unknown heavy truck	138	10.9	123	2.8
Total	8,517	48.2	4,412	100.0

These reporting patterns suggest that officers are less likely to recognize smaller vehicles as CMVs, either because they perceive the GVWR requirements are not being met, or more likely, that the vehicles do not meet the "used in commerce" portion of the definition. North Carolina's use of the CMV definition to define MCMIS-reportable vehicles is likely resulting in confusion, and in the exclusion of otherwise eligible cases. FMCSA's MCMIS criteria are only based on the physical characteristics of the vehicle, regardless of its commercial status.

Reporting may also be related to misunderstanding that intrastate vehicles are to be included, not just those involved in interstate commerce. Unfortunately this hypothesis cannot be tested directly, since there is no variable in the North Carolina PAR file that would indicate if the vehicle is used in interstate or intrastate operations. Although Department of Transportation (DOT) number and Interstate Commerce Commission (ICC) number are recorded on the crash report form, they are not included in the PAR file. Commercial carrier state is available on the PAR file, but is not recorded for 48.8% of the reportable cases. However, vehicle license plate

state can be used to indirectly infer interstate operations. Obviously, many trucks in interstate commerce are licensed in the state of North Carolina; but trucks with a non-North Carolina state license involved in a crash in North Carolina must be interstate trucks.

As shown in Table 13, 73.6% of trucks or buses with out-of-state plates are reported to the MCMIS Crash file, compared with only 40.3% of vehicles with North Carolina plates. For every vehicle type except tractor/doubles, in-state vehicles are reported less often than vehicles with out-of-state plates. This finding implies that officers conclude that many intrastate vehicles do not meet the CMV definition and thus do not fill out the CMV section of the crash report.

Table 13. Reporting to MCMIS Crash File by Vehicle Type and License Plate State, North Carolina PAR File, 2003

Vehicle type	Reportable cases *		Reporting rate		Unreported cases		% of total unreported cases	
	NC	Out-state	NC	Out-state	NC	Out-state	NC	Out-state
2-axle truck	2,074	233	15.0	25.3	1,764	174	50.4	35.1
3-axle truck	879	60	49.4	61.7	445	23	12.7	4.6
Truck trailer	627	333	53.8	75.4	290	82	8.3	16.5
Truck tractor (bobtail)	95	62	53.7	69.4	44	19	1.3	3.8
Tractor/semitrailer	1,392	1,125	82.0	84.4	250	176	7.1	35.5
Tractor/doubles	18	44	88.9	88.6	2	5	0.1	1.0
School bus	441	1	5.9	100.0	415	0	11.9	0.0
Other bus	245	12	15.9	25.0	206	9	5.9	1.8
Other veh (haz placard)	2	0	50.0	-	1	0	0.0	0.0
Unknown heavy truck	94	10	11.7	20.0	83	8	2.4	1.6
Total	5,867	1,880	40.3	73.6	3,500	496	100.0	100.0

* The 770 reportable cases that did not have license plate state recorded were excluded from this table.

In addition to identifying qualifying vehicles, the final step in determining cases reportable to the MCMIS Crash file is to apply the crash severity criteria. Crashes involving a fatality may be easier to recognize, and thus more likely to be reported, than either transported injury cases or crashes involving a vehicle towed due to disabling damage. Consistent with this hypothesis, Table 14 shows that more severe crashes in North Carolina are more likely to be reported. Only 47.1% of towaway involvements were reported, compared with 49.4% of injury cases and 63.3% of crashes involving a fatality. Of all unreported cases, 66 (1.5%) involved a fatality, 1,348 (30.6%) were injury cases, and 2,998 (68.0%) cases involved a tow/disabled vehicle.

Table 14. Reporting to MCMIS Crash File by Crash Severity, North Carolina PAR File, 2003

Crash severity	Reportable cases	Reporting rate	Unreported cases	% of total unreported cases
Fatal	180	63.3	66	1.5
Injured, transported	2,666	49.4	1,348	30.6
Tow, disabled	5,671	47.1	2,998	68.0
Total	8,517	48.2	4,412	100.0

4.3 Reporting Agency and Area

Beyond the application of the reporting criteria, there can be differences related to where the crash occurs or the type of agency that covered the crash. More densely populated areas with a large number of traffic accidents may not report as completely as areas with a lower work load. The level and frequency of training or the intensity of supervision can also vary. If there are such differences, they may serve as a guide to focus resources in areas and at levels that will produce the greatest improvement. The next set of tables examines areas of the state to see if there are inconsistencies in reporting patterns.

Reporting rates for North Carolina's 100 counties ranged from 0.0% (for Macon, Madison, Martin, and McDowell) to 90.0% of reportable cases (Polk). All of those counties had less than 60 reportable cases. Table 15 shows reporting rates for the ten largest North Carolina counties, based on the most unreported cases. Together, these ten counties account for 49.5% (2,185) of the total unreported cases in North Carolina for 2003, and the four counties of Mecklenburg, Wake, Guilford, and Durham represent 34.7% (1,532) of unreported cases. Because it is responsible for the most reportable cases, Mecklenburg County also has the most unreported cases, 632, which represents 14.3% of the total number of unreported cases in the state. While most of these counties have reporting rates near the statewide average, Wake and Durham Counties have significantly lower reporting rates of 36.7% and 34.9%, respectively.

Table 15. Reporting to MCMIS Crash File by County, North Carolina PAR File, 2003

County	Reportable cases	Reporting rate	Unreported cases	% of total unreported cases
Mecklenburg	1,109	43.0	632	14.3
Wake	627	36.7	397	9.0
Guilford	577	48.4	298	6.8
Durham	315	34.9	205	4.6
Forsyth	277	43.7	156	3.5
Buncombe	211	49.8	106	2.4
Cumberland	211	51.7	102	2.3
Iredell	210	52.4	100	2.3
Union	178	46.1	96	2.2
Gaston	190	51.1	93	2.1
Sum of top ten	3,905	44.0	2,185	49.5
Total (all counties)	8,517	48.2	4,412	100.0

It is also possible that reporting rates could be related to the level of reporting agency. The North Carolina PAR file identifies five types of reporting agencies: North Carolina Highway Patrol (NCHP), county sheriff's offices, local police departments, public safety departments, and other agencies.

In North Carolina during 2003 the highway patrol was responsible for 56.0% of all reportable cases (Table 16), and police departments covered 43.3% of cases. The reporting rate for the NCHP was 58.2%, compared with only 35.4% for police departments. Although police departments were responsible for fewer reportable cases than the NCHP, they represented 54.0% of cases not reported to the MCMIS Crash File.

Table 16. Reporting to MCMIS Crash File by Reporting Agency, North Carolina PAR File, 2003

Reporting agency	Reportable cases	Reporting rate	Unreported cases	% of total unreported cases
North Carolina Highway Patrol	4,766	58.2	1,993	45.2
Sheriff's offices	36	41.7	21	0.5
Police departments	3,687	35.4	2,381	54.0
Public safety and other	28	39.3	17	0.4
Total	8,517	48.2	4,412	100.0

Table 17 shows reporting rates by agency type and crash severity. Sheriff's offices, public safety departments, and other agencies were combined, as together they represent only 64 reportable cases. For injury and towaway crashes, the North Carolina Highway Patrol is significantly more likely to complete a reportable case than police departments. This finding suggests that the level of training may vary among reporting agencies.

Table 17. Reporting to MCMIS Crash File by Reporting Agency and Accident Severity, North Carolina PAR File, 2003

Reporting agency	Reporting rates (%) by crash severity			
	Fatal	Injured, transported	Tow, disabled	All
North Carolina Highway Patrol	66.7	57.7	58.0	58.2
Police departments	52.6	37.3	34.4	35.4
Other agencies	0.0*	52.9	37.0	40.6
Total	63.3	49.4	47.1	48.2

* There was only one reportable fatal case.

Reporting rates by vehicle type also vary among reporting agencies. For all vehicle types except "other," the NCHP completes CMV data for a larger proportion of qualifying cases than police departments (Table 18). This is consistent with the fact that a higher proportion of crashes covered by the highway patrol involve interstate vehicles (27.6%), than crashes investigated by the police (20.2%). Furthermore, the highway patrol reports 51.2% of intrastate vehicles they investigate, compared with only 27.8% for the police.

However, both agency types report larger trucks at a higher rate than single unit vehicles (SUTs)). Buses are essentially overlooked by all agencies. Police departments are substantially underreporting straight trucks, with reporting rates of only 18.7% for SUTs and 44.6% for straight trucks pulling a trailer.

Table 18. Reporting to MCMIS Crash File by Reporting Agency and Vehicle Type, North Carolina PAR File, 2003

Reporting agency	Reporting rates (%) by vehicle type						
	SUT	Truck trailer	Tractor trailer	Bobtail	Bus	Other	All
North Carolina Highway Patrol	31.2	76.2	83.5	65.0	12.2	11.5	58.2
Police departments	18.7	44.6	76.4	49.4	8.8	11.9	35.4
Other agencies	28.6	45.5	92.3	100.0*	0.0*	0.0*	40.6
Total	25.4	60.2	81.4	58.3	9.9	11.4	48.2

* These percentages are based on fewer than six reportable cases.

The section below will examine reporting by police departments in more detail. One might expect there to be differences in reporting rates by specific department, with agencies in more densely populated areas not completing as high a proportion of reportable cases.

The reporting department code variable on the PAR file, in conjunction with an agency description, enables specific police departments to be identified. In 2003, there were 207 different North Carolina police agencies that covered MCMIS-reportable crashes. Table 19 shows the top ten police agencies with the most unreported cases. They accounted for 59.8% of all unreported cases covered by the police. These offices were also among those responsible for the most reportable cases. Reporting rates for these top ten agencies taken together were very low (34.5%), but comparable to the average for all police departments, 35.4%. It appears that police departments in large cities are reporting the same proportion of cases as those in less populated areas.

Table 19. Reporting Rates for Top Ten Police Agencies, North Carolina PAR File, 2003

PD Office	Reportable cases	Reporting rate	Unreported cases	% of total unreported cases
Charlotte-Mecklenburg Police Dept.	725	30.3	505	21.2
Raleigh Police Department	321	35.2	208	8.7
Durham Police Department	255	32.2	173	7.3
Greensboro Police Department	308	43.8	173	7.3
Winston-Salem Police Department	165	35.2	107	4.5
Fayetteville Police Department	82	26.8	60	2.5
Gastonia Police Department	98	46.9	52	2.2
Monroe Police Department	70	28.6	50	2.1
Wilmington Police Department	72	31.9	49	2.1
High Point Police Department	78	38.5	48	2.0
Sum of top ten	2,174	34.5	1,425	59.8
Total (all PDs)	3,687	35.4	2,381	100.0

The tables below further examine the top five police departments with the most unreported cases. As major cities in North Carolina, they represent agencies with the heaviest case loads. When reporting rates for the top five agencies are compared by accident severity, some variation is

apparent. The Greensboro department reports over half of their fatal and injury cases compared with the Durham P.D., reporting only 23.5%. Reporting of tow, disabled cases ranges from 27.8% for the Charlotte-Mecklenburg P.D. to 39.6% for the Greensboro P.D. However, average reporting rates for the top five agencies are very similar to the overall rates for all police departments.

Table 20. Reporting Rates for the Top 5 Police Agencies with the Most Unreported Cases by Crash Severity, North Carolina PAR File, 2003

Reporting agency	Reporting rates (%) by crash severity		
	Fatal and injured *	Tow, disabled	All
Charlotte-Mecklenburg Police Dept.	35.4	27.8	30.3
Raleigh Police Department	36.5	34.7	35.2
Durham Police Department	23.5	34.3	32.2
Greensboro Police Department	52.5	39.6	43.8
Winston-Salem Police Department	31.0	36.6	35.2
Total (Top 5 PDs)	37.4	33.0	34.3
Total (all PDs)	37.8	34.4	35.4

* Since there were few reportable fatal cases, they were combined with the injured/transported category.

The top five agencies show a relatively consistent pattern in the types of vehicles submitted to the MCMIS crash file. All five agencies report tractor trailer combinations most frequently (averaging 77.5%), followed by bobtails (averaging 51.3%), and straight trucks with trailers (averaging 43.5%). The least reported vehicle types are the two and three-axle single unit trucks, with reporting rates ranging from 14.0% to 24.8%. Bus cases are also frequently overlooked, with the top five agencies only reporting an average of 10.6% of these vehicles. Again, rates for these large agencies are very much in line with the reporting rates of all police agencies combined.

Table 21. Reporting Rates for Top 5 Police Agencies with the Most Unreported Cases by Vehicle Type, North Carolina PAR File, 2003

Reporting agency	Reporting rates (%) by vehicle type						
	SUT	Truck trailer	Tractor trailer	Bobtail *	Bus	Other *	All
Charlotte-Mecklenburg Police Dept.	24.8	41.1	73.3	53.9	3.9	15.8	30.3
Raleigh Police Department	20.8	44.0	80.7	-	28.0	18.8	35.2
Durham Police Department	14.0	35.3	81.1	62.5	14.3	9.1	32.2
Greensboro Police Department	18.6	52.5	81.1	45.5	14.8	0.0	43.8
Winston-Salem Police Department	18.3	42.9	72.5	42.9	18.2	0.0	35.2
Total (Top 5 PDs)	20.7	43.5	77.5	51.3	10.6	13.2	34.3
Total (All PDs)	18.7	44.6	76.4	49.4	8.8	11.9	35.4

* Reporting rates for the bobtail and other vehicle categories are based on few reportable cases in some instances. The Raleigh P.D. had no reportable bobtail cases in 2003.

Although police departments show some variation by specific agency, overall their reporting patterns are very consistent. The fact that police departments have a lower reporting rate than the

highway patrol is due to the fact that, as a group, they are not completing the CMV section of the crash report form as often. This may be due to differences in training and understanding of when the CMV section of the crash report needs to be completed.

5. Data Quality Issues

In addition to examining the number of records reported to the MCMIS Crash file, it is important to evaluate completeness of data reported. Missing data rates are important in evaluating the utility of a data file, since records with missing data cannot contribute to an analysis. Table 22 shows the unrecorded rates for required variables. For most variables, the recording rate for North Carolina is 100%. Missing data rates are higher for DOT number, crash events two through four, vehicle license number, and vehicle license state. The event variables may be difficult to record, contributing to their high numbers of unrecorded values. In addition, there are a large number of towaway cases which may have had only one catastrophic event. For the 27 vehicles displaying a hazardous materials placard, three of the variables were recorded in 100% of the cases; however, the name of the hazardous material was always omitted.

Table 22. Unrecorded Rates for Selected Variables, North Carolina MCMIS File, 2003

Variable	Percent unrecorded	Variable	Percent unrecorded
Accident year	0.0%	Event one	0.0
Accident month	0.0	Event two	70.0
Accident day	0.0	Event three	83.5
Accident hour	0.0	Event four	93.3
Accident minute	0.0	Number of vehicles	0.0
Body type	1.5	Officer badge number	5.5
Configuration	1.5	Report number	0.0
County	0.0	Road access	0.0
DOT number	18.9*	Road surface	0.0
Driver date of birth	2.1	Road trafficway	1.2
Driver license number	2.1	Towaway	0.0
Driver license state	2.1	Truck or bus	0.0
Fatal injuries	0.0	Vehicle license number	9.0
Non-fatal Injuries	0.0	Vehicle license state	8.8
Interstate	0.0	VIN	1.6
Light	0.0	Weather	0.0
* Counting cases where the carrier is coded interstate.			

Hazardous materials variable	Percent unrecorded
Hazardous materials placard	0.0%
Percentages of placarded vehicles only:	
Hazardous cargo release	0.0%
Hazardous materials class (1-digit)	0.0%
Hazardous materials class (4-digit)	0.0%
Hazardous materials name	100.0%

The following set of tables compares the actual data values in the North Carolina PAR file with the values in the MCMIS Crash file to determine if the data are consistent between the two datasets. It is possible that errors of translation and formatting can occur when the data are prepared for submission to the MCMIS crash file.

For most variables, it appears that the data are accurately prepared for the MCMIS Crash file. In fact, code levels were exactly consistent between the PAR data and MCMIS data for the variables lighting condition, weather, and road condition. For the variable cargo body type, the only discrepancy was one case coded as concrete mixer in MCMIS, but unrecorded in the PAR file.

Table 23 displays the consistency between the vehicle type variable as recorded in the North Carolina PAR file and the coding of configuration in the MCMIS Crash file. There are several inconsistencies, given that the vehicle code levels map fairly cleanly between the two files. Vehicles coded as buses on the PAR file are also coded as buses in MCMIS, with the exception of unrecorded cases in MCMIS. For every truck type in the PAR file, cases are only coded with that specific truck type in the MCMIS file. However, for every truck category in the PAR file, cases are additionally coded as buses in MCMIS. In total, there are 47 PAR trucks coded as buses in the MCMIS crash file (1.1% of the 4,105 cases). This type of obvious error, perhaps in the data transmission system, should be easy to detect and correct. Overall, 54 cases (1.3%) were inconsistently coded between the vehicle type variables in the two files.

Table 23. Vehicle Type Coding in North Carolina PAR Compared with MCMIS Crash File, 2003

NC PAR vehicle type variable	MCMIS configuration variable	N	%
School bus	Unrecorded	2	0.0
	Bus (seats >15,incl dr)	25	0.6
	Subtotal	27	0.7
Other bus	Unrecorded	4	0.1
	Bus (seats 9-15,incl dr)	1	0.0
	Bus (seats >15,incl dr)	40	1.0
	Subtotal	45	1.1
Pickup/panel (hazmat placard)	Unrecorded	1	0.0
Single unit truck (2-axle,6-tire)	Bus (seats 9-15,incl dr)	1	0.0
	Bus (seats >15,incl dr)	5	0.1
	SUT, 2-axle, 6-tire	384	9.4
	Subtotal	391	9.5
Single unit truck (3+ axles)	Bus (seats 9-15,incl dr)	2	0.0
	Bus (seats >15,incl dr)	1	0.0
	SUT, 3+ axles	485	11.8
	Subtotal	488	11.9
Truck/trailer	Bus (seats 9-15,incl dr)	3	0.1
	Bus (seats >15,incl dr)	13	0.3
	Truck trailer	632	15.4
	Subtotal	648	15.8
Truck/ tractor(bobtail)	Bus (seats >15,incl dr)	5	0.1
	Truck tractor (bobtail)	97	2.4
	Subtotal	102	2.5
Tractor/semitrailer	Bus (seats 9-15,incl dr)	4	0.1
	Bus (seats >15,incl dr)	11	0.3
	Tractor/semitrailer	2,308	56.2
	Subtotal	2,323	56.6
Tractor/doubles	Bus (seats >15,incl dr)	1	0.0
	Tractor/double	65	1.6
	Subtotal	66	1.6
Unknown heavy truck	Bus (seats >15,incl dr)	1	0.0
	Unk. Heavy trk>10,000 lbs	14	0.3
	Subtotal	15	0.4
Total		4,105	100.0

Coding of the variable indicating a vehicle displayed a hazardous materials placard is shown in Table 24. A “no” coded in the MCMIS Crash file was coded as either “no” or was unrecorded in the PAR file, all probably meaning the vehicle did not display a placard. A true inconsistency exists in the ten cases coded “yes” in the PAR file, but “no” in the MCMIS file, resulting in a coding error for cases with a hazardous materials placard of $10/37=27.0\%$.

Table 24. Hazardous Placard Coding in North Carolina PAR Compared with MCMIS Crash File, 2003

NC PAR Hazardous Placard variable	MCMIS Hazardous Placard variable	N	%
Unrecorded	No	4,068	99.1
No	No	1	0.0
Yes	No	10	0.2
Yes	Yes	26	0.6
Total		4,105	100.0

6. Summary and Discussion

The purpose of the present study was to evaluate the completeness of data reported from North Carolina to the MCMIS Crash file. To accomplish that goal, the North Carolina PAR file for 2003 was obtained, and these data were compared with the data reported to the MCMIS Crash file.

The North Carolina Crash Report Instruction Manual provides a comprehensive description of data elements on the PAR form, and how to record them. The crash report form and resulting PAR file both include all the data items necessary to identify crashes reportable to MCMIS. Thus, MCMIS-reportable vehicles and crashes could be more precisely defined for North Carolina than for many other states that have been previously evaluated. In lieu of GVWR, which is essentially unrecorded, the vehicle style (type) variable is used to select trucks and buses meeting the MCMIS criteria. However, the 2003 North Carolina commercial motor vehicle (CMV) documentation had apparently not been updated pertaining to the definition of buses, as they were defined as “seating for at least 16, including the driver,” instead of the newer definition “seating for at least 9, including the driver.” Vehicles with hazmat placards can also be identified using the hazardous materials placard variable in the CMV hazardous materials section of the crash report form. The state’s definition of a CMV included vehicles *of any size*, if transporting hazardous materials, so thus was consistent with MCMIS requirements.

The PAR data also include the standard injury severity variable for each passenger and non-passenger involved in the accident. In addition, whether or not an injured person was transported for care can be determined by looking at the variable which records the facility and city where the injured were taken.

To address the towaway criteria, the PAR file contains three vehicle-level variables: Vehicle_drivable, Towed_by and Towed_to. A “no” response in the Vehicle_drivable variable indicates the vehicle was disabled by damage severe enough to prevent driving it. Using a combination of the three variables, vehicles towed due to disabling damage can be ascertained.

Thus, it appears that North Carolina has made its data collection system consistent with MCMIS reporting requirements. Further examination of the data file determined that there were some

duplicate records, although the number was very small and accounted for only 0.01% of cases. In addition, North Carolina has very high recording rates for most MCMIS-required variables. Missing data rates are somewhat higher for DOT number, crash events two through four, vehicle license number, and vehicle license state.

The North Carolina PAR instruction manual states that the reporting officer is supposed to complete the CMV section of the crash report for collisions involving commercial motor vehicles. It appears that filling out this section is correlated with case submission to the MCMIS Crash file. Percent of cases submitted was examined based on recording status of nine variables from the CMV section of the PAR. All but one submitted case had at least one CMV variable recorded. However, for reportable, but not reported cases, only 5.8% had CMV variables recorded. The evidence indicates that when this area of the PAR form is not completed eligible cases are not being submitted to the MCMIS Crash file.

Thus, in North Carolina it is evident that cases are not submitted to MCMIS unless the CMV section of the PAR form is filled out. Based on the CMV definition, it may be difficult for officers to determine if a vehicle qualifies as a CMV. Yet virtually all vehicles that meet MCMIS criteria are indeed commercial vehicles. This is a problem that needs to be solved. Appropriate steps should be taken to ensure that the CMV information is recorded for vehicles that qualify based on their physical characteristics.

Overall, North Carolina submits 48.2% of its reportable cases to the MCMIS Crash file. A previous study of MCMIS reporting estimated that nationwide only 60% of qualifying crash involvements were actually reported [1]. In-depth studies on the states of Ohio, Missouri, Michigan, Florida, California and New Jersey found reporting rates ranging from 24% to 82.5% [2, 3, 4, 5, 6, 7]. As with other states, North Carolina reports fatal crashes at a higher rate (63.3%) than injury cases (49.4%) and towaways (47.1%). Of 4,412 unreported cases, 2,998 (68.0%) are towaway cases. Improving the reporting of vehicles involved in these less serious crashes would greatly improve the overall reporting rate for North Carolina.

Responsibility for determining which cases should be submitted to MCMIS ultimately lies at the state level. In addition to errors in applying the reporting criteria, there can be delays in transmitting cases. Late case submission did not measurably affect overall reporting rates for this evaluation, since the MCMIS Crash file as of March 14, 2005 was used. However, an analysis of reporting rates by month showed that the average delay in case reporting for crashes occurring in 2003 was 333 days beyond the 90-day allowable period.

Other variables were examined for their potential relationship to case underreporting. In applying the MCMIS criteria it is crucial to identify the eligible vehicles correctly; hence the vehicle type variable was compared between reported and unreported cases. Overall, trucks are reported 51.8% of the time. Two-axle single unit trucks are reported only 15.7% of the time, while tractor

semitrailers and tractor doubles are reported at rates of 81.3% and 85.7%, respectively. Buses are even less likely to be reported, averaging only 9.9%. Since the state is identifying eligible vehicles based on data items in the CMV section, it is crucial the officers understand that these vehicles require the additional information.

Underreporting may also be related to misunderstanding that vehicles involved in intrastate commerce, not just interstate, are to be included. Indeed, in North Carolina trucks and buses with out-of-state license plates were reported 73.6% of the time, compared with only 40.3% of vehicles with in-state plates.

It was hypothesized that reporting rates might be lower in more densely populated areas. The top ten counties in North Carolina with the most unreported cases were also counties with high numbers of reportable cases. The average reporting rate for these counties (44.0%) is only slightly different from the statewide rate of 48.2%. With a couple of exceptions, these ten counties had high numbers of unreported cases because they had large caseloads, not because of unusually low reporting rates.

Reporting rates for the various reporting agencies were also examined to determine if understanding of reporting requirements differed by agency. In North Carolina, 56.0% of the MCMIS-reportable cases are the responsibility of the highway patrol (NCHP). The NCHP reports an average of 58.2% of their cases, compared with the statewide average of 48.2%. Although police departments are responsible for only 43.3% of reportable cases, they represented 54.0% of cases (2,381) not reported to the MCMIS Crash file. The overall reporting rate for police departments is 35.4%. As a group, they are significantly underreporting straight trucks, with reporting rates of only 18.7% for single unit trucks. Of 207 statewide police departments covering MCMIS crashes, the top ten offices with the most unreported cases accounted for 59.8% of all unreported cases covered by the police. The top five police departments - Charlotte-Mecklenburg, Raleigh, Durham, Greensboro and Winston-Salem – represent major cities with heavy case loads. However, their reporting rates were very similar to the rates for all police departments.

In summary, North Carolina is reporting 48.2% of its eligible cases to the MCMIS Crash file. Although North Carolina's data collection system is very complete, and generally consistent with MCMIS reporting requirements, less than half the eligible cases are being submitted. Less severe crashes are reported less often than more serious ones. Smaller trucks are reported at a lower rate than large trucks, and over 90% of eligible bus cases are ignored. Vehicles with out-of-state license plates are reported much more often than in-state trucks and buses.

Evidence supports the hypothesis that reporting to MCMIS is based on filling out the CMV section of the crash report. It is not recognized that virtually all vehicles that meet MCMIS criteria are indeed commercial vehicles. Officers are undoubtedly less likely to recognize smaller

vehicles and intrastate vehicles as CMVs, and thus do not proceed to fill out the CMV section of the crash report. The result is substantially lower reporting rates for these vehicle types, contributing to the overall number of unreported cases, 4,412. Helping officers to understand that they need to complete the CMV section for vehicles that meet MCMIS requirements would likely go a long way in solving North Carolina's underreporting problems.

References

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7. Green, P.E., and Blower, D., *Evaluation of New Jersey Crash Data Reported to MCMIS Crash File*. University of Michigan Transportation Research Institute, Ann Arbor, Michigan. February 2005. Sponsor: Federal Motor Carrier Safety Administration, U.S. D.O.T.
8. Federal Motor Carrier Safety Administration (FMCSA) MCMIS Crash File Documentation, April, 2005.
9. North Carolina Department of Transportation Division of Motor Vehicles, *North Carolina Crash Report Instruction Manual*, September, 1999.
10. *North Carolina Crash Report Form DMV-349*, revision March 2000.

Appendix A: Variables Used for North Carolina PAR Data to Identify a MCMIS-Reportable Crash

MCMIS Reporting Criteria	Implementation in North Carolina PAR Data
<p>Truck with GVWR over 10,000 or GCWR over 10,000</p>	<p>Although GVWR was included as a variable on the crash report and was also on the PAR file, it was essentially unrecorded for 2003.</p> <p>However, the vehicle style (type) variable appeared to be sufficient for selecting trucks meeting the MCMIS criteria. The following codes were used to identify eligible trucks:</p> <p>Veh_style = 10 (Single unit truck, 2-axle 6-tire) 11 (Single unit truck, 3 or more axles) 12 (Truck/trailer) 13 (Truck tractor, i.e. bobtail) 14 (Truck tractor, semi-trailer) 15 (Tractor/doubles) 16 (Unknown heavy truck)</p>
<p>or Bus with seating for at least nine, including the driver</p>	<p>The following codes were used to identify eligible buses:</p> <p>Veh_style= 6 (Commercial bus) 7 (School bus) 8 (Activity bus) 9 (Other bus)</p> <p>Other potential vehicles used to transport passengers (such as vans) could not be identified, since variables indicating number of seats and vehicle use were not available.</p>
<p>or Vehicle displaying a hazardous materials placard</p>	<p>The North Carolina crash report form includes a section titled CMV: Hazardous Materials Involvement. Since the third definition of a CMV (page 45 of instruction manual) included vehicles <i>of any size</i>, if used to transport hazardous materials, this section should be recorded for vehicles lighter than 10,001 lbs. Thus, vehicles displaying a hazardous materials placard were defined as:</p> <p>Hazmat_placard_indicator =1</p>
AND	
<p>at least one fatality</p>	<p>North Carolina has an injury severity variable on the accident level PAR file reflecting the most serious injury in the crash:</p>

MCMIS Reporting Criteria	Implementation in North Carolina PAR Data
	Severity_code= code 1 (fatal)
<p>or at least one person injured and transported to a medical facility for immediate medical attention</p>	<p>At the occupant level, the North Carolina PAR file includes an injury severity variable, as well as treatment facility name and city.</p> <p>The injury severity variable is coded as follows: injury_severity = code 2 (Type A injury, disabling), code 3 (Type B injury, evident), code4 (Type C injury, possible), code 5 (No injury), and code 6 (Unknown injury).</p> <p>The treatment facility name and city were on the crash report as Injured taken to EMS: _____ (treatment facility and city or town).</p> <p>The following entries were not considered to be valid facility names: “not transported,” “treated at scene,” “no transport,” “N/A,” “NA,” “refused,” “refused transport,” “did not transport”. A person was considered to be transported if facility name was valid or if facility name was unrecorded, but facility city was valid (not equal to unrecorded or “not transported”).</p> <p>Injured, transported persons were defined as those who had an injury code of A, B, C, No injury, unknown, 7 or 8 and were transported. It was assumed the individuals designated “no injury”, “unknown”, and codes 7 or 8 suffered some degree of injury since they were transported for medical care.</p>
<p>or at least one vehicle towed due to disabling damage</p>	<p>The North Carolina PAR file contains three vehicle-level variables that could be used to determine tow/disabled status: Vehicle_drivable, Towed_by, and Towed_to.</p> <p>The PAR veh_drivable variable is coded as no (0), yes (1), or unknown (2). All of the North Carolina data had a value of either yes (1) or missing. The PAR instruction manual states that a “no” response means that the vehicle was disabled by damage severe enough to prevent driving it (p. 43). The Towed_by and Towed_to instructions state that the officer is supposed to record where the vehicle was towed, followed by the name of the business responsible for towing (p.19).</p> <p>The following cases were not considered 'towed due to disabling damage' even though Vehicle_drivable is not 'yes':</p>

MCMIS Reporting Criteria	Implementation in North Carolina PAR Data
	<p>a. Towed_by and Towed_to are both blank (It is not possible to distinguish a 'no' from a missing value. It appears as though the tow variables are simply unrecorded, as the estimated_damage variable is missing for most of these cases as well. Since estimated_damage_amount was also missing for 96.8% of them, it is likely that these cases had missing data for the Vehicle_drivable variable as well. (For comparison, where vehicle_driveable was not yes, but Towed_to and Towed_by were recorded, < 0.1% of cases had missing estimated_damage).</p> <p>b. Towed_by and Towed_to are both notow ('NA' or "not towed")</p> <p>c. Towed_by is blank and Towed_to is notow</p> <p>d. Towed_by is recorded, but Towed_to is notow (Towed_by contains some valid tow companies, but also just miscellaneous comments. Since 'not towed' was specified, they were excluded.</p> <p>In cases where Vehicle_drivable was 'yes', they were not considered towed due to disabling damage. Even though some cases had Towed_to or Towed_by recorded, it was possible these vehicles were towed, but not due to disabling damage.</p> <p>Thus, an accident included a vehicle "towed due to disabling damage" if any vehicle in the crash met the following conditions: Vehicle_drivable variable is not 'yes' and any of the following apply:</p> <p>a. Towed_by and Towed_to are both recorded</p> <p>b. Towed_by is blank, but Towed_to is recorded</p> <p>c. Towed_by is recorded, but Towed_to is blank</p> <p>d. Towed_by is 'not towed', but Towed_to is recorded</p>

Assignment of the tow/disabled variable is summarized in the following table.

Veh_drivable	Towed_by	Towed_to	Number of cases	Tow/disabled status assigned	Comments
No/missing	Blank	Blank	4,820	no	Assumed all missing data
No/missing	Blank	"Not towed"	1	no	
No/missing	Blank	Recorded	8	yes	
No/missing	"Not towed"	"Not towed"	3,645	no	
No/missing	"Not towed"	Recorded	111	yes	Assumed towed
No/missing	Recorded	Blank	4	yes	
No/missing	Recorded	"Not towed"	483	no	Towed_by includes many invalid entries
No/missing	Recorded	Recorded	155,420	yes	
Yes	Blank	Blank	349,399	no	
Yes	Blank	Recorded	1	no	Assumed not disabling damage
Yes	"Not towed"	"Not towed"	3	no	
Yes	Recorded	Recorded	48	no	Assumed not disabling damage

Appendix B: North Carolina Crash Report Form

DMV-349 (Rev. 3/2000) THIS REPORT IS FOR THE USE OF THE DIVISION OF MOTOR VEHICLES. THE DATA IS COLLECTED FOR STATISTICAL ANALYSIS AND SUBSEQUENT HIGHWAY SAFETY PROGRAMMING. DETERMINATIONS OF "FAULT" ARE THE RESPONSIBILITY OF INSURERS OR OF THE STATE'S COURTS.

Do not write in these spaces

No. of Units Involved _____ Form _____ of _____ Supplemental Report Non-Reportable

Date _____ County _____ Time _____ Local Use/Patrol Area _____

mm/dd/ccyy (24 Hour Clock)

Date Received by DMV _____

LOCATION

33 Relation to Roadway Surface _____ Crash occurred In _____ or _____ Miles _____ outside municipality

on _____ Municipality _____ (R.R. Crossing # _____) _____ Miles _____ ft. _____

at or from _____ Ramp or Service Road _____ (If available)

Use Highway Number, Street Name or Adjacent County or State Line _____ toward _____ Use Highway Number, Street Name or Adjacent County or State Line _____

Latitude _____ Longitude _____ Altitude _____

<p>UNIT # <input type="checkbox"/> VEHICLE <input type="checkbox"/> PEDESTRIAN <input type="checkbox"/> HIT & RUN <input type="checkbox"/> COMMERCIAL 20 VEHICLE</p> <p>Driver _____</p> <p>First _____ Middle _____ Last _____ Suffix _____</p> <p>Address _____</p> <p>City _____ State _____ Zip _____</p> <p>Same Address on Driver's License? <input type="checkbox"/> Yes <input type="checkbox"/> No Driver's Phone Numbers H (_____) W (_____)</p> <p>D.L. # _____ State _____</p> <p>DOB _____ CDL License <input type="checkbox"/> 34 Vision Obstruction _____ 35 Physical Condition _____ 36 D.L. Restrictions _____</p> <p>37 Alcohol/Drugs Suspected _____ 38 Alcohol/Drugs Test _____ 39 Results (if known) _____ 40 Vehicle Seizure (DWI) <input type="checkbox"/></p>	<p>UNIT # <input type="checkbox"/> VEHICLE <input type="checkbox"/> PEDESTRIAN <input type="checkbox"/> HIT & RUN <input type="checkbox"/> OTHER</p> <p>Driver _____</p> <p>First _____ Middle _____ Last _____ Suffix _____</p> <p>Address _____</p> <p>City _____ State _____ Zip _____</p> <p>Same Address on Driver's License? <input type="checkbox"/> Yes <input type="checkbox"/> No Driver's Phone Numbers H (_____) W (_____)</p> <p>D.L. # _____ State _____</p> <p>DOB _____ CDL License <input type="checkbox"/> 34 Vision Obstruction _____ 35 Physical Condition _____ 36 D.L. Restrictions _____</p> <p>37 Alcohol/Drugs Suspected _____ 38 Alcohol/Drugs Test _____ 39 Results (if known) _____ 40 Vehicle Seizure (DWI) <input type="checkbox"/></p>
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<p>Owner _____</p> <p>Same as Driver? <input type="checkbox"/></p> <p>Address _____</p> <p>Same Address as Driver? <input type="checkbox"/></p> <p>City _____ State _____ Zip _____</p> <p>Plate # _____ State _____ Plate Year _____</p> <p>VIN _____</p> <p>Vehicle Make _____ Year _____ 41 Vehicle Style (Type) _____ 42 Vehicle Drivable <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>43 TAD _____ 44 Estimated Damage _____</p> <p>Insurance Company _____</p> <p>Policy # _____</p>	<p>Owner _____</p> <p>Same as Driver? <input type="checkbox"/></p> <p>Address _____</p> <p>Same Address as Driver? <input type="checkbox"/></p> <p>City _____ State _____ Zip _____</p> <p>Plate # _____ State _____ Plate Year _____</p> <p>VIN _____</p> <p>Vehicle Make _____ Year _____ 41 Vehicle Style (Type) _____ 42 Vehicle Drivable <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>43 TAD _____ 44 Estimated Damage _____</p> <p>Insurance Company _____</p> <p>Policy # _____</p>
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20 COMMERCIAL VEHICLE: Cargo, Carrier Name, Address, Source

45 Cargo Body Type _____ Same Address as Owner? _____

Source: Truck Shipping papers Driver

Carrier Identification Numbers, GVWR, Axles

US DOT# _____ ICC# _____ Axles on Vehicle Including Trailers _____

State# _____ State# _____ IFTA# _____

FEE# _____ Fleet# _____ Gross Vehicle Weight Rating _____

	21	22	23	24	25	26	27	28	29	30	31	32	Names and Addresses for All Persons (Unit 1/Unit 2 Drv, Ped, etc. - See Above); Use check blocks if address same as Driver
A													see above Veh# Towed To/By: _____
B													see above Veh# Towed To/By: _____
C													
D													
E													
F													
G													
H													

46 Name of EMS _____ 46 Name of EMS _____

47 Injured Taken by EMS to _____ (Treatment Facility and City or Town) 47 Injured Taken by EMS to _____ (Treatment Facility and City or Town)

48 POINTS OF INITIAL CONTACT (Write in Codes) Unit# _____ Unit# _____	VEHICLE INFO.	Veh # _____	Veh # _____	ROADWAY INFO.	WORK ZONE RELATED
CRASH SEQUENCE (Unit Level) Unit# _____ Unit# _____ 49 Vehicle Maneuver/Action 50 Non-Motorist Action 51 Non-Motorist Location Prior to Impact 52 Crash Sequence - First Event for This Unit 53 Crash Sequence - Second Event 54 Crash Sequence - Third Event 55 Crash Sequence - Fourth Event 56 Most Harmful Event for This Unit 57 Distance/Direction to Object Struck 58 Vehicle Under/Over/Under 59 Vehicle Defects	60 Authorized Speed Limit 61 Estimate of Original Traveling Speed 62 Estimate of Speed at Impact 63 Tire Impressions Before Impact (ft.) 64 Distance Traveled After Impact (ft.) 65 Emergency Vehicle Use 66 Post Crash Fire (if "Yes" check block) 67 School Bus - Contact Vehicle 68 School Bus - Noncontact Vehicle	69 Road Feature 70 Road Character 71 Road Classification 72 Road Surface Type 73 Road Configuration 74 Access Control 75 Number of Lanes 76 Traffic Control Type 77 Traffic Control Oper	78 Workzone Area 79 Work Activity 80 Work Area Marked 81 Crash Location TRAILER INFO. Unit# _____ Unit# _____ 82 Trailer Type 1st Trailer No. Axles Width (inches) Length (feet) 2nd Trailer No. Axles Width (inches) Length (feet) 83 Unit# _____ Overwidth Trailer and Overwidth Mobile Home Overwidth Permit # _____		
	COMMERCIAL VEHICLE: Hazardous Materials Involvement Haz Mat Placard <input type="checkbox"/> Yes <input type="checkbox"/> No From Placard indicate: Hazardous Cargo <input type="checkbox"/> Yes <input type="checkbox"/> No 4-digit placard number or name from diamond or box 1-digit number from bottom of diamond Released (does not include fuel from fuel tank) Carrying Haz Mat <input type="checkbox"/> Yes <input type="checkbox"/> No				
84 DIAGRAM <div style="border: 1px solid black; padding: 5px; width: 50px; float: left; margin-bottom: 10px;"> Indicate North </div>					
Unit# _____ was: <input type="checkbox"/> Traveling <input type="checkbox"/> Parked Facing N <input type="checkbox"/> S <input type="checkbox"/> E <input type="checkbox"/> W on _____ Unit# _____ was: <input type="checkbox"/> Traveling <input type="checkbox"/> Parked Facing N <input type="checkbox"/> S <input type="checkbox"/> E <input type="checkbox"/> W on _____					
85 NARRATIVE (Include pertinent and unusual aspects, which are not listed elsewhere on the form) _____ _____ _____ _____ _____ _____ _____ _____ _____					
86 Type/Owner _____ Owner Address _____ Phone _____ State _____ ADDITIONAL PROPERTY DAMAGE _____ Property? <input type="checkbox"/> Estimated Damage \$ _____					
WITNESSES					
Name _____ Address _____ Phone No. (_____) _____ Name _____ Address _____ Phone No. (_____) _____					
TRAFFIC VIOLATION(S)					
Name _____ Charge(s) _____ (Citation # optional) Name _____ Charge(s) _____					
Officer Name _____		Officer Number _____		Department _____	
Date of Report _____					