

**EVALUATION OF 2006 PENNSYLVANIA
CRASH DATA REPORTED TO THE MCMIS
CRASH FILE**

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**Evaluation of 2006 Pennsylvania Crash Data
Reported to the MCMIS Crash File**

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16. Abstract <p>This report is part of a series 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. The earlier studies showed that reporting to the MCMIS Crash File was incomplete. This report examines the factors that are associated with reporting rates for the state of Pennsylvania.</p> <p>MCMIS Crash File records were matched to the Pennsylvania Crash file to determine the nature and extent of underreporting. Overall, it appears that Pennsylvania is reporting about 77 percent of crash involvements that should be reported to the MCMIS Crash file. However, the vehicle type variables in the Pennsylvania data contain inconsistencies, and the MCMIS Crash severity criteria cannot be applied directly. A method using the vehicle identification number (VIN) was employed to identify the appropriate vehicles, and a surrogate was developed for crash severity.</p> <p>Reporting rates were highest for fatal involvements, and significantly lower for injury/transported and tow/disabled crash involvements. Smaller qualifying vehicles were less likely to be reported than larger vehicles like tractor-semitrailers. Unlike most states, bus involvements were more likely to be reported than truck involvements. Reporting rates also varied by the type of investigation agency (state police, county, or city police).</p> <p>Missing data rates are low for most variables, except for driver license class, roadway access, and road trafficway. Some inconsistencies between data reported to the MCMIS file and recorded in the Pennsylvania data were also noted.</p>			
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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)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
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)				
°C	Celsius	1.8C+32	Fahrenheit	°F
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.
(Revised March 2003)

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Evaluation of 2006 Pennsylvania Crash Data Reported to the MCMIS Crash File

1. Introduction

The Motor Carrier Management Information System (MCMIS) Crash file has been developed by the Federal Motor Carrier Safety Administration (FMCSA) to serve as a census file of trucks and buses involved in traffic crashes meeting a specified crash severity threshold. FMCSA maintains the MCMIS file to support its mission to reduce crashes, injuries, and fatalities involving large trucks and buses. It is essential to assess the magnitude and characteristics of motor carrier crashes to design effective safety measures to prevent such crashes. The usefulness of the MCMIS Crash file depends upon individual states transmitting a standard set of data items on all trucks and buses involved in traffic crashes that meet a specific severity threshold.

The present report is part of a series evaluating the completeness and accuracy of the data in the MCMIS Crash file. Previous reports on a number of states showed underreporting due in large part to problems in interpreting and applying the reporting criteria. Each state also had problems specific to the nature of its system. Some states also had overreporting of cases, often due to technical problems with duplicate records. [See references 3 to 22.] The states are responsible for identifying and reporting qualifying crash involvements. Accordingly, improved completeness and accuracy must ultimately reside with the individual states.

In this report, we focus on MCMIS Crash file reporting by Pennsylvania. In recent years, Pennsylvania has reported from 5,200 to 7,820 involvements annually to the MCMIS Crash file. According to the 2002 Vehicle Inventory and Use Survey, in 2002, Pennsylvania had over 157,000 trucks registered, ranking 11th among the states and accounting for 2.9 percent of all truck registrations.[1] Pennsylvania is the sixth largest state by population and typically also ranks sixth in terms of the number of annual truck and bus fatal involvements.

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

1. The complete police accident report file (PAR file hereafter) from Pennsylvania was obtained for the most recent year available, 2006. This file was processed to identify all cases that qualified for reporting to the MCMIS Crash file.
2. All cases in the Pennsylvania 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 Pennsylvania.
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 Pennsylvania's statewide files as of June 2007 were used in this analysis. The 2006 PAR file contains the computerized records of 227,674 units (vehicles and pedestrians) involved in 128,334 crashes that occurred in Pennsylvania.

2. Data Preparation

The Pennsylvania PAR file and MCMIS Crash file each required some preparation before the Pennsylvania records in the MCMIS Crash file could be matched to the Pennsylvania PAR file. In the case of the MCMIS Crash file, the only processing necessary was to extract records reported from Pennsylvania and to eliminate duplicate records. The Pennsylvania PAR file required more extensive work to create a comprehensive unit-level file from accident, unit, and occupant files. The following sections describe the methods used to prepare each file and some of the problems uncovered.

2.1 MCMIS Crash Data File

The 2006 MCMIS Crash file as of June 4, 2007 was used to identify records submitted from Pennsylvania. For calendar year 2006 there were 6,901 cases. 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). One such instance was found. But further examination revealed that these were two different vehicles and drivers in the same accident. Likely, the sequence number (vehicle number) was mistakenly assigned a '1' in both cases. Thus, both of these records were left in the file.

In addition, records were examined for identical values for accident date, time, crash county, crash city, officer badge number, vehicle license plate number, and driver license number, even though their case numbers were perhaps different. One would not expect all of these variables to be identical between two cases. Four such duplicates were found, representing two unique occurrences of the examined variables. In both instances, case number was different for each member of the pair, but vehicles and drivers were the same. A few of the other variables also differed.

In both duplicate instances one record may have been entered erroneously during the process of updating information on the original record. The record with the latest "input date" was kept, and the earlier one was deleted. After deletion of two records the resulting file contains 6,899 unique records.

2.2 Pennsylvania Police Accident Report File

The Pennsylvania PAR data for 2006 (as of June 2007) was obtained from the state of Pennsylvania. The data were stored as eleven tables in an Access database. Records were then combined into accident, unit, and person-level data files. The combined files contain records for 128,334 crashes involving 227,674 units (vehicles and pedestrians). Data for the PAR file are coded from the Commonwealth of Pennsylvania Police Crash Reporting Form (AA-500) completed by police officers.

The PAR file was first examined for duplicate records. A search for records with identical case numbers and vehicle numbers found no such instances. In addition, inspection of case numbers verified that they were recorded in a consistent format, so there was no reason to suspect duplicate records based on similar, but not identical, case numbers (such as 2006027466 and 2006-27466, 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, crash county, city, vehicle identification number (VIN), and driver license number. A total of 497 duplicate instances were found, representing 244 unique occurrences of the examined variables.

Duplicate pairs (in some cases triplicates) were examined more closely for any patterns that might explain why they were occurring. In most cases, members of the duplicate pair had different accident numbers, but vehicles and drivers were the same. A few other variables differed, but most were identical between both members of the pair. Perhaps one record was intended to be an update to the original case, and mistakenly resulted in the addition of a duplicate record. Since there was no variable indicating a date the record was updated or processed, the last member of each pair was kept, and others excluded. After the deletion of 253 cases, the resulting PAR file has 227,421 records.

3. Matching Process

The next step involved matching records from the Pennsylvania PAR file to corresponding records from the MCMIS file. After removing duplicates, there were 6,899 Pennsylvania records from the MCMIS file available for matching, and 227,421 records from the Pennsylvania PAR file. All records from the Pennsylvania 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 did not meet the MCMIS Crash file reporting criteria.

Matching records in the two files requires finding combinations of variables common to the two files that have a high probability of uniquely identifying accidents and specific vehicles within the accidents. Crash Report Number, which is the identifier used to uniquely identify a crash in the Pennsylvania PAR data, and Report Number in the MCMIS Crash file, are obvious first choices. Indeed, there is a correspondence between the two numbers, and case number was never unrecorded in either file. Crash Report Number in the Pennsylvania PAR file is a ten-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 (PA, in this case), followed by ten digits. Since five of these numbers were consistent with the last five digits of the PAR Crash Report Number, the relevant digits were extracted, and these two variables were used in the match.

Other variables available for matching at the crash level include Crash Date, Crash Time (stored in military time as hour/minute), Crash County, Crash City, Crash Street and Reporting Officer's Identification number. Since Crash City code did not match between the two files, it could not be used. Officer ID number was not present in the PAR file. In addition, Crash Street in the MCMIS file did not readily match either Route Number or Street Name in the PAR data.

Variables in the MCMIS file that distinguish one vehicle from another within the same crash include vehicle license plate number, driver license number, vehicle identification number (VIN), driver date of birth, and driver last name. Vehicle license plate number was unrecorded in 12.0 percent of PAR cases and driver license number was unknown in 11.2 percent of the cases.

Four separate matches were performed using the available variables. At each step, records in either file with duplicate values on all the match variables were excluded, along with records that were missing values on the match variables. The first match included the variables case number, crash date (month, day), crash time (hour, minute), crash county, VIN, vehicle license number, and driver license number. The second match step dropped case number, minute, and VIN, but retained the other variables. The third match step matched on crash date, county, and driver last name. After some experimentation, the fourth match included variables crash month, crash day, and VIN. All cases in the last match were also hand-verified. This process resulted in matching 96.5 percent of the MCMIS records to the PAR file.

See Table 1 for the variables used in each match step along with the number of records matched at each step.

Table 1 Steps in MCMIS/Pennsylvania PAR File Match, 2006

Step	Matching variables	Cases matched
Match 1	Case number, crash date, crash time, crash county, VIN, vehicle license number, and driver license number	6,013
Match 2	Crash date, crash hour, crash county, vehicle license number, and driver license number	320
Match 3	Crash date, county, and driver last name	270
Match 4	Crash date, and VIN	54
Total cases matched		6,657

Matched records were verified using other variables common to the MCMIS and PAR file as a final check to ensure the match was valid. The above procedure resulted in 6,657 matches, representing 96.5 percent of the 6,899 non-duplicate records reported to MCMIS.

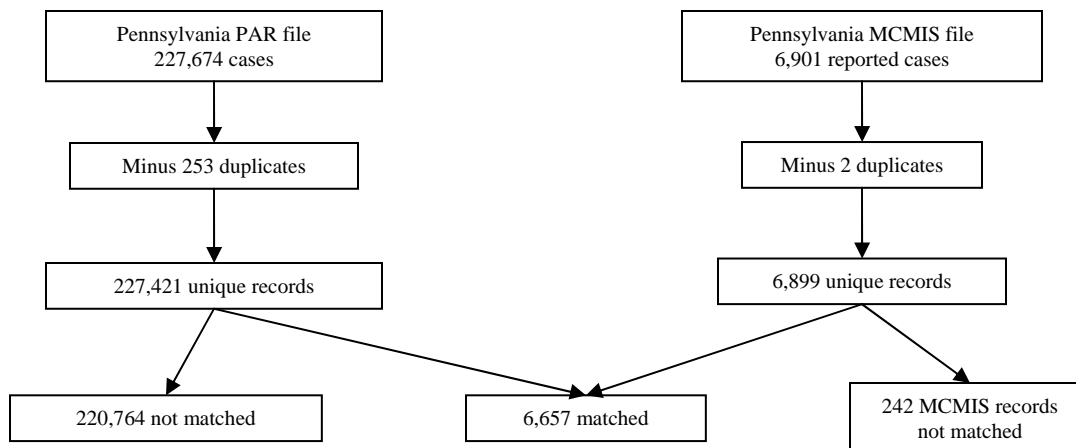


Figure 1 Case Flow in MCMIS/Pennsylvania Crash File Match

Of the 6,657 matched cases, 780 are not reportable and 5,877 are reportable. Of the cases that were reported and were not found to be reportable, 606 did not qualify because they did not meet the crash severity criteria and the other 174 were not found to be qualifying vehicles. However, there are many uncertainties in identifying qualifying cases in the Pennsylvania data, both with respect to vehicle type and crash severity. These problems are discussed in the next section.

4. Identifying Reportable Cases

The next step in the process of evaluating the completeness of reporting to the MCMIS Crash file is to identify the records in the Pennsylvania data that qualified for reporting. In order to determine if all eligible records are reported, we attempt to identify reportable records in the crash data, without reference to whether the reporting officer or any other entity determined that a record was reportable. In Pennsylvania, data on crash-involved commercial vehicles are collected on Form AA-500C. Form AA-500C is a supplement to the main crash report form (Form AA-500). On that form, the reporting officer is directed to fill out the supplemental form for all commercial vehicles. But the purpose here is to determine if all the appropriate vehicles and crashes are being identified for reporting, including by the reporting officer. So it is necessary, in effect, to attempt to identify all reportable vehicles and cases, even those an officer may have overlooked. For this purpose, we use the data that is completed for all cases. The goal of the selection process 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 2.

Table 2 Vehicle and Crash Severity Threshold for MCMIS Crash File

Vehicle	Truck with gross vehicle weight rating (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.

It is not possible to apply all the reporting criteria set out in Table 2 because the Pennsylvania crash data do not include all of the information needed. On some criteria, notably identifying crashes in which a vehicle was towed due to disabling damage, the variables and completeness of data are sufficient to use with high confidence. However, identifying crashes in which an injured person was transported for immediate medical attention is not feasible because of high rates of missing data. And identifying vehicles that meet the criteria is complicated by the fact that the variables available do not specify GVWR (for trucks) or seating capacity (for buses). In addition, the variables are substantially inconsistent with each other.

4.1 Qualifying vehicles

As noted above, Pennsylvania uses a supplemental form to collect the data to be reported to the MCMIS Crash file. On the main form, the officer is directed to fill out the supplemental data for “commercial vehicles.” The instruction manual for crash report defines a commercial vehicle as “a motor vehicle designed or used to transport passengers or property,” with any of the following characteristics:¹

- GVWR of 26,001 pounds or more;
- Designed to transport 15 or more passengers, including the driver;
- Is a school bus; or
- Is transporting hazardous materials and requires a hazmat placard.

This definition of a commercial vehicle does not meet the MCMIS reporting criteria on a number of dimensions. The GVWR reporting threshold for a truck is 10,000 pounds, not 26,001. Buses transporting passengers for compensation are reportable if they have seating for nine or more, not 15 or more. And school buses are only included if they meet the minimum seating threshold of nine, including the driver. The threshold relating to the number of passengers was changed in 1999 from the 15 passenger minimum, and the manual and instructions have not been updated to reflect that change. At the same time, the criteria for a reportable truck was changed from a

¹ *Commonwealth of Pennsylvania Police Officers Crash Report Manual*, no publisher or date. PENNDOT Publication 153, pages 36-37.

vehicle with at least two axles and six tires to a vehicle with a GVWR or GCWR of 10,001 pounds or more. The GVWR threshold in the crash report instructions was never a valid criteria for the MCMIS Crash file.

The Pennsylvania crash data include a number of variables that provide some information about vehicles, but the two primary variables are called *veh_type* and *body_type_cd*. *Veh_type* is taken directly from a variable on the crash report, so it records the reporting officer's identification of the vehicle. Two codes, "bus" and "large truck" identify vehicles that likely meet the MCMIS Crash file vehicle criteria. The *body_type_cd* variable appears to be a derived variable, since there is no place on the crash report that records the information directly. It is likely that the variable is in some way derived from the vehicle identification number (VIN). The *body_type_cd* variable is detailed and includes a number of levels that identify vehicles that would qualify for the MCMIS Crash file.

There are substantial differences in vehicle identification between the *veh_type* and *body_type_cd* variables. Of the 8,903 vehicles that are tentatively identified as a qualifying truck or bus in either the *veh_type* variable or the *body_type_cd* variable, the identification is in conflict on 3,821 of the vehicles, or 42.9 percent. For example, there are 1,006 vehicles classified as a large truck in the *veh_type* variable (as recorded by the reporting officer) that are coded as compact pickups in *body_type_cd*.

With such a substantial level of internal inconsistency, it was not considered reasonable to attempt to identify MCMIS-qualifying vehicles from the Pennsylvania data alone. Accordingly we contacted a third party to decode the VINs of candidate vehicles, as a way of evaluating the two Pennsylvania variables. David Hetzel of the National Institute for Safety Research, Inc., (NISR) kindly agreed to process the VINs of candidate vehicles through a VIN-decoding program he has developed.

Hetzel processed the VINs of the 8,903 vehicles identified as a truck or bus in either of the two variables from the Pennsylvania crash data. The result was to validate generally the *veh_type* variable. The NISR decoding program was unable to assign a vehicle type to 917 vehicles, primarily because the VIN was either missing or invalid. Of the remaining 7,986, the vehicle type differed significantly in 648 cases, or 8.1 percent of the vehicles. In contrast, the NISR-assigned vehicle type differed significantly from the *body_type_cd* in 1,603 cases, or 20.1 percent of the cases that could be compared.

From the NISR work, it appears that *veh_type* variable, which is coded by the reporting officer, is more accurate than the *body_type_cd* variable. Accordingly, it was decided to take as vehicles that meet the MCMIS Crash file vehicle criteria vehicles identified as either a truck or bus in *veh_type*. In addition, we included all vehicles identified as a truck or bus by the NISR VIN-decoding program. As a result, 8,635 vehicles were identified in the Pennsylvania crash data as meeting the MCMIS Crash file criteria.

Vehicles that are not trucks but which meet the MCMIS criteria because they display a hazardous materials (or hazmat) placard could not be identified and so are not included. Such vehicles are rare and thus do not have a material impact on the results of this evaluation.

4.2 Injury severity

The second main criteria in identifying a reportable crash involvement relates to injury severity. Crashes that result in either a fatality or an injured person transported for immediate medical attention meet the injury severity threshold. Crashes with persons injured or killed are readily identified but identifying injuries transported for immediate medical attention is more problematic. There is a variable that records whether a person was transported but examination of the data showed that it is seriously underreported. The variable is missing in 73.3 percent of the cases which result in rates of transported injuries that are not credible. For example, of the 202,305 persons coded with an incapacitating injury, only 27 percent are recorded as transported for medical attention. One would expect virtually all such persons to be transported. In states with acceptable rates of reporting, typically 75 to 95 percent of A injuries are reported as transported for treatment. In the case of non-incapacitating but evident injuries (B-injuries), typically 50 to 75 percent are coded as transported, and minor (C-injuries) are transported at a lower, but still significant, rate.

Since the variable recording whether a person was transported appears to be substantially under-recorded, it was necessary to use an approximation to identify cases that meet the crash severity criterion of the MCMIS Crash file. Accordingly, crashes in which a person was fatally injured, or suffered A or B injuries, or suffered a minor injury but was transported for treatment, were taken as meeting the injury severity criterion. This is an approximation but a very reasonable one in light of the fact that it is highly likely that a crash involving a serious injury is also likely to involve a vehicle towed due to disabling damage. Thus, these crashes should qualify either because of the severity of injury or because of the severity of damage to vehicles.

4.3 Towaway crashes

The final criteria for reporting severity is crashes in which at least one vehicle is towed due to disabling damage. The Pennsylvania crash data includes a variable that records whether a vehicle was towed. This variable has valid code levels (either 'Y' or 'N') in 97.7 percent of cases, which is quite high. In addition, the variable that records the level of vehicle damage explicitly addresses whether a vehicle is drivable or not. The most severe damage is defined as disabling. The intermediate level is defined as functional damage, but the vehicle may be driven. The minor damage category is defined as drivable. Thus, the Pennsylvania crash data supports the identification of crashes in which a vehicle was towed due to disabling damage very well. Crashes in which a vehicle sustained disabling damage or functional damage and the vehicle was towed were defined as qualifying crashes. In addition, crashes in which a vehicle sustained an unknown level of damage, but were towed, were also taken as qualifying crashes.

The application of the vehicle type and crash severity criteria identified 7,598 reportable cases in the 2006 Pennsylvania crash data. Table 3 shows the distribution of these cases by the crash severity criteria for the MCMIS file.

Table 3 MCMIS Reportable Cases in the 2006 Pennsylvania Crash File

Severity	N	%
Fatal	217	2.9
Injury/transported	1,546	20.3
Towed/disabled	5,835	76.8
Total	7,598	100.0

A total of 6,899 records were reported from Pennsylvania to the MCMIS Crash file in 2006. However, analysis of the records and identification of reportable cases shows that, of the 6,899 reported cases, only 5,877 qualified for reporting, giving a reporting rate of 77.3 percent. Figure 2 shows the combined results of matching the cases reported to the MCMIS file with the Pennsylvania crash file and the determination of whether the cases qualified for reporting.

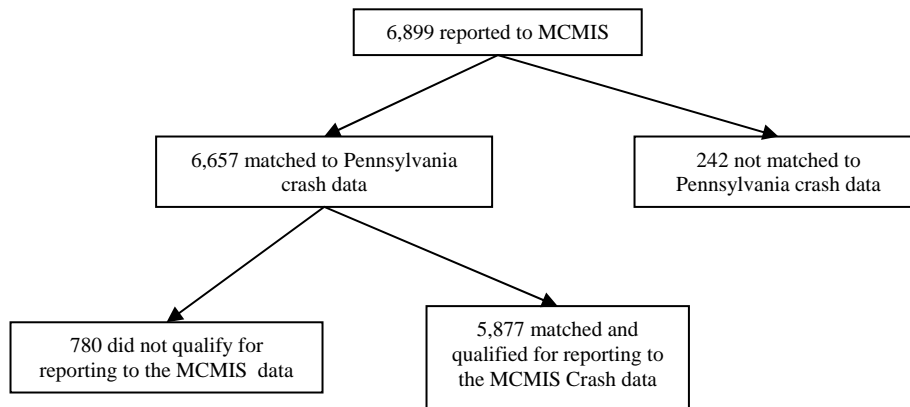


Figure 2 Disposition of Pennsylvania Cases Reported to MCMIS Crash File

However, the 77.3 percent reporting rate should be interpreted with care. The discussion of the problem of identifying cases that qualify for reporting shows that there are a number of uncertainties. Of the 780 reported cases that did not qualify for reporting, 606 did not meet the crash severity threshold. The discussion above noted the problems with identifying qualifying crashes because of missing data on the variable that identifies persons transported for medical attention. It is possible that if the transported variable had been complete, some fraction of the 780 may have qualified. On the other hand, the likelihood that many additional cases would have qualified is low, since crashes severe enough to include a transported injury almost always included a vehicle towed due to damage, and the variables that identified towed/disabled vehicles appear to be quite complete. There were also 174 reported cases that did not meet the vehicle type reporting criteria, and the inconsistencies in the variables that describe vehicles were fully discussed above. So it is possible that some of the 174 were actually vehicles that qualified for reporting, though the likelihood of this is also low, since the vehicles we excluded did not qualify as trucks or buses, based on the VIN and the reporting officer's judgment.

5. Factors Associated with Reporting

The process discussed in section 4 identified 7,598 crash involvements in the Pennsylvania crash report data from 2006 that qualified for reporting to the MCMIS Crash file. In this section we discuss factors that are associated with the observed reporting rate. In Pennsylvania, police officers fill out the form that includes most of the data reported to the MCMIS Crash file for vehicles they identify as “commercial vehicles.” Thus, the process of reporting cases to MCMIS is initiated by the reporting officer checking the “commercial vehicle” box on the main crash report, and then completing the supplemental form with the data specific to the MCMIS Crash file. Unlike in many other states, the reporting officer does not have to apply the crash severity criteria, just identify a “commercial vehicle” and complete the supplementary form.

A number of factors that influence the reporting rate were identified, including crash severity, whether the commercial vehicle flag on the main report was checked, characteristics of the vehicle type, the type of agency submitting the report, and other factors. Several factors were identified that are obstacles to full reporting, which may be addressed through training and changes in procedures. The problems in identifying reportable cases should be kept in mind, however, since if all reportable cases could be precisely identified, the relationships here might be somewhat different.

5.1 Crash severity

Reporting rates tended to vary by crash severity, with lower severity crash involvements reported at a lower rate. Table 4 shows that almost 92 percent of fatal involvements were reported, while injury/transported and towed/disabled involvements were reported at similar rates, 74.5 percent and 77.6 percent respectively. Since the officer’s responsibility is to complete the supplemental data for all qualifying vehicles, regardless of severity, the difference in rates by crash severity seems to indicate a problem farther along in the process. It is not known how Pennsylvania extracts reportable cases, but there may be some difficulty in the application of the MCMIS criteria.

Table 4 Reporting Rate by MCMIS Crash Severity, Pennsylvania 2006

Crash severity	Reportable	Reporting Rate	Unreported	% of total unreported
Fatal	217	91.7	18	1.0
Injury/transported	1,546	74.5	394	22.9
Towed/disabled	5,835	77.6	1,309	76.1
Total	7,598	77.3	1,721	100.0

5.2 Vehicle characteristics

As noted, the process of reporting cases begins with the officer checking the commercial vehicle box on the main crash report form and then completing the crash supplement, Form AA-500-C. Table 5 shows that the commercial vehicle flag is a necessary but not sufficient condition for reporting. Over 93 percent of the reportable cases with the commercial vehicle flag checked were reported, and only 424 were not reported. On the other hand, there were 1,300 cases determined

to qualify for reporting to the MCMIS Crash file which did not have the CMV flag set, and only three were actually reported. Without the flag (and completing the supplementary form) cases do not get reported. The table also shows that there are many vehicles for which the flag and form should have been completed but were not. The original instructions in the crash report manual for identifying commercial vehicles do not correctly describe reportable vehicle types, so officers may be accurately following those instructions and thus missing a large number of reportable vehicles.

**Table 5 Reporting Rates by Commercial Vehicle Indicator
Pennsylvania 2006**

Commercial vehicle flag	Reportable	Reporting Rate	Unreported	% of total unreported
No	1,300	0.2	1,297	75.4
Yes	6,298	93.3	424	24.6
Total	7,598	77.3	1,721	100.0

Interestingly, the reporting rate for buses is higher than for trucks, the reverse of what is observed in many other states. Table 6 shows reporting rates by CMV type, where the CMV type is derived from the Pennsylvania vehicle type recorded by the reporting officer, and the body type decoded by NISR from the VIN. Almost 84 percent of reportable bus involvements were reported, compared with only 76.5 percent of reportable truck involvements. And this despite the fact that the instructions in the crash report manual are inaccurate for both trucks and buses. The difference could be that the smaller buses overlooked by the instructions are a lower share of the population of buses involved in reportable crashes than the smaller trucks are of the trucks involved in such crashes. In any case, it is likely that rates would be improved with more accurate instructions.

Table 6 Reporting Rate by CMV Type, Pennsylvania 2006

CMV type	Reportable	Reporting Rate	Unreported	% of total unreported
Truck	6,749	76.5	1,584	92.0
Bus	849	83.9	137	8.0
Total	7,598	77.3	1,721	100.0

As in other states, reporting rates are lower for smaller qualifying vehicles than for larger ones, particularly with regard to trucks. Table 7 shows reporting rates by the VIN-derived body type. The instructions to the officer are to complete the supplementary form for trucks with GVWR over 26,000 pounds, and rates for large trucks are quite good. Over 88 percent of the involvements of single unit trucks (SUT) with a GVWR over 26,000 were reported. In addition, 95.3 percent of truck/tractors were reported; almost all truck/tractors have a GVWR over 26,000 pounds. On the other hand, only 45.8 percent of qualifying step vans were reported, only 22.1 percent of SUTs with GVWR between 10,000 and 19,500, and only 39.4 percent of SUTs with GVWR between 19,500 and 26,000. Officers are doing a reasonable job of completing the supplementary data for the largest trucks, and less often for the smaller ones. One could argue

that they should not complete any for the smaller vehicles, given their instructions, but some of the smaller trucks are being included, possibly because of the inherent difficulty in applying a GVWR criterion.

Table 7 Reporting Rate by VIN-Derived Body Type, Pennsylvania 2006

Body type class	Reportable	Reporting Rate	Unreported	% of total unreported
School bus	371	88.9	41	2.4
Transit bus	229	70.7	67	3.9
Unknown bus	25	92.0	2	0.1
Step van > 10,000 GVWR	24	45.8	13	0.8
SUT 10K-19.5K GVWR	217	22.1	169	9.8
SUT 19.5K - 26K GVWR	345	39.4	209	12.1
SUT > 26K	1,575	88.1	188	10.9
Other medium/heavy truck	2	0.0	2	0.1
Truck/tractor	3,438	95.3	160	9.3
Medium/heavy pickup	43	9.3	39	2.3
Other vehicle type	700	27.4	508	29.5
Unknown	629	48.6	323	18.8
Total	7,598	77.3	1,721	100.0

Reporting also varies by the state of vehicle registration. Reportable cases are reported at a higher rate if the vehicle is registered out of state than if it is a Pennsylvania-registered vehicle. Over 90 percent (Table 8) of the out-of-state vehicles were reported, compared with 72.4 percent of Pennsylvania-registered vehicles. It could be that reporting officers more readily recognize that the vehicle is in commercial operations if it is registered in another state. Officers may also understand that the supplementary data is submitted to a national file, and thus believe that only CMVs in interstate commerce are required. Regardless of the explanation, the difference in reporting rates is significant, both statistically and in practical terms, and points up an opportunity for education.

Table 8 Reporting Rate by Vehicle Registration State, Pennsylvania 2006

Vehicle registration state	Reportable	Reporting Rate	Unreported	% of total unreported
Unknown	267	18.7	217	12.6
Out of state	2,818	90.8	260	15.1
Pennsylvania	4,513	72.4	1,244	72.3
Total	7,598	77.3	1,721	100.0

5.3 Investigating agency

Reporting rates vary to some extent by the type of investigating agency. There are three primary levels of investigating agencies identified in the Pennsylvania crash file, though only two apparently are actually doing the crash reports, the state police and local police. A county sheriff was also identified in only one case, which was correctly reported. Different levels of law enforcement have different sets of responsibilities, though reporting rates for both of the primary agency types—state police and local police—were high, with the rate for state police higher. Overall, reportable crash involvements covered by state police were reported to the MCMIS Crash file at an 82.1 percent rate, while 71.8 percent of those covered by local police were reported. This difference is statistically significant and may be related to differences in training and experience.

Table 9 Reporting Rate by Investigating Agency, Pennsylvania 2006

Investigating agency	Reportable	Reporting Rate	Unreported	% of total unreported
State Police	4,113	82.1	738	42.9
Police	3,475	71.8	979	56.9
Sheriff	1	100.0	0	0.0
Unknown	9	55.6	4	0.2
Total	7,598	77.3	1,721	100.0

The Pennsylvania data also identify the specific state police troop that covered the crash, so it is possible to determine reporting rates by the specific troop. Almost all the seventeen troops identified have reporting rates above the statewide average, with a few exceptions. Troop T, which may be assigned to the Pennsylvania turnpike, had both one of the highest reporting rates as well as covering the most reportable crash involvements. Troop H, which covers an area including Harrisburg and York also had the highest number of reportable cases but the reporting rate was about at the mean for all state police troops. Troops L and C also had reporting rates and covered among the most reportable crash involvements, but overall, there appears to be little relationship between the number of cases covered and the rate at which those cases were reported. There is some tendency for Troops with higher numbers of reportable cases to have somewhat higher rates, but the association is not strong.

Table 10 Reporting Rate by State Police Troop, Pennsylvania 2006

State Police troop	Reportable	Reporting Rate	Unreported	% of total unreported
SP Troop A	181	78.5	39	5.3
SP Troop B	304	76.0	73	9.9
SP Troop C	279	87.1	36	4.9
SP Troop D	206	83.0	35	4.7
SP Troop E	121	90.1	12	1.6
SP Troop F	174	86.8	23	3.1
SP Troop G	233	84.1	37	5.0

State Police troop	Reportable	Reporting Rate	Unreported	% of total unreported
SP Troop H	547	81.5	101	13.7
SP Troop J	192	60.9	75	10.2
SP Troop K	226	75.7	55	7.5
SP Troop L	296	86.5	40	5.4
SP Troop M	290	75.2	72	9.8
SP Troop N	261	81.6	48	6.5
SP Troop Pennsylvania	85	90.6	8	1.1
SP Troop R	177	85.3	26	3.5
SP Troop S	1	0.0	1	0.1
SP Troop T	540	89.4	57	7.7
Total	4,113	82.1	738	100.0

5.4 Month and day of week

We also examined reporting rates by some time dimensions, including day of week and month of year. If reporting rates by month decline over the course of the year, that might reflect delays in processing, extracting, and uploading cases through the SafetyNet system to the MCMIS Crash file. However, on examination, there was very little fluctuation over the year that might be consistent with any such delays. Figure 3 shows reporting rates by month, include 95 percent confidence intervals, and there is little discernable trend. The rate was lower for crashes in November, but the difference is not large or statistically significant. It appears that there is no delay in reporting cases that contributes to the overall reporting rate.

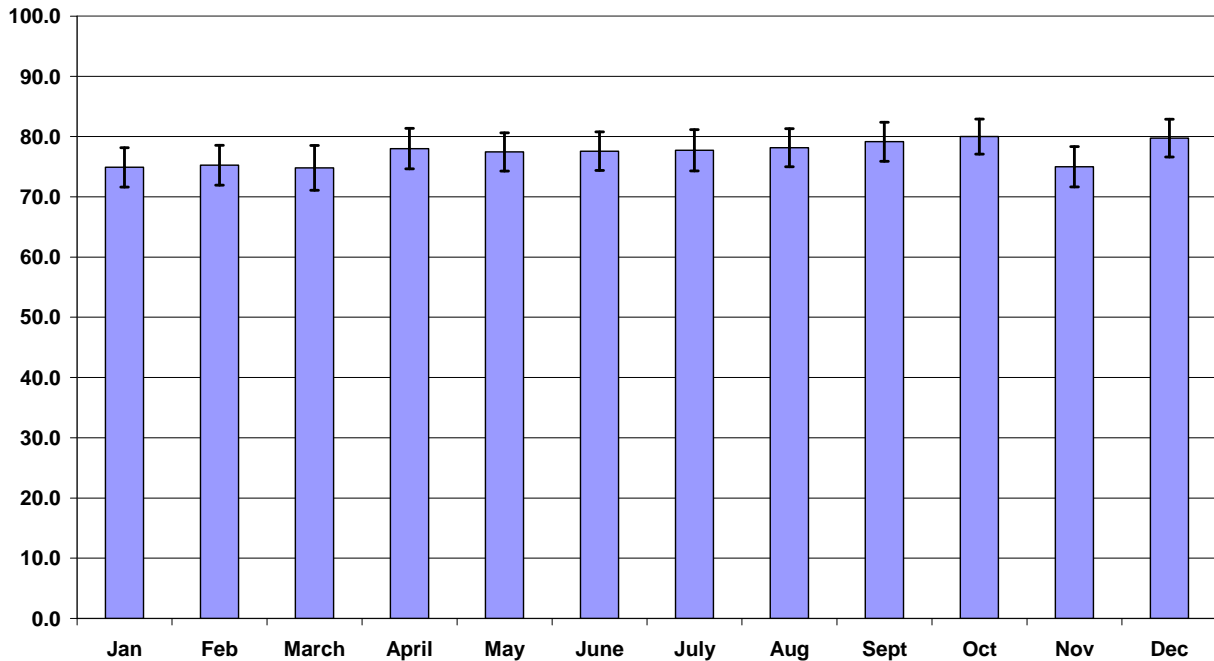


Figure 3 Reporting Rate by Crash Month, Pennsylvania 2006

On the other hand, there is an interesting pattern to reporting rates by the day of week, as shown in Figure 4. Reporting rates are significantly lower for the weekend, in comparison with the Monday through Friday work week, and lowest of all for crashes that occur on a Sunday. It is not known why this pattern occurs, though it may be related to who is policing the crashes on the weekends, or to additional responsibilities on the weekend that results in lower rates of reporting. Differences in the CMV population on weekends are not likely to account for the drop. Work trucks operate mostly during the work week, while the set of trucks operating on the weekend tends to be the largest trucks such as tractor-semitrailer and doubles combinations in long-haul operations. And those vehicle types have the highest rates of reporting.

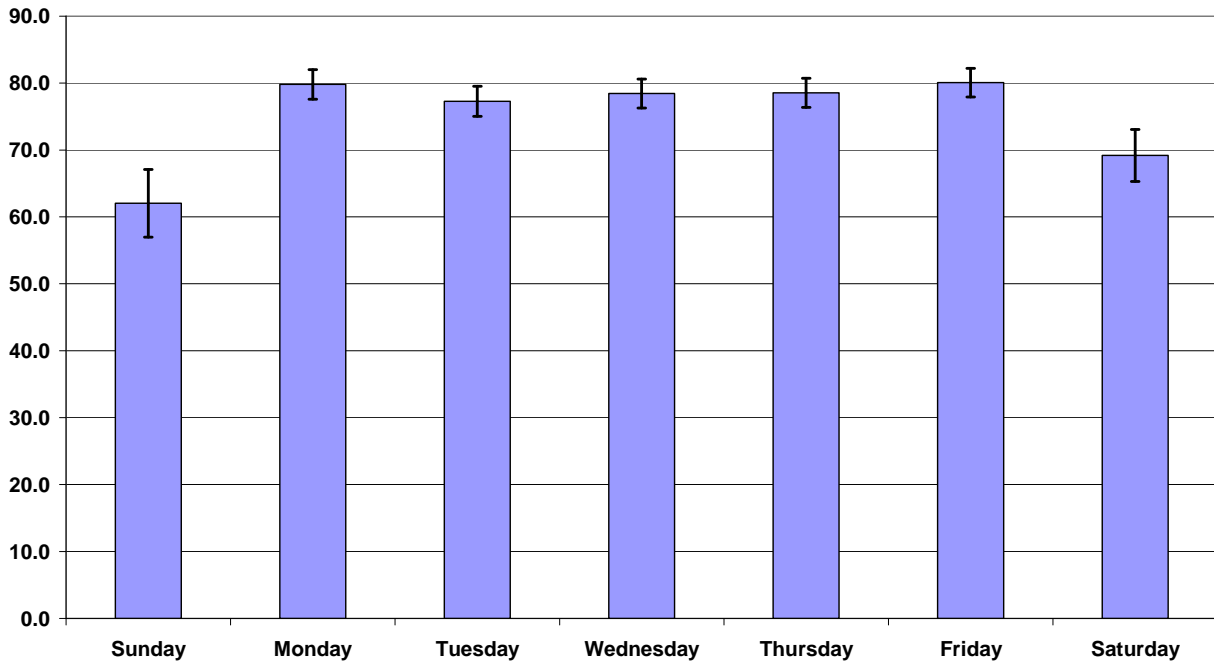


Figure 4 Reporting Rates by Crash Day of Week, Pennsylvania 2006

5.5 Fire

Reporting rates also varied by whether the vehicle experienced a fire as part of the crash. Fire in the vehicle is recorded as part of a set of variables that capture the sequence of harmful events in the crash. Table 11 shows that of the 70 reportable involvements that included a fire, all but nine were reported, for a reporting rate of 87.1. Involvements with fire are actually somewhat more likely to be reported than other reportable involvements, and the difference is statistically significant.

Table 11 Reporting Rates by Vehicle Fire, Pennsylvania 2006

Fire	Reportable	Reporting Rate	Unreported	% of total unreported
No	7,528	77.3	1,712	99.5
Yes	70	87.1	9	0.5
Total	7,598	77.3	1,721	100.0

Reporting rates where a fire was involved also variable by the type of vehicle (truck or bus) but not in a way that is statistically significant. (Please see Table 12.) There were four buses in a reportable crash in which the bus had a fire, and three of those cases were reported, for a rate of 75.0 percent. Among trucks, 66 had a fire in the crash and all but eight were reported, for a reporting rate of 87.9 percent. But the higher rate for trucks is not statistically significant, since there were only four fires among the bus crashes. With so few relevant crashes, even one unreported case results in a low rate. A fire in the vehicle is associated overall with a higher reporting rate, but there is no evidence that the type of vehicle has an additional effect on the probability of reporting.

**Table 12 Reporting Rate by Vehicle Type and Fire Event,
Pennsylvania 2006**

Fire	Reportable	Reporting Rate	Unreported	% of total unreported
Truck				
None	6,683	76.4	1,576	99.5
Fire	66	87.9	8	0.5
Bus				
None	845	83.9	136	99.3
Fire	4	75.0	1	0.7
Total	7,598	77.3	1,721	100.0

6. Data Quality of Reported Cases

In this section, we consider the quality of data reported to the MCMIS crash file. Two aspects of data quality are examined. The first is the amount of missing data. Missing data rates affect the usefulness of a data file because records with missing data cannot contribute to an analysis. The second aspect of data quality considered here is the consistency of coding between records as they appear in the Pennsylvania crash data and in the MCMIS Crash file. Inconsistencies may indicate errors in translating information recorded on the crash report to the values in the MCMIS Crash file.

Table 13 shows missing data rates for selected important variables in the MCMIS Crash file. Missing data rates are generally quite low, with a handful of exceptions. On most fundamental, structural variables, such as date, time, number of fatalities and number of injuries, missing data rates are either zero or extremely low. Missing data rates for some other variables are higher. Driver license class is missing for 41.9 percent of cases, even though both driver license number and class are collected on the Pennsylvania crash report. Road Access is a derived data element, and is unrecorded 27.1 percent of the time. Road trafficway is missing for 58.1 percent, which is unfortunate because the crash report form has extensive information about the type of road involved. DOT number is not recorded for 19.9 percent of cases in which the carrier is coded as interstate, and therefore must have a DOT number. Events two through four are missing data for from 90.4 percent to 99.9 percent. This is not unexpected, since most crashes consist of only a single harmful event, but comparison of the event variables in the Pennsylvania data with the event variables in MCMIS showed that there are a few hundred cases which have valid codes in the Pennsylvania data but which are left as missing data in the MCMIS file. This may be a processing problem.

Table 13 Missing Data Rates for Selected MCMIS Crash File Variables, Pennsylvania 2006

Variable	Percent unrecorded	Variable	Percent unrecorded
Report number	0.0	Fatal injuries	0.0
Accident year	0.0	Non-fatal injuries	0.0
Accident month	0.0	Interstate	0.0
Accident day	0.0	Light	0.0
Accident hour	1.6	Event one	1.9
Accident minute	1.6	Event two	90.4
County	0.0	Event three	99.4
Body type	<0.1	Event four	99.9
Configuration	5.3	Number of vehicles	0.0
GVWR class	0.0	Road access	27.1
DOT number *	19.9	Road surface	0.0
Carrier state	3.7	Road trafficway	58.1
Citation issued	1.3	Towaway	0.0
Driver date of birth	4.6	Truck or bus	0.0
Driver license number	4.4	Vehicle license number	5.5
Driver license state	3.0	Vehicle license state	4.7
Driver license class	41.9	VIN	6.0
Driver license valid	1.3	Weather	0.0
* Counting cases where the carrier is coded interstate.			

Hazardous materials variable	Percent unrecorded
Hazardous materials placard	2.8
Percentages of hazmat placarded vehicles only:	
Hazardous cargo release	0.0
Hazardous materials class (1-digit)	0.0
Hazardous materials class (4-digit)	100.0
Hazardous materials name	0.0

There were 168 vehicles recorded as displaying a hazardous materials (hazmat) placard. (Whether the vehicle displayed a hazmat placard was not recorded in 2.8 percent of cases.) The table above shows information about the recording of hazmat variables only for those vehicles coded with a hazmat placard. The 4-digit hazardous materials class variable was unrecorded for all of the placarded vehicles. All other hazmat variables were complete.

We also compared the values of variables in the MCMIS Crash file with the values of comparable variables in the Pennsylvania crash file. The purpose of this comparison is to

identify any errors in translating variables from the values in the state crash file to the values required for the MCMIS Crash file.

We compared variables that record the vehicle configuration, cargo body, number of fatalities in the crash, number of units involved in the crash, light condition, roadway surface condition, weather, vehicle license state, hazmat release, hazmat placard indicator, and harmful events in the crash.

Vehicle configuration and cargo body showed some minor inconsistencies. Comparing the configuration variable in the commercial vehicle table of the Pennsylvania crash data and the same variable in the MCMIS Crash file showed that they differed in about 5 percent of the records. Cases which were left unknown in one file but had a specific code in the other were not counted as different. For example, the 142 cases coded as Single Unit Truck, three or more axles in the Pennsylvania data, but unknown heavy truck, GVWR over 10,000 pounds were not counted as in conflict. But the 138 cases coded as a bus with 9 to 15 seats in the Pennsylvania data but coded as a bus with more than 15 seats in the MCMIS Crash file were counted as in conflict. The conflict in bus size in the example just given accounted for the greatest number of inconsistencies, and this may be a simple code translation problem. There were also 110 cases with valid configuration codes, but left as missing data in the MCMIS file. Translation errors may also account for those differences.

The coding of cargo body was consistent between the two files, except for 17 cases (0.2 percent of the cases for which there was valid data.) The inconsistencies had no discernible pattern. There were only minor inconsistencies in the other variables examined. With regard to light condition, there were 63 cases coded dusk in one file and dark (unknown roadway light) in the other, despite the fact that there are codes for dusk and dark (unknown roadway light) in both files. The errors amount to less than one percent of the cases, but should be easily corrected. Code values for the roadway surface condition variables matched well, with only a handful of differences: road surface condition was reported as ice patches in 38 cases in the Pennsylvania data but snow in the MCMIS data, despite the availability of a code for ice. Weather was coded identically in almost all cases. There were four cases coded with no fatal injuries in the MCMIS file, but with one in the Pennsylvania data, and one case coded as including one fatal injury in MCMIS, but zero in Pennsylvania. Also, the number of vehicles involved differed (by only one or two vehicles) in seven cases.

7. Summary and Discussion

Overall, about 77 percent of reportable crash involvements in Pennsylvania were correctly reported to the MCMIS Crash file. There is some uncertainty as to the precise rate because of difficulties in applying the MCMIS reporting criteria to the Pennsylvania data. The difficulties affected both identifying the right vehicles and crashes that met the severity criteria. These problems have been fully discussed in this report, so there is no need to repeat that here. In brief, the two variables that might be used to identify vehicle types that qualify for reporting were significantly inconsistent.

To resolve the issue of qualifying vehicles, David Hetzel of NISR, Inc., processed the VINs of candidate vehicles to determine the size and type of vehicle indicated by the VIN. The results of this effort showed that the information recorded by the officer was more often consistent with the

description derived from the VIN by Hetzel than the other Pennsylvania variable, so the former two pieces of information were used to extract qualifying vehicles.

There was also a problem in identifying crashes meeting the severity threshold, specifically in identifying crashes in which an injured person was transported for immediate medical attention. The variable recording whether a person was transported was left blank in almost three-quarters of the cases, so it was not usable. To approximate this criterion, crashes in which a person was fatally injured, or sustained incapacitating or non-incapacitating but evident injuries were taken, along with those in which a person had less serious injuries but were coded as transported. However, since the final reporting criteria is a crash in which a vehicle was towed due to disabling damage, and since such crashes are highly likely to include a transported injury, it is believed that the crash severity criteria used here are reasonably accurate.

Reporting rates varied by both the vehicle type criteria and crash severity. Fatal crashes were much more likely to be reported than nonfatal, with about 92 percent of fatal involvements reported, but around 75 percent of injury/transported and tow/disabled involvements. Similarly, larger trucks and buses are more likely to be reported than smaller ones.

The underreporting of smaller vehicles, particularly those under 26,000 pound GVWR, is likely related to a mismatch between the instructions to officers and the MCMIS reporting criteria. On the Pennsylvania crash report, there is a check box to indicate if the vehicle is a commercial vehicle. If the officer checks yes, he is directed to fill out a supplemental form, which supplies most of the information transmitted to the MCMIS Crash file. The problem is that the definition of a commercial vehicle in the instruction manual for the crash report is not consistent with the MCMIS reporting criteria. The manual defines a commercial vehicle as a truck with a GVWR of 26,000 pounds or more, or a bus with seats for 15 or more passengers. Neither specification matches the MCMIS vehicle criteria, which is a truck with a GVWR or GCWR over 10,000 pounds, or a bus with seating for nine or more, including the driver. This mismatch likely explains much of the underreporting observed. Moreover, it could be readily addressed in training and issuing a corrected manual.

There were also some differences in reporting rates by the type of agency filing the report and registration state of the vehicle. State police had higher rates of reporting than local police. This may be due to training or experience differences, or to different focuses in duties. However, local police filed reports on almost 46 percent of reportable cases, so improvements in their reporting rate would be significant. It was also noted that over 90 percent of the reportable involvements of vehicles registered out of state were reported, compared with about 72 percent of reportable involvements of in-state vehicles. This may be related to an incorrect understanding that only CMVs in interstate commerce qualify. There is an opportunity for training and education.

By and large, Pennsylvania takes a useful approach by requiring officers to collect the supplemental information on all commercial vehicles. This is particularly desirable since the officer is not asked to determine if the crash meets the MCMIS severity criteria. Generally, the best system is one in which officers collect uniform information on all cases and then a computerized algorithm is used to extract appropriate cases, so the Pennsylvania approach relieves the officer of at least part of that burden. Unfortunately, the instructions on what a commercial vehicle is conflicts with the MCMIS definition, which is a serious obstacle to full reporting. Also, inconsistencies between the vehicle type variables, which might be used to

identify the right vehicles, are a serious impediment to identifying the desired vehicles. The data recorded by the reporting officers is typically more accurate, but is fairly simple, distinguishing only a few vehicle types. The other vehicle variable in the coded crash data, *body_type_cd*, which must be derived somehow, appears to be seriously inaccurate, at least insofar as it conflicts with the VIN. And finally, the missing data rate on whether an injured person was transported could be easily reduced by the officers.

Many of the elements are present for improved reporting in Pennsylvania, and the overall rate is not unreasonably low. But there are still clear areas where improvement could be readily obtained.

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