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DIVISION OF ARVIN/CALSPAN

A STUDY OF LIGHT TRUCK AND PASSENGER CAR ROLLOVER AND EJECTION IN SINGLE-VEHICLE CRASHES

Kenneth W. Terhune, Ph.D.

Accident Research Section

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VALLEY FORGE CORPORATE CENTER 2600 MONROE BOULEVARD NORRISTOWN, PA 19403 TEL. (215) 666-3000

ABSTRACT

This study follows-up previous Calspan research revealing that, while light trucks protect their occupants about as well as cars do in single-vehicle crashes, light trucks had substantially higher rollover and ejection rates than cars. The new research sought to determine (a) the roles of driver, environment, and vehicle factors in the rollovers of light trucks and (b) how occupants are ejected from light trucks. Studied were pickups, vans, and utility vehicles from model years 1979-1986, using data from the 1980-1985 files of the National Accident Sampling System (NASS). To provide additional details about roadsides, rollovers, and ejections, a special clinical file was created by coding from 487 hard-copy NASS cases. In controlling for driver and environmental factors, light truck overturn rates remained higher than car rates, with utility vehicle rates distinctly the highest. Compared to cars, light trucks exhibited more precrash lateral skidding, more on-road rollovers, and more tripping-type rollovers. Occupant ejections were the highest in utility vehicles, somewhat higher in pickups than in cars, and about the same in vans as in cars. Controlling for crash severity indicated that ejections were highly injurious to occupants. Structural failures associated with ejection were doors opening, windows and windshields breaking, and in the case of utility vehicles, roof failures. It was concluded that vehicle factors appear to play a role in

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Clinical analysis and coding of NASS cases to create the "clinical file" used in this study were performed by Nova Engineering of Oakton, Virginia. Mr. Francis A. DiLorenzo, P.E., was the principal analyst.

FOREWORD

The "Study of Light Truck and Passenger Car Rollover and Ejection in Single Vehicle Crashes" presents valuable insights. However, MVMA believes that readers should be aware of the limitations of the database and of the research design, so that its results are not generalized further than warranted, or intended by the researchers.

The study is based on data from the National Accident Sampling System (NASS). The number of NASS cases involving vans and utility vehicles is small and the information on each case is limited. While some information is available on the driver, the environment, and the vehicle, there is no information available on other, sometimes subtle factors, that may influence accident risk and accident type. The cases selected for inclusion in NASS are identified from listings based on police reports. Generally, all injury accidents are reported by police. Reporting of property damage accidents may vary by jurisdiction. Rollovers, with a high injury risk, are more likely to be reported.

Pickup trucks, vans, and utility vehicles are designed to be used differently than passenger cars. They are used in different applications and by different types of drivers although they are sometimes used like passenger cars. These differences in use and users are unlikely to be adequately measured by the limited information available in the NASS data base. To assess the contribution of various factors to accident causation, detailed information on these usage patterns, i.e., exposure, is needed for each vehicle type. Exposure information describes both accident and non-accident situations. Unfortunately, this information is not available. To make valid estimates of the risk of a particular type of crash, e.g., a rollover crash, both accident data and exposure information are needed. The present study is based on accident data alone.

It should be understood that this study was not intended to be a comparison of vehicle types in their relative risks of a rollover accident. To estimate relative risks, exposure data are needed. Because this was not a study of relative risks, it follows that the study does not indicate the influence of environmental and driver factors on those risks. That remains for further research.

It was a research objective to study conditional probabilities--the likelihood of vehicle rollover given that a single-vehicle crash has occurred. Consequently, the study examines various correlates of rollover percentages in single-vehicle crashes. Those percentages estimate, within the sample limitations, the conditional probabilities of rollover. The report refers to these percentages as "rates", which should not be confused with rates based on exposure data and intended to estimate risks.

The study's second conclusion that "Light trucks have a higher single-vehicle-crash overturn rate than cars; while driver and environmental factors play a role in elevating the overturn rates, vehicle factors appear to play a significant role" needs to be placed in context. As discussed above, the study did not control for the influence of driver and environmental factors on the rollover crash risk and the author acknowledges that light truck vehicle factors were not examined as it was beyond the scope of the study. The study, therefore, does not allow definitive statements to be made about the relative contribution of driver, environmental and vehicle factors to the rollover crash risk.

In summary, MVMA believes that the findings, conclusions, and recommendations of the study must be reviewed and interpreted in the context of the limitations of the NASS data, the lack of exposure data, and the limitations of the analytical methods used.

Motor Vehicle Manufacturers Association
of the United States, Inc. (MVMA)

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The Foreword was prepared by the Motor Vehicle Manufacturers Association, and it is included at the request of that organization. The opinions expressed in the Foreword do not necessarily represent the views of the author or the Franklin Research Center. Interested readers will find in Section 4.0 of the report further discussion of some of the issues raised by the Foreword.

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1.0 INTRODUCTION

In previous Calspan research, light trucks were found to protect their occupants better than cars when in two-vehicle crashes (Terhune, Ranney, Smist, and Woodill, 1984). In single-vehicle crashes, however, no clear differences between car and light truck injury rates were found (Terhune, 1986). Pickup and van occupants appeared no more at risk of injury in single-vehicle crashes than did car occupants. Results for utility vehicles were inconclusive, however, because of their small numbers in the sample. Although no overall problem of occupant protection was revealed in light truck single-vehicle crashes, high light truck rollover and ejection rates suggested particular ways in which light truck occupants may be more vulnerable to injury than car occupants. This vulnerability tended to be offset by somewhat better light truck occupant protection in nonrollover crashes.

Despite the fact that the single-vehicle injury rate of cars and light trucks differed little, the interests of light truck safety suggested that high rollover and ejection rates of light trucks merited further investigation. It is important to know whether light truck rollover rates are due mainly to the vehicles, to their drivers, or to their crash environment. It is also important to know specifically how occupants are being ejected from light trucks. Answers in each case may suggest directions for improving light truck safety. That was the general objective of the study reported here.

1.1 Background

In Terhune's (1985) review and in subsequent research (Reinfurt, Stutts, and Hamilton, 1985; Terhune, 1986; Partyka, Sikora, Surti, and Van Dyke, 1987), rollover rates were consistently found higher in light trucks than in cars. Typically, rollover rates were highest for utility vehicles and second highest for pickups. Vans were usually found to have rollover rates between those of cars and of pickups, in studies of overall rollover rates. In the one study that examined van rollover rates in single-vehicle crashes, however, van rollover rates were second only to the utility vehicle rates (Terhune, 1986).

A fundamental question is whether the high rollover rates of light trucks are due to their intrinsic properties. Since these vehicles typically have high centers of gravity in relation to their track widths, this may make them more susceptible to overturn than cars, as some have suggested (Reinfurt et al., 1985; Robertson and Kelley, 1986). On the other hand, driver characteristics and the conditions in which the vehicles are used may elevate the light truck rates. This possibility has been raised primarily with respect to utility vehicles (Joksch, 1983). Our 1986 report examined this issue by comparing light truck and car rollover rates while controlling for several non-vehicle factors which could possibly produce roll-rate differentials among the vehicle types; these were driver age, driver gender, and rural-urban crash location. Both State of Washington and National Accident Sampling System (NASS) data were used. Light trucks continued to exhibit higher rollover rates than cars when controlling for the possibly confounding variables, although the NASS data had insufficient sample sizes for some of the breakdowns needed. Especially important, the automated NASS file lacked detail on the environments of single-vehicle crashes, especially in regard to roadside features to which the vehicles were exposed. Hence, our study was unable to refute the idea that high light truck rollover rates may be due to crash circumstances. This remained a subject for further research.

Occupant ejection appears to be an important source of injury in rollovers. For example, 1985 NASS data revealed that 18% of occupants in light truck towaway rollover crashes were ejected, compared to only 1% of those in nonrollovers. Furthermore, 17% of the rollover ejectees were seriously injured (AIS> 3), compared with only 4% of the nonejectees (National Highway Traffic Safely Administration [NHTSA], 1987b). Thus, one may expect that high rollover rates of light trucks will elevate their ejection and injury rates. It is not surprising to learn from a NHTSA report to Congress that "The number of ejections from light trucks is three times that of passenger cars." (NHTSA, 1987a, p.17). This tendency was also found in Calspan's study of single-vehicle crashes. However, only utility vehicles exhibited ejection rates distinctly higher than car rates, and only the Washington sample size was large enough to show this (Terhune, 1986). So on ejection also, data limitations indicated the need for further study.

As with rollovers, questions may be raised as to the interpretation of higher ejection rates of light trucks. For example, might the higher ejection rates be attributable to the more frequent light truck crashes in rural areas, where accidents are usually more severe? And if ejections occur primarily in severe crashes, would not the ejected occupants have been as seriously injured even had they remained in their vehicles? This seemed to be the implication of ejection research by Huelke, Compton, and Studer (1985). Answers to these questions will help us to understand whether ejection *per se* is a problem deserving special attention in light trucks. If ejection *is* a special light truck problem, determining how the ejections occurred should help in finding remedies. These are further matters addressed in this study.

In summary, previous research has found crash rollover and ejection rates to be substantially higher in light trucks than in cars, yet the two vehicle types differed little in overall injury rates. This paradox in itself merits further investigation and explanation. But light truck rollover and ejection also deserve further study to see if these are special sources of injury potential in light trucks, possibly subject to countermeasures.

1.2 Objectives

As in our previous investigation (Terhune, 1986), this study examined rollover and ejection in single-vehicle crashes, a crash type important for the following reasons:

- Past research indicated that light truck occupants are fairly well-protected in two-vehicle crashes, but a possible problem may exist in single-vehicle crashes (Terhune, 1985);
- Rollovers are found to occur mainly in single-vehicle crashes (Huelke, Marsh, and Sherman, 1972; McGuigan and Bondy, 1980), and occupant ejections occur primarily in rollovers (Terhune, 1986);
- This study was intended to be an in-depth follow-up of our 1986 study, in order to obtain detailed explanations and clarifications of its findings; hence it was important to examine the same types of crashes.

The specific objectives of this study were:

(1) To determine if differences between light truck and passenger car rollover rates in single-vehicle crashes can be attributed mainly to their drivers and the circumstances in which the accidents occurred;

(2) **To determine if ejection *per se* is an important injury-producing event in light truck single-vehicle crashes, and if so, to determine how light truck ejections occur.**

In addition to pursuing these objectives, we took advantage of an expanded NASS data set to see if our previous findings, comparing light truck and car rollover and injury rates, would be confirmed.

2.0 RESEARCH METHODS

Accident cases from the National Accident Sampling System (NASS) were analyzed to achieve the research objectives. Statistical analyses of rollovers, ejections, and occupant injury examined the relevant NASS variables which could clarify our understanding of differences among light trucks and cars. However, the NASS database does not include critical information on how rollovers and ejections occurred, information desirable to explain differences among the vehicle types. Hence, a special database was created by reviewing the vehicle photographs, scene photographs, scene diagrams, and other information in the original NASS case files, in order to code new rollover and ejection variables not in the automated NASS data files. The new database was subjected to additional statistical analyses addressing our research objectives.

Details of the databases and research methods are provided in the sections which follow.

2.1 Why NASS Data Were Chosen.

Of the many accident data files available for research, the NASS file was selected as the best available, using the criteria as follows.

(a) Inclusion of cars and light trucks. Most of our analyses compare light trucks to cars, which provide a benchmark or standard of comparison. Consequently both vehicle types must be in the database.

(b) Representativeness. The accidents included should comprise an unbiased sample, preferably a nationally representative one. Although it was unavoidable that the samples would omit unreported minor "fender-benders", it was essential that the data sets not be restricted to severe crashes such as towaways. Such data sets introduce biases by selecting only the worst crashes of vehicles less easily damaged.

(c) Current relevance. The accidents had to occur within recent years and involve recent-model vehicles so that results would be relevant to the current vehicle fleet. Consequently, an up-to-date database was essential.

(d) Completeness of variables. Many variables were needed for the analyses (Table 2.1). It was important not only that each variable be recorded, but that it be recorded in sufficient detail on all cases, with few unknowns. Especially troublesome are data sets providing only partial information, e.g., a rollover is recorded only if it is a "First Harmful Event," or restraint system usage is identified only for severely injured occupants.

Table 2.1: Variables Needed for the Data Analyses

1. Vehicle type clearly distinguishing light truck types and passenger cars.
2. Number of vehicles in accident
3. Collision type
4. Occurrence of rollover (overturn)
5. Occupant role/seating location
6. Occupant injury level or outcome
7. Occurrence of ejection, by occupant
8. Occupant age
9. Occupant gender
10. Occupant restraint system use
11. Vehicle model year
12. Accident urban/rural location
13. Ejection details (portals, etc.)
14. Crash severity
15. Roadside characteristics
16. Vehicle actions prior to and during crash

(e) Accessibility. It was necessary that the data be available in a short time and at modest cost.

(f) Sample size. For the detailed breakdowns of the samples that were anticipated, a data file with thousands of accidents was needed.

The major accident data files considered were the NASS, the Fatal Accident Reporting System (FARS), state files, and the Motor Vehicle Manufacturers Association (MVMA) light truck file. The FARS file is widely used, for it includes virtually all fatal highway accidents occurring annually in the U.S. It was not chosen mainly because our interest was in broader crash consequences than just fatalities. The MVMA file was excluded on similar grounds, for that file includes only injury accidents, and no single-vehicle car crashes. State files were considered, but they were rejected on grounds of accessibility or completeness. Some state files are readily accessible through the University of Michigan Automated Data Access and Analysis System (ADAAS), but they were limited in their recording of essential variables like vehicle type, rollover, and/or restraint system use.

The NASS database is nationally representative of police-reported accidents, its data are subjected to extensive quality control, and its variables met most of our requirements. Needed data that were not in the automated database could be coded from the original files, which include extensive photographs and a scene diagram for most of the crashes.

While the NASS was selected as the best available accident data file, two of its limitations should be noted. First, while NASS now includes many thousands of accidents, light trucks, particularly vans and utility vehicles, comprise only a fraction of the cases. The second limitation is that, while most NASS cases contain complete information, some types of cases lack data needed for our study. These cases are as follows:

(a) Source-document-only (SDO) cases. During NASS work reductions, some cases selected for the sample are designated source-document-only, which means that no vehicle or accident scene examinations are performed; only documents such as police reports and medical records are collected. Data are coded from these source documents, which are then deleted from the files. Because of the lack of complete information in such cases, some variables (e.g., rollover) may be recorded less accurately, while others (e.g., occupant ejection) may be recorded as unknown.

(b) Nontowaways. Vehicle data for vehicles not towed from the accident scene are recorded on a short vehicle form, which omits the rollover variable contained in the standard form. While we may assume that non-towed vehicles did not overturn, that will sometimes be incorrect. Errors here can be magnified when weighting the data to produce estimates of rollover rates, for nontowaway cases have high weighting factors in the NASS scheme.

Thus, while the NASS database was judged the best available for our purposes, its limitations indicate that some loss of statistical reliability may be expected.

2.2 Data Sets Created.

The NASS data files were accessed through the University of Michigan's ADAAS system, which makes the data readily available at modest cost. From the complete NASS files, three working files were assembled: a vehicle/driver file (RNASTRK3), an occupant file (RNASTRK4), and an injury file (RNASTRK5). They are described in Table 2.2. For comparability with our previous study on light truck single-vehicle crashes, the case-selection criteria for the vehicle/driver file were identical to those in the previous study, with one exception: the earlier study included only 1982-1984 NASS cases, whereas the current study included accidents for the years 1980-1985. Previously, the 1982-1984 cases were examined because the needed NASS variables were identical across those years. There were only 58 vans and 75

Table 2.2: Composition of the Working Files
Selected from the NASS Automated Data Base

A. Selection Criteria

RNASTRK3*: (Vehicle/ driver file)	RNASTRK4*: (Occupant file)	RNASTRK5*: (Injury file)
1. Single-vehicle crashes 2. Occupant role = driver 3. Vehicle model years 1979 and newer 4. Accident years 1980-1985 5. Passenger cars, vans, pickup trucks, and utility vehicles under 10,000 lb. GVSR 6. Exlude pedestrian, animal, railroad, pedacyclist collisions, and fires/ explosions as first harmful event	Same as RNASTRK3, except all the vehicle occupants are included. Each case is one occupant.	Same as RNASTRK4, except all the injuries of the occupants are included. Each case is one injury.

B. Sample Sizes

RNASTRK3	RNASTRK4	RNASTRK5
3,558 passenger cars	4,566 drivers	11,445 AIS1 injuries
749 pickup trucks	2,490 passengers	1,514 AIS2 injuries
108 vans		710 AIS3 injuries
150 utility vehicles		153 AIS4 injuries
		85 AIS5 injuries
4,565 total vehicles	7,056 total occupants	45 AIS6 injuries
		751 inj., AIS unknown
		14,703 total injuries

*The file names are acronyms signifying "revised NASS truck" files. RNASTRK1 and RNASTRK2 were files used in previous Calspan research.

utility vehicles in the file, however, resulting in small subsamples in data breakdowns. Consequently, the new file was expanded to the years 1980-1985. (The 1979 NASS sample was too small to include, while 1985 was the latest data-year available). However, modifications in variable formats during the sampled years required that there be many recodes to bring all years of data into a common format. This was done, resulting in data files unique to this study.

Section B of Table 2.2 shows the sample sizes in the working files. It may be noted that the total of 4,565 single vehicle crashes is nearly double the NASS sample size of our previous study. Nevertheless, the 108 vans and 150 utility vehicles are fairly small numbers to work with, although those samples also are about double those in our previous study.

Vehicle types were classified by the same criteria used in the earlier study. The coding rules are shown in Table 2.3.

The clinical file. The NASS automated data lacked certain rollover and ejection details, such as how the rollovers happened, and whether structural failures facilitated ejection. Since the needed information was extractable from the photographs and scene diagrams in NASS cases, the original cases were individually examined at the NASS storage-site in Arlington, Virginia. The University of Michigan computer system was used to identify random samples of the crashes from

Table 2.3: Coding Rules for Light Truck Identification: NASS 1980-1985

Vehicle Type		NASS Classification	Numbers in RNASTRK3 Sample
Passenger Car	(a)	Convertible (excludes sun-roof, t-bar)	19
	(b)	2-door sedan, hardtop, coupe	1256
	(c)	3-door/2-door hatchback	958
	(d)	4-door sedan, hardtop	798
	(e)	5-door/4-door hatchback	270
	(f)	Station wagon (excluding van and truck based)	221
	(g)	Other automobile type	1
	(h)	Unknown automobile type	35
Pickup	(a)	Auto based pickup (includes El Camino, Caballero, Ranchero, Brat)	27
	(b)	Pickup (includes open box and caps)	722
Van	(a)	Van (includes VW bus, Vanagon, Kombi, Beauville, Chateau, Club Wagon, Sportsman; excludes moving van)	98
	(b)	Van-commercial cutaway (includes box van, multi-stop, parcel, van pickups)	5
	(c)	Other van type	2
	(d)	Unknown van type	3
Utility Vehicle	(a)	Short utility - not truck based (includes Jeep CJ-5, Jeep CJ-7, Renegade, Landrover, Landcruiser)	48
	(b)	Truck based station wagon (includes Suburban, Travelall, Wagoneer)	13
	(c)	Truck based utility (includes Blazer, Bronco-78 on, Jimmy, Ramcharger, Cherokee, Trailduster, Scout)	89

those in the RNASTRK3 file. Selected for examination were 50 rollover and 50 nonrollover crashes of cars, pickups, vans, and utility vehicles respectively. These cases were then pulled from the Arlington files. When cases were missing (e.g., SDO cases) they were replaced, to the extent possible, with cases from a backup list.

Each selected case was individually reviewed and the variables in Table 2.4 were coded using a data form specially designed by Calspan for this study (Appendix A). A coding manual was used for reference in coding (Appendix B). All coding was performed by an experienced accident investigator from Nova Engineering of Oakton, Virginia. Training and quality control were conducted by Calspan. Training comprised a discussion of the coding manual definitions and a coding review of individual cases. Quality control consisted of an in-depth review of the first 100 cases, with returns for correction of all cases exhibiting inconsistencies, ambiguities, or other errors. Spot-checks were used for the remaining cases.

Since only a portion of the selected cases involved occupant ejection, a supplementary random sample of light truck crashes involving ejection was identified. In these cases, only the ejection questions (numbers 28 and 29) on the data form were coded. The samples were limited by the number of ejection cases available for each vehicle type.

Table 2.4: Variables Extracted from the NASS Cases Through Clinical Case Examination

1. Predominant land use

2. Pre-crash travel surface

3. Roadside features
   a. Ditch depth
   b. Curb height
   c. Edge dropoff distance
   d. Side slope type
   e. Side slope angle
   f. Density of narrow fixed objects
   g. Longitudinal objects present
   h. Other objects present

4. Vehicle preimpact travel orientation

5. Collision type

6. First harmful event

7. Surface at first harmful event

8. Roadside features traversed/contacted by vehicle

9. Rollover
   a. Occurrence
   b. Type
   c. Feature producing rollover
   d. Surface roll trigger

10. No. doors opening during crash

11. No. windows open before crash

12. Occupant ejection
    a. Occurrence
    b. Seating position of ejected occupant
    c. Effect of vehicle damage/failure

Because sophisticated judgments had to be made for many of the variables on the coding form, the resulting data file is referred to as "the clinical file." Data of the primary clinical sample were entered into an automated data file for subsequent statistical analysis, while the supplementary ejection cases were used for individual inspection and hand tabulations only. Table 2.5 gives the sample composition.

2.3 Weighted vs. Unweighted Data.

A judgment had to be made as to whether the analyses should use data weighted in accordance with the NASS sampling fractions and annual sample sizes. NASS, it should be understood, uses a stratified sample, resulting in unequal representations of different kinds of accidents. Accidents of greater interest, such as fatal accidents, are more extensively sampled. With such a sample, it is necessary to weight each case by the inverse of its sampling fraction in order to estimate parameters in the national accident population. When using several years of NASS data, weights are assigned according to the annual sample sizes. To make valid unbiased comparisons among vehicle types, such as on rollover, ejection, and injury rates, the weighted data must be used. This was done in Calspan's 1986 light truck study.

Table 2.5: Composition of the Clinical File

A. Primary Sample (Data were entered into automated database)

	Non-Rollovers	Rollovers	Totals
Cars	62	57	119
Pickups	49	52	101
Vans	60	37	97
U-Vehs	39	46	85

B. Light Truck Ejection Cases (Vehicles)

	Primary Sample	Supplementary Sample*
Pickups	13	66
Vans	5	0
U-Vehs	21	19

*Not entered into automated database; ejection details only.

In examining the <u>details</u> of rollover and ejection cases, use of weighted data is more problematic. Weighting multiplies individual cases by dozens, hundreds, or even thousands of times, depending on the sampling fractions used in NASS. A case error in sampling, measurement, or coding will be multiplied by the weighting factor. This has the potential of creating large distortions when examining small samples, as when determining ejection rates of vans and utility vehicles. Consequently, for most of the analyses in this study, we examined unweighted data, and indicate this in our data tables. Only when we are interested in gross population estimates, such as in comparing rollover rates in this study with those in our 1986 report, were weighted data used. All tables and figures have the use of weighted or unweighted data clearly labelled.

The rationale for using unweighted data applies particularly to the clinical case file, which comprises but a fraction of the NASS sample. Here again, our purpose was not to generate national estimates, but to learn more about the rollover and ejection phenomena. However, some weighting of the clinical data was necessary, as described next.

<u>Clinical file weighting</u>. Since, to the extent possible, approximately equal numbers of overturn and nonoverturn cases were selected in creating the clinical file, this would distort the rollover rates of each vehicle type. To examine the effects of various factors on rollovers, it was necessary to adjust the data for the case-selection process. Consequently, in analyses of rollover rates, the clinical data were weighted to make them representative of the RNASTRK3 sample. Thus, the rollover results with the weighted clinical file can be directly compared with the results from the unweighted RNASTRK3 file.

3.0 RESULTS

The results of our analyses are given in three main sections below. First, a partial replication of analyses in our previous study of single-vehicle crashes (Terhune, 1986) is presented to see if the earlier findings were upheld. Second, detailed examinations of rollover crashes are made to indicate the roles of vehicle, driver, and environmental factors in explaining light truck rollover rates. Third, occupant ejections are examined in detail to see if a light truck problem is indicated.

Our detailed analyses of rollover and ejection used both the large NASS databases described in section 2.0, and the smaller clinically-derived database formed from a subset of the larger file. Results from each data set are presented in the rollover and ejection sections (3.2 and 3.3).

3.1 Replications of Analyses in Calspan's 1986 Report

Our analyses determined whether the fundamental findings of our 1986 light truck study were upheld with the 6-year NASS sample of the study. That is:

(a) Did light truck injury rates still differ little from the car rates?

(b) **Did light trucks continue to exhibit rollover rates substantially higher than car rates? And were there significant differences among pickups, vans, and utility vehicles?**

(c) **If the injury and rollover findings were upheld, why were not the higher rollover rates of light trucks associated with higher injury rates?**

These are addressed in the following sections.

3.1.1 Injury Rates.

To address the first question, we replicated an analysis from our 1986 report, wherein injuries of a predominant occupant group -- male unrestrained drivers -- were examined. The results (Table 3.1) maintained previous indications of minor differences in injury rates between cars and light trucks. In the rural crashes, the injury rates among vehicle types were very similar, except for vans. Since that rate was based on only 21 drivers, the reliability of the result is uncertain. In the urban crashes, however, all the light truck types had injury rates slightly lower than cars. Judging from the results, the urban crashes were generally less severe than the rural ones.