January 1983
NHTSA Technical Report

DOT HS-806-335

U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

Evaluation of Federal Motor Vehicle Safety Standard 301-75, Fuel System Integrity: Passenger Cars

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Plans and Programs
Office of Program Evaluation

Technical Report Documentation Page

1. Report No.
DOT HS 806 335

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
Evaluation of Federal Motor Vehicle Safety Standard 301-75, Fuel System Intregity: Passenger Cars

5. Report Date
January 1983

6. Performing Organization Code
NPP-10

7. Author(s)
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8. Performing Organization Report No.

9. Performing Organization Name and Address
Office of Program Evaluation
National Highway Traffic Safety Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

13. Type of Report and Period Covered
NHTSA Technical Report

14. Sponsoring Agency Code

15. Supplementary Notes
An Agency staff review of existing federal regulations performed in compliance with Executive Order 12291 and the Agency's regulatory review plan (Regulatory Reform - The Review Process).

16. Abstract

To reduce the hazard caused by motor vehicle crash fires, Federal Motor Vehicle Safety Standard 301, Fuel System Integrity, was promulgated. Various vehicle modifications were made in response to the Standard, all intended to increase the crashworthiness of the fuel system. The objectives of this evaluation of Standard 301 are to estimate: (1) its effectiveness in reducing crash fires, injuries, and fatalities; (2) the consumer cost of the Standard; (3) the cost-effectiveness of the Standard. The evaluation addresses the major version of the Standard (301-75) as it applies to passenger cars. The study is based on statistical analysis of crash fire data from five States, with primary emphasis given to data from the State of Michigan. Cost estimates are based on information obtained from the motor vehicle manufacturers. The study found that:

- Standard 301 has significantly reduced post-crash fires in passenger car crashes; the greater reductions have occurred in the more severe crashes in terms of vehicle damage.
- The reduction in crash fires has resulted annually in: 400 fewer fatalities, 520 fewer serious injuries, 110 fewer moderate injuries, and 6,500 fewer crash fires.
- The Standard has increased the consumer cost of owning and operating a vehicle by $8.50.

17. Key Words
motor vehicle crash fires, Federal Motor Vehicle Safety Standard 301, statistical analysis, evaluation, effectiveness, cost-effectiveness, motor vehicle occupant injuries, fuel leakage

18. Distribution Statement
Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)
Unclassified

20. Security Classif. (of this page)
Unclassified

21. No. of Pages
176

22. Price

Form DOT F 1700.7 (8-72)

Reproduction of completed page authorized

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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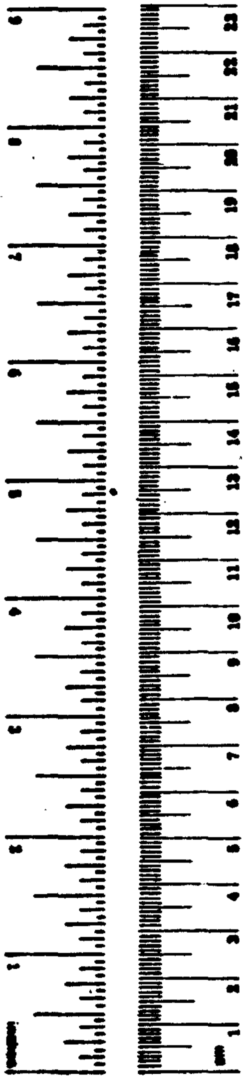
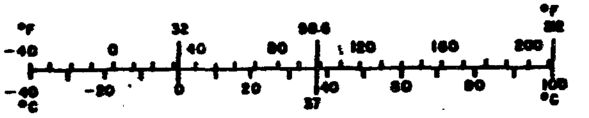
*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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ACKNOWLEDGEMENTS

The author would like to express his sincere appreciation to the following individuals for their valued assistance in this evaluation project:

Ms. Grace Hazzard of NHTSA's National Center for Statistics and Analysis

Dr. Charles J. Kahane, Mr. Robert Lemmer and Mrs. Alleyne Monkman, all of NHTSA's Office of Program Evaluation

Mr. Tom Grubbs of NHTSA's Office of Vehicle Safety Compliance

Dr. Jairus D. Flora of the University of Michigan's Transportation Research Institute

Dr. Donald W. Reinfurt of the University of North Carolina's Highway Safety Research Institute

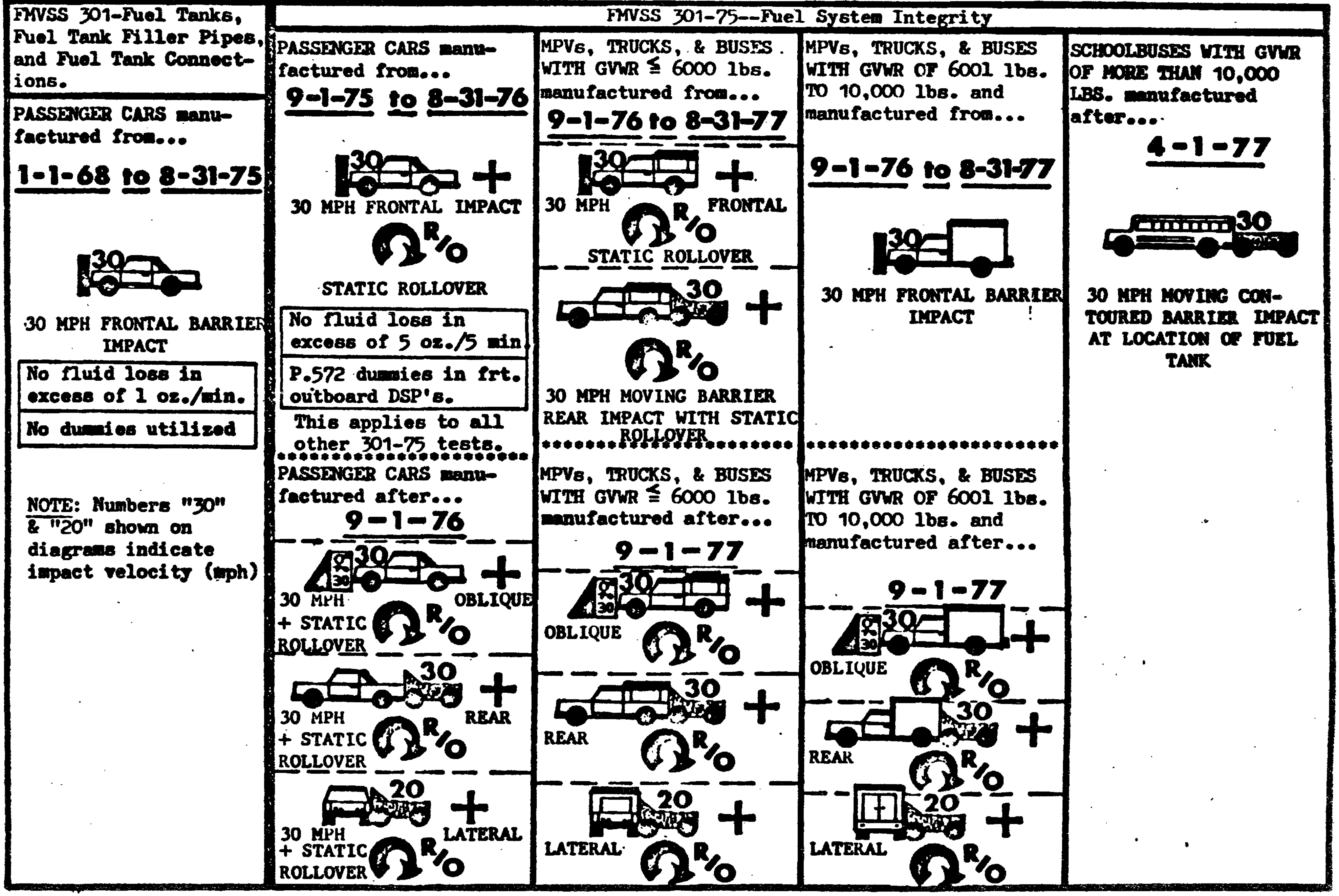
EXECUTIVE SUMMARY

Motor vehicle crash fires have been a source of interest and concern within the highway safety community since the time that motor vehicle and highway safety was established as a National program in the late 1960's. Although it has generally been held that fires resulting from motor vehicle crashes occur only rarely, the fact that they do occur has been of concern because the physical effects of the fire phenomenon can significantly increase the risk to vehicle occupants involved in a crash.

Responding to this perceived hazard of fires resulting from motor vehicle crashes, the National Highway Traffic Safety Administration (NHTSA) in 1968 issued a Federal Motor Vehicle Safety Standard (FMVSS), No. 301, whose objective was to mitigate this hazard. The Standard specified certain performance criteria intended to limit the amount of fuel spilled during, and after a vehicle crash. Hence, the objective of the Standard was to reduce the occurrence of crash fires which resulted from the ignition of spilled or leaked fuel. The initial version of the Standard, which became effective in 1968, applied only to passenger cars and crashes involving only frontal impacts.

In 1975, the Standard was substantially upgraded by extending the coverage of impact types to include rollover, rearend, and side, and the vehicle coverage to include light trucks, light buses, multipurpose vehicles, and school buses. The following "Summary of Test Requirements" relates the chronological history of FMVSS 301.

*** SUMMARY OF TEST REQUIREMENTS ***



FMVSS 301-Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections.

PASSENGER CARS manufactured from...

1-1-68 to 8-31-75

30 MPH FRONTAL BARRIER IMPACT

No fluid loss in excess of 1 oz./min.

No dummies utilized

NOTE: Numbers "30" & "20" shown on diagrams indicate impact velocity (mph)

FMVSS 301-75--Fuel System Integrity

PASSENGER CARS manufactured from...

9-1-75 to 8-31-76

30 MPH FRONTAL IMPACT

STATIC ROLLOVER

No fluid loss in excess of 5 oz./5 min

P.572 dummies in frt. outboard DSP's.

This applies to all other 301-75 tests.

PASSENGER CARS manufactured after...

9-1-76

30 MPH + STATIC ROLLOVER OBLIQUE

30 MPH + STATIC ROLLOVER REAR

30 MPH + STATIC ROLLOVER LATERAL

MPVs, TRUCKS, & BUSES WITH GVWR ≦ 6000 lbs. manufactured from...

9-1-76 to 8-31-77

30 MPH FRONTAL

STATIC ROLLOVER

30 MPH MOVING BARRIER REAR IMPACT WITH STATIC ROLLOVER

MPVs, TRUCKS, & BUSES WITH GVWR ≦ 6000 lbs. manufactured after...

9-1-77

OBLIQUE

REAR

LATERAL

MPVs, TRUCKS, & BUSES WITH GVWR OF 6001 lbs. TO 10,000 lbs. and manufactured from...

9-1-76 to 8-31-77

30 MPH FRONTAL BARRIER IMPACT

MPVs, TRUCKS, & BUSES WITH GVWR OF 6001 lbs. TO 10,000 lbs. and manufactured after...

9-1-77

OBLIQUE

REAR

LATERAL

SCHOOLBUSES WITH GVWR OF MORE THAN 10,000 LBS. manufactured after...

4-1-77

30 MPH MOVING CONTOURED BARRIER IMPACT AT LOCATION OF FUEL TANK

In February 1981, Executive Order 12291 (Federal Regulations) was issued which, among other requirements, directed Federal agencies to review existing regulations. This evaluation was conducted to comply both with this Order and with NHTSA's regulatory review plan published in March 1982 (Regulatory Reform - The Review Process).

This study is an evaluation, or review, of FMVSS-301, Fuel System Integrity using on-the-road data of actual motor vehicle crashes involving fire, and fuel leakage. Only that portion of the standard that was promulgated in 1975 and which applies to passenger cars is addressed by this evaluation. Insufficient data are available at this time, to adequately evaluate the effect of Standard 301-75 on light trucks.

The objectives of the evaluation are to determine or estimate:

(1) the extent to which crash fires and fuel leakage have been reduced by the Standard (herein referred to as effectiveness).

(2) the magnitude of the savings of fatalities, injuries, and crash fires due to reduced crash fire rates (herein referred to as benefits).

(3) the nature of the vehicle modifications made in response to the requirements of the Standard.

(4) the costs incurred in order to meet the requirements as set forth in the Standard.

The analyses of effectiveness are based on Statewide police-reported accident data from five States (Michigan, Illinois, North Carolina, Maryland, and Pennsylvania). Primary emphasis is placed on the data from Michigan due to the nature and extent of the accident information available, and the fact that data on fuel leakage in addition to crash fires, were available from this State.

Estimates of standard benefits have been derived using the results of the effectiveness analyses together with data from NHTSA's Fatal Accident Reporting and National Accident Sampling Systems.

Cost estimates of standard implementation are derived by NHTSA on the basis of information obtained from the motor vehicle manufacturers.

Findings and Conclusions

Following are the principal findings and conclusions reached in this evaluation:

1. The magnitude of this national problem for passenger cars is estimated at 20,600 crash fires annually. These fires are associated with 1,100 fatalities, 3,200 serious injuries, and more than 3,300 moderate to minor injuries. These fatalities and injuries are to occupants of passenger cars and do not consider occupants of other vehicles such as light, medium, and heavy trucks.

2. The presence of post-crash fires is estimated to markedly increase the chances of occupant fatality or serious injury for passenger car crashes of similar impact force levels.

3. Standard 301 has been effective in significantly reducing the post-crash fire rate and post-crash fuel leakage rates for passenger cars.

    a. The greatest reductions have occurred in the more severe crashes as defined by the extent of crash-force deformation sustained by the vehicle.

    b. Reductions in fire and fuel leakage rates have occurred for most of the major types of impacts addressed by the Standard.

4. The reduction in crash fire rates is estimated to result in the following annual savings, or benefits:

    a. 400 fewer fatalities
    b. 520 fewer serious injuries
    c. 110 fewer moderate injuries
    d. 6,500 fewer passenger car crash fires

5. The total cost required to implement Standard 301 is estimated at $8.50 per vehicle, or a total of $85 million annually. The types of vehicle modifications made in response to the Standard varied widely, and for the most part were specific to individual vehicle models or body styles. The basic objective of these modifications was to provide a "friendlier" environment for fuel system components, given the event of a vehicle crash.

6. In terms of comparing benefits and costs resulting from Standard 301, it can be stated that for each $10 million expended to comply with the Standard, the following benefits are expected to accrue:

   a. 47 fatalities avoided
   b. 61 serious injuries avoided
   c. 13 moderate injuries avoided
   d. 762 crash fires avoided

7. Although significantly lower crash fire rates have been found for Post-Standard vehicles, there is some indication that the fire rate may be increasing slightly for newer vehicles. This is a preliminary finding and reasons for it are not clear. It does suggest, however, that the Agency continue to monitor the phenomenon of motor vehicle crash fires.

CHAPTER 1

INTRODUCTION

This is the sixth report in a continuing series of evaluation studies being conducted by the National Highway Traffic Safety Administration (NHTSA) to review the effectiveness of its existing regulations in the motor vehicle safety area. Pursuant to the issuance of Executive Order 12291 on February 17, 1981, NHTSA developed and published a regulatory review plan [1] together with a schedule and description of those regulations selected for review. Federal Motor Vehicle Safety Standard-301 (FMVSS-301) was listed in this review plan under the category of "moderate to high" priority.

The purpose of FMVSS-301 is to reduce the number of deaths and injuries occurring from fires that result from fuel spillage during and after motor vehicle crashes. The Standard was originally promulgated in January 1968, and applied to all passenger cars produced after that date. This initial version of the Standard addressed fuel spillage as a result of impacts from a frontal direction only.

A second version, or upgrade, of Standard 301 (FMVSS-301-75) became effective in September of 1975. This upgrade extended the impact coverage to rollover, rearend, and side, as well as frontal crashes; and vehicle coverage was expanded to include light trucks and buses, and school buses, in addition to passenger cars. Table A summarizes the chronological history [2,3] FMVSS-301:

TABLE A - CHRONOLOGICAL HISTORY
OF FMVSS-301,
FUEL SYSTEM INTEGRITY

Vehicle Model Year	Vehicle Type(s):	Impact Velocity	Impact Mode	With Static Rollover
1968 thru 1975	Passenger Cars	30 mph	Frontal	No
1976	Passenger Cars	30 mph	Frontal	Yes
1977	Passenger Cars	30 mph	Frontal	Yes
		30 mph	Oblique	Yes
		30 mph	Rear	Yes
		20 mph	Lateral	Yes
1977	Trucks, MPVs, and Buses (6000# GVWR<10000#)	30 mph	Frontal	No
1977	Light Trucks, MPVs, and Buses (GVWR≤6000 lbs.)	30 mph	Frontal	Yes
		30 mph	Rear	Yes
1978	Light Trucks, MPVs, and Buses (GVWR≤6000 lbs.)	30 mph	Frontal	Yes
		30 mph	Oblique	Yes
		30 mph	Rear	Yes
		20 mph	Lateral	Yes
1978	Trucks, MPVs, and Buses (6000#>GVWR<10000#)	30 mph	Frontal	Yes
		30 mph	Oblique	Yes
		30 mph	Rear	Yes
		20 mph	Lateral	Yes
1978	School Buses (GVWR>10000 lbs.)	30 mph	Location of Fuel Tank	No

This study addresses the effectiveness of Standard 301-75 (hereafter referred to as Standard 301-76/77) for passenger cars only. Insufficient data are available at this time to adequately assess the effect of Standard 301-75 for light trucks, multi-purpose vehicles, and school buses.

The original version of Standard 301 (301-68, passenger cars, frontal impacts) has been studied under two support contracts sponsored by NHTSA as part of the overall process of evaluation of the Standard. Within the constraints of limited data due to the small number of pre-1968 Model Year vehicles still on the road, reports [4, 5] from these two contracts found no significant difference between the crash fire rate for vehicles produced prior to the Standard and the crash fire rate for vehicles produced after the effective date of the Standard. Limited data [6] concerning the implementation costs of this initial version of Standard 301 indicated that negligible costs were incurred and the general conclusion is that most passenger car designs existing in 1967-1968 already met the requirements of this first version of the Standard.

The objective of the study reported herein is to estimate the effectiveness of 301-76/77 in reducing passenger car crash fires and the benefits, in terms of fatalities and injuries avoided, due to any such reductions.

Accident data from five States, in addition to data from NHTSA's Fatal Accident Reporting System and National Accident Sampling System are analyzed or otherwise employed to arrive at the effectiveness and benefits estimates. Primary emphasis is placed upon the data from the State of Michigan. The nature and extent of the information available from this State, both in terms of crash fires and fuel leakage, make it the best data source available.

Costs of Standard 301-76/77 are also estimated on the basis of information obtained from the motor vehicle manufacturers.

This evaluation project is also supported by two contractual efforts which acquired the majority of the State accident data on crash fires used in this evaluation, and which performed separate analyses of the data obtained.

The report is presented in the four chapters which follow. Chapter 2 contains the analyses of the accident data on crash fires and fuel leakage to arrive at estimates of standard effectiveness in terms of reducing the rate of occurrence of these crash hazards. Chapter 3 translates the effectiveness estimates into estimates of the benefits (fatalities, injuries, and crash fires avoided). It concludes with an analysis of cost and cost effectiveness. The final chapter, Chapter 4 summarizes the overall findings and conclusions of the evaluation.

Appendix A contains a description of the primary data sources employed in the study. Appendix B contains copies of the various accident report forms for these data sources.

CHAPTER 2

The Effectiveness of Standard 301-75/76

2.0 Introduction

This Chapter contains the results of the statistical analyses conducted to estimate the effectiveness of Standard 301-75. Effectiveness, as used herein, is defined in terms of the magnitude of reduction in crash fire rates, per vehicle crash, and in terms of the magnitude of reduction of crash-induced fuel leakage per vehicle crash. Crash fire reduction is the principal measure of effectiveness as this is considered most closely associated with the ultimate objective of the Standard, which is to reduce the number of deaths and injuries attributable to crash fires. Also available data are restricted primarily to fires vis-a-vis fuel leakage. The estimate of the reductions in fire-related deaths and injuries are covered in Chapter 3.0 on Benefits.

Perhaps the greatest obstacle to be overcome in carrying out the evaluation of FMVSS-301 has been that of acquiring satisfactory data, both with which to estimate effectiveness and to estimate the costs of implementing the Standard.

Early in the evaluation process, a contract [7] was let to the Highway Safety Research Institute (HSRI), University of Michigan, for the purpose of searching out and acquiring data sources on vehicle crash fires, and performing analysis of the data obtained. An exhaustive search of State accident data sources, State Fire Department data sources, and the National Fire Administration's National Fire Incident Reporting System (NFIRS) revealed very few sources that could supply satisfactory data on vehicle crash fires. Preliminary information had indicated that fire departments might be a usable source. However, this possibility did not prove fruitful as the data contained insufficient information to adequately determine whether a vehicle fire resulted from a crash or from other factors, and vehicle model year (a "must" variable) was inconsistently reported. State accident data was determined to offer the best potential for vehicle crash fire data, but even here the availability was severely limited as very few States were found to record vehicle fires as part of their motor vehicle accident reporting systems. Fire data from this source consisted of two basic types: (1) fire occurrence recorded as a specific and independent element to be reported on each motor vehicle accident report, and (2) fire occurrence recorded as a secondary or auxiliary item of information, usually in a narrative portion of the accident report form or as a "second adverse or harmful event." Of a total of seven States where some type of fire data was reported, only two, Michigan and Illinois, were concluded to be potentially satisfactory for use in evaluating the effects of Standard 301.

It was later determined that three additional States, North Carolina, Pennsylvania, and Maryland offered some potential for the analysis of crash fire data from motor vehicle accident files. A second support contract was let to the Highway Safety Research Center, University of North Carolina to access and analyze the data from the data from the States of North Carolina and Maryland [8] and a follow-on effort [5] was awarded to HSRI to analyze the data from Pennsylvania as well as more current data from Michigan and Illinois. Appendix A contains a more detailed discussion of the data sources.

This study analyzes fire data from five States, Michigan, Illinois, North Carolina, Maryland, and Pennsylvania along with fuel leakage data from one State, Michigan. The Michigan data are considered the best source of information on crash fires and fuel leaks, and therefore the primary analysis is carried out on this set.

Throughout the analyses, vehicles are grouped into two categories, Pre-standard vehicles, comprised of Model Years 1972 through 1975, and Post-Standard vehicles, comprised of Model Years 1976 through 1980. This grouping assumes that effectively a single, or combined standard was introduced and no attempt is made to assess the individual effectiveness of the two Standard upgrades, for reasons given in the subsequent analyses.

In addition to the effect of the standard, the analyses also considers the effects of other factors such as vehicle age, impact direction, and impact severity, which may influence crash fire rates and crash-induced fuel leakage.

2.1 Analysis of Michigan Crash Fire Data

Michigan Data on Crash Fires encompasses three calendar years (1978, 1979, 1980) of Statewide, police-reported accidents. Beginning in 1978, the Michigan Accident Report Form was revised to include a specific check-box element for denoting presence of crash fires and/or fuel leakage (see Appendix B for a copy of the report form).

For purposes of analysis, the data were grouped into two categories corresponding to those vehicles produced before, and after, Standard 301 became effective. These two groups are referred to as "Pre-Standard" and "Post-Standard," respectively, throughout this report. The Pre-Standard Group contains vehicles of Model Years 1972 through 1975, while the Post-Standard Group contains vehicles of Model Years 1976 through 1980. This choice of restricting the Pre-Standard Group to four years creates a more balanced sample size for comparison and also minimizes any potential, extraneous variation (due to vehicle model year change, traffic exposure changes, aging effects, reporting biases, etc.) which might exist. This restriction essentially provides for a "cleaner" and more conservative analysis of the effects of Standard 301.

Also in the analysis, Standard 301-75, which became fully effective over two Model Years, 1976 and 1977, is considered as a single, combined standard, or effect, in a statistical sense, and attempts are not made to estimate the effect of these two standard upgrades separately. The reasoning here is that rollover accidents, to which the 1976 version of the standard was directed, occur <u>very</u> rarely as compared to other types such as frontal impacts or rear impacts and the resultant small sample size would likely be insufficient to provide a very sensitive or precise test, especially since fires themselves are such rare events. This small sample size constraint is further compounded in that only one Model Year, 1976, existed before the standard was upgraded to include side, and rear, as well as strengthened frontal impact requirements. Therefore, the two standard upgrades are considered as a "single" standard for purposes of analysis of their impact.

Table 1 displays the fire data as described above for each of the three calendar years. The data refer to all crash fires reported by the State of Michigan. Individual table entries are the ratios of fire frequency to that of vehicle crash frequency and the corresponding relative frequency, or proportion of vehicle crashes resulting in fire.

The overall fire rate is approximately two (2.0) fires per 1,000 vehicle crashes. Inspection of the column totals does not reveal any evidence of an increase in fire rate, due to possible aging or degradation of vehicle/fuel system components. In fact, the overall rates for the three calendar years are amazingly close. Similarly, inspection of row totals, <u>within</u> each Pre- and Post-Standard grouping, indicates little evidence of a trend of higher fire rates for older vehicles. Of course this latter comparison also contains a potential effect of model year as distinct from any age effect. Within standard groups, however, the rates for model years are reasonably homogeneous.

TABLE 1 - MICHIGAN CRASH FIRE RATES

No. of Crash Fires/No. of Crash-Involved Vehicles and
Fire Rates, Per 1,000 Vehicle Crashes,
for Calendar Years Shown

MODEL Year	Calendar Years → 1978	1979	1980	TOTAL 1978 thru 1980
1972	115/50635 = 2.271	116/40530 = 2.862	71/28543 = 2.487	302/119708 = 2.523
1973	134/57560 = 2.328	138/48529 = 2.844	106/36290 = 2.921	378/142379 = 2.655
1974	137/49783 = 2.752	91/43199 = 2.107	95/32659 = 2.909	323/125641 = 2.571
1975	96/40235 = 2.386	76/35497 = 2.141	71/28037 = 2.532	243/103769 = 2.342
1976	90/52393 = 1.718	86/45713 = 1.881	64/36069 = 1.774	240/134175 = 1.789
1977	104/65928 = 1.729	82/55664 = 1.473	67/44426 = 1.508	263/166018 = 1.584
1978	86/47002 = 1.830	102/60281 = 1.692	69/46349 = 1.489	257/153632 = 1.673
1979		82/41475 = 1.977	86/47791 = 1.780	168/89266 = 1.882
1980			47/28305 = 1.660	47/28305 = 1.660
1981				
TOTALS	772/363536 = 2.124	773/370888 = 2.084	676/328469 = 2.058	2221/1062893 = 2.090

Yet a third view of the potential effect of age can be seen in Table 2. Here fire rates for Pre- and Post-Standard vehicles are shown as a function of the (chronological) age of the vehicle at the time of the crash. Again it is seen that little evidence of an age effect (i.e., higher rates for older vehicles) appears within either the Pre- or the Post-Standard groups, but a rather distinct difference is noted between the two groups with the rates for Pre-Standard vehicles being consistently higher than the rates for Post-Standard vehicles. For the two cases where the same ages (e.g., three years and four years, denoted by the "box" in Table 2) are available, this same trend holds.

TABLE 2 - MICHIGAN CRASH FIRE RATES BY AGE OF VEHICLE (AT TIME OF CRASH) AND STANDARD STATUS

	Fires Per Vehicle Crash (x 10^{-3})	
Vehicle Age, Years	Pre-Standard	Post-Standard
8	2.487	
7	2.890	
6	2.640	
5	2.298	
4	2.498	1.774
3	2.386	1.697
2		1.561
1		1.736
0		1.841

Tables 1 and 2 both show a rather distinct breakpoint beginning with the 1976 Model Year group, or the onset of the Post-Standard period. Figure 1 graphically illustrates this decline in fire rates between the

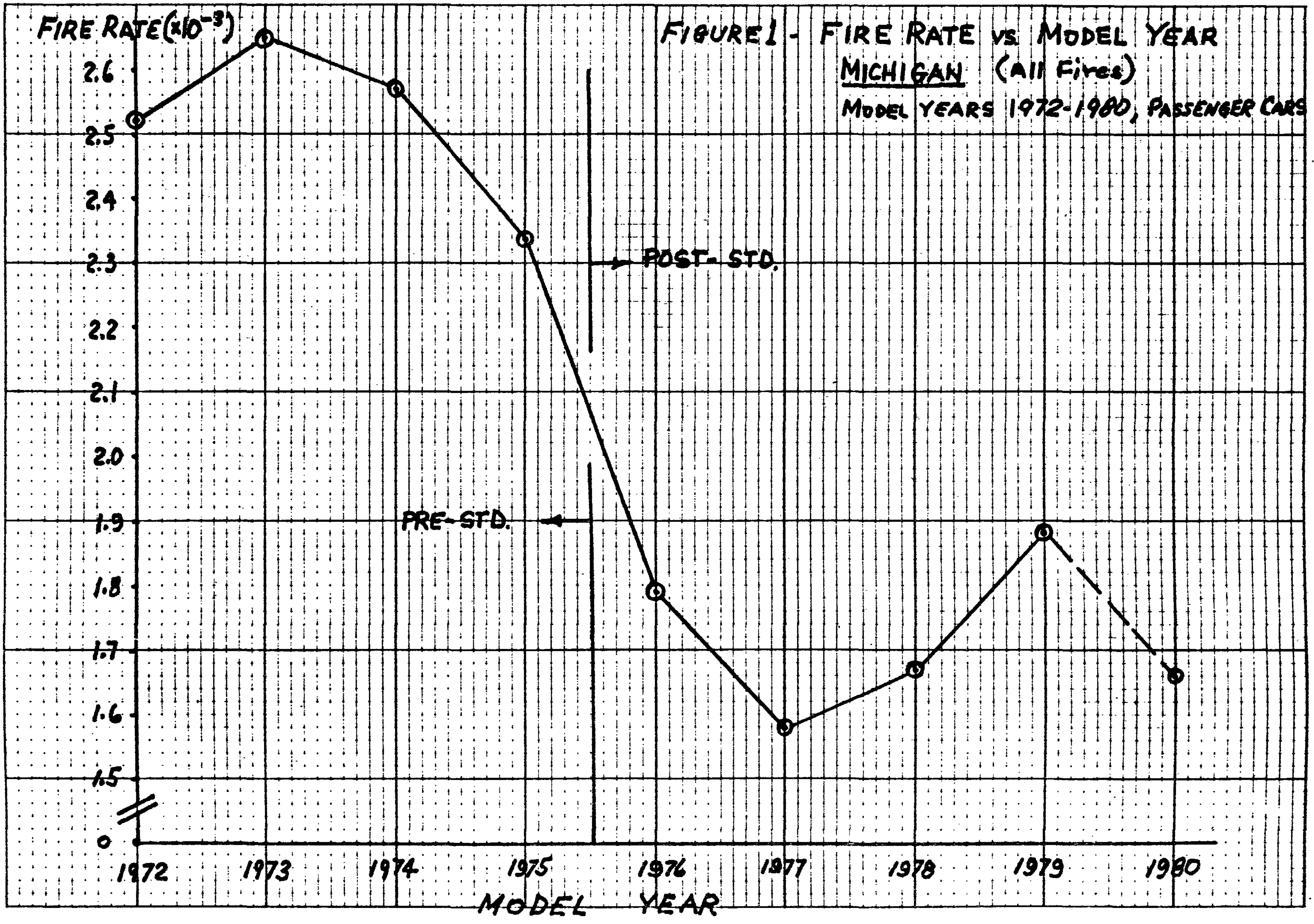


FIGURE 1 - FIRE RATE vs. MODEL YEAR
MICHIGAN (All Fires)
MODEL YEARS 1972-1980, PASSENGER CARS

1975, and earlier, model years, and the 1976, and later, model years. The mean fire rates for the two groups, computed from the data in Table 1, are:

Pre-Standard:

$$\frac{\text{1246 vehicle fires}}{\text{491,497 vehicle crashes}} = \text{2.535 fires per 1,000 crashes}$$

Post-Standard:

$$\frac{\text{975 vehicle fires}}{\text{571,396 vehicle crashes}} = \text{1.706 fires per 1,000 crashes}$$

The difference in these two means is 2.535 -1.706 = 0.828 fires per 1,000 vehicle crashes, or a reduction of .828/.2535 = 32.7 percent for the Post-Standard group compared to the Pre-Standard group.

2.1.1 Overall Fire Rate

We can assess whether this difference is statistically significant using the normal distribution since the sample sizes are quite large even though the individual "p's" are quite small. We compute the value:

$$z_{calc} = \frac{p_1 - p_2}{\hat{\sigma}_{p_1 - p_2}}$$

$$= \frac{p_1 - p_2}{\left[\hat{p}\,(1 - \hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)\right]^{\frac{1}{2}}} \qquad (1)$$

where

p_1, p_2 = observed sample rates for the Pre-Standard and Post-Standard groups, respectively, with corresponding sample sizes n_1, n_2;

and

$\hat{p}$ = overall, or weighted average rate given by

$$\hat{p} = \frac{n_1 p_2 + n_2 p_2}{n_1 + n_2} \qquad (2)$$

$\hat{\sigma}_{p_1 - p_2}$ is the estimate of the overall population standard deviation.

Substituting into (2), we obtain

$$\hat{p} = \frac{491497\ (.002535) + 571396\ (.001706)}{491740 + 571396}$$

$$= .002089$$

Next, substituting into (1):

$$Z_{calc} = \frac{.002535 \quad -.001706}{\left[(.002089)(.997911) \quad \left(\frac{1}{491740} + \frac{1}{571396}\right)\right]^{\frac{1}{2}}}$$

$$= \ 9.324$$

Assuming a one-tail test at a 95 confidence level, (i.e., $H_0: \mu_1 = \mu_2$ against the alternative, $H_1: \mu_1 > \mu_2; \alpha = .05$), this result is highly significant since

$$Z_{calc} = 9.325 > Z_{Table;.05} = 1.645$$

From this we reject the null hypothesis in favor of the alternative and conclude that the samples do not represent vehicles from the same population; the fire rate in the Post-Standard population is significantly lower than that for the Pre-Standard population. The estimated difference is 0.828 fires per vehicle crash less for the Post-Standard group, or a reduction of .828/2.534 = 32.8 percent.

2.1.2 Influence of Other Factors on Crash Fire Rates

In the above analysis, the effect of Pre- and Post-Standard vehicles, age, model year, and calendar (or accident) year have been considered. Of course it is possible that other factors could be influencing crash fire rates in addition to standard effects. For instance, impact speed, object impacted, type or direction of impact, and vehicle type/size are other potential factors that might affect whether or not a fire occurs as a result of a vehicle crash. Certainly, it is more reasonable to expect that the more severe the crash, in terms of damage to the vehicle, the more likely fuel system damage and fuel leakage would occur; similarly, ignition sources such as friction-generated sparks (from metal-to-metal contact, metal-to-pavement contact, electrical shorting, etc.) would be expected to occur with greater probability in more severe crashes. Due to the nature and location of fuel system components, fuel tank, fuel lines, fuel pump, carburetor, etc.), it is also reasonable to expect that type of impact (i.e., rollover, side swipe) or the direction of impact (rear, front, etc.) could influence the likelihood of fires in vehicle crashes.

In the Michigan data, one can investigate vehicle crash severity as recorded on the accident report by a Vehicle Damage Severity (VDS) scale. For each accident involved vehicle, the investigating/reporting officer assigns a numerical value, from 1 to 8, to denote the extent of damage sustained by each vehicle. A VDS of 1 represents very light, or minor, vehicle damage, while a VDS of 8 represents very extreme damage (See Appendix A). The Michigan data also include a variable to describe the direction, or type, of impact sustained by each accident involved vehicle.

Tables 3 and 4 contain the distribution of Vehicle Damage Severity and the distribution of impact direction, for the Pre-Standard and Post-Standard vehicle groupings, respectively. It can be postulated that if the distribution of either, or both, of these variables differs significantly between Pre- and Post-Standard groups, then the overall fire rates for these groups, as computed earlier might need to be adjusted, in order to obtain a more realistic, or "net" effect of Standard 301.

TABLE 3 - DISTRIBUTION OF VEHICLE DAMAGE SEVERITY BY STANDARD GROUP

	Pre-Standard (Mod. Yrs. 1972-1975)			Post-Standard (Mod. Yrs. 1976-1980)			
Vehicle Damage Severity	Observed Frequency	Expected Frequency	Column Frequency	Observed Frequency	Expected Frequency	Column Frequency	TOTALS (Observed Frequency)
1	4721	3990	.03858	5743	6474	.02892	10464
2	31317	31711	.25595	51842	51448	.26108	83159
3	31976	32761	.26134	53936	53151	.27162	85912
4	24740	24981	.20220	40770	40529	.20532	65510
5	15230	15196	.12447	24619	24653	.12398	39849
6	8017	7866	.06552	12610	12761	.06350	20629
7	3814	3590	.03112	5601	5825	.02821	9415
8	2540	2261	.02076	3390	3669	.01707	5930
TOTALS	122355	--	.999	198511	--	.999	320866

Based on Michigan data
for Calendar Year 1980

TABLE 4 - DISTRIBUTION OF IMPACT TYPE BY STANDARD GROUP

	Pre-Standard (Mod. Yrs. 1972-1975)			Post-Standard (Mod. Yrs. 1976-1980)			TOTALS (Observed Frequency)
Impact Type	Observed Frequency	Expected Frequency	Column Percentage	Observed Frequency	Expected Frequency	Column Percentage	
Frontal	76943	75406	72.1	118511	120048	69.8	195454
Rollover	1793	1773	1.7	2802	2822	1.6	4595
Rearend	27981	29539	26.2	48584	48026	28.6	76595
TOTALS	106717	—	100.0	169897	—	100.0	276614

Based on Michigan data
for Calendar Year 1980

To ascertain whether the Vehicle Damage Severity and impact type distributions differ between Pre- and Post-Standard groups, Chi-square tests for independence were run.

For the distribution of Vehicle Damage Severity, the test proceeds as follows; first compute:

$$\chi^2 = \sum_{i=1}^{16} \frac{(o_i - e_i)^2}{e_i} \tag{3}$$

Where o_i and e_i represent the individual observed and expected cell frequencies, respectively, from Table 3. Substituting these individual values and performing the calculation yields a χ^2 value of 341.6. This value is significant, statistically, since it is larger than the corresponding tabled Chi-square value of 14.1 ($\alpha = .05$, df = 7). This value implies that indeed, Pre- and Post-Standard vehicles cannot be presumed to come from the same population of Vehicle Damage Severity. Closer inspection reveals that the primary contributors to a significant test statistic, are the upper and lower ends of the damage severity scale. More specifically the Post-Standard vehicles tend to have a smaller proportion of higher severity crashes, but a larger proportion of lower severity crashes than Pre-Standard vehicles. One would, of course, expect higher severity crashes to result in greater likelihood of fire.

Turning to the Impact Type Distribution, a similar test is performed using equation (3), but this time substituting the data from Table 4. This calculation yields a χ^2 value of 185.2. Again this result is statistically significant since 185.2 is greater than the corresponding tabled Chi-square value of 5.99 (α= .05, df = 5). Inspection of Table 4 indicates that Post-Standard vehicles experience a somewhat greater proportion of rear end, but a slightly lower proportion of frontal impacts, than do Pre-Standard vehicles.

The foregoing findings of different Vehicle Damage Severity and Impact Type distributions, between Pre- and Post-Standard groups imply the need to investigate these effects on the overall decrease in fire rates for Post-Standard vehicles, as computed earlier, to determine if some adjustment is warranted.

The investigation of the Vehicle Damage and Impact Type effects takes the form of breaking the data down, according to these additional variables, and reperforming the analyses of Pre- and Post-Standard groups. Specifically, the two groups, Pre and Post, will be compared for each Vehicle Damage Severity level and Impact Type.

2.1.3 Analysis of Michigan Data by Crash Type and by Vehicle Damage Severity

In order to preserve reasonable cell sizes and since fire rates exhibited a rather distinct difference between lower and higher damage severity levels, the data were grouped into two categories, "Low to Moderate," defined by Vehicle Damage Severity = 2, 3, 4, or 5, and "Major," defined by Vehicle Damage Severity = 6, 7, 8, for purposes of analysis. Vehicle Damage Severity = 1 was not included since it represented a very minor accident severity and since very few crash fires occur at this level.

2.1.3.1 Vehicle Damage Severity: Low to Moderate (VDS = 2, 3, 4, 5)

Tables 5, 6, and 7 contain the distributions of fires, crashes, and fire rates for Pre- and Post-Standard vehicles for each of the three major impact types, frontal, rearend, and rollover. The data are from Michigan and cover years 1978, 1979, and 1980. In general, the magnitude of the fire rates for frontal and rearend impacts is similar at slightly more than one fire per 1,000 vehicle crashes. Rollover fire rates are highest, ranging from approximately three to five fires per 1,000 vehicle crashes.

TABLE 5 - FIRE RATES, PRE- AND POST-STANDARD GROUPS, FRONTAL CRASHES, LO-MODERATE CRASH SEVERITY

Standard Group	No. Fires	No. Veh. Crashes	Fire Rate (x 10^{-3})
Pre-Std.	360	229,433	1.569
Post-Std.	311	261,002	1.192

First a comparison is made for frontal impacts. As before, the Pre-Standard rate is representated by p_1 and the Post-Standard rate by p_2.

Substitution of the respective values from Table 5 into (1) gives a Z-calculated value of 3.577. Since 3.577 is greater than the normal distribution value of 1.645 (α = .05, one-tailed test), the null hypothesis of equal fire rates for Pre- and Post-Standard vehicles is rejected in favor of the alternative hypothesis that the Post-Standard fire rate is lower. The estimated magniture of the reduction in fire rate is given by:

$$\frac{P_1 - P_2}{P_2} = \frac{.000377}{.001509} = 24.0\%$$

Moving to rearend crashes (Table 6), a similar comparison yields a Z-value of 1.49. The test statistic value of 1.49 is less than the tabled value of 1.645. Therefore, the conclusion for rearend impacts at a Lo to Moderal level is that no significant difference exists between the fire rate for Pre- and Post-Standard vehicles. Although the Post-Standard fire rate is numerically lower by an amount equal to $\frac{P_1 - P_2}{P_1} = \frac{.000377}{.001395} = 16.3$ percent, it is not significant at the .05 level which is the (risk) level chosen for the statistical comparison. The value 1.49 would reach significance, however, if the risk level were raised by approximately only <u>two</u> percentage points, to a level of 0.7, which would correspond to a 93 percent confidence level.

TABLE 6 - FIRE RATES, PRE- AND POST-STANDARD GROUPS, REAREND CRASHES, LO-MODERATE CRASH SEVERITY

Standard Group	No. Fires	No. Veh. Crashes	Fire Rate (x 10^3)
Pre-Std.	139	99,663	1.395
Post-Std.	139	119,141	1.167

The final comparison in the Lo-Moderate crash severity is for rollover crashes for which the data are shown in Table 7.

TABLE 7 - FIRE RATES, PRE- AND POST-STANDARD GROUPS, ROLLOVER CRASHES, LO-MODERATE CRASH SEVERITY

Standard Group	No. Fires	No. Veh. Crashes	Fire Rate (x 10^3)
Pre-Std.	14	2,946	4.752
Post-Std.	10	3,541	2.824

This time, since cell sample sizes are considerably lower, a non-parametric statistic is employed to test for difference between the Pre- and Post-Standard groups. Using the Chi-square test, as in (3) and the data from Table 7, the following calculation results

$$\chi^2 = \frac{(14 - 10.9)^2}{10.9} + \frac{(3935.1 - 2932)^2}{2935.1}$$

$$+ \frac{(10 - 13.1)^2}{13.1} + \frac{(3531 - 3527.9)^2}{3527.9}$$

$$= 1.63$$

Comparison of this value, 1.63 with the corresponding table value of the χ^2 distribution of 3.84 ($\alpha = .05$, df = 1), indicates a non-significant result. Hence the conclusion of no difference between the Pre- and Post Standard fire rates for rollover crashes of Lo-Moderate crash severity. Once again, the Post-Standard rate is numerically lower than the Pre-Standard rate--by an amount equal to: $\frac{p_1 - p_2}{p_1} = \frac{.004752 - .002824}{.004752}$ = 40.6 percent, but the small number of fires and vehicle crashes precludes this reduction as significant.

Summarily, for the Lo-Moderate crash category, only Frontal impacts showed a statistically significant reduction in fire rate for the Post-Standard vehicles. This reduction was estimated at 24 percent based on a difference of 1.57 fires per 1,000 crashes for Pre-Standard vehicles vis-a-vis

1.19 fires per 1,000 crashes for Post-Standard vehicles. Rearend and rollover crashes, although displaying numerically lower fire rates for Post-Standard vehicles did not reach statistical significance between Pre- and Post-Standard groups at the chosen significance level of 5 percent. Very sparse data were available for rollover crashes and rearend crashes which would show significance at an α-level of 7 percent (i.e., 93 percent confidence level.

2.1.3.2 Vehicle Damage Severity: Major (VDS = 6, 7, 8)

Pre- and Post-Standard fires and fire rates for frontal, rearend, and rollover impacts are shown in Tables 8 through 10, respectively, for those vehicles sustaining Major crash damage (i.e., VDS = 6,7,8). As with the Lo-Moderate crash damage level, the data are from Michigan Statewide files for Calendar Years 1978, 1979, and 1980.

The general trend of the fire rates over the three impact types is somewhat similar to that noted for the Lo-Moderate severity impacts with the rates for frontals and rearends being more nearly similar but less in magnitude than the rates for rollovers. One departure within this general trend, however, is that for Pre-Standard vehicles, rearend fire rates are higher than frontal fire rates, and in fact are as high as rollover fire rates. When contrasted with the fire rates for the Lo-Moderate crash level, the effect of higher crash forces on the liklihood of fire is clearly evident, with fire rates ranging as much as ten times higher for the major severity crashes.

TABLE 8 - FIRE RATES, PRE- AND POST-STANDARD GROUPS, FRONTAL CRASHES, MAJOR CRASH SEVERITY

Standard Group	No. Fires	No. Veh. Crashes	Fire Rate $(\times 10^{-3})$
Pre-Std.	91	9,465	9.614
Post-Std.	79	14,425	5.477

Table 8 displays the fire rate data for Frontal crashes. Testing for significance between the Pre- and Post-Standard rates, as before, gives a value of 3.848. This value of 3.848 is greater than 1.645, the reference value of 1.645 ($\alpha = .05$) and it is concluded that the Post-Standard fire rate is significantly lower than the Pre-Standard rate. The corresponding magnitude of reduction is given by $\frac{P_1 - P_2}{P_1} = \frac{.004137}{.009614} = 43.0$ percent.

Turning next to Rearend impacts, Table 9 shows the Post-Standard rate of 5.76 fires per 1,000 vehicle crashes to be considerably below the Pre-Standard rate of 14.28.

TABLE 9 - FIRE RATES, PRE- AND POST-STANDARD GROUPS, REAREND CRASHES, MAJOR CRASH SEVERITY

Standard Group	No. Fires	No. Veh. Crashes	Fire Rate $(\times 10^{-3})$
Pre-Std.	90	6,304	14.28
Post-Std.	40	6,944	5.76

To ascertain whether this difference is statistically significant, the previous computation is repeated using the data from Table 9. This results in a Z-value of 4.982 which again, is significant since it exceeds 1.645 ($\alpha = .05$), the reference normal distribution point. Computing the extent of the reduction in fire rate for the Post-Standard group yields

$$\frac{p_1 - p_2}{p_1} = \frac{.00852}{.01428} = 66.7 \text{ percent.}$$

TABLE 10 - FIRE RATES, PRE- AND POST-STANDARD GROUPS, ROLLOVER CRASHES, MAJOR CRASH SEVERITY

Standard Group	No. Fires	No. Veh. Crashes	Fire Rate ($\times 10^{-3}$)
Pre-Std.	49	3,389	14.46
Post-Std.	29	3,599	8.05

The final analysis under the Major crash severity category is for Rollovers. Using the data from Table 10 and performing the calculations as before gives a Z-value of 2.504.

Hence, the third and last analysis under Major crash severity also yields a significant result, the computed value of 2.504 once again being greater than the reference value of 1.645 ($\alpha = .05$). The corresponding reduction in fire rate for the Post-Standard group over the Pre-Standard group being $\frac{p_1 - p_2}{p_1} = \frac{.00641}{.01466}$ or 44.3 percent.

In summary, analysis of the crashes involving Major crash severity (i.e., major vehicle damage) exhibited statistically significant fire rate reductions for the Post-Standard vehicles for all three impact types, Frontal, Rearend, and Rollover. The greatest reduction was noted for Rearend impacts (67 percent), followed by Rollovers and Frontal impacts with nearly identical reductions estimated at 44 percent and 43 percent, respectively.

2.1.3.3 Summary of Analysis of Other Factors

In summary, even though Post-Standard vehicles, overall, experienced a slightly lower rate of higher severity crashes, and slightly lower relative frequencies of those types of impacts most likely to be associated with fires, separate analyses of the data, controlling for these factors showed Post-Standard vehicles still had significantly lower fire rates than Pre-Standard vehicles for four of the six subgroups compared. In the remaining two subgroups where significant reductions were not found, one subgroup (Rollover Lo-Moderate) was characterized by limited sample size; the other subgroup (Rearend, Lo-Moderate) was nearly significant, needing a relaxation of only two percentage points above the 5 percent risk level chosen for the statistical comparison to be declared significant, (i.e., at an $\alpha = .07$, or a confidence level of 93 percent, the fire rate for Rearend, Lo-Moderate severity would have been significantly lower for the the Post-Standard group).

The reductions in fire rate were concentrated in the higher crash severity range, as defined by extent of vehicle damage, and occurred for all three major impact types, Frontal, Rearend, and Rollover. Finally, the magnitude of the reduction in fire rates for these categories was greater than the reduction noted in the overall, unadjusted data and these categories accounted for approximately 80 percent of the total number of vehicle crash fires. Table 11 summarizes the results of these analyses.

TABLE 11 - SUMMARY OF ANALYSES BY CRASH TYPE AND VEHICLE DAMAGE SEVERITY MICHIGAN FIRE DATA

Crash Type	Vehicle Damage Severity	Proportion of Total Fires	Percent Reduction for Post-Std. Group	Reduction Statistically Significant?
Frontal	Lo-Mod.	53.1	24.0	Yes
	Major	11.7	43.0	Yes
Rearend	Lo-Mod.	19.2	16.3	No
	Major	9.0	66.7	Yes
Rollover	Lo-Mod.	1.7	40.6	No
	Major	5.4	44.3	Yes

2.1.4 Summary of Analysis of Michigan Crash Fire Data

Collectively, the results of analysis of the Michigan fire data indicate that not only have significantly lower fire rates occurred in Post-Standard vehicles, but that the majority of these reductions have occurred in those accidents that have been more severe in terms of the extent of (crash) damage to the vehicle. Also, reductions occurred for the three major impact types investigated, Frontal, Rearend, and Rollover. This can be seen graphically in Figure 2, which plots fire rates by vehicle model year for the family of vehicle damage severity ratings (i.e., VDS) from 3 through 8. Here it is seen that at the lower crash severities (3 to 5), rather homogeneous fire rates occur over the eight to nine model years. In contrast, for the highest crash severities (6, 7, 8), rather marked decreases are noted, in fire rates, over the same model year span. Furthermore, these changes are basically consistent over each of the three highest crash severity ratings. This figure also shows that the primary point of decrease in fire rates occurs at the 1976 Model Year and, once again, this phenomenon is consistent for each of the three highest crash severities (VDS = 6, 7, 8).

From a safety standpoint, the fact that the greatest reductions in fire rates occurred at the higher crash force levels can be viewed in at least two ways. First, since more severe crash forces are more likely to produce occupant injury (due to the crash forces themselves), it may be stated that the concomitant occurrence of fire might not be considered so great a hazard. On the other hand, it can be argued that it is desirable to minimize fire in more severe (crash force) accidents, since the higher

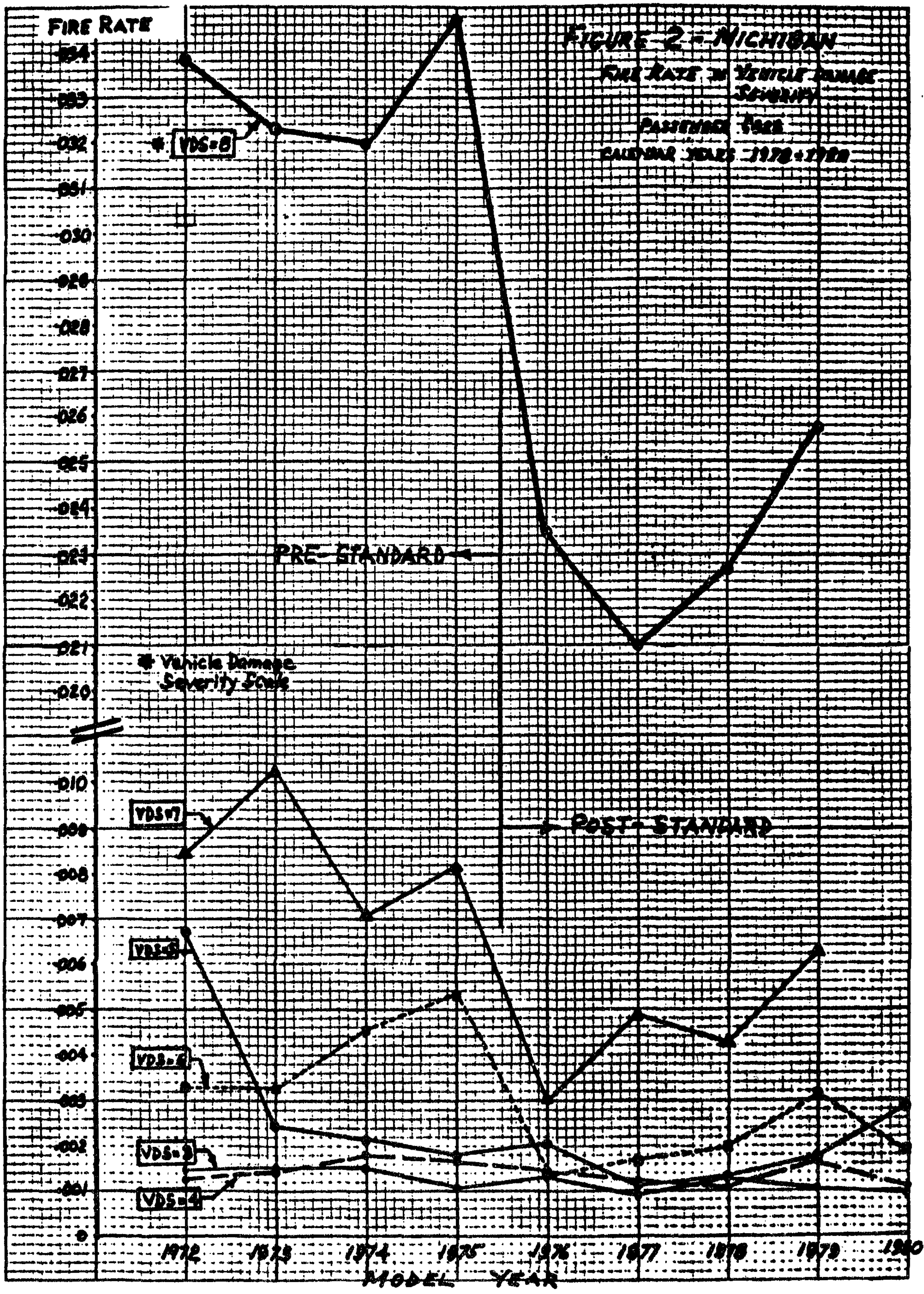


FIGURE 2 - MICHIGAN
FIRE RATE vs VEHICLE DAMAGE SEVERITY
PASSENGER CARS
CALENDAR YEARS 1978-1980
FIRE RATE
.034
.033
.032
.031
.030
.029
.028
.027
.026
.025
.024
.023
.022
.021
.020
.010
.009
.008
.007
.006
.005
.004
.003
.002
.001
0
* VDS=8
VDS=7
VDS=5
VDS=6
VDS=3
VDS=4
* Vehicle Damage Severity Scale
PRE-STANDARD
POST-STANDARD
1972
1973
1974
1975
1976
1977
1978
1979
1980
MODEL YEAR

likelihood of occupant injury (due to impact forces) would render the (victim)(s) less likely to be able to extricate themselves from the vehicle, should fire occur, and therefore less likely to escape further injury, even severe or fatal injury. Furthermore, severe crashes are more likely to result in entrapment of vehicle occupants, due to collapsed vehicle structures (jammed doors, broken/jammed window cranks, etc.). In such instances the occurrence of fire poses an extreme hazzard since the only hope for occupants would be extrication by "outside" assistance, and since critically short time would typically be available for rescue.

Finally, the results of these analyses are in general agreement with the nature of the 1976 and 1977 upgrades of Standard 301. That is, the greatest decreases in fire rates were noted for Rearend and for Rollover crashes, the primary types of impacts addressed by the 1976 and 1977 revisions of Standard 301. Significant reductions in fire rates were also noted for Frontal impacts, which also were addressed, as an upgrade by the 1976/77 Standard.

2.2 Analysis of Illinois Crash Fire Data

Analysis of data from the State of Illinois covers four calendar years, 1977, 1978, 1979, and 1980. Although data for six years (1975 through 1980) were available, years 1975 and 1976 were excluded from the analysis because of markedly higher incidences of unknown data, relative to crash fires, for these two earliest years. Such differences in reporting could bias the data and possibly give misleading analytical results, particularly since the phenomenon of interest (crash fires) is such a rare occurrence relative to the differences in proportions of missing data.

The Illinois Accident Report form (see Appendix B) contains a specific element for the reporting of fires, although the method differs somewhat from that used by Michigan (see Appendix A - Data Sources).

As with the data from Michigan, vehicle model year range was restricted to 1972 through 1980, in order to obtain a more balanced set of data in terms of sample size, and to minimize the potential for extraneous effects which might contribute bias or confounding influences. Similarly, for purposes of analysis, and for reasons described previously (see Section 3.1), Standard Revisions 301-76 and 301-77 are considered as a "single" standard effect beginning with Model Year 1976.

2.2.1 Fire Rates Based on Illinois Data

Table 12 displays the data for Illinois for the four Calendar Years 1977 through 1980. The overall fire rate is approximately 1.6 fires per 1,000 vehicle crashes. Inspection of the column totals does not reveal any increase in fire rate due to possible aging, or vehicle/component degradation, up to a period of four years. As with the Michigan data, the results for the four years show little variation. Additionally,

TABLE 12 - ILLINOIS CRASH FIRE RATES

No. of Crash Fires/No. of Crash-Involved Vehicles
and Fire Rates, Per 1,000 Vehicle Crashes,
for Calendar Years Shown

MODEL Year	Calendar Years → 1977	1978	1979	1980	TOTAL 1977 thru 1980
1972	110/63101 = 1.743	95/58621 = 1.621	79/50068 = 1.578	57/33465 = 1.703	341/205,255 = 1.661
1973	144/71685 = 2.009	122/67289 = 1.813	100/58769 = 1.702	79/41178 = 1.919	445/238,921 = 1.863
1974	104/64359 = 1.616	114/60710 = 1.878	88/53936 = 1.632	67/38974 = 1.719	373/217,979 = 1.711
1975	90/42959 = 2.095	83/50609 = 1.640	73/45282 = 1.612	51/33120 = 1.540	297/171,970 = 1.727
1976	103/56615 = 1.819	104/67086 = 1.550	99/60903 = 1.626	66/44139 = 1.495	372/228,743 = 1.626
1977	72/57080 = 1.261	119/78599 = 1.514	102/71059 = 1.435	101/51205 = 1.972	394/257,943 = 1.527
1978		83/56314 = 1.474	107/77098 = 1.388	93/55683 = 1.670	283/189,095 = 1.497
1979			81/48130 = 1.683	81/57708 = 1.404	162/105,838 = 1.531
1980				57/30704 = 1.856	57/30704 = 1.856
TOTALS	623/355799 = 1.751	720/43922 = 1.639	729/465236 = 1.567	652/386176 = 1.688	2724/1646448 = 1.654

inspection of row totals, within Pre- and Post-Standard groups shows little evidence of a higher rate for older vehicles. Figure 3. is a plot of the data from Table 12.

For an additional view of the potential for an aging effect, the reader is referred to Table 13, which lists fire rates as a function of vehicle age, at time of test, for the Pre- and Post-Standard groups. As was noted above, no age trend is apparent within either of the two groups.

TABLE 13 - ILLINOIS FIRE RATES BY AGE OF VEHICLE (AT TIME OF CRASH) AND STANDARD STATUS

Vehicle Age, Years	Fires Per Vehicle Crash (x 10^{-3}) Pre-Standard	Post-Standard
8	1.703	
7	1.732	
6	1.676	
5	1.706	
4	1.863	1.495
3	1.627	1.784
2	2.095	1.543
1		1.518
0		1.524

In contrast to the Michigan data, Tables 12 and 13 do not evidence a distinct decrease in rates beginning with the 1976 Model Year, although

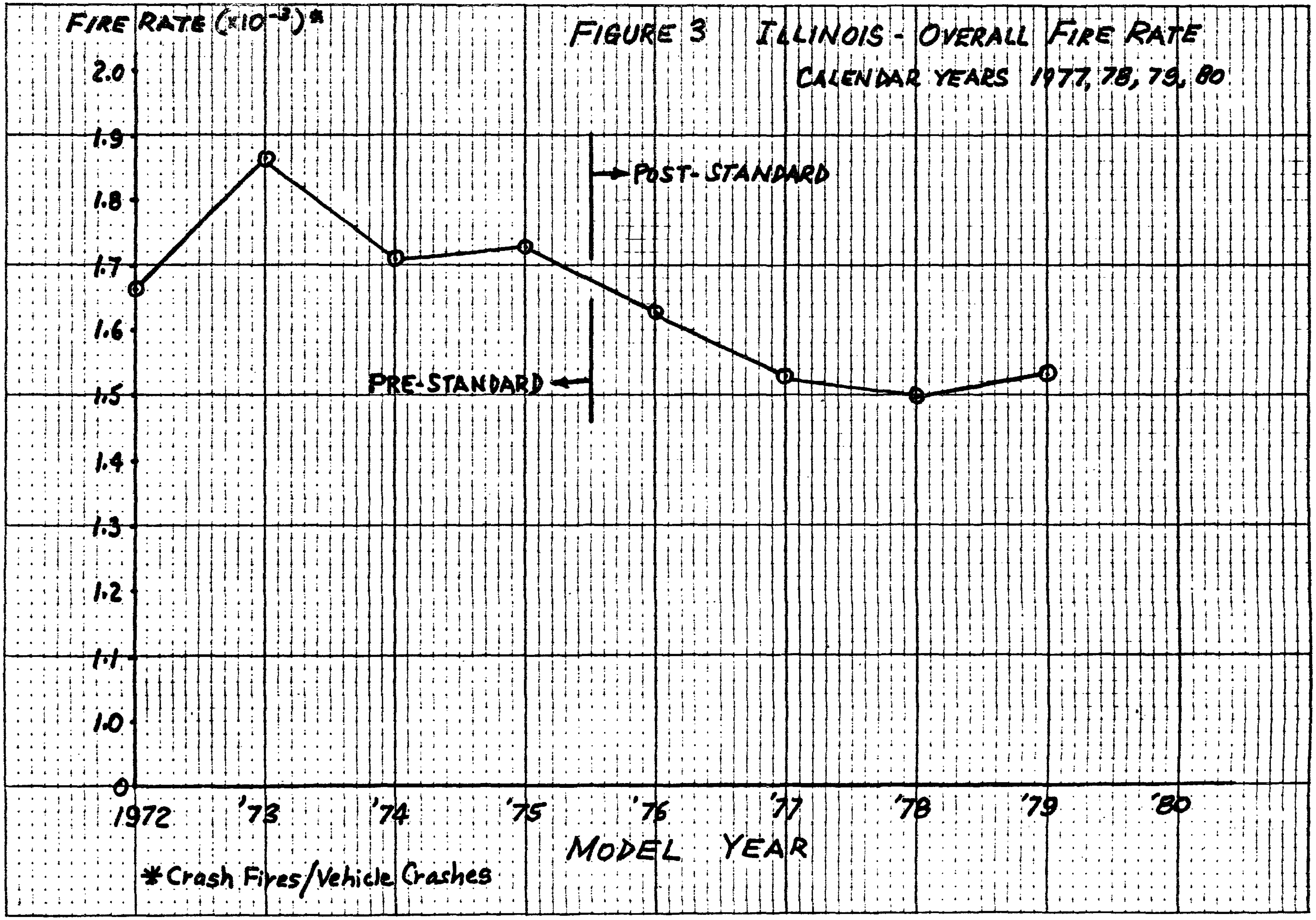


FIGURE 3 ILLINOIS - OVERALL FIRE RATE
CALENDAR YEARS 1977, 78, 79, 80

a somewhat lower overall rate is shown for the Post-Standard group, 1.56 versus 1.75 fires per thousand crashes.

Substituting into (1) to test whether this overall observed difference is statistically significant produces a Z-statistic of 2.920. This value is significant since 2.92 is greater than $Z_{TAB,\ .05} = 1.645$. The magnitude of the reduction is thus

$$\frac{.000185}{.001746} = 10.6 \text{ percent}$$

2.2.2 Influence of Other Factors

Further analysis of the Illinois data to investigate potential influence of other factors such as type of impact or crash severity, is precluded since definitive variables for such factors are not available from the Illinois data. Some data exist on "type of crash" (fixed object, head-on, etc.) but it is not possible to reliably relate such information to the type of impact, as was the case with the data from Michigan.

2.3 Analyses of North Carolina, Maryland, and Pennsylvania Data

Analysis of North Carolina, Maryland, and Pennsylvania data are presented in this section. The data on crash fires from these three States have been obtained by an indirect method of extracting data from police accident reports. That is, the accident reports from these States do not contain specific data elements for recording the presence (absence) of a crash fire. Therefore, information on fires is obtained by extracting data from the narrative portion of the accident report (North Carolina), or by using a filtering algorithm, composed of a number of other accident report variables (Maryland, Pennsylvania). The data sources and the processes of fire data extraction are described in Appendix A.

In accordance with the approach for analysis of data from the two previous States, the data are grouped into two categories: Pre-Standard, denoting those vehicles of Model Years 1972 through 1975, and Post-Standard, denoting those vehicles of Model Years 1976 through 1980. Also, as before, Standards 301-76 and 301-77 are considered as a single standard for purposes of analysis. The data from North Carolina cover eleven (11) calendar (or accident) years, 1971 through 1981; the data from Maryland cover four calendar years, 1977-1981, and Pennsylvania data represent calendar years 1977 through 1979 (three years).

Table 14, displays the fire rates for North Carolina, Maryland, and Pennsylvania, respectively. An initial point of interest here is the fact that the fire rates from each of the three States are of the same order of magnitude, ranging from approximately five (Maryland) to approximately seven (Pennsylvania) fires per 10,000 vehicle crashes. The consistency of the rates lends some support to the contention that fire data obtained by the indirect method yields reasonably consistent results. These rates, however, are considerably lower, by a factor of three to four, than those found in the Michigan and Illinois data sets. These lower rates are to be expected since they are derived from indirect reporting methods as described earlier, as opposed to the direct data element methods used by Michigan and Illinois. Figure 4 displays graphically the data from Table 14.

Because of: (a) the similarity of the fire rates from each of these three States, (b) the fact that the fire data for each State are obtained by similar (indirect) methods, and (c) the lack of adequate sample sizes within each State to permit satisfactory, State-by-State analysis of various factors which might influence crash fire rates, it is therefore deemed most appropriate to carry out analysis of the data from North Carolina, Maryland, and Pennsylvania on a collective basis, i.e., by considering the data as a combined set.

Reference to Table 14 and Figure 4 give some indication that age may be a factor in contributing to higher fire rates for older, or for Pre-Standard Vehicles. Some evidence of this is seen in the rates within the Pre-Standard group for Pennsylvania and within both Pre-Standard and Post-Standard groups for the Maryland data. In contrast, little or no evidence of an age factor is seen for the Post-Standard group for Pennsylvania or for either group (Pre- or Post-Standard) in the North Carolina data.

TABLE 14 - CRASH FIRE RATES FOR NORTH CAROLINA, MARYLAND, AND PENNSYLVANIA

No. of Crash Fires/No. of Crash-Involved Vehicles and
Respective Crash Fire Rates, Per 1,000 Vehicle Crashes

Model Year	North Carolina	Maryland	Pennsylvania
1972	91/151,787 = .5995	49/72,824 = .6729	46/63,261 = .7746
1973	79/139,931 = .5646	51/85,020 = .5999	48/74,032 = .6484
1974	58/100,553 = .5768	38/76,994 = .4935	49/69,093 = .7092
1975	31/57,957 = .5349	33/63,881 = .5166	37/55,844 = .6621
1976	36/69,947 = .5147	35/85,959 = .4072	42/68,383 = .6142
1977	24/57,015 = .4209	28/85,159 = .3288	44/77,900 = .5648
1978	12/46,200 = .2597	19/62,689 = .3031	41/61,928 = .6621
1979	9/39,222 = .2295	6/33,053 = .1815	26/30,394 = .8554
1980	11/21,259 = .5174		
Overall	351/683,871 = .5133	239/565,579 = .4579	336/500,875 = .6708

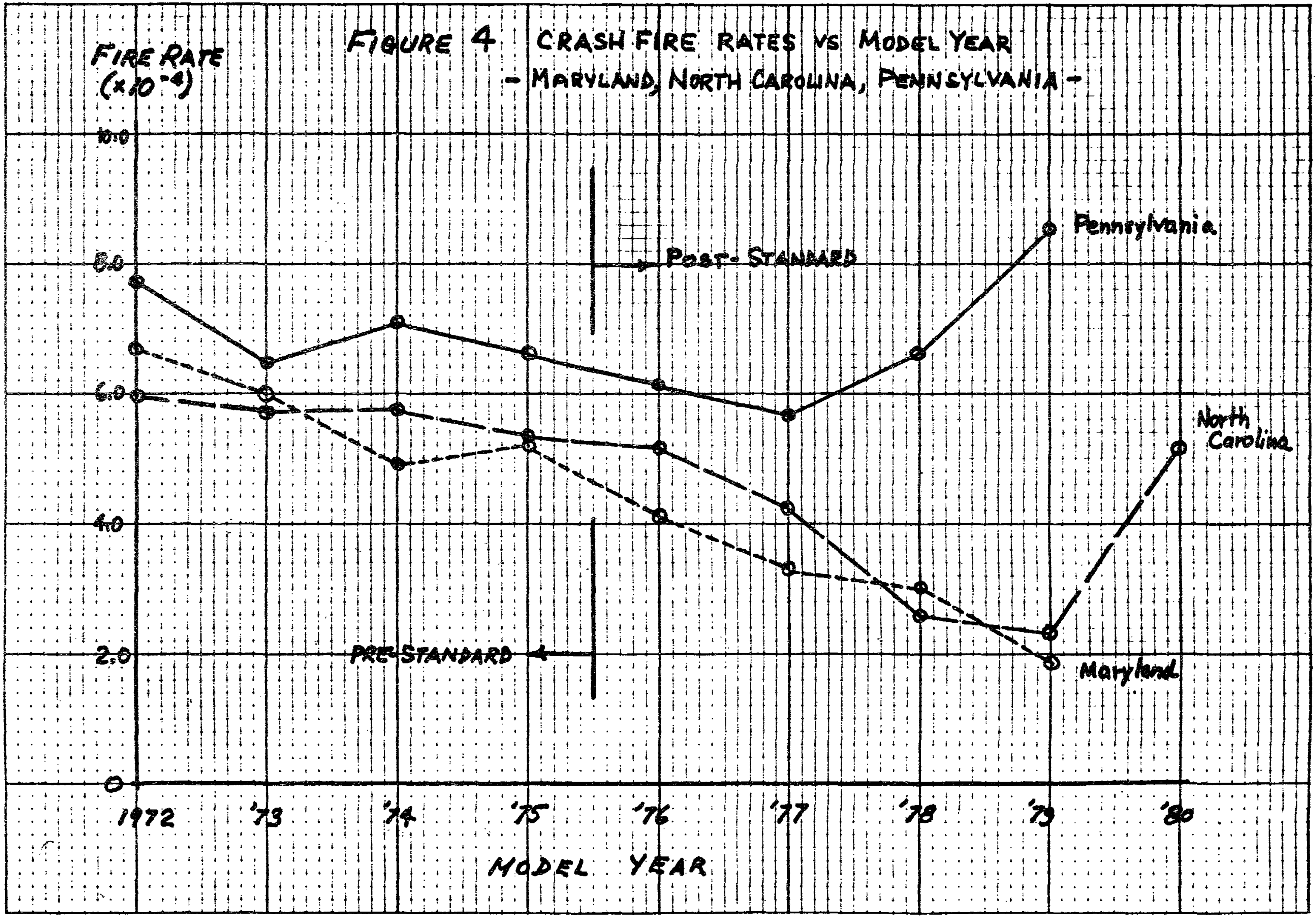


FIGURE 4 CRASH FIRE RATES VS MODEL YEAR
- MARYLAND, NORTH CAROLINA, PENNSYLVANIA -

TABLE 15 - CRASH FIRE RATES, PRE- AND POST-STANDARD VEHICLES BY AGE AT TIME OF CRASH FOR NORTH CAROLINA, MARYLAND, AND PENNSYLVANIA

No. of Crash Fires/No. of Crash-Involved Vehicles and Fire Rates, Per 1,000 Vehicle Crashes

Age (Yrs.) at Time of Crash	North Carolina		Maryland		Pennsylvania	
	Pre-Standard	Post-Standard	Pre-Standard	Post-Standard	Pre-Standard	Post-Standard
7	—	—	—	—		
6	50/90746 = .5510	5/10433 = .4792	—	—	11/29119 = .6182	—
5	57/96150 = .5928	14/26175 = .5349	40/67436 = .5932	7/11189 = .6256	54/69414 = .7729	—
4	64/103732 = .6170	19/38207 = .4973	22/45320 = .4854	13/33945 = .3830	42/64198 = .6542	—
3	64/103414 = .6189	11/46611 = .2360	8/20258 = .3949	17/63062 = .2696	18/32250 = .5581	20/3201 = .6236
2	46/90638 = .5075	17/62825 = .2706	—	30/69986 = .4287	9/10385 = .8667	31/59535 = .5207
1	29/58555 = .4953	26/52694 = .4934	—	21/66663 = .3150	—	52/80511 = .6459
0	—	—	—	—	—	50/66488 = .7520

In addition to age as a potential factor here, it must be borne in mind that other factors, such as model year differences, could also be affecting the fire rates. Perhaps a better method of examining the effect of age is to compare the Pre- and Post-Standard vehicle groups on the basis of similar age (of vehicle) at the time of the accident, or crash. Such comparisons are made in Table 15 for North Carolina, Maryland, and Pennsylvania, individually, and in Table 16 for the three States, combined.

TABLE 16 - FIRE RATES, PRE- AND POST-STANDARD VEHICLES, BY AGE AT TIME OF CRASH - NORTH CAROLINA, MARYLAND AND PENNSYLVANIA DATA, COMBINED

Vehicle Age Years	Fire Rates (x 10^{-3}) Pre-Standard	Post Standard
7	--	--
6	.5510	.4792
5	.5930	.5620
4	.5770	.4435
3	.5772	.4253
2	.5444	.3923
1	.4953	.4934
0	--	--

A study of Table 15 indicates that age has a minor or negligible influence while for equivalent ages, fire rates for Post-Standard vehicles are rather consistently below fire rates for Pre-Standard vehicles. In eight of eleven individual cases where vehicles of the same age could be compared, Post-Standard vehicles had lower fire rates. In one case, Pre- and Post-Standard vehicle rates were essentially the same, and in the remaining two cases, Post-Standard vehicles had higher fire rates. Figure 5 is a graphic display of the combined data from Table 16. In summary, this comparison does not support the theory that vehicle aging affects crash fire rates, at least for the range of data considered here.

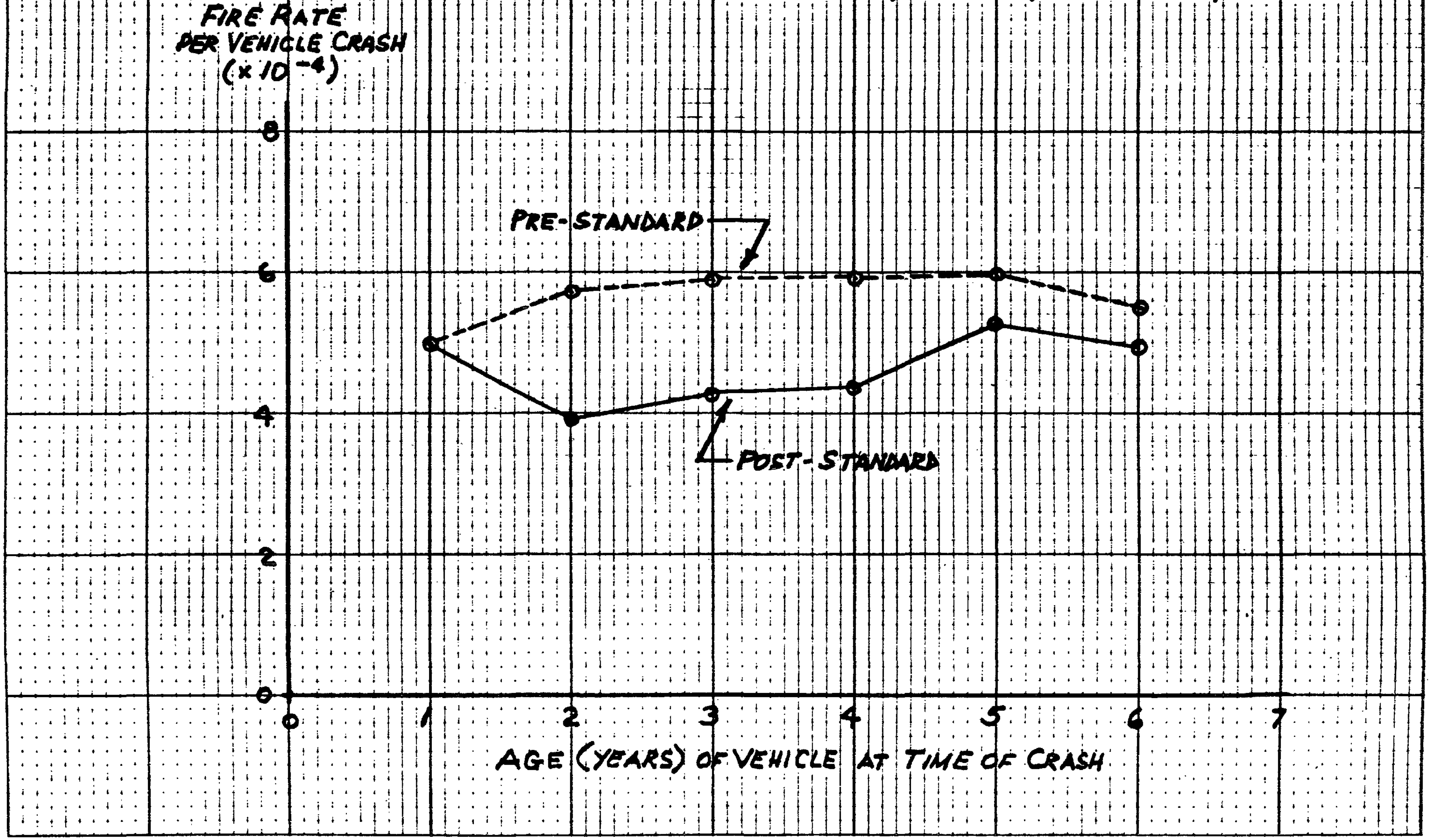
To determine if the overall Pre- and Post-Standard rates as shown in Table 16 are statistically significant, a Z-statistic is calculated. The value obtained is 9.867.

Therefore, it is concluded that the difference (e.g., $22.0\% = \frac{p_1 - p_2}{p_1} = \frac{.0001248}{.0005662}$

is statistically significant, since $9.867 > Z_{TAB,.05} = 1.645$, and that the Post-Standard vehicle population exhibits a 22 percent lower fire rate than Pre-Standard vehicles.

Further analysis of other factors which might influence fire rates is precluded since common variables are not identified in the three State data sets.

FIGURE 5 FIRE RATES, PRE AND POST-STANDARD VEHICLES,
BY AGE AT TIME OF CRASH
— NORTH CAROLINA, MARYLAND, PENNSYLVANIA, COMBINED —



2.4 Fuel Leak Reduction (Michigan Data)

Data of fuel leakage were available from only one source--the State of Michigan. Appendix A describes the procedure for recording fuel leakage on the Michigan Accident Report Form, a copy of which is included in Appendix B.

Overall leakage rates are contained in Table 17 for the three calendar years of data and for Model Years 1972 through 1980. It is seen that the overall leak rate is approximately one per 100 vehicle crashes, which is some five times as high as the overall fire rate for the same (i.e., Michigan) set of data.

Inspection of the marginal totals in Table 17 reveals little evidence of an age trend over the three calendar years, but over model years there is considerable indication that older vehicles may have higher leak rates, particularly for the Pre-Standard or 1972-1975 group where a linear increase appears most consistent.

Of course, as was stated earlier, such differences or indications of age trends may be confounded with other factors such as the model year of the vehicle. Table 18 affords a better view of the aging phenomenon by age of vehicle at the time of the crash. Here a trend relating to age

TABLE 17 - FUEL LEAKAGE RATES, STATE OF MICHIGAN

Frequency of Fuel Leakage (Vehicles)/No. of Crash-Involved
Vehicles, and Leak Rates, Per 1,000 Vehicle Crashes,
for Calendar Years Shown

MODEL Year	Calendar Years → 1978	1979	1980	TOTAL 1978 thru 1980
1972	802/50635 = 15.84	664/40530 = 16.38	475/28543 = 16.64	1941/119708 = 16.21
1973	800/57560 = 13.90	667/48529 = 13.74	520/36290 = 14.33	1987/142379 = 13.96
1974	647/49783 = 13.00	501/43199 = 11.60	428/32659 = 13.11	1576/125461 = 12.54
1975	416/40235 = 10.34	342/35497 = 9.63	282/28037 = 10.06	1040/103769 = 10.02
1976	415/52393 = 7.92	403/45713 = 8.82	308/36069 = 8.54	1126/134175 = 8.39
1977	496/65928 = 7.52	391/55664 = 7.02	332/44426 = 7.47	1219/166018 = 7.34
1978	383/47002 = 8.15	411/60281 = 6.82	290/46349 = 6.26	1084/153632 = 7.06
1979		329/41475 = 7.93	326/47791 = 6.82	655/89266 = 7.34
1980			177/28305 = 6.25	177/28305 = 6.25
TOTALS	3959/363536 = 10.89	3708/370888 = 9.998	3138/328469 = 9.55	10805/1062893 = 10.17

is still in evidence and is similar to that noted above in that the trend is more pronounced for the Pre-Standard group. Figures 6 and 7 are graphical illustrations of these data and trends from Tables 17 and 18, respectively.

TABLE 18 - FUEL LEAKAGE RATES, PRE- AND POST-STANDARD VEHICLES BY AGE AT TIME OF CRASH (MICHIGAN DATA)

Vehicle Age (Years)	Fuel Leakage Rate (x 10^{-2})	
	Pre-Standard	Post-Standard
8	16.64	--
7	15.41	--
6	15.39	--
5	12.29	--
4	11.60	8.539
3	10.34	8.154
2	--	7.098
1	--	7.086
0	--	7.251

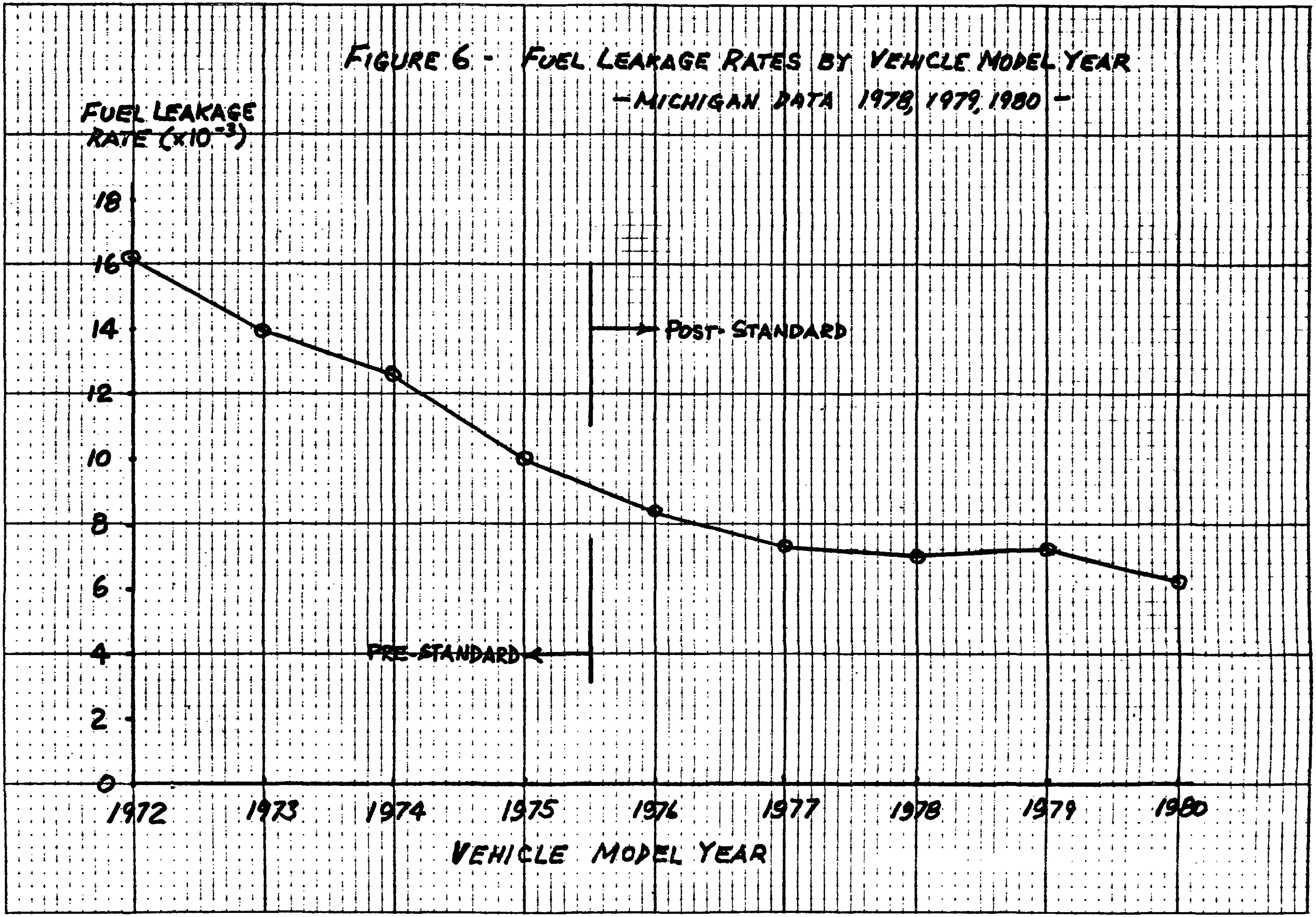


FIGURE 6 - FUEL LEAKAGE RATES BY VEHICLE MODEL YEAR
- MICHIGAN DATA 1978, 1979, 1980 -

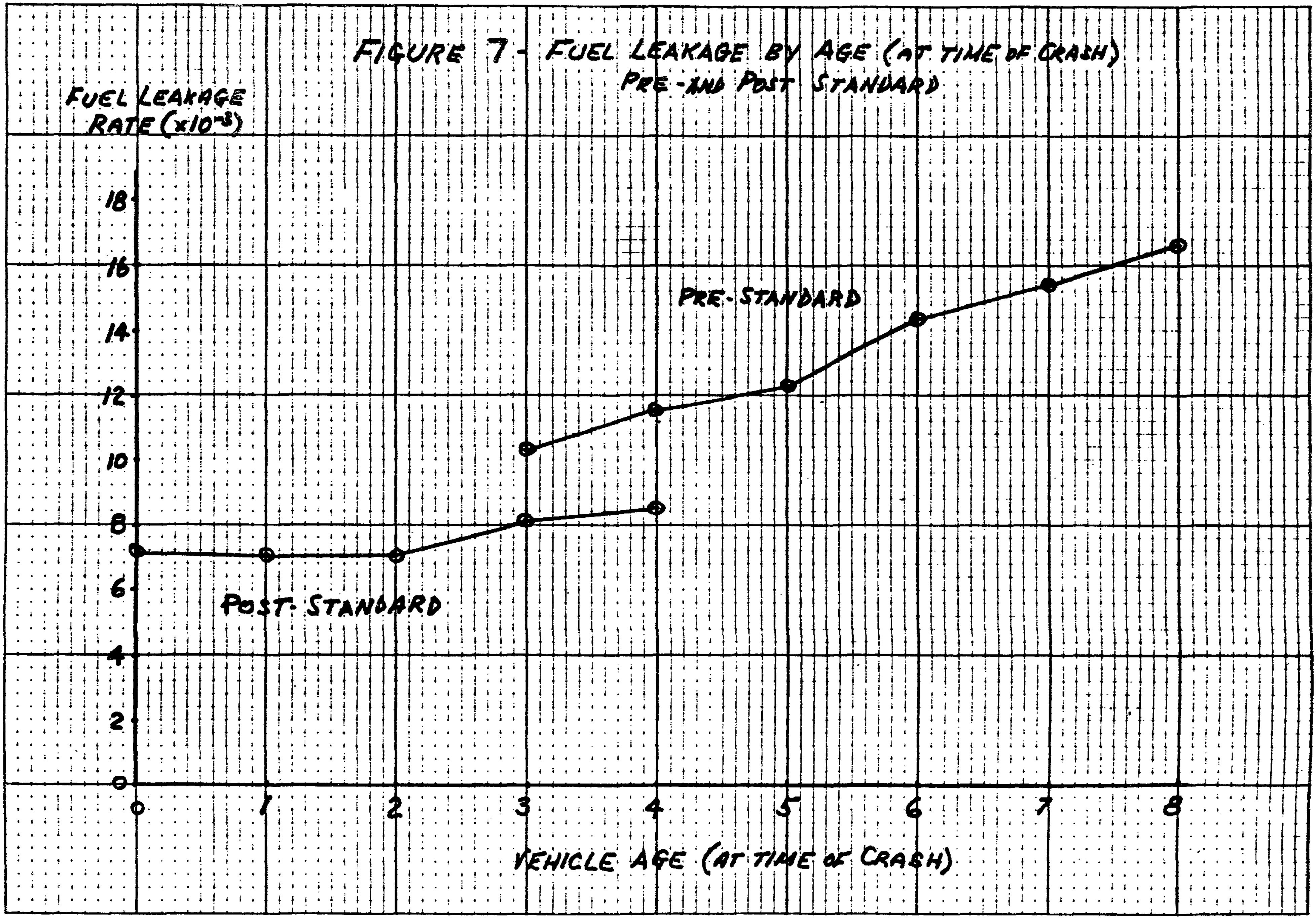


FIGURE 7 - FUEL LEAKAGE BY AGE (AT TIME OF CRASH)
PRE- AND POST STANDARD

In order to statistically evaluate the age trends appearing in the fuel leakage data, simple linear regressions were run on the data from Table 18 for the Pre-Standard and Post-Standard groups. The following results were obtained.

Pre-Standard:

$$X_1 = 8.9420(10^{-3}) + 1.28657(10^{-3})\ X_2$$

$$s_h = 7.312\ (10^{-5})$$

Post-Standard:

$$X_1 = 6.5324(10^{-3}) + 3.6440(10^{-4})\ X_2$$

$$s_b = 1.2849(10^{-4})$$

In the above equations, X_1 represents the leakage rate; X_2 represents vehicle age, at time of crash; and s_b is the standard error of the estimates, or coefficients of the X_2 variables, generally denoted by "b". From Table 18, it is seen that the Pre-Standard model is based on N = 6 observations while the Post-Standard model is based on N = 5 observations.

The positive coefficients for X_2 in both of the above equations indicates that leakage rates tend to increase with age. Testing for significance of these trends (i.e., the null hypothesis is that the coefficient is not significantly different from zero, against the alternative hypothesis that the coefficient is greater than zero), we have:

Pre-Standard:

$$t_s = \frac{b - o}{s_b} = \frac{1.28657\ (10^{-4})}{7.312\ (10^{-5})}$$

$$= 17.595$$

Post-Standard:

$$t_s = \frac{b - o}{s_b} = \frac{3.6440(10^{-4})}{1.2849(10^{-4})}$$

$$= 2.836$$

For the Pre-Standard group, the test statistic, t_s, is significant since $t_s = 17.595$ is greater than the corresponding table value of "t"$_{TAB,.05} = 2.776$ (with N -2 = 4 df). For the Post-Standard group, the test statistic is not significant since $t_s = 2.836$ is not greater than the corresponding table value of "t"$_{TAB,.05} = 3.182$ (with N -2 = 3 df). Hence, it is concluded that there is a significant age trend for the Pre-Standard vehicle group, but not for the Post-Standard group.

2.4.1 Effect of Standard 301 on Fuel Leakage

Since age (at time of crash) has been found to have a significant influence on leakage rate, it is appropriate to use data sets of common age (e.g., denoted to "box" in Table 18 to test for any difference between Pre-Standard and Post-Standard groups. These data correspond to vehicles that were three and four years of age at the time of crash, and more specifically, represent vehicles of Model Years 1974 and 1975, for the Pre-Standard group and Model Years 1976 and 1977, for the Post-Standard group. To test for differences, we proceed as in prior analyses:

Let p_1 = Pre-Standard mean rate = (989 + 416)/(85,280 + 40,235)

= 1405/125,515

= .01119

Let p_2 = Post-Standard mean rate = (308 + 735)/(36,069 + 90,139)

= 1043/126,208

= .008264

Substituting into (1) and performing the indicated calculations gives a Z-statistic = 7.491.

Thus it can be concluded that the Post-Standard group has a significantly lower leak rate since 7.491 is greater than $Z_{TAB} = 1.645$ ($\alpha = .05$).

This lower rate translates to a 26.2 percent reduction $\left(\frac{p_1 - p_2}{p_1}\right)$ and is the difference after controlling for age.

It should be noted in the above analysis that age at time of crash also includes some effect of vehicle model year. It may be that model year, in addition to age, has an effect on leak rate. To the extent this effect exists, the above analytical approach will produce estimates of fuel leak reduction that are somewhat high, since the estimates of differences between Pre- and Post-Standard groups would also include the confounded effect of model year. Preliminary investigation of this possibility indicates that the greater effect of model year is for the lower severity crashes (i.e., crashes having a small likelihood of serious occupant injury). While estimates of fuel leakage reduction between Pre- and Post-Standard groups would decline, significant reductions in fuel leakage would still exist, especially for accidents of higher crash severity.

2.4.2 Influence of Vehicle Damage Severity and Impact Type

Since the earlier analysis of fire data for the State of Michigan showed some differences in distributions of crash severity as denoted by vehicle damage severity (VDS), and impact type between the Pre-Standard and Post-Standard groups, it is appropriate to examine the effect on fuel leakage of these same parameters. Even though differences in crash severity and impact type distributions were found to be statistically significant, the actual numerical magnitude of these differences was quite small and subsequent analyses of sublevels of data showed predominately significant reductions in fire rate for the Post-Standard population of vehicles. The analyses in the following sections are based on vehicles of equal age, Pre- and Post-Standard, since age was found to have a significant effect on fuel leakage.

2.4.2.1 Vehicle Damage Severity: Lo-Moderate

Tables 19, 20, and 21 contain the fuel leakage rates for Pre- and Post-Standard vehicles for the three Impact Types, Frontal, Rearend, and Rollover, respectively. The data are from Michigan for the years 1978, 1979, and 1980. For this Lo-Moderate level of crash severity, it is seen that fuel leakage rates are lowest for Frontal impacts at 3 to 4 leaks per 1,000 vehicle crashes. Rollovers are next with 6 to 7 leaks per 1,000 vehicle crashes, and Rearend collisions have the highest rate at 6 to 10 leaks per 1,000 crashes.

To determine whether significant differences exist between the Pre- and Post-Standard groups, analyses similar to those performed on the fire data are carried out. First the rates for Frontal crashes (Table 19) are compared:

TABLE 19 - LEAKAGE RATES, PRE- AND POST-STANDARD GROUPS, FRONTAL CRASHES, LO-MODERATE CRASH SEVERITY

Standard Group	No. Fuel Leaks	No. Vehicle Crashes	Leakage Rate (x 10^{-3})
Pre-Std.	276	61,951	4 455
Post-Std.	197	52,665	3.741

As with the fire analysis, p_1 and p_2 are used to denote the leak rates for the Pre- and Post-Standard groups, respectively. Calculating the test statistic from (1) and (2), as before results in a Z-value of 1.879.

Since 1.879 is larger than the reference Z-statistic of 1.645 ($\alpha = .05$, one-tailed test), the conclusion is that the fuel leak rate is lower for the Post-Standard group. The percent reduction in leak rate is $\frac{p_1 - p_2}{p_1} = 7.14 \times 10^{-4} / 4.455 \times 10^{-3} = 16.0$ percent.

Next Rearend crashes (Table 20) are compared:

TABLE 20 - LEAKAGE RATES, PRE- AND POST-STANDARD GROUPS, REAREND CRASHES, LO-MODERATE CRASH SEVERITY

Standard Group	No. Fuel Leaks	No. Vehicle Crashes	Leakage Rate (x 10^{-3})
Pre-Std.	204	20,321	10.039
Post-Std.	169	26,301	6.426

Substituting into equation (1), the values from Table 20, yields a Z-value of 4.342.

Comparing this value, 4.342 with the tabled value (i.e., $Z_{tab} = 1.645, \alpha = .05$) again results in statistical significance; the conclusion being that Post-Standard vehicles exhibit a lower rate of fuel leakage than do Pre-Standard vehicles. The reduction in leakage rate is given by $3.613 \times 10^{-3}/1.0039 \times 10^{-2} = 36.0$ percent.

The final comparison of Pre- and Post-Standard leakage rates at the Lo-Moderate crash severity level is for Rollovers. The corresponding data are contained in Table 21.

TABLE 21 - LEAKAGE RATES, PRE- AND POST-STANDARD GROUPS, ROLLOVER CRASHES, LO-MODERATE CRASH SEVERITY

Standard Group	No. Fuel Leaks	No. Vehicle Crashes	Leakage Rate ($\times 10^{-3}$)
Pre-Std.	62	704	8.807
Post-Std.	60	781	7.682

To determine whether the above numerical difference is significant, a statistical test of hypothesis is performed as before. Calculations produce a Z-value of .788, which is non-significant.

The conclusion is that no significant difference exists between the fuel leakage rates of Pre-Standard vehicles and Post-Standard vehicles for Rollover crashes with vehicle damage in the Lo-Moderate level.

2.4.2.2 Vehicle Damage Severity: Major

Tables 22, 23, and 24 list the fuel leakage rates for crashes of Major impact severity; Pre- and Post-Standard rates are given for Frontal, Rollover, and Rearend impacts, respectively. In general, it is seen that Frontal impacts have lower rates of fuel leakage, ranging from 25 to 40 per 1,000 vehicle crashes, while rates for Rollovers and Rearend impacts are much higher at 60 to 130 leaks per 1,000 vehicle crashes. The effect of higher crash severity on leakage rate is clearly seen here as the leakage rates are markedly higher than those for Lo-Moderate severity crashes as given in the previous section.

To determine whether the Pre- and Post-Standard leakage rates given in Tables 22-24 are significantly different, statistical analyses similar to those for the Lo-Moderate crashes are performed.

TABLE 22 - LEAKAGE RATES, PRE- AND POST-STANDARD GROUPS, FRONTAL CRASHES, MAJOR CRASH SEVERITY

Standard Group	No. Fuel Leaks	No. Vehicle Crashes	Leakage Rates (x 10^{-3})
Pre-Std.	354	8,798	40.24
Post-Std.	213	8,402	25.35

First, for Frontal crashes, the data from Table 22 are substituted into equation (1) and calculations carried out as for the Lo-Moderate severity impacts. This gives a Z-statistic of 5.384, which is greater than the reference value of 1.645 ($\alpha = .05$), and therefore it is concluded that the leakage rate for the Post-Standard vehicle is significantly lower than for Pre-Standard vehicles. The amount of the reduction in leakage rate for Post-Standard vehicles is $1.4866 \times 10^{-2}/4.024 \times 10^{-2} = 37$ percent.

TABLE 23 - LEAKAGE RATES, PRE- AND POST-STANDARD GROUPS, REAREND IMPACTS, MAJOR CRASH SEVERITY

Standard Group	No. Fuel Leaks	No. Vehicle Crashes	Leakage Rate (x 10^{-3})
Pre-Std.	177	1,398	126.61
Post-Std.	172	2,795	61.54

Secondly, a comparison is made for Rearend Impacts. Using the data from Table 23 and performing the computations as before. For this comparison, Z = 7.191.

As before our reference value is Z = 1.645 ($\alpha = .05$). Since the calculated Z is greater than 1.645, the conclusion again is that Post-Standard vehicles have a significantly lower fuel leak rate. The magnitude of the reduction is $\frac{p_1 - p_2}{p_1} = 6.507 \times 10^{-2}/.12661$ or 51.4 percent.

TABLE 24 - LEAKAGE RATE, PRE- AND POST-STANDARD GROUPS, ROLLOVER IMPACTS, MAJOR CRASH SEVERITY

Standard Group	No. Fuel Leaks	No. Vehicle Crashes	Leakage Rate (x 10^{-3})
Pre-Std.	96	733	130.97
Post-Std.	50	725	68.97

The third and last comparison in the Major crash severity category is for Rollovers. Using the data from Table 24 and performing the computations as before gives a Z-value = 3.741.

Once again the conclusion is that the fuel leakage rate is significantly lower for the Post-Standard vehicles since the computed value of 3.741 is greater than the tabled value of 1.645 (α= .05). The percent reduction in leakage rate for the Post-Standard group is .0620/.13097 or 47.3.

2.4.3 Summary of Analysis of Fuel Leakage Data

Figure 8 is a plot of fuel leakage rate as a function of vehicle damage severity (VDS). These VDS levels are the same as those described in the section on fires. The data for the plot come from Table 18 and hence account for the effect of vehicle age. The graph is similar to earlier findings on fire rates, with the fuel leakage rates exhibiting marked tendencies to rise with higher vehicle damage severity or crash levels. The figure also depicts a consistently lower leak rate for the Post-Standard group.

FIGURE 8 - FUEL LEAKAGE RATE BY VEHICLE DAMAGE SEVERITY

MICHIGAN DATA, PRE, POST-STANDARD VEHICLES, EQUAL AGE AT TIME OF CRASH

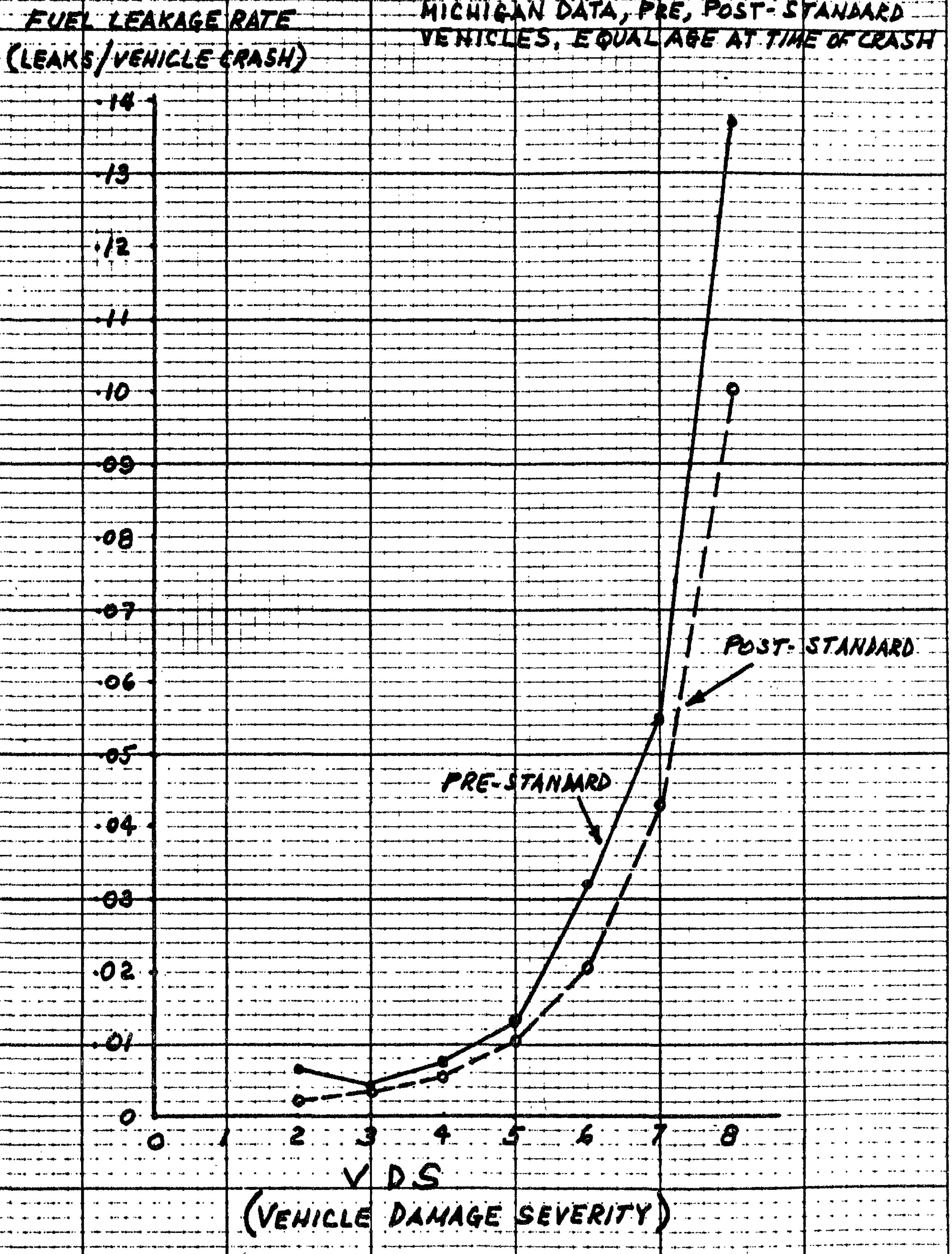


Table 25 summarizes the results of the analyses of fuel leakage by Impact Type and Vehicle Damage Severity. Although age was found to have a significant effect on fuel leakage following a crash (i.e., older vehicles had significantly higher leakage rates), analyses controlling for this factor gave results which are in general agreement with the earlier results for crash fire data.

TABLE 25 - SUMMARY OF STATISTICAL COMPARISONS OF LEAK RATES FOR PRE- VS. POST-STANDARD VEHICLES: IMPACT TYPE X VEHICLE DAMAGE SEVERITY

Impact Type	Vehicle Damage Severity	Percent Reduction For Post-Std.	Reduction Statistically Significant?
Frontal	Lo-Mod.	16.0	Yes
	Major	37.0	Yes
Rearend	Lo-Mod.	36.0	Yes
	Major	51.4	Yes
Rollover	Lo-Mod.	12.8	No
	Major	47.3	Yes

Leakage rates for Post-Standard vehicles showed significant reductions for five of the six subgroups, with the magnitude of the reduction ranging from 16.0 percent (Frontal-Lo-Moderate) to 51.4 percent (Rearend-Major). Again, as with the earlier results on fire, the largest reductions are noted for Rearend and Rollover impacts (which is in general agreement with the intent of Standard 301-76 and 301-77 upgrades), and for the more severe crashes, as denoted by the extent vehicle damage (VDS). Figures 9, 10, and 11 graphically illustrate the results.

FIGURE 9 - LEAKAGE RATES BY VEHICLE DAMAGE SEVERITY, PRE-STANDARD VS POST-STD. VEHICLES, FRONTAL IMPACTS.

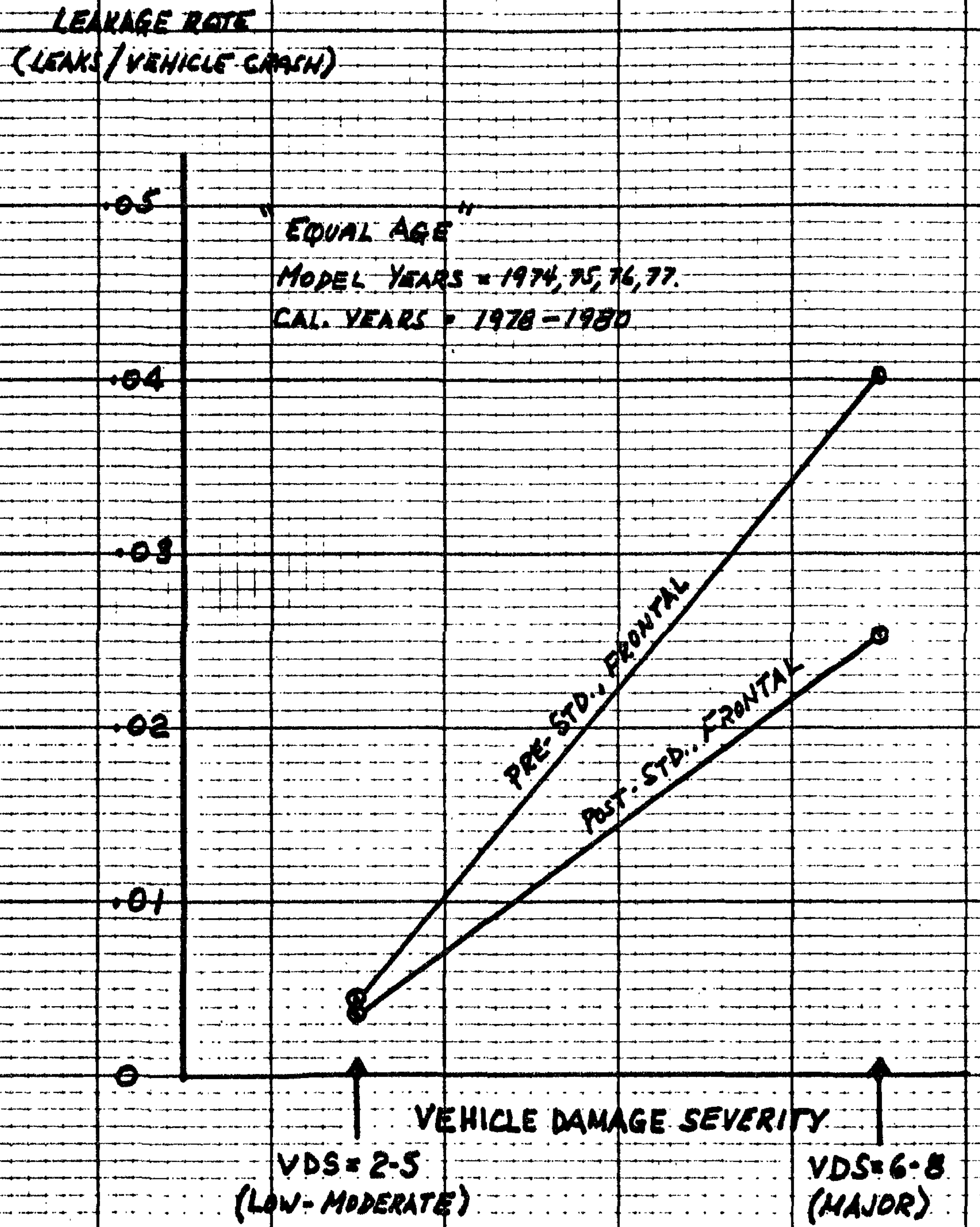


FIGURE 10 - LEAKAGE RATES BY VEHICLE DAMAGE SEVERITY, PRE-STD. VS POST-STD. REAREND IMPACTS.

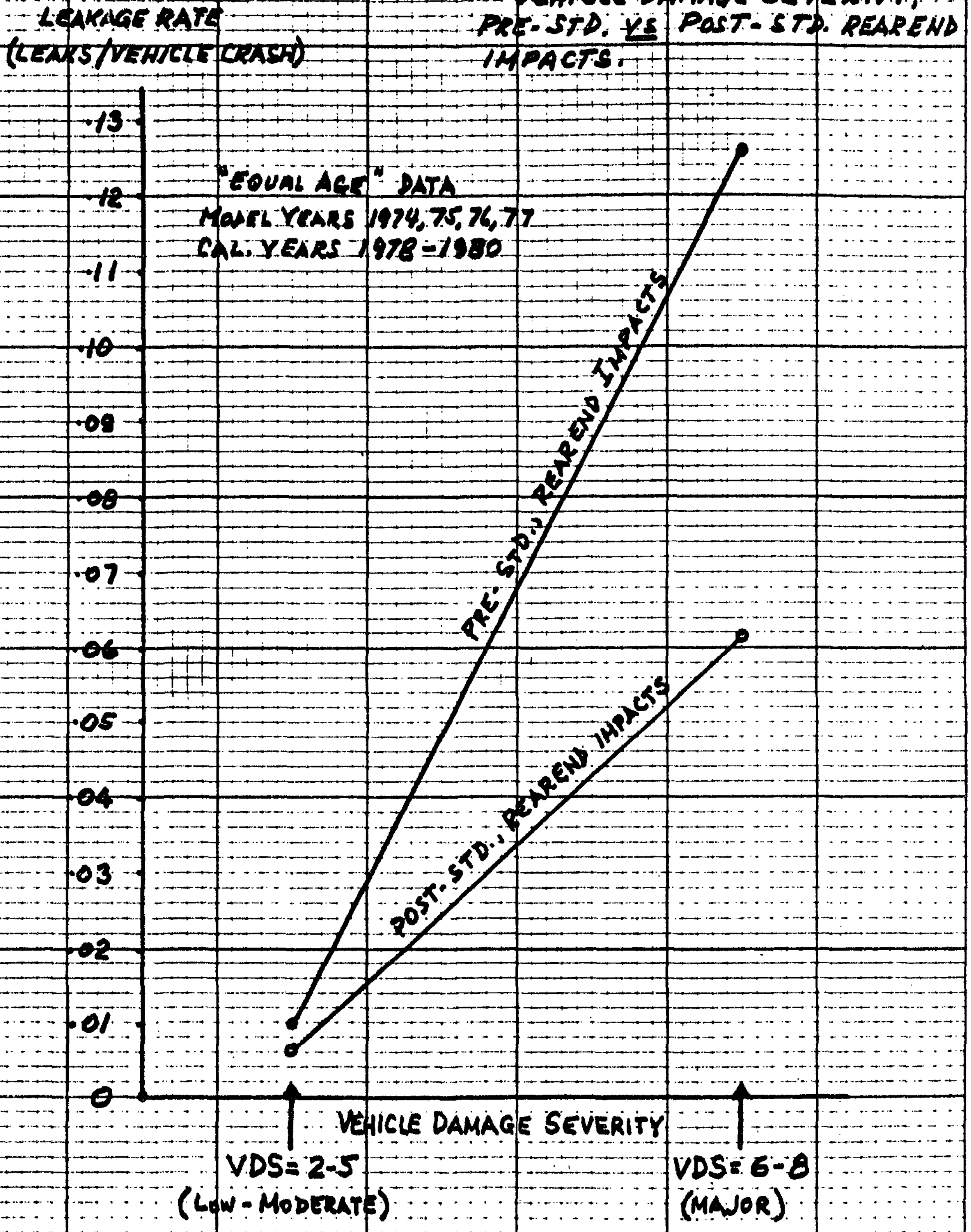
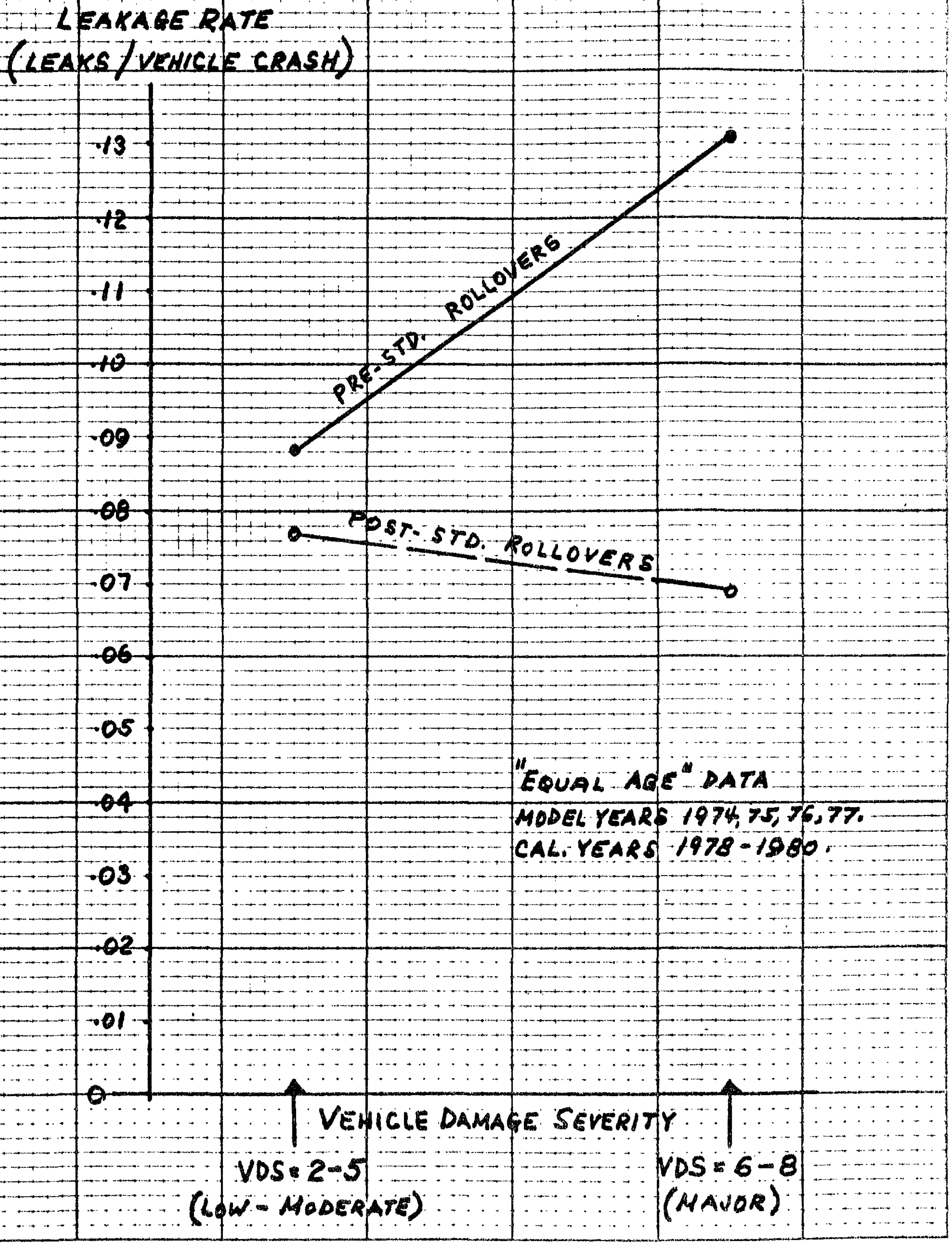


FIGURE 11 - LEAKAGE RATE BY VEHICLE DAMAGE SEVERITY, PRE-STD. VS POST-STD. VEHICLES, ROLLOVERS



"EQUAL AGE" DATA
MODEL YEARS 1974, 75, 76, 77.
CAL. YEARS 1978 - 1980.

2.5 Summary of Effectiveness Analyses

The preceding analyses indicate that significantly lower rates of both crash-induced fire and crash-induced fuel leakage have occurred coincident with passenger cars manufactured after the effective dates of 301-76/77, as compared with cars produced prior to the standard. The greatest reductions have occurred at the higher crash severities, where crash severity is defined as the extent of crash deformation sustained by the vehicle. The reductions in fire and fuel leakage rates have occurred at three of the major types of impacts addressed by the standard: rollovers, rearend impacts, and frontal impacts. Side impacts could not specifically be evaluated with the available data. Age was found to have a significant effect on fuel leakage, but not on crash fires. A possible explanation here is the degradation, with time, of metal fuel system components due to rust, corrosion, and the hardening, cracking of rubber-based/neoprene connecting hoses or lines, and clamps.

Both fire and fuel leakage increase markedly at the higher severity crashes, which coincides with engineering judgment.

The findings of a significant reduction in fire rate for Post-Standard vehicles, and the factors which affect five rates are in general agreement with two other contractual studies, [5], and [8], performed for NHTSA in support of its overall evaluation of Standard 301. The first study was done by the Highway Safety Research Institute, (HSRI), University of Michigan, and analyzed data from the States of Michigan, Illinois, and Pennsylvania. The second study, performed by the Highway Safety Research Center, University of North Carolina, analyzed data from North Carolina, and Maryland. The latter study covered only fires while the former study covered both fires and fuel leakage. As stated earlier, fuel leakage data was available only from one State, Michigan. The findings of the latter study with respect to fuel leakage are also in general agreement with the findings given in this report.

All data sources analyzed herein showed significantly lower fire rates for vehicles produced after Standard 301 became effective. As is not unexpected, however, not all data sources showed the same degree of fire reduction. It is believed that most of these differences relate to the manner in which the fire event is recorded in the various accident report systems and that the data from the State of Michigan represents the best source from which to infer about the extent and nature of the crash fire problem, and hence the best source with which to evaluate the effects of Standard 301.

Data sources where fire is accorded a specific reporting element (as in the States of Michigan and Illinois) provide considerably higher estimates of crash fire rates than do sources where fire is not designated as an independent element, but can be investigated through secondary methods such as accident narratives or vehicle damage contributing factors. This difference is to be expected since some crash fires will no doubt go unreported on accident forms where explicit provision is not made to record such events. It is considered likely that fires reported via non-specific element methods will tend to represent the more serious or catastrophic fires. On the other hand, since fires are relatively rare events compared to the "average" accident, it is reasonable to expect less than complete reporting even for systems which list fire as an explicit element. On balance, it is believed that systems which embody specific reporting elements for fire provide the more accurate picture of the crash fire problem and hence the better basis for evaluation of the effectiveness of Standard 301.

A few concluding comments are offered concerning the potential influence or confounding effect that various factors might have on the analyses of the effect of Standard 301 in reducing passenger car crash fires. Certainly there are several factors which could reasonably be expected to influence the occurrence of crash fires, other than the standard itself. Perhaps the most obvious factors would be: (1) the severity of the crash experienced by the vehicle in terms of crash speed, extent of vehicle damage, or other similar measure; (2) the direction of impact sustained by the vehicle; and (3) the age of the vehicle. These factors have been evaluated in this study. Perhaps the factor having the greatest influence on the occurrence of crash fires (and fuel leakage) is the crash severity, with fire rates markedly higher for the crashes of high vehicle damage levels. Fire rates also vary by the type of impact. Although slight differences in the distributions of crash severity and impact type were noted between Pre- and Post-Standard vehicles, these differences did not appreciably alter the estimated effect of Standard 301. Age was found to significantly affect fuel leakage, but did not exhibit a significant effect on fire rates. Other factors such as the number of vehicles in the crash or the time of the accident (day versus night) were investigated by the HSRI study, but these were found to be correlated with and adequately explained by crash severity.

Other potential factors which might affect the likelihood of crash fires are the size of the vehicle and other vehicle modifications such as emission control devices (e.g., catalytic converters and fuel evaporation control systems--cannisters, lines). As for vehicle size, the Post-301 Standard vehicles comprise a population of increasingly smaller-sized vehicles as compared with the Pre-Standard vehicle population. Beginning in 1977, the first major wave of vehicle downsizing began with General Motors' completely new design of its standard-sized vehicle line; 1978 and subsequent years have seen a steadily increasing proportion of smaller vehicles being introduced into the Nation's fleet, with further downsizing by domestic manufacturers and with an increased penetration of import vehicles. To the extent that smaller vehicles are more vulnerable in a crash, including any increased tendency to experience a crash fire, it would appear that the analyses categories used in this study would serve to provide a more conservative estimate of Standard 301. A similar situation would hold with respect to emission control devices.

Evaporation control systems saw general application in the early 1970's so that both Pre-301 and Post-301 vehicle populations should be equipped with similar proportions of this equipment; catalytic converters saw general introduction with the 1975 Model Year so that a greater proportion of the Post-301 vehicle population should contain these devices. Again, this would argue for a conservative estimate of the effect of 301, as given herein, to the extent that such emission control devices might increase the likelihood of a crash fire.

Another factor of general concern in most "before-after" analyses such as this (where experimental control or randomization of extraneous sources of variation is not possible) is that older vehicles may be subject to greater underreporting of accidents as compared with newer vehicles. Such a phenomenon could serve to artificially increase fire rates for older vehicles. It is believed that the restriction on the age of the vehicles permitted in the Pre-Standard population as used herein and the analysis on "equal age vehicles" where such is indicated, serve to minimize any confounding due to any "artifactual" effect of age.

Summarily, with available data, complete elimination of all potential confounding effects is not possible. Additionally, the rare event characteristic of crash fires and limited sample size preclude investigation of all possible factors of interest. However, the results obtained, which are based on the factors deemed most important, and which show general agreement, both between the data sources analyzed in this evaluation and with other separate analyses [5], and [8], are collectively believed sufficient to demonstrate that a statistically significant and substantial effect has resulted from the promulgation of FMVSS-301-76/77.

One final observation from the effectiveness analyses is noted. Although there are significant reductions in crash fire rates for the Post-Standard vehicles, there is some indication that rates may be increasing slightly for the newer vehicles (see Figures 1, 3, 4). This is considered a preliminary finding and reasons for it are not clear at this juncture. It may be only a statistical aberration or it may portend an actual increase. Additional data over the next one to two years should be sufficient to determine the answer.

CHAPTER 3

THE BENEFITS, COST, AND COST-EFFECTIVENESS OF STANDARD 301-76/77

3.0 Introduction

The benefits, cost, and cost-effectiveness of Standard 301-76/77 are developed and discussed in this chapter.

The benefits are defined in terms of the fatalities, injuries and vehicle crash fires avoided as a result of the standard. These benefits are derived by applying the effectiveness estimates from the preceding chapter to the estimated magnitude of the problem of fire-related fatalities, injuries, and crashes, and adjusting the results by estimates of the hazard attributable to a crash fire (i.e., the degree to which fatalities and injuries result from the physical hazards of fire itself apart from the hazards of impact forces). Accident data from Michigan, together with data from the Fatal Accident Reporting System and the National Accident Sampling System are used to derive the benefits.

The cost of Standard 301-76/77 is given in Section 3.2. The costs are based on detailed information solicited from the manufacturers as to the vehicle modifications made in order to comply with the standard requirements. Individual cost and modification weight estimates are developed and extrapolated to national totals on a sales-weighted basis. The cost estimates include both the final (i.e., consumer) cost of the manufacturing changes and the lifetime cost of the increased fuel penalty due to the added increment of vehicle weight.

Finally in Section 3.3, a brief discussion of the cost-effectiveness of the standard is presented.

3.1 Benefits

In order to estimate the magnitude of benefit due to Standard 301, it is necessary to translate the effectiveness estimates from the preceding chapter into estimates of the number of fatalities and injuries, and vehicle crash fires avoided. The additional factors needed for these benefit estimates are:

(1) National estimates of the total number of "fire-related" fatalities and injuries occurring annually in passenger car crashes. Here, "fire-related" is interpreted to mean that a crash fire accompanied a fatal crash but the degree of contribution of the fire to occupant fatality or injury is not ascertainable, or unknown. However, the assumption is made that the fatalities are a result of both crash force injuries and burn injuries, in some combination.

(2) A national estimate of the total number of passenger car crash fires occurring annually.

(3) An estimate of the increased likelihood of a passenger car occupant fatality, or injury, due to the presence of fire resulting from a vehicle crash. This factor is herein referred to as the "fire-lethality" factor.

Only one of the above needed estimates, national fire-related fatalities, is available from existing sources. The remaining estimates, therefore, have been derived and are explained throughout the following analyses sections. The Fatal Accident Reporting System (FARS), operated by NHTSA is the source for the national estimate of fire-related fatalities. FARS is an automated data system containing information on all (i.e., a census) fatal motor vehicle accidents occurring annually in the united states, and has been in continuous operation since 1975. FARS reporting forms (see Appendix A) have a specific data element for recording the presence of crash fires which accompany fatal accidents.

The effectiveness estimates derived in this report, for reasons given in Appendix A and Section 2.5 are based on the results of the analyses of the data from Michigan. Michigan data are also used to estimate the fire lethality factor, and are considered the best source for such estimates. Ideally, if autopsy information were available from a representative sample of fire-related passenger car occupant fatalities, it would be the preferable basis for estimating a fire-lethality factor. However, no known source of autopsies of fire-related crash deaths is available.

The benefits of Standard 301-75/76, in terms of fatality reduction, injury reduction, and crash fire reduction, are derived in the following sections.

3.1.1 Fatality Reduction

The estimated benefit of Standard 301-75/76 in terms of fatality reduction, is calculated from the following basic formula:

$$B_{fat} = (N - NL)\ E = N(1 - L)E \qquad (3)$$

where,

B_{fat} = estimated number of fatalities avoided,

N = national estimate of the number of fire-related fatalities (i.e., fatalities in crashes accompanied by post-crash fires),

L = fire-lethality factor = ratio of P [fatality/no fire] to P [fatility/fire] for crashes of similar levels of crash force severity,

and,

E = effectiveness estimate for standard at given crash force level.

The quantity NL, in the above equation, is seen to be an estimate of the number of fatalities that would be expected to occur if fires were completely eliminated as a post-crash phenomenon. The fatalities saved would thus be the difference between N and NL, or N(1 -L).

The product of this number and E, the effectiveness estimate, or the proportion of total crash fires estimated to be eliminated by the standard thus provides an estimate of the total fire-fatalities saved.

The fire-lethality factors are derived from the data contained in Tables 26 and 27 which show the distribution of vehicle occupant injury, in police-reported K (fatal), A-B-C levels for vehicles in which fire occurred versus vehicles in which no fire occurred. The data represent total accident statistics for calendar years, 1978, 1979, and 1980 from the State of Michigan and the injury distribution is based on the "worst

TABLE 26 - DISTRIBUTION OF OCCUPANT INJURY FOR FIRE VERSUS NO-FIRE (PASSENGER CAR) CRASHES. INJURY = WORST INJURY IN VEHICLE, VEHICLE DAMAGE SEVERITY = 6,7,8 (MAJOR), MICHIGAN DATA FOR 1978, 1979, 1980 (TOTALS)

INJURY	FIRE	NO FIRE	TOTALS
FATAL			
No.	148	2590	2738
Row%	5.41	94.59	100.00
Col%	11.31	1.61	1.69
A-INJURY			
No.	318	24068	24386
Row%	1.30	98.70	100.00
Col%	24.29	14.97	15.05
B-INJURY			
No.	266	38057	38323
Row%	.69	99.31	100.00
Col%	20.32	23.67	23.65
C-INJURY			
No.	153	32122	32275
Row%	0.47	99.53	100.00
Col%	11.69	19.98	19.91
NO INJURY			
No.	424	63929	64353
Row%	0.66	99.34	100.00
Col%	32.39	39.77	39.71
TOTAL			
No.	1309	160766	162075
Row%	0.81	99.19	100.00
Col%	100.00	100.00	100.00

TABLE 27 - DISTRIBUTION OF OCCUPANT INJURY FOR FIRE VERSUS NO-FIRE PASSENGER CAR CRASHES. INJURY = WORST INJURY IN VEHICLE, VEHICLE DAMAGE SEVERITY = 2,3,4,5 (LO-MODERATE). MICHIGAN DATA FOR 1978, 1979, 1980 (TOTALS)

INJURY	FIRE	NO FIRE	TOTALS
FATAL			
No.	7	201	208
Row%	3.37	96.63	100.00
Col%	0.40	0.02	0.02
A-INJURY			
No.	43	11593	11636
Row%	0.37	99.63	100.00
Col%	2.47	0.97	0.97
B-INJURY			
No.	131	51117	51248
Row%	0.26	99.74	100.00
Col%	7.54	4.27	4.27
C-INJURY			
No.	205	125264	125469
Row%	0.16	99.87	100.00
Col%	11.80	84.28	10.47
NO INJURY			
No.	1352	100825	1010177
Row%	0.13	99.87	100.00
Col%	77.79	84.28	84.27
TOTAL			
No.	1738	1197000	1198738
Row%	0.14	99.86	100.00
Col%	100.00	100.00	100.00

injury in the vehicle." As would be expected, this injury distribution, particularly the proportion of fatal or serious injuries, varies markedly with the crash severity level, or Vehicle Damage Severity (VDS) discussed in the previous chapter as does the probability of crash fire, as was also noted previously. Therefore, two tables were produced which show the injury distribution, fire versus no fire, for Lo-Moderate (VDS = 2, 3, 4, 5) and for Major (VDS = 6, 7, 8) crash severity levels. Fatality reduction estimates are made for each severity level. In order to retain resonable cell sizes, the data were not further subdivided by impact type as was done in the effectiveness analysis. Therefore slightly revised effectiveness estimates from these derived in the previous section have been made to conform to the two VDS levels, Lo-Moderate, and Major used here. Table 28 contains the data for these estimates.

TABLE 28 - CRASH FIRE RATES, PRE-STANDARD VERSUS POST-STANDARD VEHICLES, LO-MODERATE AND MAJOR CRASH SEVERITIES, MICHIGAN DATA, 1978-1980

	CRASH SEVERITY					
	Lo-Moderate (VDS=2,3,4,5)			Major (VDS =6,7,8)		
STANDARD GROUP	FIRES	TOTAL CRASHES	RATE	FIRES	TOTAL CRASHES	RATE
PRE-STANDARD	625	406,933	.001536	562	55,564	.010114
POST-STANDARD	569	480,796	.001835	346	59,558	.005810

Reductions in crash fire rates for the Post-Standard group are 22.95% and 42.56% for the Lo-Moderate and Major crash severities, respectively. Both of these are statistically significant at α = .05 level.

For major crash severity (VDS = 6, 7, 8), the estimated fatality reduction is given by

$$B_{fat} = N (L - 1) f E \qquad (4)$$

which is the same as (3) except for the addition of the factor, f, which represents the proportion of total fire-fatalities occurring at the given crash severity (i.e., VDS = 6, 7, 8) level and computed from the data in Table 26. The following values are used to estimate the fatality savings:

$N = 1099$ = four-year average (1978-1981) of passenger car occupant fatalities in crashes with post-crash fires (i.e., fire-fatalities) per FARS,

$L = \frac{1.6110 \times 10^{-2}}{11.3063 \times 10^{-2}} = .1425$ = ratio of proportion of fatal crashes for all non-fire crashes at VDS = 6,7,8 and the proportion of fatal crashes for all fire crashes at VDS = 6,7,8 (computed from Table 26),

$f = .95$ = proportion of total fire fatalities occurring at VDS = 6,7,8 (computed from Tables 26, 27)

$E = .426$ = effectiveness estimate for standard at VDS = 6,7,8 (computed from the data in Table 28).

Substituting these values into equation (4), we obtain:

$$B_{fat} = 1099 (1 - .1425) (.95) (.426)$$

$$= 1099 (.8575) (.95) (.426)$$

$$= 381.38 \cong 381 \text{ fatalities}$$

Next, the benefit at Lo-Moderate crash severity (VDS = 2,3,4,5) is computed. For this computation, the values for the factors are:

N = 1099, as before,

$$= \frac{1.679 \times 10^{-4}}{4.028 \times 10^{-3}} = .0417 \text{ (computed from Table 27)}$$

f = .05 = 1 -f (VDS = 6,7,8) = 1 -.95

E = .2295 = effectiveness estimate for standard at VDS = 2,3,4,5 (computed from the data in Table 28)

Again substituting these values into (4), we have:

$$B_{fat} = 1099\ (1 -.0417)\ (.05)\ (.2295)$$

$$= 1099\ (.9583)\ (.05)\ (.2295)$$

$$= 12.09 = 12 \text{ fatalities}$$

Therefore, the total estimate of fatalities saved annually is:

$381 + 12 = 393 \cong 400$ fatalities

3.1.2 Injury Reduction

The estimated benefit for 301-76/77 in terms of injury reduction is calculated in the same manner as the fatality reduction benefit, except that a national estimate of the total number of fire-related injuries must be estimated since no National estimate for fire-related injuries is available as in the case of fatalities. Injury reduction is estimated in terms of standard K-A-B-C police-reported inuries since again this is the best known type of information available and is taken from the Michigan data.

Appendix B contains the definition of the K-A-B-C injury scale as used by the State of Michigan. General definitions are:

K - Fatal Injury: any injury that results in death within 12 months of the crash.

A - Incapacitating Injuries: any injury that prevents the person from performing his/her normal activities; hospitalization normally required.

B - Non-incapacitating Injury: any injury other than fatal or incapacitating.

C - Possible Injury - any injury reported or claimed, other than fatal, incapacitating, or non-incapacitating.

3.1.2.1 A-Injury Reduction

First, a national estimate of the number of A-injuries that are fire-related is needed. Two methods are used to derive this figure, both based on ratio estimation methods. The first method uses the ratio of the number of fire-related A-injuries to all passenger cars in (police-reported) accidents in Michigan and the national total of police-reported passenger car accidents as estimated by the National Accident Sampling System (NASS) being operated by NHTSA's National Center for Statistics and Analysis.

The NASS estimate used here is taken from the "Report on Traffic Accidents and Injuries for 1979-1980," which is based on the NASS System (Reference 8). The following equivalency is used:

$$\frac{\text{No. Fire-Related "A" Injuries, Mich.}}{\text{No. Passenger Cars in Police-Related Accidents, Mich.}} = \frac{x}{\text{No. Passenger Cars in Police-Reported Accidents, U.S.}} \qquad (5)$$

where x is the national estimate of the number of A-injuries.

From Tables 26 and 27, the ratio on the left side is found to be 361/1,368,813 which is the total of fire-related A-injuries and the total passenger cars in accidents, over both VDS levels, Lo-Moderate and Major.

The denominator on the right side is set equal to 9.247×10^6, the national estimate of passenger cars in accidents annually, from [8].
Substituting these values into (5), we have

$$x = 9.247 \times 10^6 \ \frac{361}{1,368,813}$$

$$= 2439$$

as the national estimate of fire-related A-injuries. Actually, this number is somewhat conservative since it only considers one fire-related A-injury per passenger car crash (recall that Tables 26 and 27 are based on the "worst" injury in the vehicle). Therefore, the number is adjusted by the average number of fire-related A-injuries per crash from Michigan which is 1.543, for calendar years 1978-1980.

This gives:

$$x' = 2439\ (1.543) = 3763 \text{ fire-related A-injuries}$$

A second method, similar to the first, for estimating the national number of fire-related A-injuries is the ratio:

$$\frac{\text{No. Fire-Related A-Injuries, Mich.}}{\text{No. Fire-Related Fatalities, Mich.}} = \frac{x}{\text{No. National Fire-Related Fatalities, FARS}} \tag{6}$$

Again, from Tables 26 and 27, the left side is set equal to 361/155. From the previous section, the denominator on the right side is 1099, the average number of "fire-fatalities" from FARS for 1978-1981. Substituting into (6), we obtain:

$$x = 1099 \frac{361}{155}$$

$$= 2650 \text{ fire-related A-injuries}$$

Thus, the two estimation methods, one based on the national total of annual fire-fatalities, from FARS, and the other based on the national total of annual, police-reported passenger car accidents from NASS, give reasonably close estimates for the national number of fire-related A-injuries annually. For purposes of the analysis, the mean of these two numbers is taken as the best estimate, which is:

$$\frac{3763 + 2560}{2} = 3161 \cong 3160 \text{ fire-related A-injuries}$$

Returning to Equation (4), the following values can be inserted to estimate the reduction in fire-related A-injuries due to Standard 301-76/77, for major crash severity:

$N = 3160$

$L = .1497/.2429 = .616$, from Table 26

$f = 318/361 = .881$, from Tables 26 and 27

$E = .426$, from Table 28

Therefore,

$$B_{A\text{-inj.}} = 3160\ (1 -.616)\ (.881)\ (.426)$$

$$= 467 \text{ fire-related A-injuries}$$

Next, for Lo-Moderate crash severity:

$N = 3160$

$L = .0097/.0247 = .393$, from Table 27

$f - 1 -(318/361) = .119$

$E = .2295$, from Table 28

Substituting,

$$B_{A\text{-inj.}} = 3160\ (1 -.393)\ (.119)\ (.2295)$$

$$= 52.4 \cong 52 \text{ fire-related A-injuries}$$

Therefore, the total fire-related A-injuries saved annually by 301-76/77 is estimated to be

$$467 + 52 = 519 \cong 520$$

3.1.2.2 B-Injury Reduction

As with the A-injuries, a national estimate of the total number of fire-related "B"-injuries must be derived in order to estimate the injury reduction at this level due to Standard 301-76/77. Methods of estimation similar to those above are used. Rewriting (5) for the case of B-injury gives:

$$\frac{\text{No. Fire-Related "B"-Injuries, Mich.}}{\text{No. Passenger Cars in Police-reported Accidents, Mich.}} \qquad \frac{x}{\text{No. Passenger Cars in Police-reported Accidents, U.S.}}$$

From Tables 26 and 27, the numerator on the left side is found to be 397.

The denominators have the same values as before, 1,368,813 and 9.247 x 10^6, respectively. Solving for x gives:

$$x = 9.247 \times 10^6 \frac{397}{1,368,813}$$

$$= 2682 \text{ fire-related B-injuries}$$

Adjusting for average number of fire-related B-injuries per crash injuries as before gives:

$$x' = 2682\ (1.392) = 3733 \text{ fire-related B-injuries}$$

Next the estimate based on FARS fire-related fatalities is computed. Rewriting (6) for the case of B-injury:

$$\frac{\text{No. Fire-Related B-Injuries, Mich.}}{\text{No. Fire-Related Fatalities, Mich.}} = \frac{x}{\text{No. National Fire-Related Fatalities, FARS}}$$

Using the values determined previously gives:

$$x = \frac{397}{155} \ (1099)$$

$$= 2814$$

Taking the mean of these two estimates, as before, for the National total of fire-related B-injuries:

$$\frac{3733 + 2814}{2} = 3274 \text{ fire-related B-injuries}$$

Equation (4) can now be used with the following values to estimate the reduction in fire-related B-injuries, for major crash severity:

$N = 3274$

$L = .2367/.2032 = 1.16$, from Table 26

$f = 266/397 = .67$, from Tables 26 and 27

$E = .426$, from Table 28

Since the fire-lethality factor, L, is > 1, it is not necessary to proceed with the computation for B-injury reduction at this crash severity - there will be none. (Actually, there will be an increase). The explanation here is that the increased injury severity for fire occurrence versus no fire is concentrated entirely in the fatal and "A" or serious injury categories. The excess of injuries at these upper levels occurs at a tradeoff of lower proportions of injuries at the "B" and lesser injury levels, as opposed to non-fire crashes. Therefore, the next step is to compute the B-injury savings of the Lo-Moderate crash severity level.

The following values are used:

$N = 3274$, as computed above

$L = .0427/.0754 = .566$, from Table 26

$f = 1 -(266/397) = .33$

$E = .2295$, from Table 27

Substituting into (4),

$$B_{B\text{-inj.}} = 2954\ (1 -.566)\ (.33)\ (.2295)$$

$$= 108.4 \cong 110$$

Therefore, the total fire-related B-injuries saved annually by 301-76/77 is estimated to be 110.

The analyses of injury reduction concludes at this juncture. Although the data in Table 27 indicate a slightly lower chance of

C-injury for no-fire versus fire crashes (Lo-Moderate severity), this difference is very small and the severity of police-reported C-injuries is minor.

3.1.3 Crash Fire Reduction

In order to estimate the number of passenger car crash fires saved annually, the national total of such fires must be estimated. Two methods are again used to derive this estimate. The first method applies the overall Michigan crash fire rate of .002090, from Table 1 to the total annual number of police-reported passenger car crashes from NASS, 9.247×10^6. This yields:

$$9.247 \times 10^6 \ (2.09 \times 10^{-3}) = 19{,}326 \text{ crash fires}$$

The second method is based on the Michigan data and the total number of fire-related fatalities from FARS. The following equality is defined:

$$\frac{\begin{array}{l}\text{Average Annual}\\ \text{Fire-Related}\\ \text{Fatalities from}\\ \text{Michigan (1978-1980)}\end{array}}{\begin{array}{l}\text{Average Annual}\\ \text{Fire-Related Fatalities}\end{array}} = \frac{\begin{array}{l}\text{Average Annual}\\ \text{Fire-Related}\\ \text{Passenger Car}\\ \text{Crashes from Michigan (1978-1980)}\end{array}}{x}$$

From Tables 26, 27 and from the previous work, this equation takes on the

$$\frac{52.7}{1099} = \frac{1055.3}{x} \text{ , or}$$

$$x = \frac{1055.3}{52.7} (1099)$$

$$= 22{,}007$$

Once again, the two methods of estimation give reasonably close results. Taking the mean of the two as the best estimate gives:

$$\frac{19,326 + 22,007}{2} = 20,667 \text{ fire-related crashes annually}$$

Using a modified version of equation (4), the number of crash fire reductions for each crash severity level (Lo-Moderate and Major), and the total can be estimated. The equation is:

$$B_{\text{crash fires}} = N\ f\ E, \text{ where } N,\ f, \text{ and } E \text{ are defined as before} \quad (7)$$

For Lo-Moderate crash severity, N = 20,667; f = 1738/(1738 + 1309) = .57 (from Tables 26 and 27); E = .2295, from Table 28. Substituting these values gives:

$$B_{\text{crash fires}} = 20,667\ (.57)\ (.2295)$$

$$= 2,703 \text{ fire-related crashes, annually}$$

For Major crash severity, the same procedure yields:

$$B_{\text{crash fires}} = N\ (1 - f)\ E$$

$$= 20,667\ (.43)\ (.426)$$

$$= 3,786 \text{ fire-related crashes, annually}$$

The total number of passenger car crash fires estimated to be reduced annually due to the standard is thus

$$2,703 + 3,786 = 6,489 \cong 6,500$$

To the extent that fire damage increases the property damage loss in passenger car crashes, above that which is a result of crash incurred damage, the above figure represents an indication of the magnitude of such loss that would be reduced by Standard 301-76/77. Property damage dollar estimates of these phenomena are not available.

3.1.4 Summary of Benefits

The following table summarizes the total benefits estimated for Standard 301-75/76:

Table 29 - Summary of Benefits, Standard 301-75/76

Benefit Category	Estimated Annual Benefit
Fatalities avoided	400
Serious ("A") injuries avoided	520
Moderate ("B") injuries avoided	110
Post-Crash Fires avoided*	6,500

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*Property damage reduction savings to the extent that crash fire increases the loss, over and above that sustained as a result of crash/impact forces. Such losses would typically be to the accident-involved vehicles.

These benefit estimates are those which would be expected to accrue annually when the entire passenger car fleet is brought into compliance with Standard 301, an estimated five-to-seven years hence or approximately 1987-1989. Also, it should be noted that the estimate of 6,500 post-crash fires avoided is not mutually exclusive of the estimated number of fatalities and injuries avoided, but is inclusive of these latter two numbers.

Note in Table 29 that "A"-injuries have been redefined by the term "serious" injuries and "B"-injuries have been redefined using the term "moderate" injuries. This places the injury categories on a more generic and readily understood scale. As previously noted in this report, fatal injuries are defined by the State of Michigan (see Appendix B) to be any injury that results in death within 12 months of the crash. A-injuries are termed incapacitating in nature and typically require hospitalization. B-injuries are defined as non-incapacitating. To these general definitions should be added the fact that the fatality and injury savings given in Table 29 would be those that would otherwise occur due to burn or asphyxiation.

As the estimates clearly show, the primary impact of Standard 301 is at the severe end of the accident consequence spectrum, or the reduction of fatalities and serious injuries. Although the actual numbers are not large relative to the overall toll of motor vehicle accident fatalities and injuries, they nonetheless constitute a sizable proportion relative to the magnitude of the problem of fire-related fatalities, injuries and fires that occur as a result of passenger car crashes.

One of the key factors in the estimation of the benefits of Standard 301 is the extent to which the likelihood of occupant fatality or serious injury is increased by the occurrence of crash fire, or the fire-lethality factor. For crashes of major accident severity, which account for an estimated 95 percent of the total fire-related fatalities, the fire-lethality factor estimated in this study indicates that fire is the cause of some 85 percent of the total fire-related fatalities. A second estimate of this fire-lethality factor is given by Cooley [10] in a study done in 1974. This study analyzed a relatively small sample of fire-related fatal accidents and assigned cause of death using information from auxiliary sources such as certificate of death, police officer's confidential reports, witness statements, and pathologists' reports in addition to microfilm files of hard-copy police accident reports. The study estimated that 70 percent of the fire-related deaths were due to fire where death was judged to be either the result of fire or ensured by fire. The study noted that "deaths associated with crash fires are actually distributed along a causal continuum on which deaths solely due to burns or asphyxiation are located at one pole and deaths due solely to impact trauma are located at the opposite pole." The Cooley study also quoted an earlier study by the National Safety Council which estimated that a total of 17,000 fires resulted annually from motor vehicle crashes; presumably, this figure included all motor vehicles, not just passenger cars as covered in this study.

Yet two additional estimates of the fire-lethality factor can be derived from NHTSA's Fatal Accident Reporting System (FARS). The first estimate is based on the occupant fatality rate for passenger car fatal crashes in which fire occurs versus the occupant fatality rate for passenger car fatal crashes in which no fire occurs. FARS data show that the occupant fatality rate is 67 percent higher for fatal crashes in which fire occurs compared to fatal crashes in which no fire occurs.

The second estimate from FARS concerns the "most harmful event" in the fatal accident. For passenger car fatal crashes in which fire occurred, 38 percent listed fire as the most harmful event. The interpretation of the most harmful event is that event which is judged the one which contributed most to the occurrence of fatality, injury, or the accident, in that order of precedence, and is assigned by the FARS analysts in the various States based on the information available to them which includes coroner's reports, and death certificates as well as police accident forms.

Collectively, these various estimates of the lethality effect of crash fires indicate that the occurrence of fire has a major impact on increasing the liklihood of fatality or serious injury. The estimate of lethality derived in this report is somewhat higher than the other estimates given, but this is to be expected since the basis for this estimate is a lower severity threshhold (i.e., accidents of major and severity as defined by VDS levels of 6, 7, 8) while the basis for the other estimates is fatal accidents, a more severe threshhold. The higher the severity of the accident, in terms of the impact or crash forces, the greater the likelihood that these forces will contribute to injury, or fatality, relative to the likelihood of fire contributing to the injury or fatality, should fire occur.

3.2 Costs

The nature of the requirements of FMVSS-301 have made it difficult to arrive at a consumer cost estimate of the standard. NHTSA's normal procedure of estimating the cost of vehicle changes necessary to comply with its Federal Standards has been to disassemble affected vehicle structures and estimate the consumer costs of the affected components. This methodology, generally referred to as "vehicle tear-down studies", uses weight differentials of affected component parts, for vehicles produced prior to and after a standard is promulgated, as the primary basis for estimation of the costs incurred. Individual cost estimates are then projected to overall fleet costs based on sales-weighted data for the various vehicle lines represented by the tear-down cost studies. While some weight changes (generally increases) have occurred as a result of 301, many of the changes made to meet the standard requirements required no or negligible weight changes. In certain few instances, no changes of any nature were made since the manufacturer determined that the then existing vehicle design was such that the 301 requirements were (already) met.

An additional factor which complicates cost estimation of 301 is that the type of changes made to comply with the standard not only varied widely among the different vehicle manufacturers (both domestic and foreign), but also these changes varied widely among vehicle lines, different make-models, and even by body style (2-door, 4-door, station wagon, hatchback, etc.).

The unique situation of 301, described above, contrasts with other standards, such as 214 (Side Door Strength), and Part 581 (Bumpers), and makes difficult not only the actual estimation of costs of various changes, but also the selection of a representative sample of vehicles on which to estimate costs. For these reasons, the primary basis for estimating costs of FMVSS-301 has been to solicit from various manufacturers the nature and cost of the changes they made to their vehicles to meet the requirements of 301. The actual information received from the manufacturers was accompanied by a request of confidentiality on the basis of being deemed proprietary in nature. Therefore the information contained in this report is of a general, or generic nature, and specific data relating to specific manufacturers have been omitted.

Only the changes made to meet the 301-77 version of the standard are covered in this report. Available information does not provide an estimate of the cost of 301-76, the rollover requirement. However, due to the basic differences between the requirements for 301-76 and 301-77, it is considered likely that the cost of 301-76 is considerably less than the cost herein estimated for 301-77, and resulted in no significant increase in vehicle weight.

3.2.1 Nature of Vehicle Modifications Made

In general, the vehicle modifications instituted to comply with 301-77 consisted of those things necessary to provide a "friendlier" and more secure environment for the fuel system components when the vehicle was subjected to a 30 MPH rear, perpendicular, barrier impact, a 20 MPH side (lateral) barrier impact, or a 30 MPH offset ($\pm 30^\circ$ from vehicle longitudinal axis) frontal, barrier impact. The primary fuel system components are listed in Table 30.

TABLE 30 - FUEL SYSTEM COMPONENTS

1. Fuel Tank
    - Tank Filler Neck
    - Tank Filler Cap (Gas Cap)
    - Tank Mounting Straps
    - Tank Mounting Bolts, Anchors
2. Fuel Gauge Sensor/Sending Units
3. Fuel Lines
    - Connecting Hoses, Clamps
4. Fuel Vapor Lines
    - Connecting Hoses, Clamps
5. Fuel Pump
    - Pump Mounting Bolts
6. Evaporation Control Cannister
7. Carburetor
8. Fuel Filter

Based on the information provided by the manufacturers, changes made to meet 301 requirements related to the first five fuel system components listed. Table 31 summarizes the various types of changes made to improve the integrity of these components. As can be seen, these changes ranged from very minor items such as revising mounting bolts or clips, or reversing the mounting procedure for these items to more major changes such as recontouring the fuel tank or adding reinforcements to the rear floor pan structure to provide a more crashworthy environment for the fuel tank. The vast majority of the modifications made involved components in the near proximity of the fuel tank, and affected components 1 through 4 of Table 30 . As stated previously, the actual modifications made to individual vehicle models and body types varied widely.

3.2.2 Cost of Vehicle Modifications

Based on the information submitted to NHTSA by the manufacturers, as noted in the above Sections, overall industry, or fleet estimates, have been derived for the cost and weight increase of the vehicle modifications made in response to FMVSS 301-77. These estimates are the average (i.e., sales or production-weighted) incremental increases, per vehicle, for model year 1977 vehicles versus 1976 vehicles. These estimates are:

Average cost increase: $4.60 per vehicle

Average weight increase: 3.07 lb. per vehicle

In order to estimate the total cost increase to the consumer, an estimate

TABLE 31 - SUMMARY OF VEHICLE MODIFICATIONS IN RESPONSE TO 301-77

Vehicle Components

Fuel System Components	Modification(s) to Improve Crashworthiness
Fuel Tank	- Increase gauge of tank material - Add protective shield - Recontour to minimize contact/puncture by other adjacent vehicle components. - Strengthen/shield filler neck - Increase strength of solder/weld seams - Strengthen mounting by adding brackets, revising mounting bolts, increasing torque of mounting straps - Strengthen filler cap seal, improve impact resistance
Fuel Gauge Sensor	- Strengthen mounting
Fuel Lines	- Recontour
Fuel Vapor Lines	- Recontour, revise, revise clamps
Fuel Pump	- Provide shield
Other Vehicle Components Changed to Improve Fuel System Integrity	
Rear Floor Pan/Support Rails/Wheel Housing	- Revise, add supports
Rear Suspension (Springs, Shock Absorbers)	- Change support brackets, Revise mounting bolts, Revise mounting procedure, and shield
Rear Axle Assembly	- Minor changes in contour of lines, screw heads, mounting clips, recontour vent cover
Tailgate (S.W.)	- Revise hinge assembly
Seat Belt Brackets	- Revise anchorage
Engine Mount	- Slight revision
Power Steering Pump Bracket	- Slight revision

of the increased fuel necessary to transport the additional vehicle weight is also made. Prior study [11] has estimated that an additional 1.0 gallons of fuel will be needed, over the life of the vehicle to compensate for each additional pound of vehicle weight. The average price for fuel in 1982 [12] is estimated at \$1.28 per gallon. Therefore the fuel cost estimate is:

3.07 lb. (1.0 gal./lb.) (\$1.28/gal.) = \$3.93 per vehicle

The total cost estimate is hence:

\$4.60 + 3.93 = \$8.53 per vehicle ≅ \$8.50 per vehicle

These cost estimates are in terms of 1982 dollars.

3.2.3 Discussion of Cost Estimates

Ideally, the cost estimate should cover both the 301-76 (rollover) and 301-77 (rear, side, offset frontal) upgrades of the standard, since benefits are estimated for both versions. However, as stated previously, no data were available to estimate the cost of 301-76; hence the total per vehicle cost of \$8.50 from the preceding section must be considered conservative. Also as discussed previously, it is believed that the (manufacturing) cost for the 301-76 version would be considerably lower than the manufacturing cost of the 301-77 version, due to the differing nature of the requirements for the two versions. Also, it is believed that no significant increase in vehicle weight resulted from 301-76. This implies that the cost of 301-77 would have to be increased by some (small) fraction of $4.60 (the 301-77 consumer cost of vehicle modification) in order to arrive at a total cost figure for both 301-76 and 301-77.

On the other hand, the cost estimate for 301-77 may be somewhat high in that the assumptions are made that: (1) the average new car sells for the full amount of the sticker, or manufacturer's suggested retail price, (2) it costs as much to incorporate 301-related component changes to a vehicle when that vehicle represents a totally newly designed vehicle as it costs when 301-related component changes are made to an existing vehicle design (i.e., retrofit changes). While no known national data are available on which to estimate the magnitude of the "average dealer discount" given to purchasers of new vehicles, it is generally accepted that some discount from the full sticker amount is typically given. Similarly, no known information is available on which to estimate the general effect of vehicle modifications made to existing vehicle designs as opposed to incorporating such changes when a vehicle is undergoing an entirely new design, but it is generally held that less effort is required to incorporate changes in the latter case.

Finally, the estimated fuel penalty cost resulting from Standard 301 may be somewhat high. The value of the extra fuel that is estimated to be consumed over the life of the vehicle is projected over that life in terms of the estimated 1982 cost of gasoline. If the present value approach for the future fuel consumed is used, as in other recent NHTSA studies [11], indications are that the additional consumer cost due to 301 would be somewhat lower than the value of $3.93 per vehicle estimated above.

Certain other assumptions were necessary in arriving at a cost and weight estimate for 301-77, since all manufacturers did not furnish similar types of data and furthermore acknowledged the difficulty of being able to obtain the required data from existing company records.

One final comment is made concerning the point at which the 301-related changes were actually made to the vehicles. Experience has shown that manufacturers may elect to incorporate standard-related modifications in advance of the actual effective date set by a given standard, if the manufacturer finds that it is more efficient (less costly) to do so. Such instances typically occur when other modifications or design changes are being made by the manufacturer, in addition to those required by the standard. Incorporation of such standard-related modifications in advance of their required date is generally referred to as "anticipating the standard." Based on information available to NHTSA, it is concluded that changes for both 301-76 and 301-77 were made at points coincident with the effective dates of the requirements (i.e., 1976 and 1977 Model Years, respectively).

3.3 Cost Effectiveness of Standard 301

In the preceding sections, it was estimated that the average consumer cost resulting from 301 was \$8.50 per vehicle. If it is assumed that the average annual production of passenger cars sold in the U.S. is 10 million, then the total estimated cost to the vehicle buying public is:

$$\$8.50/\text{vehicle} \times 10^6 \text{ vehicles} = \$85 \text{ million}$$

The corresponding benefits of 301, as estimated in Section 3.1.4 are:

No. fatalities avoided = 400

No. serious injuries avoided = 520

No. moderate injuries avoided = 110

No. post-crash fires avoided = 6,500

From these two sets of estimates, the following comparison may be developed:

> "For each \$10 million expended, Standard 301-76/77 is estimated to prevent:
>
> 47 fatalities,
>
> 61 serious injuries,
>
> 13 moderate injuries,
>
> 762 total crash fires"

The fatalities prevented are those that would otherwise occur due to fire (i.e., from burn injuries or from asphyxiation). It is possible that non-fatal (i.e., serious, moderate) injuries caused by, or contributed to by fire would be more severe than non-related injuries, due to the nature of the injury and the medical treatment required for burn injuries. However, no empirical data are available on such costs nor are data available on the property damage costs of crash fires.

Given the rare-event nature of motor vehicle crash fires, the effectiveness estimates indicate that Standard 301-76/77 has had a substantial impact relative to the magnitude of the problem of crash fires. With respect to the cost-effectiveness of the standard, no specific conclusion is drawn, but it would seem that the costs of the standard do not represent an undue investment when weighed against the estimated benefits. The vehicle modifications made to comply with Standard 301-76/77, have been comprised of a number of small and varied changes which collectively are intended to provide a "friendlier," and "more forgiving" environment for fuel system components when subjected to a vehicle crash environment. Indications are that these vehicle modifications have substantially achieved their intended purpose.

CHAPTER 4

FINDINGS AND CONCLUSIONS

Based on the results of this study, the following findings and conclusions are made:

1. Passenger car crash fires are relatively rare events compared with the total number of passenger car accidents occurring annually. Crash fires are estimated to occur at the rate of approximately two fires per 1,000 police reported passenger car crashes.

2. In terms of the magnitude of the national problem of passenger car crash fires, it is estimated that 20,600 vehicle crash fires occur each year. These crash fires are associated with 1,100 fatalities, 3,200 serious injuries and more than 3,300 moderate to minor injuries, all of which occur to occupants of the crash-fire involved vehicles.

3. Crash fire and fuel leakage rates vary by impact severity and impact type, with rates being markedly higher for crashes of higher impact severity as measured by the extent of vehicle deformation caused by impact forces.

4. Compared with non-fire crashes of similar crash force levels, passenger car crashes involving fire show a marked increase in the probability of occupant fatality and serious injury.

The primary factor contributing to this increase in lethality is concluded to be the presence of fire.

5. Standard 301-76/77 has significantly reduced the post-crash fire rate and fuel leakage rate for passenger cars.

    a. The greatest reductions have occurred in the more severe accidents as defined by the extent of crash-force damage sustained by the vehicle. These crashes are those most likely to result in serious injury or death. The standard is estimated to have reduced the fire rate by 43 percent in crashes of major crash force levels, and by 23 percent in crashes of low-to-moderate crash force levels.

    b. Reductions have occurred for most of the major types of impacts (rollover, rearend, frontal) addressed by the standard.

6. When all vehicles in the U.S. fleet comply with Standard 301-76/77, the benefits of the reduction in crash fire rates are estimated to consist of annual reductions of:

    a. 400 fatalities
    b. 520 police-reported serious injuries
    c. 110 police-reported moderate injuries
    d. 6,500 vehicle crash fires

7. The consumer cost of the standard is estimated at $8.50 per vehicle, or a total cost of $85 million annually.

8. In a type of cost-effectiveness comparison, it may be stated that for each $10 million spent to comply with Standard 301, the following total benefits are expected to accrue:

    a. 47 fatalities avoided, plus
    b. 61 serious injuries avoided, plus
    c. 13 moderate injuries avoided, plus
    d. 762 vehicle crash fires avoided

    The 762 crash fires avoided would represent a savings in property damage costs to the extent that damage from fire exceeded the damage resulting from impact forces.

9. The type of vehicle modifications made in response to Standard 301-76/77 varied widely among vehicle manufacturers and, for the most part were individual vehicle model/body style specific. The basic objective of these modifications was to provide a "friendlier" and more "forgiving" environment for the various fuel system components (i.e., fuel tank, fuel lines, fuel pump, etc.) when subjected to vehicle crash forces.

10. In view of the fact that crash fires are quite rare events relative to the frequency of total crashes, the various vehicle modifications made in response to the standard appear to have substantially achieved their goal of reducing the problem of crash fires and the attendant fatalities and injuries resulting therefrom.

11. Although signifcantly lower crash fire rates have been found for Post-Standard vehicles, there is some indication that the fire rate may be increasing slightly for newer vehicles. This is a preliminary finding and reasons for it are not clear. It does suggest, however, that the Agency continue to monitor the phenomenon of motor vehicle crash fires.

REFERENCES

[1] "Regulatory Reform - The Review Process," U.S. Department of Transportation, National Highway Traffic Safety Administration, March 1982 (DOT HS-806-159)

[2] Motor Vehicle Safety Standard No. 301, Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections - Passenger Cars; 32 F.R. 2416, February 3, 1967, Part 571; S 301-1.

[3] Motor Vehicle Safety Standard No. 301-75, Fuel System Integrity; 38 F.R. 22397, August 20, 1973, PART 571; S 301-75-1, 2, 3; and 40 F.R. 48352, October 15, 1975, PART 571; S 301-75-1, 2, 3, 4.

[4] Donald W. Reinfurt. "A Statistical Evaluation of the Effectiveness of FMVSS 301: Fuel System Integrity", National Technical Information Service, Springfield, Virginia, June 1981 (DOT-HS-8-02014).

[5] Jairus D. Flora and James O'Day. "Evaluation of FMVSS 301 - Fuel System Integrity - Using Police Accident Data," Draft Report, March 1982 (DOT-HS-7-01755).

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[7] J. D. Flora, P. Beitler, J. Bromberg, N. Goldstein, and J. O'Day. "An Evaluation of FMVSS-301 - Fuel System Integrity," University of Michigan Highway Safety Research Institute, Ann Arbor, Michigan, June 1979 (DOT-HS-7-01755).

[8] Donald W. Reinfurt. "A Statistical Evaluation of the Effectiveness of the 1976 Version of FMVSS 301: Fuel System Integrity," Draft Report, August 1982 (DTNH22-81-C-06006).

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[10] Peter Cooley. "Fire in Motor Vehicle Accidents," University of Michigan Highway Safety Research Institute, Ann Arbor, Michigan, HIT LAB Reports, Volume 5, Number 1, September 1974.

[11] "Final Regulatory Impact Analysis, PART 581 Bumper Standard," National Highway Traffic Safety Administration, May 1982.

[12] "Monthly Energy Reviews," U.S. Department of Energy, July 1982.

APPENDIX A

DATA SOURCES

1.0 Crash Fire Data

Data on motor vehicle crash fires were obtained from five States as described below.

1.1 Michigan Data

Beginning in 1978, the State of Michigan revised its motor-vehicle accident report form to contain specific elements relating to the occurrence of vehicle fires and fuel leakage. The following two questions were added to the report form:

"Did fire occur?" Yes_____ No_____

"Did vehicle leak fuel?" Yes_____ No_____

Four code values are used when these data are automated at the State level. A value of "1" indicates a "yes" code for fire, and a "no" code for fuel leakage. A value of "2" indicates that the fire variable was coded "no" and the fuel leakage variable was coded "yes." A value of "3" is used if both fire and fuel leakage are checked "yes" by the investigating officer. Finally, a value of "4" is used for all remaining cases, which includes a "no" check for both events and also cases where either variable, fire or leak, or both, are left blank. In automating the data at the State level, it is assumed that missing data correspond to a "no" check for either variable. Therefore computation of fire and leak rates in the Michigan data treats missing information as no fires or no leaks and the actual rate of missing data cannot be determined.

The calculation and analyses of fire and fuel leak rates from the State of Michigan excluded crashes which were coded as "non-collision" or "zero damage" in order to exclude fires that may not have resulted from vehicle crashes. Finally, discussions with reporting officers resulted in the following conventions for computing fire and leakage rates: (1) fire cases are those where fire was coded yes and where both fire and leak were coded yes; (2) leak cases are those where either fire, leak, or both fire and leak, are coded yes. The rationale for this convention is that the investigating officers indicated that when a fire occurred, it was often not possible to determine whether it was fuel-fed, due to the fire damage. In general, however, it was felt that such fires were fuel-fed.

1.2 Illinois Data

Since 1975, the State of Illinois' accident report form (see Appendix B) has contained an explicit variable to denote the occurrence of fire. The variable reads: "Did fire occur?", and the question is to be answered yes or no for each accident-involved vehicle. The State of Illinois requires two accident reports to be completed following an accident, one by the investigating officer and a second by the driver(s) involved. Both forms contain the fire variable, and in automating the accident data at the State level, both are used in the coding of the fire variable. If either the officer or the driver's reports indicate "yes" for fire, the fire variable is coded yes. If either or both reports indicate "no" for fire, the fire variable is coded no. In cases where neither of the two reports completed the fire variable question (i.e., no answer, either yes or no, is given), the fire variable is coded as unknown.

One problem with the Illinois data is the relatively large proportion of missing data on the fire-variable. Over the six calendar years of data (1975 through 1980) made available for this study, the missing data rate for the fire variable ranged from a high of 39 percent in 1975 to a low of 18 percent in 1980.

The following summarizes the missing data rate:

Cal. Year	Missing Data Rate
1975	39%
1976	33%
1977	22%
1978	20%
1979	19%
1980	18%

Because of the differences in the missing data rates and the potential for these differences to confound the analyses of fire rates, the data analyzed in this report is restricted to the four most current years 1977-1980, among which the missing rates are reasonably close.

Once again, fire cases where accident type is coded "non-collision" are excluded in order to eliminate potential non-crash fires.

1.3 North Carolina, Maryland, and Pennsylvania Data

Fire data from the States of North Carolina, Maryland, and Pennsylvania are obtained via secondary, or indirect methods rather than from explicit accident report variables, as in the cases of Michigan and Illinois, preceding.

North Carolina data on fires come from computerized files of accident report narratives. Retrieval of items of interest from these automated narratives is based on a "key word" search routine developed and maintained by the Highway Safety Research Center. Accident case narratives involving fire were selected from the file, filtered to remove non-crash fire cases, and then matched with the respective full accident report in order to obtain other needed information such as vehicle model year. Denominator data for the calculation of accident rates consisted of all police-reported crashes in North Carolina occurring in the period comparable to that from which the fire cases were extracted.

Fire data from Maryland were obtained via a filtering algorithm which is intended to select those crashes in which post-crash fires occur. The screening algorithm was specifically oriented toward screening out cases where the accident type was given as "non-collision," the listed primary or secondary cause of the crash was fire, and selecting cases where" fire damage" was indicated to have occurred.

Fire data from Pennsylvania is also based on an indirect selection method since fire is not reported as a specific element on the accident form. Fire is one of several codes that can be assigned at the automation of data at the State level. Fire is one of three sequential events which may be assigned by the analyst responsible for coding the accident reports. The sequential nature of the events is intended to represent the order in which the accident events happened. Therefore, if fire is coded first, it is assumed to be a non-crash fire. The cases selected as crash fires were those in which fire was not listed as the first sequential event, but where fire was listed together with reported crash damage.

1.4 Other Accident Data Sources

Two other accident data sources, in addition to those described above, were used in this study.

The first is the Fatal Accident Reporting System (FARS) maintained by NHTSA's National Center for Statistics and Analysis. FARS is an automated data system of all the fatal motor vehicle accidents occurring annually in the United States and has been in continuous operation since 1975. FARS is used to assist in defining the magnitude of the crash fire problem and in estimating the increased probability of fatality or injury due to the presence of a crash fire.

The second source is the National Accident Sampling System (NASS) also operated by NHTSA's National Center for Statistics and Analysis. NASS is a probability-based sample of all police-reported accidents occurring in the United States and is intended to provide a number of general and specific characteristics relating to the nature and magnitude of the Nation's motor vehicle accident problem. NASS has also been used to assist in defining the magnitude of the national problem of crash fires.

1.5 Cost Data

Data on the costs of implementing Standard 301 are based on confidential information solicited by NHTSA from various motor vehicle manufacturers, both domestic and foreign. Typically, NHTSA conducts its own cost studies based on vehicle tear-down and consumer cost estimating methodologies. Due to the singular nature of the vehicle modifications made in response to Standard 301, however, this methodology was deemed inappropriate.

APPENDIX B

State of Michigan - Accident Report Form

State of Illinois - Accident Report Form

State of North Carolina - Accident Report Form

State of Maryland - Accident Report Form

State of Pennsylvania - Accident Report Form

State of Michigan - Vehicle Damage Severity Scale for
Michigan Traffic Accident Investigators

State of Michigan - Definition of Police-Reported
K-A-B-C Injury Scale

Fatal Accident Reporting System - Accident Report Forms

STATE OF MICHIGAN - ACCIDENT REPORT FORM

CIRCLE THE APPROPRIATE SELECTION **ORIGINAL**

UD- 10 (Rev. 8-79)

State of Michigan

OFFICIAL TRAFFIC ACCIDENT REPORT

Department Name | LEIN Number | Department Complaint No.

Accident Location

County No. | City No. | Twp. No. | Section No. | Day of Week S M T W T F S | Accident Date: Mo/Da/Yr | Time A.M. P.M.

Name ON | Route No. | Ft. Mi. N S E W | Intersection | Route Nos.

Accident Conditions

WEATHER	LIGHT	ROAD SURFACE	TOTAL LANES			Total No. Vehicles
1 Clear or Cloudy 3 Rain 2 Fog 4 Snow	1 Day 3 Street Lights 2 Dawn or Dusk 4 Dark	1 Dry 3 Snowy or Icy 2 Wet 4 Other		1 Divided 2 Limited Access 3 Other	Y N Construction Zone Y N Investigated at Scene	

Vehicle Driver No. 1 — **Driver No. 1**

State | Driver's License | DOB: Mo/Da/Yr | Hazardous Action Number | Citation Charge | HBD Y N | Test | Helmet Y N

Driver's Name: First M. Last | Address | City | State | Age | Sex | Inj.

Year | Make No. | Type | Trailer | Reg. | Yr/State | VIN | Removed to/by

Y N Haz. Citation | *Y N Driver Re-exam | *Y N Vehicle Defect | *Y N Fuel Leakage | Impact | Severity | Truck Cargo: Y N Cargo Spillage | Class

Y N Other Citation | *Y N Vision Obstruct. | Y N Vehicle Drivable | *Y N Vehicle Fire | Cargo Description

Restraints by occupants pos.			Name	Address	Pos.	Age	Sex	Inj.	Helmet
									Y N
1	2	3							Y N
4	5	6							Y N

Total occupants | Local Use/Owner, Phone | Insurance Co. | Agency Address | Injured taken to/by

Vehicle Driver No. 2 — **Driver No. 2**

State | Driver's License | DOB: Mo/Da/Yr | Hazardous Action Number | Citation Charge | HBD Y N | Test | Helmet Y N

Driver's Name: First M. Last | Address | City | State | Age | Sex | Inj.

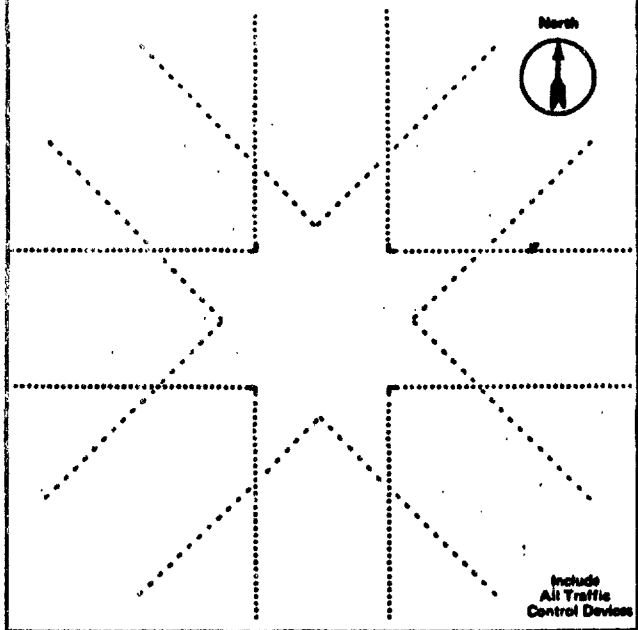
Year | Make No. | Type | Trailer | Reg. | Yr/State | VIN | Removed to/by

Y N Haz. Citation | *Y N Driver Re-exam | *Y N Vehicle Defect | *Y N Fuel Leakage | Impact | Severity | Truck Cargo: Y/N Cargo Spillage | Class

Y N Other Citation | *Y N Vision Obstruct. | Y N Vehicle Drivable | *Y N Vehicle Fire | Cargo Description

Restraints by occupants pos.			Name	Address	Pos.	Age	Sex	Inj.	Helmet
									Y N
1	2	3							Y N
4	5	6							Y N

Total occupants | Local Use/Owner, Phone | Insurance Co. | Agency Address | Injured taken to/by



Include All Traffic Control Devices

ACCIDENT DESCRIPTION AND REMARKS (*Explain)

Accid. Date - Mo/Da/Yr

File Class

Department Complaint No.

Reported: Mo/Da/Yr | Time A.M. P.M. | Investigators | Badge No. | Damaged Property Other Than Vehicles

Photos by | Comp. Disposition Open Closed | Reviewer | Person Advised of Damaged Traffic Control Device Name: Date: Time: | Owner | Address

Area
Pseudo
Time
No. Units
No. Inj.
No. Killed
Residence
Test
Intent
Direction
Obj. Hit
Situation
Cont. Cir.
Residence
Test
Intent
Direction
Obj. Hit
Situation
Cont. Cir.
Road Alig
Traffic
Road Loc
Acc. Typ
Where
How
Tags
Road Def
1 Veh. Def
1 Vision O
2 Veh. Def
2 Vision O
MALI
Coder
File

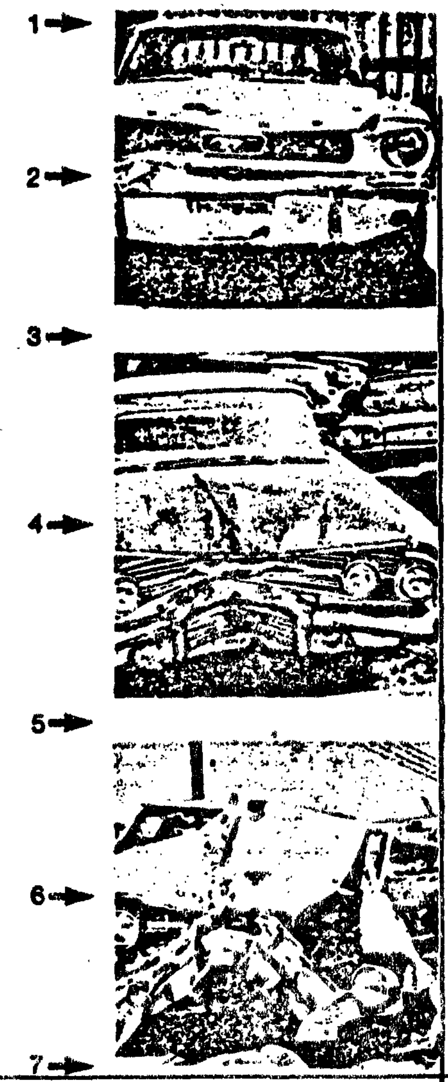
*Use "Accident Description and Remarks" area for explanation.

FORWARD COPY TO: Michigan Department of State Police, Traffic Services Division
7150 Harris Drive, Lansing, Michigan 48913

This form prescribed by Director of Department of State Police pursuant to Section 257.622 of Compiled Laws of 1970, as amended

VEHICLE SEVERITY

Select the degree of severity, 1 being least severe and 7 most severe, for each vehicle. If a vehicle sustained no discernable damage a "0" (zero) rating is used.



HAZARDOUS ACTION

Indicate the specific violation for each pedestrian, bicyclist, or driver which contributed most to the accident. Record only the specific violation even though no enforcement action is taken.

SUGGESTED HAZARDOUS ACTIONS

Select from these specific charges that which most closely fits the accident situation:

1. Speed/Violation of Posted
2. Speed Too Fast/Too Slow For Conditions
3. Unable To Stop In Assured Clear Distance
   Includes: Unsafe Manner, Failed To Use Due Care and Caution
4. Failed To Yield Right of Way/Unsafe Start
5. Improper Turning
6. Following Too Closely
7. Disregard Traffic Control
8. Drove Left of Center
9. Improper or No Signal
10. Drove Wrong Way
11. Improper Lane Usage
12. Defective Equipment (Explain)
13. Unlawful Parking
14. Pedestrian and Bicyclist Violation
15. Improper Overtaking and Passing

BICYCLISTS–PEDESTRIANS–WITNESSES

B–BICYCLIST–List name and address of bicyclist in the space normally used for passengers. For example:

	Pns	Age	Sex	Inj
Joey Doe, Lansing, Mich.	B	*10*	*M*	*A*

DO NOT carry bicyclist's name in area used for driver.

P–PEDESTRIAN–List name and address of pedestrian in the space normally used for passengers. For example:

	Pns	Age	Sex	Inj
Jane Doe, Lansing, Mich.	P	*22*	*F*	*B*

DO NOT carry pedestrian's name in area used for driver.

W–WITNESSES–List name and address of witness in the space normally used for passengers. For example:

	Pns	Age	Sex	Inj
John Doe, Lansing	W	*25*	*M*	*–*

SEATING POSITIONS

A. 1 through 6 identifies where passengers are sitting.

PARKED CARS

DO NOT put owner's name in the driver's position. Indicate owner's name and address in the LOCAL USE line Vehicle identification shall be carried in its usua position.

DIAGRAM

1. Complete the accident diagram on the accident repo even though a more detailed additional diagram completed.
2. Indicate North with an arrow for each accident.
3. Include all traffic control devices which pertain to t accident.
4. Use of the standard accident report template is e couraged for the sake of uniformity.

DESCRIPTION

1. Record in narrative form the investigating officer description of the accident.
2. Record the explanation of the reported vision obstru tion and vehicle defects.

STATE OF ILLINOIS - ACCIDENT REPORT FORM

Ill.

POLICE

TRAFFIC ACCIDENT REPORT

POLICE ACCIDENT NO. | INCIDENT NUMBER

Sheet ____ of ____ Sheets

I.D.O.T. USE ONLY

ON: Number or Name of Highway or Street
1.

COUNTY | TOWNSHIP OR CITY

1 At Intersection With ____________
(Number or Name of Intersecting Highway or Street)

2 If not at Intersection ______ or ______ N E S W of ____________
Feet Miles (Circle 1) (Nearest Highway, Street, Bridge, or other Landmark)

DATE OF ACCIDENT MO. / DAY / YR.
2.

TIME OF ACCIDENT
• A.M.
• P.M.

TOTAL UNITS INVOLVED

DAY OF THE WEEK
M T W T F S S

TYPE OF REPORT

CIRCLE ONE OR MORE
1. Conventional
2. Desk
3. Animal
4. Private Property
5. Hit & Run
6. Supplementary

CIRCLE ONE OR MORE
1. Fatal
2. Injury
3. Property Damage
4. Arrest
5. Interstate/Expressway

UNIT 1

DRIVER'S NAME. Last First M.I.
3.

DATE OF BIRTH Mo. / Day / Yr. / /

1. MALE
2. FEMALE

TAKEN TO:

TAKEN BY: | INJ. CODE

DRIVER'S ADDRESS | CITY/STATE/ZIP/PHONE

DRIVER'S LICENSE NO. | STATE | CLASSIFICATION | RESTRICTIONS

COLOR 4. | YEAR | MODEL | MAKE | VEHICLE TYPE | Total Occ. Unit 1 Including Driver

VEHICLE OWNER | VEHICLE REGIST. NO. | STATE | YEAR | VEHICLE IDENTIFICATION NO.

OWNER'S ADDRESS | CITY | STATE

VEHICLE REMOVED BY | VEHICLE REMOVED TO
1. DRIVEN AWAY
2. TOWED AWAY

CIRCLE POINT OF CONTACT

$ ____________
APPROX. COST TO REPAIR OR REPLACE

SEATING IN VEHICLE

1	2	3
4	5	6

STATION WAGON

7	8	9

UNIT 2 OR PEDESTRIAN

☐ DRIVER'S NAME. Last First M.I.
5.
☐ PEDESTRIAN

DATE OF BIRTH Mo. / Day / Yr. / /

1. MALE
2. FEMALE

TAKEN TO:

TAKEN BY: | INJ. CODE

DRIVER'S ADDRESS | CITY/STATE/ZIP/PHONE

DRIVER'S LICENSE NO. | STATE | CLASSIFICATION | RESTRICTIONS

COLOR 6. | YEAR | MODEL | MAKE | VEHICLE TYPE | Total Occ. Unit 2 Including Driver

VEHICLE OWNER | VEHICLE REGIST. NO. | STATE | YEAR | VEHICLE IDENTIFICATION NO.

OWNER'S ADDRESS | CITY | STATE

VEHICLE REMOVED BY | VEHICLE REMOVED TO
1. DRIVEN AWAY
2. TOWED AWAY

CIRCLE POINT OF CONTACT

$ ____________
APPROX. COST TO REPAIR OR REPLACE

CODE FOR INJURY

Use only most serious one in each space for injury.

K-Dead Before Report Made
O-No Indication of Injury
A-Bleeding Wound, Distorted Member, or Had to be Carried From Scene
B-Other Visible Injury, as Bruises, Abrasions, Swelling, Limping, etc.
C-No Visible Injury But Momentary Unconsciousness or Complaint of Pain.

DAMAGE TO PROPERTY OTHER THAN VEHICLES

NAME OF OWNER OF PROPERTY | ADDRESS OF OWNER

NATURE OF DAMAGE | APPROX. COST OF REPAIR OR REPLACE $ ______

TIME NOTIFIED OF ACCIDENT	ARRIVED AT SCENE	DATE NOTIFIED OF ACCIDENT	DATE REPORT COMPLETED
• A.M. • P.M.	• A.M. • P.M.	MONTH / DAY / YEAR	MONTH / DAY / YEAR

ARREST (NAME) Last First M.I. | SECTION NUMBER | TICKET NUMBER

ARREST (NAME) Last First M.I. | SECTION NUMBER | TICKET NUMBER

SIGNATURE OF INVESTIGATING OFFICER X | I.D. NUMBER | BEAT/ZONE | COURT DATE / / | REVIEWING OFF.

If witness place W in unit no. box

List Additional Passenger or Witness Information On a Separate Attached Sheet

PASSENGERS AND/OR WITNESSES

NAME Last First M.I.
7.
ADDRESS
CITY | STATE
1-M 2-F | AGE | TAKEN TO:
UNIT NO. | SEAT POS. | TAKEN BY: | INJ. CODE

NAME Last First M.I.
ADDRESS
CITY | STATE
1-M 2-F | AGE | TAKEN TO:
UNIT NO. | SEAT POS. | TAKEN BY: | INJ. CODE

NAME Last First M.I.
ADDRESS
CITY | STATE
1-M 2-F | AGE | TAKEN TO:
UNIT NO. | SEAT POS. | TAKEN BY: | INJ. CODE

NAME Last First M.I.
ADDRESS
CITY | STATE
1-M 2-F | AGE | TAKEN TO:
UNIT NO. | SEAT POS. | TAKEN BY: | INJ. CODE

NAME Last First M.I.
ADDRESS
CITY | STATE
1-M 2-F | AGE | TAKEN TO:
UNIT NO. | SEAT POS. | TAKEN BY: | INJ. CODE

(SR1733A-250M - Rev 1-80)

INDICATE BY DIAGRAM WHAT HAPPENED

○ Indicate North

R ____ ____

T ____ ____

SECTION ________

IDENTIFY STREETS AND HIGHWAYS BY NAME AND NUMBER

____

____

____

____

____

____

____

____

____

____

Describe what happened - REFER TO UNITS BY NUMBERS

8 TYPE OF ACCIDENT

1 Pedestrian
2 Motor Vehicle in Traffic
3 Parked Motor Vehicle
4 Railroad Train
5 Pedalcyclist
6 Animal ________
7 Fixed Object
8 Other Object
9 Motorcycle
10 Moped
11 Other

____

9 MANEUVER

Driver 1	2	
1	10	Avoiding Pedestrian
2	11	Avoiding other Vehicle
3	12	Avoiding Animal
4	13	Avoiding Previous Accident
5	14	Skidding-Before Braking
6	15	Skidding-After Braking
7	16	Crowded off Roadway
8	17	Driverless Moving Vehicle
9	18	Other ________

10 WHAT VEH. WERE DOING

Veh. 1	2	
1	13	Go Straight Ahead
2	14	Changing Lanes
3	15	Make Right Turn
4	16	Make Left Turn
5	17	Make U Turn
6	18	Slow or Stop
7	19	Start in Traffic Lane
8	20	Start from Parked Positio
9	21	Stopped in Traffic
10	22	Parked
11	23	Backing
12	24	Other ________

11 WHAT PEDESTRIAN WAS DOING

1 Crossing at Intersection with Signal
2 Crossing at Intersection Against Signal
3 Crossing at Intersection No Signal
4 Crossing Not at Intersection
5 Coming from Behind Parked Vehicle
6 Walking in Roadway - With Traffic
7 Walking in Roadway - Against Traffic
8 Getting off or on School Bus
9 Getting off or on Other Vehicle
10 Playing in Roadway
11 Hitching on Vehicle
12 Working in Roadway
13 Not in Roadway
14 Other ________

12 ALCOHOL

Driver 1	2	
1	5	No Evidence of Drinking
2	6	Drinking-ability Impaired
3	7	Drinking-No Evidence of Impairment
4	8	Undetermined

14 CHEM. TEST

1. Driver No. 2.

TEST OFFERED

Yes-No Yes-No

TEST REFUSED

Yes-No Yes-No

TEST RESULTS

____ % ____ %

13 APP. PHY. CONDITIO

Driver 1	2	
1	12	Previous Inj-Disabl
2	13	Illness-temporary
3	14	Fatigued-Asleep
4	15	Medicated
5	16	Normal
6	17	Emotionally Upset
7	18	Distract-In or Outsi
8	19	Preoccupied
9	20	Age
10	21	Condition Unknow
11	22	Other ________

15 ROAD CHARACTER

1 Straight Level
2 Straight-on-Grade
3 Straight Hillcrest
4 Curve Level
5 Curve-on-Grade
6 Curve-Hillcrest

16 LIGHT

1 Daylight
2 Dawn
3 Dusk
4 Darkness
5 Darkness-Road Lighted

17 WEATHER

1 Clear
2 Raining
3 Snowing
4 Fog/Smog
5 Sleeting
6 Blowing Dust

18 ROAD SURFACE CO

1 Dry
2 Wet
3 Snowy/Ice
4 Muddy
5 Oily
6 Other ________

19 ROADWAY DEFECTS

1 Shoulder Low
2 Shoulder Soft
3 Holes, Bumps, etc.
4 Loose Material
5 Repair Work Barricaded
6 Repair Work not Barricaded
7 No Defects
8 Other ________

20 ROADWAY LANES

VEH. 1	2	
1	8	One Lane
2	9	Two Lanes
3	10	Three Lanes
4	11	Four Lanes
5	12	Five Lanes or more
6	13	Unpaved any width
7	14	One way

21 VISION OBSCURED

VEH. 1	2	
1	13	Not Obscured
2	14	Rain, Snow, Ice on Windsh
3	15	Trees, Crops, Bushes
4	16	Buildings
5	17	Embankment
6	18	Sign Board
7	19	Hillcrest
8	20	Parked Vehicle(s)
9	21	Moving Vehicle(s)
10	22	Blinded by Headlights
11	23	Blinded by Sunlight
12	24	Other ________

22 TRAFFIC CONTROL

1 Stop Signs
2 Stop and Go Light
3 Officer or Flagman
4 Railroad Crossing Gates
5 Railroad Flashing Lights
6 None
7 Other ________

Traffic Control/Sign Visible

1 Yes 2 No

Controls Functioning?

1 Yes 2 No

23 MISC. INFORMATION

VEHICLE

1. | 2.

SPEED LIMIT (Miles per Hour)

SPEED LIMIT POSTED?

1 Yes-No 2 Yes-No

DID FIRE OCCUR?

1 Yes-No 2 Yes-No

24 VEHICLE CONDITION

VEH. 1	2	
1	9	No Apparent Defects
2	10	Lights Defective
3	11	Brakes Defective
4	12	Steering Defective
5	13	Puncture - Blowout
6	14	Worn or Slick Tires
7	15	Motor Trouble
8	16	Other Defects ________

25 SPECIAL STUDIES

MOTORIST'S REPORT OF ILLINOIS MOTOR VEHICLE ACCIDENT

I.D.O.T. USE ONLY

WHERE ACCIDENT OCCURRED

COUNTY | CITY

Road or Street on which Accident Occurred ______________________
(Highway Number, U.S. or State, if no highway number - Identify Road by name)

At Intersection With ______________________
(Number or Name of Intersecting Highway or Street)

If not at Intersection ________ Feet or ________ Miles (Circle 1) N E S W of ______________________
(Nearest Highway, Street, Bridge, or other Landmark)

WHEN ACCIDENT OCCURRED

MONTH / DAY / YEAR

Day of the Week M T W T F S S

HOUR : AM PM

NUMBER OF VEHICLES INVOLVED IN ACCIDENT ________

DRIVER NUMBER 1 - YOURSELF

DRIVER'S NAME (LAST, FIRST, MIDDLE)	BIRTH MO / DAY / YR	DRIVERS LICENSE NO.	STATE	1. MALE 2. FEMALE
STREET ADDRESS	CITY/STATE/ZIP CODE		COUNTY	

VEHICLE NUMBER 1 - YOUR VEHICLE

OWNER'S NAME	ADDRESS				
VEHICLE MAKE	YEAR	MODEL & TYPE	VEHICLE LICENSE NUMBER - STATE AND YEAR		
IDENTIFICATION NUMBER - SERIAL	APPROX COST TO REPAIR $	WAS VEHICLE PARKED? 1 - YES 2 - NO	LEGALLY? 1 - YES 2 - NO		

Were you driving a vehicle owned by your employer, in the course of your employment? If yes check square ☐.

DRIVER NUMBER 2 - OTHER DRIVER - OR PEDESTRIAN

☐ DRIVER'S NAME (LAST, FIRST, MIDDLE) ☐ PED.	BIRTH MO / DAY / YR	DRIVERS LICENSE NO.	STATE	1 MALE 2 FEMALE
STREET ADDRESS	CITY/STATE/ZIP CODE		COUNTY	

VEHICLE NUMBER 2 - OTHER VEHICLE

OWNER'S NAME	ADDRESS				
VEHICLE MAKE	YEAR	MODEL & TYPE	VEHICLE LICENSE NUMBER STATE AND YEAR		
IDENTIFICATION NUMBER - SERIAL	APPROX COST TO REPAIR $	WAS VEHICLE PARKED? 1 YES 2 - NO	LEGALLY? 1 - YES 2 - NO		

Was driver (owner) of this vehicle insured? Yes ☐ No ☐ Not Known ☐

YOUR INSURANCE

If you fail to give full information below it will be assumed that you did not have automobile liability insurance.

Have your insurance policy in front of you when you fill in this form.

Full name of your insurance company (not agency) which issued policy to cover liability for damage or injury to others.

Name and Address of Representative who sold Policy.

Policy Number

Policy Period From: ________ To: ________

Name of Policy Holder

CODES FOR COMPLETION OF INJURY INFORMATION

SEATING IN VEHICLE

USE CODE "P" IF PEDESTRIAN

STATION WAGON

INJURY

K - Dead before Report made
1 - Visible signs of injury as bleeding wound or distorted member, or had to be carried from scene.
2 - Other visible injury bruises, etc
3 - No visible injury but complaint of pain or momentary unconsciousness

YOUR REPORT IS CONFIDENTIAL AND CANNOT BE USED AS EVIDENCE IN ANY TRIAL
PRINT OR TYPE ALL INFORMATION ON THIS FORM

LIST PERSONS KILLED OR INJURED

NAME	ADDRESS	AGE	SEX	VEH NO.	SEAT ING	IN JURY
DESCRIBE INJURIES						
NAME	ADDRESS					
DESCRIBE INJURIES						
NAME	ADDRESS					
DESCRIBE INJURIES						

DESCRIBE DAMAGE TO PROPERTY OTHER THAN MOTOR VEHICLES	APPROX. COST TO REPAIR $	OWNER'S NAME OWNER'S ADDRESS

THIS SPACE FOR FLEET OPERATORS ONLY

If your vehicle operated in compliance with the Federal "Motor Carrier's Act," show the Interstate Commerce Commission docket number.

Is a Form SR-23 on file with the Department of Transportation covering your vehicle?

Has the Secretary of State issued a certificate of self-insurance covering your vehicle?

SIGN HERE | ADDRESS | DATE

SIGNATURE OF PERSON MAKING REPORT

Mail Report To:
Accident Report Office
Illinois Department of Transportation
Springfield, Illinois 62766

COMPLETE BOTH SIDES OF THIS FORM

Form SR-1 (Rev. 3/79)

DIAGRAM WHAT HAPPENED INSTRUCTIONS

1. Follow dotted lines to draw outline of roadway at place of accident.
2. Number each vehicle and show direction of travel by arrow.

→ 1 2 ←

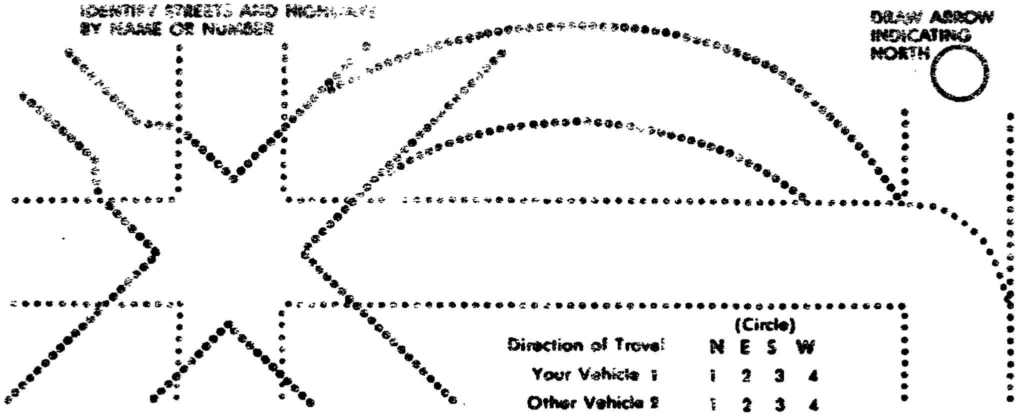
Use solid line to show path before accident ——→ 2

dotted line after accident ---→ 2

4. Show pedestrian by: ——O
5. Show railroad by: ┼┼┼┼┼
6. Show utility poles by: ⏀
7. Show motorcycle by: O-O

IDENTIFY STREETS AND HIGHWAYS BY NAME OR NUMBER

DRAW ARROW INDICATING NORTH ○



Direction of Travel	N	E	S	W
	(Circle)			
Your Vehicle 1	1	2	3	4
Other Vehicle 2	1	2	3	4

DESCRIBE WHAT HAPPENED (Refer to vehicles by number):

CIRCLE NUMBER OF ITEM OR ITEMS IN EACH BOX PERTAINING TO ACCIDENT

8 TYPE OF ACCIDENT - WITH

1 - Pedestrian
2 - Motor Vehicle in Traffic
3 - Parked Motor Vehicle
4 - Railroad Train
5 - Bicyclist
6 - Animal ________
7 - Fixed Object
8 - Other Object
9 - Motorcycle
10 - Other ________

9 MANEUVER

1 - Avoiding Pedestrian
2 - Avoiding Other Vehicles
3 - Avoiding Animal
4 - Avoiding Previous Accident
5 - Skidding Before Braking
6 - Skidding After Braking
7 - Crowded off Roadway
8 - Driverless Moving Vehicle
9 - Other ________

10 YOUR ACTION AT TIME OF ACCIDENT

1 - Going Straight Ahead
2 - Changing Lanes
3 - Making Right Turn
4 - Making Left Turn
5 - Making U Turn
6 - Slowing or Stopped
7 - Starting in Traffic Lane
8 - Starting from Parked Position
9 - Stopped in Traffic
10 - Parked
11 - Backing
12 - Other ________

11 WHAT PEDESTRIAN WAS DOING

1 - Crossing at Intersection With Signal
2 - Crossing at Intersection Against Signal
3 - Crossing at Intersection No Signal
4 - Crossing Not at Intersection
5 - Coming From Behind Parked Vehicle
6 - Walking in Roadway - With Traffic
7 - Walking in Roadway - Against Traffic
8 - Getting off or on School Bus
9 - Getting off or on Other Vehicle
10 - Playing in Roadway
11 - Hitching on Vehicle
12 - Working in Roadway
13 - Not in Roadway
14 - Other ________

12 ROAD CHARACTER

1 - Straight Level
2 - Straight-on-Grade
3 - Straight-Hillcrest
4 - Curve-Level
5 - Curve-on-Grade
6 - Curve-Hillcrest

13 LIGHT

1 - Daylight
2 - Dawn
3 - Dusk
4 - Darkness
5 - Darkness-Road Lighted

14 WEATHER

1 - Clear
2 - Rain
3 - Snow
4 - Fog/Smog
5 - Sleet
6 - Blowing Dust

15 ROAD SURFACE CONDITION

1 - Dry
2 - Wet
3 - Snow/Icy
4 - Muddy
5 - Oily
6 - Other ________

16 ROAD DEFECTS

1 - Low Shoulder
2 - Soft Shoulder
3 - Holes, Bumps, Etc.
4 - Loose Material on Roadway
5 - Construction-Barricaded
6 - Construction-Not Barricaded
7 - No Defects
8 - Other ________

17 TOTAL ROADWAY LANES

1 - One Lane
2 - Two Lanes
3 - Three Lanes
4 - Four Lanes
5 - Five or More
6 - Unpaved any Width

7 - One Way?
1-Yes 2-No

18 VISION OBSCURED

1 - Not Obscured
2 - Rain, Snow, Ice on Windshield
3 - Trees, Crops, Bushes
4 - Buildings
5 - Embankment
6 - Sign Board
7 - Hillcrest
8 - Parked Vehicle(s)
9 - Moving Vehicle(s)
10 - Blinded by Headlights
11 - Blinded by Sunlight
12 - Other ________

19 TRAFFIC CONTROL

1 - Stop Sign
2 - Stop and Go Light
3 - Officer or Flagman
4 - Railroad Crossing Gates
5 - Railroad Flashing Lights
6 - None
7 - Other ________

1-Was Traffic Sign Visible?
1-Yes 2-No

2-Control Functioning?
1-Yes 2-No

20 MISCELLANEOUS INFORMATION

ODOMETER READING
☐☐☐☐☐.☐
1/10

SPEED LIMIT
________ M.P.H.
POSTED 1-Yes 2-No

Were You Familiar With Road on Which Accident Occurred? 1 - Yes 2 - No

DID FIRE OCCUR?
1-Yes 2-No

The Safety Responsibility Law

For general information only

(See Sections 7-100 through 7-216 of the Illinois Vehicle Code for complete statute).

In certain cases drivers and owners may be required to prove financial responsibility, usually by presenting evidence of automobile liability insurance.

When any person sustains property damage in excess of $250, or personal injuries, the names of uninsured motorists are sent to the Secretary of State with a legal notice of possible security deposit. The notice names all potential property damage and bodily injury claimants, and lists the evaluated amounts of those potential claims. The evaluations are based on information shown in the reports filed by drivers or owners. It is important that reports be filed promptly and that complete and accurate descriptions of property damage and bodily injuries be shown in the spaces provided on the report form.

The accident file, which usually contains a police report and a report from each driver, will be sent to the Secretary of State. That office will review the reports to ascertain if the uninsured driver was legally at fault. If the driver was clearly not at fault the file will be closed; otherwise, a Hearing will be held. If the Hearing officer concludes, after considering all written and oral evidence, that there is a reasonable possibility of legal fault, the uninsured driver will have the following options: 1. Deposit security. 2. Present evidence of releases from liability (or signed agreements to pay for damages in installments) from all potential claimants named on the security deposit notice. 3. Show evidence of a final adjudication of nonliability. If the uninsured motorist fails to comply with any of the above options, his/her driver's license (if driver) and vehicle registration privileges (if owner) would be suspended.

(None of the above affects any person's right to sue to recover damages)

(Security deposits, releases, or installment agreements are to be submitted to the Secretary of State)

STATE OF NORTH CAROLINA - ACCIDENT REPORT FORM

ACCIDENT SEQUENCE CODES

1. VEHICLE MANEUVER/PEDESTRIAN ACTION:
VEHICLE
- 1. Stopped in travel lane
- 2. Parked out of travel lanes
- 3. Parked in travel lanes
- 4. Going straight ahead
- 5. Changing lanes or merging
- 6. Passing
- 7. Making right turn
- 8. Making left turn
- 9. Making U turn
- 10. Backing
- 11. Slowing or stopping
- 12. Starting in roadway
- 13. Parking
- 14. Leaving parked position
- 15. Avoiding object in road
- 16. Other

PEDESTRIAN
- 17. Crossing at intersection
- 18. Crossing not at intersection
- 19. Crossing from behind parked vehicle
- 20. Walking with traffic
- 21. Walking against traffic
- 22. Getting on or off vehicle
- 23. Standing in road
- 24. Working in road
- 25. Playing in road
- 26. Lying in road
- 27. Other in road
- 28. Not in road

2. ACCIDENT TYPE:
RAN OFF ROAD
- 1. Right
- 2. Left
- 3. Straight ahead

NON-COLLISION
- 4. Overturn
- 5. Other

COLLISION OF MOTOR VEHICLE WITH
- 6. Pedestrian
- 7. Parked vehicle
- 8. Train
- 9. Bicycle
- 10. Moped
- 11. Animal
- 12. Fixed object
- 13. Other object

COLLISION OF MOTOR VEHICLE WITH ANOTHER MOTOR VEHICLE
- 14. Rear end, slow or stop
- 15. Rear end, turn
- 16. Left turn, same roadway
- 17. Left turn, different roadways
- 18. Right turn, same roadway
- 19. Right turn, different roadways
- 20. Head on
- 21. Sideswipe
- 22. Angle
- 23. Backing

3. OBJECT STRUCK (excluding another motor vehicle in traffic)
- 1. None
- 2. Parked vehicle
- 3. Bicycle, moped
- 4. Pedestrian
- 5. Animal
- 6. Tree
- 7. Utility pole (with or without light)
- 8. Luminaire pole (non-breakaway)
- 9. Luminaire pole (breakaway)
- 10. Official highway sign (non-breakaway)
- 11. Official highway sign (breakaway)
- 12. Commercial sign
- 13. Guardrail end on shoulder
- 14. Guardrail face on shoulder
- 15. Guardrail end in median
- 16. Guardrail face in median
- 17. Shoulder barrier end } Non-Guard-rail
- 18. Shoulder barrier face } Non-Guard-rail
- 19. Median barrier end } Non-Guard-rail
- 20. Median barrier face } Non-Guard-rail
- 21. Bridge rail end
- 22. Bridge rail face
- 23. Overhead part of underpass
- 24. Pier on shoulder of underpass
- 25. Pier in median of underpass
- 26. Abutment (supporting wall of underpass)
- 27. Curb, median or traffic island
- 28. Catch basin or culvert on shoulder
- 29. Catch basin or culvert in median
- 30. Ditch bank
- 31. Mailbox
- 32. Fence or fence post
- 33. Construction barrier
- 34. Crash cushion
- 35. Other object (describe)

4. DISTANCE
- 1. In road
- 2. Right of road, 0-10 ft.
- 3. Right of road, 11-30 ft.
- 4. Right of road, over 30 ft.
- 5. Left of road, 0-10 ft.
- 6. Left of road, 11-30 ft.
- 7. Left of road, over 30 ft.

5. TRAILER TYPE:
NON-SEMI TRAILERS
- BT = Boat
- CT = Camper
- UT = Utility
- HE = Horse
- HS = House trailer (mobile home)
- TV = Towed vehicle
- OT = Other

SEMI TRAILERS
- TN = Tanker
- VN = Van (enclosed trailer)
- FB = Flat-bed or platform
- OS = Other semi

N.C.

DMV-349 (Rev. 1/79)

TRAFFIC ACCIDENT REPORT - Send To: N.C. Division of Motor Vehicles Raleigh, N.C. 27697

PAGES 37 ______ (Initial)

Local Use

Patrol Area

Do not write in these spaces
DMV Report No.:

Date Received by DMV:

LOCATION

Date: ______ 19___ Day of Week: ______ Time: ______ (24 Hour Clock)
(Month Day Year)

Accident Occurred in ______ County ☐ In ☐ Near Incorporated City or Town of ______

Outside City or Town ______ Miles ☐ N ☐ E ☐ S ☐ W of City or Town Limits

On ______
Hwy. No. (I., U.S., N.C., R.P., R.U.). If within corporate limit or no hwy. no., identify by street name. If ramp or service road, indicate on line.

RR. Crossing No.: ______

______ Miles ☐ N ☐ E ☐ S ☐ W At or from ______ Toward ______

______ Feet (0 ft. if Intersec.)

Use Hwy. No., Street Name, or Adjacent County or State Line

Use Hwy. No., Street Name, Incorporated Town, or Adjacent County or State Line

ACCIDENT SEQUENCE

1. VEHICLE MANEUVER/ PEDESTRIAN ACTION		2. ACCIDENT TYPE			3. OBJECT STRUCK AND 4. DISTANCE			
		FIRST HARMFUL EVENT	MOST HARMFUL EVENT: Repeat code if same as for FIRST HARMFUL EVENT		Vehicle 1		Vehicle 2	
Veh. 1	Veh. 2 or Ped.		Veh. 1	Veh. 2 or Ped.	Object	Distance	Object	Distance

No. of Units Involved ☐

VEHICLE NO. 1

Driver: ______ (First Middle Last Name)
Address: ______
City: ______ State: ______ Zip Code: ______
Same Address as on Driver's License? Yes ☐ No ☐ Driver's Phone No.: ______
Race/Sex ______ Driver's Lic.: ______ State ______
Date of Birth: ______ (Month Day Year) Specify Restriction: ______
Veh. Year: ______ Veh. Make: ______ Veh. Type: ______ Trailer Type: ______
Lic. Plate No.: ______ State: ______ Year: ______
VIN: ______
Owner: ______
Address: ______
City: ______ State: ______ Zip Code: ______
TAD (Parts Damaged): ______ Estimated Damage: $ ______
Vehicle Drivable? ☐ Yes ☐ No
Removed to: ______
Address: ______
By: ______ Authority: ______

☐ VEHICLE NO. 2 ☐ PEDESTRIAN ☐ OTHER

Driver: ______ (First Middle Last Name)
Address: ______
City: ______ State: ______ Zip Code: ______
Same Address as on Driver's License? Yes ☐ No ☐ Driver's Phone No.: ______
Race/Sex ______ Driver's Lic.: ______ State: ______
Date of Birth: ______ (Month Day Year) Specify Restriction: ______
Veh. Year: ______ Veh. Make: ______ Veh. Type: ______ Trailer Type: ______
Lic. Plate No.: ______ State: ______ Year: ______
VIN: ______
Owner: ______
Address: ______
City: ______ State: ______ Zip Code: ______
TAD (Parts Damaged): ______ Estimated Damage: $ ______
Vehicle Drivable? ☐ Yes ☐ No
Removed to: ______
Address: ______
By: ______ Authority: ______

Other Property Damaged: ______
Estimated Damage: $ ______
Owner Name: ______
Address: ______

INJURY SECTION INSTRUCTIONS: Give Injury Class, Belt Usage, Race/Sex and Age of all Occupants in the space corresponding to the seat occupied (see codes at bottom). Names and addresses are necessary for persons who were injured.

Seat	Inj. Cl.	Belt Use	Race Sex	Age	Injured Names and Addresses First Name Last Name	Seat	Inj. Cl.	Belt Use	Race Sex	Age	Injured Names and Addresses First Name Last Name
Left Front					DRIVER 1	Left Front					DRIVER 2, PEDESTRIAN, OTHER
Center Front						Center Front					
Right Front						Right Front					
Left Rear						Left Rear					
Center Rear						Center Rear					
Right Rear						Right Rear					

Total No. Occupants: ______ Total No. Injured: ______ Total No. Occupants: ______ Total No. Injured: ______

Ambulance Requested? ☐ Yes ☐ No. If Yes, Ambulance Arrived At: ______ (24 Hour Clock)

Injured Taken To: ______ (Treatment Facility and City or Town)

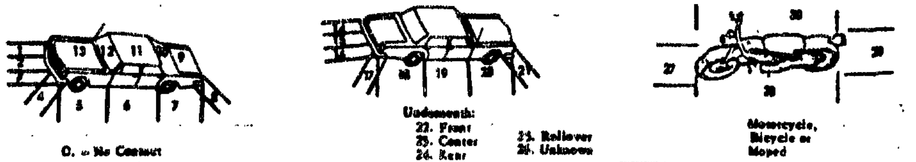
Injury Class
- K = Killed
- A = Incapacitating (Injury obviously serious enough to prevent carrying on normal activities for at least 24 hours: e.g., massive loss of blood, broken bone)
- B = Non-incapacitating (injury other than K or A evident at the scene)
- C = No visible sign of injury but complaint of pain or momentary unconsciousness
- O = No injury

Belt Use
- 1. None or not used
- 2. Lap only
- 3. Lap and shoulder
- 4. Child restraint system
- 9. Unable to determine

1. LOCALITY
1. Rural (< 30% developed)
2. Mixed (30% to 70% developed)
3. Urban (> 70% developed)
2. PREDOMINANT DEVELOPMENT TYPE
1. Farms, woods, pastures
2. Residential
3. Commercial
4. Institutional
5. Industrial
3. ROAD FEATURE
1. Bridge
2. Underpass
3. Driveway, public
4. Driveway, private
5. Alley intersection
6. Intersection of roadways
7. Non-intersection median crossing
8. End or beginning of divided highway
9. Interchange ramp
10. Interchange service road
11. Railroad crossing
12. Tunnel
13. Other (write in narrative)
14. No special feature
4. ROAD CHARACTER
1. Straight, level
2. Straight, hillcrest
3. Straight, grade
4. Straight, bottom (sag)
5. Curve, level
6. Curve, hillcrest
7. Curve, grade
8. Curve, bottom (sag)
5. ROAD CLASS
1. Interstate
2. U.S. route
3. N.C. route
4. State secondary route
5. Local street
6. Other public road
7. Private road, property or driveway
6. NUMBER OF LANES
Enter "0" if parking lot
7. ROAD CONFIGURATION
1. Undivided, one-way
2. Undivided, two-way
3. Divided
8. ROAD SURFACE
1. Concrete
2. Grooved concrete
3. Smooth asphalt
4. Coarse asphalt
5. Gravel
6. Sand
7. Soil
8. Other (write in narrative)
9. ROAD DEFECTS
1. Loose material on surface
2. Holes, deep ruts
3. Low shoulders
4. Soft shoulders
5. Other defects
6. Under construction
7. No defects
10. ROAD CONDITION
1. Dry
2. Wet
3. Muddy
4. Snowy
5. Icy
6. Other (write in narrative)
11. LIGHT CONDITION
1. Daylight
2. Dusk
3. Dawn
4. Darkness (street lighted)
5. Darkness (street not lighted)
12. WEATHER
1. Clear
2. Cloudy
3. Raining
4. Snowing
5. Fog, smog, smoke, dust
6. Sleet or hail
13. TRAFFIC CONTROL
1. Stop sign
2. Yield sign
3. Stop and go signal
4. Flashing signal with stop sign
5. Flashing signal without stop sign
6. RR gate and flasher
7. RR flasher
8. RR crossbucks only
9. Human control
10. Other (write in narrative)
11. No control present
14. VISION OBSTRUCTION
1. None
2. Vehicle window(s) obscured
3. Trees, crops, brush, etc.
4. Building(s)
5. Embankment
6. Sign(s)
7. Hillcrest
8. Parked vehicle(s)
9. Moving vehicle(s)
10. Blinded, headlights
11. Blinded, sunlight
12. Blinded, other lights
13. Other (write in narrative)
15. PHYSICAL CONDITION
1. Normal
2. Ill
3. Fatigued
4. Asleep
5. Impairment due to medicine or drugs
6. Other physical impairment
7. Restriction not complied with
8. Condition not known
16. INTOXICATION
1. Had not been drinking
2. Drinking – ability impaired
3. Drinking – unable to determine impairment
4. Unknown
17. CHEMICAL TEST GIVEN
18. VEHICLE DEFECTS
(List one or more)
1. Defective brakes
2. Defective headlights
3. Defective rear lights
4. Defective steering
5. Defective tires
6. Other defects
7. Not known if defective
8. No defects detected

POINT(S) OF INITIAL CONTACT
Write in Codes

VEH. 1	VEH. 2



ROADWAY INFORMATION					DRIVER 1	DRIVER 2 OR PED.		VEH. 1	VEH. 2
1. Locality		8. Road Surface							
2. Development Type		9. Road Defects		14. Vision Obstruction			18. Vehicle Defects		
3. Road Feature		10. Road Condition		15. Physical Condition			19. Speed Limit (for each vehicle)		
4. Road Character		11. Light Condition		16. Intoxication			20. Estimated Original Traveling Speed		
5. Road Class		12. Weather		17. Chemical Test Given	☐ Yes ☐ No ☐ Refused	☐ Yes ☐ No ☐ Refused	21. Estimated Speed at Impact		
6. Number of Lanes		13. Traffic Control					22. Tire Impressions Before Impact (ft.)		
7. Road Configuration		Operating ☐ Yes ☐ No Visible ☐ Yes ☐ No					23. Distance Traveled After Impact (ft.)		

INDICATE NORTH

Vehicle 1 was Traveling ☐ N ☐ E ☐ S ☐ W on ____ Vehicle 2 was Traveling ☐ N ☐ E ☐ S ☐ W on ____

DESCRIBE WHAT HAPPENED:

WIT- Name ____ Address ____ Phone No. ____
NESSES: Name ____ Address ____ Phone No. ____

ARRESTS: Name ____ Charge(s) ____ (Cit. No.) ____
Name ____ Charge(s) ____ (Cit. No.) ____

Sign Here: ____
Officer's Rank and Name Number Department Date of Report

VIOLATION INDICATED (Check as many violations as apply)

Driver
1 2
☐ ☐ 1. No violation indicated
☐ ☐ 2. DUI/alcohol
☐ ☐ 3. DUI/drugs
☐ ☐ 4. Yield
☐ ☐ 5. Stop sign
☐ ☐ 6. Traffic signal
☐ ☐ 7. Exceeding speed limit
☐ ☐ 8. Exceeding safe speed

Driver
1 2
☐ ☐ 9. Minimum speed law
☐ ☐ 10. Pass stopped school bus
☐ ☐ 11. Passing on hill
☐ ☐ 12. Passing on curve
☐ ☐ 13. Other improper passing
☐ ☐ 14. Improper lane change
☐ ☐ 15. Use of improper lane
☐ ☐ 16. Improper turn

Driver
1 2
☐ ☐ 17. Improper or no signal
☐ ☐ 18. Improper vehicle equipment
☐ ☐ 19. Safe movement violation
☐ ☐ 20. Following too closely
☐ ☐ 21. Improper backing
☐ ☐ 22. Improper parking
☐ ☐ 23. Unable to determine
☐ ☐ 24. Other ____

RESERVED FOR CITY OR OTHER USE

RESERVED FOR STATE USE

	Driver 1	Driver 2
24. Duration		
25. Violation		
26. Min. Action		
27. Charges		

28. Investigating Agency:

STATE OF MARYLAND - ACCIDENT REPORT FORM

BALTIMORE BUSINESS FORMS, INC.

A-1 REPORT NO [redacted]

STATE OF MARYLAND

MOTOR VEHICLE ACCIDENT REPORT

2 FORM ___ OF ___

3 LOCAL AREA CASE NO.
4 ACCIDENT DATE MO DAY YR
5 TIME (MILITARY)
6 DAY OF WEEK
7 REPORT TYPE ☐ 1 - TRAFFIC ACCIDENT 2 - NON TRAFFIC ACCIDENT
8 COUNTY
9 TIME NOTIFIED (MILITARY)
10 TIME ARRIVED (MILITARY)

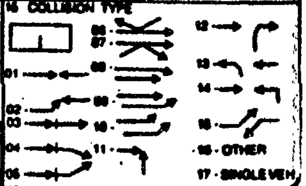
11 ACCIDENT SEVERITY ☐ 1 - Damage only 2 - Possible Injury 3 - Non-Incapacitating 4 - Incapacitating 5 - Fatal

12 FIRST HARMFUL EVENT ☐ 01 - Other Motor Veh in transport 02 - Parked Motor Vehicle 03 - Motor Veh on other roadway 04 - Pedestrian 05 - Pedalcycle 06 - Other Convey 07 - Animal 08 - Rlwy Train 09 - Fixed Object 10 - Other Object 11 - Overturned 12 - Other Non Collision

13 SUBSEQUENT EVENTS ☐ ☐ ☐

14 FIXED OBJECT STRUCK ☐ ☐ ☐ 01 - Bridge/Overpass 02 - Building 03 - Culvert Ditch 04 - Curb, Wall 05 - Guardrail/Barrier 06 - Embankment 07 - Fence 08 - Light support pole 09 - Sign support pole 10 - Other pole 11 - Tree Shrubbery 12 - Construction Barrier 13 - Crash Attenuator 14 - Other

15 COLLISION TYPE ☐



16 RELATIONSHIP TO INTERSECTION ☐ 1 - Non-Intersection 2 - Intersection 3 - Intersection Related 4 - Driveway Access

17 KIND OF LOCALITY ☐ 1 Manufacturing or Industrial 2 Shopping or Business 3 Residential 4 School or Recreational 5 Open Country

B-1 DAMAGE TO PROPERTY OTHER THAN VEHICLE - OBJECT
2 OWNER NAME
3 DAMAGE SEVERITY ☐ 1 No Damage 2 Superficial 3 Moderate 4 Destroyed

C-1 ACCIDENT OCCURRED ON - ROAD NAME
3 DISTANCE ☐ 1 Feet 2 Miles
5 REFERENCED ROAD NAME
7 CITY ACCIDENT OCCURRED IN - OR INDICATE RURAL
8 MUNICIPAL CODE
2 TYPE, ROUTE NO. SUFFIX
4 GOING FROM ACCIDENT ☐ 1 North 2 South 3 East 4 - West 5 N/A
6 TYPE ROUTE NO SUFFIX
9 LOG MILE REFERENCE ON C-1 AT C-5
10 RAMP MOVEMENT ☐ 0 N/A 1 - N → W 2 W → N 3 - E → N 4 N → E 5 S → E 6 E → S 7 W → S 8 - S → W 9 Other

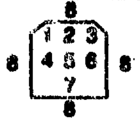
D- MOVEMENT OF VEHICLES
VEH 1 1. ☐
VEH 2 2. ☐
01 - Moving Constant Speed 02 - Accelerating 03 - Slowing or Stopping 04 - Starting from Traffic Lane 05 - Starting from Parked Position 06 - Stopped in Traffic Lane 07 - Changing Lanes 08 - Passing 09 - Parking 10 - Parked 11 - Backing 12 - Making Left Turn 13 - Making Right Turn 14 - Making Right Turn on Red 15 - Making U Turn 16 - Skidding 17 - Driverless Moving Vehicle 18 - Other/Unknown

DIRECTION PRIOR TO TURNING
VEH 1 3. ☐
VEH 2 4. ☐
1 - N 2 - S 3 - E 4 - W 5 - N/A

E-1 ACCIDENT OCCURRED IN ☐ 01 - Lane 1 02 - Lane 2 03 - Lane 3 04 - Lane 4 05 - Merge/Transition Lane 06 - Acceleration Lane 07 - Deceleration Lane 08 - Left Turn Lane 09 - Right Turn Lane 10 - Left Shoulder 11 - Right Shoulder 12 - Center Median 13 - Left Roadside 14 Right Roadside 15 - Outside Trafficway 16 - Median Crossover 17 - Gore 18 - Parking Lot 19 - Other

F- TRAFFIC CONTROLS
FUNCTIONING 1. ☐ ☐ ☐ ☐
NOT FUNCTIONING 2 ☐ ☐ ☐ ☐
01 - Police Officer 02 - RR Watchman, Gate, Etc 03 Stop & Go Signal 04 - Flashing Signal 05 - Lane Markings 06 - Channelization Painted 07 - Channelization Physical 08 - Construction/Maintenance Controls 09 - Warning Sign 10 - Stop Sign 11 - Yield Sign 12 - Center Line 13 - Edge Line 14 - Other Traf Control 15 - No Control Present

G-1 MV UNIT NO
2 HIT & RUN ☐ 1 - NO 2 - YES
3 DRIVER NAME - FIRST, MIDDLE & LAST
4 ADDRESS - NO., STREET CITY, STATE & ZIP
5 PHONE NO
6 DATE OF BIRTH MO DAY YR
7 SEX
8 DRIVER LICENSE NO
9 CLASS
10 RESTRICTIONS
11 STATE
12 YEARS DRV EXP
13 DRIVER EDUCATION ☐ 1 - Public 2 - Com'l 3 - None 4 - Unkn
14 INJ SEV ☐
15 SAFETY EQPT ☐
16 E/T ☐



17 OCC NO	18 ST POS	19 AGE	20 SEX	21 INJ SEVERITY	22 SFTY EQPT	23 E/T	24 OCCUPANT NAME & ADDRESS
1							
2							
3							
4							

25 OWNER - NAME & ADDRESS

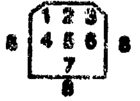
26 MAKE
27 MODEL
28 YR
29 VEHICLE ID NO
30 PLATE NO
31 STATE
32 YR
33 VEH TYPE
34 TOWED TYPE
35 DAMAGE SEVERITY ☐ 1 - Disabling 2 - Functional 3 - Other Veh Damage 4 - No Damage 5 - Unknown

P R I M A R Y V E H I C L E

T O W E D V E H I C L E

36 VEHICLE REMOVED BY
37 VEHICLE REMOVED TO
38 REMOVAL AUTHORITY ☐ 1 - Owner 2 - Driver 3 - Officer 4 - Occupant 5 - Other 6 - N/A

G-1 MV UNIT NO
2 HIT & RUN ☐ 1 - NO 2 - YES
3 DRIVER NAME - FIRST, MIDDLE & LAST
4 ADDRESS - NO STREET, CITY, STATE & ZIP
5 PHONE NO
6 DATE OF BIRTH MO DAY YR
7 SEX
8 DRIVER LICENSE NO
9 CLASS
10 RESTRICTIONS
11 STATE
12 YEARS DRV EXP
13 DRIVER EDUCATION ☐ 1 Public 2 - Com'l 3 None 4 Unkn
14 INJ SEV ☐
15 SAFETY EQPT ☐
16 E/T ☐



17 OCC NO	18 ST POS	19 AGE	20 SEX	21 INJ SEVERITY	22 SFTY EQPT	23 E/T	24 OCCUPANT NAME & ADDRESS
1							
2							
3							
4							

25 OWNER - NAME & ADDRESS

26 MAKE
27 MODEL
28 YR
29 VEHICLE ID NO
30 PLATE NO
31 STATE
32 YR
33 VEH TYPE
34 TOWED TYPE
35 DAMAGE SEVERITY ☐ 1 - Disabling 2 - Functional 3 - Other Veh Damage 4 - No Damage 5 - Unknown

P R I M A R Y V E H I C L E

T O W E D V E H I C L E

36 VEHICLE REMOVED BY
37 VEHICLE REMOVED TO
38 REMOVAL AUTHORITY ☐ 1 - Owner 2 - Driver 3 - Officer 4 - Occupant 5 - Other 6 - N/A

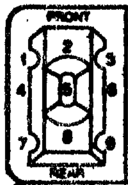
MSP REV 1 77

REMOVE THIS STUB (& ATTACHED CARBON PAPERS) BEFORE COMPLETING REVERSE SIDE

INJURY SEVERITY
1-No Injury
2-Possible Injury
3-Non Incapacitating
4-Incapacitating
5-Fatal

SAFETY EQUIPMENT
01 Lap Belt
02 Harness Only
03 Belt & Harness
04-Child Restraint
05-Air Bag or other Passive Restraint
06 Helmet only
07 Eye protection only
08 Helmet & Eye protection
09-Other
10-None used
11-None available
12-Usage unknown

EJECTED
1-Not Ejected
2-Fully Ejected
3-Partially Ejected
4-Trapped
5-Unknown



H- POINT OF IMPACT

VEH 1 1 ☐

VEH 2 2 ☐

10 Undercarriage
14 Other
15 None/Unknown

AREAS DAMAGED

VEH 1 3 ☐ ☐ ☐

VEH 2 4 ☐ ☐ ☐

11 - Overturned
12 - Totaled
13 - Fire Damage } AREA DAMAGE ONLY

VEHICLE CONDITION

VEH 1 5 ☐ ☐

VEH 2 6 ☐ ☐

01 - No Apparent Defects
02 - Defective Brakes
03 - Defective Headlights
04 - Defective Rear Lights
05 - Defective Steering
06 - Puncture/Blowout
07 - Tire Excess Wear/Smooth
08 - Defective/Altered Exhaust
09 - Defective/Altered Suspension
10 - Motorcycle Lights on - Daylight
11 - Other
12 - Unknown

DRIVER CONDITION

VEH 1 7 ☐ ☐ ☐

VEH 2 8 ☐ ☐ ☐

1 - Apparently Normal
2 - Had been Drinking
3 Using Drugs
4 - Physical Defects/Handicap
5 Ill
6 - Fatigued
7 - Apparently Asle
8 - Blinded by Gla
9 Condition Unkn

I-1 ILLUMINATION ☐
1 - Daylight
2 - Dawn
3 - Dusk
4 - Dark (Street Lts on)
5 - Dark (Street Lts off)
6 - Dark (No Lts)
7 - Unknown

2 WEATHER ☐
1 - Clear
2 - Cloudy
3 - Foggy
4 - Raining
5 - Snowing
6 - Severe Wind
7 - Other
8 - Unknown

3 SURFACE TYPE ☐
1 - Concrete
2 - Tar & Chip
3 - Asphalt Blacktop
4 - Gravel
5 - Brick
6 - Dirt
7 - Other

4 ROADWAY SURFACE ☐
1 - Wet
2 - Dry
3 - Snow
4 - Ice
5 - Mud
6 - Other
7 - Unknown

5 ROAD CONDITION ☐
1 - No Defects
2 - Shoulder Defect
3 - Holes, Ruts, Etc.
4 - Foreign Material
5 - Loose Surface Material
6 - Obstruction not Lighted
7 - Obstruction not Signaled
8 - View Obstructed
9 - Construction/Maintenance

6 ROAD CHARACTER ☐
1 Straight & Level
2 Straight & Grade
3 Straight & Hillcrest
4 Curve & Level
5 Curve & Grade
6 Curve & Hill
7 On Bridge
8 Other

7 SPEED LIMIT ☐
1 - [illegible]
2 - 25 MPH or Less
3 30 MPH
4 - 35 MPH
5 - 40 MPH
6 - 45 MPH
7 - 50 MPH
8 - 55 MPH

J-1 PED NO

2 PED INDICATOR ☐
1 Pedestrian
2 Pedalcyclist

3 PED NAME

4 PED BIRTHDATE

5 PED INJ SEV ☐

6 PED SEX

7 ADDRESS-NO., STREET, CITY, STATE & ZIP

8 PHONE NO

9 PED MANEUVER ☐
01 - Crossing/Entering Roadway at Intersection
02 - Crossing/Entering Roadway Not at Intersection
03 - Walking/Riding on Road w/Traffic
04 Walking/Riding on Road against Traffic
05 - Playing
06 - Standing
07 - Getting on/off Veh
08 Pushing/Working On Veh
09 - Other Working
10 - Hitch-Hiking
11 - Approaching/Leaving School Bus
12 - Other
13 - Unknown

10 PED CONDITION ☐
1 Apparently Normal
2 Had been Drinking
3 - Using Drugs
4 - Physical Defects
5 Other Handicaps
6 Ill
7 - Fatigued
8 - Apparently Asleep
9 - Condition Unknown

11 PED VISIBILITY ☐
1 Light Clothing
2 Dark Clothing
3 Mixed Clothing
4 - Retro-Reflective Material
5 Head Light
6 - Rear Light Reflector
7 Hd Lt & Rear Lt/Reflector

PEDESTRIAN TRAFFIC CONTROLS

FUNCTIONING 12 ☐ ☐ ☐

NOT FUNCTIONING 13 ☐ ☐ ☐

1 - Walk/Don't Walk Signal
2 - Push Button Control
3 - Crosswalk-Marked
4 - Uniformed Crossing Guard
5 - Student Crossing Guard
6 No Control Present
7 - N/A

14 PED LOCATION AT TIME OF ACCIDENT ☐
1 Shoulder
2 - Curb
3 Sidewalk
4 Outside Rt of Way
5 On Roadway at Crosswalk
6 On Roadway not at Crswlk
7 School Bus Zo
8 Bikeway
9 Unknown

15 BICYCLE - MAKE, WHEEL SIZE & OTHER DESCRIPTION

K-1 FIRST AID ADMINISTERED BY ☐ ☐
1 - Policeman
2 - Fireman
3 - Ambulance Personnel
4 - Helicopter Personnel
5 - Refused
6 - Other
7 - None Adm
8 - Unknown

2 EMS REPORT NO

3 EMS REPORT NO

4 INJURED TAKEN BY

5 TO

L-1 UNIT

1

2

2 CITATION NO

3 CHARGE SEC SUB SEC PAR ( )

2 CITATION NO

3 CHARGE SEC SUB SEC PAR ( )

2 CITATION NO

3 CHARGE SEC SUB SEC

M-1 PHOTO TAKEN ☐
1 - YES
2 - NO

2 INVEST'D AT SCENE ☐
1 - YES
2 - NO

3 INVEST'N COMPLETE ☐
1 - YES
2 - NO

N - ALCOHOL TEST ☐ 1 VEH ONE ☐ 2 VEH TWO ☐ 3 PED
1 - Breathalyzer
2 - Blood
3 - Urine
4 - Post Mortem
5 - Refused
6 - None Offered

O - TEST RESULTS
1 VEH ONE
2 VEH TWO
3 PED

P-1 WITNESS NAME 1

2 ADDRESS

3 PHONE NO

4 WITNESS NAME 2

5 ADDRESS

6 PHONE NO

Q-1 DESCRIPTION

R-1 DIAGRAM

INDICATE NORTH BY ARROW →

R-2

S-CAUSE ACCIDENT
1 PRIMARY 2 SECONDARY

CONTRIBUTING CIRCUMSTANCE
3 VEH ONE 4 VEH TWO

T-1 INVESTIGATING OFFICER

2 OFFICER ID NO

3 AGENCY

4 INSTALLATION

5 PATROL AREA

6 DATE

7 SPECIAL STUDY

8 SUPVR APPROVAL

9 ID NO

10 REVIEWER

STATE OF PENNSYLVANIA - ACCIDENT REPORT FORM

REMOVE THIS STUB (& ATTACHED CARBON PAPERS) BEFORE COMPLETING REVERSE SIDE

PA. DEPT. OF TRANSPORTATION
BUREAU OF SAFETY PROGRAMMING AND ANALYSIS
T & S BUILDING
HARRISBURG, PA. 17120

COMMONWEALTH OF PENNSYLVANIA POLICE ACCIDENT REPORT

☐ REPORTABLE ☐ NON REPORTABLE

1. INCIDENT NUMBER
2. AGENCY NAME
3. STATION/PRECINCT
4. INVESTIGATING OFFICER — BADGE NO
5. DATE OF REPORT
6. APPROVED BY
7. DATE APPROVED
8. DATE
9. DAY
10. TIME
11. COUNTY
12. CODE
13. PATROL ZONE
14. NO. VEH.
15. NO. KILLED
16. NO INJURED
17. MUNICIPALITY
18. CODE

UNIT NO 1

19. OPERATOR LICENSE NO — CLASS
20. STATE
21. SEX
22. D.O.B.
23. LEGALLY PARKED
24. ILLEGALLY PARKED
25. HIT & RUN
26. NAME — ADDRESS
27. OWNER NAME — ADDRESS
28. VEHICLE TITLE NO
29. YEAR
30. MAKE
31. MODEL
32. VEHICLE REGISTRATION NO
33. STATE
34. INSURANCE COMPANY NAME
37. TOWED TO
39. TRAILER (MAKE, MODEL, TYPE)
35. INS CO CODE
36. INS. POLICY NUMBER
38. TOWED BY
40. TRAILER REGISTRATION NO — STATE
41. OWNER OF TRAILER — ADDRESS

UNIT NO 2

19. OPERATOR LICENSE NO — CLASS
20. STATE
21. SEX
22. D.O.B.
23. LEGALLY PARKED
24. ILLEGALLY PARKED
25. HIT & RUN
26. NAME — ADDRESS
27. OWNER NAME — ADDRESS
28. VEHICLE TITLE NO
29. YEAR
30. MAKE
31. MODEL
32. VEHICLE REGISTRATION NO
33. STATE
34. INSURANCE COMPANY NAME
37. TOWED TO
39. TRAILER (MAKE, MODEL, TYPE)
35. INS CO CODE
36. INS POLICY NUMBER
38. TOWED BY
40. TRAILER REGISTRATION NO — STATE
41. OWNER OF TRAILER — ADDRESS

42. DESCRIPTION OF DAMAGED PROPERTY — OWNER

PRINCIPAL ROAD

43. ROUTE NO. OR STREET NAME
44. SPEED LIMIT
45. CIRCLE IF ONE WAY — N S E W

INTERSECTING ROAD

46. ROUTE NO OR STREET NAME
47. SPEED LIMIT

IF NOT AT INTERSECTION

48. NEAREST CROSS ROUTE OR STATION-MILEPOST NO
49. DIRECTION FROM ACCIDENT SITE — N S E W
50. DISTANCE FROM ACCIDENT SITE ______ FT ______ MI
51. WAS DISTANCE ☐ MEASURED? ☐ ESTIMATED?

52. ILLUMINATION
1 - DAWN OR DUSK
2 - DAYLIGHT
3 - DARK (ST. LIGHTS ON)
4 - DARK (NO ST. LIGHTS)

53. WEATHER
0 - NO ADVERSE COND.
1 - RAINING
2 - SLEET, HAIL, ETC.
3 - SNOWING
4 - FOG, SMOKE, ETC.
5 - RAINING AND FOGGY

54. ROAD SURFACE
1 - DRY
2 - WET
3 - MUDDY
4 - SNOW OR ICE

55. TRAFFIC CONTROL DEVICE TYPE
PRIN. ROAD
0 - NO CONTROLS
1 - FLASHING TRAFFIC SIGNAL
2 - TRAFFIC SIGNAL
3 - STOP SIGN
4 - YIELD SIGN
5 - RR CROSSING CONTROLS
6 - POLICE OFFICER OR FLAGMAN
7 - FLASHING SCHOOL ZONE SIGN
8 - OTHER
INT. ROAD

56. WITNESS NAME — ADDRESS
WITNESS NAME — ADDRESS

57. INJURED TAKEN TO — BY

58. USE CODES ON OVERLAY SHEET TO COMPLETE BLOCKS A THRU N OF THIS SECTION

A	B	C	D	E	F	G	NAME	ADDRESS	H	I	J	K	L	M	N

AA-45 (2-80)

INVESTIGATING AGENCY USE

59. DIAGRAM

INDICATE NORTH

USE ARROW

Number of Lanes on Principal Road:

60. NARRATIVE

INCIDENT NUMBER:

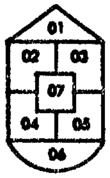
VEHICLE NUMBER

1 | 2

61. AUTO/TRUCK BODY TYPE ☐ ☐

01 - CONVERTIBLE
02 - 2 DR HARDTOP
03 - 4 DR HARDTOP
04 - 2 DR SEDAN
05 - 4 DR SEDAN
06 - STA. WAGON
07 - LIMOUSINE
08 - OTHER AUTO
11 - JEEP, ETC.
12 - PICK-UP
13 - VAN (NOT MOVING VAN OR HORSE VAN)
14 - TOW TRUCK
15-OTHER "SINGLE-UNIT" TRUCK
16 - TRACTOR (CAB ONLY)
17 - TRACTOR TRAILER
18 OTHER TRUCK BODY

62. INITIAL POINT OF IMPACT ☐ ☐



00 - NONE
07 - TOP
08 - UNDERCARRIAGE
09 - TOWED UNIT
99 - UNKNOWN

63. VEHICLE DAMAGE SEVERITY ☐ ☐

0 - NONE
1 - LIGHT
2 - MODERATE
3 - SEVERE

64. WAS TOWING REQUIRED? ☐ ☐

0 - NO
1 - YES

65. ESTIMATED TRAVEL SPEED ☐ ☐

00 - NONE (STOPPED/PARKED)
01-97 - CODE ACTUAL SPEED
98-98 OR GREATER
99 - UNKNOWN

66. VEHICLE GRADIENT ☐ ☐

1 - LEVEL ROADWAY
2 - UPHILL
3 - DOWN HILL

67. SPECIAL USAGE ☐ ☐

00 - NONE
01 - PUPIL TRANSPORT
02 - FIRE VEHICLE
03 - AMBULANCE
04 - OTHER EMERGENCY VEHICLE
05 - STATE POLICE VEHICLE
06 - PENN DOT VEHICLE
07 - OTHER STATE GOV'T. VEHICLE
08 - MUNICIPAL POLICE VEHICLE
09 - OTHER MUNICIPAL GOV'T VEHICLE
10 - FEDERAL GOV'T VEHICLE
11 - TAXI
12 - TOWING CAR
13 - TOWING TRUCK
14 - TOWING UTILITY TRAILER
15 - TOWING MOBILE/MODULAR HOME
16 - TOWING CAMPER

68. HAZARDOUS SUBSTANCE TYPE
- FROM PLACARD - ☐ ☐

00 - NOT APPLICABLE
01 - NON-FLAMMABLE GAS
02 - COMBUSTIBLE
03 - ORGANIC PEROXIDE
04 - CORROSIVE
05 - EXPLOSIVE "A"
06 - OXYGEN
07 - POISON
08 - EXPLOSIVE "B"
09 - CHLORINE
10 - OXIDIZER
11 - POISON GAS
12 - FUEL OIL
13 - DANGEROUS
14 - RADIOACTIVE
15 - FLAMMABLE SOLID - W
16 - FLAMMABLE
17 - FLAMMABLE GAS
18 - FLAMMABLE SOLID
19 - GASOLINE
98 - OTHER/NOT SIGNED

69. VIOLATIONS INDICATED UNIT NO. 1

70 CITATION(S) UNIT NO. 1

71 CITATION REPORT NO.(S)

72 VIOLATIONS INDICATED UNIT NO. 2

73. CITATION(S) UNIT NO. 2

74. CITATION REPORT NO.(S)

FOR ALCOHOL TEST TYPES - BLOCKS 76 AND 79 USE THE FOLLOWING CODES:

1 - BLOOD
2 - BREATH
3 - URINE
4 - TEST REFUSED
8 - OTHER CHEMICAL

75. NAME

76. TYPE

77. RESULT 0.___ ___%

78. NAME

79 TYPE

80. RESULT 0.___ ___%

81. IS THE INVESTIGATION COMPLETE?

STATE OF MICHIGAN - VEHICLE DAMAGE SEVERITY SCALE FOR MICHIGAN TRAFFIC ACCIDENT INVESTIGATORS

Vehicle Damage Severity Scale for Michigan Traffic Accident Investigators

FOREWORD

Since the Michigan Department of State Police has not previously had a specific published guide for use by investigators in evaluating vehicle damage in traffic accidents, the Department is attempting to fill this need with the printing of this booklet in the hope that it will prove to be a valuable tool for all law enforcement officers in Michigan.

Information as presented in this booklet is based on a brochure, "Vehicle Damage Scale for Traffic Accident Investigators", published by the National Safety Council and is produced by the Safety and Traffic Division of the Michigan Department of State Police, with the written approval of the Council, in a format applicable to Michigan.

The Michigan Department of State Police gratefully acknowledges this assistance from the Council and hopes that this booklet will help the investigator prepare a more accurate and comprehensive vehicle damage report in Michigan.

George L. Halverson

COL. GEORGE L. HALVERSON
Director

PURPOSE

Purpose of this manual is to aid investigators in assessing damage sustained by motor vehicles in traffic accidents. By means of a relatively simple procedure, most common types of damage can be rated in terms of a 7-point scale.

Basically, the vehicle damage scale consists of several pages of photographs of automobiles damaged in accidents. There is a separate page for each of the common impacts that investigators are likely to encounter. In order to rate damage on a vehicle, the user must select the proper page of photographs, and then attempt to match the damage on the subject vehicle with one of the photographs appearing on the page.

In the upper left corner of each page facing a photo page, there is a small diagram of a car and an arrow, or series of arrows, showing direction of the principal impact force. In addition to the diagram, there is a number which indicates the part of the vehicle damaged and type of impact. The number is repeated in the upper right corner of the photo page.

On each of the pages in the damage rating section of this appendix, there are 3 photographs, or 3 two-view sets of photographs, showing automobiles damaged in traffic accidents. Numerals on the left page opposite the photographs and intervening spaces are used for indicating severity of damage.

Damage in the top photographs, or sets of photographs, is minor and is generally limited to dents and gouges in body sheet metal and trim. The damage rating corresponding to these photographs is "2".

The second photographs, or sets of photographs, show automobiles that have been moderately damaged, with considerable crumpling of body sheet metal, but little or no distortion of the basic structure or frame. The damage rating in this case is "4".

In the photographs at the bottom of each sheet, vehicles are severely, but not totally damaged. Sheet metal is severely distorted, torn, or crumpled; the basic structure of the car is distorted somewhat; and there is usually some penetration of the passenger compartment. The damage rating is "6".

The reason for the "2, 4 and 6" rating is that an investigator may not be able to match damage on the vehicle on which he is reporting with any of the photographs. In that case, he may use "1, 3, 5 or 7" ratings for damage less or greater than shown in the photographs. Thus with the 3 photographs, he should be able to select any one of seven degrees of severity to describe how badly a car was damaged.

HOW TO USE SCALE

In order to make a damage rating, the investigator must first select the proper page of pictures. The selection will be determined by the type of collision. For example, if he is reporting a broadside collision which occurred at an intersection, and the front end of a vehicle struck another vehicle on its left side, he must refer to the Index to Damage Scale and find the diagram that most nearly describes the impact on the first vehicle. In this case, it may be the diagram which shows impact on the front end (1). For convenience, the pages are arranged in the same order as their designators appear in the index.

The next step is to compare the damage on the vehicle with the photograph in the selected page. If the front end damage of the first vehicle appears to match that of the bottom photograph on page 1 the damage rating would be "6". The entry in the accident report form would then be 1–6. However, if the damage were more severe, the rating would be 1–7; and, if less severe, 1–5.

The procedure for rating the damage on the car that was struck on its left side is similar. The entry in the accident report would be 7–6 if the vehicle damage appears to match that of the bottom photograph on page 3 or 7.

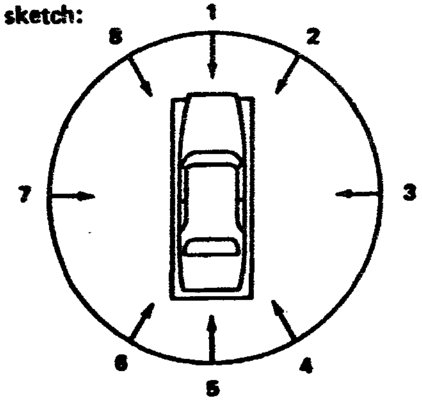
Dual designations such as 3/7, 2/8 and 4/6 mean that the pages so labeled may be used for either left or right sides of vehicle to be rated. The investigator should exercise care in writing the rating so that there will be no question as to what side or corner was damaged.

In cases in which vehicles are damaged in more than one area, the investigator should enter the rating of the total damage after vehicle comes to rest. If a vehicle sustained no discernable damage, a "0" (zero) rating with appropriate prefix should be used; e.g., 1–0, 5–0, etc. Such ratings are usually applicable to collisions of motor vehicles with pedestrians and collisions of heavy trucks with light passenger cars.

In the case of trucks and buses, the investigator should be able to make satisfactory ratings on damage to the front end, front quarter, and side impacts in the vicinity of the driver compartment. However, in the case of impacts in other parts of the vehicle, he may rate the damage without pictures to help if he applies the principles established for passenger cars.

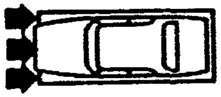
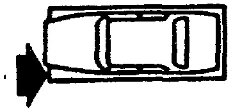
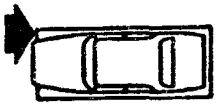
DIRECTION OF FORCE

A rough indication of the direction of force is provided by an imaginary circle superimposed around the vehicle as indicated by the following sketch:

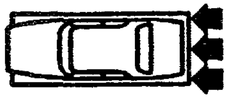
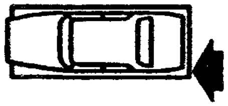
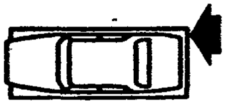
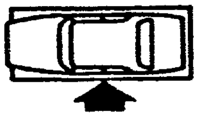
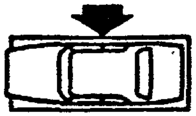
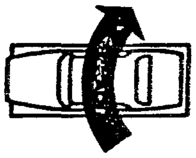


Any of the above numbers that is used should precede the numerical severity code.

INDEX TO DAMAGE SCALE

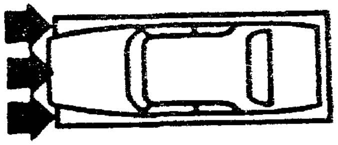
Location of Impact	Type of Impact	Impact Code
	Front end damage due to concentrated or distributed impact resulting from contact of front end of subject vehicle with other vehicle or object.	1
	Front left corner damage due to contact of front end of subject vehicle with other vehicle or object.	8
	Front right corner damage due to contact of front end of subject vehicle with other vehicle or object.	2

INDEX TO DAMAGE SCALE

Location of Impact	Type of Impact	Impact Code
	Rear end damage due to concentrated or distributed impact resulting from contact of rear end of subject vehicle with another vehicle or object. Applicable to rear-end collisions.	5
	Rear left corner damage due to contact of rear end of subject vehicle with another vehicle or object. Applicable to rear-end collisions.	6
	Rear right corner damage due to contact or rear end of subject vehicle with another vehicle or object. Applicable to rear-end collisions.	4
	Left side damage due to impact by another vehicle or object.	7
	Right side damage due to impact by another vehicle or object.	3
	Top damage due to roll-over	0

SEVERITY SCALE

Impact 1
Front End Damage



This scale is applicable to damage to front of subject vehicle due to distributed impact resulting from contact with other vehicle or object.

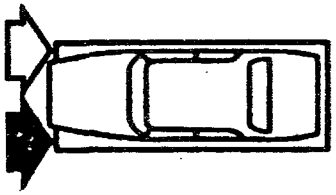
Damage Rating

1 ➧
2 ➧
3 ➧
4 ➧
5 ➧
6 ➧
7 ➧

1

SEVERITY SCALE

Impact 2 or 8
Front Corner Damage



This scale is applicable to damage resulting from contact of front end (Left front corner or right front corner) of subject vehicle with another vehicle or object.

Damage Rating

1 ➧

2 ➧

3 ➧

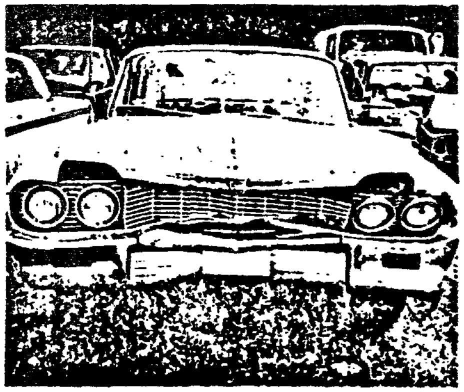
4 ➧

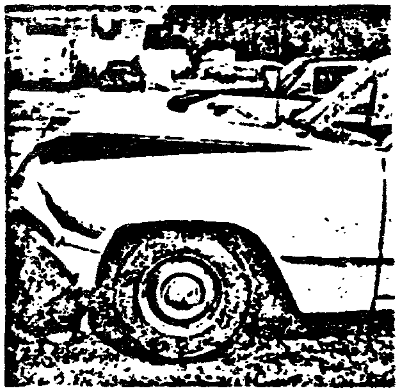
5 ➧

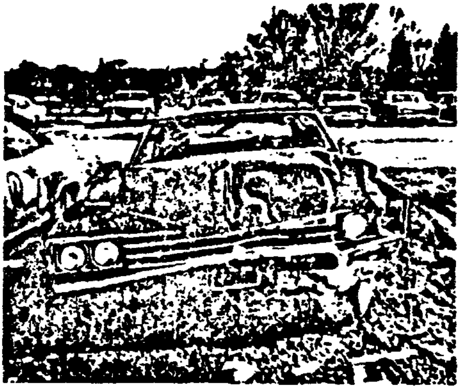
6 ➧

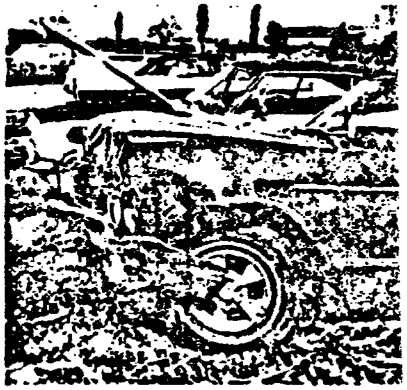
7 ➧

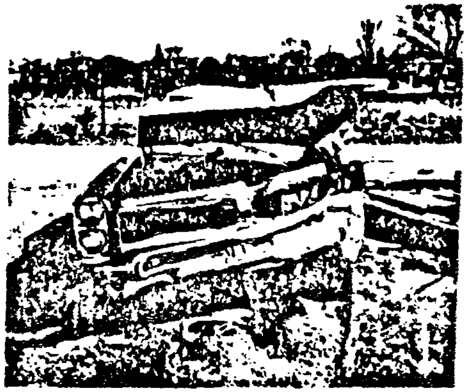
2 or 8

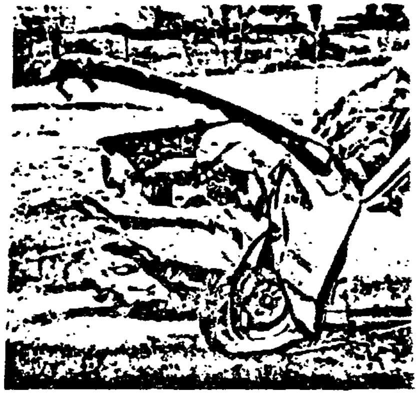






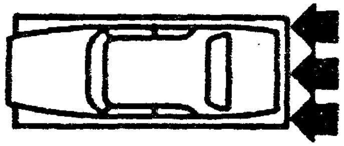






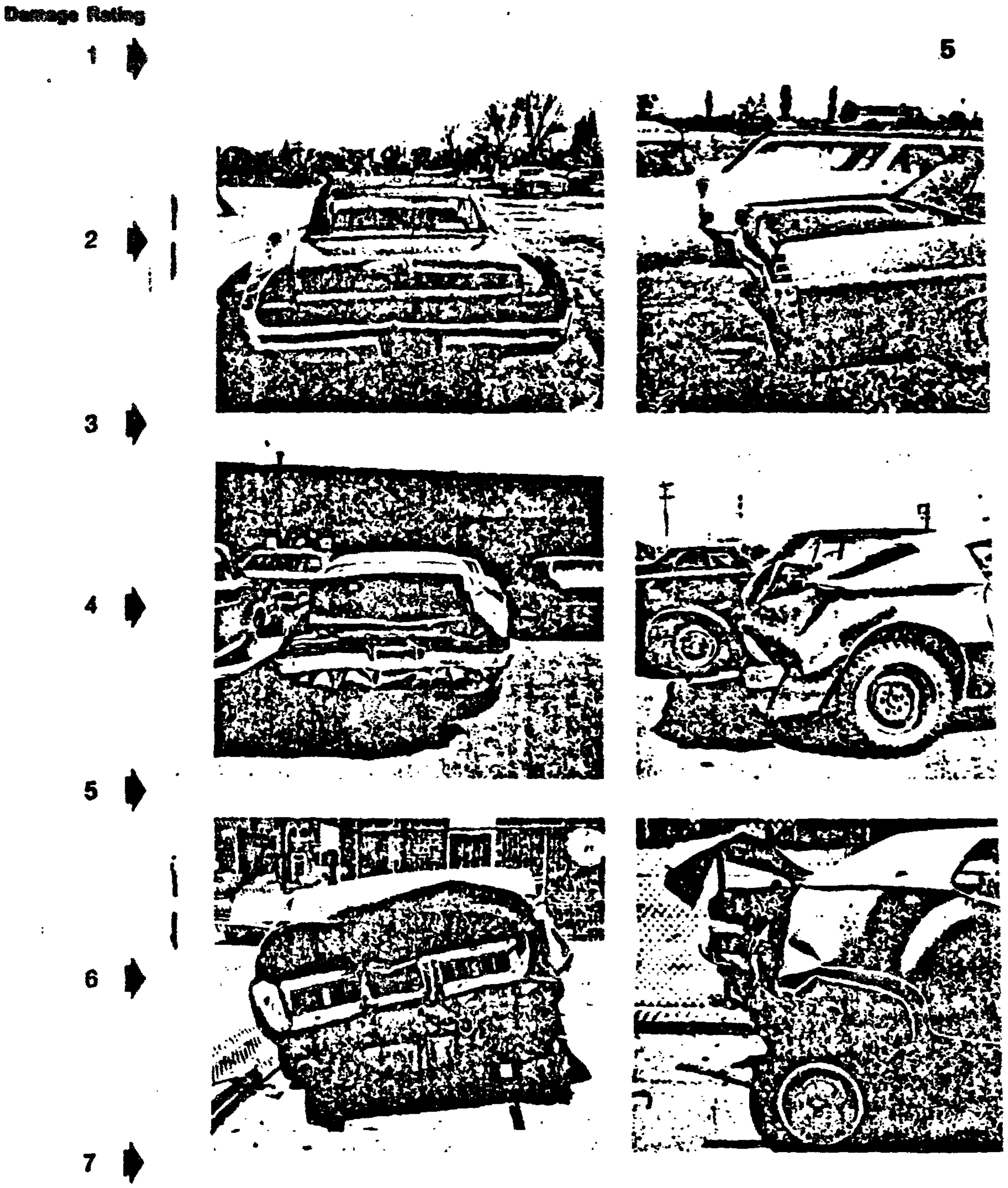
SEVERITY SCALE

Impact 5
Rear End Damage



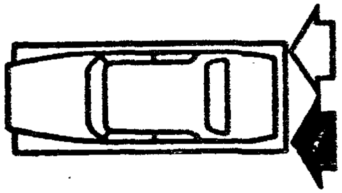
This scale is applicable to damage to rear of subject vehicle resulting from contact of rear end of subject vehicle with other vehicle or object.

5



SEVERITY SCALE

Impact 4 or 6
Rear Corner Damage



This scale is applicable to damage resulting from contact with left rear corner of right rear corner of subject vehicle with another vehicle or object.

Damage Rating

1 ➧

2 ➧

3 ➧

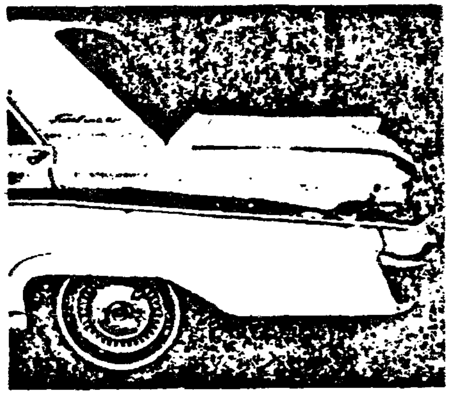
4 ➧

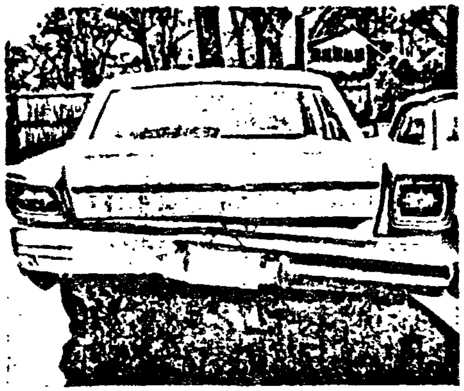
5 ➧

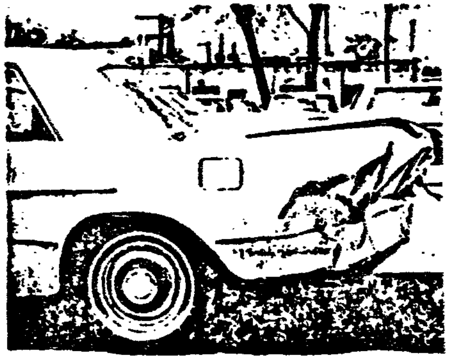
6 ➧

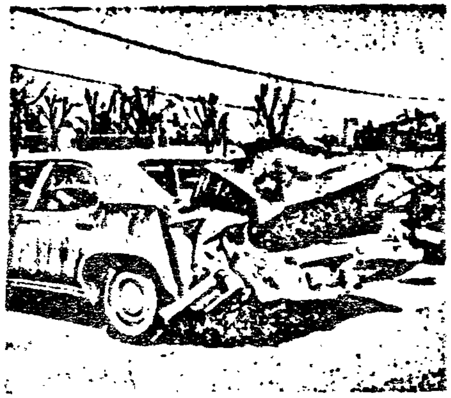
7 ➧

4 or 6



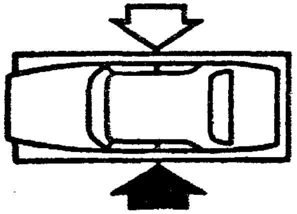






SEVERITY SCALE

Impact 3 or 7
Side Damage



This scale is applicable to damage to side of subject vehicle resulting from an impact by another vehicle or object.

Damage Rating

1

2

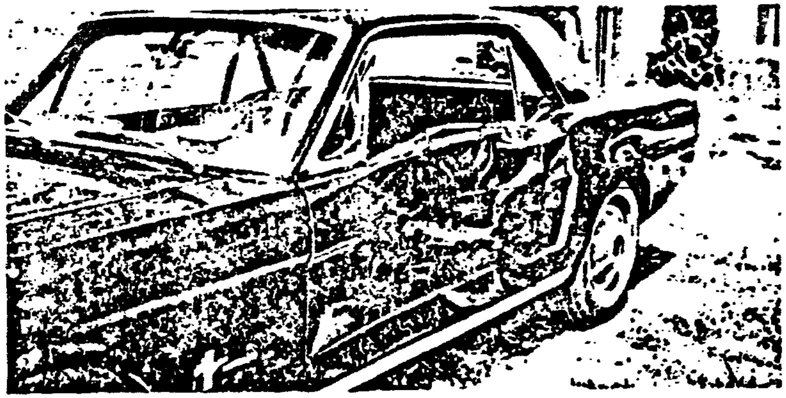
3

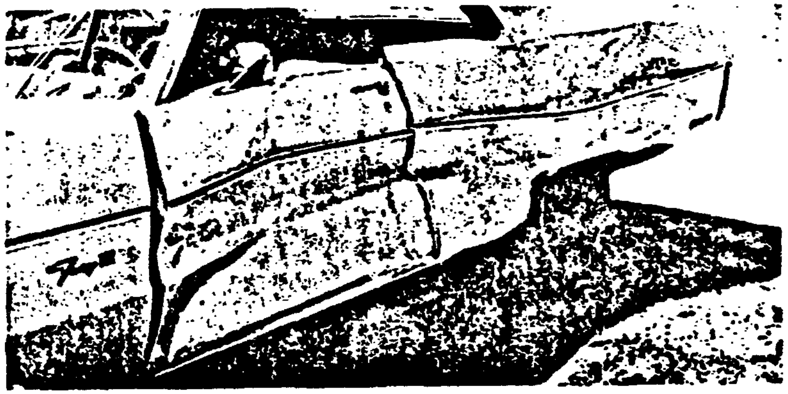
4

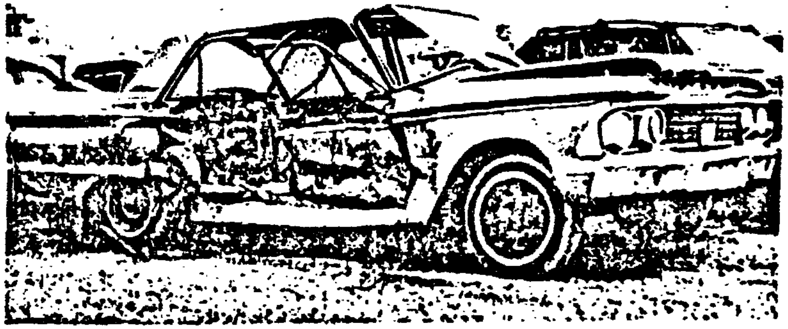
5

6

7

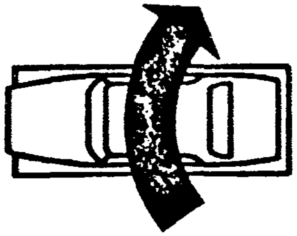






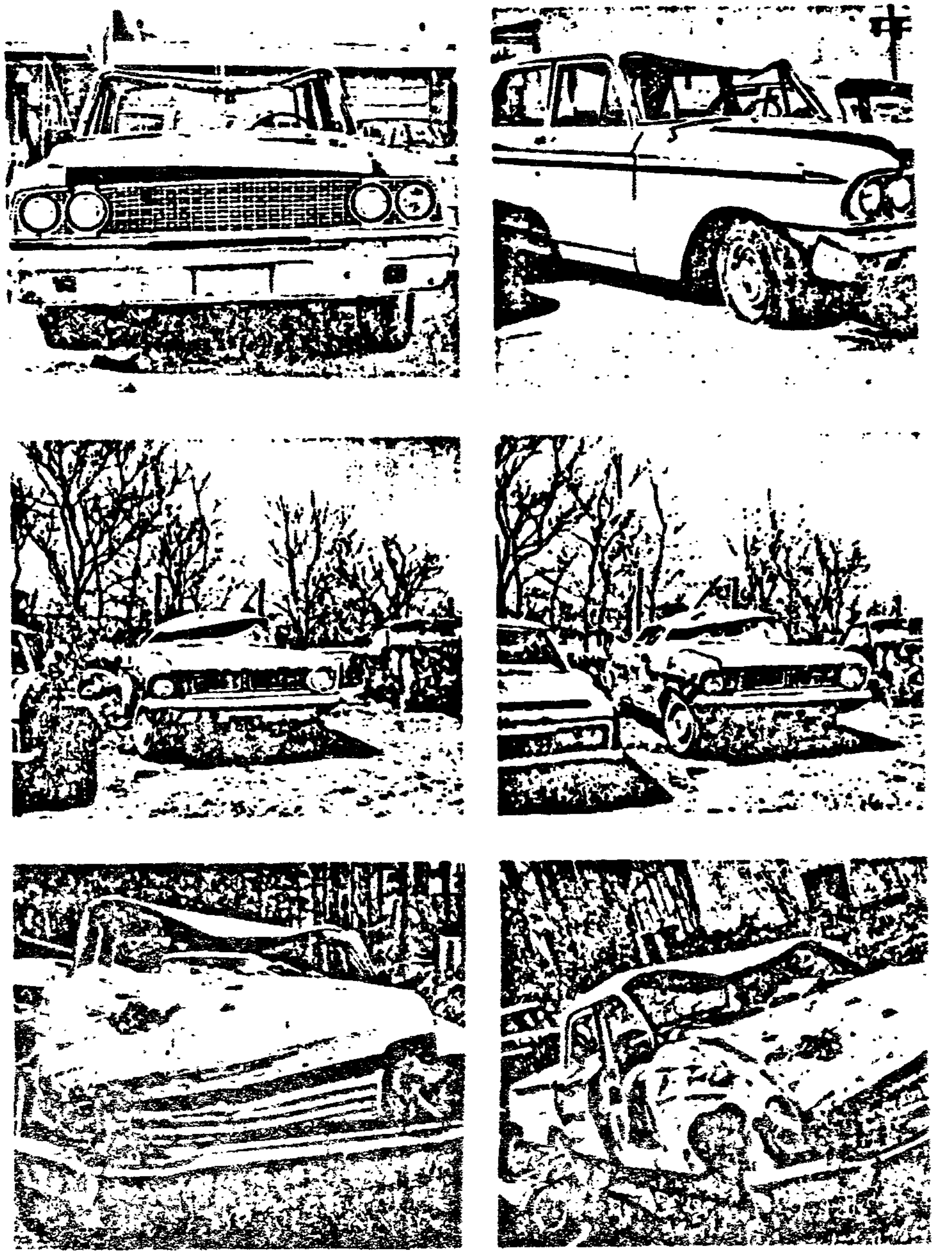
SEVERITY SCALE

Impact 0
Top Damage



This scale is applicable to roll-over damage.

0



STATE OF MICHIGAN

POLICE-REPORTED K-A-B-C INJURY SCALE

THE K,A,B,C INJURY SCALE

= This definition is taken from the 'Manual On =
= Classification Of Motor Vehicle Traffic =
= Accidents, second edition.' =

Fatal injuries - K

A fatal injury is any injury that results in death within twelve months of the crash.

Incapacitating injuries - A

An incapacitating injury is any injury, other than fatal, which prevents the injured person from walking, driving, or normally continuing the activities which he was capable of performing prior to the crash. Incapacitating injuries include the following: severe lacerations, broken or distorted limbs, skull fracture, crushed chest, internal injuries, unconscious when taken from the scene, and unable to leave scene without assistance.

Hospitalization normally will be required for incapacitating injuries.

Non-incapacitating injuries - B

A non-incapacitating injury is any injury, other than fatal or incapacitating, which is evident to any observer at the scene of the crash. Non-incapacitating injuries include the following: lumps on head, abrasions, and minor lacerations.

Possible injuries - C

A possible injury is any injury reported or claimed, other than fatal, incapacitating, or non-incapacitating evident injuries. Possible injuries include the following: momentary unconsciousness, limping, complaints of pain, nausea, hysteria, and claims of injuries not evident. (Whiplash frequently falls into this catagory.)

No injury

A person is not injured when there is no reason to believe that the person received any bodily injury from the crash. No injury includes the following: confusion, excitement, and anger.

FATAL ACCIDENT REPORTING SYSTEM - ACCIDENT REPORT FORMS

U.S. Department of Transportation
National Highway Traffic Safety Administration

1982 Fatal Accident Reporting System (FARS)
ACCIDENT LEVEL

Form Approved thru 12/31/83
O.M.B. No. 2127-0006
STATE CASE NO. ____________

This report is authorized by the Highway Safety Act of 1966, P.L. 89-564. While the law does not require you to respond, the State is obligated under the terms of a grant of funds to defray the expense of reporting this information to cooperate in or to make the results of this survey comprehensive, accurate and timely.

CASE NUMBER STATE (GSA CODES) 1 2

CONSECUTIVE NUMBER 3 – 6

TRANSACTION CODE 7 8: 1
11—Original Submission
12—Update or Change

CARD NO. 9: 1

CITY 14 – 17

COUNTY 18 – 20

DATE (MONTH DAY YEAR) 21 – 26: 8 2

TIME 27 – 30
Military Time
9999—Unknown

Number of Vehicle Forms Submitted 31 32

Number of Person Forms Submitted 33 34

LAND USE 35
1—Urban
2—Rural
3—Unknown

ROADWAY FUNCTION CLASS 36
1—Principal Arterial - Interstate
2—Principal Arterial - Other Urban Freeways and Expressways
3—Principal Arterial - Other
4—Minor Arterial
5—Urban Collector
6—Major Rural Collector
7—Minor Rural Collector
8—Local Road or Street
9—Unknown

FEDERAL-AID SYSTEM 37
1—Interstate
2—Other Federal-Aid Primary
3—Federal-Aid Secondary
4—Federal-Aid Urban Arterials
5—Federal-Aid Urban Collectors
6—Non-Federal-Aid Arterials
7—Non-Federal-Aid Collectors
8—Non-Federal-Aid Local
9—Unknown

CLASS TRAFFICWAY 38
1—Interstate
2—Other U.S. Route
3—Other State Route
4—County Road
5—Local Street
8—Other
9—Unknown

TRAFFICWAY IDENTIFIER 39 – 48
Actual Posted Number, Assigned Number, or Common Name (If No Posted or Assigned Number)
Except: Nine Fill If Unknown

MILEPOINT 49 – 53
Actual to Nearest .1 Mile (Assumed Decimal)
Except: 00000 — None
99999 — Unknown

SPECIAL JURISDICTION 54
0—No Special Jurisdiction
1—National Park Service
2—Military
3—Indian Reservation
4—College/University Campus
5—Other Federal Properties
8—Other
9—Unknown

FIRST HARMFUL EVENT 55 56
(See Instruction Manual)

MANNER OF COLLISION 57
0—Not Collision with Vehicle in Transport
1—Rear-End
2—Head On
3—Rear-to-Rear
4—Angle
5—Sideswipe, Same Direction
6—Sideswipe, Opposite Direction
9—Unknown

RELATION TO JUNCTION 58
1—Non-Junction
2—Intersection
3—Intersection Related
4—Interchange Area
5—Driveway, Alley Access, etc.
6—Entrance/Exit Ramp
7—Rail Grade Crossing
8—In Crossover
9—Unknown

RELATION TO ROADWAY 59
1—On Roadway
2—Shoulder
3—Median
4—Roadside
5—Outside Right-of-Way
6—Off Roadway—Location Unknown
7—In Parking Lane
8—Gore
9—Unknown

TRAFFICWAY FLOW 60
1—Not Physically Divided (Two Way Trafficway)
2—Divided Highway, Median Strip (Without Traffic Barrier)
3—Divided Highway, Median Strip (With Traffic Barrier)
4—One Way Trafficway
9—Unknown

NUMBER OF TRAVEL LANES 61
Actual Value Except:
7—Seven or more lanes
9—Unknown

SPEED LIMIT 62 63
Actual Miles Per Hour Except:
00—No Statutory Limit
99—Unknown

ROADWAY ALIGNMENT 64
1—Straight
2—Curve
9—Unknown

ROADWAY PROFILE 65
1—Level
2—Grade
3—Hillcrest
4—Sag
9—Unknown

ROADWAY SURFACE TYPE 66
1—Concrete
2—Blacktop (Bituminous)
3—Brick or Block
4—Slag, Gravel or Stone
5—Dirt
8—Other
9—Unknown

ROADWAY SURFACE CONDITION 67
1—Dry
2—Wet
3—Snow or Slush
4—Ice
5—Sand, Dirt, Oil
8—Other
9—Unknown

TRAFFIC CONTROL DEVICE 68 69
(See Instruction Manual)

TRAFFIC CONTROL DEVICE FUNCTIONING 70
0—No Controls
1—Device Not Functioning
2—Device Functioning - Functioning Improperly
3—Device Functioning Properly
9—Unknown

HIT AND RUN 71
0—No Hit and Run
1—Hit Motor Vehicle in Transport
2—Hit Pedestrian or Non-Motorist
3—Hit Parked Vehicle or Object

LIGHT CONDITION 72
1—Daylight
2—Dark
3—Dark but lighted
4—Dawn
5—Dusk
9—Unknown

ATMOSPHERIC CONDITIONS 73
1—No Adverse Atmospheric Conditions
2—Rain
3—Sleet
4—Snow
5—Fog
6—Rain and Fog
7—Sleet and Fog
8—Other: Smog, Smoke, Blowing Sand or Dust
9—Unknown

CONSTRUCTION/MAINTENANCE ZONE 74
0—None
1—Construction
2—Maintenance
3—Utility
4—Work Zone, Type Unknown

NOTIFICATION TIME EMS 75 – 78
Military Time Except:
0000—Not Notified
9999—Unknown

ARRIVAL TIME EMS 79 – 82
Military Time Except:
0000—Not Notified
9999—Unknown

SCHOOL BUS RELATED 83
0—No
1—Yes

RELATED FACTORS 84 85 86 87 88 89
See Instruction Manual
"Related Factors—ACCIDENT LEVEL"

RAIL GRADE CROSSING IDENTIFIER 90 – 98
(See Instruction Manual)

CARD NO. 9: 2

ADDITIONAL STATE INFORMATION 14 – 24 – 33
(See Instruction Manual)

HS Form 214 (Rev. 12/81)

U.S. Department of Transportation
National Highway Traffic Safety Administration

1982 Fatal Accident Reporting System (FARS)
VEHICLE/DRIVER LEVEL

Form Approved thru 12/31/83
O.M.B. No. 2127-0006

STATE CASE NO. ____________

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CONSECUTIVE NUMBER 3 … 6 ☐☐☐☐

TRANSACTION CODE 7 8 [2]☐
21—Original Submission
22—Update or Change

CARD NO. 9 [1]

VEHICLE NUMBER (Assigned by Analyst) 10 11 ☐☐

VEHICLE MAKE (See Instruction Manual) 14 15 ☐☐

VEHICLE MODEL (See Instruction Manual) 16 17 ☐☐

BODY TYPE (See Instruction Manual) 18 19 ☐☐

MODEL YEAR 20 21 ☐☐
Actual Value except
99—Unknown

VEHICLE IDENTIFICATION NO. 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Actual Value except:
Zero Fill if no VIN
Nine Fill if Unknown

REGISTRATION STATE 39 40 ☐☐
GSA CODES Except:
00—Not Applicable
92—No Registration
93—Multiple State Reg. In-State
94—Multiple State Reg., Out-of-State
95—U.S. Government Tags
96—Military Vehicle
97—Foreign Countries
99—Unknown

ROLLOVER 41 ☐
0—No Rollover
1—First Event
2—Subsequent Event

JACKKNIFE 42 ☐
0—Not an Articulated Vehicle
1—No
2—First Event
3—Subsequent Event

TRAVEL SPEED 43 44 ☐☐
Actual Miles Per Hour Except:
00—Stopped Vehicle
97—Ninety-seven MPH or Greater
99—Unknown

HAZARDOUS CARGO 45 ☐
0—No
1—Yes
9—Unknown

VEHICLE TRAILERING 46 ☐
0—No
1—Yes, One Trailing Unit
2—Yes, Two or more Trailing Units
3—Yes, Number of Trailing Units Unknown
9—Unknown

SPECIAL USE 47 ☐
0—No Special Use
1—Taxi
2—Vehicle Used as School Bus
3—Vehicle Used as other Bus
4—Military
5—Police
6—Ambulance
7—Firetruck
9—Unknown

EMERGENCY USE 48 ☐
0—No
1—Yes

IMPACT POINT—INITIAL 49 50 ☐☐
00—Non-Collision
01-12—Clock Points
13—Top
14—Undercarriage
15—Under Ride
16—Override
99—Unknown

IMPACT POINT—PRINCIPAL 51 52 ☐☐
00—Non-Collision
01-12—Clock Points
13—Top
14—Undercarriage
15—Under Ride
16—Override
99—Unknown

EXTENT OF DEFORMATION 53 ☐
0—None
2—Other (Minor)
4—Functional (Moderate)
6—Disabling (Severe)
9—Unknown

VEHICLE ROLE 54 ☐
0—Non-Collision
1—Striking
2—Struck
3—Both
9—Unknown

MANNER OF LEAVING SCENE 55 ☐
1—Driven
2—Towed Away
3—Abandoned
9—Unknown

FIRE OCCURRENCE 56 ☐
0—No Fire
1—Fire Occurred in Vehicle During Accident

NUMBER OF OCCUPANTS 57 58 ☐☐
Actual Value if Total Known
96—96 or more
97—Unknown—Only Injured Reported
99—Unknown

RELATED FACTORS 59 60 ☐☐ 61 62 ☐☐
See Instruction Manual
"Related Factors—VEHICLE LEVEL"

VEHICLE MANEUVER 63 64 ☐☐
(See Instruction Manual)

MOST HARMFUL EVENT 65 66 ☐☐
(See Instruction Manual)

Card No. 9 [2]

DRIVER PRESENCE 14 ☐
1—Driver Operated Vehicle
2—Driverless
3—Driver Left Scene
9—Unknown

LICENSE STATE GSA CODES 15 16 ☐☐
Except:
94—Military
95—Canada
96—Mexico
97—Other Foreign Countries
99—Unknown

LICENSE/CLASS VEHICLE COMPLIANCE 17 ☐
0—No License Required
1—No License, License Required
2—Valid License for This Class Vehicle Only
3—One Valid License, but Not for This Class Vehicle
4—Multiple Class Licenses, Valid License for This Class Vehicle
5—Multiple Class Licenses, No Valid License for This Class Vehicle
9—Unknown

LICENSE STATUS 18 ☐
0—None Required
1—None
2—Valid
3—Suspended
4—Revoked
5—Expired
6—Cancelled or Denied
7—Learner's Permit
8—Temporary
9—Unknown

COMPLIANCE WITH LICENSE RESTRICTIONS 19 ☐
0—No Restrictions
1—Restrictions Complied With
2—Restrictions Not Complied With
3—Restrictions, Compliance Unknown
9—Unknown

DRIVER TRAINING 20 ☐
0—None
1—High School
2—Commercial
3—School Bus
4—Traffic School
5—Two or more Types
6—Training, Type Unknown
9—Unknown

VIOLATIONS CHARGED 21 ☐
0—None
1—Alcohol or Drugs
2—Speeding
3—Alcohol or Drugs and Speeding
4—Reckless Driving
5—Driving with a Suspended or Revoked License
6—Other Moving Violation
7—Non-Moving Violation
8—Violation, Type Unknown or Other Violation
9—Unknown

PREVIOUS RECORDED ACCIDENTS 22 23 ☐☐
Actual Value Except:
00—None
99—Unknown

PREVIOUS RECORDED SUSPENSIONS AND REVOCATIONS 24 25 ☐☐
Actual Value Except:
00—None
99—Unknown

PREVIOUS DWI CONVICTIONS 26 27 ☐☐
Actual Value Except:
00—None
99—Unknown

PREVIOUS SPEEDING CONVICTIONS 28 29 ☐☐
Actual Value Except:
00—None
99—Unknown

PREVIOUS OTHER HARMFUL MV CONVICTIONS 30 31 ☐☐
Actual Value Except:
00—None
99—Unknown

DATE OF LAST ACCIDENT, SUSPENSION, OR CONVICTION 32 … 35 ☐☐ ☐☐
Mo. Yr.
00—No Record
99—Unknown

DATE OF FIRST ACCIDENT SUSPENSION, OR CONVICTION 36 … 39 ☐☐ ☐☐
Mo. Yr.
00—No Record
99—Unknown

RELATED FACTORS 40 41 ☐☐ 42 43 ☐☐ 44 45 ☐☐
See Instruction Manual,
"Related Factors—DRIVER LEVEL"

HS Form 214A (Rev. 12/81)

U.S. G.P.O. 1981-522-849/70

U.S. Department of Transportation

National Highway Traffic Safety Administration

1982 Fatal Accident Reporting System (FARS)
PERSON LEVEL

Form Approved thru 12/31/83
O.M.B. No. 2127-0006

STATE CASE NO. ______________

This report is authorized by the Highway Safety Act of 1966, P.L. 89-564. While the law does not require you to respond, the State is obligated under the terms of a grant of funds to defray the expense of reporting this information to cooperate in or to make the results of this survey comprehensive, accurate and timely.

CASE NUMBER STATE (GSA CODES) 1 2 ☐☐

CONSECUTIVE NUMBER 3 6 ☐☐☐☐

TRANSACTION CODE 7 8 3 ☐
31—Original Submission
32—Update or Change

CARD NO. 9 1

VEHICLE NUMBER (Assigned by Analyst) 10 11 ☐☐
00—Non-Motorist

PERSON NUMBER 12 13 ☐☐
(Assigned by Analyst)

NON-MOTORIST STRIKING VEHICLE NUMBER
14 15 ☐☐

Assigned Vehicle Number
Except:
99—Unknown

AGE
16 17 ☐☐

Actual Value
00—Up to One Year
97—Ninety-Seven Years or Older
99—Unknown

SEX
18 ☐

1—Male
2—Female
9—Unknown

PERSON TYPE
19 ☐

1—Driver of a Motor Vehicle in Transport
2—Passenger of a Motor Vehicle in Transport

3—Occupant of a Motor Vehicle Not in Transport
4—Occupant of a Non-Motor Vehicle Transport Device

5—Non-Occupant — Pedestrian
6—Non-Occupant — Bicyclist
7—Non-Occupant — Other Cyclist
8—Non-Occupant — Other or Unknown

9—Unknown Occupant Type in a Motor Vehicle in Transport

SEATING POSITION
20 21 ☐☐

00 — Non-Motorist
11—Front Seat — Left Side (Driver's Side)
12— — Middle
13— — Right Side
18— — Other
19— — Unknown
21—Second Seat — Left Side
22— — Middle
23— — Right Side
28— — Other
29— — Unknown
31—Third Seat — Left Side
32— — Middle
33— — Right Side
38— — Other
39— — Unknown
41—Fourth Seat — Left Side
42— — Middle
43— — Right Side
48— — Other
49— — Unknown
50—Sleeper Section of Cab (Truck)
51—Other Passenger in Enclosed Passenger or Cargo Area
52—Other Passenger in Unenclosed Passenger or Cargo Area
53—Other Passenger in Passenger or Cargo Area, Unknown Whether or Not Enclosed
54—Trailing Unit
55—Riding on Vehicle Exterior
99—Unknown

MANUAL (ACTIVE) RESTRAINT SYSTEM—USE
22 ☐

0—None Used - Vehicle Occupant/Not Applicable - Non-Motorist
1—Shoulder Belt
2—Lap Belt
3—Lap and Shoulder Belt
4—Child Safety Seat
5—Motorcycle Helmet
8—Restraint Used — Type Unknown or Other Including Other Helmet
9—Unknown

AUTOMATIC (PASSIVE) RESTRAINT SYSTEM — FUNCTION
23 ☐

0—Not Equipped or Non-Motorist
1—Automatic Belt in Use
2—Automatic Belt Not in Use
3—Deployed Air Bag
4—Non-deployed Air Bag
9—Unknown

NON-MOTORIST LOCATION
24 25 ☐☐

00—Not Applicable — Vehicle Occupant
01—Intersection — In Crosswalk
02—Intersection — On Roadway, Not in Crosswalk
03—Intersection — On Roadway, Crosswalk Not Available
04—Intersection — On Roadway, Crosswalk Availability Unknown
05—Intersection — Not on Roadway
09—Intersection — Unknown
10—Non-Intersection — In Crosswalk
11—Non-Intersection — On Roadway, Not in Crosswalk
12—Non-Intersection — On Roadway, Crosswalk Not Available
13—Non-Intersection — On Roadway, Crosswalk Availability Unknown
14—Non-Intersection — In Parking Lane
15—Non-Intersection — On Road Shoulder
16—Non-Intersection — Bike Path
17—Non-Intersection — Outside Trafficway
18—Non-Intersection — Other, Not on Roadway
19—Non-Intersection — Unknown
99—Unknown

EJECTION
26 ☐

0—Not Ejected
1—Totally Ejected
2—Partially Ejected
9—Unknown

EXTRICATION
27 ☐

0—Not Extricated
1—Extricated
9—Unknown

POLICE REPORTED ALCOHOL INVOLVEMENT
28 ☐

0—No (Alcohol Not Involved)
1—Yes (Alcohol Involved)
8—Not Reported
9—Unknown (Police Reported)

ALCOHOL TEST RESULT
29 30 ☐☐

Actual Value (Decimal Implied before First Digit) (0.xx)
95—Test Refused
96—None Given
97—AC Test Performed, Results Unknown
99—Unknown

INJURY SEVERITY
31 ☐

0—No Injury (O)
1—Possible Injury (C)
2—Nonincapacitating Evident Injury (B)
3—Incapacitating Injury (A)
4—Fatal Injury (K)
5—Injured, Severity Unknown
6—Died Prior to Accident
9—Unknown

TAKEN TO HOSPITAL OR TREATMENT FACILITY
32 ☐

0—No
1—Yes
9—Unknown

DEATH DATE
33 38 ☐☐☐☐☐☐
MONTH DAY YEAR

000000—Not Applicable
999999—Unknown

DEATH TIME
39 42 ☐☐☐☐

Military Time Except:

0000—Not Applicable
9999—Unknown

RELATED FACTORS
43 44 ☐☐ 45 46 ☐☐ 47 48 ☐☐

See Instruction Manual
"Related Factors—PERSON LEVEL"

HS Form 214S (Rev. 12/81)

U.S. G.P.O. 1981- 22-850/71