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Technical Report

Analysis of Motor Vehicle Fuel Tank-Related Fires

By

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Standards Development and Support Branch
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I. Introduction

Recently several parties have expressed concern regarding the safety of onboard refueling emission controls. These parties have commented that adding canister-based onboard controls to current motor vehicles would add some complexity to the fuel system which could increase the risk of crash and non-crash fires. In a separate analysis, EPA conducted an evaluation of the safety implications of canister-based onboard systems to address the concerns raised. This evaluation concluded that straightforward, reliable, relatively inexpensive engineering solutions exist for each of the potential problems identified and that no increase in risk need occur or be accepted because of the presence of an onboard system.[1]

Since onboard refueling controls will modify the fuel/evaporative systems of motor vehicles and thus could have some impact on the risk of fire, it is important to have a baseline assessment of the risk for current vehicles. The purpose of this technical report is to provide an assessment of the current risk of fuel tank-related fires for motor vehicles which meet current safety standards, and therefore provide a baseline from which to assess any potential change in risk (increase or decrease) which may occur due to onboard vapor recovery systems.

A preliminary assessment of fuel tank-related fires was drafted and released for comment and review to agencies with expertise in this area.[2] (This preliminary assessment was also placed in EPA Docket A-87-11 for public review.) Agencies which were asked to review this analysis include the National Highway Traffic Safety Administration (NHTSA), the Office of Motor Carrier Safety (OMCS) of the Federal Highway Administration, the Federal Emergency Management Agency (FEMA), and the Insurance Institute for Highway Safety (IIHS). Based on comments and further data received from these parties, the preliminary analysis has been refined and is summarized in this technical report.[3,4,5]

Before presenting this analysis, it is important to note that the potential hazard of fuel tank-related fires has been a concern in the past. To address such concerns, Federal Motor Vehicle Safety Standard (FMVSS) 301 was promulgated by the Department of Transportation in 1967 (effective January 1, 1968) to decrease the potential of crash fires.[6] This standard improved the fuel system crashworthiness of passenger cars by limiting the amount of allowable fuel leakage in the event of an accident. Since that time, there have been two additional FMVSS 301 rulemakings to upgrade the standard and further improve the fuel system integrity of motor vehicles.[7,8] In 1975, this Standard was substantially enhanced by extending the coverage of impact types and applicable vehicles. According to this upgraded standard, FMVSS 301-75, which was effective for 1976 model year passenger cars and 1977 and 1978 model year light-duty trucks, all vehicles with a Gross Vehicle Weight Rating (GVWR) of 10,000 pounds or less must restrict fuel leakage to less than five ounces per five minutes when subjected to a rollover test following front and rear collisions at 30 miles per hour (mph), and side collision(s) at 20 mph.[7] Furthermore, beginning in April 1977, school buses with a GVWR greater than 10,000 pounds must meet the same requirements when subjected to an impact with a contoured moving barrier at any speed up to and including 30 mph, at any point and angle.[8] Therefore, past concerns regarding crash fires have lead to three FMVSS 301 rulemakings with increasing stringency.

As a result of these variations of FMVSS 301, the motor vehicle fire data base is more complex. The fire data which exists today includes a mixture of vehicles of varying model years which comply with different versions of FMVSS 301 and in some cases meet no standard. These data must be analyzed closely to assess the fire risk associated with current motor vehicles, to which FMVSS 301-75 is applicable.

As mentioned above, the purpose of this report is to analyze the motor vehicle fire data and to estimate the current risk of fuel tank-related fires. The report begins with a summary of currently available data on the annual number of total motor vehicle fires, post-collision fires, and fuel tank-related fires and the subsequent associated fatalities, injuries and property damage with these fires. This is followed by a discussion of how these data were analyzed and adjusted to project the number of fuel tank fires, fatalities, injuries, and property damage in 1990 and beyond when refueling controls could be required.[9] The report closes with a brief summary of the analysis and draws some conclusions.

II. Summary of Available Data

The available data on fuel tank-related fires and their subsequent effects are limited; no single body of data exist which accurately assesses the overall hazards. Virtually all of the available data arise initially from police and fire marshall reports from different states. While police reports from such states as Michigan, Illinois, North Carolina, Maryland, and Pennsylvania are quite useful, these records alone are not adequate to characterize the problem. Data from these records can be extrapolated to obtain an estimate of national values.

Further, the nature and extent of the fire crash data varies in different state reports. For example, some state accident reports are very explicit in evaluating fires from fuel leakage, the type of accident (front end, rear end, rollover) and the accident severity. Others are less complete perhaps only reporting information on fires and fatalities without much supporting detail on the cause or location of the vehicle fire.

The available fire information from police and fire reports has been used by several different motor vehicle safety experts to develop data bases and other analyses which can estimate the number of fuel tank-related fires and their subsequent effects. This analysis of fuel tank fires uses information from two data bases, the Fatal Accident Reporting System (FARS) and the National Fire Incident Reporting System (NFIRS), and four past analyses on motor vehicle fires. Each of these data bases and analyses will be described below, together with the important information drawn from the source.

A. Motor Vehicle Fire Data Bases

Fatal Accident Reporting System (FARS)[10]

The Fatal Accident Reporting System (FARS) is a motor vehicle accident data base operated and maintained by NHTSA which gathers data on all nationwide police-reported accidents (for all types of vehicles, including passenger cars, light-duty trucks, buses, and heavy-duty vehicles) in which a fatality occurs. FARS specifies the occurrence of fire in such motor vehicle accidents, but does not define the severity of the fire, the cause of the fire, which vehicle the fire was initiated in (when two or more vehicles are involved), or whether a fatality was caused directly by fire. Since the FARS data represent only accidents with fatalities, the reported motor vehicle accidents contained in this data base are generally more severe. Therefore, use of these data alone could misrepresent or overestimate the overall fire hazard for current vehicles.

Nevertheless, FARS does offer some useful information with respect to the number of fatalities from all motor vehicle accidents and those in which a post-collision fire occurred. The data cover vehicles of all model years (i.e., both pre- and post-standard vehicles). The key data extracted from this source were averaged over the time period of 1980 through 1984 and are summarized below:

- 1,605 annual post-collision motor vehicle fires in which a fatality was reported.
- 46,237 annual fatalities resulted from all motor vehicle accidents.
- 1,655 (3.6 percent) of these total fatalities resulted in accidents where a post-collision fire occurred.

National Fire Incident Reporting System (NFIRS)[11]

The National Fire Incident Reporting System (NFIRS) is a fire data base operated and maintained by FEMA which gathers data on all types of reported fires, including motor vehicle fires. (This motor vehicle data are based on all types of vehicles, including passenger cars, light-duty trucks, buses, and heavy-duty trucks.) The system receives a sampling of state fire reports and extrapolates national statistics from these. (For example, NFIRS received about 40 percent of the total nationwide fires for 1985.) NFIRS supplies data on the number of fires and the fatalities, injuries and property damage in these fires. Furthermore, this data base can characterize the fire information by type of vehicle, the vehicle area where the fire originated (i.e., fuel tank area), and whether the fire was a result of a collision or had some other non-collision cause.

For the purpose of this analysis, NFIRS data were extrapolated to represent nationwide estimates and were then averaged over the period of 1980 through 1985. (Detailed information obtained from NFIRS is presented in the appendix to this report.) Since NFIRS statistics are compiled on an annual basis, the data cover both pre- and post-standard vehicles. The important motor vehicle fire estimates (expressed as annual average values for both collision and non-collision fires) from the NFIRS data include:

- 488,000 total motor vehicle fires (of all vehicle types).
- 10,800 motor vehicle fires (2.2 percent) which originated in the fuel tank area.
- 237 fatalities in motor vehicle fires which originated in the fuel tank area.
- 631 injuries in motor vehicle fires which originated in the fuel tank area.
- $32 million in property damage from motor vehicle fires which originated in the fuel tank area.

The NFIRS annual average nationwide fire estimates using data from 1981 to 1985 for post-collision fires exclusively include:

- 1,871 motor vehicle fires which originated in the fuel tank area.
- 185 fatalities in motor vehicle fires which originated in the fuel tank area.
- 336 injuries in motor vehicle fires which originated in the fuel tank area.
- $14 million in property damage from motor vehicle fires which originated in the fuel tank area.

Another accident data base, the MCS 250 Accident Reports, which is operated and maintained by the Federal Highway Administration/OMCS, also reports the occurrence of motor vehicle fires in accidents. As is prescribed in the Code of Federal Regulations (49 CFR 394.3), all heavy-duty vehicle accidents in which death, bodily injury, or property damage of $4400 or greater have occurred must be reported to this data base. Since the data from this source only covers one class of vehicles and its nationwide representativeness of all accidents can not be determined, the MCS 250 Accident Reports were not used for this analysis. Other sources of helpful information for this assessment include previous analyses by vehicle safety experts. These analyses will be presented and discussed below.

B. Previous Motor Vehicle Fire Analyses

"Evaluation of Federal Motor Vehicle Safety Standard 301-75, Fuel System Integrity: Passenger Cars," Glenn Parsons, NHTSA (1983)[12]

This analysis was published by NHTSA in 1983 to evaluate the effectiveness of the improved FMVSS 301-75. The report characterizes the in-use accident and fire experience of both pre- and post-standard vehicles. The data contained in this report are obtained primarily from Michigan police accident reports for the calendar years 1978, 1979, and 1980 for accidents involving passenger vehicles only. From data presented in this report, Tables 1 and 2 show the distribution of impact type and vehicle damage severity in accidents involving both pre- and post-standard passenger cars. Table 1, which presents the frequency of accidents from the various impact types, shows that rollover accidents are rare occurrences (about 1.4 percent frequency) and most accidents are frontal impacts (about 60.9 percent frequency). Table 2 presents the damage severity sustained by each vehicle involved in an accident based on a Vehicle Damage Severity (VDS) scale. A VDS of 1 represents very minor vehicle damage, whereas a VDS of 8 represents extreme damage. As expected, this table shows that accidents with Lo-Moderate severity damage (VDS = 2, 3, 4, 5) are more frequent in comparison to major severity accidents (VDS = 6, 7, 8).

Furthermore, this report supplies data which characterizes the occurrence of fires in accidents involving pre- and post-standard vehicles. Table 3 presents the fire rates (number of fires per number of vehicle crashes) for both types of vehicles by impact type and damage severity. The data show that rollover and rear end collisions, especially those with major damage severity, have the highest fire rates. This table also shows that FMVSS 301-75 gave a greater reduction in the fire rates for major severity accidents (50.6 percent) than for Lo-Moderate severity accidents (22.4 percent) of these impact types.

Other data provided by this NHTSA technical report include the number and degree of injuries which result from vehicle accidents and post-collision fires. It categorizes the injuries into four types: fatal injuries, incapacitating injuries, non-incapacitating injuries, and possible injuries. In addition to the key data with regard to fire rates shown in Table 3, some further information presented in this report include:

Table 1

Distribution of Accidents by Impact Type*

Impact Type	Pre-Standard Frequency (%)	Post-Standard Frequency (%)	Overall Frequency (%)
Frontal	62.9	59.7	60.9
Rollover	1.5	1.4	1.4
Rear end	22.9	24.5	23.9
Other (Side, etc.)	12.8	14.4	13.8

* Based on Michigan data for calendar year 1980.

Table 2

Distribution of Accidents by Vehicle Damage Severity*

Vehicle Damage Severity	Pre-Standard Frequency (%)	Post-Standard Frequency (%)	Overall Frequency (%)
1	3.858	2.892	3.26
2	25.595	26.108	25.92
3	26.134	27.162	26.78
4	20.220	20.532	20.42
5	12.447	12.398	12.42
6	6.552	6.350	6.43
7	3.112	2.821	2.93
8	2.076	1.707	1.85

* Based on Michigan data for calendar year 1980.

Table 3

Fire Rates for Pre- and Post-Standard Vehicles by Impact Type and Damage Severity*

# of fires/# of vehicle crashes = fire rate($x10^{-3}$)

	Lo-Moderate Severity (VDS = 2,3,4,5)	Majority Severity (VDS = 6,7,8)
Pre-Standard		
Front end	360/229,433 = 1.569	91/9465 = 9.614
Rear end	139/99,663 = 1.395	90/6304 = 14.28
Rollover	14/2946 = 4.752	49/3389 = 14.46
TOTAL	513/332,042 = 1.545	230/19,158 = 12.01
Post-standard		
Front end	311/261,002 = 1.192	79/14,425 = 5.477
Rear end	139/119,141 = 1.167	40/6944 = 5.76
Rollover	10/3541 = 2.824	29/3599 = 8.05
TOTAL	460/383,684 = 1.199	148/24,968 = 5.93
Reduction from Standard	22.4%	50.6%

* Based on Michigan data for calendar years 1978, 1979, and 1980. Information for other types of impacts were not reported.

- 20,600 annual motor vehicle fires resulting from passenger car accidents.
- 1,099 annual fatalities in passenger car accidents with fire (average from FARS for 1978-1981).
- Total injuries in all passenger car accidents:
  - 385,892 incapacitating injuries
  - 865,642 non-incapacitating injuries
  - 1,095,180 possible injuries
- Injuries in passenger car accidents with post-collision fire:
  - 3,867 incapacitating injuries
  - 3,836 non-incapacitating injuries
  - 2,486 possible injuries

"Fires in Motor Vehicle Accident," Peter Cooley (1974)[13]

This analysis done by Peter Cooley of the Highway Safety Research Institute (HSRI, now the University of Michigan Transportation Research Institute or UMTRI) provides data on the total number of vehicle fires and the resulting fatalities. In this analysis, Cooley studies accidents of passenger cars to estimate the number of post-collision fires. Furthermore, he analyzes the fatalities involved in post-collision fires and determines whether the fatality was "accompanied by" or "directly caused by" the post-collision fire. Unfortunately, his data do not specify the source of the fire (i.e., fuel tank). Since this report was written in 1974, the data are based entirely on pre-standard vehicles. The key data presented in this analysis include the following:

- 17,000 annual fires result from motor vehicle accidents.
- 720-1,250 fatalities are accompanied by these fires.
- 450-650 fatalities are directly caused by the vehicle fires.

"General Motors and Fuel System Collision Fires" (1974)[14]

This study provides General Motors' point of view on the fire hazards of motor vehicles. It offers statistics on the number of passenger car fatalities caused directly by post-collision fires and more specifically, fuel system collision fires. Since this study was performed in 1974, it only relates to pre-standard vehicles. Key data include:

- 560-1,870 annual fatalities due to collision fires.

- 250 annual fatalities due to vehicle fuel system collision fires.

"A Perspective on Automobile Crash Fires," SAE 850092, Warner, James and Woolley, (1985)[15]

This SAE publication analyzes previous studies regarding automobile crash fires. The major conclusion from this analysis is that post-collision fuel-fed fires cause approximately 1-1.5 percent of all vehicle occupant fatalities in spite of the FMVSS 301 improvements.

This concludes the data available on fuel tank-related fires which were used in this analysis. Based on information gathered from these motor vehicle fire data bases and previous studies, the fire hazard of current vehicles can be estimated.

III. Analysis of Data

As shown in the previous section, Summary of Available Data, the data bases and previous analyses regarding motor vehicle fires provide different types of information covering different time periods. With careful analysis, the information obtained from these sources can be used to generate estimates of fuel tank-related fires, fatalities, injuries, and property damage for vehicles operating in the post-1990 time frame. In the post-1990 time frame, essentially all light-duty vehicles and light-duty trucks would be in compliance with FMVSS 301-75 and onboard refueling controls would be required on these gasoline-powered motor vehicles.[9] Therefore, for purposes of this analysis, the year 1990 is used to adjust the data by vehicle miles travelled (VMT) to account for such a time frame.

Before these data can be used to generate the desired estimates, two adjustments are necessary to get all data on a common basis. First, all data must be put in terms of post-standard fire rates, since refueling controls would be required on post-standard vehicles only. To put the data in terms of post-standard rates, the fraction of fires contributed by pre-standard vehicles was determined using the estimated percentage of VMT by these vehicles when the data were taken.[16,17] These pre-standard fractions were then adjusted to post-standard rates based on the effectiveness of FMVSS 301-75 given in the aforementioned NHTSA report.[12] Since it is reasonable to assume that most rear-end and rollover accident fires occur in the fuel tank area, a fuel tank-related fire reduction factor for FMVSS 301-75 was calculated using the pre- and post-standard fire rates for rear-end and rollover collisions shown in Table 1. For purposes of this analysis, these overall post-collision and fuel tank-related fire reduction factors for FMVSS 301-75 were estimated to be 32.7 and 36.9 percent, respectively.

The estimated fire reduction factors for FMVSS 301-75 discussed above are based on fire data involving only passenger cars. It should be noted that these adjustment factors were applied to all data sources, including FARS and NFIRS, which include fires from other vehicles besides passenger cars (e.g., light-duty trucks, buses, and heavy-duty vehicles). Absent any other data, it is reasonable to assume that FMVSS 301-75 would reduce fires involving light-duty trucks and school buses as effectively as the NHTSA report shows for passenger cars. Using the fire reduction factors on heavy-duty vehicle (over 10,000 pound gross weight) data, however, could possibly underestimate the number of fires and their consequences, since these vehicles do not have to comply with FMVSS 301-75. To put such a possible underestimation in proper perspective, it is important to note that heavy-duty vehicles account for less than five percent of the in-use vehicles and VMT each year, and information in the appendix to this report suggests that these vehicles contribute only a few percent of the annual motor vehicle fires.[18,19] Nevertheless, it is important to note that by 1973 all fuel tanks manufactured for heavy-duty vehicles which are involved in interstate commerce must comply with OMCS performance requirements.[20] Therefore, applying the fire reduction factors estimated from NHTSA's report to data sources which include fires from heavy-duty vehicles (FARS and NFIRS) should not introduce an appreciable error to the fire estimate projections presented in this analysis.

Second, after the data are adjusted to post-standard fire rates it is also necessary to consider that increasing VMT between the time when the data were generated and 1990 would increase the absolute number of fuel tank fires and related after effects. It is logical to project that absent other measures, fires and subsequent fatalities, etc., would increase as VMT increases. It should be noted that fatality rates based on VMT have generally declined over the last several years.[21] However, absent any other method to account for the effects of the increase in vehicles and VMT between the time when the data were collected and 1990, using VMT for this adjustment seems reasonable. Thus, all data were adjusted to 1990 using the ratio of the 1990 total VMT to the total VMT of the year(s) in which the data were generated.[18]

One other adjustment which was considered but not incorporated into this analysis is the effect of vehicle aging on fire rates. If vehicle aging does affect fire rates, the data adjustments for pre- to post-standard vehicles would have to be adjusted further. This concern arises because the pre- and post-standard fire rate data used to develop the adjustment factor did not use all vehicles of the same age. The post-standard fire rate was based on vehicles 0-4 years old, and the pre-standard rate was based on vehicles 3-8 years old.[12] Thus, there is the possibility that the adjustment factor could be too large since it incorporates the effect of different fire rates on different age vehicles, in addition to the improvements brought by the safety standard.

Fire rates (fires per crash) may vary by vehicle age because changes in driving patterns (less high speed freeway, more lower speed urban area), ownership, fuel system component deterioration, and lack of maintenance with vehicle age may have an effect on the possibility of a fire in the event of an accident. The net effect of these factors was evaluated using data from the NHTSA technical report.[12] Using this report, preliminary analysis of the data concluded that the effect of aging is probably small. However, an accurate and more conclusive determination (either quantitatively or directionally) cannot be made until more information becomes available with greater range in vehicle age. NHTSA plans to update their evaluation of FMVSS 301-75 in the near future based on more recent data. Regarding the effect of vehicle aging, it is interesting to note that the 1985 FARS data suggest that the percent of vehicle accidents (not fires) by model year are directly proportional to registrations of that model year's vehicles, not VMT.[21] This supports the hypothesis that vehicle aging has no effect on vehicle accidents.

IV. Development of 1990 Vehicle Fire Data

The data on motor vehicle fires extracted from the six sources were collectively analyzed, according to the methodology described above, to estimate the annual number of post-collision and fuel tank related fires and the resulting fatalities, injuries and property damage. As previously mentioned, to be useful the characteristics of all available data must be put in terms of a common basis. Therefore, the fire data were scaled to represent post-standard vehicles operating in the year 1990 when essentially all vehicles in-use will meet FMVSS 301.

Very few sources directly provide statistics for fuel tank-related fires. In fact, only three of the sources studied provide such statistics: NFIRS, the General Motors study, and SAE paper 850092.[11,14,15] Another method to estimate the statistics for fuel tank fires in particular is to approximate the percentage of total post-collision fires which are fuel tank-related. Since it is logical to assume that most of the fuel tank-related fires result from rollover and rear end collisions, this percentage can be estimated from the total fraction of these collision types. Using this assumption and the NHTSA report, it can be calculated that fuel tank fires account for approximately 31 percent of the total collision fires.[12] With this percentage factor, post-collision fire data from the remaining sources can be used to estimate the number of fuel tank-related fires and their subsequent effects.

Table 4 presents the 1990 post-standard motor vehicle fire data generated from the six sources used in this analysis. The data presented include the number of vehicle fires and/or their aftereffects for post-collision fires and particularly for fuel

Table 4

1990 Post-Standard Vehicle Fire Data

Source/Statistic	Post Collision Fires	Fuel Tank-Related Fires: Collision	Fuel Tank-Related Fires: Collision & Non-Collision
FARS			
Fires with Fatalities	1,629	505	
Fatalities	1,679	520	
NFIRS			
Vehicle Fires		1,871	10,730
Fatalities		185	236
Injuries		336	625
Property Damage		$14 million	$32 million
NHTSA Report			
Vehicle Fires	19,550	6,060	
Fatalities	1,043	323	
Injuries:			
Incapacitating	3,669	1,137	
Non-Incapacitating	3,640	1,128	
Possible	2,350	728	
Cooley's Report			
Vehicle Fires	15,313	4,747	
Fatalities	405-1,126	126-349	
GM Study			
Fatalities	505-1,685	211	
SAE 850092			
Fatalities		560-839	

tank fires (for both post-collision fires only and post-collision and non-collision fires). As previously mentioned, only the NFIRS, GM Study, and SAE 850092 directly report data for fuel tank-related fires. Fuel tank fire statistics for collisions from the remaining sources (FARS, NHTSA report, Cooley's report) were estimated by scaling the post-collision fire data with the percentage of fuel tank fires approximated from Parsons' report (31 percent). Therefore, the data in Table 4 encompasses all of the available data and presents a reasonable range of the fire hazards for motor vehicles in the year 1990.

The data from the six sources presented in Table 4 can be summarized for both the post-collision and fuel tank-related fires as presented below:

- <u>Post-Collision Motor Vehicle Fires (annual projections)</u>
  - 15,300-19,600 annual fires
  - 400-1,700 fatalities
  - 3,700 serious injuries
  - 3,600 moderate injuries

- <u>Fuel Tank-Related Fires (annual projections)</u>
  - 4,750-10,700 fuel tank-related fires (for both collision and non-collision fires)*
  - 1,870-6,060 fuel tank-related fires (for collision fires only)*
  - 126-839 fatalities
  - 625-1,140 serious injuries (for both collision and non-collision fires)
  - 336-1,140 serious injuries (for collision fire only)
  - 1,130 moderate injuries
  - $32 million property damage (for both collision and non-collision fires)
  - $14 million property damage (for collision fires only)

These statistics, based on extrapolations to 1990, represent a reasonable range for the fire hazards of motor vehicles for the post-1990 time frame, when refueling controls may be required. As can be seen from these statistics, a large percentage of fuel tank-related fires are non-collision fires.

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* Statistics for non-collision fires only cannot be obtained directly by subtracting these ranges. These ranges are based on several sources which report collision fires or collision and non-collision fires.

V. Summary and Conclusions

In response to the recent concerns regarding the potential safety implications of onboard refueling controls, this analysis estimated the potential hazard of fuel tank-related fires for both current motor vehicles and in the post-1990 timeframe when essentially all in-use passenger cars and light-duty trucks would meet FMVSS 301-75. This assessment provides a baseline from which to assess any change in risk which could occur as a result of the addition of onboard vapor recovery systems.

As shown in this report, very few sources of motor vehicle fire data exist which accurately assess and characterize the fire hazard for current vehicles. This analysis uses fire information from two data bases and four past analyses of motor vehicle fires to perform a vehicle fire hazard assessment. With careful analysis, the fire information obtained from these sources were used to estimate a range for the number of fuel tank-related fires and their consequences for vehicles in the post-1990 time frame, when onboard refueling controls could be required on gasoline-fueled motor vehicles. In order to put all data on a common basis, this analysis accounts for both the effectiveness of FMVSS 301-75 and the increase in VMT from when the data were generated and 1990. From this analysis, the following statistics summarize the hazards of fuel tank-related fires for motor vehicles on an annual basis, projected for the post-1990 timeframe:

- 1,870-10,700 annual fuel tank-related fires
- 126-839 fatalities
- 336-1,140 serious injuries
- 1,130 moderate injuries
- $14-$32 million property damage

References

1. "Safety Implications of Onboard Refueling Vapor Recovery Systems," U.S. EPA-AA-SDSB-87-05, June 1987.

2. "Analysis of Fuel Tank-Related Fires," EPA Memorandum, Kathleen A. Steilen to Charles L. Gray, U.S. EPA, OAR, OMS, OMS, ECTD, SDSB, June 10, 1987.

3. National Fire Incident Reporting System, Motor Vehicle Fire Tallys, FEMA, U.S. Fire Administration, 1980-1985.

4. Letter, Ralph J. Hitchcock, NHTSA to Chester J. France, U.S. EPA, September 21, 1987.

5. Letter, John Glenn Hart III, U.S. Fire Administration to Kathleen A. Steilen, U.S. EPA, September 16, 1987.

6. Motor Vehicle Safety Standard No. 301, Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections - Passenger Cars: 32 FR 2416, February 3, 1967, Part 571: S 301-1.

7. Motor Vehicle Safety Standard No. 301-75, Fuel System Integrity: 39 FR 10588, March 21, 1974, Part 571: S 301-75-5.1, 5.2, 5.3.

8. Motor Vehicle Safety Standard No. 301-75, Fuel System Integrity: 40 FR 48352, October 15, 1975, Part 571: S 301-75-5.1, 5.2, 5.3, 5.4.

9. "Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Refueling Emission Regulations for Gasoline-Fueled Light-Duty Vehicles and Trucks and Heavy-Duty Vehicles," Notice of Proposed Rulemaking, FRN: pp. 31162-31271, August 19, 1987.

10. Fatal Accident Reporting System, NHTSA, DOT, 1980-1984.

11. National Fire Incident Reporting System, FEMA, U.S. Fire Administration, 1980-1985.

12. "Evaluation of Federal Motor Vehicle Safety Standard 301-75, Fuel System Integrity: Passenger Cars," DOT HS-806-335, January 1983.

13. "Fires In Motor Vehicle Accidents," UM-HSRI-SA-74-3, Peter Cooley, April 1974.

14. "General Motors and Fuel System Collision Fires," Environmental Activities Publication No. A-3177, December 16, 1974.

15. "A Perspective on Automobile Crash Fires," SAE 850092, Warner, James and Woolley, 1985.

16. "Revised Diesel Sales Fraction Projections," U.S. EPA Memorandum, John W. Mueller to Charles C. Gray, January 9, 1987.

17. "Compilation of Air Pollutant Emission Factors, Volume II: Mobile Sources," AP-42, Fourth Edition, September 1985.

18. "MOBILE3 Fuel Consumption Model," U.S. EPA-AA-TEB-EF-85-2, Mark A. Wolcott and Dennis F. Kahlbaum, February 1985.

19. "MVMA Motor Vehicle Facts and Figures 1987," Motor Vehicle Manufacturers Association of the United States, Inc., 1987.

20. "Federal Motor Carrier Safety Regulations and Noise Emission Requirements," Bureau of Motor Carrier Safety, Federal Highway Administration, U.S. DOT, October 31, 1983.

21. "Fatal Accident Reporting System 1985, A Review of Information on Fatal Traffic Accidents in the U.S. in 1985," NHTSA, DOT, 1985.

Appendix

NFIRS Detailed Data

Table A-1

NFIRS Tally by Mobile Property Type

- Annual Nationwide Projection Averages 1980 through 1985
- Collision and Non-Collision Fires

Mobile Property Type	Fires	Injuries	Deaths	Loss ($x10^6$\$)
Automobile	443,958	3,344	726	689.92
Bus, Trackless Trolley	3,622	41	4	10.31
Terrain Vehicles	8,212	246	24	11.30
Pass. Road Trans, Other	1,458	29	1	2.87
Pass. Road Trans, Unc.	3,463	23	2	1.96
Pass. Road Trans	460,713	3,683	758	716.36
Truck - Over 1 ton	19,382	260	53	60.86
Truck - Under 1 ton	35,994	455	113	49.78
Semi-Trailer Truck	7,821	114	46	59.65
Tank Truck - Non-Flam.	289	10	2	1.43
Tank Truck - Flam Lqd.	1,131	110	20	10.50
Tank Truck - Comp. Gas	372	14	1	1.91
Trash Truck	3989	15	0	8.05
Freight Road Trans, Other	530	8	0	2.15
Freight Road Trans, Unc.	4961	31	10	16.99
Freight Road Trans	74,469	1016	245	211.33
Total	535,183	4,699	1,003	927.68

Table A-2

NFIRS Tally by Area of Fire Origin*

- Annual Nationwide Projection Averages 1980 through 1985
- Collision and Non-Collision Fires

Vehicle Area	Fires	Injuries	Deaths	Loss ($x10^6$$)
Passenger Area	100,616	868	202	250.52
Trunk Area	18,659	274	30	36.79
Engine Area	332,681	1,964	286	388.92
Fuel Tank Area	10,828	631	237	32.18
Control Area	7,121	58	8	17.70
Exterior Surface	6,931	80	14	10.97
Not Classified	11,179	136	43	21.66
Total	488,015	4,010	821	758.74

* This tally includes only vehicle fires in which the fire originated in the vehicle. The total is smaller than the total of Table A-1 because it excludes apparent NFIRS reporting errors and vehicles that were involved in fires which did not originate within the vehicle.

Table A-3

1990 Post - FMVSS 301-75
Annual Projections for Motor Vehicle Fires

- Collision and Non-Collision Fires
- Based on 1980-1985 data

Area of Fire Origin	Fires	Injuries	Deaths	Loss ($x10^6$\$)
Passenger Area	101,300	874	204	253.04
Trunk Area	18,782	275	30	37.12
Engine Area	335,358	1,978	287	393.43
Fuel Tank Area	10,731	625	236	31.97
Control Area	7,175	58	9	17.88
Exterior Surface	7,005	80	14	11.09
Not Classified	11,255	137	43	21.86
Total	491,605	4,028	822	766.39

Table A-4

NFIRS Annual Fuel Tank Fire Tally

- Collision Fires Only

Year	Nationwide Projections				1990 Post-FMVSS 301-75 Projections			
	Fires	Injuries	Deaths	Loss(M$)	Fires	Injuries	Deaths	Loss ($x10^6$\$)
1981	2418	366	228	17.66	2363	357	223	17.26
1982	1945	353	159	10.76	1942	352	159	10.74
1983	1771	329	160	12.08	1786	332	162	12.18
1984	1725	387	222	16.51	1747	392	225	16.71
1985	1494	245	154	12.75	1515	248	156	12.92
Avg.	1871	336	185	13.95	1871	336	185	13.96