United States General Accounting Office

GAO

Report to Congressional Requesters

April 1999

MILITARY SAFETY

Army M939 5-Ton Truck Accident History and Planned Modifications

GAO/NSIAD-99-82

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-282071

April 9, 1999

The Honorable Christopher J. Dodd
The Honorable Joseph I. Lieberman
United States Senate

The Honorable Rosa L. Delauro
House of Representatives

In April 1997, two U.S. Army Reserve soldiers were fatally injured during a training exercise at a U.S. Army installation. Both were passengers in a M939 series 5-ton tactical cargo truck that overturned. In response to your request, this report identifies (1) the extent to which accidents involving the M939 series 5-ton tactical cargo truck have occurred and (2) the results of Army studies on the truck's design and its plans to address any identified deficiencies. You also asked us to evaluate the adequacy of the Army's training program for the drivers of the M939 truck because inadequate training could be a contributing factor in accidents. This issue will be addressed in a later report.

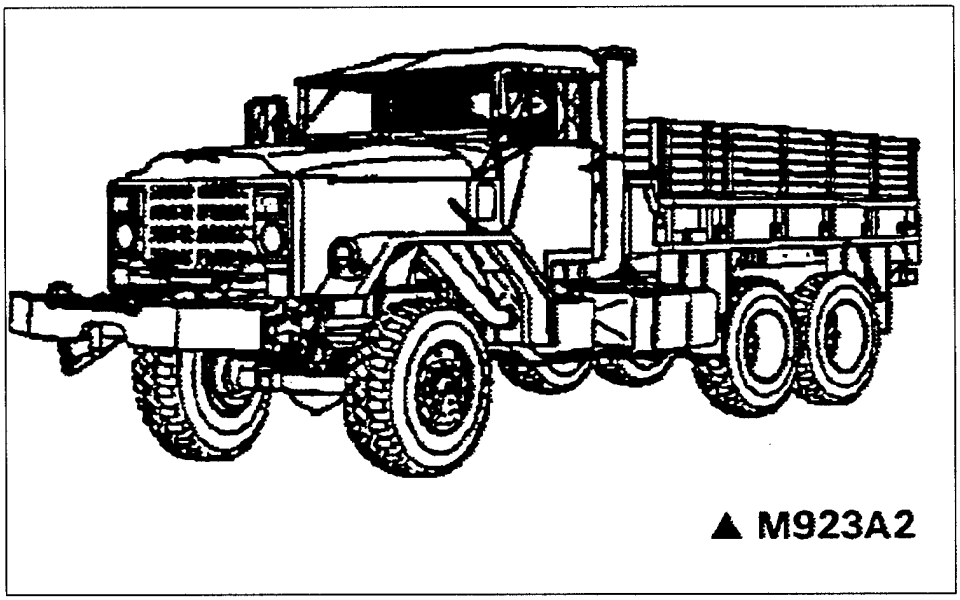
Background

The Army classifies its vehicles on the basis of such factors as function and physical characteristics. For example, tracked vehicles (Abrams Tanks and Bradley Fighting Vehicles) are classified as Army combat vehicles; wheeled vehicles (trucks, automobiles, cycles, and buses) are classified as Army motor vehicles. Within the Army motor vehicle grouping, vehicles are further separated into tactical and non-tactical categories and within the tactical grouping, into light, medium, and heavy classifications based primarily on vehicle weight. The M939 series trucks are accounted for as part of the Army motor vehicle's medium tactical fleet.

The Army reviews operational requirements for its vehicle fleet in an effort to improve readiness. From January 1983 through October 1993, the Army upgraded its 5-ton medium tactical fleet by purchasing about 34,900 M939s to replace aging and obsolete trucks. The new truck, designed to operate on and off road, maintained the basic design of its predecessors but came equipped with such first-time standard equipment as air-brakes and automatic transmissions. At present, the Army has three variations and nearly 40 different models of the M939 in its inventory. Depending on the model, the truck performs multiple duties that include hauling cargo,

collecting refuse, transporting troops, and operating as a tractor or wrecker. The last M939s were fielded in late 1993.

Figure 1: M939A2 5-Ton Tactical Cargo Truck



Source: U.S. Army.

Should vehicles or equipment prove dangerous or unsafe to operate, the Army Safety Center, Transportation School and Center, and Tank-Automotive and Armaments Command (TACOM) are responsible for identifying problems and disseminating information. Among other duties, the commands collect and evaluate information from accident investigations and field reports. They also issue Army-wide safety alerts, precautionary messages, and other information warning of identified dangers with equipment and vehicles.

Results in Brief

Our analyses and an Army analysis indicate a higher rate of accidents involving the M939 series 5-ton tactical cargo truck than other comparison vehicles. Specifically, our analysis of January 1987 through June 1998 accident data showed that, while M939s made up an average of about 9 percent of the Army motor vehicle fleet during that time, about 34 percent of the fleet's accidents resulting in fatalities of vehicle

occupants involved these trucks. Moreover, 44 percent of accidents that involved a rollover and resulted in fatalities of vehicle occupants involved the M939. Furthermore, our comparison of U.S. Department of Transportation accident statistics and M939 accident statistics showed that over a 10-year period, the fatality rate of occupants of the M939 averaged about 30 times higher than the fatality rate for occupants of comparably sized commercial trucks. Finally, an Army Safety Center analysis found that the chance of a fatality in a M939 was 3 to 21 times higher than in other similar military trucks in the Army motor vehicle fleet—the M34/M35 series 2-1/2 ton trucks.[1]

The Army plans to spend an estimated $234 million on various modifications to improve the M939's safety and operational performance. Based on the results of studies into the root causes of M939 accidents, the Army concluded that the overall truck design was sound, but some modifications were necessary. The Army plans to use the $234 million to add anti-lock brake kits, alter brake proportioning specifications, upgrade the truck's tires, install cab rollover crush protection, and modify accelerator linkage. Most modifications will be complete by 2005. The M939s will remain in service as these modifications are made.

Three Different Analyses Point to High M-939 Accident Rates

Our two analyses and the analysis conducted by the Army Safety Center all involved comparisons of different types of accident data collected over different time frames. Nevertheless, all of the analyses showed that the M939 had a higher accident rate than each type of comparison vehicle.

Comparison of M939 With Army Motor Vehicles

In our first analysis, we reviewed data from January 1987 through June 1998 and compared selected M939 accident statistics with those of the rest of the Army motor vehicle fleet. We reviewed the accident categories in terms of "fatal accidents," defined as any accident event in which at least one occupant of an Army motor vehicle died; "occupant deaths," defined as the total number of Army motor vehicle occupants killed; "rollovers," defined as any vehicle that did not remain upright as the result of an accident; and "rollover deaths," defined as those occurring to occupants of Army motor vehicles that rolled over as a result of an accident.

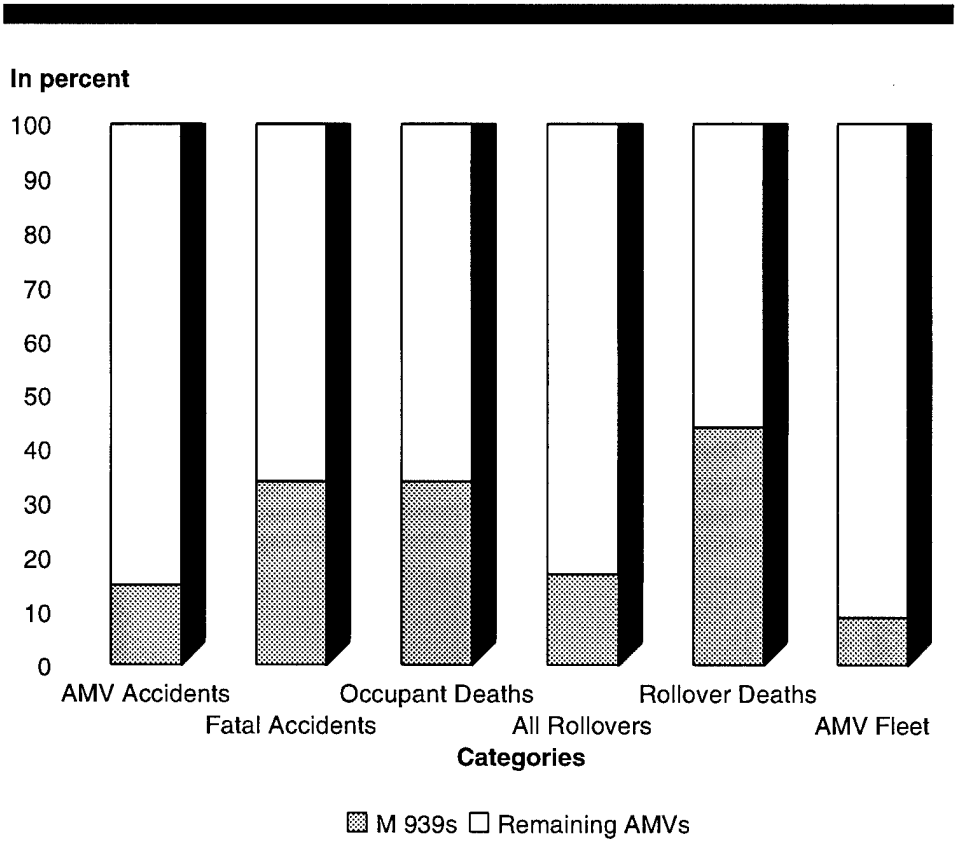
[1]The latter two analyses were based on accident rates per million miles driven.

In analyzing this selected accident information compiled by the Army Safety Center, we found the frequency of M939 accidents high in each instance. For the 11-1/2 year period reviewed, the M939 series truck inventory averaged 26,991, or about 9 percent of the average annual Army motor vehicle inventory of about 314,000 vehicles, and accounted for about 15 percent of the total Army motor vehicle accidents.[2] Appendix I shows the actual figures by year, 1987-1998.

Our comparison of M939 accident statistics with accident statistics for the rest of the Army motor vehicle fleet showed that the M939 accounted for about 34 percent of all Army motor vehicle fatal accident events, and 34 percent of all Army motor vehicle occupant deaths. Comparative rollover statistics revealed much the same. The M939 rollovers accounted for 17 percent of the total Army motor vehicle rollovers, and 44 percent of the total Army motor vehicle rollover fatalities. Figure 2 shows these accident statistics.

[2]Army Regulation 385-40 establishes the criteria for Army motor vehicle classification of a motor vehicle involved in an accident. A vehicle's general purpose must be to transport cargo or personnel, and be under full operational control of the Army. A vehicle can include a passenger car, station wagon, truck, ambulance, bus, motorcycle, fire truck, or refueling truck.

Figure 2: Comparison of Selected M939 Accident Statistics to Remaining Army Motor Vehicle Fleet, 1987-1998



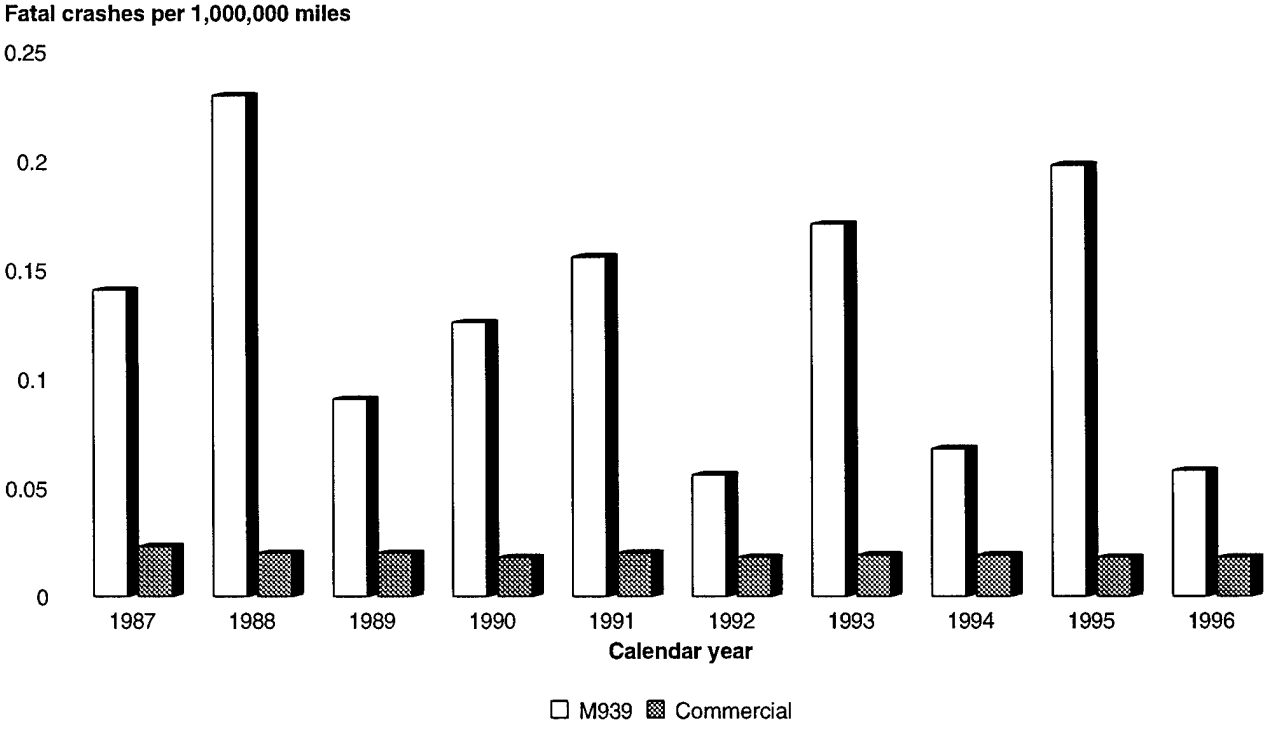
Source: GAO analysis of Army Safety Center accident data.

Comparison of M939s With Commercial, Single-Unit Medium and Heavy Trucks

In our second analysis, we used Department of Transportation published data for years 1987-1996 and compared the accident rate for M939s with the rate for single-unit medium and heavy commercial trucks (which are physically similar to M939s). According to an agency official, the Department of Transportation defines "fatal crashes" as any event in which someone is killed in a crash—vehicle occupant or otherwise—and "truck occupant fatalities" as a fatality of an occupant of a single-unit truck. These comparisons revealed that the accident rates for the M939 were substantially higher than those found for the commercial trucks. However, Army officials point out that commercial trucks are driven almost exclusively on paved roads; the M939 is driven on both paved and unpaved roads.

We found that over the 10-year period, 1987-1996, the frequency rates of fatal crashes per million miles driven for M939s averaged about seven times higher than those for commercial trucks. The M939 accident rate ranged from a high of 12 to a low of 3 times higher than the commercial truck rate. In 1988, the M939's accident rate was 0.23 and the commercial truck rate was 0.02—about 12 times higher; and in 1992, the M939 accident rate was 0.056 and the commercial truck rate was 0.018—about 3 times higher. Figure 3 shows these statistics.

Figure 3: Comparison of Rate of Commercially Driven Single-Unit Medium and Heavy Trucks Fatal Crashes With Related M939 Statistics, 1987-1996

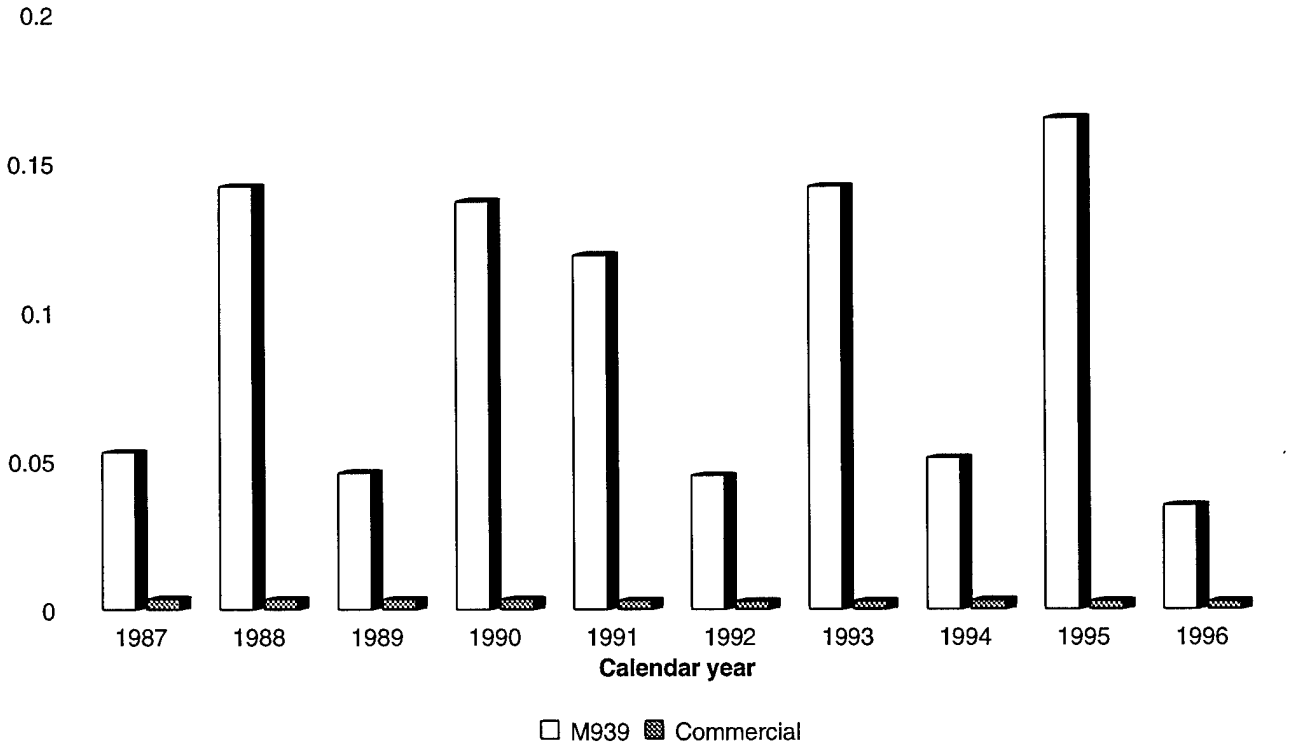


Source: GAO analysis of Federal Highway Administration, Army Safety Center, and Tank-Automotive and Armaments Command data.

We also found that, over this same 10-year period, the M939 occupant fatality rate averaged about 30 times higher than those for commercial

trucks. The M939 occupant fatality rate ranged from a high of 59 to a low of 13 times higher than the commercial truck rate. In 1995, the M939 occupant fatality rate was 0.165 and the commercial truck rate was 0.0028—about 59 times higher; and in 1989, the M939 rate was 0.046 and the commercial truck rate was 0.0035—about 13 times higher. Figure 4 shows these statistics.

Figure 4: Comparison of Rate of Commercially Driven Single-Unit Medium and Heavy Trucks Occupant Fatalities With Related M939 Statistics, 1987-1996



Source: GAO analysis of Federal Highway Administration, Army Safety Center, and Tank-Automotive and Armaments Command data.

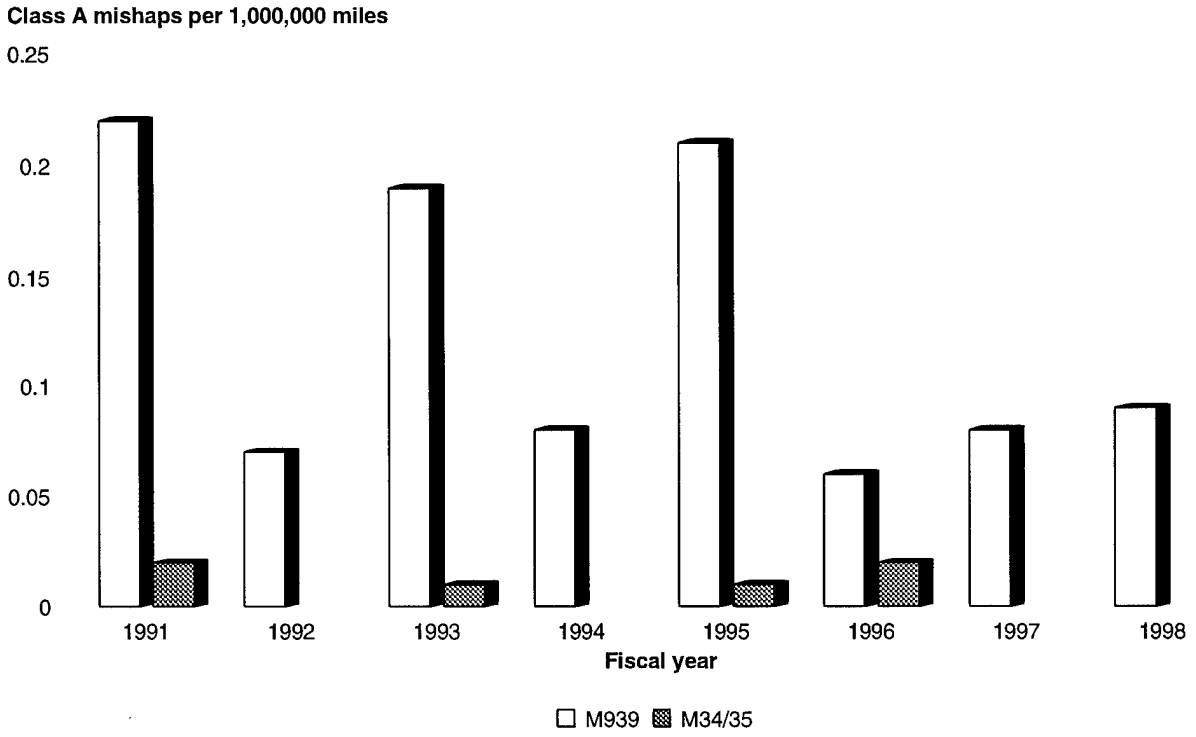
Comparison of M939s With 2-1/2 Ton Tactical Army Trucks

The Army Safety Center's analysis reviewed accident data from October 1990 through June 1998. In this analysis, the accident rate of the M939 was compared with accident rates for another series of trucks—the M34/M35 series 2-1/2 ton truck. Army officials advised us that this truck was most comparable with the M939. The analysis reviewed accidents categorized as Class A mishaps. Army Regulation 385-40 defines a "Class A" mishap as an accident where total property damage equals $1 million or more; an Army aircraft or missile is destroyed, missing or abandoned; or an injury and/or occupational illness resulting in a fatality or permanent total disability. Because an M939 costs significantly less than $1 million, almost all Class A mishaps involving an M939 are so classified because they result in a death or permanent total disability.

The Army Safety Center's analysis found accident rates for M939s to be higher than the comparison vehicles. The analysis showed M939 Class A mishap frequency rates per million miles driven to be 3 to 21 times higher than those of similar M34/M35 series 2-1/2 ton trucks.[3] For example, the 1995 Class A mishap rate for the M939 was 0.21 and for the 2-1/2 ton M34/35s, it was 0.01 per million miles driven—about a 21-fold difference. Figure 5 shows this comparison.

[3]The M939, M34, and M35 series trucks are all classified as medium tactical vehicles. Army records indicate that for the 1991-98 time frame, these three truck series comprised around 70 percent of all vehicles similarly categorized.

Figure 5: Comparison of Rate of Class A M939 and M34/35 Truck Mishaps, 1991-98



Note: For years 1992, 1994, 1997, and 1998, the M34/35 had no Class A mishaps.

Source: 1998 Army Safety Center Analysis.

Army Plans to Spend $234 Million to Improve M939 Safety Performance

The Army has initiated a program to improve the M939's safety performance and, according to TACOM estimates, plans to spend around $234 million for various modifications. Most of the modifications are the direct result of corrective actions suggested in studies. These studies focused on identifying root causes of M939 accidents based on information contained in accident investigation reports. On the basis of the studies' findings, the Army concluded that the overall truck design was sound but that some modifications were necessary to improve the truck's safety performance. Planned modifications include $120 million for upgrading the trucks tires, altering brake proportioning specifications, and adding anti-lock brake kits. Other modifications include $114 million to install cabs equipped with rollover crush protection systems and improve

accelerator linkage. The modifications, for the most part, will be completed by 2005 with the M939s remaining in service during the process.

Higher Accident Frequency and Injury Severity Rates Give Rise to M939 Causal Studies

To identify possible mechanical problems or performance limitations contributing to M939 accidents, the Army conducted two studies and a computer simulated modeling analysis. Although M939 trucks have been in service since 1983, Army Safety Center personnel stated that no aberrant accident statistics appeared before early 1992. However, during 1990-91, with the increased operating tempo associated with Desert Shield/Desert Storm, there was an increase in fatal accidents and deaths attributable to M939s.[4] In August 1992, TACOM issued Safety of Use Message 92-20 discussing M939 performance limitations. This message warned of the truck's sensitive braking system—specifically that, when the truck is lightly loaded and on wet pavement, aggressive braking could cause rear wheel lockup, engine stall-out, power steering inoperability, and uncontrolled skidding.[5]

The Army began taking a closer look at the M939's accident history after circulating Safety of Use Message 92-20. Between 1993 and 1995, TACOM, the Army Safety Center, and the Army Transportation School and Center initiated a review of M939 accident reports and began putting together evidence that validated the need for the studies. Also, in an effort to reduce the number and severity of M939 accidents, the Army issued Ground Precautionary Message 96-04 in December 1995, limiting M939s to maximum speeds of 40 miles per hour on highway and secondary roads and 35 miles per hour over cross-country roads.

Between September 1995 and June 1997, TACOM conducted two studies and a computer simulation analysis. The studies among other things, recreated and analyzed repetitive events cited in many accident investigation reports and discussed in Safety of Use Message 92-20. The two studies and modeling analysis focused on tire and air brake performance under various conditions. On the basis of the project's findings, TACOM concluded the overall truck design was sound and nothing was significantly different between the M939 and its commercial counterparts produced during the

[4]We previously noted this increase in vehicle related fatal accidents during the Operation Desert Shield/Desert Storm time period in our report, Military Safety: Analysis of DOD's On-duty Non-aviation Accident Fatalities (GAO/NSIAD-99-14, Oct. 16, 1998).

[5]The Army uses Ground Precautionary Messages and Safety of Use Messages to disseminate servicewide safety information.

same time period. However, the studies found that improvements to some vehicle subsystems would enhance the truck's safety performance.

The tire study completed in October 1996, together with other information relating to M939 usage, confirmed that the M939s were being used on-road more than originally planned. The original intent was for M939s to be driven on-road 20 percent and off-road 80 percent of the time. In some Army units, especially reserve units, this no longer held true. Some units were using the M939s on-road as much as 80 to 90 percent of the time. The truck's original tire, designed for maximum efficiency during off-road usage, performed less efficiently on-road, especially during inclement weather. The increased on-road usage enhanced the probability of the M939's being involved in an accident. On the basis of this scenario, TACOM tested several different tire designs looking to improve on-road traction under all environmental conditions, while retaining required off-road capabilities. The study recommended that all M939s be equipped with radial tires.

The brake study, completed in June 1997, concluded that the air brake system may lock up more quickly than drivers expect, especially when the vehicle is lightly loaded. In tests, the Army found that aggressively applied pressure to the brake pedal caused the sequence of events found in many accident reports: wheel lockup, engine stall-out, loss of power steering, and uncontrolled skidding, often culminating in rollover. The probability of spin-out and rollover increased on wet or inclined surfaces. To lessen the likelihood of wheel lockup and the resulting chain of events, the study suggested (1) modification of all brake proportioning systems and (2) installation of anti-lock braking kits.

The modeling analysis used computer technology to recreate the truck's probable behavioral characteristics in a simulated environment and also to validate conditions being tested in the studies. According to TACOM officials, the modeling results correlated with actual testing results compiled during the tire and brake studies.

Besides the recommended improvements from the studies, the Army identified others it considered necessary. The Army decided to replace M939 cabs when they wore out with ones outfitted with a rollover crush protection system and also to modify the accelerator pedal resistance on the A2 variant of the M939. Both TACOM and Army Safety Center personnel stated that installation of the reinforced cab rollover crush protection

system, while not an industry standard or required by law, would better protect M939 occupants in the event of a rollover.

Ongoing or Scheduled M939 Modifications

According to TACOM officials, the scheduled M939 modifications will cost around $234 million. The Army estimates that tire upgrades, brake proportioning, and anti-lock brake system improvements will cost about $120 million or about $3,800 per truck; adding cab rollover protection and modifying the A2's accelerator linkage will cost another $114 million or an additional $3,600 per truck. With respect to the current schedule for completing M939 modifications, brake proportioning and accelerator linkage equipment modifications will be completed by the end of fiscal year 1999; all remaining modifications, except for cab replacement, are scheduled for completion around 2005. Because the truck cabs will be replaced as they wear out, a precise schedule for completing this modification cannot be estimated at this time.

Even though some of the M939s have been in service for 15 years, the decision to spend $234 million on modifications and equipment upgrades is based on the need to improve the vehicles' safety because the Army expects these trucks to be in service for at least 30 years. According to TACOM, the June 1998, M939 inventory was around 31,800 trucks. All M939s will be equipped with radial tires, brake reproportioning, anti-lock brake kits installation, and reinforced cab replacements. However, the accelerator linkage improvements are needed only on the 16,800 A2 variant of the trucks. Table 1 shows the schedule for the planned modifications.

Table 1: Scheduled M939 Modifications, Costs, and Completion Dates

Dollars in millions

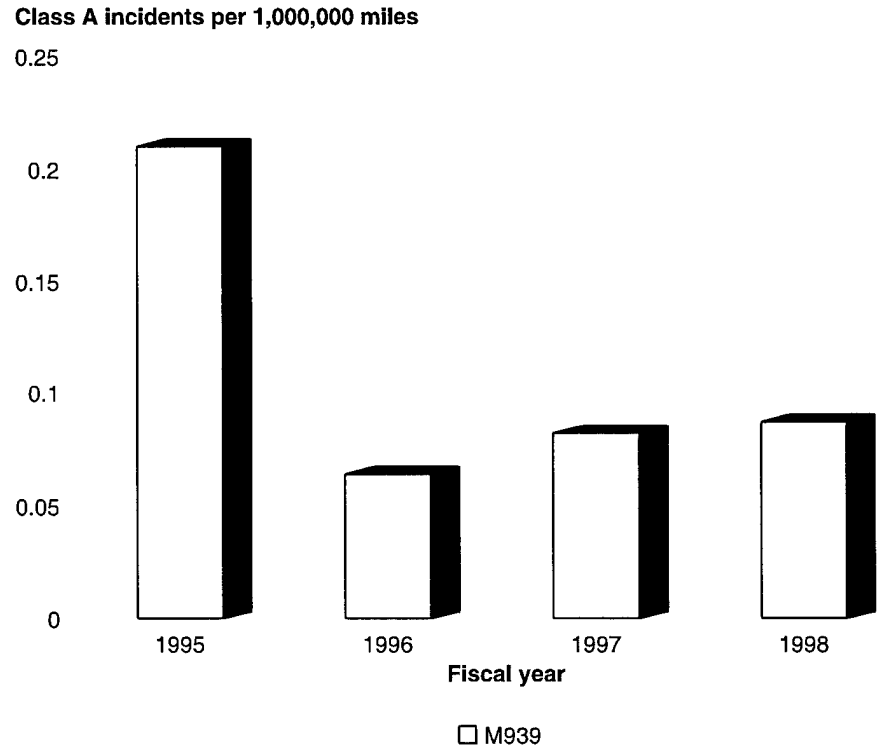
Scheduled action	Estimated cost	Completion date (fiscal year)
Upgrade tires	$39.5	2003
Realign brake proportioning	3.5	1999
Install anti-lock brake kits	77.4	2005
Add rollover crush protection cabs	112.0	2005[a]
Modify accelerator linkage	2.0	1999
Total	**$234.4**	

[a]Replacement of all M939 cabs may not be completed by the end of fiscal year 2005 because they are being replaced when they wear out.

Source: Tank-Automotive and Armaments Command.

Although most scheduled modifications will not be completed until fiscal year 2005 or later, TACOM and Army Safety Center personnel noted that accident rates have declined significantly since the reduced speed limits instituted by the December 1995 precautionary message. Figure 6 shows the drop in the number of mishaps since 1995.

Figure 6: M939 Class A Incident Rates Since 1995



Source: GAO analysis of Army Safety Center accident data.

Army officials believe the modifications being made to the M939s will improve their safety performance and reduce severe accidents, rollovers, and fatalities.

Agency Comments

In written comments on a draft of this report (see app. III), DOD stated that it concurred with this report and noted that the report accurately describes problems the Army found to be causing M939 accidents.

Scope and Methodology

To analyze the accident history of the M939 series 5-ton tactical vehicle, we obtained specific information from the Army Safety Center, Fort Rucker, Alabama; TACOM, Warren, Michigan; the Department of Transportation, Federal Highway Administration, Washington, D.C.; and the Department of the Army, Washington, D.C.

To identify any accident anomalies associated with the M939s, we conducted two analyses and reviewed another conducted by the Army Safety Center. Our first analysis compared selected M939 accident statistics with similar information for the overall Army motor vehicle fleet (of which M939s are a subset). Our second analysis compared M939 accident statistics per million miles driven to Department of Transportation accident statistics for comparable commercial trucks. The Army Safety Center study we reviewed compared various M939 accident frequency rates per million miles driven with rates for comparable military tactical trucks.

The number of years used in each comparison varied on the basis of the data available. Army motor vehicle fleet to M939 comparisons did not include events prior to 1987 because some accident statistics were not readily available. Our comparison of rates of M939 fatal accident events and vehicle occupant fatalities with rates for corresponding commercial sector trucks was limited to 1987-1996 due to the unavailability of accident data for commercial sector vehicles after 1996. Lastly, the Army Safety Center study comparing M939 Class A accident rates with rates for other similar Army tactical vehicles only included events occurring between October 1990 and June 1998. The extent to which other factors, such as human error, driver training, and off-road versus on-road usage, may have contributed to disparate accident rates was beyond the scope of this review.

To assess Army initiatives directed at identifying M939 performance, mechanical, or systemic problems and limitations, as well as recommended corrective actions, we obtained or reviewed relevant Army studies. We also interviewed officials at the Army Safety Center and TACOM about these studies but did not assess or validate the findings, estimated costs, or recommendations resulting from these studies.

Although we worked with personnel from the Army Safety Center, TACOM, Department of Transportation, and the Department of the Army during data gathering and reviewed those results for reasonableness, accuracy, and completeness, we did not validate the accuracy of accident statistics contained in various databases or other published information. However, this data is used to support the management information needs of both internal and external customers and is periodically reviewed internally by each organization for accuracy, completeness, and validity.

We conducted our review from July 1998 through February 1999 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Honorable William Cohen, Secretary of Defense; the Honorable Louis Caldera, Secretary of the Army, and interested congressional committees. Copies will also be made available to other interested parties upon request.

Please contact me on (202) 512-5140 should you or your staff have any questions concerning this report. Major contributors to this report were Carol R. Schuster; Reginald L. Furr, Jr.; Kevin C. Handley; and Gerald L. Winterlin.

Mark E. Gebicke
Director, Military Operations
and Capabilities Issues

Contents

Abbreviations

AMV	Army Motor Vehicles
DOD	Department of Defense
SUMHT	single-unit medium and heavy trucks
TACOM	Tank-Automotive and Armaments Command

M939 Selected Accident Statistics Compared to All Other Army Motor Vehicles, 1987-1998

	Total accidents		Fatal accidents		Occupant deaths		Total rollovers		Rollover deaths	
Year	**M939**	**AMV**	**M939**	**AMV**	**M939**	**AMV**	**M939**	**AMV**	**M939**	**AMV**
1987	258	2264	3	22	3	23	25	344	2	12
1988	191	1867	8	22	8	24	30	292	7	15
1989	164	1239	3	18	3	18	29	250	2	12
1990	149	1054	9	29	12	31	28	178	10	16
1991	175	958	12	41	13	51	44	179	13	30
1992	138	618	4	14	4	14	40	140	3	12
1993	130	543	10	22	10	23	39	117	9	18
1994	102	464	3	6	3	6	30	105	3	3
1995	84	415	8	16	10	19	24	85	6	14
1996	84	353	3	9	3	9	18	85	3	6
1997	62	311	4	4	5	5	9	52	2	2
1998	21	117	2	2	2	2	4	24	2	2
Total	**1,558**	**10,203**	**69**	**205**	**76**	**225**	**320**	**1,851**	**62**	**142**

Note: "Fatal accidents" are defined as any accident event in which at least one occupant of an Army motor vehicle (AMV) died. For all other definitions, see page 3 of this report.

Source: GAO analysis of Army Safety Center accident data.

M939 Fatal Crash and Occupant Fatality Statistics Compared to Commercial, Single-Unit Medium and Heavy Trucks, 1987-1996

	Fatal crashes		Occupant fatalities		Million miles driven	
Year	M939	SUMHT[a]	M939	SUMHT[a]	M939	SUMHT[a]
1987	8	1,118	3	177	56.8	49,537.
1988	13	1,014	8	180	56.5	51,239.
1989	6	1,056	3	187	65.8	52,969.
1990	11	979	12	185	87.4	53,443.
1991	17	1,072	13	168	109.2	53,787.
1992	5	987	4	156	88.6	53,691.
1993	12	1,054	10	159	70.3	56,781.
1994	4	1,188	3	193	58.7	61,284.
1995	12	1,133	10	176	60.7	62,705.
1996	5	1,159	3	174	85.5	63,967.

[a]Single-unit medium and heavy trucks.

Note: "Fatal crashes" are defined as any event in which someone is killed in a crash—vehicle occupant or otherwise—and "truck occupant fatalities" as a fatality of an occupant of a single-unit or M939 truck.

Source: GAO analysis of Federal Highway Administration, Army Safety Center, and Tank-Automotive and Armaments Command data.

Comments From the Department of Defense

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ACQUISITION AND TECHNOLOGY

MAR 22 1999

Mr. Mark E. Gebicke
Director, Military Operations
and Capabilities Issues
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Gebicke:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "MILITARY SAFETY: Army M939 5-Ton Truck Accident History and Planned Modifications," dated February 23, 1999 (GAO Code 703276/OSD Case 1758). The Department concurs with the report.

The report accurately describes the problems that the Army found to be causing M939 accidents. More importantly, the report identifies the substantial investments that the Army is making to protect the soldiers who must operate this vehicle.

The Department of Defense appreciates the opportunity to comment on the draft report.

Very truly yours

Sherri W. Goodman
Deputy Under Secretary of Defense
(Environmental Security)

Environmental Security *Defending Our Future*