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ON-ROAD
CRASH EXPERIENCE
OF UTILITY VEHICLES

FINAL TECHNICAL REPORT

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16. Abstract

The purpose of this study was to investigate the on-road crash experience, safety, and stability of utility vehicles. Selected for study among the off-road, multi-purpose passenger vehicles were the JEEP, Blazer, Bronco (pre-1978), Jimmy, Ramcharger, Trail Duster, Scout, Land Cruiser, and Thing.

Data studied included more than 12,000 fatal and non-fatal utility vehicle crashes in the states of Arizona, Colorado, Maryland, Michigan, New York, New Mexico, North Carolina, Texas, and Washington. Also, FARS data, R.L. Polk & Company Vehicle Registration data, and data from Collision Performance and Injury Report (CPIR) files were examined. Selected vehicles were subjected to physical measurement of the height of the center of gravity. Applicability of Federal Motor Vehicle Safety Standards was reviewed.

Major conclusions are that: utility vehicles experience a rollover rate 5 to 11½ times higher than passenger cars; the JEEP and pre-1978 Bronco overturn at least twice as often as Blazer; rollover and ejection in open cab vehicles appear to be major fatal injury factors; death and injury rates are approximately twice as high in utility vehicles as in passenger cars and are about twice as high in JEEPS as in Blazers.

The study findings raise serious questions concerning the safety and stability of these vehicles, which which are exempted from or not covered by several of the Federal Motor Vehicle Safety Standards required for passenger cars.

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utility vehicle; occupant injuries; occupant protection; ejection; multi-purpose; jeep-type; rollover; roll-bars; crash investigation; data analysis; mass data; collision	Unlimited

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EXECUTIVE SUMMARY

Use of utility vehicles designed for on/off-road use, such as the Blazer, Bronco, JEEP, Jimmy, Land Cruiser, and Scout, has increased rapidly over the past few years. The purpose of this study has been to analyze the available on-road collision experience involving this type of vehicle to determine the nature, extent, and seriousness of any problems unique to this category of vehicle, and to provide a basis for further investigation and/or safety recommendation.

The study involved large-scale accident data analysis, evaluation of in-depth reports on individual crashes, and the measurement of physical parameters on some utility vehicles. The data sources included the Fatal Accident Reporting System (FARS) of the U.S. Department of Transportation, Collision Performance and Injury Report (CPIR) file, and clinical case studies of serious traffic collisions from various locations in the U.S. Data obtained included reports on about 14,000 utility vehicle accidents occurring in the states of Michigan, New York, Texas, Washington, Arizona, Colorado, Maryland, North Carolina, and New Mexico during 1976, 1977, and 1978. From the CPIR in-depth collision files 93 utility vehicles (out of a total of 7,799 vehicles with 35,132 injuries) were analyzed. Supplemental data were added where possible to the CPIR data relative to roll-bar, cab type, restraints, and vehicle modifications (such as suspension and tires). The original written records of fatal accident reports from FARS and selected state files were also reviewed. Using these data the accident characteristics of utility vehicles were compared to those of passenger automobiles. To assist in determining the role of handling and stability, since many of these vehicles have a relatively high center of gravity and short wheelbase (as potential contribution to lateral motion instability), direct physical analyses of a Chevrolet Blazer, AMC CJ-5 and CJ-7 JEEP, Ford Bronco, and a modified Ford Bronco were conducted.

Major conclusions of the study are that:

** Utility vehicles experience rollover at a rate that is at least five times higher (and up to 11-1/2 times higher in Michigan) than that experienced by the average passenger car. The JEEP and pre-1978 Bronco overturn at least twice as often as the Blazer;

tire side forces alone in vehicles with a small stability envelope (such as the JEEP) may be sufficient to initiate overturn. Rollover and ejection from open-cab vehicles and lack of upper-torso restraints with roll bar protection appear to be major injury factors.

** Both the death rate and the rate of disabling injury (per accident) are about twice as high in utility vehicles, and both rates are approximately twice as high in JEEPS as in Blazers.

Only 6 of 20 Federal Motor Vehicle Safety Standards that apply to passenger cars also presently apply to utility vehicles without exception. Utility vehicles, for example, are exempted from the lap and shoulder belt requirements (FMVSS 209). The study findings indicate that the stability, crashworthiness, and occupant protection features of utility vehicles need to be improved.

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1. INTRODUCTION

1.1 Statement of Problem[1]

The versatility of utility vehicles has considerably increased their popularity and use in recent years, as available production and registration figures reveal. For example, between 1975 and 1977, total utility vehicle registrations increased 35 percent, from 831,058 to 1,125,923. In comparison, passenger car registrations increased during the same period less than seven percent.

Often popularly identified as "Jeeps," a utility vehicle as defined in this study is a multi-purpose vehicle usually designed for both on-road and off-road use. Utility vehicles considered in this study included various models of the Willys Jeep[2], AMC JEEP[3], Ford Bronco, International Scout, Toyota Land Cruiser, Chevrolet Blazer, GMC Jimmy, Dodge Ramcharger, Plymouth Trail Duster, and Volkswagen Thing.

Some of the smaller utility vehicles have evolved directly from original military designs. All utility vehicles share certain general characteristics in contrast to conventional vehicles; among these are a relatively short wheelbase, higher center of gravity, stiffer suspension systems, and, often, four-wheel drive.

Despite the increased civilian use of these utility vehicles, their civilian crash experience has not previously been comprehensively evaluated. Yet previous studies of similar military vehicles have found an extremely high incidence of occupant ejection in both collisions and rollover crashes. Among police-reported crashes in the United States,

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[1] This study was conducted under standards established by The University of Michigan Medical Center Committee to Review Grants for Clinical Research and Investigation Involving Human Beings, and conformed to guidelines of the Institutional Guide to Department of Health, Education, and Welfare Policy on Protection of Human Subjects. The research has been supported mainly by a research grant from the Insurance Institute for Highway Safety, Washington, D.C.

[2] Prior to 1963.

[3] The word JEEP is the registered trademark of Jeep Corporation, subsidiary of American Motors Corporation.

rollover (as a first event) occurs for about 2 percent of the vehicles involved.[4]

A previous U.S. Army review (1968) found that 36 percent of all European Theater of Operations military jeep crashes involved rollovers without collision, suggesting stability and operating problems. Many of these crashes reportedly resulted in fatal injuries to occupants, even at relatively low highway speeds (30-45 mph). Thus it is important to know whether comparable civilian-owned utility vehicles have similar problems, and, if so, the nature and extent of those problems.

Contrasted to passenger car occupants, utility vehicle occupants may be subjected to increased injury risk for the following reasons: (1) the combination of short wheelbase, narrow track width, and high center of gravity may make them more prone to rollover; (2) lack of substantial side and roof structure may reduce occupant protection; (3) interior structure and instrument panels may have sharp, rigid non-yielding surfaces and projections; (4) in addition, the off-road usage of this type of vehicle may also increase occupants' exposure to crash and rollover involvement.

In view of these considerations, data concerning current utility vehicle collision and occupant injury experience has been collected and analyzed to assess these problems, and recommendations have been developed concerning means of improving occupant safety.

1.2 Scope and Objectives

The purpose of this study was to provide a systematic in-depth investigation into the on-road crash experience, injury mechanisms, and potential hazards to occupants of utility vehicles. Major objectives were to:

(1) Describe the on-road crash experience, including incidence of rollover, for utility vehicles;

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[4]Based on police-reported accident data from Texas, Washington, and Michigan.

(2) Compare the on-road utility vehicle crash experience, injury potential, and operator profiles with the same for other vehicle types;

(3) Describe the injury mechanisms and injury potential for occupants of utility vehicles;

(4) Analyze available injury data (fatal and non-fatal) resulting from utility vehicle accidents;

(5) Describe ejection from utility vehicles during rollover collisions and other crashes;

(6) Compare rollover frequency, injury rates, and severity of injury to utility vehicle occupants and passenger car occupants;

(7) Describe and compare the accident involvement patterns and vehicle occupancy patterns of utility vehicles with those of passenger cars;

(8) Develop a profile of the crash-involved operator of various vehicle types.

Several secondary objectives were included. These were to:

(1) Review nationwide utility vehicle and passenger car registration data and evaluate various geographic and demographic differences;

(2) Physically measure and compare typical utility vehicles for factors that could influence stability and thus likelihood of rollover: e.g., wheelbases, track widths, suspension systems, steering, center of gravity or weight distribution, tire design;

(3) Review product liability allegations involving utility vehicles to identify specific problem areas;

(4) Review existing or proposed Federal Safety Standards and their applicability to utility vehicles;

(5) Evaluate the effectiveness of safety related equipment in utility vehicles, including roll-bars, restraint systems, and interior protection;

(6) Determine the incidence of and injury potential existing in post-crash fires involving utility vehicles.

The focus of this study has been limited to on-road collisions involving utility vehicles only.

2. BACKGROUND

2.1 Utility Vehicles: Past, Present, Future

2.1.1 Military Development

Historically, today's four-wheel-drive utility vehicles have evolved from the "Jeep" of World War II. Credit for the origin of the "Jeep" has been a controversy discussed in numerous publications. A memorial plaque listing the American Bantam employees responsible marks the Jeep's "birthplace" in Butler, Pennsylvania. One individual who may have been instrumental in its development was Karl K. Probst, temporary Chief Engineer for Bantam. He reportedly drew up the first plans "during a grinding three-day weekend in the deserted, dusty engineering rooms" (Lamm, 1975). Credits for the Jeep's design have been suggested by Vanderveen as: concept and general layout, U.S. Army; general design of vehicle and body work, Bantam; front end, Ford; power unit, Willys. But one could go on and say that the driveline layout was used by Spijker in 1902, the type of driven front axle was pioneered by Otto Zachow (FWD) in 1907, and that mechanically the Jeep was a scaled-down Ford/Marmon Herrington 1/2-ton 4x4 which has been dubbed "granddaddy of the Jeep" (Vanderveen, 1974).

The name "Jeep" was reportedly used as early as 1914-1918 by Army mechanics testing new vehicles (Lamm, 1975). A pioneering attempt at developing a military utility vehicle occurred in the early 1920's when the commanding officer of the 1st Tank Regiment at Fort Meade developed the "Puddle Jumper," the "first Jeep" (Wallace, 1978). Intended for following tanks over rough terrain, it was constructed from a 3/4-ton Ford chassis and motor, and was equipped with bucket seats taken from the salvage dump. About 1931 a War Department inspector saw these unauthorized vehicles, and the Infantry School (Tank Section) was ordered to get rid of them.

In 1936 the comic strip "Popeye" introduced a character called "Eugene the Jeep," a mythical animal who had magical talents, and this has also been suggested as a source for the name "Jeep." In 1937 tractors supplied to the Army by Minneapolis Moline were called "Jeeps."

In the armored forces, the Jeep was first known as the Peep, Quad, Pygmy, GP, and Midget. During 1940-41 the 1/2-ton Command Reconnaissance Vehicle (Dodge) was called "Jeep" (Vanderveen, 1974). The name "Jeep" replaced "Peep" in soldier and test driver terminology. When riding with a test driver in February, 1941, Katy Hillyer, a reporter for the Washington Daily News, asked what the vehicle was called, wrote it up as a "Jeep," and the name apparently stuck (Lamm, 1975). Joe Frazer, president of Willys Overland from 1939 until 1944, also was credited with coining the word "Jeep" by slurring the initials G.P. (military designation for General Purpose) (Lamm, 1975). But Sterns (1941) claims the Ford version of the G.P. was the origin of the generic term "jeep." Technical background concerning the origin of the "Jeep" may be found in Sterns (1941), Vanderveen (1969;1974), Lamm (1975), Conley (1978), and Wallace (1978). However it originated, the name "Jeep" has become synonymous with the four-wheel-drive military utility vehicle, even if it is often erroneously applied.

The first 1/4-ton 4x4 was produced by Bantam in 1940 (American Bantam Car Company, 1941), in response to a U.S. Army request for a vehicle that could carry personnel and light cargo and also tow a 37mm AT gun or 1/4-ton two-wheel trailer. Performance requirements included climbing a 65 degree grade, carrying an 800 lb. load, towing a 1/2-ton trailer, and driving along a hillside tipped laterally at an angle of 55 degrees. Seventy Bantams were produced. In late 1941 Willys-Overland produced a pilot model known as "quad." Both the Bantam 40 BRC (Bantam Reconnaissance Car) and Willys (MA) models were subsequently redesigned and 1,500 of each were ordered by the Army for further tests, as well as 1,500 of a Ford GP (General Purpose) pilot model.

The 45-hp Bantam and 40-hp Ford (tractor engine equipped) did not perform as well as the 60-hp Willys MA. Willys exploited the innovations contained in all three prototypes and developed the standardized model MB. To assure a second source Ford was awarded a contract to produce a model completely interchangeable with the MB, resulting in the Ford Model GPW (General Purpose Willys), which went into mass production in December 1941. The military jeep was produced in the following models: American Bantam 40 BRC (1941); the Ford GP

(1941); the Ford GPW (1942-1945); and the Willys MA (1941) and MB, including 277,896 GPW and 361,349 MB models (Vanderveen, 1969). By V-J day Willys and Ford had reportedly provided a total of 651,068 Jeeps (Conley, 1978).

The British Standard 5-cwt[5] 4x2 car experimentally appeared as the British version of the American "Jeep," in 1943. It had 75-inch wheelbase and 4-cylinder 44 b.h.p. motor, but no front-wheel drive. Since U.S. Lend-Lease supplied Great Britain with sufficient numbers of the Ford and Willys Jeeps, no wartime British utility vehicle was further developed (Vanderveen, 1969). However, in early 1950, the Austin Motor Co. Ltd., of Birmingham, designed and produced the first British Jeep (designated FV1801) for the War Office. The initial production contract was for 15,000 vehicles. It was powered by a Rolls Royce B.40 MK.2A/4 cylinder engine, developing 69 b.h.p. Wheelbase was 84 inches, weight 3,470 lbs., length 91.5 inches. Overall length compliance tests included a c.g. fully loaded ("laden") of 27.6 inches from the ground and 41.5 inches from the front wheels (Blake, 1979).

The M38 series (military counterpart of the CJ-5 and CJ-6) was produced from 1952 until introduction of the M151 in 1966 (Vanderveen, 1966). By the late 1960's the military had switched from the M-38A1 series of Jeep to the Ford M-151 series. The M151A1 military Jeep represents the most recent of a long series of utility military vehicles, which although continually undergoing modification, have the same basic configuration. As rigidly specified by military procurement, size and clearance dimensions result in a relatively high center of gravity and resultant stability characteristics. The addition of equipment such as plows, gun mounts, or high loading accentuates instability conditions. The Ford M151 series has been found to have stability problems which will be discussed in the following section.

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[5] cwt = hundred weight

2.1.2 Military Accident Experience

Injury data involving jeep accidents have in the past come primarily from studies of the military vehicles. In 1947 an article appeared in the American Journal of Surgery concerning an analysis of 58 injuries of the hip joint. A surgeon in the European Theater of Operations treated these over a period of 18 months (1944-1946) in 20 U.S. Army hospitals. Of these 58 injuries, 40 were incurred in jeep crashes (Urist, 1947). It was suggested that all dislocations, and certain types of fractures of the hip joint, were produced by a forceful blow on the flexed knee or on the sole of the foot. Force was believed to be transmitted through the extended knee, whether alone or in combination with violent blows against the lower back and the lateral aspect of the hip. This early study of a special class of injury, considered particularly common with regard to the jeep, may be of current interest, since it was noted that most of these occurred on concrete highways prevalent in Europe, but not found in other operational theaters.

By 1955 there was still "considerable doubt...as to the relative hazard of seat belts in military open-top vehicles, including jeeps, whether it is better or worse to be strapped to the seat in the event of an accident" (Babione, 1955). In order to estimate the possible benefits with respect to mortality that might accrue if seat belts were installed in military vehicles, data were collected from Navy and Marine Corps vehicle fatal accidents from 1952 to 1954. Rollover occurred in 33 out of 38 fatal accidents occurring in connection with Jeeps, weapons carriers, heavy trucks, and one DUKW (duck). It was concluded that ten persons who escaped death in rollover accidents by being thrown out "would probably have been killed if they had been kept in by seat belts" (Babione, 1955). However at that time no consideration was apparently given to the potential benefits of use of belts combined with a roll-bar. It was found that the costs of preventive measures compared to savings, both for fatalities and injuries, could not be determined without more detailed reporting of the causes of trauma in crashes. Except for isolated studies and accident records by the military, little attention appears to have been paid to the problems associated with military jeep injuries until the 1960's (although statistics clearly indicated that a major problem existed).

A statistical analysis of U.S. Air Force ground vehicle crashes involving Jeeps during 1951 and 1952 indicated that crashes with this type vehicle comprised eight to nine percent of all crashes involving USAF military ground vehicles. During 1951, 839 (8%) involved jeep crashes and in 1952, 727 (9%) involved jeep crashes (Mathewson et al., 1954). The Air Force reported that over 1,000 airmen per day were unavailable for duty (killed or recuperating from injuries) because of ground vehicle crashes in 1951 and 1952 (Mathewson et al., 1954). In the U.S. Navy, fatal motor vehicle (including jeeps) crashes were by far the leading cause of Navy deaths (62.4 per 100,000) leading all other causes combined, including Viet Nam casualties--until mid-1966 (U.S. Navy, 1967).

The Ford military M151 series includes seven different models of utility vehicles. The M151, M1511, and M151A2 1/4 ton 4x4 utility trucks are used as general-purpose personnel or cargo carriers. The basic M151 was further modified in the M151A1C and M785 models, equipped with a 106mm recoilless rifle on an M79 rifle mount, and the subsequent M718 and M718A1 vehicles, which were longer, higher, and weighed about 1400 pounds more, and modified as front-line ambulances.

By 1968 the Army had conducted several tests of M151 Jeep components at Aberdeen Proving Grounds, including brakes, windshield, a deep-dish steering wheel, and new acceleration pedal (personal communication, 16 September 1968). For the conduct of crash and rollover tests, the Aberdeen Proving Ground issued a Vehicle Collision and Accident Safety Test Procedure 2-2-621, effective 15 May 1968 (U.S. Army Test and Evaluation Command, 1968), and at least two M151 stability test studies were completed (Cooke, 1968; Jurrat, 1969).

During that period there was an Army regulation stating that seat belts will not be used on tactical type vehicles unless equipped with roll-bars. Making rules for use of seat belts was delegated to the local commanding officer. But field usage was slow in developing because field combat requirements differ from those of normal usage.

During the 1968 evaluation by the Army of the M561/792 1-1/4 ton utility vehicle Gamma Goat, seat belts were recommended.

Although relatively little injury data concerning the M151A Jeep are available to provide insight into the specific safety problems with this vehicle, its problems are considerably better documented than for the earlier MB and M-38 series. The military had frequently reported problems of rollovers with the M151 to the manufacturer, and single accident reports began to appear to support this (Huelke, 1968), including a rollover of an M151 at the Arizona Proving Ground which ironically injured the manufacturer's chief designer (Muller, 1966).

Impact tests of the M-151, conducted by the manufacturer, included inclined-plane sled tests of six M-151 steering wheels (King, 1966), and seven ramp rollover tests from 15-45 mph (Saalbrank, 1965). The original roll-bar withstood low-velocity rollovers up to 15 and 20 mph. A redesigned roll-bar for the production vehicle collapsed in tests at 45 mph, and even when dummy occupants were fitted with lap belt and shoulder harness, they leaned outside the rolling vehicle. In a 31-mph barrier crash, the lap-belted dummy occupant jackknifed into the sharp upper edge of the instrument panel (Schafenek, 1966). An unpublished evaluation of the M-151A1 Jeep crash problems and injury mechanisms was conducted by Snyder (1968).

Accident experience for the M151, M151A1, M151A1C, and the M718 Front Line Ambulance, for the six-year period 1962 through 1967 for the U.S. Army in Europe, included 126 deaths (U.S. Army Material Command, 1967). From 1963 through 1967 some 4,870 accidents were recorded involving the M151 for that theater of operations alone (935 accidents in 1963 with 21 fatalities; 951 in 1964 with 30 fatalities; 1,074 in 1965 with 23 fatalities; 923 in 1966 with 14 fatalities; and 987 accidents in 1967 with 15 fatalities). The Army accident rate (per 100,000 miles driven) in the European Theatre during the period for the M151 vehicle was 1.57, varying from 2.01 (1963) to 1.17 (1967), compared to an Army world-wide M151 accident rate of 1.44. The fatality rate was reported as 26.90 per 100,000,000 miles driven for Europe, and 20.94 for the Army world-wide for the M151 vehicles.

Although similar data for the earlier M38 series vehicle were not given in the referenced study, based upon a fatality rate (in 100,000,000 miles driven) of 59 for the M38A1 in fiscal 1963 (July 1963 - 30 June 1964), the Army had projected 182 fatalities for the period FY1963 (fiscal year) through FY1967 in the European Theatre. This compares with 113 actual fatalities for the same period involving the M151 (U.S. Army Material Command, 1967).

Eight of 14 (57%) fatal U.S. Army M151 accidents occurring in Europe during fiscal year 1967 involved rollover. Two were collisions with subsequent rollover, and six (43%) involved non-collision single-vehicle rollovers; two of the latter occurred on straight sections of road and four on curves. The two non-single-vehicle collisions with rollover both occurred on straight roads (U.S. Army Material Command, 1967).

The M151 Jeep was involved in 7,460 accidents world-wide in the years FY1967 through FY1970, involving 138 fatalities; 2,201 (30%) were rollover accidents (Department of the Army, 27 November 1970). During the three-year period FY1974-FY1976 the U.S. Army reported 1,102 M-151 Jeep crashes, involving 42 fatalities and 507 injured occupants. Overall, 66 percent of the total FY1974-FY1976 Jeep accidents involved rollovers. It is significant to note that in none of these 1,102 crashes was post-crash fire reported (Table 2.1-1).

The M151 series Jeep accounted for 965 (45%) of the 2151 Department of the Army rollover crashes occurring between April 1974 and September 1978 (from U.S. Army computer data printouts cited in Brune, 1979). The basic M151 military jeep has an overturn rate of 16.1 accidents per million miles. This is reflected in the warning printed in the M151 operator's Manual stating: WARNING: <u>Extreme care should be used when driving M151 series vehicles. They have more responsive steering and acceleration than other vehicles. Watch speed, especially on turns. A full right or left turn at speeds over 20 mph can cause any vehicle to go out of control and/or turn over</u> (U.S. Army, 1978). It should be noted that significantly reduced overturn rates in the later M151A1, M151A1C, M718 (1.8 accidents per million miles), and in the M151A2, M825, and

TABLE 2.1-1

SUMMARY OF 1,102 U. S. ARMY
JEEP CRASHES REPORTED DURING
FY1974-1976

Year	Rollover	Vehicle Ran Off Road	Fire	Fatality	Injury
1976	236	129	0	17	159
1975	211	135	0	8	173
1974	278	113	0	17	175
Totals	725	337	0	42	507

(Department of the Army, 26 October 1976)

M718A1 (0.5 accidents per million miles) are attributed to subsequent design changes (Brune, 1979, p. 16-17).

Not until 1971 did the federal government officially recognize the serious hazards to occupants of military utility vehicles in crashes. At that time an NHTSA "position paper" (Office of Defects Management, 1971) disclosed the M151 FY1967-1970 accident record of 7,460 accidents world-wide involving 138 fatalities. The Army world-wide M-151 fatality rate was 12.18 (per 100,000,000 miles driven) and the accident rate was 0.83 (per 100,000 miles driven). As a result, the NHTSA refused to sanction a Department of the Army plan to sell surplus Jeeps to the general public (IIHS, 1972; Anon, 1969; Mohbat, 1969). The National Highway Traffic Safety Administration (NHTSA) was pressed by the Department of the Army and the Defense Supply Agency to allow sale of the M151 (including the older models M151A1, M151AC, and 718, and the more recent models M151A1, M825, and M718A1). An estimated 73,309 vehicles were planned to be disposed of during the next six to ten years (1971-1981 period) at the Army's estimated salvage value of $300 to $1,200 per vehicle at an average return of $750 per vehicle. Approximately $55 million was at stake.

However, it was concluded by the NHTSA Office of Defects Investigation (ODI) that the Department of Defense had already recognized the unsafe handling characteristics of the M151 Jeep, and pointed out that it was Department of Defense policy not to sell an item if it is considered unsafe for a non-military user. They noted that the Army had required special training of drivers, including a film to illustrate the hazards of unsafe handling. They also noted the rollover propensity of the rear swing axle assembly despite modifications (M151A2), and the apparent rollover problem, involving a record of 7,460 world-wide M151 Jeep accidents (FY67 through FY70) with 138 fatalities. Of those 7,460 accidents, 2,201, or roughly 30 percent, were rollover accidents. The full text of this NHTSA position paper is provided in Appendix A. At present surplus M151 Jeeps must be rendered unusable by cutting the frame and suspensions before they can be purchased in the open market. Despite this some have been repaired and are in civilian use.

2.1.3 Utility Vehicles[6] in Domestic Use

Subsequent to World War II sales of military equipment popularized the "Jeep" as a civilian utility vehicle. Post-war civilian models were produced by Willys (to 1963), Kaiser-Willys (after 1963) and Ford. The name "Jeep" became a registered trade mark of Willys-Overland in 1945. In April 1953 the name was changed to Willys Motors Inc., when the company was taken over by the Henry J. Kaiser Industrial interests. In March 1963 it became Kaiser Jeep Corporation, until 1970 when the company became part of the American Motors Corporation (Vanderveen, p. 62, n.d.).

In June 1945 Willys produced the first civilian Jeeps which were actually demilitarized MB's. By August, 1945 the first redesigned "Universal Jeep" model CJ-2A was introduced. The slightly modified model CJ-3A was produced in 1950, followed by the CJ-3B in 1953. In 1952 the 81 inch wheelbase CJ-5 and 101 inch wheelbase CJ-6 was

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[6]This study purposely excluded certain "utility vehicles" of limited production or vehicle design, such as the Willys Jeepster, Chevrolet Suburban, etc., as not being central to the scope of this study. The vehicles depicted in figure 2.1.3-1 are representative of, but not inclusive of, the vehicles included in the study population. Section 2.2 provides a precise definition of the study population.

introduced which featured a new body design (the military counterparts were the M38A1 utility truck and M170 ambulance truck 1/4 ton 4x4). American Motors Corporation bought manufacturing rights to the Jeep from Kaiser Industries in 1970. Following this acquisition, substantial body style changes were made in the CJ-5 and CJ-6 with no corresponding change in model designation. The CJ-7 was introduced in 1976.

Figure 2.1.3-1 shows the utility vehicles in domestic use and illustrates their years of manufacture and/or sales in the domestic market.

Current domestic manufacturers include AMC JEEP, Chevrolet Blazer (introduced in 1968) and GMC Jimmy (introduced in 1969), Ford Bronco (the 92 inch wheelbase model was produced from 1965 - 1968, and now produced in a 104 inch wheelbase), International Scout (introduced in 1961), and Dodge Ramcharger/Plymouth Trail Duster (introduced in 1973).

Foreign competitors include the British Land Rover (1949) and the Japanese Toyota Land Cruiser (1970). The German Volkswagen "Thing," introduced in 1973 and 1974, and markedly different in construction, is also classed as a utility vehicle.

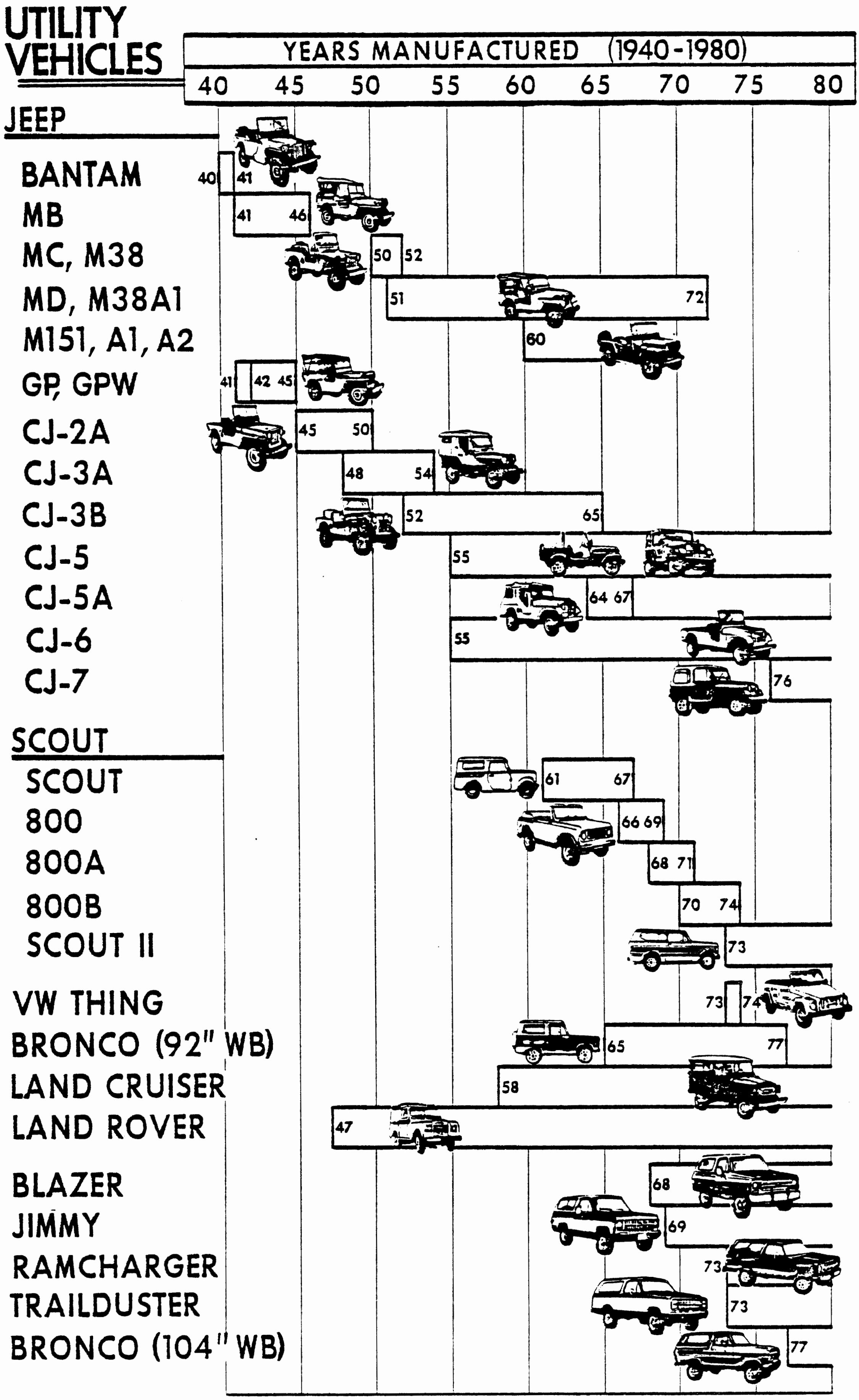
2.1.4 Utility Vehicles in Foreign Use

Although this study is concerned with utility vehicles in use in the United States, there are a large number of four-wheel-drive multipurpose (utility) vehicles in use in other parts of the world.

Leyland Australia's Mini Moke utility vehicle can be converted into a Gran Turismoke through conversion kits marketed through dealers. This kit (about $2,500 Australian) allows the Moke owner to restyle his vehicle with fiberglass panels, suede sheepskin upholstery and carpet, and two roll-bars. The Moke, designed in England, is manufactured in Australia, and exported worldwide (Automotive News, May 22, 1978).

An Italian utility vehicle, the Moretti Midimaxi 127, Features front-wheel drive and uses Fiat 127 running gear (Automotive News March 27, 1978). The Moretti Jungla, with roll-bar, fold-down windshield, and open body, has a rear-wheel drive only. It uses a Fiat 126 two-cylinder engine, and has limited off-road capability. Another Italian utility

Figure 2.1.3-1 Utility Vehicles and Years of Manufacture*



*Certain foreign vehicles may still be in production but are no longer for sale in the U.S.

vehicle, designed by Ferriccio Covini, is four-wheel drive and features a turbo-charged diesel engine and symmetrical steel body (Automotive News, May 22, 1978).

In 1979 the light weight (715Kg) Citroen Mehari front-wheel-drive utility vehicle, produced since May, 1968, was modified to a 4-wheel-drive utility vehicle (Automotive News, June 25, 1979).

A new Russian utility vehicle, the ZAZ 969, is four-wheel-drive, 132 inches long, and powered by a 1,196-CC V-4 engine (Automotive News, May 22, 1978).

Annual market growth of utility four-wheel-drive vehicles in Europe currently ranges from 15 to 25 percent per year. An excellent review of a number of utility vehicles world-wide was provided in Automotive News (November 27, 1978). Other current utility vehicles described include the Austrian Pinzgaver by Steyr-Daimler-Puch, British Leyland Land Rover (since 1948) and Range Rover (since 1970), the Italian Fiat Campagnola, the Russian Lada Niva, the Embo four-wheel-drive wagon with a Fiat engine, the Swedish Volvo Laplander, Rumanian ARO-244, the Portuguese UMM-Uniao Metalo Mecanica Cournil, the Italian Soleado, the French Stemat Veltt, Society Sinpar Renault 4L, and ACL Rodeo 4x4 vehicles.

The Japanese produce a number of utility vehicle models including the Nissan Patrol 4x4, Subaru 4x4, Daihatsu F-20 LV 4x4 Wagon, Suzuki LJ10, Isuzu Unicab, Mitsubishi Jeep-type models (J-3R, J-20C), and Toyota Land Cruiser Hardtop FJ40V.

2.1.5 Future Utility Vehicles

Several new utility vehicles are in production or planned for the future, and suggest the direction of future designs.

Mercedes-Benz initiated production in February, 1979, on a four-wheel-drive utility vehicle known as Explorer. During its development phase it is being marketed as the Mercedes-Benz G-series (G=Gelande, for Terrain). Frame and body is by Steyr-Daimler-Puch of Austria. The 240 GD is powered by a 2.4 liter four-cylinder diesel engine, and has a built-in roll-bar. Several gasoline and diesel engines are offered along with a number of body types (Automotive News, November 27, 1978; Time, December 18, 1978; Automotive News, January 29, 1979).

AMC's 1980 model Eagle is the only U.S. manufactured four wheel drive (4WD) passenger car. Standard equipment is reported to include a 258-cid L-6 engine, three speed automatic transmission, automatic 4WD system, power steering, power front disc brakes and radial tires. It is available both in Standard and Limited versions of the two-door and four-door automobile and four-door station wagon (Automotive News, August 27, 1979; American Eagle, 1979; Lund, 1979). It appears to be identical to the AMC Concord in design and options, except that the Eagle is a four-wheel drive version. It is anticipated that the AMC Spirit of 1981 will also be available in two- and four-wheel drive models.

In England the Yak Yeoman, designed and developed by Manchester Garages (Motorcraft) Ltd. is going into production for export to developing countries. It has a wheelbase of 109.2 inches and features an automatic differential lock fitted into the rear axle, instead of four-wheel-drive (Automotive News, May 7, 1979).

Besides the present Toyota Land Cruiser, the Japanese may market the Diahatsu Taft Gran, "a four-wheel-drive vehicle that closely resembles the Jeep," in the United States in the early 1980's (Automotive News, March 20, 1978). The Taft Gran has a wheelbase of 79.5 inches. It has a flip-down windshield and integral roll-bar. It is described as smaller than the Jeep. Daihatsu engineers are reported to be reducing weight (2,380 lbs) and increasing power output (from the Toyota Corolla 1,600cc four-cylinder engine to an 1,800cc engine).

An advanced four-wheel-drive vehicle concept by American Motors indicates the directions utility vehicles may take during the next decade. The 100-inch wheelbase Jeepster II design features extensive use of light-weight materials, soft front and rear panels, a built-in roll-bar, flat glass folding windshield, and aluminum or fiberglass detachable doors. Basically envisioned as a two-seat vehicle, the Jeepster II concept would feature two additional removable seats in the rear cargo areas as required. The roof, of two-piece light-weight panels, could be stored behind the front bucket seats. Power would be from a four-cylinder turbo gasoline or diesel engine, and body size dimensions would be 160 inches long, 65 inches wide, and 60 inches high (Automotive News, January 1, 1979). In 1980 the AMC Spirit will have four-wheel drive, joining the AMC four-wheel drive JEEP and Concord-based Eagle (Dunne, 1979).

Described as an "off-road Fiesta," Ford Motor Company's Tuareg is another concept car whose ideas may be incorporated in production utility vehicles of the 1980's (Skwira, 1979).

By far the most expensive utility vehicle design is the German Sea Ranger, designed by Luigi Colani. An all-terrain vehicle, it is much larger than most--6.2 meters (20 feet) in length and 4,000kg (8,800 lbs) in weight. Equipped for long expeditions, it carries four occupants in bucket seats and has a swivel chair mounted on top. To date only one prototype has been built. The price will be about $385,000.00, depending upon equipment (Automotive News, January 15, 1979).

2.2 Study Population

The population of utility vehicles considered in the present study consists of the vehicle makes and models listed in Table 2.2-1.

Utility vehicles are a sub-class of the more general grouping of vehicles called multi-purpose passenger vehicles. A multi-purpose passenger vehicle is designed primarily to carry passengers but is easily converted to other non-passenger carrying uses. Common vehicle types under this classification include truck based station wagons (GM Suburban, for example), jeep-type[7] open vehicles (Toyota Land Cruiser, Willys Jeep, etc.), some vans, pick-up cars, sport-recreational vehicles, etc.

The utility vehicles shown in Table 2.2-1 were selected because they account for approximately 95 percent of the utility vehicles registered in the U.S. in recent years.

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[7] The National Highway Traffic Safety Administration (NHTSA) defines "jeep-type vehicle" as a "four-wheel-drive, general purpose automobile capable of off-highway operation that has a wheelbase not more than 110 inches, and that has a jeep-type configuration" (Code of Federal Regulations, 49. Part 533.4. Revised. October 1, 1977).

TABLE 2.2-1

STUDY POPULATION

Make	Model	Type of Drive (2 or 4 wheel)
Chevrolet	Blazer	2
	Blazer K10	4
Dodge	Ramcharger	2
	Ramcharger	4
Ford	Bronco	4
	Bronco Pick-up	4
	Bronco Wagon	4
	Bronco Roadster	4
GMC	Jimmy	2
	Jimmy K1500,K1550	4
	K1500	4
International	Scout, Scout II	2
	Scout, Scout II	4
AMC	CJ3, CJ3B JEEP	4
	DJ3A JEEP	2
	CJ5, CJ5A JEEP	4
	DJ5 JEEP	2
	CJ6, CJ6A JEEP	4
	DJ6 JEEP	2
	CJ7 JEEP	4
Plymouth	Trail Duster	2
	Trail Duster	4
Toyota	Land Cruiser	4
VW	Thing	2

Excluded from this list were some vehicles such as the Jeep Wagoneer, which appears to be a four-wheel drive version of a truck-based station wagon, or, as in the case of the Land Rover, Jeepster, Kaiser and/or Willys, are no longer for sale or in production in the United States.

A good example of the problem in defining a utility vehicle is presented by the 1980 AMC Eagle. Advertised and Marketed as a "four-wheel drive automobile" in three body styles (two-door and four-door sedans, and a four-door station wagon version) it is classified by its manufacturer as a multi-purpose (utility) vehicle (American Eagle sales brochure, 1979) yet classified as a truck by the government relative to meeting Federal fuel standards (personal communication, 1979; Automotive Industries, p. 52, 1979). Similarly the four-wheel-drive Subaru, while also marketed as a passenger car, is also classified as a multi-purpose vehicle.

2.3 Utility Vehicle Registration

Data obtained from the National Vehicle Population Profile (produced by R. L. Polk & Company from national motor vehicle registration data) show that in 1975 there were 831,058 utility vehicles and 106,712,551 passenger vehicles registered. This gives a percentage of utility vehicles to passenger cars of 0.78 percent. In 1976 these figures were 971,510 utility vehicles and 109,675,855 passenger vehicles, for a percentage of 0.89 percent, and in 1977 1,125,923 utility vehicles and 114,113,000 passenger cars, for a percentage of 0.99 percent.

Utility vehicles are a growing segment of the motor vehicle population, now accounting for almost one percent of all vehicles on the road. From 1976 to 1977 the utility vehicle growth was 15.9 percent, compared to passenger cars' growth of 4.1 percent for the same period. For the two-year period of 1975-1977, utility vehicles had a growth of 35.5 percent compared to passenger cars' rate of 6.9 percent.

Table 2.3-1 shows the number of utility vehicles by make and percent of total for each of the three years, 1975, 1976, and 1977.

Production data for the 1978 model year, as provided in Ward's 1979 Automotive Yearbook, show that the top three 1978 models were: Blazer (78,507); JEEP CJ-5, CJ-6, CJ-7 (76,628); and Bronco (69,120). For the 1978 model year, AMC reported "145,716 JEEPS were sold," and 156,000 units estimated for the 1979 model year (Automotive News, September 3, 1979).[8]

Registration counts for individual models within a make, e.g. Blazer and Blazer K10, are not listed, since detailed model information is not reported on the majority of accident reports.

Using the most recent (1977) registration data available, the makes in Table 2.3-1 are rearranged to list them in order of decreasing frequency in the population as shown in Table 2.3-2.

Data from eight states were used to study the collisions and registration to provide geographical and demographic distribution. These were Arizona, Maryland, Michigan, New Mexico, New York, North Carolina, Texas, and Washington. The registration data are discussed in detail in subsequent sections. However, for convenience, the total numbers of utility vehicles registered in each state are summarized in Table 2.3-3. This table also shows the percent increase in registration of these vehicles between 1975 and 1977. Together they represent 235,922 vehicles, or 21 percent of the total 1977 U.S. utility vehicle population.

Tables 2.3-4 and 2.3-5 provide a model-by-model tabulation of the utility vehicles in each state. Table 2.3-4 shows this tabulation for 1976, and Table 2.3-5 for 1977.

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[8] Although not counted as a utility vehicle in this report, the JEEP Cherokee is occasionally classified as a utility vehicle. The Ward's production figure for the Cherokee is 36,945 for the 1978 model year.

TABLE 2.3-1

UTILITY VEHICLE REGISTRATION IN THE U.S. BY MAKE*

Vehicle		1975		1976		1977	
Make	Model	N	%	N	%	N	%
Chevrolet	Blazer	200,484	24.1	256,071	26.4	315,947	28.1
AMC	JEEP**	187,059	22.5	205,342	21.1	240,955	21.4
International	Scout**	184,465	22.2	205,371	21.1	220,057	19.5
Ford	Bronco	149,392	18.0	159,306	16.4	166,089	14.8
GMC	Jimmy	31,218	3.8	43,085	4.4	56,627	5.0
Toyota	Land Cruiser	36,909	4.4	44,378	4.6	53,894	4.8
Dodge	Ramcharger	13,981	1.7	25,340	2.6	35,245	3.1
VW	Thing	21,555	2.6	21,803	2.3	21,817	1.9
Plymouth	Trail Duster	5,995	0.7	10,814	1.1	15,292	1.4
Totals		831,058	100.0	971,510	100.0	1,125,923	100.0

*In order of popularity (number of registrations) in 1977.

**The figures shown slightly under count actual registrations because the Polk data do not list models separately prior to the 1966 model year.

TABLE 2.3-2

UTILITY VEHICLES IN THE U.S.
ARRANGED BY POPULARITY (1977 DATA)

Model	Percent of Total 1977
Blazer	28.1
JEEP	21.4
Scout	19.5
Bronco	14.8
Jimmy	5.0
Land Cruiser	4.8
Ramcharger	3.1
Thing	1.9
Trail Duster	1.4

TABLE 2.3-3

NUMBERS OF REGISTERED UTILITY VEHICLES
BY SELECTED STATES
FOR 1975-1977

State	Year			Percent Increase (75-77)
	1975	1976	1977	
Arizona	17,805	19,634	22,267	25
Maryland	7,980	9,235	11,121	39
Michigan	41,430	53,111	64,200	55
New Mexico	9,850	11,336	13,785	40
New York	42,584	49,284	54,284	27
N Carolina	18,556	23,684	28,404	53
Texas	35,884	44,569	57,131	59
Washington	21,745	22,871	24,255	12

TABLE 2.3-4

UTILITY VEHICLE REGISTRATIONS BY MODEL FOR SELECTED STATES, 1976

Model	Arizona n	Arizona %*	Michigan n	Michigan %*	New Mexico n	New Mexico %*	Maryland n	Maryland %*
Blazer	5,824	29.7	19,213	36.2	3,436	30.3	2,598	28.1
Ram-charger	355	1.8	2,094	3.9	234	2.1	205	2.3
Bronco	3,385	17.2	7,375	13.9	2,492	22.0	3,305	14.1
Jimmy	1,042	5.3	3,074	5.8	656	5.8	351	3.8
Scout	3,318	16.9	8,156	15.4	1,930	17.0	1,981	21.5
JEEP	3,637	18.5	11,011	20.7	1,700	15.0	1,998	21.6
Trail Duster	147	0.7	859	1.6	110	1.0	124	1.4
Land Cruiser	1,359	6.9	691	1.3	544	4.8	354	3.8
Thing	567	2.9	638	1.2	234	2.1	309	3.4
Total	19,634		53,111		11,336		9,235	

Model	New York n	New York %*	Texas n	Texas %*	Washington n	Washington %*	N Carolina n	N Carolina %*
Blazer	14,455	29.3	13,687	30.7	6,121	27.6	4,736	20.0
Ram-charger	1,361	2.8	1,062	2.4	510	2.3	359	1.5
Bronco	7,143	14.5	6338	14.2	3887	17.5	4,543	19.2
Jimmy	2,052	4.2	2,955	6.6	1,197	5.4	724	3.1
Scout	11,921	24.2	8,765	19.7	3,637	16.4	3,926	16.6
JEEP	8,684	17.6	7,927	17.8	4,832	21.2	7,346	31.0
Trail Duster	710	1.4	470	1.1	167	0.8	136	0.6
Land Cruiser	1,741	3.5	1,721	3.9	1,436	6.5	1,370	5.8
Thing	1,217	2.5	1,644	3.7	400	1.8	544	2.3
Total	49,284		44,569		22,187		23,684	

*Percentages may not add to 100% due to round-off error.

TABLE 2.3-5

UTILITY VEHICLE REGISTRATIONS BY MODEL
FOR SELECTED STATES, 1977

Model	Arizona n	Arizona %*	Michigan n	Michigan %*	New Mexico n	New Mexico %*	Maryland n	Maryland %*
Blazer	6,991	32.9	24,906	38.8	4,183	30.3	3,424	30.8
Ram-charger	563	2.6	3,330	5.2	351	2.5	315	2.8
Bronco	3,578	16.8	7,109	11.1	2,805	20.3	1,387	12.5
Jimmy	1,293	6.1	3,992	6.2	910	6.6	382	3.4
Scout	2,415	11.4	8,516	13.3	2,244	16.3	2,052	18.5
JEEP	4,144	19.5	13,535	21.1	2,038	14.8	2,671	24.0
Trail Duster	209	1.0	1,234	1.9	181	1.3	153	1.4
Land Cruiser	1,459	6.9	1,029	1.6	824	6.0	428	3.8
Thing	615	2.9	549	0.9	249	1.8	309	2.8
Total	21,267		64,200		13,785		11,121	

Model	New York n	New York %*	Texas n	Texas %*	Washington n	Washington %*	N Carolina n	N Carolina %*
Blazer	17,139	31.6	19,640	34.4	6,936	28.6	5,984	21.1
Ram-charger	2,047	3.8	1,616	2.8	683	2.8	470	1.6
Bronco	6,878	12.7	6,806	11.9	3,941	16.2	4,829	17.0
Jimmy	2,371	4.4	4,381	7.7	1,366	5.6	995	3.5
Scout	11,977	22.1	9,559	16.7	3,716	15.3	4,291	15.1
JEEP	9,492	17.5	10,322	18.1	5,058	20.9	9,404	33.1
Trail Duster	1,032	1.9	628	1.1	228	0.9	194	0.7
Land Cruiser	2,233	4.1	2,390	4.2	1,951	8.0	1,672	5.9
Thing	1,115	2.1	1,789	3.1	376	1.6	565	2.0
Total	54,284		57,131		24,255		28,404	

*Percentages may not add to 100% due to round-off error.

2.4 Product Liability Review

A search was made to determine the nature and extent of collision cases involving utility vehicles in litigation. These services were provided by the Professional Research and Development Department of the Association of Trial Lawyers of America (ATLA). This information provided insight into alleged safety and crashworthiness defects and other vehicle problems which resulted in serious and fatal injuries to utility vehicle occupants.

Information was obtained on 111 cases in some stage of litigation reported during the period 1967-1979. These included only cases brought to the attention of ATLA, generally by members, and undoubtedly considerably underrepresent the actual nationwide incidence of lawsuits involving utility vehicles. While JEEP was most frequently listed in cases reported to ATLA, "Jeeps," the Ford Bronco, and the Chevrolet Blazer appeared to have greater involvement than other makes of utility vehicles.

A list of the models involved:

7 - 1974 Toyota Land Cruiser (4-1970, 2-1974, 1-1976)

1 - 1969 Kaiser

3 - AMC DJ-5 "Dispatcher" postal JEEPS

1 - 1964 Willys Jeep

2 - Military M-151A2 (1974, Year not given)

2 - Ford military M-151

1 - 1971 Commando

5 - Wagoneers (1961, 1965, 1968, 1972, 1974)

3 - AMC CJ-7 JEEPS (1976, 1977, 1978)

21 - AMC CJ-5 JEEPS (5-1973, 2-1974, 3-1975, 2-1976, 4-1977, 5-year not given)

23 - identified only as "jeeps"

1 - case involving "1972-1976 Jeep"

19 - Ford Bronco (1-1966, 2-1969,1-1970, 1-1971 1-1973, 3-1974, 2-1978, 1-1979, 7-Year not given)

12 - Chevrolet Blazer (3-1972, 4-1973, 1-1975, 3-Year not given)

6 - International Harvester Travelalls (3-1970, 1-1968, 2-Year not given)

3 - GMC Jimmy (1974, 1975, Year not given)

The nature of the alleged defects is of interest as directly pertinent to the findings of this study. Alleged defects or problems which were specified in more than one case are listed in Table 2.4-1.

TABLE 2.4-1

PRIMARY PRODUCT LIABILITY
SAFETY ALLEGATIONS

Alleged Problem*	Incidence Reported
Roll-over	45
Roll-bar collapse	16
Steering mechanism, lost control	16
Fiberglass roof collapse	11
Brake failure	8
Fire	6
Brakes failed when engine quit on hill, roll-over	4
Unstable, C.G. too high, no roll-bar	4
Axle, Wheel failure	4
Transmission defect	4
Door latch	3
Seat belt released or failed	3
Wheel "lock-up"	3
Starts in gear	2
Drive shaft defect	2
Lack of seat belts	2
Other	19
TOTAL	152

*Problems listed were alleged in more than one case. Some cases listed more than one item; thus the total number of defects or problems is greater than the number of cases.

By far the most common problem indicated by these data is that of rollover. Roll-bar collapse, and loss of control through an alleged steering mechanism defect were also problems noted. However, rollover takes on added significance when combining the cases including rollover, roll-bar collapse, rollover subsequent to engine/brake failure on hill, no roll-over bar, fiberglass roof collapse, too high C.G., and "unstable." One or more of these are a factor in over half of the cases in litigation. However, rollover also probably occurred in additional cases where other allegations were listed.

Alleged problems with the steering mechanism and loss of control were noted in 16 cases; brake failure in eight cases; axle or wheel failure noted in four cases; transmission defects were noted in four cases; and wheel lock-up noted in three cases. Fire as a result of a crash occurred in six cases reported. In two cases the fuel tank exploded in the collision and in one the fuel cap and filler neck came in contact with the ground in a rollover. In another case the driver was soaked with gasoline subsequent to rollover and fatally burned, and in other cases the fire occurred after the collision and after rollover.

In four crashes it was alleged that the vehicle's engine stalled while going up a steep incline and as a result the power brakes did not function, allowing the vehicle to roll backwards down the hill out of control and rollover.

A defective door latch design was listed in three cases, while a brake failure, starts in gear, driveshaft defect, failure or premature release of seat belt, lack of seat belts, or clutch pressure plate explosion was each listed in two crashes.

Several alleged defects were each listed in only a single case. These included "crashworthiness," rear seat belt inaccessible, door came off frame, front axle, grease on brake shoes, connecting rod, lug nut fell off, vision obscured by side curtain, defective rear view mirror placement on windshield, front universal joint. Obviously some of these allegations overlapped other categories. One additional alleged defect is one of human factors design. It was alleged that since the only way to put on the back-up lights was with the transmission in reverse and engine running, that when the driver put the parking brake on (with the engine running and transmission in reverse) the vehicle (a 1972 AMC JEEP Wagoneer) began to roll backward toward the driver, who was half out of the vehicle. When the driver attempted to step on the brake pedal he stepped on the accelerator pedal "only two inches away." The defendant alleged that the cause was the driver's position and that he had boots on. (Ed. note: The engine does not have to be running, only the ignition "on." However, we wonder how many operators are aware of this. Similarly, it is doubtful that the parking brakes alone are sufficient to prevent the vehicle from moving backwards when the engine is running and the transmission is in reverse.)

Probably the most publicized case was a recent one involving an AMC CJ-7 JEEP, which rolled front-over-back down a steep 30 degree motorcourse slope, which resulted in the jury finding for the plaintiff with a $2.2 million verdict. In this crash it was alleged that the factory-installed roll-bar was ineffective, that the manufacturer had failed to test the support system, and that the manufacturer had advertised through television commercials which showed CJ JEEPS speeding and becoming airborne in rough terrain. The manufacturer contended that the roll-bar was intended to protect in a side rollover, not end-to-end vault. TV advertising which claimed "suitable for off-road climbing" was also alleged in another case involving a 1974 CJ-5 JEEP which lost traction and rolled sideways down a hill. In this case, although the rear seat passenger was belted, it was alleged the roll-bar did not provide protection to the rear-seat occupant. The manufacturer has subsequently changed this television advertising strategy (personal communication, 1979).

Collapse of roll-bars, and by inference, defective design, has been a frequent allegation in these cases. Most of these appear to involve original equipment as manufactured. In one case where a JEEP rolled over on a steep grade and the roll-bar collapsed, it was alleged that failure was due to defective design in using spot welds to attach to the wheel wells. "Collapse," "did not maintain height," "inadequate for lateral loads," "defective design" were common allegations. In one AMC CJ-5 JEEP crash, the plaintiffs alleged that the roll-bar collapsed forward in the roll-over (resulting in the bar striking the neck of the front-seat occupants, causing paraplegia), due to defective design in that the roll-bar was attached to sheet metal rather than to the frame.

In one case involving passenger ejection from a Ford military Jeep struck from behind, it was alleged that the manufacturer was liable for failing to provide seat belts or a roll-bar. However, the court apparently held that the manufacturer who made the vehicle in compliance with government specifications, which did not call for seat belts or a roll-bar, cannot be held liable.

An additional alleged defect that has been brought to our attention and warrants further concern occurred separately in at least nine vehicles involved in crashes in the states of Washington, Oregon, and West Virginia. These were related to pre-1974 (Saginaw steering gear equipped) Bronco, JEEP, and Scout vehicles. In these cases loss of control occurred when the two bolts attaching the steering column to the bottom of the instrument panel loosened up sufficiently to allow the shaft to back off about 1/4 inch(Southerland, 1979).

It must be emphasized that inclusion of these lawsuit-reported allegations are intended only to indicate the nature and general incidence of safety related problems which have come to light through this source. This information appears to reinforce observations of this study in many respects, but cannot be treated as more than indicative, since no attempt was made to determine the full extent and details of such civil suits. Nevertheless, as these cases indicate, there appear to be some significant occupant protection problems in crashes of utility vehicles, particularly when rollover occurs.

2.5 Federal Standards

The Federal Motor Vehicle Safety Standards (FMVSS) for motor vehicles and equipment were established under section 103 of the National Traffic and Motor Vehicle Safety Act of 1966 (80 Stat. 718) (33FR19703, Dec. 25, 1968). Redesignated as 35FR5118, Mar. 26, 1970, and currently identified under 49CFR Part 571, these standards were reviewed to assess both the current and pending application to utility vehicles. Utility vehicles represent a sub-class of the general grouping of vehicles designated as "multi-purpose," and in this section the term "multipurpose" should be understood to encompass "utility vehicles." Under 571.3, a "multipurpose passenger vehicle" is defined as "a motor vehicle with motive power, except a trailer, designed to carry 10 persons or less which is constructed either on a truck chassis or with special features for occasional off-road operation" (CFR 571.3, p. 689). It includes the type of vehicles in this study as well as forward control vehicles[9], vans, step-vans, and carryalls.

The results of this review are tabulated in Table 2.5-1. Of the 20 standards in effect (FMVSS201 through 219), only half currently apply to multipurpose vehicles, but in several of these safety standards, there are differences in requirements between passenger cars and multipurpose vehicles. In three other standards, application to multipurpose vehicles is pending.

The current safety standards only apply to multipurpose vehicles in their entirety in six areas, FMVSS 205 (glazing materials), 207 (seating systems), 209 (seat belt assemblies), 210 (seat belt assembly anchorages), 211 (wheel nuts, discs, hub caps), and 213 (child seating systems). Seat requirements are provided in 207, notably a 20g rearward and forward test requirement. While Standard 209, seat belt assemblies, specified belt requirements, the type of restraint system is specified in Standard 208. Standard 213 (child seating systems) actually related to an accessory item which may not even be supplied by an automotive manufacturer, and really can't be considered as a part of the vehicle as manufactured.

Standard 206 specifies requirements for side door locks and retention components including latches and hinges, to minimize the possibility of occupants being ejected in a crash. While this standard applies to multipurpose vehicles, in fact it does not apply if the manufacturer chooses a different door design. Thus "components on folding doors, roll-up doors and doors that are designed to be easily attached to or removed from motor vehicles manufactured for operation

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[9]A "forward control" vehicle means configuration in which more than half of the engine length is rearward of the foremost point of the windshield base and the steering wheel hub is in the forward quarter of the vehicle length (CFR571.3, p. 688).

TABLE 2.5-1

SUMMARY OF APPLICABILITY OF CURRENT AND PENDING FEDERAL MOTOR VEHICLE SAFETY STANDARDS TO MULTIPURPOSE VEHICLES

FMVSS*	Standard	Application	
		Current	Pending
201	Occupant Protection in Interior Impact	No	Yes(6)
202	Head Restraints	No	No
203	Driver Impact Protection from Steering Wheel	No	Yes(6)
204	Steering Control Rearward Displacement	No	Yes(6)
205	Glazing Materials	Yes	No
206	Door Locks, Retention Components	Maybe(2)	No
207	Seating Systems	Yes	No
208	Occupant Crash Protection	Maybe(3)	No
209	Seat Belt Assemblies	Yes	No
210	Seat Belt Assembly Anchorages	Yes	No
211	Wheel Nuts,Discs,Hub Caps	Yes	No
212-76	Windshield Mounting	Maybe(4)	No
213	Child Seating Systems	Yes	No(7)
214	Side Door Strength	No	No
215	Exterior Protection	No	No
216	Roof Crush Resistance	No	No
217	Bus Window Retention/Release	No	No
218	Motorcycle Helmets(1)	No	No(7)
219	Windshield Zone Intrusion	Maybe(5)	No
219-75	Windshield Zone Intrusion	Maybe(5)	No

*49 CFR Part 571

(1) Motorcycles and other motor vehicle

(2) Excludes from requirements "components on folding doors, roll-up doors and doors that are designed to be easily attached to or removed from motor vehicles manufactured for operation without doors need not conform to this standard" (571.206.5.4).

(3) Contains some differences in requirements between passenger and multipurpose vehicles (i.e. type 2 (upper torso) restraints not required for utility vehicles).

(4) Excludes from requirements "open body vehicles with fold-down or removable windshields" (e.g. utility vehicles such as JEEP, Land Cruiser), as well as forward control vehicles. "Open body type vehicle" means a vehicle having no occupant compartment top

or an occupant compartment top that can be installed or removed by the user at his convenience" (CFR571.3, p. 689).

(5) Does not apply to forward control vehicles, walk-in van-type vehicles, or to open-body-type vehicles with fold-down or removable windshields.

(6) Proposed effective date 1 Sept., 1980 [FR43(218):52264 Nov.9,1978]. Extended to 1 September, 1981 (Final Rule, 49CFR Docket no. 78-16; Notice 2. FR 44(231):68470 29 November, 1979).

(7) Actually refers to accessory item not a part of vehicle as manufactured.

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without doors need not conform to this standard" (571.206.5.4). Soft top vehicles such as the AMC JEEP are thus technically excluded from requirements of FMVSS 206, and do not provide the occupant with the same level of protection "to minimize the likelihood of occupants being thrown from the vehicle as a result of impact" (571.206.5.1).

On June 2, 1977, the NHTSA exempted indefinitely the manufacturers of light trucks, vans, and multipurpose vehicles from the passive restraint requirements of Standard 208. For multipurpose vehicles and trucks under 10,000 lbs. GVWR[10] manufactured after January 1, 1976, Standard 208 currently allows the manufacturer an exemption from the passenger car requirements for forward control vehicles, convertibles, open-body type vehicles (and others), allowing either a type 1 (lap belt only) or type 2 (lap and shoulder belt) restraint installation at each designated seating position. Thus, <u>for most utility vehicles, an upper torso restraint is not required</u> (S4.2.2 and S4.2.1.2(a)). In its Five-Year Plan (NHTSA, 1978) the NHTSA plans to study the feasibility of equipping light trucks and vans with passive restraints.

Standard 212, windshield mounting, did not apply to multipurpose passenger vehicles until revised standard 212-76 became effective September 1, 1978. However, the latter standard still does not apply to "forward control vehicles, walk-in van vehicles, or to open-body type vehicles with fold-down or removable windshields." So in effect utility vehicles such as the JEEP and Land Cruiser are excluded from the requirements of FMVSS 212-76.

FMVSS 201, Occupant Protection in Interior Impact, does not presently apply to multipurpose vehicles. The stated purpose of this

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[10] GVWR - Gross Vehicle Weight Rating.

standard is to reduce occupant injuries and fatalities by requiring that instrument panels, seat backs, sun visors, and arm rests be designed to reduce injuries to impacting occupants through the use of energy absorbing material. The instrument panel and seat back performance is determined by impact with a head form at a velocity of 15 mph. The head form deceleration cannot exceed 80g's for more than 3 milliseconds.

Responding to results of accident research, and in part, to petitions filed by the Insurance Institute for Highway Safety, the NHTSA has proposed (FR43(218) 52264. November 9, 1978) that this standard (201) as well as standards 203 and 204 be extended to multipurpose vehicles, effective September 1, 1980.

NHTSA has also proposed that two additional standards, No. 203 and No. 204, would be extended to apply to multipurpose vehicles. Safety standard 203 (impact protection for the driver from the steering control system) is intended to limit the amount of force that can be exerted on the driver by the steering assembly in a frontal crash. It specifies a performance requirement that when the steering assembly is impacted in the laboratory at a speed of 15 mph by a body block ("black tuffy" torso and head), the force imposed by the body block on the steering control system shall not exceed 2,500 pounds.

FMVSS 204 (steering control rearward displacement) limits the rearward movement of the steering assembly. In a 30 mph frontal barrier crash, dynamic rearward displacement of a vehicle's steering assembly is prohibited for more than five inches. Currently, neither standard applies to utility vehicles.

Currently there is neither a safety standard requirement, nor one proposed by NHTSA to be applicable to utility vehicles in the five areas of: FMVSS 202 (Head Restraints), 214 (Side door strength), 215 (Exterior protection), 216 (Roof crush resistance), and 218 (Helmets). A sixth area, FMVSS 217 (Bus window retention/release) does not apply to utility vehicles.

The purpose of FMVSS 202 is to limit rearward angular displacement of the occupant's head relative to his torso line by use of a head restraint at each outboard front seat. Requirements are that it must limit rearward angular displacement of the head reference line to 45° from the torso reference line during a forward acceleration of at least 8g on the seat supporting structure. Standard 214 specifies side door strength requirements to minimize the hazard of intrusion during a side impact. Exterior protection as specified in 215, relative to low-speed collision, involved front and rear impacts.

At this time the NHTSA is planning exploratory rulemaking related to consolidation of static test requirement standards for steering columns, instrument panels, side doors, roofs, door latches, and hinges into dynamic performance standards (NTSB, 1979). To support this activity, in April 1978, accident data collection began on light trucks, vans, and multipurpose vehicles under the National Crash Severity Study (NCSS), and in January 1979, data collection was also initiated under the National Accident Sampling System (NASS). No additional safety requirements for multipurpose vehicles seem likely for the immediate future, however, since it will take some time for the results of these studies to be analyzed and incorporated into the proposed rulemaking process.

The Subaru, and 1980 AMC Eagle (marketed as a 4WD passenger car in two- and four-door versions, and in a four-door wagon), are classified as multi-purpose vehicles. As indicated in the foregoing discussion, multi-purpose vehicles are presently excluded from the requirements of many of the federal standards. Nevertheless, upper torso restraints are provided in the two outboard front seat positions of both the Subaru and Eagle as standard equipment.

In a previous study of light truck and van crashes, Sherman and Huelke (1978) related accident experience to the federal safety standards and recommended appraisal of the entire 200-series standards. They concluded that a roof-crush standard (FMVSS 216) is meaningful only if the occupants are restrained in their seated position, and that lap-shoulder belts (FMVSS 208) should be installed in regard to proposed FMVSS 201 (for light trucks and vans). They cautioned that the lower and the mid portion of the instrument panel is not presently covered in passenger car requirements and yet these portions have been found to produce severe and fatal thoracic and abdominal injuries in unrestrained passengers in collisions.

In a recent evaluation of the crashworthiness of multipurpose vans, involving investigation of 18 accidents, the National Transportation Safety Board found that existing safety standards 201, 202, 203, 204, 212, 214, 215 and 216 do not apply (NTSB, 1979). They summed up NHTSA's 5-year plan by noting the General Accounting office report ("Unwarranted Delays by the Department of Transportation to Improve Light Truck Safety") of July 1978, concluded: "The Agency (NHTSA), however, has previously developed plans and promised to extend many of the same standards to light trucks. Most of the standards discussed in Chapter 4 were, at one time or another, planned for extension to light trucks. Even through many were incorporated into notices of proposed rulemaking, light trucks still remain exempt from safety features which have been on passenger cars for more than ten years. Although the Administrator has informed the Congress that improving the safety of these vehicles is one of the agency's top priorities we see little actual movement in that direction" (GAO, 6 July 1978).

In summary, of the 20 Federal Motor Vehicle Safety Standards in effect, only six apply to multipurpose vehicles in their entirety (FMVSS205, glazing materials; 207, seating systems; 209, seat belt assemblies; 210, seat belt assembly anchorages; 211, wheel nuts, discs, hub caps; and 213, child seating systems). In one standard there are differences in requirements between passenger cars and multipurpose vehicles (FMVSS 208, occupant crash protection). In other standards the requirements do not apply to open-body-type vehicles with fold-down or removable windshields, such as the JEEP or Land Cruiser (FMVSS 212-76, windshield mounting; and 219-75, windshield zone intrusion). Application to multipurpose vehicles is proposed effective 1 September 1980 in three other standards (FMVSS 201, occupant protection; 203 driver steering wheel protection; and 204, steering control rearward displacement), but is not yet required. At this time nine safety standards required for passenger cars are not required in multipurpose vehicles. It is clear that multipurpose vehicles currently, and for the near future at least, are not required by federal safety standards to offer the occupant the same degree of crash protection as is required for passenger cars.

2.6 Literature Review

A comprehensive search and review of the literature pertaining to utility vehicles in the area of safety performance and crash involvement was undertaken. It was found that no comprehensive body of literature exists on utility vehicles and safety. Most references to utility vehicles were scattered across a diverse selection of popular magazines many of which are transient in nature. Among publications reviewed were: sources for current publications (reference guides); periodicals; year books; purchasing guides; etc., as related to utility vehicles. Often, however these sources are not catalogued by libraries because of their limited longevity and limited appeal.

Most useful of the library resources was the Consumers Index, which regularly scans the popular literature for consumer-oriented articles. However, several of the publications which were listed as containing articles of interest were not available from any of the libraries and also not available from the publisher.

The literature on utility vehicles can be classified under three major subjects: road tests, driving impressions, and descriptions of journeys or trips. Most of the articles which focused on the trip rather than the vehicle (or vehicles) have not been included in the study bibliography. Appendix B contains complete citations of sources used for this study and numerous articles are listed in this review. Not listed, but also reviewed, were brochures obtained from car and truck dealerships (most 1978 and 1979 utility models are covered), sales and production statistics from several Ward's Yearbooks, parts catalogues, and miscellaneous articles.

Very little space in articles about sports-utility vehicles is allocated to safety. When safety is mentioned the discussion is usually concluded in one or two sentences. The one exception is Consumer Reports, in which safety was emphasized in an evaluation of five sports-utility vehicles (1972). Roll-bars are often recommended if the stability of a vehicle is mentioned.

Acceleration on the road and traction off the road are emphasized in the reports of most road tests. Very few negative aspects of sports-utility vehicles appear in the literature. Again, the exception is Consumer Reports, which gave all the sports-utility vehicles tested low marks for handling, braking, and stability (1972).

The popular literature follows a similar format whether reporting on a new vehicle's introduction or comparing several vehicles. Articles introducing a new vehicle usually compare its cosmetic differences with the previous vehicles, and the "tests" used to evaluate the vehicle are seat-of-the-pants impressions based on driving a single vehicle. The impression is given that the article is written in praise of the vehicle from a sales point of view. The formula for the article is basically the same from article to article, regardless of the vehicle being tested.

Articles comparing vehicles do provide some information useful for making a purchase decision. However, the test data offered are incomplete and their validity and reliability are questionable. Vehicle-to-vehicle comparisons are inexact unless the vehicles are identically equipped. Differences in suspension, engines, etc., can alter the safety performance of a vehicle, thus negating any valid comparison. The tests and measurements employed are often no more than observations and opinions regarding acceleration, cornering, comfort, etc.

Certain safety-related data on braking and steering (handling) are obtained by simple tests, but more critical parameters, such as C.G. height, stability, stopping ability, and traction, are not measured. Even the basic tests are performed on only one "typical" vehicle and do not cover the range of options available and in frequent use. Also lacking is any kind of safety assessment of the vehicle interior and exterior.

Thus in the predominant popular literature there is a lack of safety-related information upon which a prospective purchaser may adequately assess the safety performance of a vehicle.

The recency of the boom in sports-utility vehicles is under-scored by the fact that Ward's Automotive Yearbook did not provide sales or production figures for these vehicles until 1975. Ward's placed the 1977 U.S. sales at 287,212 units for sports-utility vehicles (Jeep, Blazer, Scout, Bronco, Jimmy, Ramcharger, Land Cruiser, and Trail Duster). That figure amounts to about 2.6 percent of new car sales in 1977.

3. DATA SOURCES

3.1 Introduction

The data sources were organized into Primary and Secondary sources. The data sources labeled primary were those data files descriptive of accident involvement and vehicular registration. The secondary data sources were those used in a corollary or supportive role in the analysis.

The breadth of sources used in this study permits one to independently study several data sources and compare conclusions drawn from each. If conclusions from several independent sources are similar, the overall conclusions of the study are enhanced.

Table 3.1-1 lists each of the data sources and shows its particular role in the analysis. Following the table is a brief description of each of the data sources.

3.2 Primary Data Sources

Three types of data were obtained which describe the experience of the population of interest: mass accident data; clinical accident data; and vehicle registration data.

3.2.1 Mass Accident Data

The mass data are comprised of many individual reports of accidents or registration within a particular geographic area. Such large data sets are useful since they report the experience of the population at large and are capable of indicating trends in the population. The mass data used in this study consisted of accident report data from several states, the U.S. as a whole, and from specialized large scale data files.

These data were obtained either as computerized representation of accident reports or as actual copies (with photographs) of accident reports. The mass data also included computerized records of motor vehicle registrations from several states and the U.S. as a whole.

TABLE 3.1-1

DATA SOURCES

Source	Type of Data	Described in Section	Original Data
1. Primary	Mass Accident Data	3.2.1	State Statistical Files Arizona Maryland Michigan New Mexico New York North Carolina Texas Washington CPIR FARS R.L. Polk and Company U.S. Summary Michigan Washington Texas N. Carolina Accident Photograph Analysis
	Clinical Data	3.2.2	Fatal Accident Case Review Michigan Colorado New York Arizona
	Population Data	3.2.3	
2. Secondary	Literature	3.3.1	Popular Historical Scientific Regulatory
	Special Studies	3.3.2	Product Liability Physical Measurement

State <u>Statistical Files</u> containing computerized reports of accidents were obtained from the states indicated in Table 3.2-1. Also shown are the total number of cases (accidents) represented in the files. From these files, samples of vehicle crashes of interest were formed for the purposes of analysis. Because some of the files used are based on a sample of total accidents, sampling error is present. (See Appendix E for a table showing approximate sampling errors.)

TABLE 3.2-1

STATE MASS ACCIDENT DATA FILES
OBTAINED FOR ANALYSIS:
VEHICLE CRASHES
1975-1978

State	Number of Cases per Year			
	1975	1976	1977	1978
Michigan*5%	NA**	31,504	32,133	NA
Arizona*	NA	68,781	75,769	87,725
Washington	NA	218,893	NA	NA
Texas*5%	NA	40,712	42,750	NA
Texas Fatal	NA	NA	5,309	NA
N. Carolina	129,013	139,179	145,787	156,418
Maryland	152,187	156,632	163,696	NA

*A 5% sample of all accidents in the state.
**Data not obtained or used.
***Number of Accidents.

State statistical data for the states of New York, New Mexico, and Arizona, while obtained, were not used, due to technical problems in file construction or vehicle identification. The coding used by the State of New York, for example, does not allow adequate identification of utility vehicles. Arizona lumps utility vehicles into a "recreational vehicle" category, also without specific model identification.

The data in these files originate when the local police officer investigates a collision and completes an official state accident report form. These reports are collected at the state level and transcribed into computer readable form by extracting all the data descriptive of the accident, involved vehicles and driver, etc. and constructing it into a data file. Once completed for a particular year, these data sets are available for analysis. Certain of the data sets reside at HSRI and others were obtained specially to supplement HSRI's data base.

The CPIR data file contains motor vehicle crash data recorded on the "Annotated Collision Performance and Injury Report, Revision 3" which have been edited and computerized by the Highway Safety Research Institute at The University of Michigan. These crash reports are the result of in-depth investigations by Multidisciplinary Accident Investigation Teams sponsored by the Canadian Ministry of Transport, the Motor Vehicle Manufacturers Association, or the National Highway Traffic Safety Administration.

It is important to note that the CPIR data sets do not contain a cross-section of typical accidents, but are a non-random compilation of individual clinical studies of special interest accidents by more than thirty teams using independent accident selection and investigation methods.

A case was initially included in the CPIR file because it met the criteria of the submitting agency. To some extent, these data are biased toward more severe injury cases. The majority of the cases submitted were passenger vehicles but a few light trucks, utility vehicles, etc., were included.

Ninety-three cases were identified as utility vehicles in this file. These cases were sub-set into a separate data file and the original case documentation was retrieved. Since the original data form was passenger car oriented, several variables of interest were not coded. To overcome this deficiency, the documentation was reviewed and supplemental data were added to the file concerning cab enclosure type, roll protection, vehicle modification, etc. The information to complete these data elements came from reviewing the narrative and supplemental photographs for each case and recording the data on a form identical to that shown in figure 4.4.2-22, Section 4.4.2. The vehicle selection was also reviewed for inclusion of the correct vehicles. These data were appended to the file, computerized and added to the utility vehicle file.

This CPIR file was initially chosen because of its extensive coding of injury to occupants and damage to the vehicle.

The Fatal Accident Reporting System (FARS) is a file of fatal motor vehicle accidents which is maintained by the National Center for Statistics and Analysis of the National Highway Traffic Safety Administration. The data are furnished in a standardized form by specially designated persons in each state, and the computer files were subsequently built under NHTSA's direction. The earliest years did not have participation of all of the states, but since 1976 this file has been a relatively complete record of virtually all U.S. fatal accidents. Quality of the data has continually improved.

The attractiveness of using the FARS data, from a research point of view, lies in the fact that they represent a census of the nation's fatal accidents. When a question arises about the limited population of fatal traffic accidents, an unequivocal answer is available from this source. The latest years' files have a relatively low missing data rate, and for many variables there is a basis for analysis of significant depth.

The 1977 FARS data file contains approximately 42,700 fatal accident reports and the 1978 file contains approximately 44,400 reports.

Accident Photographic Analysis of selected cases was undertaken. At many of the serious injury and most of the fatal accidents, photographs are taken of the accident scene and involved vehicles by police. Additional detail concerning the crash is also recorded. Much useful information can be obtained concerning these crashes through a review of this additional documentation--thus data not available through the computerized data system were added to the study's data base.

In the states of Arizona, Michigan, and Colorado, the collisions involving a fatality in a utility vehicle were designated for further study through viewing and interpretation of the written and pictorial documentation developed as a part of the crash investigation process.

Through the FARS and state collision data files, those cases involving a fatality in a utility vehicle were identified.

The appropriate state official was contacted and asked to furnish a copy of the collision report to us. Upon receipt of these reports they were scanned to verify the utility vehicle type and fatality. A request was then made to the investigating police jurisdiction for copies of any photographs taken at the scene.

For Arizona, 22 utility vehicle fatal cases were identified from the 1977 FARS data file. Copies of the accident reports and photographs were requested and received for this set. Each case was reviewed and additional data were recorded for them onto a data form similar to that used for the CPIR data. These data were then prepared for computerized analysis.

Similar procedures were used for Colorado and Michigan. In Colorado, 54 fatal cases were identified from the 1977 FARS data. Of these cases, 46 were coded as usable, with pictures accompanying 37 cases. Eight cases were not usable for the purpose of this report since they included pedestrian or bicycle fatalities with no damage to the utility vehicle, or included other types of vehicles improperly coded on the accident report.

In Michigan, 41 cases were identified for the years 1976 and 1977. In all, 36 cases were coded, with pictures available for 27. Five cases were excluded because the utility vehicle was not actively involved in the crash (i.e.: parked vehicle or vehicle-pedestrian collision, etc.).

3.2.2 Clinical Data

Data on selected accidents were obtained from several states such that a detailed review of individual cases could be undertaken.

The Fatal Accident Case Review data consisted of the collection and examination of all fatal accident reports in the states of Arizona and New Mexico for the years 1978 in Arizona and 1977-78 for New Mexico which involved a utility vehicle.

Obtained were a copy of the accident report and a representative photograph of the involved utility vehicle. These data, once received, were cataloged and summarized to provide a set of documents for review.

3.2.3 Population Data

The R. L. Polk & Company motor vehicle registration data base was used in this study to provide a count of total vehicles in use. Such information is necessary in providing data on vehicle exposure and population.

The R. L. Polk company compiles motor vehicle registration data from all states except Oklahoma on all classes of motor vehicles registered in the United States. These data are obtained from the states' motor vehicle registration activities. The data, for our purposes, consist of a compilation and decoding of the VIN (Vehicle Identification Number) for selected vehicle makes and models.

The VIN contains data elements that provide a basic description of a vehicle. Most important for our purposes are the make, model, and model year of the vehicle. Other data encoded but not used here include GVWR (Gross Vehicle Weight Rating), vehicle fuel type, and engine type and size.

These data files are organized into several categories based on basic vehicle type: domestic passenger cars, imported passenger cars, light trucks, heavy trucks, etc. Information was extracted from the file containing light truck data. Separated from the pick-up trucks, vans, and other light trucks in the file was the classification for utility vehicles. Registration counts for these vehicles were available for the period 1965-1977.

For the sub-class of utility vehicle, three separate geographic descriptions were available. First, a summary of the registrations for all utility vehicles was analyzed. This file, titled the National Vehicle Population Profile, contained summary data for all utility vehicles in the U.S. Second, data were obtained for the eight study states: Arizona, Maryland, Michigan, New Mexico, New York, North Carolina, Texas, Washington. This registration data provided estimates of the at-risk population. Third, utility vehicle registration data by county were obtained for the two states of Michigan and Washington.

3.3 Secondary Data Sources

In an attempt to provide supportive or corollary data, several additional data sources were examined. These included the literature, product liability litigation and physical measurement of the vehicles.

3.3.1 Literature Survey

A Literature Survey was undertaken to review the existing literature concerning utility vehicles. Since this project was intended as a general survey of the utility vehicle and its problems, all sources of potential literature were surveyed. These sources included: the popular literature (magazine and other periodical sources including catalogs, special interest group (club) publications, etc.); historical and military literature concerning the origin and development of the vehicle; scientific literature including studies of the accident experience of the vehicle, manufacturer and user testing, medical literature on injury causation, and manufacturer product development; regulatory literature concerning the applicability of governmental regulation to the manufacture (and use) of these vehicles not only in terms of safety, but in other areas such as fuel economy and emission.

The results of this literature survey can be found in Appendix B.

3.3.2 Special Studies

Two special studies were undertaken to provide additional support to the data analysis activities.

Product Liability data are generated whenever a legal proceeding is initiated against a manufacturer alleging a defect in design of the vehicle.

These data were provided by the Professional Research and Development Division of the Association of Trial Lawyers of America (ATLA). They compile data on completed litigation and litigation in progress. The data file is continually updated as new and pending cases are concluded.

The vehicle itself is also a source of corollary data in that a Physical Measurement of the selected vehicle parameters can yield useful data on the stability of the vehicle. Several representative vehicles were measured for height and center of gravity and track width for the purpose of comparison to other non-utility vehicles.

3.4 Data Editing

In each of the mass data files, the on-/off-road vehicle sub-classification (or its equivalent) was sub-set into special files for analysis. The list of vehicles in each sub-set was manually edited to delete vehicles which did not fit our definition or whose make-model identification could not be verified. Thus, the resulting vehicle composition of each file more closely matched our study definition (see Table 2.2-1). In FARS, for example, approximately 40 percent of the original vehicles were discarded as either not included in our population definition or as unidentifiable in sufficient detail (through the VIN) to permit make-model verification. Thus, undoubtedly, some utility vehicles were excluded. The resulting special FARS utility vehicle file for 1977 contained 486 verified cases.

Similar steps were taken with the data used in the photographic and clinical data analysis to assure as pure a data set as possible.

4. FINDINGS

This chapter presents the basic results obtained from the crash experience of utility vehicles. Most interpretive comment, opinion, and discussion are confined to subsequent chapters. An attempt was made to ascertain which findings are general in the sense that similar findings are observed in at least two states (or two data files).

4.1 Crash Rates

The frequency of reported utility vehicle crashes compared to total passenger car crashes is shown in Table 4.1-1.

TABLE 4.1-1

UTILITY VEHICLE
CRASHES IN RELATION TO PASSENGER
CAR CRASHES: SELECTED STATES

State	Number of Utility Vehicle Crashes	Utility Vehicle Crashes as a Percent of Passenger Car Crashes
Maryland* (1975-1977)	1,336	0.3
Michigan (1976-1977)	6,599	0.7
North Carolina* (1975-1978)	3,691	0.6
Texas (1976-1977	6,225	0.5
Washington (1976)	1,456	0.9

*Excludes crashes with pedestrians, pedacyclists, motorcycles, and trains in this and in subsequent tables.

Utility vehicle crashes range from a low of 0.3 percent of total passenger car crashes in Maryland to a high of .9 percent in Washington. These percentages are all below the figure suggested by the registration data, as is shown in Table 4.1-2.

TABLE 4.1-2

UTILITY VEHICLE CRASHES
AND REGISTRATIONS IN RELATION TO
PASSENGER CAR CRASHES AND REGISTRATIONS:
SELECTED STATES

State	Utility Vehicle Crashes as a Percentage of Passenger Car Crashes %	Utility Vehicle Registrations as a Percentage of Passenger Car Registrations %
Maryland	0.3	0.5
Michigan	0.7	1.3
N. Carolina	0.6	0.9
Texas	0.5	0.8
Washington	0.9	1.1

Using vehicle registrations as the standard, the data show that utility vehicles are less likely than passenger cars to be involved in a reported crash.

The opposite finding is observed, however, when only fatal crashes are considered. These data are summarized in Table 4.1-3.

TABLE 4.1-3

FATAL CRASHES AND TOTAL REGISTRATIONS:
UTILITY VEHICLES AND PASSENGER CARS
(ALL STATES,1977)

Vehicle Type	Crashes %	Registrations %
Utility Vehicles	1.36	0.98
Passenger cars	98.64	99.02
Total	100.00	100.00
Number	35,790	115,238,923

Compared to the number of vehicles registered, utility vehicles are found to be over-involved in fatal crashes. Rates of involvement in fatal crashes per 100,000 vehicles registered are 43.2 for utility vehicles and 30.9 for passenger cars. The difference is that utility vehicles are involved in fatal crashes almost 40 percent more often than passenger cars.

Additionally, as is shown in section 4.2 (Table 4.2.1-3), the proportion of 1977 fatal crashes in which at least one occupant was killed is higher for utility vehicles than passenger cars. At least one occupant was killed in a utility vehicle in 31.8 fatal crashes per 100,000 registered utility vehicles. The corresponding rate for passenger cars is 18.5. These figures present a rate for utility vehicles that is 71.9 percent higher than the rate for passenger cars.

In summary the findings indicate that utility vehicles are less likely then passenger cars to be involved in a crash, but when a crash occurs, it is almost 40 percent more likely than a passenger car to involve a fatality.

4.2 Occupant Injury and Death Rates

The discussion in this section is focused on the likelihood of serious injury and death as a consequence of the crash. Traffic death rates and disabling injury rates in utility vehicles are compared to those in cars.

4.2.1 Death Rates

The likelihood of death as a consequence of a crash is higher in utility vehicles than in passenger cars as is shown in Table 4.2.1-1.

The total number of people killed per 1,000 crashes is about twice as high in utility vehicles as in passenger cars. It is unlikely that vehicle occupancy rates account for much, if any, of the rate differences between utility vehicles and passenger cars. Michigan data for 1977 show that the vehicle occupancy rate is 1.57 for utility vehicles and 1.60 for passenger cars. The corresponding figures for the

TABLE 4.2.1-1

TRAFFIC DEATH RATES (NUMBER KILLED PER THOUSAND CRASHES):SELECTED STATES

	Michigan	Washington	Texas
	All Occupants		
Utility Vehicles	4.7	6.9	6.3
Passenger cars	2.2	3.0	3.3
	Drivers		
Utility Vehicles	2.0	3.4	3.6
Passenger cars	1.5	2.0	2.1
	Number of Crashes		
Utility Vehicles	6,599	1,456	3,649
Passenger cars	24,912*	153,331	31,697*

*5% sample

State of Washington in 1976 are 1.27 and 1.21. The general pattern of driver death rates follows closely that observed for total occupants.

Obviously, not all automobiles are equally safe. In Michigan, the 1977 traffic death rate for full-size passenger cars was 2.0 persons killed per 1,000 crashes. The corresponding figure for compacts and intermediates is 2.5.

Utility vehicle crashes, compared with passenger car crashes, are more likely to occur in rural than in urban areas. It is also true that the likelihood of death or serious injury is greater in rural crashes than in urban crashes. Traffic death rates per 1,000 vehicle crashes in urban and rural areas are shown in Table 4.2.1-2.

Three major conclusions can be drawn from this table: (1) traffic death rates in rural crashes are considerably higher than are those for urban crashes, (2) regardless of the type of area, total traffic death rates in utility vehicles are higher than are the rates in passenger

TABLE 4.2.1-2

TRAFFIC DEATH RATES (NUMBER KILLED PER THOUSAND VEHICLE CRASHES): SELECTED STATES

	Utility Vehicles		Passenger Cars	
	Rural	Urban	Rural	Urban
All Occupants				
Michigan*	7.9	1.5	4.2	1.4
Texas	27.8	2.3	18.7	1.8
Washington	14.1	3.1	12.9	1.1
Drivers				
Michigan*	3.3	0.6	3.0	0.9
Texas	17.3	1.0	11.6	1.1
Washington	8.3	1.0	8.2	0.8

*The classification for Michigan is township and city.

cars, and (3) in urban areas differences in driver death rates between utility vehicles and passenger cars are negligible.

For the country as a whole, the probability of being killed in a fatal crash is greater in rural than urban areas, and regardless of area, the probability of being killed is higher in utility vehicles than in passenger cars. These data are shown in Table 4.2.1-3.

At least one person was killed in a utility vehicle in almost three-fourths of all fatal crashes involving a utility vehicle. (The remainder killed were occupants of the other vehicle). The corresponding figure for passenger cars is 60 percent. The highest percentage shown in the table is for utility vehicles in rural areas.

The results shown in Table 4.2.1-4 are: (1) death rates in single-vehicle crashes are higher than for other types of crashes, (2) death rates in single-vehicle crashes are higher in utility vehicles than in

TABLE 4.2.1-3

PERCENT OF FATAL CRASHES IN WHICH
AT LEAST ONE PERSON WAS KILLED
IN THE SPECIFIED VEHICLE
ALL STATES

	Utility Vehicles %	Passenger Cars %
Urban	60	50
Rural	80	68
All Areas	74	60

TABLE 4.2.1-4

TRAFFIC DEATH RATES (NUMBER OF PERSONS KILLED
PER THOUSAND CRASHES) AND THE PROPORTION OF
SINGLE VEHICLE CRASHES:
SELECTED STATES

	Michigan		Washington	
	Utility Vehicles	Passenger Cars	Utility Vehicles	Passenger Cars
Total Occupants Killed				
Single-Vehicle Crashes	8.3	5.4	20.3	11.4
All Crashes	4.8	2.1	6.3	3.0
Single-Vehicle Crashes (as a proportion of)				
Total Crashes	.33	.18	.28	.12
Number of Crashes*				
Total Crashes	6,492	24,343	1,435	150,020

*Excludes crashes involving pedestrians, pedacycles, motorcycles,and trains.

passenger cars, and (3) utility vehicles are more likely than passenger cars to be involved in single-vehicle crashes.

There is a close relationship between single-vehicle crashes and rural areas. In Michigan, for example, 72 percent of single-vehicle crashes involving a utility vehicle occurred in the townships (largely rural areas).

4.2.2 Serious Injury Rates

The likelihood of serious (disabling) injury[11] is greater in utility vehicles than in passenger cars. These data are shown in Table 4.2.2-1.

TABLE 4.2.2-1

NUMBER OF DISABLING INJURIES PER THOUSAND CRASHES: SELECTED STATES

	Michigan	Washington
All Occupants		
Utility Vehicles	61.8	73.9
Passenger Cars	32.2	34.0
Drivers		
Utility Vehicles	33.3	40.4
Passenger Cars	17.9	21.8

Rates of serious injury are higher in utility vehicles than in passenger cars for both total occupants and for drivers.

Regarding disabling injury, some utility vehicle makes appear to be safer than others, as is shown in Table 4.2.2-2.

[11] Injuries classified as type A in the police reports.

TABLE 4.2.2-2

NUMBER OF DISABLING INJURIES PER
1,000 UTILITY VEHICLE CRASHES: MICHIGAN, WASHINGTON

Make	Rate	Number of Crashes
Michigan		
Blazer	38.3	1305
Scout	57.9	656
Bronco	62.9	843
Jeep	75.8	2983
Washington		
Blazer	56.0	375
Bronco	72.7	275
JEEP	125.0	352
Scout	48.2	249
Land Cruiser	43.5	161

The data indicate that the Blazer exhibits the lowest serious injury rate among the makes shown. (Other utility vehicle makes were not included in the tabulation because the number of crashes is so small as to make the stability of the injury rate questionable.) These findings support the proposition that the shorter the wheelbase, the higher the rate of serious injury. Note that these findings reflect experience with the earlier Bronco with a 92-inch wheelbase. The 1978 Bronco has a wheelbase of 104 inches. (See Section 4.5.3 for more details regarding physical factors and vehicle stability).

Rates of serious injury are higher in rural areas than in urban areas. And, the rates are substantially higher in utility vehicles than in passenger cars (see Tables 4.2.2-3 and 4.2.2-4).

In summary, death rates and rates of serious injury are substantially higher in utility vehicles than in passenger cars. In part, these differences are a result of the fact that, compared to passenger cars, proportionately more utility vehicle crashes occur in

TABLE 4.2.2-3

NUMBER OF DISABLING INJURIES
PER 1,000 CRASHES:
SELECTED STATES

	Utility Vehicles		Passenger Vehicles	
	Rural	Urban	Rural	Urban
All Occupants				
Michigan	95.9	18.2	59.3	20.9
Washington	135.1	41.7	79.4	26.4
Drivers				
Michigan	48.4	18.2	35.3	13.3
New Mexico	121.8	17.4	N.A.	N.A.
Washington	70.4	28.2	47.5	17.9

TABLE 4.2.2-4

PERCENT OF FATAL CRASHES
IN WHICH AT LEAST ONE PERSON
WAS SERIOUSLY INJURED IN THE SPECIFIED VEHICLE:
ALL STATES

	Utility Vehicles	Passenger Cars
Urban	20	22
Rural	32	32
All Areas	29	27

rural areas and are single-vehicle crashes. The implications of these findings will be discussed fully in Chapter Five.

4.3 Characteristics

This section discusses characteristics of utility vehicle operators, characteristics of the crash location, temporal characteristics of the crashes, and data on the interactions of the driver, crash location, and temporal characteristics as they combine in the production of crashes.

4.3.1 Characteristics of Drivers

Age, sex, occupation, and reported alcohol use characteristics for utility vehicle drivers and drivers of other vehicles were analyzed from selected state accident files.

Women are seldom drivers of crashed utility vehicles. Women drivers are involved in only 16 to 21 percent of utility vehicle crashes, whereas women are the drivers in 31 to 46 percent of passenger car crashes, as is shown in Table 4.3.1-1.

Drivers of utility vehicles involved in a crash are younger, on the average, than the drivers of other vehicles involved in a crash. As shown in Table 4.3.1-2, only about 3 out of 10 crash-involved utility vehicle drivers are aged 35 or older, compared with 4 out of 10 passenger car drivers.

Data on occupation of drivers are available for the State of Washington. Compared with drivers of passenger cars involved in a crash, utility vehicle drivers are more often skilled or semi-skilled workers (18% vs. 13%).

The use of alcohol or other drugs appears to be somewhat more widespread among drivers of utility vehicles than among drivers of other types of vehicles. Data from the Michigan files show that in 15 percent of utility vehicle crashes and in 10 percent of passenger car crashes the police reported that the driver had taken alcohol or other drugs. Data from the Washington accident files show the same percentages, in that 15 percent of the utility vehicle drivers were reported to have been drinking compared to 10 percent of passenger car drivers.

However, caution must be exercised in interpreting the findings on the use of alcohol or other drugs. Chemical tests are administered

TABLE 4.3.1-1

VEHICLE CRASHES ACCORDING
TO SEX OF DRIVER
SELECTED STATES

Sex of Driver	Utility Vehicles %	All Vehicles %
Michigan		
Male	84	69
Female	16	31
Total	100%	100%
Number of Crashes	6,599	30,880
Texas		
Male	79	54
Female	21	46
Total	100%	100%
Number of Crashes	302	31,697
Washington		
Male	83	64
Female	17	36
Total	100%	100%
Number of Crashes	1,456	153,331

infrequently. Therefore, these data arise largely from subjective determinations.

The results of these data show that among crashed vehicles, utility vehicle drivers are younger than passenger car drivers. Also, men substantially more often than women are driving when utility vehicles crash.

TABLE 4.3.1-2

VEHICLE CRASHES ACCORDING TO AGE OF DRIVER:
SELECTED STATES

Age of Driver	Utility Vehicles %	All Vehicles* %
Michigan		
Under 20	16	19
20-24	26	18
25-29	20	13
30-34	12	8
35 and older	26	42
Total	100	100
Texas		
Under 20	16	16
20-24	18	21
25-29	20	14
30-34	14	10
35 and older	32	39
Total	100	100
Washington		
Under 20	15	19
20-24	20	18
25-29	20	13
30-35	14	8
35 and older	31	42
Total	100	100

*Texas and Washington, limited to passenger cars only.

4.3.2 Crash Locations

To determine the major differences between utility vehicle crashes and passenger car crashes regarding the site of the accident. An analysis of the location of crashes was made.

One finding of major importance in comparisons between utility vehicles and passenger cars is that substantial differences emerge when rural and urban areas are considered separately.

Compared with passenger car crashes, utility vehicle crashes are more likely to occur in the rural parts of the states studied. These data are summarized in Table 4.3.2-1.

Urban-rural differences between utility vehicle and passenger car crashes remain pronounced when attention is focused on fatal crashes. As is shown in Table 4.3.2-2, fatal crashes involving utility vehicles are largely rural crashes.

Why would somewhat more than one-half of the fatal passenger car crashes, and almost three-fourths of the fatal utility vehicle crashes, occur in rural areas? One hypothesis is that the prominence of rural areas in fatal crashes is largely due to average travel speed.

Previous studies have shown that average speed of travel in rural areas exceeds that in urban areas. Data from the FARS, for example, show that in fatal crashes a speed of 50 or more miles per hour is more than twice as common in rural areas compared to urban areas. These data are shown in Table 4.3.2-3.

Additional evidence of the difference in travel speed between urban and rural areas is included in a report prepared by the Federal Highway Administration (U.S. Department of Transportation, Federal Highway Administration, Traffic Speed Trends, 1976). A few statistics from that report are presented in Table 4.3.2-4.

Although the figures are somewhat dated, the rural/urban differences found in travel speed were about 12 mph for primary and secondary roads, and 3 mph for interstates.

Closely related to differences between urban and rural areas are some of the characteristics of the site of the crash. Table 4.3.2-5

TABLE 4.3.2-1

COMPARISON OF UTILITY VEHICLE CRASHES
IN URBAN AND RURAL AREAS:
SELECTED STATES

State	Utility Vehicles %	Passenger Cars* %
Michigan		
Township**	50	30
City	50	69
Total	100%	100%
Number of Crashes	6,599	30,880
Texas		
Rural	17	9
Urban	83	91
Total	100%	100%
Number of Crashes	302	31,697
Washington		
Rural	35	16
Urban	65	84
Total	100%	100%
Number of Crashes	1,456	153,331

*Includes all vehicles in Michigan.

**Most townships are in rural areas, but a few townships are in urban areas. Therefore, percentage differences between urban and rural probably are somewhat greater that those shown in the table.

shows the relationship between total crashes and several site characteristics for urban and rural areas.

TABLE 4.3.2-2

DISTRIBUTION OF FATAL CRASHES
ALL STATES, 1977 FARS

	Utility Vehicle %	Passenger Car %
Urban	28	44
Rural	72	56
Total	100%	100%
Number of Crashes	486	35,304

TABLE 4.3.2-3

PERCENTAGE DISTRIBUTION
OF FATAL CRASHES ACCORDING
TO TRAVEL SPEED: ALL STATES
1977

Travel Speed (mph)	Utility Vehicles		Passenger Cars	
	Urban	Rural	Urban	Rural
Under 55	25	14	21	17
55 or over	9	27	11	26
Not Ascertained	66	59	68	57
Total Number of Crashes	348	134	15,495	19,749

Each characteristic shown in Table 4.3.2-5 is more prevalent in rural areas than in urban areas. And, compared with passenger crashes, utility vehicle crashes are more likely to occur when the specified road characteristics or conditions are present. The results for Washington are consistent with the findings for Michigan.

TABLE 4.3.2-4

AVERAGE SPEED (M.P.H.) OF PASSENGER CARS
1975

	Urban	Rural
Completed Interstate	55.2	58.0
Primary	42.9	55.1
Secondary	39.5	52.0

Table 4.3.2-6 shows the relationship between fatal crashes and several road characteristics for urban and rural areas. For each of the road characteristics, fatal utility vehicle crashes are compared with fatal car crashes.

The overwhelming proportion of fatal crashes occur on roads having only two lanes, and these roads are very common in rural areas. The proportion of fatal crashes on two-lane roads in utility vehicles is only slightly higher than that for passenger cars in both urban and rural areas.

The character of the road at the site of the crash is associated with moderately large differences between utility vehicles and passenger cars with regard to fatal crashes. Fatal utility vehicle crashes are 9 and 12 percentage points higher than the figure for passenger cars at curves or on hills, respectively (Table 4.3.2-6). As would be expected, curves and hilly roads are more often crash sites in rural areas.

Table 4.3.2-6 also shows that fatal utility vehicle crashes are less likely than fatal car crashes to occur at intersections or on the roadway. Crashes on the roadway are even less likely in the rural areas; that is, fatal utility vehicle or passenger car crashes in rural areas are more likely than those in urban areas to involve leaving the roadway. This conclusion must be tempered somewhat because of a reporting problem. Certain crashes which occur off-road are treated as entirely off-road (and may or may not be recorded as traffic related) even though the vehicle started on-road.

TABLE 4.3.2-5

PERCENT OF TOTAL CRASHES
ACCORDING TO DIFFERENT ROAD CHARACTERISTICS:
SELECTED STATES

Selected Road Characteristics	Township		City		Total	
	Utility Veh %	All Veh %	Utility Veh %	All Veh %	Utility Veh %	All Veh %
Michigan						
Snow or ice on surface	41	25	29	17	35	20
Curve in the road	11	7	3	3	7	4
Darkness without streetlights	35	33	15	15	25	20
Number of crashes	3304	9510	3295	21370	6599	30880

	Rural		Urban		Total	
	Utility Veh %	Pass Car %	Utility Veh %	Pass Car %	Utility Veh %	Pass Car %
Washington						
Snow or ice on surface	20	11	6	2	10	4
Curve in the road	33	24	8	6	16	9
Darkness without streetlights	32	27	6	5	15	9
Number of crashes	496	24698	960	128357	1456	153331

TABLE 4.3.2-6

PERCENT OF FATAL CRASHES
ACCORDING TO DIFFERENT ROAD CHARACTERISTICS:
ALL STATES

Road Characteristic	Urban		Rural		Total	
	Utility Vehicles %	Pass Car %	Utility Vehicles %	Pass Car %	Utility Vehicles %	Pass Car %
Two lanes	66	62	94	92	86	79
Curve in road	19	15	37	29	32	23
Vertical grade	29	19	42	31	38	26
Intersection	34	32	11	17	17	23
On roadway	66	76	53	68	57	71
Snow or ice on surface					11	4
Darkness	29	23	51	46	45	36
Number of Fatal Crashes	134	15495	348	19749	486	35304

Other road conditions that affect driving include snow or ice on the surface and the amount of light present. Proportionately more utility vehicles than passenger cars crash when ice or snow is on the road surface, especially in rural areas. In rural areas, eleven percent of fatal crashes in utility vehicles occur with snow or ice on the road, compared with five percent for passenger cars.

Forty-five percent of all fatal utility vehicle crashes occur during the evening hours in the absence of streetlights. The corresponding figure for passenger cars is 36 percent. Again, darkness without street lights is a condition more often present in rural than urban areas.

In summary, utility vehicles are much more likely than passenger cars to crash in rural areas. Within rural areas, utility vehicles crash more often than passenger cars when snow or ice is on the road surface, when darkness prevails, or when there is a curve in the road.

4.3.3 Temporal Characteristics

What, if any, are the major differences between utility vehicle and passenger car crashes according to when these accidents occur? Presented below are statistics on month of year, day of week and hour of day.

Some seasonal differences between passenger car and utility vehicle crashes are observed in Table 4.3.3-1. Compared with passenger cars, utility vehicles experienced proportionately more crashes in the winter months.

TABLE 4.3.3-1

UTILITY VEHICLE AND PASSENGER CAR CRASHES BY MONTH: SELECTED STATES

Month	Michigan		Washington	
	Utility Vehicles %	Passenger Cars %	Utility Vehicles %	Passenger Cars %
January	15	11	9	8
February	10	8	8	7
March	7	7	8	8
April	5	7	7	8
May	6	8	7	8
June	6	8	7	8
July	6	7	9	8
August	5	7	7	9
September	6	8	9	8
October	8	7	8	9
November	11	9	10	9
December	15	13	11	10
Total	100%	100%	100%	100%
Number of Crashes	6,599	24,912	1,456	153,331

Over one-half (51%) of the utility vehicle crashes in Michigan are seen in the table to occur in four months (November-February). The corresponding figure for passenger cars is 41 percent. Although the difference is not as pronounced as in Michigan, crashes in Washington reveal a similar pattern. Thirty-eight percent of utility vehicle crashes in Washington were observed in the November-February time period compared to 34 percent for passenger cars.

Compared to passenger car crashes, utility vehicle crashes are slightly more prevalent on weekends than weekdays, as is shown in Table 4.3.3-2.

TABLE 4.3.3-2

UTILITY VEHICLE AND PASSENGER CAR CRASHES BY DAY OF WEEK: SELECTED STATES

Day of Week	Michigan		Washington	
	Utility Vehicles %	Passenger Cars %	Utility Vehicles %	Passenger Cars %
Monday	13	13	12	14
Tuesday	12	13	12	13
Wednesday	13	13	12	14
Thursday	15	16	14	14
Friday	18	18	17	18
Saturday	16	15	19	16
Sunday	13	12	14	11
Total	100%	100%	100%	100%

The largest difference between the two types of vehicles in Washington is seen to fall on Saturdays, when 19 percent of utility vehicle crashes occur.

Time of day by four hour periods is shown in Table 4.3.3-3 for accidents from the Michigan file. As shown, utility vehicle crashes are somewhat more likely than passenger car crashes to occur between midnight and 8:00 a.m.

TABLE 4.3.3-3

UTILITY VEHICLE AND PASSENGER CAR CRASHES BY TIME OF DAY: MICHIGAN

Hour Period	Utility Vehicles %	Passenger Cars %
8 am-Noon	15	14
Noon-4 PM	25	27
4 PM-8 PM	26	28
8 PM-Midnight	15	16
Midnight-4 AM	11	9
4 AM-8 AM	8	6
Total	100%	100%

More fatal crashes occur in the last half of the year than in the first half. Fifty-eight percent of fatal utility vehicle crashes and 51 percent of fatal passenger car crashes take place between July and December. July is the peak month for fatal utility vehicle crashes.

With the exception of the seasonal pattern observed for Michigan, temporal differences between the distributions of utility vehicle and passenger car crashes are small.

4.3.4 Statistical Significance

Previous sections in this chapter have considered driver characteristics, environmental characteristics and temporal patterns. This section considers all these variables simultaneously. In some instances a relationship observed between two variables is actually more a result of a third variable not included in the table. When several characteristics are considered together, significant relationships can be separated from insignificant ones. All characteristics discussed earlier in this chapter were included in multiple regression equations (linear probability functions) using accident files from the States of Michigan and Washington.[12] The results regarding the level of statistical significance associated with each of these characteristics are shown in Table 4.3.4-1.

TABLE 4.3.4-1
RELATIONSHIPS BETWEEN SPECIFIED CHARACTERISTICS AND THE PERCENTAGE OF UTILITY VEHICLE CRASHES

	Whether Significant at the 95% Level of Confidence		Whether Significant at the 99% Level of Confidence	
	Michigan	Washington	Michigan	Washington
Driver Characteristics				
Age	Yes	Yes	Yes	Yes
Sex	Yes	Yes	Yes	Yes
Occupation	NA	Yes	NA	No
Reported Alcohol Use	No	No	No	No
Crash Locations				
Rural area	Yes	Yes	Yes	Yes
Curve in road	Yes	Yes	No	No
Snow or ice on road surface	Yes	Yes	Yes	Yes
Temporal Characteristics				
Month	No	No	No	No
Day of week	No	No	No	No
Hour of Day	No	No	No	No

Reported use of alcohol and all temporal characteristics are not significantly associated with the percentage of utility vehicle crashes.

12 The equations and correlation matrices are presented in appendix D.

Significant relationships are observed, however, between all other characteristics considered in this chapter and the percentage of utility vehicle crashes.

Relationships between characteristics examined and the percentage of utility vehicle crashes were found to be statistically significant at the 99 percent level of confidence for: driver characteristics of age and sex; crash locations of rural area; and snow or ice on the road surface. It was found significant at the 95 percent level of confidence for occupation for the state of Washington, and for curve in the road for both Washington and Michigan crashes.

4.4 CLINICAL CASE REVIEW

Information about utility vehicle crashes was obtained from accident reports and photographs from selected states. In addition, the CPIR file was examined as a possible source of information about injury in utility vehicle crashes. Considered below are accident reports from Arizona, Michigan, New Mexico, and New York. Data from Arizona, Colorado, and Michigan are included in 4.4.2 (Photographic Analysis).

4.4.1 Accident Reports: Arizona, New Mexico, and New York

Arizona traffic accident reports are filed only for the current year, with records for the previous years maintained on microfilm. The Department of Transportation keeps accident records pertaining to all jurisdictions in the state in a central file. However, individual accident reports must be obtained independently for collisions coming under jurisdiction of the Department of Public Safety (Highway Patrol), or from the individual sheriffs, or from the local police department having jurisdiction in all other cases. Accident reports are stored on microfilm covering the period back to January 1, 1973. Prior to that time data are available only for those accidents reported on state highways back to January 1, 1965.

An initial computer search was conducted for all traffic accident reports for 1976, 1977, and 1978 identified under the coding for recreational vehicles. This includes all off-road utility vehicles, listing the model year and vehicle make (i.e., 1978 Ford 2-door), body style, and VIN. However no further identification was provided in the coding to determine whether the vehicle was in fact a pickup truck or CJ-7. To obtain this information it would have been necessary to examine each individual traffic accident report, a prohibitive task under the time and budget available. Therefore, the decision was made to identify and examine all 1978 accidents involving recreation vehicles investigated by the Department of Public Safety which would give the best and most recent state-wide distribution of data. Also all fatal accident reports for 1978, in any Arizona law enforcement jurisdiction, were evaluated.

The Arizona accident records report a large number of recreational vehicles in accidents each year, most of which appear to be utility vehicles as defined by this study. As shown in Table 4.4.1-1 there have been a total of 5,098 recreational vehicle accidents in Arizona over the past three years. This represents an increase of 8.9 percent in 1977, and 8.5 percent in 1978. In 1978 the numbers of fatal accidents (37), fatalities (42), injury accidents (808), and injuries (1,360) are all higher than recorded the previous year. Of the 1,948 recreational vehicle accidents during 1978, 1,215 involved the utility vehicle as the primary accident vehicle, and in 733 cases as struck by another vehicle.

TABLE 4.4.1-1

ARIZONA RECREATIONAL VEHICLE COLLISIONS
1976-1978

	1976	1977	1978	Totals
Fatal accidents	27	23	37	87
Number of fatalities	32	26	42	100
Injury accidents	616	712	808	2,136
Number of injuries	1,082	1,220	1,360	3,662
Total Accidents	1,488	1,662	1,948	5,098

The frequency of occurrence of various models of utility vehicles included in the review of the accident reports from Arizona for the year

1978 is shown in Table 4.4.1-2. Of the 300 cases investigated by the Arizona Department of Public Safety, Jeeps are shown to be involved in over one-half of the accidents.

TABLE 4.4.1-2

INCIDENCE OF ACCIDENTS
BY MODEL: ARIZONA, 1978

Injury Accident	Percent of Total
Jeep*	54
Blazer	18
Bronco	8
Scout	7
Land Cruiser	5
Jimmy	3
Other (Travel-alls, Station Wagons, etc.)	5
Total	100%
Total Number of Crashes	300

*Includes Willys, Kaiser Jeeps, and AMC JEEP

A tabular listing of the 1978 Arizona utility vehicle collisions for which accident reports were reviewed is provided in Appendix G.

An effort was made to obtain copies of all accident reports for utility vehicles in the State of Arizona in which a fatality occurred during 1978. Of the 37 fatal collisions (with 42 fatalities) during this period, twenty-seven cases are listed in Table 4.4.1-3. Other cases involved dune buggies or other vehicles not included in this study, a fatal pedestrian collision, and a fatality in a parked JEEP struck by another vehicle driven by a DWI (driving while intoxicated) driver.

When the 27 fatal accidents which were analyzed (of the 37 recreational vehicle fatal crashes occurring in Arizona during 1978) are compared in Table 4.4.1-4, a disproportionate number of AMC JEEP vehicles, 16 (or 59%), were involved. Two Willys Jeeps (7%) were also

Table 4.4.1-3

COMPARISON OF 27 ARIZONA FATAL UTILITY VEHICLE CRASHES IN 1978

Date and Time of Day	Year & Body Style	Driver Age	Driver Sex	Est. Speed	Type of Accident and Comments	Injuries
1/29/1921	1976 AMC JEEP "Special"	27	M	-	Rolled 1-3/4 times	Fatal
2/1/0640	1947 Willys JEEP	55	M	-	Windshield icy, heavy fog, head-on collision with 1975 GMC stepvan, flotation tires, no restraints installed, occupants ejected.	Two fatalities, rt. front age 28 female and 2-year-old child.
2/20/1750	1972 AMC JEEP CJ-5	24	M	-	Skidded on 8^{0} downgrade turn soft shoulder, Rollover, 2-1/2 times, roll-bar equipped, seatbelts not worn.	Fatal, 26 M passenger. Serious injury, driver.
3/5/2015	1975 AMC JEEP CJ-5	20	M	40	Rollover, roll-bar equipped. Collided with 1971 Chevrolet pick-up truck at intersection, hit 3rd vehicle, rolled over into canal.	Fatal to age 35 M, vehicle #2. Fatal to age 18 M passenger. Serious injuries to driver, fatal 18-year-old male passenger. (commimuted, depressed skull fractures, fractures left shoulder & left femur)
5/7/1820	1977 AMC JEEP CJ-5	36	M	20	Lost control off road, rollover multiple times down 60^{0} grade.	Fatal
3/20/1650	1967 AMC JEEP CJ-5 Special	33	M		Ran off curve, rollover, fire, driver ejected.	Fatal
4/25/0117	1969 AMC JEEP	50	M	20-45	Ran off curve, rollover, into canyon, alcohol a factor, driver ejected.	Fatal
5/21/1950	1978 AMC JEEP CJ-5 Special	32	M	36	Rollover, fiber glass top, factory standard roll-bar	Fatal
6/3/0144	1976 AMC JEEP CJ-5	43	M	25	Hit in rear by 1969 Oldsmobile at estimated 51 m.p.h., Rollover	Fatal
6/7/2231	1978 International Scout	39	M	45	Head-on collision with 1975 Chevrolet	Driver, lacerated face; Fatal to Chevrolet passenger; Driver of Chevrolet, age 55 female, compoung fracture both lower legs, internal injuries
6/16/1745	1968 GMC Suburban	61	M	10	Left turn, collision with 1965 Ford Falcon	Fatal

Date and Time of Day	Year & Body Style	Driver Age	Driver Sex	Est. Speed	Type of Accident and Comments	Injuries
6/30/2045	1977 AMC JEEP CJ-5 Golden Eagle	33	M	60	Broadside skid, collided with ditch, Rollover onto side, unbelted driver ejected and crushed. Seat belt restrained passenger injured.	Fatal ejection.
7/3/0130	1973 AMC JEEP CJ-5	24	M	35	Lost control on curve, Rollover 1 1/2 times, seat belts were installed on 2 front seats, but not worn, roll-bar installed. Driver cited for DWI and excess speed, 3 passengers ejected.	3 injured, 1 Fatal.
7/18/2300	1978 Ford Bronco	28	M	65	Swerved off road into embankment. Driver struck head on windshield, eat belts not used, probably intoxicated and fell asleep.	Fatal head injuries.
7/24/0930	1973 AMC JEEP CJ-5 Special	16	F	-	75' braodside skid, Rolled end-over-end 45', airborne 27' and 20' prior to first impact. Soft top.	2 Fatal (including driver and 15 year old female ejected, 16 year old male ejected from rear seat. Driver ejected.
7/14/1400	1974 AMC JEEP CJ-5	28	M	-	Lost control in loose gravel on 275° left curve, Rolled. Roll-bar and seat belt fastened. Was not ejected.	Fatal (driver died of head injury and fractured neck).
8/21/0417	1977 International Scout II	30	M	70+	Right front tire blow out, Rolled several times, ejected driver. 4 x 4 travel top A.	Fatal
8/26/1530	1974 AMC JEEP Renegade	17	M	-	Ran off highway and hit rock and embankment. Rolled over. DWI (manslaughter charges). Unrestrained occupants ejected.	Fatal - Age 22 M passenger Serious injuries - Age 22 F passenger Age 23 F passenger (punctured lung, fractured rib, fractured collar bone) Serious injuries - Age 30 F passenger
9/13/1855	1978 AMC JEEP CJ-5	25	M	35	Lost control in rapid lane change, rolled onto left side and hit 1973 Chevrolet Van, rotated 170°, ejected passenger.	Fatal to age 29 M, age 26 F, and age 52 F passengers.
9/27/0650	1978 AMC JEEP CJ-7	29	M	20	Hit rear of 1976 Chevrolet.	Injury to driver. Fatal to Chevrolet driver. Injuries to age 31 M, Age 4 M, age 27 F Chevrolet passengers.
10/5/1845	1967 Toyota Landcruiser	26	M	40	Hit 1978 Chevrolet broadside at intersection. Rollover.	Serious injury to Toyota driver. Fatal to Chevrolet driver. Serious injuries to 3 Chevrolet passengers.

Date and Time of Day	Year & Body Style	Driver Age	Driver Sex	Est. Speed	Type of Accident and Comments	Injuries
10/08/0900	1960 Willys Jeep	60	M	5-8	Rollover. Hit soft shoujder on hunting trip, mountain road, 31' drop-off, roll-bar equipped.	Fatal to age 60 M passenger; no injuries to age 60 M driver.
10/27/0246	1970 Ford Bronco	22	M	50	4-wheel drive, DWI driver racing another DWI driver. Rollover.	Fatal to driver and age 25 M passenger, no injury to age 21 F passenger.
10/27/1945	1970 AMC JEEP CJ-5	26	M	70	Rollover. 2 1/4 times.	Fatal head injuries.
10/28/2037	1967 Ford Bronco	62	M	55	Head-on collision, police pursuit at 85-90 m.p.h.	Fatal.
12/9/1115	1978 Ford Bronco	24	M	55	Rollover and ejected.	Fatal to driver.
12/29/2030	1977 Toyota Landcruiser	32	M	50	Collided head-on with 1977 Chevrolet.	Toyota driver injured. Fatal to Chevrolet driver. Serious injury to 2 Chevrolet passengers.

involved in fatal accidents, for a total of 67 percent Jeep and JEEP utility vehicles.

Unfortunately, injury details in many of these accidents as reported by the enforcement agencies were insufficient to determine their precise nature. Although ejection with fatality was identified in eight of the 27 cases, it actually probably occurred in other cases. These fatal Arizona cases are outlined in Table 4.4.1-4.

Age of the drivers in these fatal accidents ranged from 16 to 62 years, with 23 percent being between 16-25 years, 42.3 percent between 26-35 years, 15.4 percent being between 36-50 years, and 15.4 percent being between 51-62 years. One female (aged 16) and 26 male drivers were involved. Alcohol was noted to be a factor in 18 cases, unknown in six, and determined to be absent in 3 cases. Speeds as estimated by the officer varied from 5 to over 70 miles per hour. One fatality was a 60 year old male passenger, when rollover of a 1960 Willys Jeep occurred at an estimated speed of only 5-8 miles per hour. This vehicle was equipped with a roll-bar, but there was no indication as to whether the passenger was wearing a seatbelt.

TABLE 4.4.1-4

FREQUENCY OF MODEL INVOLVEMENT
IN 1978 ARIZONA FATAL UTILITY VEHICLE COLLISIONS

Model	Percent of Total*
JEEP, Jeep**	67
Bronco	15
Scout	7
Land Cruiser	7
Misc. (GMC, Suburban)	4
Blazer	-
Jimmy	-
Total	100%

*27 vehicles, listed in detail in Table 4.4.1-3.
**Includes 16 AMC JEEPS;2 Willys Jeeps.

Twenty of the 27 fatal utility vehicle accidents (74%) examined involved rollover, often with ejection of unrestrained occupants. Fourteen of the 19 fatal rollovers involved JEEPS. An additional JEEP fatal crash involved an end-over-end overturn. Rollovers also occurred in one of two fatal Scout collisions.

So far as could be determined from examination of photographs and descriptions where provided in police accident reports, the roll-bars in these particular accidents appeared to hold up well in rollovers. However, the protection provided by the roll-bar was often negated by the fact that the occupants in these fatal accidents were not wearing lap-belts in at least eight of the 20 accidents, allowing fatal ejection. In one case, involving a vehicle equipped with roll-bar and in which the driver was reportedly wearing a lap-belt, fatal head injuries occurred during rollover due to flailing of the unrestrained head and upper torso. More recently, two 1979 fatal accidents in Arizona have occurred in which the fatally injured occupants were riding in roll-bar equipped vehicles and were also reported by state authorities to be wearing both lap-belts and shoulder harness restraints. In these cases, however, the roll-bars were apparently not factory installed (although one was installed by a dealer), and it is not known what type of restraints were installed, nor how tightly they were worn. This suggests that much more attention should be given to the proper installation and wearing of upper torso restraints, and detailed reporting of the crash scene.

The preceding discussion illustrates representative crashes from the Arizona 1978 fatal utility vehicle records. In nearly all cases shown, the roll-bar should have provided sufficient protection to have prevented fatality, had adequate restraints also been installed and worn.

No case of upper torso restraint usage was identified in the 1978 fatal cases, although two 1979 fatal collisions mentioned above have involved usage of both roll-bars and upper torso restraints. The roll-bars do not appear to offer sufficient protection without installation and use of a complete restraint system to prevent head and upper torso flailing and contact during rollover.

New Mexico uses one of the most detailed and complete report forms and data processing systems of any state. However, the injury data are coded according to the categories (K-killed; A-incapacitated, carried from scene; B-visible injury), and seldom is more detailed trauma information given on the report form.

A copy of the crash investigation report for all accidents statewide investigated by the New Mexico State Police was reviewed. This provided a sampling similar to that conducted for the State of Arizona and formed a basis for comparison of collisions in these two neighboring southwestern states. These included 48 crashes in 1977 for the five months August through December, and 97 crashes during 1978.

Data on these collisions are summarized in Appendix H, providing vehicle, driver age, sex, and injury code information, as well as brief circumstances or factors of the collision, speed where known, and whether alcohol was involved.

Eleven New Mexico fatal accidents involving utility vehicles for the period 1978 and the last half of 1977 were reviewed. Ten of these, in which there was a fatality in the utility vehicle, were also associated with a rollover. In one case, a Blazer head-on collision with another vehicle resulted in four fatalities in the other vehicle, but none in the Blazer. Rollover was also associated with ejection. Occupants were ejected in six collisions involving rollover. In four other cases it was not known whether the occupants were ejected. Ten cases involved loss of control, or correction, and subsequent rollover. Thus rollover and ejection of unrestrained occupants appeared to be primary factors in these fatalities. Detailed injury data were generally not provided in the police reports.

Since the State of New York represented a different geographic area as well as different climate, highway, and potentially different usage patterns, an attempt was made to obtain fatal utility crash data for the year 1977.

Twenty five fatal utility vehicle crashes were reported for the State of New York during 1977. However, only 16 of the 25 were usable for reasons mentioned previously. Unfortunately, however, no photographs were obtained for analysis because it would have involved the requirement of going in person to each local law enforcement jurisdiction to ascertain the specific make/model and to obtain the photographs in each individual case. Further, the information provided in the accident forms permitted only limited analysis. However, from the limited data available, five cases of rollover were indicated (30% of the 16), including one collision between a 1968 "Jeep" and a 1975 "Jeep" resulting in both overturning. Neither injuries nor occupant fatal injury causation was provided by the New York reports, and information concerning restraint/rollover protection was not given.

In summary, rollover and ejection of unrestrained occupants are observed to be primary factors in fatal utility vehicle crashes.

4.4.2 Photographic Analysis

In each of three study states -- Arizona, Michigan, and Colorado -- the collisions involving a fatality in a utility vehicle crash were designated for further study through viewing and interpretation of the written and pictorial documentation developed as a part of the crash investigation process. Selected data elements were recorded on the form shown in Figure 4.4.2-22 for further data analysis.

For Arizona, 22 utility vehicle fatal cases were identified from the 1977 FARS data file. Accident reports and photographs were requested and received for this set. Selected cases are illustrated in Figures 4.4.2-1 through 4.4.2-9.

Similar procedures were used for Colorado and Michigan. In Colorado, 54 fatal cases were identified from the 1977 FARS data. Of these cases, 46 were coded as usable, with pictures accompanying 37 cases. The eight cases not usable included pedestrian or bicyclist fatality with no utility vehicle damage or utility vehicles improperly coded on the accident report. Twelve cases are shown in Figures 4.4.2-10 through 4.4.2-21. Because these cases involve a fatality there may be a disproportionate number of crashes involving ejection of occupants due to failure to wear seat belts.

Figure 4.4.2-1 The driver of this 1978 Ford Bronco lost control at an estimated 55-60 mph entering a freeway and rolled several times. The unrestrained 25-year-old male driver was ejected through the driver's door window. Occupant restraints were installed but not used in this vehicle.

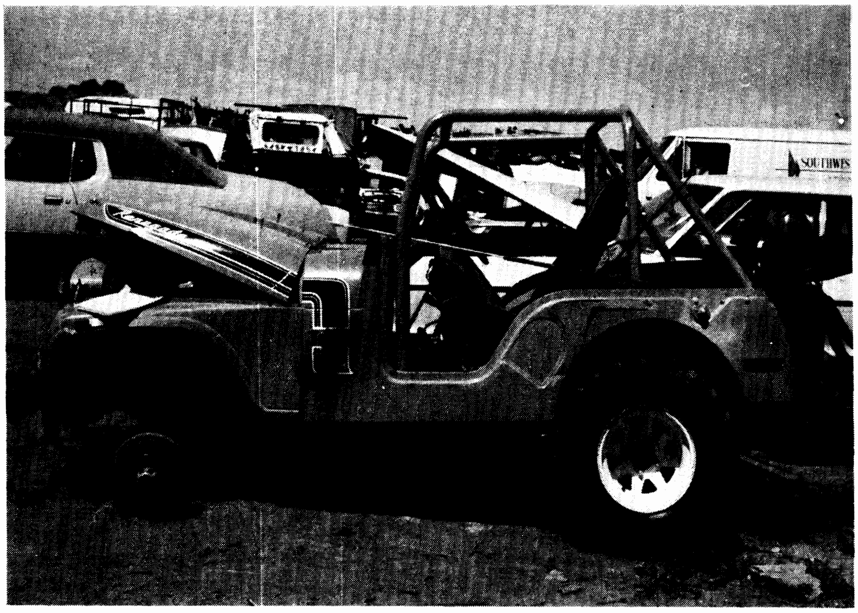

Figure 4.4.2-2 This 1975 "Renegade" JEEP ran off a mountain road and hit a rock, rolling over. The four unrestrained occupants were ejected with one fatality. The driver was cited for DWI and reckless driving. Despite rollover, note the intact roll-cage. The restraints were not used.

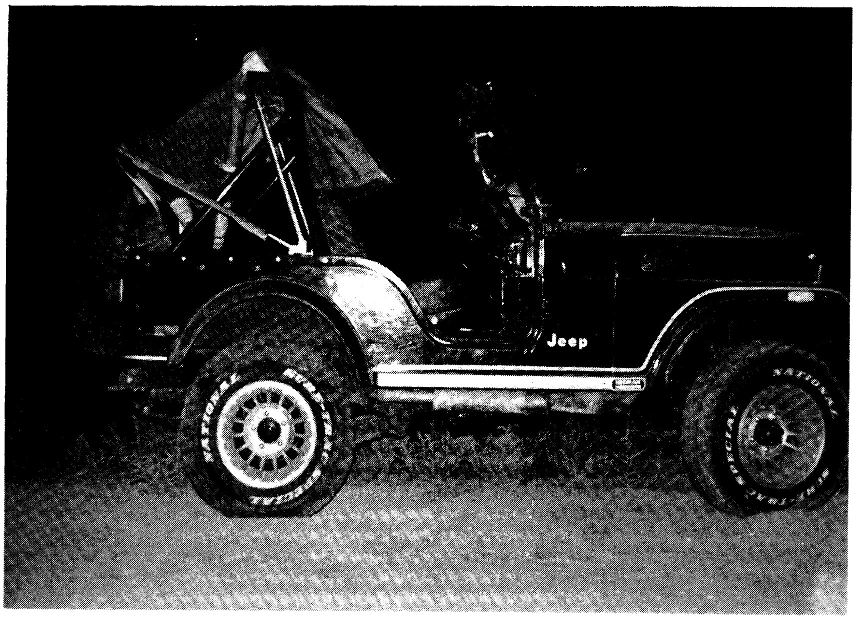

Figure 4.4.2-3 The driver of this 1977 Golden Eagle JEEP swerved to the left to avoid a parked truck and entered a high speed broadside skid, colliding with a ditch, and rolled over (at 45°). The unrestrained driver was ejected and crushed between vehicle and ground. The front left restrained passenger was not injured. Note the intact roll-bar and padded steering wheel.

Figure 4.4.2-4 The driver of this 1974 CJ-5 JEEP lost control on loose gravel, and overcorrected. The vehicle skidded broadside toward opposite shoulder, went airborne for 16 feet, rolled over, hit a culvert, and dropped vertically 20 feet. The seat belt was fastened and the driver was not ejected, but no upper torso belt was installed. Death was due to a fractured neck and head injuries as the driver flailed during rollover.

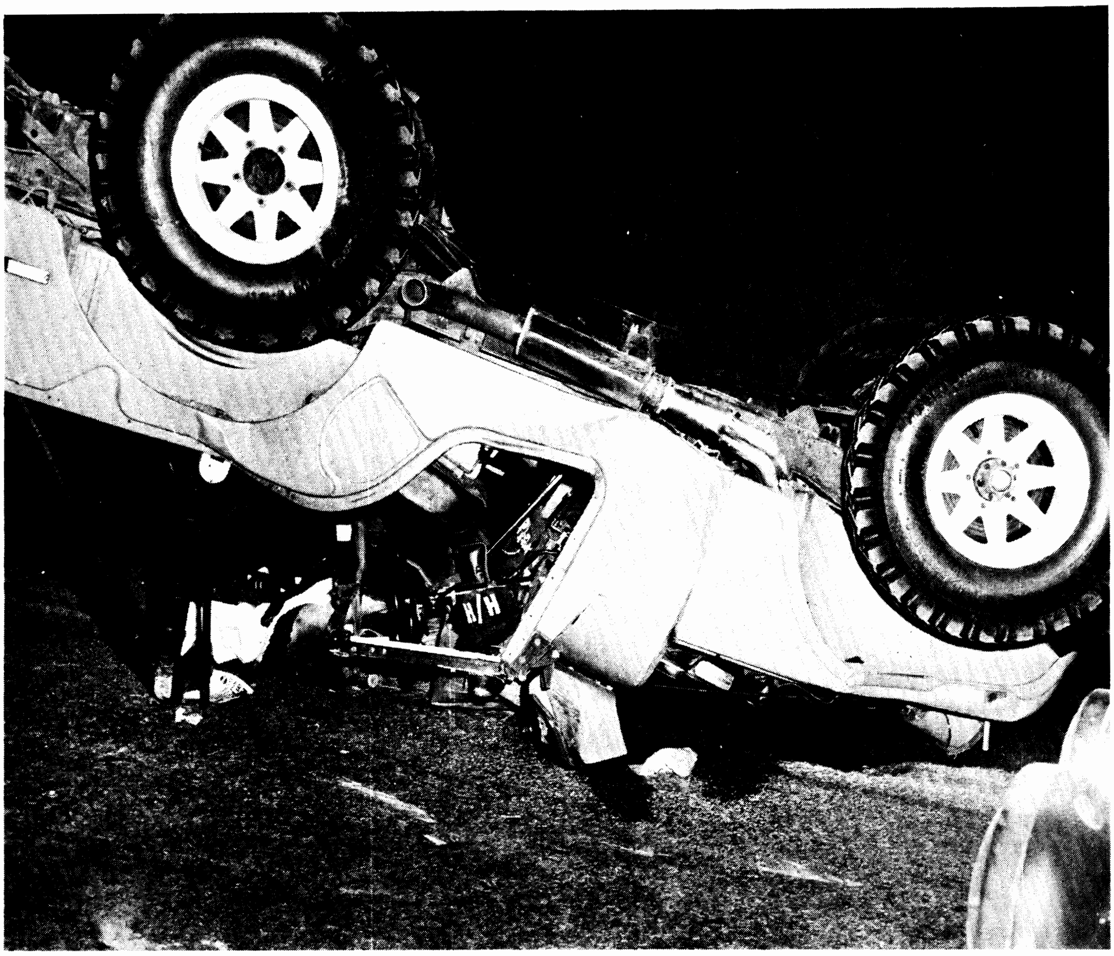

Figure 4.4.2-5 The intoxicated driver of this 1975 CJ-5 JEEP lost control on a curve and the vehicle rolled 1-1/2 times, coming to rest on the top. Three passengers were ejected. Although equipped with roll-bar and seat belts, the seat belts in the two front seats were not worn. The right front passenger was fatally injured.

Figure 4.4.2-6 Losing control on 8° downgrade curve, this 1972 CJ-5 JEEP rolled 1-1/2 times. Although equipped with sturdy roll-cage and seat belts, the belts were not worn. The driver was seriously injured and the passenger fatally injured.

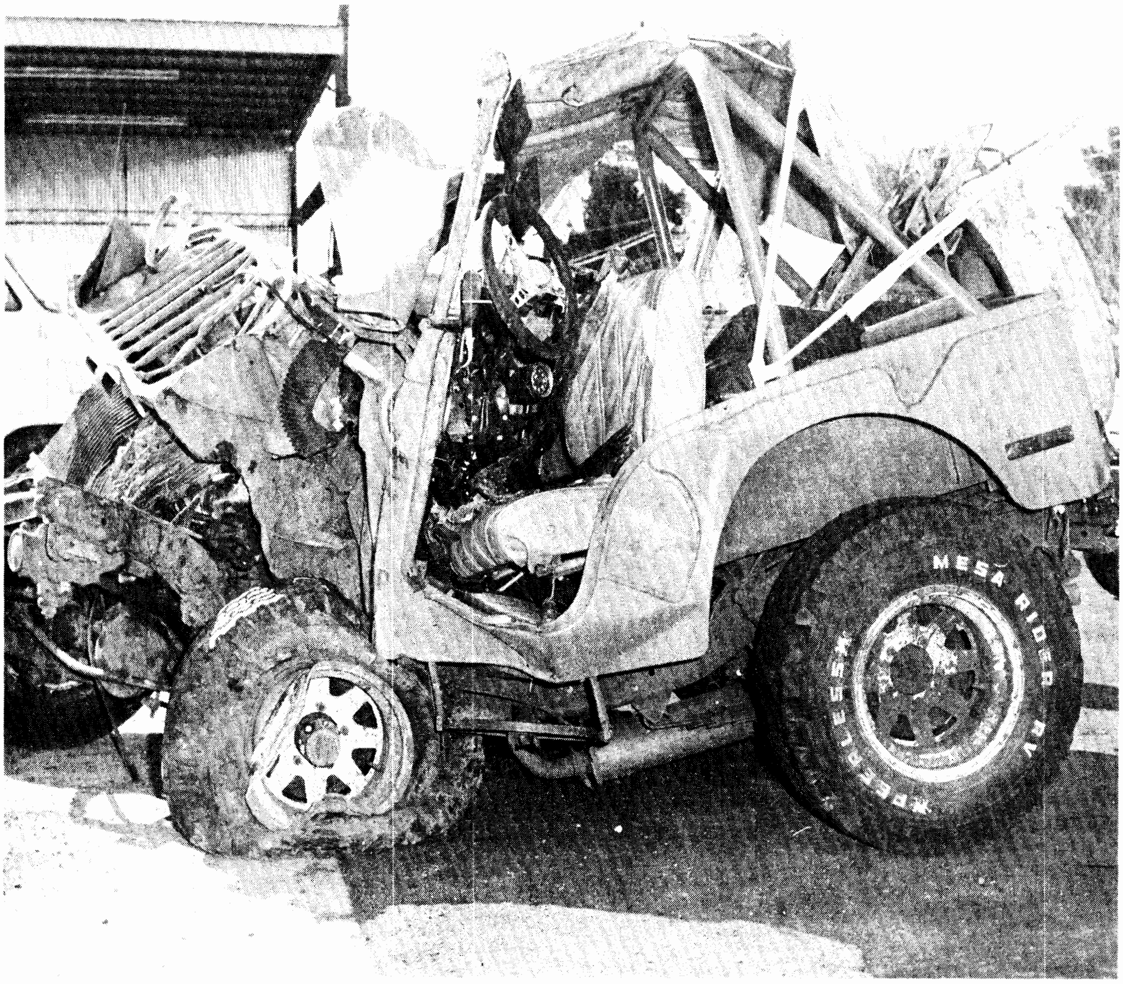

Figure 4.4.2-7 In this 1975 CJ-5 JEEP which collided with two other vehicles at intersection and rolled over into a canal coming to rest upside down. In a three fatality, three vehicle collision, two passenger fatalities occurred.

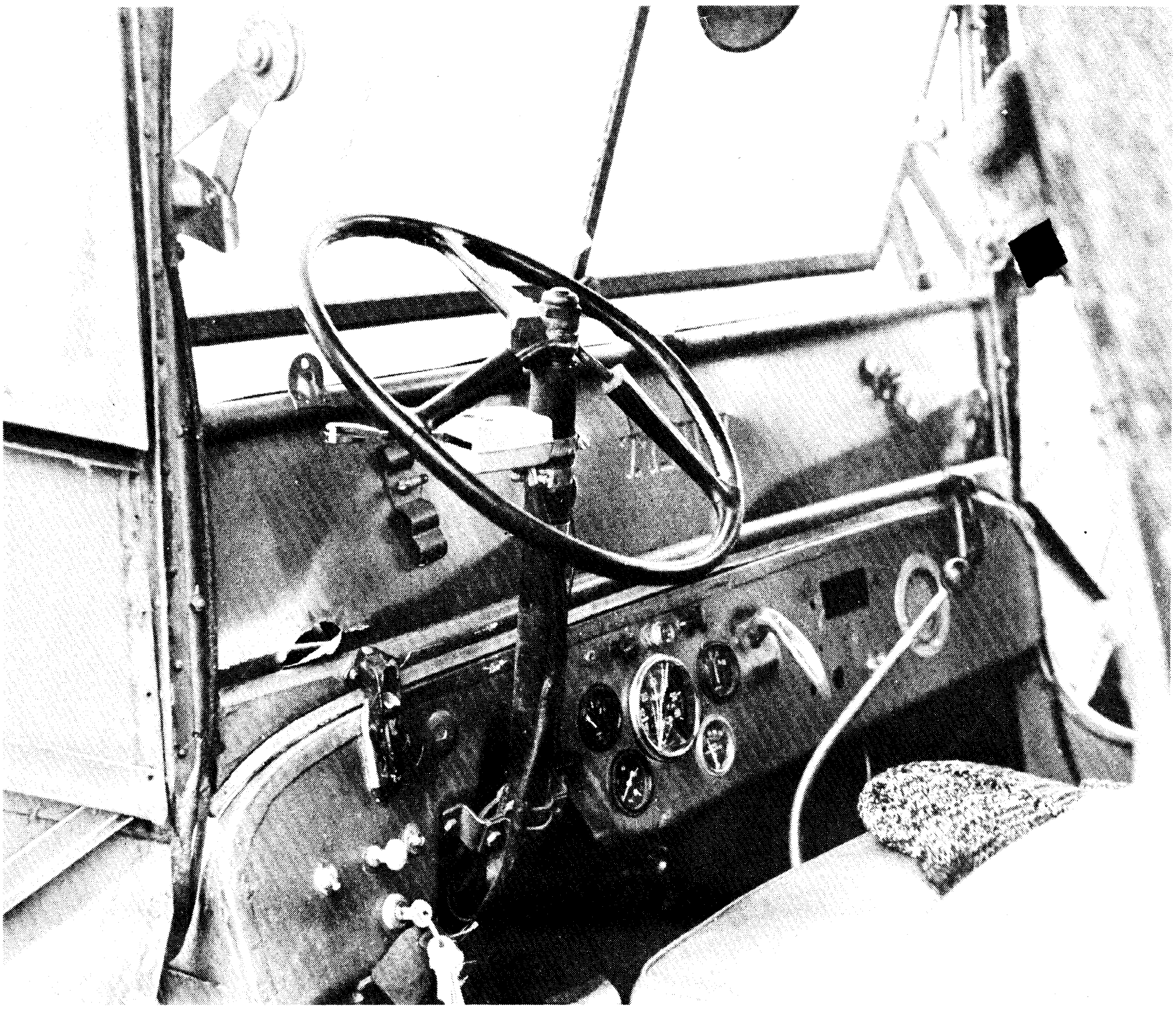

Figure 4.4.2-8 This older World War II-type Willys Jeep crossed center line while driving in heavy fog in pre-dawn darkness and hit a 1975 GMC stepvan in a headon collision. No seatbelts were installed and all three occupants were ejected, resulting in fatal injuries to the 28-year-old wife in the right front seat and a two-year-old on her lap. Heavy icing on the windshield probably obscured vision. Note the rigid, non-collapsible steering column, without hub protection, and the lack of any interior occupant protection.

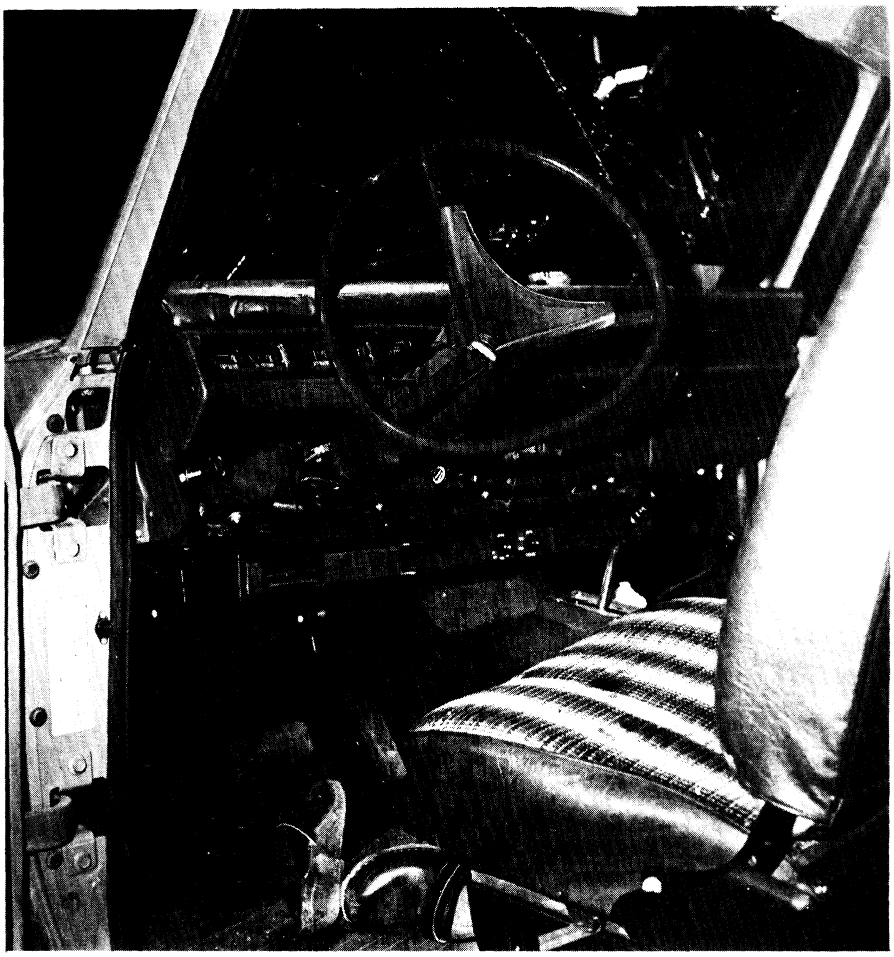

Figure 4.4.2-9 This 1978 Scout was involved in a head-on collision. It had a rigid steel cab without roll-bar or restraints. The impact was fatal to the 60-year-old male front right seat passenger. The driver received lacerations to face and lower left leg. Note the padded upper panel and steering wheel hub.

Figure 4.4.2-10 In this intersection collision the 1976 Dodge Colt in the foreground was struck on the left side by a 1977 Chevrolet Blazer. The Colt then rolled over on its top and skidded 81 feet. The driver was fatally injured. Lap belts installed in the Blazer were not used by the 30-year-old male driver, who was injured.

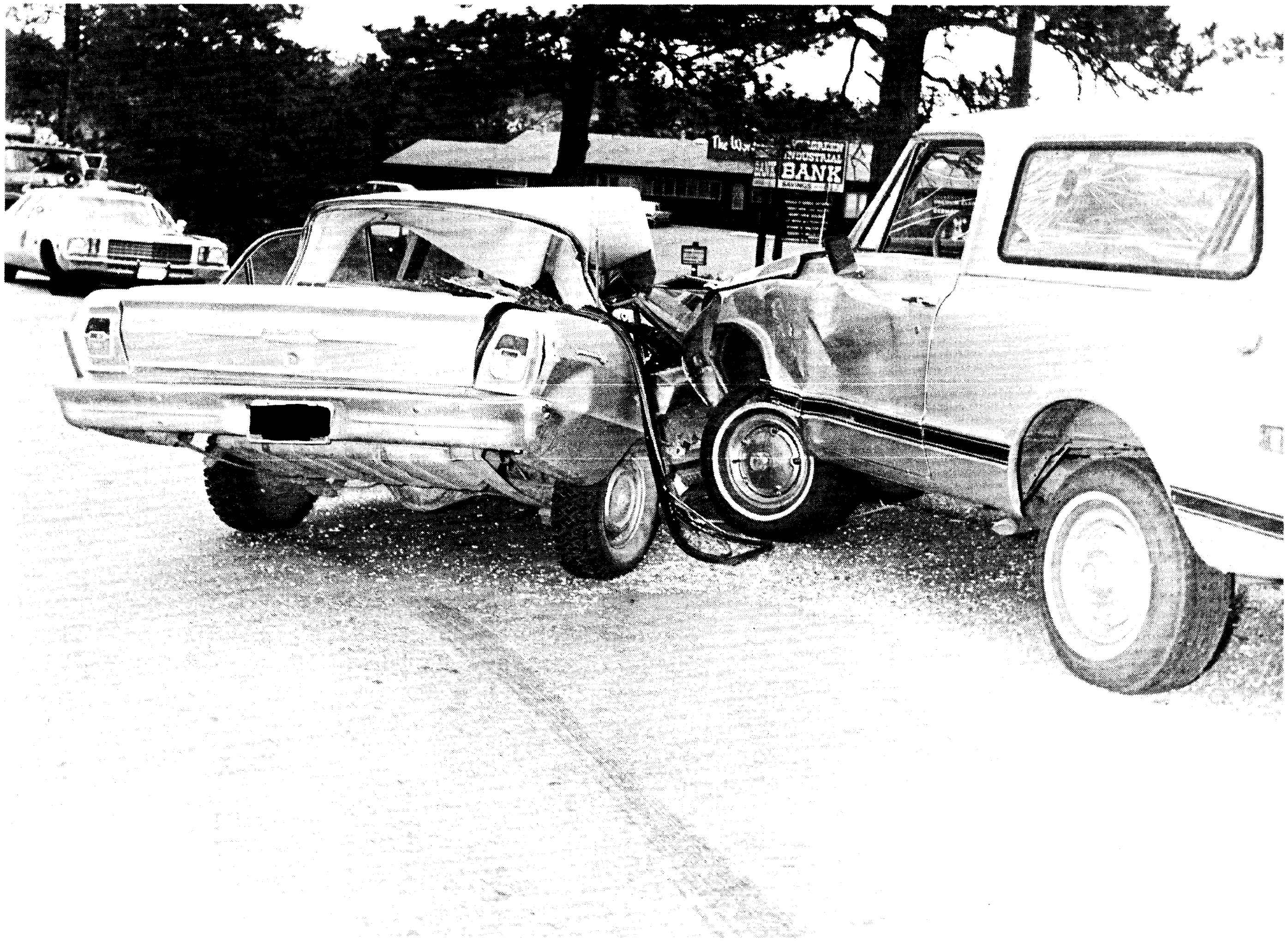

Figure 4.4.2-11 Four persons were injured and one fatality occurred as a result of a three car collision (a 1964 Chevy II crossed into the opposite lane and was struck on the right side by a 1971 Chevrolet Blazer). The Blazer had no rollbar and the lap-belt restraint was not utilized by the two injured Blazer occupants. Note windshield head-contact damage in the Blazer.

Figure 4.4.2-12 This 1965 International Scout collided with a 1975 Triumph TR-7 which had hydroplaned and skidded out of control at high speed, resulting in fatal injury to the TR-7 occupants. The Scout had no roll-bar. A lap belt restraint was used by the injured driver.

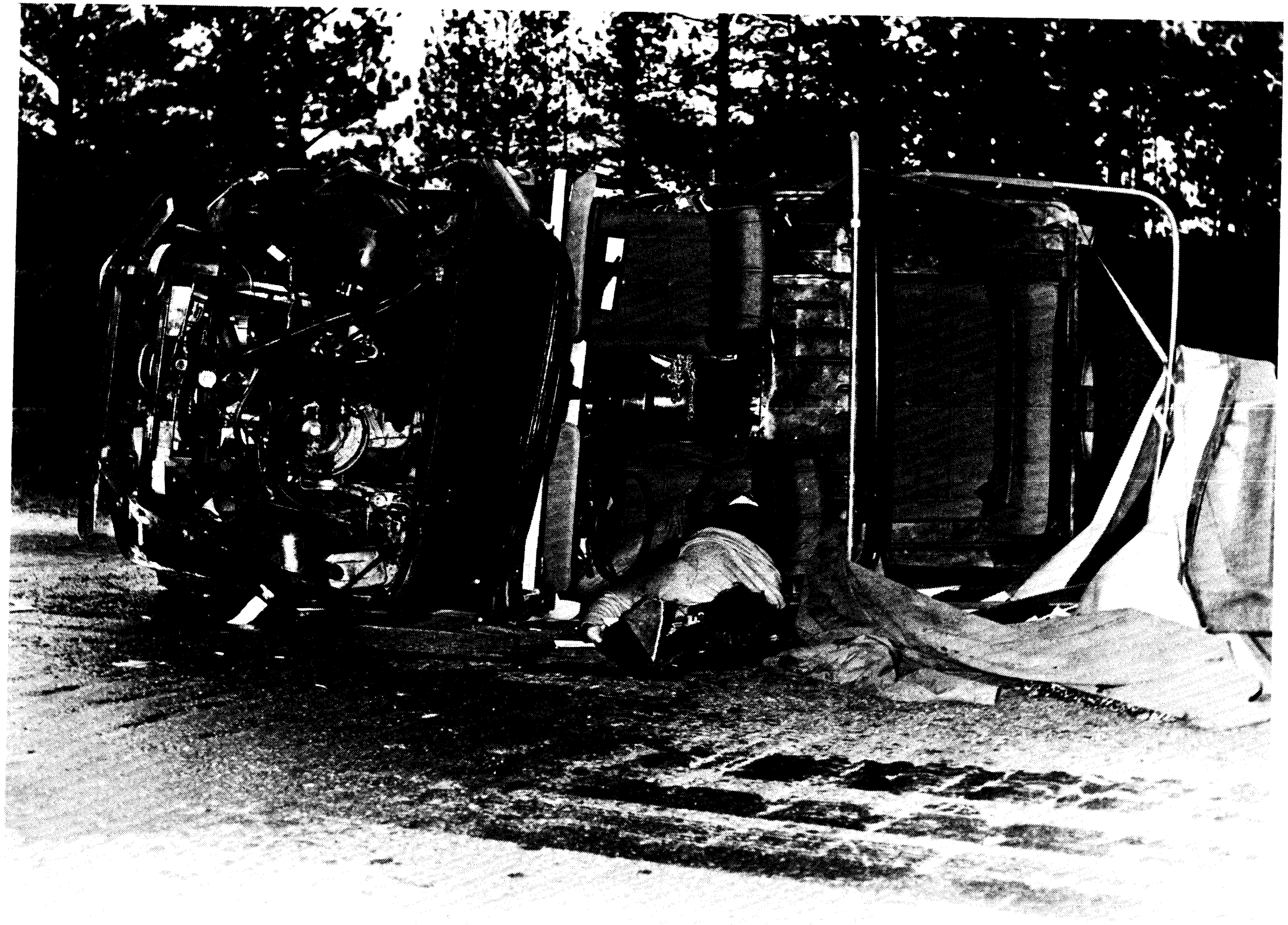

Figure 4.4.2-13 The 19-year-old driver of this 1965 JEEP Renegrade received fatal head injuries, even though lap-belted, in this single-vehicle collision. After running off the side of the road into a delineator and bridge abutment, the vehicle rolled over 2-1/2 times. The original equipment roll-bar remained intact. No shoulder harness was installed.

Figure 4.4.2-14 After colliding with a parked 1976 Toyota, this 1976 Chevrolet Blazer continued into a ditch, hit a tree, came back on to the road, then broadsided and spun around a utility pole (note indentation behind roll-bar installation). The three unrestrained Blazer occupants (lap belts were installed but not used) were ejected, with one fatally injured. The roll-bar remained intact.

Figure 4.4.2-15 After losing control on a curve and rolling 1-1/2 times, both the unrestrained driver and her passenger were ejected in this fatal 1974 International Scout crash. No roll-bar was installed and there was no shoulder harness. The lap belts were not used.

Figure 4.4.2-16 The driver and one passenger of this 1975 Ford Bronco were pinned in the vehicle after it collided with a 1977 Ford pickup truck and rolled 1-1/2 times down an embankment. The vehicle was not equipped with a roll-bar or shoulder harness, and the lap belts were not used by the occupants. There was one fatality.

Figure 4.4.2-17 After losing control at an intersection, this 1973 Chevrolet K5 Blazer rolled 1-1/2 times down an embankment. One of the two occupants was fatally injured. No roll-bar or shoulder harness was installed. The lap belts were reportedly not used.

Figure 4.4.2-18 Three unrestrained occupants were ejected, one fatally, from this 1973 Chevrolet Blazer when the driver lost control and the vehicle rolled over twice. It was not equipped with a roll-bar or shoulder harness. The lap belts were not used.

Figure 4.4.2-19 The driver of this 1974 AMC CJ-5 JEEP lost control on a curve and the vehicle rolled 1-1/2 times down an embankment, partially ejecting and fatally rolling on the right front passenger. The roll-bar effectively prevented crushing of the top; however, no shoulder harnesses were installed, and none of the three occupants were wearing the lap belt provided.

Figure 4.4.2-20 The driver was killed and the passenger injured when both, unrestrained, were ejected from this 1972 AMC CJ-4 JEEP as it rolled over two times. The original equipment roll-bar remained intact.

Figure 4.4.2-21 This 1976 AMC CJ-7 JEEP was struck from the rear and rolled over. Serious injury to the unrestrained passenger occurred in ejection, and the driver received fatal injuries. Although deformed, original equipment roll-bar remained intact. There were no shoulder harnesses and the occupants were not wearing lap belts.

Figure 4.4.2-22 Short Wheel Base Data Work Sheet

Column

1 - 2 State __ __

3-10 Case No. __ __ - __ __ __ __ __ __ __ __

11-16 Make-Model ______________________

17-18 Roll Bar:

( ) 1 None
( ) 2 Cage
( ) 3 Bar → 18
( ) 7 Can't tell
( ) 9 Unknown

18 ( ) 1 Original equipment
( ) 2 Aftermarket
( ) 3 Homemade
( ) 8 Non applicable
( ) 9 Unknown

19-21 Cab Type:

( ) 1 Open
( ) 2 Canvas
( ) 3 Rigid → 20

20 ( ) 1 Fiberglass
( ) 2 Steel
( ) 3 Can't tell
( ) 4 Other ______
( ) 8 Non applicable
( ) 9 Unknown

21 ( ) 1 Full cab
( ) 2 Half cab
( ) 3 Split cab
( ) 4 Other ______
( ) 8 Non applicable

22-25 Restraints:

Type - ( ) 1 Lap
( ) 2 Lap-shoulder
( ) 3 Harness
( ) 9 Unknown
( ) 5 Not equipped

23 Use - ( ) 1 Used → 24
( ) 2 Not used
( ) 9 Unknown

24 ( ) 1 Failed
( ) 2 Did not fail
( ) 8 Non applicable
( ) 9 Unknown

25 Source -
( ) 1 Original equpt.
( ) 2 Aftermarket
( ) 3 Replacement for original
( ) 9 Unknown

VEHICLE MODIFICATION:

26-29 Suspension - ( ) 1 Original
( ) 2 Modified → 27
( ) 3 Can't tell
( ) 9 Unknown

27 ( ) 1 Jacked up
( ) 2 Stiffened
( ) 3 Both
( ) 4 Other
( ) 8 Non App.
( ) 9 Unknown

28 - Axle
( ) 1 Original
( ) 2 Modified → 29
( ) 3 Can't tell
( ) 9 Unknown

29 ( ) 1 Wide track
( ) 2 Other ______
( ) 8 Non applicable
( ) 9 Unknown

30-31 Tires - ( ) 1 Original equipment
( ) 2 Optional → 31
( ) 9 Unknown

31 ( ) 1 Wide track
( ) 2 Over diameter
( ) 3 Both
( ) 4 Other ______
( ) 8 Non applicable

32 Tread - ( ) 1 Regular
( ) 2 Special Type: ______
( ) 9 Unknown

35 Tread condition - ( ) 1 New
( ) 2 Good
( ) 3 Fair
( ) 4 Bald
( ) 9 Unknown

33 Exterior - ( ) 1 No change
( ) 2 Snow plow (or attachment mechanism)
( ) 3 Other ______
( ) 4 Front bumper modification or structure
( ) 5 Rear bumper modification or structure
( ) 6 Both front & rear bumper modification
( ) 7 Combination of above
( ) 9 Unknown

34 Interior - ( ) 1 No change
( ) 2 Other ______
( ) 9 Unknown

In Michigan, 41 cases were identified for the years 1976 and 1977. In all, 36 cases were coded with photographs available for 27.

The photographic analysis produced information about these crash-involved vehicles over and above what was available on the police report. For example detail on the cab structure of the vehicle (whether open or enclosed), roll-bar equipment, and vehicle modification are not available from the police report. These data are summarized and reported in Table 4.4.2-1.

For those vehicles equipped with a roll-bar, Table 4.4.2-1 shows that a majority of the bars appeared to be original equipment. The type of cab enclosure is important in injury reduction. For those vehicles with a rigid cab, the majority were of the full cab style.

Vehicle modifications are largely related to the suspension, axle, tires, and interior and exterior as shown in Tables 4.4.2-2 through 4.4.2-7. Most vehicles were unmodified.

Of those few modified, either the suspension had been jacked-up, stiffened, or both.

In most vehicles, the axle (track) of the vehicle had not been changed, or it was impossible to tell.

Tire modifications, however, were more common.

The tire options as defined here, were often difficult to determine photographically. However, they were either wide track or over diameter or both.

For all tires, the type of tread wear could not be determined.

The results show, in general, no modification to either the interior or exterior of the vehicle.

Several variables were crossed with cab type. Of importance here is the type of protection available to the occupants. The several tables below describe the type of cab enclosure, roll-bar restraint availability, and use in these crash-involved utility vehicles.

Note that the majority of the open and canvas enclosed vehicles had some form of roll-bar protection. About 22 percent of the rigidly

TABLE 4.4.2-1

STRUCTURAL DETAILS AND VEHICLE MODIFICATIONS

	Arizona %	Colorado %	Michigan %	Total %
Roll-bar Equipped				
None	9	30	17	21
Roll Cage	9		3	3
Roll Bar	50	26	47	38
Can't Tell	23	13	17	16
Unknown	9	30	17	21
Total Number	22	46	36	104
Roll-bar Source				
Original Equipment	80	78	93	85
After market	20	22	7	15
Total number	10	9	14	33
Cab-type				
Open	23	2	14	11
Canvas	14	17	25	19
Rigid	64	76	50	64
Unknown		5	11	6
Total number	22	46	36	104
Rigid Cab Material				
Fiberglass	41	40	18	39
Steel	4	60	76	55
Can't tell	5	0	6	6
Total number	14	25	17	56

TABLE 4.4.2-2

MODIFICATIONS OF SUSPENSIONS

Suspension	Arizona %	Colorado %	Michigan %	Total %
Original	73	70	81	74
Modified	14	0	3	5
Can't tell and unknown	14	28	17	21
Total Number	22	46	36	104

TABLE 4.4.2-3

MODIFICATIONS OF TIRES

	Arizona %	Colorado %	Michigan %	Total %
Original equipment	36	70	61	60
Optional	50	7	19	20
Unknown	14	24	19	20
Total number	22	46	36	104

enclosed vehicles had no auxiliary rollover protection and thus relied on the rigid structure for protection.

Eight of the 22 fiberglass enclosed cabs and 13 of the 31 steel enclosed cabs were not equipped with roll-bars.

Lap-belts plus shoulder belt and harness variety were rare. Only three of the utility vehicles had lap and shoulder restraints and no vehicle had a harness-type restraint.

TABLE 4.4.2-4

MODIFICATIONS OF TIRES: TRACK AND DIAMETER

	Arizona %	Colorado %	Michigan %	Total %
Wide Track	73	100	100	86
Over diameter	0	0	0	0
Both	27	0	0	14
Total number	22	46	36	104

TABLE 4.4.2-5

TREAD TYPES AND CONDITIONS

	Arizona %	Colorado %	Michigan %	Total %
Tread Type				
Regular	55	70	58	63
Special	36	7	22	18
Unknown	9	24	17	18
Total number	22	46	36	104
Tread Condition				
New	9	2	11	7
Good	50	46	61	52
Fair	27	20	14	19
Bald	5	4		3
Unknown	9	28	14	19
Total number	22	46	36	104

TABLE 4.4.2-6

GENERAL MODIFICATIONS: INTERIOR AND EXTERIOR

	Arizona %	Colorado %	Michigan %	Total %
Exterior				
No change	73	57	61	62
Snow plow			6	2
Other	14		6	5
Bumper Modification	5	11	11	10
Unknown	9	33	17	22
Total number	22	46	36	104
Interior				
No Change	36	41	44	41
Other		2		1
Unknown	64	57	56	58
Total number	22	46	36	104

Table 4.4.2-8 shows the distribution of lap-type restraints by vehicle cab type and the portion of each vehicle cab type not equipped with restraints in those vehicles where restraint type could be determined.

For those vehicles equipped with a restraint system the question of use becomes important. This table shows the use of restraints by type of cab enclosure.

Data on ejection by type of cab are shown in Table 4.4.2-9.

These data also show that in two crashes there was partial ejection from the rigid cab vehicles and one instance of partial ejection from a canvas cab vehicle.

TABLE 4.4.2-7

ROLL-BAR BY CAB TYPE

	Cab Type			
	Open N	Canvas N	Rigid N	Unknown N
None	0	1	21	0
Cage	3	0	0	0
Bar	7	18	15	0
Unknown or unable to determine	1	1	31	6
Total number	11	20	67	6

TABLE 4.4.2-8

RESTRAINTS BY CAB TYPE

	Cab Enclosure Type			
Restraint	Open N	Canvas N	Rigid N	Total N
Not equipped	5	2	11	18
Lap	5	10	32	47
Lap and Shoulder	0	1	2	3
Total number	10	13	45	68

Ejection from open and canvas enclosed vehicles occurred in three-fourths of the fatal accidents, but in only two-fifths of the rigid cab vehicles. It appears that only the rigid cab provides a substantial protection from ejection.

TABLE 4.4.2-9

EJECTION BY CAB TYPE

Ejection	Type of Cab Open %	Canvas %	Rigid %
Yes	73	74	40
No	27	26	60
Total number	11	19	36

Restraint usage does prevent ejection. In eight accidents, restraint use almost totally eliminated ejection, as is shown in Table 4.4.2-10.

TABLE 4.4.2-10

EJECTION AS A FUNCTION OF RESTRAINT USAGE

Ejection	Restraint Usage Used %	Not Used %
Yes	12	67
No	88	30
Partial	0	3
Total number	8	60

In eleven of the total number of crashes, the utility vehicle was the injury source. In these circumstances, the vehicle came to rest on the individual, inflicting fatal injuries. In eight of these eleven cases, the occupant was ejected from the vehicle, and the vehicle subsequently rolled on top of the occupant.

Thus, occupants in rigidly enclosed vehicles (steel preferred) with rollover protection and adequate restraint are much less likely to incur serious or fatal injury.

Unrestrained occupants of open-door, flimsily enclosed utility vehicles are most likely to be ejected and possibly crushed by the vehicle. Restrained occupants in open vehicles, while somewhat better off, are likely to contact the roll-bar or other vehicle parts.

4.4.3 Collision Performance and Injury Report

Of all of the data files examined during this project, only one -- the CPIR file -- coded occupant injury and object contacted, thus allowing the researcher to ascertain the injury mechanism and seriousness of the resultant injury. All other data files coded only overall injury -- and often inaccurately.

Upon examination of the CPIR file, it was determined that only 93 utility vehicles were coded out of a total of 7,799 total vehicles (mostly passenger cars) and that only one of those utility vehicles was of the open body type. Secondly, the file coded injury and severity related to occupant contact in such great detail that it was impossible to ascertain general injury and severity patterns. This diversity, coupled with the lack of coding of vehicle type and problems with the injury coding, led to the abandonment of efforts relating to injury production. Therefore, no injury/occupant contact data are presented from the CPIR.

4.5 Vehicle Stability

The potential for utility vehicles to be involved in overturn (rollover)[13] collisions has been alluded to in previous sections of this report. In the following section, rates of rollover in utility vehicle crashes are compared to those exhibited by passenger cars. The next

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[13]The terms rollover and overturn are used interchangeably. In a pure technical sense, overturn is the general term for a vehicle maneuver in which the vehicle upsets during or as a result of a crash. The term rollover describes the side-to-side overturn whereas the term pitch-over describes the end-to-end overturn.

section considers vehicle rollover according to type of crash. The final section considers those physical factors that are important in determining the potential for vehicle rollover.

4.5.1 Rollover

A specific study of rollover accidents was made in the states of Maryland, Michigan, North Carolina, Texas, and Washington. The percentage of crashes involving a rollover of a utility vehicle was compared to the percentage for passenger cars in each of these states. Table 4.5.1-1 shows these percentages and gives the number of crashes upon which it is based.

TABLE 4.5.1-1

CRASHES INVOLVING ROLLOVER:
UTILITY VEHICLES AND PASSENGER CARS*

	Michigan	Washington	Texas	Maryland	North Carolina
Rollovers					
	%	%	%	%	%
Utility vehicles	12.7	10.1	5.6	9.7	11.7
Passenger cars	1.1	1.6	0.7	1.0	2.2
Number of Crashes					
Utility vehicles	6,599	1,456	302	1,336	3,691
Passenger cars	23,700 (1)	153,331 (2)	62,536 (3)	497,234 (4)	595,944 (5)

*Rollover coded as first harmful event.
(1)Michigan: Utility vehicles, all 1976 and 1977; Passenger cars 5%, 1976
(2)Washington: Census of all 1976 crashes
(3)Texas: 5% of all crashes, 1976 and 1977
(4)Maryland: All crashes, 1975-1977
(5)North Carolina, 1975-1978

In Table 4.5.1-1, the ratio of utility vehicle to passenger car rollovers ranges from a low of 5.3 to 1 (North Carolina) to a high of 11.5 to 1 (Michigan).

Although data for passenger cars are not available, rollover was involved in 19 percent of the 443 utility vehicle crashes in New Mexico (1977 and 1978).

Obviously, not all types of vehicles have the same overturn rate. Michigan data for 1976 indicate the amount of the difference between different types of vehicles (Table 4.5.1-2).

TABLE 4.5.1-2

PERCENT OF CRASHES
INVOLVING ROLLOVER BY VEHICLE TYPE:
MICHIGAN, 1976

Vehicle Type	Percent Overturn Accidents %
All Passenger Cars	1.1
Full Size	0.6
Intermediate	1.4
Compact	2.3
Sports car	3.5
Pick-up or Panel Truck	2.9
Straight Truck	3.1
Utility Vehicle	12.7
All Vehicles	1.7

A partial explanation of why different types of vehicles experience different rates of rollover is provided in Section 4.5.3 -- Physical Factors.

Rollover is experienced in almost 30 percent of fatal crashes involving utility vehicles, as is shown in Table 4.5.1-3.

TABLE 4.5.1-3

PERCENT OF FATAL CRASHES
INVOLVING ROLLOVER:
ALL STATES,1977 FARS

Vehicle	Urban %	Rural %	Total %
	Rollovers		
Utility Vehicles	11	36	29
Passenger Cars	2	9	6
	Number of Crashes		
Utility Vehicles	134	348	486
Passenger Cars	15,495	19,749	35,304

A substantially higher proportion of utility vehicles and passenger cars overturn in rural areas than in urban areas.[14]

The chances of overturning in a crash vary according to the make of utility vehicle, as is shown in Table 4.5.1-4.

The first three makes in this group are smaller vehicles than the last three. It should be noted here that the 1978 Ford Bronco is larger than the models included in these data. A subsequent analysis (including the larger Bronco) should show the new Bronco performing more like the Blazer size vehicles.

[14] A new approach to coding rollovers was used in the 1978 FARS. Rollover, in the 1978 FARS, is coded regardless of when the event occurs during a crash. In 1977, rollover was coded only if associated with the first harmful event. Using an interim version (#86) of the 1978 FARS, 181 of 773 (23%) of the on/off road vehicles were coded as overturning in the first event. And, an additional 22 percent of the 773 vehicles overturned subsequent to the first harmful event. Thus, 45 percent of the on/off road vehicles were coded as overturning at some point during the crash. It remains to be seen if many states will adopt the 1978 FARS codes for rollover.

TABLE 4.5.1-4

PERCENT OF CRASHES INVOLVING ROLLOVER
BY UTILITY VEHICLE MAKE

Utility Vehicle Make	Percent Overturn	
	Michigan	Washington
Bronco	18	15
Jeep	16	14
Scout	11	7
Jimmy	6	not reported
Blazer	5	5
Ramcharger, Trail Duster	3	not reported

4.5.2 Rollover and Crash Type

Rollover as a first harmful event is substantially more prevalent in single-vehicle crashes than in other types of crashes. Table 4.5.2-1 shows the findings regarding rollover for single-vehicle crashes.

Thus, rollover rates for all crashes are substantially lower than the rates shown for single-vehicle crashes. This implies that rollover is coded infrequently in multiple-vehicle crashes. Data from selected states provide confirmation, as is shown in Table 4.5.2-2.

The difference between passenger cars and most makes of utility vehicles in terms of the probability of total ejection of the driver is substantial. Little difference in seat belt usage between drivers of utility vehicles and drivers of passenger cars is noted. Seventeen percent of the drivers of utility vehicles wore a seat belt at the time of the crash compared with 16 percent among the drivers of passenger cars.

In summary, compared to passenger cars, the frequency of vehicle rollover is high in utility vehicles, especially in single-vehicle crashes and in rural areas.

TABLE 4.5.2-1

PERCENT OF VEHICLES THAT OVERTURNED IN SINGLE-VEHICLE CRASHES: SELECTED STATES

	Michigan %	Texas %	Washington %	Maryland %	North Carolina %
Rollovers					
Utility Vehicles	39	41	36	45	37
Passenger Cars	7	6	12	10	14
Number of Single-Vehicle Crashes					
Utility Vehicles	2162	27	395	252	1,040
Passenger Cars	4,281	4,077	18,785	42,157	88,085

TABLE 4.5.2-2

PERCENT OF VEHICLES THAT OVERTURNED IN MULTIPLE-VEHICLE CRASHES: SELECTED STATES

State	Utility Vehicles %	Passenger Cars %
Maryland	1.5	0.1
Michigan	0.1	0.0
North Carolina	1.8	0.2
Texas	0.0	0.0
Washington	0.2	0.0

4.5.3 Physical Factors

The preceding section showed that, in relation to passenger cars, utility vehicles exhibit a high propensity to overturn in crashes, especially single-vehicle crashes. Various aspects of the physical factors that are important in determining the potential for vehicle rollover have been investigated by the National Highway Transportation Safety Administration (Ervin, 1972; Rice, 1978), and in previous military utility vehicle (Jeep) studies (Cooke, 1968; Jurkat, 1969; Sharp, 1979; and Brune, 1979).

Measurements of physical parameters were made on several vehicles during the present study, using a laboratory facility called a "pitch-plane swing." Shown in Figure 4.5.3-1, this apparatus establishes a knife-edge pivot about which the restoring torque at differing pitch angles is measured to deduce the height of the overall vehicle's center-of-gravity (C.G.). The C.G. height can be examined as a ratio with the track width to determine a measure which is of general value in characterizing rollover potential.

As shown in Figure 4.5.3-2, a first-order estimate of a vehicle's rollover properties can be obtained by considering the body to be rigidly suspended. By this simplification, the vehicle will reach its overturning limit when a lateral acceleration level of $A_y = \frac{T}{2} \div h$ has been established. The parameters are shown schematically in Figure 4.5.3-3. In practice, the rigid suspension assumption yields an estimate of the overturning limit which is higher than the level of lateral acceleration needed to roll over actual vehicles. Suspension spring compliance, suspension geometry, and location of bump stops all serve to modify the actual overturning limit with respect to the 'Ay' value. Nevertheless, the rigid-suspension assumption yields a measure which discriminates the relative differences in rollover propensity among vehicles of differing C.G. height. Utility vehicles are often stiffly suspended and thus more nearly approximate this model.

Generally speaking, levels of 'Ay' up to 1.0 can be attained through tire cornering traction on dry pavements. Levels above 1.0 require other mechanisms such as sideslipping in soft soil or contact of the sideslipping tire with curbs or other rigid surface irregularities.

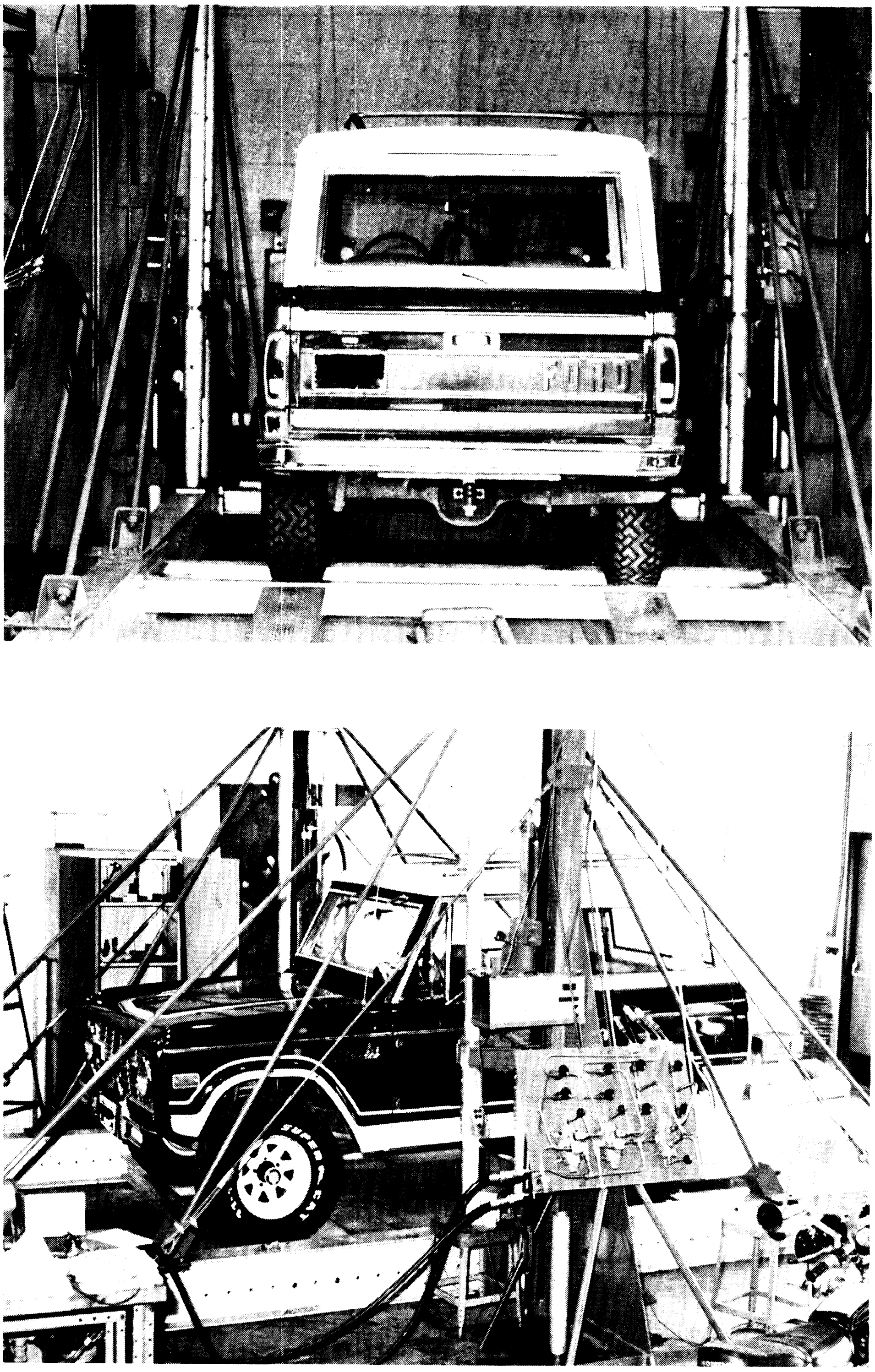


Figure 4.5.3-1 Example of Utility Vehicle on the Pitch Plane Swing

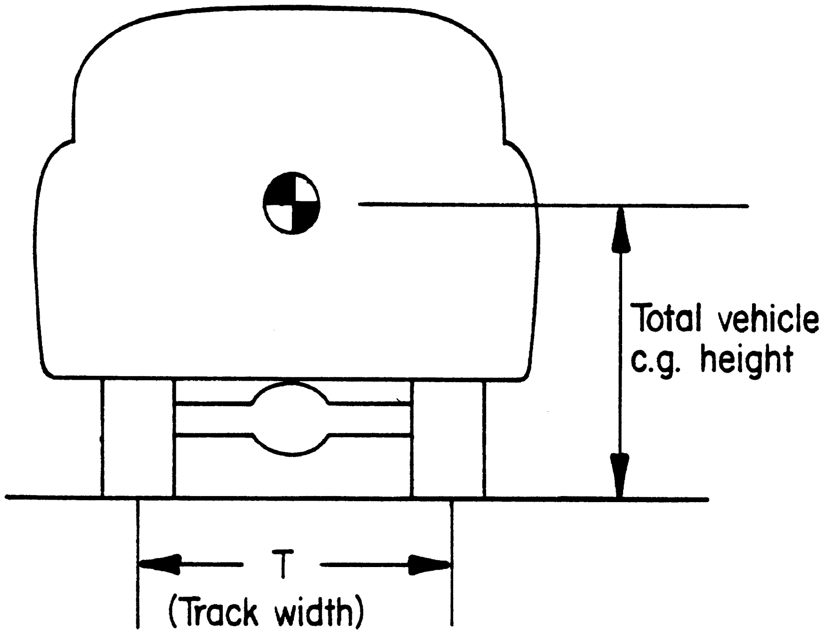


Figure 4.5.3-2 Vehicle Test Parameter Location

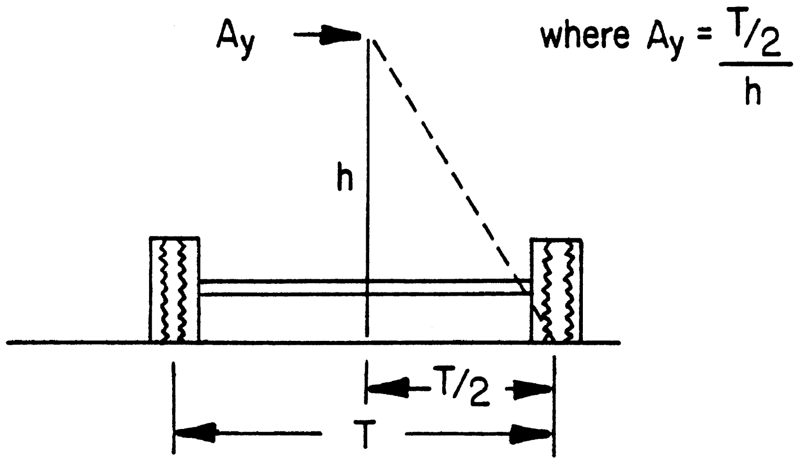
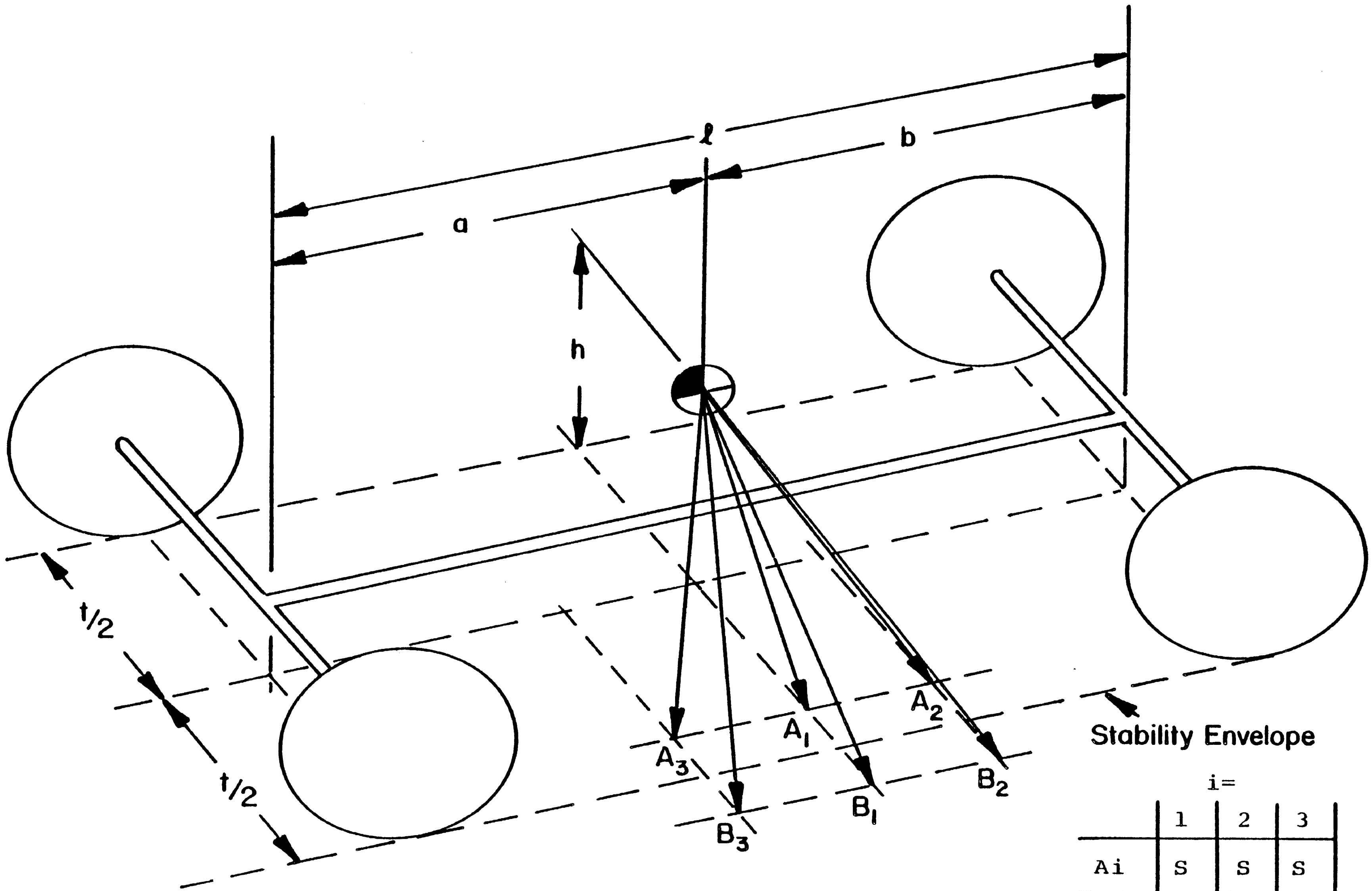


Figure 4.5.3-3 Schematic Diagram of Applicable Vehicle Parameters



i=	1	2	3
Ai	S	S	S
Bi	U	U	U

Stability Table
S: Roll Stable
U: Roll Unstable

Figure 4.5.3-4 Roll Stability of the Four-Wheeled Vehicle

Thus, heavily loaded commercial vehicles can easily be rolled over in single-vehicle crashes on the roadway since the related values of 'Ay' are in the range of .45 to .65. On the other hand, most typical passenger cars, exhibiting values of 'Ay' in the range 1.3 to 1.7, cannot be rolled over on the roadway without some precipitating first impact (or tire blowout).

Utility vehicles fall in an intermediate class, as evidenced by the measures of 'Ay' obtained for five example vehicles.

Five vehicles were selected to represent the range of utility vehicles normally found on the road.

The five vehicles were:

1) A 1975 Chevrolet Blazer with a fiberglass top. This vehicle was equipped with standard factory equipment.

2) A new 1979 JEEP CJ-5 with a canvas top and roll-bar. This was a new vehicle with factory installed extra duty suspension and optional tires (one inch larger diameter).

3) A new 1979 JEEP CJ-7 with a canvas top and roll-bar. This was a new vehicle with no optional equipment.

4) A 1973 Ford Bronco Ranger with a steel top. This vehicle had no modifications to its suspension or tires.

5) A highly modified 1968 Ford Bronco. This vehicle was equipped with a modified suspension and oversize tires. It is considered typical of the "Arizona-California-Desert" type of modification.

The results of the physical measurements of the value 'Ay' for these five vehicles are given in Table 4.5.3-1. Also listed are several passenger vehicles for comparison purposes.

Since values of 'Ay' for the utility vehicles fall in the range 1.01 to 1.21, rollover may become possible as an on-road (tire traction force-induced) phenomenon. Also, of course, rollover due to off-road irregularities and side slope is a more probable occurrence according to

Table 4.5.3-1

SUMMARY OF PHYSICAL MEASUREMENTS AND HEIGHT OF THE CENTER-OF-GRAVITY

Vehicle	Wheel Base	Track**	Stability Envelope*	Center-of-Gravity from ground	Lateral Acceleration Required to Roll (Ay) in G's
Test					
1975 Blazer	106.5 in.	65.75 in.	7002 sq.in.	27.14 in.	1.21
1979 CJ5	83.5	53.25	4446	26.45	1.01
1979 CJ7	93.5	53.25	4979	24.80	1.07
1973 Bronco	92.0	60.00	5520	27.19	1.10
1968 Mod. Bronco	92.0	61.00	5612	28.62	1.07
Comparison					
1971 Pontiac Trans Am	108.5	61.05	6624	18.79	1.62
1971 V.W. Bug	96	52.45	5035	19.38	1.35
1969 Mustang	108	58.5	6318	19.80	1.48
1974 Pinto	94.2	55.0	5181	20.60	1.33
1974 Ford Full Size	121	64.3	7780	20.50	1.57
AMC Pacer	104	60.6	6302	21.38	1.41
Chevrolet Nova	111	60.15	6676	19.03	1.58
1980 AMC Eagle	109	59.0	6431	22.6	1.31
1980 AMC Concord	109	59.0	6431	21.1	1.40

**Where the front and rear tracks differ, value given is the average.

*Stability envelope (track x wheel base) values are approximate.

the scale of the 'Ay' value in contrast to other passenger vehicles. The five utility vehicles, in order of increasing stability, are shown in Table 4.5.3-2.

TABLE 4.5.3-2

TESTED UTILITY VEHICLES ARRANGED IN
ORDER OF INCREASING RESISTANCE TO ROLLOVER

Test Vehicle	Value of Ay
1979 JEEP CJ-5	1.01
1979 AMC AMC JEEP CJ-7	1.07
1968 Modified Ford Bronco	1.07
1973 Ford Bronco	1.10
1975 Chevrolet Blazer	1.21

As can be seen from Tables 4.5.3-1 and 4.5.3-2 the vehicles with the larger stability envelope (track x wheelbase) have a greater resistance to rollover than those with a smaller stability envelope.

Correspondingly, a lower C.G. height increases the roll stability for vehicles with the same stability envelope size.

To enhance the roll stability of a utility vehicle, either the track must be made wider or the C.G. lowered, or both. (Merely placing wider tires on the vehicle does not necessarily increase the roll stability.) Any attempt at gaining more ground clearance or riding height of the vehicle is done so at a sacrifice in roll stability.

The effect of placing over-diameter tires on a small utility vehicle, for example, would be to decrease the roll resistance to a point where tire forces alone could cause it to overturn if given sufficient lateral acceleration. The lateral acceleration could result from the vehicle going into a skid and rotating such that the side of the vehicle is presented to the line of travel (not an uncommon situation). In such a case, any pavement irregularity or change in the road surface coefficient of friction could become the tripping agent, inducing vehicle roll.

It should be noted that in 1977 the Ford Bronco changed in dimension (stability envelope) such that it now approximates the Chevrolet Blazer in size and should be inherently more stable than its predecessor.

The major conclusion from this analysis is that the utility vehicles with small stability envelopes (JEEP, Land Cruiser, pre-1978 Bronco) are more likely to roll over than vehicles with larger stability envelopes (Blazer, post-1977 Bronco, Ramcharger)given similar C.G. heights. (The Scout II has a stability envelope that would be classified as medium in size.) The small utility vehicles may be overturned by only the side forces generated by the tires in unusual maneuvers whereas the larger utility vehicles generally require some tripping force or obstacle (such as a curb, etc.) before overturning.

4.6 Injury Mechanisms

This section presents data on driver and occupant ejection in crash-involved utility vehicles and passenger cars. A discussion of the relationship between vehicle design and injury is also presented in this section.

4.6.1 Occupant Ejection

Occupant ejection more often occurs in utility vehicle crashes than in passenger car crashes. Table 4.6.1-1 shows that 15 percent of utility vehicle occupants were ejected in single-vehicle crashes between 1975 and 1977 in Maryland. The corresponding figure for passenger cars in one percent.

Table 4.6.1-1 also shows that occupant ejection is much more common in single-vehicle crashes than in multiple-vehicle crashes.

Total driver ejection reported in Washington is much more likely in a Jeep than in most other models of utility vehicles or passenger cars. These data are shown in Table 4.6.1-2.

The difference between passenger cars and most makes of utility vehicles in terms of the probability of total ejection of the driver is substantial. Little difference in seat belt usage is noticed between

TABLE 4.6.1-1

PERCENT OF OCCUPANTS
EJECTED ACCORDING TO THE
TYPE OF CRASH
MARYLAND, 1975-1977

	Single-Vehicle Crashes		Multiple-Vehicle Crashes	
	Utility Vehicles %	Passenger Cars %	Utility Vehicles %	Passenger Cars %
Ejected	15	1	0.9	0.2
Not Ejected	85	99	99.1	99.8
Total	100%	100%	100%	100%
Number of Occupants	416	64,125	1,496	6,559

TABLE 4.6.1-2

PERCENT OF TOTAL CRASHES IN WHICH
TOTAL DRIVER EJECTION
FROM THE VEHICLE WAS REPORTED:
WASHINGTON, 1976

Make	Total Ejection %
Blazer	1
Bronco	2
Jeep	10
Scout	2
Land Cruiser	4
Passenger car	1

drivers of utility vehicles and passenger cars. Seventeen percent of the drivers of utility vehicles wore a seat belt at the time of the crash, compared with 16 percent among the drivers of passenger cars.

4.6.2 Occupant Protection

While definitive data on vehicle design as it relates to occupant protection is not usually a component of the data files, a few general comments on vehicle design and ejection will serve to introduce the reader to certain inherent design characteristics which promote occupant ejection and hence a greater risk of injury or death.

Ejection occurs when a port (opening) is presented in the trajectory of the occupant during the crash. Any opening in the vehicle through which an occupant exits during the crash is referred to as an ejection port.

This ejection port can be a window (without the glass), an open door, or in the case of an open utility vehicle, that portion of the vehicle not covered by anything.

Total ejection frequently occurs during a rollover as the occupant is flung out of the vehicle. The distance travelled while airborne is a function of the occupant's exit velocity.

It is not uncommon for the occupant to land in the path of the overturning vehicle and be contacted by some portion of it. The accident discussed in Section 5.8.3 is an excellent example of occupant ejection through the top of the vehicle with subsequent vehicle contact. In this case, had a top of substantial material been present the occupant would not have been ejected, and not fatally injured by this mechanism. The use of a full restraint system would have kept the occupant in position and hence prevented total ejection.

Seat belt restraint systems, and even some types of single-belt upper-torso systems, do not prevent occupant flailing, partial ejection or injuries to the unrestrained extremities. Injuries to upper extremities have been described in two articles (see Section 5.8.3). The first describes injuries to the hand as a result of the occupant using the roll-bar as a grip during vehicle overturn. The second describes injuries due to entrapment of the hand and forearm between the side of the vehicle and the ground during overturn. Both types of injuries occurred in vehicles which were open at the time of the crash.

The size of the ejection port has a direct bearing on the potential ejection, as the smaller the port the lower the possibility of ejection. Suffice it to say that particularly with open type vehicles, ejection is an frequently observed and real problem often resulting in death.

4.7 Post-Crash Fires

The incidence of crash related fire in utility vehicle accidents has been reported.

Military and civilian utility vehicle post-crash fire experience appears similar. Of 1,102 military M-151 crashes during the three-year period FY1974 - FY1976, not one post-crash fire was reported.

In the clinical case review, in which accident reports were scanned for data not included in the accident data files, the incidence of fire was virtually non existent. In the Arizona clinical data, only one of the 27 fatal crashes reviewed resulted in post-crash fire.

Fire as a result of a crash occurred in three of the 63 cases reported to the ATLA (See section 2.4 -- Product Liability Review). In one case the fuel tank exploded in the collision. In another the fuel cap and filler neck came in contact with the ground in a rollover. In the third the driver was soaked with gasoline subsequent to rollover and fatally burned.

Thus it can be concluded that crash related fire in utility vehicles is not a major problem.

5. DISCUSSION OF FINDINGS

The order of presentation in this chapter follows closely that used in Chapter 4. A few results not shown in the previous chapter are included here relative to the interpretation of the basic findings.

5.1 Mass Accident Data

Nationally, utility vehicle registrations amounted to about one percent of passenger car registrations in 1977. The prominence of utility vehicles is much greater than that for fatal crashes, however. Possible reasons why the death rate is higher in utility vehicles compared to passenger cars will be provided in subsequent parts of this chapter.

The data from selected states indicate that utility vehicles are involved in fewer crashes than would be expected, given the number of registrations. What is needed for an adequate interpretation of this finding is information regarding exposure to risk. It is possible, for example, that utility vehicles are driven, on the average, fewer miles than are passenger cars. Data on the number of miles driven per year in areas differing in population density could be used, but these data are not currently available.

5.2 Death and Injury Rates

The two major findings regarding death rates are (1) traffic death rates in rural crashes are considerably higher than are those for urban crashes, and (2) regardless of whether the area is rural or urban, traffic death rates (total deaths per 1,000 crashes) are higher in utility vehicles than in passenger cars.

Related to the differences in death rates between rural and urban crashes is the fact that death rates are higher in single-vehicle crashes than in other types of crashes. A substantial proportion of single-vehicle crashes occur in rural areas, and utility vehicles are about twice as likely as passenger cars to be involved in a single-vehicle crash.

Seat belt usage is not a likely explanation of differences in death or injury rates between utility vehicles and passenger cars. In Washington, for example, seventeen percent of utility vehicle drivers were wearing a lap belt at the time of the crash, compared to 16 percent of passenger car drivers.

The findings regarding rates of serious (disabling) injury parallel those observed for total traffic death rates. The number of disabling injuries per 1,000 crashes is highest in rural areas. Overall, serious injury rates in utility vehicles are more than twice as high as those in passenger cars.

Rates of serious injury vary according to the make of utility vehicle. JEEPS exhibit by far the highest rate of disabling injury among the utility vehicles considered in the analysis.

One of the key questions regarding utility vehicle crashes is the extent to which the problem is distributed among an unsafe operating environment, vehicle, or driver. One reason why death and disabling injury rates are higher for utility vehicles than for passenger cars is that the relative frequency of utility vehicle accidents in rural areas is so much higher than the corresponding frequency for passenger cars. That fact by itself accounts for a substantial proportion of the difference in death rates between utility vehicles and passenger cars. The standardized traffic death rate[15] for utility vehicles in Michigan is 3.8, compared with a crude rate of 4.7. Thus, 36 percent of the difference in overall death rates between utility vehicles and passenger cars can be attributed to the distribution of crashes between urban and rural areas.

The physical characteristics of utility vehicles are such that vehicle rollover is more likely in these vehicles than in passenger cars. Physical characteristics and vehicle rollover are discussed in Section 5.5.

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[15]If utility vehicle crashes were distributed between urban and rural areas in the same proportions as passenger car crashes.

5.3 Characteristics of Drivers and Crash Locations

The drivers of utility vehicles involved in a crash are younger and more often male than is true of their counterparts in passenger car crashes. These findings are consistent with the "macho" image often associated with utility vehicles (Time, December 18, 1978). Although the result regarding age does not permit generalization from drivers in crashes to all drivers, it does point to the possibility that drivers (particularly young ones) of utility vehicles are not as experienced in driving as are the drivers of passenger cars.

The role of temporal factors appears minor in accounting for differences between utility vehicles and passenger cars regarding the frequency of crashes. Some clustering of utility vehicle crashes in the winter months has been observed, but that relationship was shown to be very weak in the multivariate analyses (See Section 4.3.4 and Appendix D.

Without doubt, one of the most consistent findings in this study is the relationship between population density and the frequency of utility vehicle crashes. Compared with crashes involving passenger cars, utility vehicle crashes are much more likely to occur in rural areas. Similar results were also observed for all fatal crashes.

Two questions should be considered. Are utility vehicles more popular, proportionately, than regular passenger cars in the rural areas? Are the number of miles driven in a utility vehicle on rural roads much greater than is the case among passenger cars? Unfortunately, no statistics regarding the number of miles driven in rural areas are available. Polk registration data by county for Michigan suggest that in 1977 utility vehicles were somewhat more popular in rural than urban areas.[16] Thus, it would seem logical to assume that exposure to risk (the probability of crash-involvement) for utility vehicles is higher in rural areas. Regardless, the locational pattern of utility vehicle crashes is not fully explained on the basis

[16]The Southern Lower Peninsula, containing highly urbanized areas, is where 91 percent of the passenger cars are registered in the state. The corresponding figure for utility vehicles is 79 percent.

of county of registration. Also, when urban and rural areas are treated separately, important differences in crash experience remain between utility vehicles and other vehicles.

Although there are small differences between Michigan and Washington regarding the importance of the different road characteristics, the two major findings are the same for each state. Utility vehicles are more likely to be involved in a crash on curves or snowy or icy roads than is true of other vehicles, especially in rural areas. Most of the environmental conditions investigated in this study are correlated with population density. Curvy roads, ice covered roads, and darkness without street lights are much more characteristic of rural than urban areas. Those situations, combined with relatively high average travel speeds, suggest a problem greater for utility vehicles than passenger cars.

The findings exhibited in fatal crashes throughout the country parallel those just described for the two states. Vertical grades and two-lane roads are more prevalent in rural than urban areas. These road characteristics are also associated with a high incidence of utility vehicle crashes in comparison with the figure for passenger car crashes.

The probability of utility vehicle crashes varies inversely with population density. Within rural areas certain road characteristics and average travel speeds combine to produce more troublesome effects for utility vehicles than passenger cars. Two lanes, curves, grades, and snow or ice on the surface more often characterize crash sites for utility vehicles than passenger cars, especially in rural areas.

It is unknown to what extent the ratio of passenger car travel to utility vehicle travel changes when ice or snow is on the road.

The relatively young, largely male, drivers of utility vehicles appear not to be sufficiently aware of the risks of driving in the rural environment.

5.4 Clinical Case Review

Accident reports and photographs for individual crashes involving utility vehicles were obtained from several states. Most of the analyses of these data cover the crashes in which one or more persons were killed in a utility vehicle.

The data from Arizona and New Mexico indicate that a substantial proportion of the fatal utility vehicle crashes involved rollovers. In a majority of the rollovers, one or more occupants were ejected from the vehicle. Without the use of an adequate restraint system, roll-bars do not appear to offer sufficient protection for vehicle occupants. Rigid cabs do reduce the likelihood of ejection, but the use of adequate restraint (lap and shoulder) prevents ejection. It should be noted that a lap-belt alone does not appear to be sufficient, as occupant flailing has been observed among those wearing lap-belts but not shoulder harnesses.

5.5 Vehicle Stability

Depending on the make, utility vehicles overturn from about three to around 16 times as often as passenger cars. Of the utility vehicles, the larger utility vehicles (Blazer, Jimmy, Trail Duster, Ramcharger) are the least likely to overturn during a crash. The smaller utility vehicles (Jeep, JEEP, Land Cruiser, and pre-1978 Bronco) are substantially more likely to overturn during a crash than are the larger utility vehicles.

The lateral acceleration required for rollover is lower for utility vehicles than for passenger cars (which explains why the incidence of rollover is higher in utility vehicles than passenger cars). The high center of gravity, characteristic of utility vehicles, is the principal measurement that partly explains utility vehicles' lower resistance to rollover than passenger cars. Given the same height of center of gravity, the wider the track the greater is the resistance to rollover. (The basis for an "index of rollover propensity" has been established recently by Brune,1979.)

These factors combine to place the small utility vehicle at a comparative disadvantage with regard to roll stability. If large diameter tires are used on this vehicle, rollover could occur as a result of tire cornering traction on dry pavement.

It should be noted that when four-wheel-drive utility vehicles are used to tow trailers (or to tow other vehicles) the control and stability problems are often magnified. Several of the national rental organizations have found this reflected in their safety statistics. One organization has analyzed nearly 5,000 accidents involving vehicles towing trailers Of these accidents slightly more than 100 involved utility vehicles. Bodily injury claims were made in almost one-half of the accidents involving utility vehicles. For crashes involving all vehicles towing trailers, only about 20 percent involved a bodily injury claim.

These data also showed that when a utility vehicle is towing a trailer, the incidence of rollover is markedly higher than with passenger vehicles. The smaller utility vehicles in particular show an elevated rollover rate.

5.6 Injury Mechanisms

Data described in Section 4.6, Injury Mechanisms, focused primarily on occupant ejection and subsequent injury and death. The major reason for this emphasis is that little data is available which links occupant injury to specific vehicle and/or crash configurations which cause injury.

The following section discusses roll-over and ejection as injury-producing mechanisms. Following this are a few general comments on injury production.

5.6.1 Rollover and Ejection

The problem is not that rollover is much less serious for occupants of passenger cars than it is for occupants of utility vehicles, but that utility vehicles overturn substantially more often than passenger cars.

In Michigan, one percent of the rollovers in both passenger cars and utility vehicles were recorded as fatal crashes.

As was seen in the review of fatal crashes in Arizona and New Mexico, and clinical study of Colorado and New York fatal crashes, rollover of utility vehicles is often accompanied by the ejection of one or more occupants from the vehicle.

The data indicate that total driver ejection occurs more often in Jeeps than in other utility vehicles. This result is consistent with the findings on type of cab that show ejection is more prevalent with open or canvas tops than with rigid tops.

As was pointed out in Section 4.6 the presence of an ejection port during rollover greatly increases the chance of ejection -- complete ejection in the case of a unrestrained occupant and partial in the case of a lap-belted occupant.

Those vehicles without substantial side structure protection at the time of the crash present to the unrestrained occupant a significant opportunity for ejection.

While it would be undesirable to require all vehicles to be equipped with an effective side/roof structure (so as to prevent ejection), those vehicles of an "open design" should be equipped with a fully protective restraint system which, if properly worn, would prevent ejection during overturn.

5.6.2 Vehicle Design

Utility vehicle occupants are subject to the same general kinematics during a crash as are passenger car occupants. Differences in patterns of injury and severity, however, may be due to differences found in passenger compartment contact structures and surfaces. Therefore, injury attenuating methods as have been employed in passenger cars should be available to utility vehicle occupants. Some have already been utilized, but the balance should be applied wherever appropriate.

The exception comes in the open vehicle where roof and side protection methods are not identical to passenger car methods. However, most open vehicles are "closed" at one time or another (canvas tops, for example) and when closed should they not offer the same level of protection to the occupants of this vehicle as is available to occupants of any other closed vehicle?

One author witnessed an accident where a JEEP Dispatcher vehicle had skidded and overturned on an icy portion of the road. The dispatcher model (DJ-6) is essentially the same as an open body JEEP except it has a post-office style steel cab enclosure. The jeep hit an icy patch of road, skidded, overturned on its right side and slid for approximately 100 feet. The two female occupants were unharmed. Had the vehicle been without its top, it is likely that serious injury would have occurred from occupant contact with the ground.

In open vehicles equipped with a roll-bar or rollcage, serious injury and even death have resulted from ejection and subsequent contact with the roll-bar as has been previously shown. (See section 5.8.3 for an example case). Proper restraint would have prevented ejection.

Roll-bar and rollcage collapse has also been observed. There are no performance standards for roll protection devices. Hence, a device supposedly engineered to protect the occupant space has collapsed, severely compromising the available occupant space.

It seems to logically follow that even if the incidence of crash involvement were the same for utility vehicles and passenger cars, the occupants of utility vehicles are less well protected and hence in a position to receive more serious injuries.

All open vehicles (including those with flimsy enclosures) should be required to be equipped with upper torso restraints to prevent occupant ejection and flailing. Also warnings should be prominent on these vehicles warning of the dangers of unrestrained occupancy and of extremity flailing during an accident.

5.7 Post-crash Fires

Post-crash fires as reported in the data are not a problem as their occurrence in utility vehicle crashes is rare.

5.8 General Discussion

5.8.1 Multipurpose (Utility) Vehicles: A Compromise?

Multipurpose (utility) vehicles are designed for more than one purpose. They are capable of operation in both on- and off-road environments.

Such a design has both advantages and disadvantages. The advantages are that the vehicle can be driven off-road in environments where a normal passenger car or truck could not be operated. To operate off-road, the vehicle usually needs a high ground clearance, narrow overall width, and short turning radius so as to be maximally maneuverable under a very wide ranging set of conditions. All wheel drive and special tires enhance the vehicle's capability to travel anywhere.

Such a design also has disadvantages. While possessing the off-road capability, utility vehicles are also driven on-road, where certain of the off-road design features may be a liability. The short wheel base and narrow track give the vehicle quick response at both low and high speeds. At the higher speed, the quick response capability is neither needed nor safe. The high ground clearance coupled with the narrow track width produce a vehicle more easily overturned. In rough terrain, speeds are, of necessity, low, resulting in a slow rate of dynamic response of the vehicle. At higher speeds, such responses become more rapid and may indeed outstrip the capability of the driver to respond to the vehicle. A passenger vehicle, designed for on-road use, attempts to maximize the controllability of the vehicle at the expense of maneuverability. The response of the vehicle to dynamic inputs is slower and hence the driver has more time to react.

The utility vehicle thus represents a compromise between the on-road and off-road applications. As a compromise, handling and maneuverability factors must be balanced between the intended use patterns of the vehicle.

The potential users of this vehicle need to be made aware of the compromises that exist in such a vehicle so that individual driving skills can match the capabilities and limitations of the vehicle.

It is misleading to depict utility vehicles as suitable for highway use unless they have the same handling and stability characteristics as other vehicles. Adequate warning and instructions are needed from the manufacturer (similar to the warning provided in the M151 operator's manual). Similarly, it is inappropriate to show the vehicle to be suitable for a variety of uses when certain of the uses compromise the safety of the operator. If the vehicle is truly "multi-purpose" then the purposes for which it is most suitable need to be conveyed to the consumer through advertising, etc., and those purposes for which its safety and capabilities are marginal or unsafe should not be emphasized.

Care must be taken so as not to instill in the consumer a false sense of security concerning the safety of utility vehicles.

5.8.2 Implications for Federal Safety Standards[17]

The findings discussed above make it rather clear that utility vehicles pose a significantly higher risk of rollover and of injury and fatalities in accident events than that posed by the more conventional motor car. The question immediately arises as to whether there are vehicle-directed countermeasures, in the form of safety standards, that can reduce these higher levels of risk without eliminating the utility vehicle as a transportation option available to the consumer. The findings suggest that these countermeasures (or standards) should seek to (1) reduce the probability of rollovers and (2) increase the level of occupant protection available in a crash or rollover event.

Given that the utility vehicle is, by definition, a vehicle which is suitable for operations off-road as well as on-road, it will, by virtue of its high ground clearance, tend to have a higher center of gravity than typical on-road passenger cars. To the degree that utility vehicles are designed with track widths that are roughly equivalent to

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[17]This section is authored by Leonard Segel, Head, Physical Factors, HSRI.

those used on passenger vehicles, the utility vehicle will almost always pose a higher risk of rollover. The question then arises as to whether the public should regard this increased risk as acceptable and whether it is feasible to develop a standard that would, in effect, put some upper bound on this risk.

First, it must be recognized that this question is not unique to the utility vehicle, since there are passenger cars, more notably the small subcompacts, that have less immunity to rollover than the typical passenger car. Further, the goods-carrying truck has a significantly greater potential for rollover than any motor car. This latter fact demonstrates that society invariably trades off certain risks versus the transportation services to be provided. In the case of the truck, the state laws limiting the maximum width of motor vehicles effectively constrain the designer from alternatives that would improve roll stability. The utility vehicle, on the other hand, is not so constrained. In theory, the utility vehicle could be designed with a wider track so as to increase its rollover immunity to levels approaching that exhibited by many passenger cars. If this is so, it is logical to consider whether safety standards can be developed so as to achieve this goal in practice.

Research conducted under NHTSA auspices (Ervin, et al., 1972; Rice, 1978) has demonstrated that the development of rollover performance standards based on an objective test procedure is fraught with difficulty. These difficulties could be offset, however, if one were willing to accept a standard that is written in other than performance terms. In this particular instance, a standard could speak to the maximum value of the c.g. height to track width ratio that a utility vehicle would be permitted to exhibit. Clearly, the selection of the value of this ratio (for incorporation into a safety standard) should be based on the recognition that the finite risk of rollover must be traded off against the transport function and utility provided to the consumer.

A second not unexpected finding of this study, namely, that fatalities and injuries are more likely to occur in crashes involving utility vehicles, suggests that consideration needs to be given to countermeasures which would reduce the trauma generated by these vehicles. Unfortunately, many utility vehicles have limited overhead structures to provide protection in the event of a rollover. Again, we come to the difficult question of whether standards can, or should, be developed which, if implemented, would alter the basic character and function of a specific category of vehicle.

Recognizing that there is a demand for the off-road capability of utility vehicles, consideration needs to be given to the alternatives for safety standards that acknowledge this demand but still provide a safety benefit to the public. Unfortunately, we are handicapped in such an endeavor in that the definitive research serving to define representative rollover scenarios remains to be performed. For example, we do not know enough to be able to state that a roll-bar of a given design and strength will have a specific probability of surviving the loads imposed by a representative spectrum of rollover trajectories. If we knew these facts, we would at least be able to develop "equipment standards," namely, manufacturers who offered roll-bars as an option on a given utility vehicle would have to certify that their device was capable of providing a specified level of protection in specified rollover scenarios. This would be a countermeasure that attempts to guarantee that consumers obtain a bona fide reduction in the risk of injury as a result of their having chosen to invest in a crash protection device, as proposed to a countermeasure that limits the spectrum of vehicles available for purchase.

5.8.3 Off-Road Use and Injury

While not the primary focus of this research, this report would be incomplete without some reference to the off-road use of utility vehicles. Being on-/off-road vehicles, they can be driven on the highway to an off-road place and then operated in the off-road environment.

Two Michigan accident reports relate both common off-road operation and accident involvement.

In one accident, occurring in January 1977, the driver stated that "they were driving along the ridge when they stopped and looked down the hill (while they were out of the vehicle). They got back into the vehicle and drove down the ridge aways and turned around and came back to that same spot and began to edge down the hill." The driver then stated that he "lost control, and didn't try to stop or turn.... The vehicle flipped once and he was thrown out. The vehicle continued on down the hill and the passenger was found next to the right front tire. Elevation of the hill was about 80 feet high." In this case the ejected driver received minor injuries, while his passenger was fatally injured. The attached photograph (figure 5.8.3-1) shows the crushed condition of the occupant space due to collapse of the roll cage. The cause of death was massive head injury probably caused by either contact with the ground or the roll cage. Restraints were not used and the driver had been drinking.

A second accident involving two vehicle occupants occurred in May, 1976. "Driver advised that he and two passengers were out riding in his jeep when he told one passenger to get out as there were only two seats and they would be going up and down some hills. Driver stated he started out and when he attempted to make a right turn just over a small hill the front left tire caught in the dirt and the jeep rolled over throwing both he and the right front female passenger out. He stated that the jeep turned over on its top, pinning the deceased beneath it. Driver was also pinned but was able to free himself. Seat-belts in the jeep were not used." In this case the vehicle overturned on a hill side during a turning maneuver. The occupant was ejected and the front right corner of the rollcage contacted her head, causing death. This case is shown in figure 5.8.3-2.

In both cases, what was installed as a safety device --namely the rollcage-- turned out to be the cause of death. A recent study of off-road vehicle accidents in the desert and mountain regions of Southern California indicated a significant incidence of associated trauma (Charters and Schroedl, 1978). During the four years 1972 through 1975, there was a mean annual incidence reported of 931 serious injuries and 15 fatalities related to off-road vehicle accidents. These were primarily on Bureau of Land Management land in a three-county area and included motorcycles and dune buggies, as well as four-wheel-drive vehicles. These authors found that 21 percent of the 64 drivers

Figure 5.8.3-1 Roll Cage Collapse During Vehicle Overturn

Figure 5.8.3-2 Occupant Death Caused by Contact with the Roll Bar

surveyed had had an accident resulting in injury and 75 percent of the 64 drivers admitted to drinking alcohol and driving. Distributions of injuries showed the head to be the most susceptible body area, with 34 percent (183 injuries) of the reported injuries, followed by the lower extremity, with 23 percent (122 injuries), and upper extremity, with 21 percent (114 injuries).

Recently, two studies published in the medical literature attribute injuries to the roll-bar itself. Dune buggy rollover accidents have led to the description of a new hand injury, "the roll-bar hand" (Charters and Davis, 1978). The mechanism is attributed to a reflex action (primarily using the dominant hand), usually of the passenger, to grasp the roll-bar during a rollover. This may result in a crush-avulsion injury at the level of the metacarpals, often requiring amputation. Eleven such injuries have been reported for "dune buggies," but no identification as to the models or cab configuration was given. Redesign of the roll bar, provision for better passenger protection and an internal grasp support were suggested by Charters and Davis to reduce the incidence of this type of injury.

A second mechanism of injury involving the roll-bar in eleven cases of off-road rollovers has been described by Harris and Wood (1978). As the rollover occurs the occupant may hang onto the roll-bar or the arm may be caught between the vehicle and the ground, resulting in upper arm injury. These authors recommend that a hand hold be constructed inside the vehicle.

The two accident cases and the journal articles described expose just the tip of what appears to be a major problem in the operation of on-/off-road vehicles in the off-road environment. It is postulated that these vehicles suffer from similar problems in the off-road area that have been found to exist in the on-road operation. Namely, vehicle stability and occupant protection are major problems, and operator judgement has played a role in the production of the crashes. Bear in mind also that in off-road operation the vehicle is on terrain which is not prepared for vehicular travel. Thus the operator is faced with the additional task of navigating over rough surfaces that usually exhibit none of the characteristics of a "road."

6. DISCUSSION OF TECHNICAL PROBLEMS

Several problems encountered during the course of this study had a direct impact on its viability and implementation.

A. Foremost was the matter of definition of a utility vehicle. What is a utility vehicle and how many models are included? Because most motor vehicle research has been devoted to passenger cars and trucks, these two categories are most easily defined. Utility vehicles are sometimes classified as light trucks, and sometimes classified as passenger cars.

The problem of definition is similar to the following analogous situation. In the past both passenger cars and pick-up trucks could easily be identified. To fulfill a market need (perceived or real) a combination vehicle was created--half passenger car, half pick-up truck, where a sedan-type cab and chassis were used along with a pick-up style box. Since the unit has characteristics of both types of vehicle, is it classified as a passenger vehicle or a light truck? Or should it be assigned to a yet different class, i.e.: multipurpose vehicle?

Congress has wrestled with this problem in the creation of the Clean Air Act and other automotive-related legislation. In addition, NHTSA seems to have settled on several definitions. A vehicle under 6,000 pounds GVW is either a passenger automobile or a non-passenger automobile as stated in 49CFR523 and 49CFR533 (reproduced in Appendix F). The term "multipurpose passenger vehicles" is defined in 49CFR571.1, Federal Motor Vehicle Safety Standards.

Depending upon the definition used in either of these two acts, the vehicle would be either classified as a non-passenger automobile or as a truck even though it is built on a passenger car chassis! A recently introduced model by AMC further typifies the problem of vehicle classification. The 1980 AMC Eagle is officially designated as a truck by the Environmental Protection Agency, presumably because it is a 4-wheel-drive vehicle. However, the manufacturer builds this vehicle by adding 4-wheel-drive components to the AMC Concord (a passenger vehicle). Yet it is considered a multi-purpose passenger vehicle for purposes of FMVSS requirements by NHTSA. The Eagle and Concord are identical in all respects --body style, seating, appearance, etc.-- except for the increase in vehicle height of about three inches to accommodate the addition of a transfer case, front differential, front-drive axle and increased front suspension capacity. This type of gamesmanship begs the question: When is a passenger car not a passenger car? Answer: When it is a truck or a multi-purpose passenger vehicle.

According to 49CFR571.1, our vehicles of interest would seem to fall under the classification of multi-purpose passenger vehicles.

SAE Recommended Practice J1100a defines multi-purpose passenger vehicle (MPV) as "a vehicle with motive power, except a trailer, designed to carry ten persons or less which is constructed either on a truck chassis or with special features for occasional off-road operation.

The term "utility vehicle," or "sports utility vehicle," has apparently derived from common usage as a vehicle marketing device to describe a set of vehicles.

As provided in the Code of Federal Regulations (533.4), NHTSA has defined "jeep-type vehicle" as "a four-wheel-drive, general-purpose automobile capable of off-highway operation that has a wheelbase not more than 110 inches, and that has a jeep-type configuration."

The original scope of this project was to investigate injury experience in jeep-type vehicles and vehicles similar to that of the Jeep--namely, an open-body vehicle of short wheelbase designed for off-road as well as on-road use. These vehicles are sometimes classified as "all-terrain" vehicles. It became apparent that this jeep-type vehicle was inclusive of more than just those previously described, as certain other vehicles are similar in nature and use, but larger and less amenable to being used as "open" vehicles. Thus a sub-set of vehicles was defined for the purposes of the study which included the jeep-type as well as selected other on-/off-road vehicles with a common purpose.

B. Another problem encountered was the limited descriptive and technical literature concerning these types of vehicles. In part this can be seen in the difficulty of defining the study population and in the lack of descriptive information in the accident data files. This paucity of literature probably stems from the recent popularity of this vehicle class.

C. Concomitant with the limited literature is a lack of data concerning manufacture and sale of this class of vehicle. Not until 1974 was this vehicle class separately identified in the published production figures. Previously (and still today to a more limited extent) these data were lumped together with truck production. Thus, the figures needed to establish growth rates in production and sales are not available.

D. There is conflicting information in the literature concerning the years of manufacture of particular models, and it is difficult to find any two sources which agree, even within the same manufacturer. This can, in some instances, be associated with changes in corporate entity. For example, the civilian manufacturer of the Willys-Overland jeep (trademark "Jeep") from 1945, became Willys in 1953, Kaiser Jeep Corporation in 1963, and AMC Jeep Corporation (trademark "JEEP") in 1970. But during that same period there was overlapping production of a number of different models (CJ-2A, 1945-50; CJ-3A, 1948-54; CJ-3B, 1953-65; CJ-5, 1955-**[18]; CJ-6, 1964-**; CJ-7, 1976-**). Thus a CJ-5 or CJ-6, for example, could be a Willys Jeep, a Kaiser Jeep, or an AMC JEEP. In the case of the CJ-5 and CJ-6, a substantial change in body style was introduced in 1970 but the model designation (CJ-5, CJ-6) remained the same. It is very difficult to untangle and identify from accident records not only who the manufacturer of a particular model is, but also to determine how many of an identical model designation were actually produced by which manufacturer. The company product genealogy chart available to dealers by the AMC Jeep Corporation, for example, lists all models with specifications, but omits the manufacturer designation.

E. The lack of literature, vehicle type definition, and specifications have created data encoding problems in the police-reported data. In most of the data files examined, passenger vehicles by make, model, and body style, etc., are defined such that one can sub-set the data by

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[18] ** Still in production.

make, model, body style, etc., for analysis of specific questions. Trucks are usually fairly well defined, but the proliferation of makes and types makes this somewhat less certain. However, the undefined nature of the multi-purpose vehicle and utility vehicle classes leads to confusion as to how to encode them. This is solved in a variety of ways, either by providing a specific category (i.e.: utility, recreation, four-wheel-drive, on-/off-road, multi-purpose, jeep) or by providing no category (forcing a truck or car classification) or by the use of "other." Where it is possible to separate out the vehicles of interest through a combination of coding of make, model, type, VIN, analysis is possible. This usually involves considerable hard work or the acceptance of a high level of miscoding and subsequent inclusion of unwanted vehicle types. As earlier mentioned the AMC Eagle is classified as a truck (ostensibly because of bumper height incompatibility with passenger cars) when in fact the vehicle is constructed as a passenger car. One can only speculate at this point as to how it will be coded for accident analysis purposes.

The federal government in its FARS and NASS systems run into these same problems. FARS has a category labeled "on-/off-road vehicle" which includes any vehicle in our sub-set plus any vehicle which has the capability of traveling off-road through four-wheel-drive, etc. This category also seems to be use oriented, i.e., classification is based on the operation of the vehicle at the time of the accident, rather than on the manufacturer's designation of the vehicle's intended vocation. While the federal government now has a uniform body of data in FARS, it cannot uniquely identify the very classes of vehicles to which it is now extending the standards.

It would seem, therefore, that a uniform system of vehicle identification and coding needs to be developed such that the unique characteristics of design and use can be encoded. It seems that unless great care is taken by the analyst, substantial numbers of vehicles can be excluded from analysis because they are incorrectly coded. The foregoing discussion on the Concord/Eagle designation is a case in point. This system would allow the analyst to make the decision as to how to group the vehicles of interest, rather than to have such a grouping predetermined.

F. Documentation, aside from the make-model problem, often leaves something to be desired. Some fatal and serious injury accidents have adequate documentation when the accident report, narrative, and photograph are considered. However, many fatal accidents were reviewed in which the only documentation available was the one-page accident report. Such a brief report does not permit additional encoding of items of interest.

One accident report form is used to cover all types of accident vehicles--trucks, buses, motorcycles, passenger cars. This universal form appears to be developed primarily for passenger cars with very little means available to encode the differences between the various types of vehicles. Even the NASS data collection system report form primarily addresses passenger vehicles, whereas the data collection encompasses all vehicle types. This inability to adequately describe differing vehicle types and equipment leads to missing information on vital parameters which may affect safety in these other vehicle types.

For example, the NASS accident data collection forms do not provide for coding of the type of cab enclosure for the on-/off-road vehicle classification--a factor critical to the problem of ejection. Also, the type of rollover protection (roll-bar) is not encoded. Both items are essential to describing the vehicle performance in terms of occupant protection. While the inclusion of these items may seem to make the data collection burdensome, their exclusion renders the collected data useless in assessing vehicle performance in terms of injury reduction.

On the other hand the CPIR file codes injury and interior object contacted in great detail. Where there are a large number of cases available with sufficient numbers for each body style variation, a meaningful analysis of injury pattern can be undertaken. However in this study only 92 cases were available, spread over two basic body styles (open and enclosed) with three types of enclosure material. Thus it became impossible to describe injury mechanisms with so few cases available of any one type.

While initially investigated but not subsequently utilized in this study, this discussion of the CPIR has been included so as to alert future researchers of the potential and limitations of the CPIR (and similar) file.

In many jurisdictions there appears to be an increasing reliance on the Vehicle Identification Number (VIN) for vehicle information. The VIN permits verification of the basic make and model information encoded in the VIN. However, the VIN encodes only basic make, model, and body style information and does not code trim and equipment options which are often key to occupant safety and protection. For example, until February, 1979, the roll-bar on a AMC Jeep was an optional, extra-cost item, as was any type of cab enclosure. In February, 1979, the roll-bar was made standard equipment and the canvas top offered at a substantially reduced price. Both items are key to occupant protection. However, the VIN did not indicate the absence or presence of these, still does not, and under the revised VIN system (to go into effect soon) will not. The only way to determine the absence or presence of roll-bars, tops, etc., is to review accident reports and pictures if they exist. The VIN can change, too, from the original, when a vehicle is substantially modified or re-built. Replacement engines, etc., can produce a false VIN.

G. Another concern is the collision experience of these vehicles in off-road environments. Accident data files derived from police reports usually concern themselves only with on-road collisions, yet these vehicles frequently operate off-road. Presently there is no large-scale data collection effort (similar to the on-road reported accidents) to collect off-road data. Therefore, this study has been limited to on-road collisions.

H. Jurisdictional problems and data file case identification presented some obstacles in terms of retrieving accident reports and photographs.

While the collision data are centralized in most states (making access easier) the supporting documentation is not. Photographs, for example, remain with the investigating agency. Thus, while one can frequently centrally identify vehicle and case identification, follow-up to the investigating agencies must be undertaken so as to secure photographic data, and in some instances, accident reports. In at least one state, it was necessary to visit two agencies to identify the vehicles of interest and secure accident reports and photographs.

I. Computer file formats vary considerably from state to state. The data base is usually designed for use in one state and in one computer system. Little thought has gone into the design of a data base that would facilitate data sharing.

Most research data analysis program systems require that data be in a fixed-record-length, fixed-block format. With data in this format, the application of any number of analysis systems to the data becomes possible. Analysis programs such as SPSS, ADAAS, OSIRIS, etc., which provide broad-based statistical analysis, are easily adapted to a fixed record system. However, many state mass accident data systems use a variable-record-length format with mixed record formats to achieve maximum data storage. This, it can be argued, is necessary to accommodate the large quantities of data. However, to utilize the data in any of the aforementioned analysis systems, it is necessary to reformat the data into the fixed-record format. Such a procedure is time-consuming and expensive and seriously limits acquiring enough data to study the less common vehicle classifications.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The basic objective of this study was to describe the accident experience of the class of vehicles generally known as utility vehicles. The specific vehicle types studied included: AMC JEEP, Kaiser and Willys Jeep, Ford Bronco (pre-1978), International Scout, and Toyota Land Cruiser (vehicles with small stability envelopes), Chevrolet Blazer, GMC Jimmy, Plymouth Trail Duster, and Dodge Ramcharger (vehicles with larger stability envelopes).

The major conclusions of this study are:

A. Crash Involvement

1) Based upon 1977 data for all states, utility vehicles are involved in fatal crashes almost 40 percent more often than passenger cars. The proportion of 1977 total crashes in which at least one occupant was killed is 72 percent higher for utility vehicles than passenger cars (31.8 utility vehicle fatal crashes per 100,000 registered vehicles vs. 18.5 passenger car fatal crashes per 100,000 registered vehicles).

2) Utility vehicles crash in rural areas proportionately more often than passenger cars, accounting for about 36 percent of the difference in overall death rates between utility vehicles and passenger cars. Higher average travel speed, curves, and ice or snow on the road surface have been shown to be major factors in the rural environment that are associated with an increase in crashes among utility vehicles.

3) Utility vehicle drivers involved in crashes generally are younger and more often male than their counterparts in passenger cars. The importance of these factors in contributing to total crashes or fatal crashes has not yet been established.

B. Rollover and Occupant Ejection

1) As a group, utility vehicles are much more likely than passenger cars to overturn, especially in single-vehicle crashes and in rural

areas. Utility vehicles experience rollover at a rate that is at least five times (and up to 11-1/2 times in Michigan) higher than that experienced by passenger cars (Maryland, Michigan, North Carolina, Texas, Washington). Among utility vehicles, some models have a higher rate of rollover than do others.

2) Based on the height of the center of gravity, utility vehicles as a class are more likely to overturn, and within the utility vehicle class those with a small stability envelope (JEEP, Jeep, pre 1978 Bronco, Scout, Land Cruiser) are more likely to overturn than those with a larger stability envelope (Blazer, Ramcharger, Jimmy, Trail Duster. The JEEP and the Bronco (pre-1978) overturn at least twice as often during a crash as the Blazer. Further, among those vehicles with the smaller stability envelope, the tire side forces may be sufficient to initiate the overturn, whereas utility vehicles with a larger stability envelope probably require an external tripping force (curb, pothole, etc.).

3) Driver ejection is more often reported among JEEPS than other makes of utility vehicles or passenger cars. Driver ejection is also more often reported among open or canvas top utility vehicles than among rigid top utility vehicles.

4) Rollover occurs in about 30 percent of U.S. fatal crashes involving utility vehicles. In comparison, rollover is reported in only six percent of all U.S. fatal passenger car crashes.

5) Until 1977, rollover was coded in the Fatal Accident Reporting System (FARS) data (when it occurred) as the first harmful event, yielding a rollover rate of 29 percent. In contrast, the 1978 FARS coded rollover as both first and subsequent harmful events. This yielded a fatal on-/off-road vehicle overturn rate of 45 percent. In this study, the more conservative (first harmful event) definition was used.

6) Rollover and ejection of unrestrained occupants are observed to be primary factors in fatal utility vehicle crashes.

7) Rollover protection (roll bars, cages, etc.), particularly in open vehicles is inadequate as the roll protection frequently collapses or is a source of injury to the occupants.

8) Occupant ejection is more common in single-vehicle crashes than multiple-vehicle crashes. Fifteen percent of utility vehicle occupants were ejected in single-vehicle crashes, 1975 through 1977, in Maryland as compared to 1 percent in passenger cars.

9) Ejection from open and canvas-enclosed vehicles occurred in three-quarters (75%) of the fatal crashes but in only two-fifths (40%) of the rigid cab vehicles in three study states (Arizona, Michigan, and Colorado) in 1978.

C. Rate of Injury and Death

1) Traffic death rates and rates of disabling injury are higher in utility vehicles than in passenger cars, whether considering all occupants or just drivers. Considering all occupants, both the death rate and rate of serious injury are about twice as high in utility vehicles. Additionally, both death and injury rates are approximately twice as high in JEEPS as in Blazers.

2) The likelihood of serious (disabling) injury is about twice as great in utility vehicles as in passenger cars, for all occupants and for drivers, based on Michigan and Washington data.

3) The Blazer exhibits the lowest serious injury rate when compared with the Scout, Bronco, and JEEP.

4) The likelihood of death as a consequence of a crash (for all occupants) was found to be twice as high in utility vehicles as in passenger cars, based on Michigan, Texas, and Washington data. At least one person was killed in a utility vehicle in almost three-fourths of all fatal crashes involving a utility vehicle (the remainder killed were occupants of the other vehicles).

D. Occupant Protection

1) A steel cab enclosure reduces the chance of ejection and subsequent fatal crushing by the vehicle. In all vehicles, the use of restraints prevents ejection, which is a primary cause of death and

injury. Roll-bars in open, canvas, and fiberglass-type cabs produce a measure of safety only if the occupant is not ejected. However, rollbars without sufficient upper body restraint do not offer the occupant adequate protection against flailing injury. Rollbars themselves can produce injuries.

2) Little difference in seat belt usage is found between drivers of utility vehicles and passenger cars. In one state which reported this factor, seventeen percent of drivers of utility vehicles wore a seat belt at the time of the crash, compared with 16 percent among the passenger car drivers.

E. Other

1) Of the 20 Federal Motor Vehicle Safety Standards (Numbers 201-219), only six apply to utility vehicles in their entirety. They are: 205 -- Glazing Materials; 207 -- Seating Systems; 209 -- Seat Belt Assemblies; 210 -- Seat Belt Assembly Anchorages; 211 -- Wheel Nuts, Discs, Hub Caps; 213 -- child Seating systems. In two standards (201 -- Occupant Protection, Interior Impact; and 212 -- Windshield Mounting) multi-purpose vehicles are exempted from the safety requirements. In another (208 -- Occupant Crash Protection) there are differences in requirements between passenger cars and multipurpose vehicles. Of particular importance, lap and shoulder belt restraint are not required (209 -- Seat Belt Assemblies).

2) Post-crash fire for utility vehicles as a result of collision is rare and was not found to be a safety problem.

7.2 Recommendations

7.2.1 Recommendations for Improving Utility Vehicle Safety

Based on the results of this study, the following recommendations for improving utility vehicle safety are offered.

A) Federal safety standards that apply to passenger cars should be extended to utility vehicles. In particular, restraint systems should be installed in all utility vehicles, with the design of a particular system geared to the vehicle style (i.e., full harness in open vehicles).

B) Performance standards (and perhaps design standards) should be promulgated for roll protection equipment --particularly for open vehicles.

C) Manufacturers, dealers, insurance companies, etc., should develop and distribute to prospective purchasers, drivers, educators, insureds, etc., literature describing the performance limitations (handling and stability) of these vehicles for both on-road and off-road use. Adequate consumer information can help alleviate many of the problems.

D) Additional research on the behavior of utility vehicle drivers should be conducted. We need to know to what extent the relatively high rates of utility vehicle fatal and serious injury accidents are a reflection of how the vehicles are driven. To answer that question satisfactorily more information is needed. Are drivers of utility vehicles generally more reckless than drivers of passenger cars? And, does an experienced passenger car driver become more reckless when driving a utility vehicle?

E) Additional studies need to be undertaken to examine and link the factors of vehicle design, occupant protection, driver, and environmental factors as they relate to the production of crash-induced injuries.

7.2.2 Recommendations for Improving Data Analyses

Based on the results of the data analysis and the discussion of technical problems encountered, the following are recommendations for improving data collection/analysis systems.

a) A comprehensive set of data definition and coding conventions and terminology should be developed for use by all governmental units collecting accident data. Such a uniform list would provide definitional information (define jeep-type, utility vehicle, passenger car, etc.) and abbreviations and coding convention for items such as body style, make, model, etc. Pieces of this type of system exist, but no one standard covers all the data elements on a motor-vehicle accident report, and there are gaps. Existing SAE and ANSI standards are inadequate in this area.

b) A standard should be developed for computerizing mass accident data so that data from each state is in a common format, readily available for statistical analysis.

c) Additional special studies on utility vehicles need to be undertaken so as to examine and link the factors of vehicle design, occupant protection, driver, and environmental factors as they relate to the production of crashes and crash-induced injuries. Care must be taken in the design of such a study and in the methods of data collection so as to overcome the deficiencies uncovered as a result of this project.

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APPENDIX A

POSITION PAPER:
DISPOSITION OF THE M151 (1/4 TON JEEP)

Office of Defects Investigation
National Highway Traffic Safety Administration

Office of Defects Investigation September 13, 1971

POSITION PAPER

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DISPOSITION OF THE M151 (1/4 TON JEEP)

INTRODUCTION

Since the mid 1960's the Department of the Army and the Congress have been aware of the hazards of operating the M151 vehicle. The Army initiated stringent operators' training requirements and operating restrictions in order to reduce the accident rate. These controls resulted in a fifty percent reduction in the accident rate of the M151 in Europe.

Senator Abraham Ribicoff, as a follow-up on previous inquiries concerning the M151 vehicle, wrote letters on July 3, 1970, to the Department of the Army and the Department of Transportation. The Army replied on July 23, 1970, (attachment 1), and Secretary Volpe replied on August 6, 1970, (attachment 2).

In his reply to Senator Ribicoff, Secretary Volpe stated ". . . we have not received any reports or information concerning accidents of M151 trucks purchased as surplus vehicles. We will, however, continue to evaluate and take appropriate action on any reported safety-related defects in these vehicles when used on the Nation's highways. . . ." At the present time this statement is still true.

NHTSA'S CURRENT INVOLVEMENT

In a May 19, 1971, letter (attachment 3), the Army requested the Office of Defects Investigation (ODI) to provide comments and recommendations on the disposal of the M151. As a result of this request, representatives of both the Army and ODI met on June 11, 1971, and again on July 23, 1971, to discuss the disposition of this vehicle. Attachment 4 lists the persons present at these meetings.

The meeting on June 11, 1971, was primarily an introduction to the problem. After reviewing the past correspondence concerning the M151, all parties agreed to meet on an unspecified future date to discuss the answers to several questions raised by ODI personnel. ODI requested that the Army make arrangements for another meeting and be prepared to answer questions (attachment 5). At this meeting on July 23, 1971, ODI requested additional information concerning the accident rate of the M151 vehicle when used on the highway and the exact numbers of vehicles to be offered for disposition during the next few years.

Mr. William Lawrence of the Department of Health, Education, and Welfare (DHEW) attended the July 23, 1971, meeting and expressed his department's desire to obtain the vehicles for some of their programs. He stated that the DHEW could use these vehicles as training aids in vocational maintenance training courses or as off-highway vehicles to be driven by facility and plant maintenance personnel on college or university campuses. Mr. Lawrence also stated that DHEW would follow DOT's recommendations pertaining to the use of the M151, that is, whether or not to permit the use of the vehicle on the public highways.

On August 2, 1971, Mr. Melvin Chambers provided the following information by phone:

Scheduled for Disposal

	Currently (As of 6-30-71)	FY 72	FY 73	FY 74
M151	1099	733	1030	1030
*M151A1	--	4019	3415	3192
**M151A2	--	195	890	1081

Current Inventory (6-30-71)

M151	5,987
M151A1	52,032
M151A2	15,290
TOTAL	73,309

Attachment 6 confirms the above figures and requests a rapid reply.

On August 4, 1971, Mr. Joseph Valoris, Defense Supply Agency, requested by phone that his agency would like to receive DOT's comments and recommendations as soon as possible, since various branches of the DOD are beginning to apply pressure to DSA to dispose of the vehicles.

---

* Heavy Duty Suspension

** Modified Suspension (See p. 3, para. 1.b)

At this time ODI contacted Mr. Raymond Sirianne, Army DCSLOG, concerning the on and off highway accident rates of the M151. Mr. Sirianne transferred the ODI representative to Mr. David Abernathy, Army DESPER, who stated that this type of information was not available without manually reviewing the accident records in the field units.

Both the Army and the Defense Supply Agency requested by letter in August 1971 (attachments 6 and 7) that our comments and recommendations be expedited. As a result of these discussions and other information furnished by the Army, ODI has reached the following conclusions:

1. The Department of Defense has recognized the unsafe handling characteristics of the M151 to the extent that:

   a. Specialized training in driving these vehicles is required of all drivers in the military system. A specially prepared training film TF55-3707 was made to illustrate the potential unsafe handling of these vehicles if not driven in a specified manner.

   b. Design features of the rear swing axle assembly were modified for later versions (M151A2) to lessen rollover propensity. These changes did not eliminate the problem but allowed approximately 10 mph greater speeds before rollover, coupled with more "feel" or warning for the driver.

   c. Special attention has been given to the high rollover accident rates in the military environment. Army records indicate that the M151 was involved in 7460 accidents world-wide in the years FY 67 through FY 70, involving 138 fatalities. 2201, or roughly 30%, were rollover accidents.

2. There are an estimated 73,309 vehicles which may be disposed of in the next six to ten years, with approximately 5,000 scheduled for disposal during each of the following years: FY 72, FY 73, and FY 74. The Army's estimated salvage value is $300 to $1200 per complete vehicle.

   Assuming an average salvage value of $750 per complete vehicle, the yearly sales return for 5,000 vehicles would be approximately $3,750,000 and the total return for 73,309 vehicles would be approximately $54,981,750.

For military vehicles which use the basic M151 chassis, the older models are the M151, M151A1, M151A1C, and M718; and, the newer models are M151A2, M825, and M718A1. The M718 and M825 are special purpose vehicles.

3. For these vehicles to be operated safely on the public highway, a public user should have a level of special training equivalent to that given a military driver. Such a course of action would be impractical to achieve and enforce, considering the different licensing and registration practices in the various States.

4. In the Army letter of July 23, 1970 (attachment 1), it was stated:

"It is DOD policy, that first consideration will be given to the protection of the buyer with respect to disposition of military items evidencing a high safety risk when used in a non-military situation. If an item is considered unsafe it is not sold. (emphasis added) When possible to point out the unsafe condition sufficiently to protect the buyer, the item may be sold with adequate warning.

In accordance with this policy, the DOD should not sell the M151 vehicles as the "warning notices" are not sufficient to protect the buyer.

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APPENDIX B

ANNOTATED LITERATURE REVIEWS

PERIODICALS

A. MECHANIX ILLUSTRATED

(A1) "The All-New Scout," by Tom McCahill

Tests a 1961 IH Scout. Discusses acceleration, top speed, tires and steering column. Presents specifications and data on acceleration.

April 1961, p. 76-79, 163-164.

(A2) "Now It's Four-Wheeling for Family Fun," by Marshall Spiegel

Discusses off-roading clubs for "4WD familes" to join. Stresses the importance of safety and the environment to the clubs.

December 1971, p. 30-31.

(A3) "We Test the Immortal Jeep and International's Wow Wagon," by Tom McCahill

Tests a 1972 Jeep CJ5 and a 1972 Scout II. Discusses acceleration, top speed, tires, and comfort. Presents, in tabular form, specifications of the test vehicles.

April 1972, p. 102, 104-105, 166-168.

(A4) "We Test Three 4WD's in Death Valley"

Tests three 1978 models: Jeep CJ-7, IH Scout II, and Ford Bronco Ranger XLT. Discusses acceleration, handling, and cornering. Mentions that both Bronco and Scout have high centers of gravity. Presents specifications and data on acceleration in tabular form.

July 1978, p. 43-45, 116.

(A5) "Color Portfolio of Vans and 4WD's," by Allen Stockton

Reports on available four-wheel-drive vehicles for 1979, complete descritpions with pictures.

February 1979.

(A6) "We Test Three 4WD's in Death Valley"

Off-road test of a Jeep CJ-7, a Ford Bronco and an International Scout. Compares the practicality of the Jeep to the more comfortable but equally rugged Scout and Bronco. Some specifications.

July 1978, p. 43-46, 116.

B. <u>POPULAR MECHANICS</u>

(B1) "It Separates the Ranchers from the Cowboys," by Jim Liston

Tests a 1969 Scout 800 (prototype). Describes features of the test model.

May 1969, p. 90.

(B2) "Chevy's Blazer: A Different Four-Wheel Drive," by V. Lee Oertle

Tests a 1969 Blazer (prototype). Discusses acceleration, handling, and comfort. Includes a few specifications of the test vehicle.

April 1969, p. 56, 58.

(B3) "Beautiful Ugliness in a Wheeled Breadbox," by Michael Lamm

Discusses results of a survey of owers of a VW Thing. Presents survey findings in tabular form.

February 1974, p. 128-131.

C. <u>POPULAR SCIENCE</u>

(C1) "What You Need to Know Before You Buy 4-Wheel Drive" by Barry Lopey

Describes different equipment for 4WD vehicles, including free-wheeling hubs, transfer cases, winches, and tires. Discusses safety equipment.

March 1971, p. 76-77, 137.

(C2) "Full-Time Four-Wheel Drive: Forget about Driving Conditions" by Jan P. Norbye and Jim Dunne

Tests four 1974 4WD models: Blazer, Cherokee, Ramcharger and Trail Duster. Discusses handling, acceleration, tabular form, full specifications and test results for the four vehicles.

June 1974, p. 22, 28, 30, 32-34.

(C3) "Four-Wheel Drive: Is It For You?" by Ray Hill

Discusses size, drivetrain, and locking front-wheel hubs for 4WD vehicles. Presents driving tips which emphasize safety.

March 1976, p. 106-107.

(D5) "Up Front Jeep," by Chuck Koch

Reports on the improved performance in Jeep CJ-5's when custom equipped with a 401 cid V-8 engine.

September 1972, p. 114.

(D6) "The Jeep Twins," by Bob Kovacik

Compares the Jeep CJ-5 to the newer CJ-7 model. Good discussion of fuel economy in four-wheel drive vehicles; also examines the advantages of free-wheeling hubs and a creeper gear. Notes available options such as center console glove box and interior carpeting.

May 1978, p. 89, 91-92.

(D7) "Toyota Land Cruiser Station Wagon," by Bob Kovacik

Non-technical report on a 1978 Land Cruiser. Construction, performance and handling compared with a 1972 model. Comments on changes since 1972, including improved manual transmission. Also reports fuel economy figures. No complete list of specifications.

March 1978, p. 89-91.

(D8) "Jeep CJ-7," by Ro McGonegal

Tests a fully equipped Jeep CJ-7, particular attention given to handling. Accompanied by full specifications. Evaluation primarily from a practical viewpoint; technical discussion held to a minimum.

March 1979, p. 70-72.

(D9) "Jeep Wagoneer and Subaru DL," by Fred Stafford

Evaluates two very different four-wheel drives as family vehicles, comparing their advantages and disadvantages. Full specifications given for each. Tested for performance, handling and ride in both city driving and on the open road.

April 1979, p. 48-49, 122-123.

E. CAR AND DRIVER

(E1) "Jeep CJ-5 and New CJ-7: Feeling Free," by Jim Williams

Tests and 1976 CJ-5 and CJ-7. Describes impressions of the two test vehicles in on- and off-road settings. Presents full specifications and performance results (acceleration and top speed) in tabular form.

April 1976, 76-78, 80, 96-97.

(C4) "For On or Off the Road: 4WD Trailbreakers" by Jim Dunne and Ray Hill

Tests three 1975 4WD models: Scout Traveler, Jeep CJ-7, and Subaru Wagon. Presents ratings on acceleration, braking, handling, visibility, and noise-level. Discusses features of the test vehicles and includes a section on maintenance.

July 1976, p. 32, 34, 36, 108.

D. MOTOR TREND

(D1) "The Roughnecks," by John Fuchs

Tests five 1974 prototype models: Ford Bronco, Chevrolet Blazer, AMC Cherokee, Jeep CJ-5, Toyota Land Cruiser, and Ford Quadravan. Discusses the on- and off-road performance of the test vehicles. Presents specifications in tabular form.

May 1974, p. 45-48, 126.

(D2) "Toyota Land Cruiser, Jeep Cherokee, Jeep CJ-5, the International Scout II, and Dodge Ramcharger," by David Carlton

Tests five 1975 models. Presents performance results on acceleration, braking, fuel mileage, and speedometer error. Includes full specifications of the test vehicles.

August 1975, p. 76-80.

(D3) "You've Come a Long Way, Baby," by David Carlton

Describes impressions driving a 1976 Jeep CJ-7 on and off the road. Discusses tires and optional tops.

March 1976, p. 51-53.

(D4) "Everything's Out Front," by Chuck Koch

Examines the 1972 Jeep CJ-5, anlayzing the changes over the 1971 model. Improvements noted include more powerful engines (3 to choose from), new 3-speed manual transmission, improved running gear and steering. Discusses idiosyncrasies and problems unique to jeep-type vehicles. Section on handling and performance; complete specifications.

August 1972, p. 91-94.

(E2) "AMC Cherokee Chief"

Tests a 1977 Cherokee Chief Wagon. Discusses driving impressions formed furing a 4500 mile trip in the test vehicle. Presents full specifications and performance data (acceleration, top speed, braking, and fuel economy). Compares performance of the Cherokee with the following 1976 models: Subaru GL Wagon (4WD), Plymouth Volare Wagon, and Chevrolet C-10 Pickup.

March 1977, p. 43-48.

(E3) "Ford Bronco Ranger XLT," by Steve Thompson

Tests a 1978 Ford Bronco Ranger XLT. Describes on- and off-road driving impressions of the test vehicle. Presents full specifications and performance data covering acceleration, top speed, braking, and fuel economy. Compares performance of the Bronco with the 1977 IH Scout Traveler, the 1977 Jeep Cherokee, and the 1976 Subaru GL Wagon (4WD).

January 1978, p. 37-39, 41-43.

(E4) "Off-Road Bash," by R. J. O'Rourke

Summarizes an informal off-road test of four on/off road vehicles, including a Jeep CJ-7 and a Chevrolet Blazer. Tests performed on rutted roads, sand slopes and in shallow water.

December 1978, p. 88-99.

F. AUTOCAR

(F1) "New Romance," by Colin Taylor

Describes the virtues of the Land Rover. Discusses modifications which can be made for comfort and safety, including new seats and hubs, and a Belsize hard-top roof.

May 1974, p. XIV-XV.

G. TRAILER AND RV TRAVEL

(G1) "Sport Trucks As Tow Vehicles: How Do They Measure Up?" by Larry Green

Tests the towing capability of four 1978 models: Chevrolet Blazer, Ford Bronco, Plymouth Trail Duster, and I.H. Scout Traveler. Recommends options for frequent towing. Rates handling with and without a trailer. Presents full specifications and performance data covering acceleration and fuel economy.

August 1978, p. 59-62

(G2) "Woodall's Guide to the '77 Sport Trucks"

Presents a market guide to the 1977 sports trucks, including the sports-utility vehicles. The vehicles covered include: Jeep Wagoneer, Ford Bronco, Dodge Ramcharger, Plymouth Trail Duster, I.H. Scout, Jeep CJ-5 and CJ-7, Jeep Cherokee, Chevrolet Blazer, and GMC Jimmy.

February 1977, p. 73-77.

H. <u>POPULAR OFF-ROADING</u>

(H1) "Driving Impression: Subaru Brat," by Brian Brennan

Discusses on and off the road driving impressions. Presents full specifications on engine, body, axle and suspension, brakes, and other systems for the 1978 model.

June 1978, p. 34-39.

(H2) "Driving Impression: GMC Jimmy Desert Fox," by Brian Brennan

Discusses on and off the road driving impressions. Presents specifications and a trailering guide for the 1978 model.

June 1978, p. 48-53.

I. <u>FOUR WHEELER</u>

(I1) "Jeep Wagoneer," by Bill Sanders

Tests the 1978 model. Discusses powertrain, performance, ride, handling, and braking. Presents full specifications and performance ratings in tabular form.

July 1978, p. 64-68.

(I2) "GMC Jimmy Desert Fox," by Julian G. Schmidt

Tests the 1978 model. Discusses powertrain, performance, ride, handling, and braking. Presents full specifications and performance ratings in tabular form.

June 1978, p. 40-44.

(I3) "Toyota FJ-40 Land Cruiser," by Julian G. Schmidt

Tests the 1978 model. Discusses powertrain, performance, ride, handling, and braking. Presents full specifications and performance ratings in tabular form.

June 1978, p. 75-80.

J. HOUSE AND GARDEN

(J1) "Auto Suggestions: The Jeep and Beyond," by Richard and Jean Taylor

Discusses some of the reasons for the popularity of 4WD vehicles. Presents price, length, base engine, mileage, and weight for twenty-one 4WD models.

June 1978, p. 32, 35-36.

K. CONSUMER REPORTS

(K1) "4-Wheel-Drive Utility Vehicles"

Tests five 1972 4WD models: the Chevrolet Blazer, the I.H. Scout II, the Jeep Commando, the Ford Bronco, and the Toyota Land Cruiser. Discusses safety, comfort, handling, and braking. Presents full specifications and performance data in tabular form.

September 1972, p. 598-605.

L. OFF-ROAD

(L1) "The Toyota Land Cruiser," by Tom Madigan

Tests the 1973 Land Cruiser (soft-top). Discusses tires, brakes, and handling. Presents specifications in tabular form.

May 1973, p. 38-41.

(L2) "A Touch of Glass", by Don Emmons

Discusses the Parmley fiberglass body kit for the Jeep CJ-5, and notes that different tops and roll-bars are available.

April 1974, p. 42-45.

(L3) "4WD Clinic", by Bruce Eikelberger

Discusses the differences between pickup trucks and utiltity vehicles. Divides utility vehicles into three groups based on size of vehicle.

July 1974, p. 14-15.

(L4) "Introducing the '75 4WD Vehicles," by Tom Madigan

Presents pictures and brief descriptions of the vehicles. The following models are included: the Plymouth Trail Duster, the Jeep Wagoneer, the Dodge Ramcharger, the Ford Bronco, the Chevrolet Blazer, the Jeep Cherokee "S", and the Jeep CJ-5.

November 1974, p. 20-23.

(L5) "Road Test: Scout Traveler," by John Lawler
"Road Test: Scout II," by Kevin Smith

Two tests presented side-by-side offer a comparison between these International models. Larger-size Traveler is rated against the Scout II in handling and general utility; some technical discussion primarily centering on drivetrains. Complete specifications for both vehicles.

March 1979, p. 60-64, 96, 106.

M. MOTORCAMPING HANDBOOK

(M1) "Four-Wheel Drive - 1978," by Dick Fosdick

Reviews several 1978 model utility vehicles, including Ford Bronco (notes complete redesigning)), GMC Jimmy, Chevrolet Blazer and Suburban, AMC Jeep and Cherokee models, Chrysler's Dodge Ramcharger and Plymouth Trail Duster, Toyota Land Cruiser, and International Harvester's Scout and Traveler. Notes numerous available options, particularly engine and drivetrain; also indicates revisions and changes over 1977 models for all makes.

p. 83-86.

N. ROAD AND TRACK

(N1) "Jeep Wagoneer Limited," by Thos L. Bryant

Examines the special edition Wagoneer. Options such as Turbo Hydra-matic transmission, air conditioning, aluminum wheels, cruise control, AM/FM stero/CB radio and many others are reported and inspected. Some attention given to the usual road test topics of performance and handling.

August 1978, p. 48-50.

O. WOODALL'S TRAILER AND RV TRAVEL

(01) "Towing with the Jeep CJ-7," by Larry Green

Examines the Jeep CJ-7 as a tow-vehicle from a camper's point of view; discusses performance and handling with some attention given to interior comfort.

March 1979, p. 57-59.

I. BOOKS

IA The Jeep, edited by Bart H. Vanderveen

Presents a detailed historical sketch of the military Jeeps used in World War II. (A few pages near the end of the book are devoted to the early civilian versions.) Detailed descriptions of the military Jeeps are presented along with photographs.

Compiled by the Olyslager Organization, Frederick Warne & Co. Ltd., London and New York, 1972, 64 p.

IB Four Wheel Drive

Most of this book is devoted to evaluations of 16 four-wheel drive vehicles. Other chapters in the book cover: (1) the role of the Jeep in the history of 4WD vehicles, (2) tips on driving 4WD vehicles, (3) tips on pulling trailers in off-road settings, and (4) conversion kits for 4WD pickup trucks. For each of the 16 vehicles tested, the discussion covers the chassis, driveline, and body. Also discusses on and off-road driving impressions. Presents full specifications, performance data, and ratings for the test vehicles. Among the 1975-1977 vehicles tested are the following: Chevrolet Blazer, Dodge Van Charger, Ford Bronco, I.H. Scout II, Cherokee Chief, Jeep CJ-7, Jeep Wagoneer, and Plymouth Trail Duster.

Peterson Publishing Co., Los Angeles, 1976, 144 p.

IC The Land-Rover: Workhorse of the World, by Graham Robson

Discusses the development of the Land Rover. Describes the features of the Land Rover, and compares the specifications of the 1947 Land Rover with the Willys Jeep. Presents sales statistics by year (1964-1974) for sales in England and abroad.

David and Charles, Newton Abbot, London, North Pomfret (VT), Vancouver, 1976, 143 p.

II REPAIR MANUALS

CHILTON'S Repair and Tune-Up Guide:

II A. Blazer, Jimmy (1969-1973)

II B. Bronco (1966-1973)

II C. Jeep Universal (CJ-3, CJ-5, CJ-6, CJ-7; 1953-1976)

II D. Jeep Wagoneer, Commando and Cherokee (1966-1974)

II E. International Scout (800, 800A, 800B, Scout II, 1967-1973)

(The Repair Guides include general information abour the vehicles, including model identification, serial number identification, and engine serial number identification.)

Chilton Book Company, Radnor, Pennsylvania.

APPENDIX C

UTILITY VEHICLE STATISTICS: MICHIGAN AND WASHINGTON

UTILITY VEHICLE ACCIDENTS: MICHIGAN AND WASHINGTON

The tables shown on the following pages provide detailed statistics for some of the characteristics of utility vehicle crashes in Michigan and Washington. The percentages shown in the tables are based on 6,599 crashes in Michigan and 1,456 crashes in Washington. The sum of the individual percentages in a column does not always equal 100.0 percent because of rounding.

TABLE C1

CHARACTERISTICS OF UTILITY VEHICLE CRASHES

	Michigan	Washington
Hour of Day		
Midnight to 01:00 AM	3.0%	4.6%
01:00 AM - 02:00 AM	3.1	3.7
02:00 AM - 03:00 AM	3.4	3.4
03:00 AM - 04:00 AM	1.7	1.3
04:00 AM - 05:00 AM	1.0	0.9
05:00 AM - 06:00 AM	0.9	0.8
06:00 AM - 07:00 AM	2.4	2.0
07:00 AM - 08:00 AM	3.5	3.4
08:00 AM - 09:00 AM	3.4	3.6
09:00 AM - 10:00 AM	3.3	3.2
10:00 AM - 11:00 AM	3.8	4.5
11:00 AM - Noon	4.6	4.3
Noon to 01:00 PM	5.3	4.7
01:00 PM - 02:00 PM	5.7	4.8
02:00 PM - 03:00 PM	6.3	7.8
03:00 PM - 04:00 PM	7.4	5.1
04:00 PM - 05:00 PM	7.7	8.6
05:00 PM - 06:00 PM	7.3	7.9
06:00 PM - 07:00 PM	5.6	5.6
07:00 PM - 08:00 PM	5.2	5.2
08:00 PM - 09:00 PM	3.9	3.7
09:00 PM - 10:00 PM	4.1	3.4
10:00 PM - 11:00 PM	3.4	3.5
11:00 PM - Midnight	3.8	4.0
Not Ascertained	0.1	0.0
	100.0%	100.0%
Day of Week		
Sunday	12.8%	13.9%
Monday	12.8	12.0
Tuesday	12.2	11.9
Wednesday	13.0	11.9
Thursday	14.5	14.6
Friday	18.2	17.2
Saturday	16.5	18.6
Not Ascertained	0.0	0.0
	100.0%	100.0%

(continued)

TABLE C1

(continued)

Population of City	Michigan	Washington
Over 250,000	5.8%	8.1%
100,000 - 250,000	6.6	10.6
50,000 - 100,000	7.9	2.3
25,000 - 50,000	8.1	9.3
10,000 - 25,000	8.8	11.7
5,000 - 10,000	5.1	3.0
2,500 - 5,000	4.2	3.1
Under 2,500	3.5	2.8
Townships	50.1	0.0
Missing Data	0.0	49.0
	100.0%	100.0%

<table>
<tr><th>Road Surface</th><th>Michigan</th><th>Washington</th></tr>
<tr><td>Dry</td><td>45.3%</td><td>65.5%</td></tr>
<tr><td>Wet</td><td>19.1</td><td>23.8</td></tr>
<tr><td>Snow</td><td rowspan="2">35.0</td><td>3.2</td></tr>
<tr><td>Ice</td><td>7.2</td></tr>
<tr><td>Other</td><td rowspan="2">0.5</td><td>0.3</td></tr>
<tr><td>Not Ascertained</td><td>0.1</td></tr>
<tr><td></td><td>100.0%</td><td>100.0%</td></tr>
</table>

Light Conditions	Michigan	Washington
Daylight	59.3%	60.9%
Dawn or Dusk	5.3	4.1
Darkness with Street Lights	10.5	20.2
Darkness without Street Lights	24.9	14.8
Not Ascertained	0.0	0.0
	100.0%	100.0%

(continued)

TABLE C1

(continued)

	Michigan	Washington
Weather		
Clear or Cloudy	74.6%	77.2%
Raining	8.6	15.6
Snowing	16.1	2.8
Fog	0.7	4.1
Other or Not Ascertained	0.0	0.2
	100.0%	100.0%
Drinking or Use of Drugs by the Driver		
Had Taken Alcohol or Drugs	14.2%	14.6%
Had Not Taken Alcohol or Drugs	82.0%	48.2%
Not Ascertained	3.9	37.3
	100.0%	100.0%

APPENDIX D

MULTIPLE REGRESSION EQUATIONS AND SIMPLE CORRELATIONS BETWEEN INDEPENDENT VARIABLES

Multiple Regression Equations

The results of regression analyses conducted using accident data from Michigan and Washington are shown in Tables D1 and D2. All variables included in the equations are dichotomous, having the value one or zero. When dummy variables are used as independent variables in regression analysis, one category in each class can be set equal to zero.* All independent variables shown in the tables are significant at the 95 percent level of confidence.

Simple Correlations Between Independent Variables

Tables D3 and D4 show the zero-order (or simple) correlation coefficients between pairs of independent variables. These coefficients indicate the level of association between the independent variables. The statistic can vary in value from -1 to +1. A correlation of +1 shows perfect correlation; such a result means that a variable has been correlated with itself, as is the case along the diagonal. If a simple correlation between two predictor variables in the same equation is around .90 or higher, one variable would be redundant. No independent variables were removed from equations in this study because of high zero-order correlation.

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*When the dependent variable is dichotomous the equations are often called linear probability functions. Also, multipe regression with a dependent variable limited to two values is closely related to discriminant analysis. Lansing and Morgan report that such multiple regression equations produce the same statistical results as linear discriminant functions when classification errors are minimized (John B. Lansing and James N. Morgan, Economic Survey Methods, Institute for Social Research, The University of Michigan, 1971, pp. 300-301).

**For a discussion of the mathematical basis for this procedure, see: Daniel B. Suits, "The Use of Dummy Variable in Regression Equations," Journal of The American Statistical Association, Vol. 52, 1957, pp. 548-551.

TABLE D1

MULTIPLE REGRESSION: MICHIGAN

Dependent Variable (Y): Utility Vehicle Crash=1, and
Passenger Car Crash=0

Multiple correlation ratio (R) .42
Number of cases 8,000

Multiple determination ratio (R^2) .18
Constant term .03

Independent Variable	Coefficient	Standard Error	T Ratio	Simple Correlation With Y
Environmental Characteristics				
(X_1) Upper Peninsula	.19	.02	9.1	.15
(X_2) Northern Lower Peninsula	.19	.02	10.0	.16
(X_3) Curve in Road	.05	.01	2.2	.07
(X_4) Snow or Ice on Road Surface	.11	.01	9.3	.16
(X_5) Township	.23	.02	15.6	.17
(X_6) City Size: under 25,000	.18	.01	10.6	.12
(X_7) City Size: 25,000-99,999	.08	.02	4.9	.06
Driver Characteristics				
(X_8) Age: 20-29	.18	.01	15.8	.17
(X_9) Age: 30-39	.16	.01	11.3	.06
(X_{10}) Sex: Male	.23	.01	19.5	.23

The Equation $Y=.03 + .19X_1 + .19X_2 + .15X_3 + .11X_4 + .23X_5 + .18X_6 + .08X_7 + .18X_8 + .16X_9 + .23X_{10}$

TABLE D2

MULTIPLE REGRESSION: WASHINGTON

Dependent Variable (Y): Utility Vehicle Crash=1, and
Passenger Car Crash=0

Multiple correlation ratio (R) .38
Number of cases 2,740

Multiple determination ratio (R^2) .14
Constant term .24

Independent Variable	Coefficient	Standard Error	T Ratio	Simple Correlation With Y
Driver Characteristics				
(X_1) Sex: Male	.22	.02	11.0	.23
(X_2) Age: 20-29	.12	.02	5.7	.12
(X_3) Age: 30-39	.14	.03	5.6	.09
(X_4) Age: 60-69	-.18	.05	-3.9	-.11
(X_5) Age: 70-79	-.18	.07	-2.6	-.07
(X_6) Occupation: Skilled, Semi-skilled	.07	.03	2.7	.10
Environmental Characteristics				
(X_7) Rural	.11	.02	5.0	.19
(X_8) City Size: 100,000 or more	-.10	.02	-4.5	-.15
(X_9) Curve in Road	.08	.03	2.6	.13
(X_{10}) Snow or Ice on Road Surface	.17	.04	4.6	.14

The Equation $Y=.24 + .22X_1 + .12X_2 + .14X_3 - .18X_4 - .18X_5 + .07X_6 + .11X_7 - .10X_8 + .08X_9 + .17X_{10}$

TABLE D3

SIMPLE CORRELATION BETWEEN INDEPENDENT VARIABLES: MICHIGAN

	$X_{(1)}$	$X_{(2)}$	$X_{(3)}$	$X_{(4)}$	$X_{(5)}$	$X_{(6)}$	$X_{(7)}$	$X_{(8)}$	$X_{(9)}$	$X_{(10)}$
$X_{(1)}$	1.00	-.09	.05	.15	.04	+.23	-.14	-.00	-.02	.04
$X_{(2)}$		1.00	.12	.09	.19	.09	-.16	.01	.04	.04
$X_{(3)}$			1.00	.03	.17	-.04	-.07	.04	-.03	.03
$X_{(4)}$				1.00	.14	.05	-.09	.03	.02	.01
$X_{(5)}$					1.00	-.40	-.43	.01	.06	.05
$X_{(6)}$						1.00	-.24	-.00	-.02	.00
$X_{(7)}$							1.00	.02	-.05	-.03
$X_{(8)}$								1.00	-.35	.04
$X_{(9)}$									1.00	-.02
$X_{(10)}$										1.00

CRASH CHARACTERISTICS

(X_1) Upper Peninsula
(X_2) Northern Lower Penisula
(X_3) Curve in the Road
(X_4) Snow or Ice on the Road Surface
(X_5) Township
(X_6) City size is under 25,000 (population)
(X_7) City size is 25,000-99,999 (population)
(X_8) Age of driver is 20-29 years
(X_9) Age of driver is 30-39 years
(X_{10}) Male Driver

TABLE D4

SIMPLE CORRELATION BETWEEN INDEPENDENT VARIABLES: WASHINGTON

	$X_{(1)}$	$X_{(2)}$	$X_{(3)}$	$X_{(4)}$	$X_{(5)}$	$X_{(6)}$	$X_{(7)}$	$X_{(8)}$	$X_{(9)}$	$X_{(10)}$
$X_{(1)}$	1.00	.07	-.01	-.02	.01	.15	.09	-.03	.08	.02
$X_{(2)}$		1.00	-.35	-.15	-.10	.08	.03	-.02	.05	.03
$X_{(3)}$			1.00	-.10	-.07	.05	.02	-.03	-.00	.02
$X_{(4)}$				1.00	-.03	-.03	-.01	.02	-.06	-.05
$X_{(5)}$					1.00	-.05	-.02	.00	-.04	-.04
$X_{(6)}$						1.00	-.01	-.03	.00	.04
$X_{(7)}$							1.00	-.35	.32	.24
$X_{(8)}$								1.00	-.15	-.11
$X_{(9)}$									1.00	.13
$X_{(10)}$										1.00

CRASH CHARACTERISTICS

(X_1) Male Driver
(X_2) Age of Driver is 20-29 years
(X_3) Age of Driver is 30-39 years
(X_4) Age of Driver is 60-69 years
(X_5) Age of Driver is 70-79 years
(X_6) Skilled or Semi-skilled worker
(X_7) Rural Area
(X_8) City size is 100,000 or more (population)
(X_9) Curve in the Road
(X_{10}) Snow or Ice on the Road

APPENDIX E

APPROXIMATE SAMPLING ERROR

APPROXIMATE SAMPLING ERROR

Some of the findings in this report are based on sample files. For Texas, both utility vehicle and passenger car crashes represent five percent of the total number of crashes. A five percent sample file was also used in the analysis of the total vehicle crashes in Michigan.

Because some of the findings are based on probability samples, one can estimate the range of error due to the fact that a sample instead of a total universe was analyzed. Some approximate sampling errors for different percentages are presented in the table.

TABLE E1

APPROXIMATE SAMPLING ERRORS OF PERCENTAGES*

Number of Interviews	Reported percentages around:			
	50	30 or 70	20 or 80	10 or 90
20	30.0	21.4	17.8	13.4
50	14.2	13.0	11.4	8.5
100	10.0	9.2	8.0	6.0
200	7.0	6.8	5.6	4.2
500	4.4	4.1	3.6	2.7
1,000	3.2	3.0	2.4	1.9
5,000	1.4	1.3	1.1	.8
10,000	1.0	.9	.8	.6
40,000	.5	.4	.4	.3

*The sampling error does not measure the actual error that is involved in specific measurements. It shows that - except for non-sampling errors, errors in reporting, in interpretation, etc. -- differences larger than those found in the table will arise in only 5 cases in 100.

APPENDIX F

EXCERPTS FROM FEDERAL REGULATIONS:

1) Part 523 - Vehicle Classification
2) Part 533 - Average Fuel Economy
3) 49CFR571.3 - FMVSS Definitions

PART 523—VEHICLE CLASSIFICATION

Sec.
523.1 Scope.
523.2 Definitions.
523.3 Automobiles.
523.4 Passenger automobiles.
523.5 Nonpassenger automobiles.

AUTHORITY: Sec. 301, Pub. L. 94–163, 80 Stat. 901 (15 U.S.C. 2001).

§ 523.1 Scope.

This part establishes categories of vehicles that are subject to Title V of the Motor Vehicle Information and Cost Savings Act, 15 U.S.C. 2001 *et. seq.*

§ 523.2 Definitions.

"Approach angle" means the smallest angle, in a plan side view of an automobile, formed by the level surface on which the automobile is standing and a line tangent to the front tire static loaded radius arc and touching the underside of the automobile forward of the front tire.

"Axle clearance" means the vertical distance from the level surface on which an automobile is standing to the lowest point on the axle differential of the automobile.

"Breakover angle" means the supplement of the largest angle, in the plan side view of an automobile, that can be formed by two lines tangent to the front and rear static loaded radii arcs and intersecting at a point on the underside of the automobile.

"Cargo-carrying volume" means the luggage capacity or cargo volume index, as appropriate, and as those terms are defined in 40 CFR 600.315, in the case of automobiles to which either of those terms apply. With respect to automobiles to which neither of those terms apply, "cargo-carrying volume" means the total volume in cubic feet rounded to the nearest 0.1 cubic feet of either an automobile's enclosed nonseating space that is intended primarily for carrying cargo and is not accessible from the passenger compartment, or the space intended primarily for carrying cargo bounded in the front by a vertical plane that is perpendicular to the longitudinal centerline of the automobile and passes through the rearmost point on the rearmost seat and elsewhere by the automobile's interior surfaces.

"Curb weight" is defined the same as "vehicle curb weight" in 40 CFR Part 86.

"Departure angle" means the smallest angle, in a plan side view of an automobile, formed by the level surface on which the automobile is standing and a line tangent to the rear tire static loaded radius arc and touching the underside of the automobile rearward of the rear tire.

"Gross vehicle weight rating" means the value specified by the manufacturer as the loaded weight of a single vehicle.

"Passenger-carrying volume" means the sum of the front seat volume and, if any, rear seat volume, as defined in 40 CFR 600.315, in the case of automobiles to which that term applies. With respect to automobiles to which that term does not apply, "passenger-carrying volume" means the sum in cubic feet, rounded to the nearest 0.1 cubic feet, of the volume of a vehicle's front seat and seats to the rear of the front seat, as applicable, calculated as follows with the head room, shoulder room, and leg room dimensions determined in accordance with the procedures outlined in Society of Automotive Engineers Recommended Practice J1100a, Motor Vehicle Dimensions (Report of Human Factors Engineering Committee, Society of Automotive Engineers, approved September 1973 and last revised September 1975.)

(a) For front seat volume, divide 1,728 into the product of the following SAE dimensions, measured in inches to the nearest 0.1 inches, and round the quotient to the nearest 0.001 cubic feet.

(1) H61—Effective head room—front.

(2) W3—Shoulder room—front.

(3) L34—Maximum effective leg room—accelerator.

(b) For the volume of seats to the rear of the front seat, divide 1,728 into the product of the following SAE dimensions, measured in inches to the nearest 0.1 inches, and round the quotient to the nearest 0.001 cubic feet.

(1) H63—Effective head room—second.

(2) W4—Shoulder room—second.

(3) L51—Minimum effective leg room—second.

"Running clearance" means the distance from the surface on which an automobile is standing to the lowest point on the automobile, excluding unsprung weight.

"Static loaded radius arc" means a portion of a circle whose center is the center of a standard tire-rim combination of an automobile and whose radius is the distance from that center to the level surface on which the automobile is standing, measured with the automobile at curb weight, the wheel parallel to the vehicle's longitudinal centerline, and the tire inflated to the manufacturer's recommended pressure.

"Temporary living quarters" means a space in the interior of an automobile in which people may temporarily live and which includes sleeping surfaces, such as beds, and household conveniences, such as a sink, stove, refrigerator, or toilet.

§ 523.3 Automobile.

(a) An automobile is any 4-wheeled vehicle propelled by fuel which is manufactured primarily for use on public streets, roads, and highways (except any vehicle operated exclusively on a rail or rails), and that either—

(1) Is rated at 6,000 pounds gross vehicle weight or less; or

(2) Which—

(i) Is rated more than 6,000 pounds gross vehicle weight, but less than 10,000 pounds gross vehicle weight,

(ii) Is a type of vehicle for which the Administrator determines, under paragraph (b) of this section, average fuel economy standards are feasible, and

(iii)(A) Is a type of vehicle for which the Administrator determines, under paragraph (b) of this section, average fuel economy standards will result in significant energy conservation, or

(B) Is a type of vehicle which the Administrator determines, under paragraph (b) of this section, is substantially used for the same purposes as vehicles described in paragraph (a)(1) of this section.

(b) A vehicle that is rated at more than 6,000 pounds and less than 10,000 pounds gross vehicle weight, is manufactured primarily for use in the transportation of not more than 10 individuals, and does not meet the criteria in § 523.5(b)(1) for automobiles capable of off-highway operation is a type of vehicle—

(1) For which average fuel economy standards are feasible, and

(2) Which is substantially used for the same purposes as vehicles described in paragraph (a)(1) of this section.

§ 523.4 Passenger automobile.

A passenger automobile is any automobile (other than an automobile capable of off-highway operation) manufactured primarily for use in the transportation of not more than 10 individuals.

§ 523.5 Nonpassenger automobile.

(a) A nonpassenger automobile is an automobile either designed for off-highway operation, as described in paragraph (b) of this section, or designed to perform at least one of the following functions:

(1) Transport more than 10 persons;

(2) Provide temporary living quarters;

(3) Transport property on an open bed;

(4) Provide greater cargo-carrying than passenger-carrying volume; or

(5) Permit expanded use of the automobile for cargo-carrying purposes or other nonpassenger-carrying purposes through removal of seats by means installed for that purpose by the automobile's manufacturer or with simple tools, such as screwdrivers and wrenches, so as to create a flat, floor level surface extending from the forward-most point of installation of those seats to the rear of the automobile's interior.

(b) An automobile capable of off-highway operation is an automobile—

(1) (i) That has 4-wheel drive; or

(ii) Is rated at more than 6,000 pounds gross vehicle weight; and

(2) That has at least four of the following characteristics (see Figure 1) calculated when the automobile is at curb weight, on a level surface, with the front wheels parallel to the automobile's longitudinal centerline, and the tires inflated to the manufacturer's recommended pressure—

(i) Approach angle of not less than 28 degrees.

(ii) Breakover angle of not less than 14 degrees.

(iii) Departure angle of not less than 20 degrees.

(iv) Running clearance of not less than 8 inches.

(v) Front and rear axle clearances of not less than 7 inches each.

42 F.R. 38362
July 28, 1977

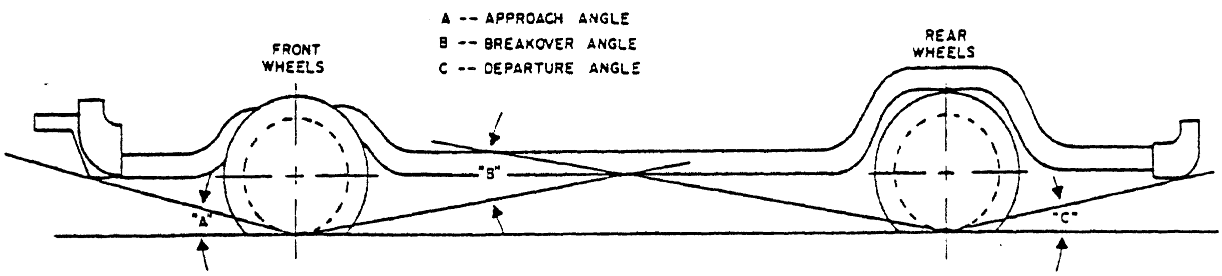

Fig. I

PART 533—AVERAGE FUEL ECONOMY STANDARDS FOR NONPASSENGER AUTOMOBILES

Sec.

533.1 Scope

533.2 Purpose

533.3 Applicability

533.4 Definitions

533.5 Requirements

533.6 Measurement and calculation procedures

S533.1 Scope. This part establishes average fuel economy standards pursuant to section 502(b) of the Motor Vehicle Information and Cost Savings Act, as amended, for nonpassenger automobiles.

S533.2 Purpose. The purpose of this part is to increase the fuel economy of nonpassenger automobiles by establishing minimum levels of average fuel economy for those vehicles.

S533.3 Applicability. This part applies to manufacturers of nonpassenger automobiles.

S533.4 Definitions.

(a) *Statutory terms.*

(1) The terms "average fuel economy," "average fuel economy standard," "manufacture," "manufacturer," and "model year" are used as defined in section 501 of the Act.

(2) The term "automobile" is used as defined in section 501 of the Act and in accordance with the determinations in 49 CFR 523.

(b) *Other terms.* As used in this part, unless otherwise required by the context—

"Act" means the Motor Vehicle Information Cost Savings Act, as amended by Pub.L. 94-163.

"Nonpassenger automobile" is used in accordance with the determinations in 49 CFR Part 523.

"Jeep-type vehicle" means a 4-wheel drive, general purpose automobile capable of off-highway operation that has a wheelbase not more than 110 inches, and that has a jeep-type configuration.

S533.5 Requirements

(a) Each manufacturer of nonpassenger automobiles shall comply with the requirement in paragraph (b) of this section, or, at the option of the manufacturer, shall comply with the requirements of paragraph (c) of this section.

(b) The average fuel economy of all nonpassenger automobiles manufactured in model year 1979 by a manufacturer described in paragraph (a) of this section shall be not less than 17.2 mpg, as determined under S533.6.

(c)(1) The average fuel economy of all nonpassenger automobiles, except jeep-type vehicles, manufactured in model year 1979 by a manufacturer described in paragraph (a) of this section, shall be not less than 17.2 mpg, and

(2) The average fuel economy of all jeep-type vehicles manufactured in model year 1979 by a manufacturer, described in paragraph (a) of this section, shall be not less than 15.8 mpg, as determined by S533.6.

S533.6 Measurement and calculation procedures.

(a) Any reference to a class of nonpassenger automobiles manufactured by a manufacturer shall be deemed—

(1) To include all nonpassenger automobiles in that class manufactured by persons who control, are controlled by, or are under common control with, such manufacturer; and

(2) To exclude all nonpassenger automobiles in that class manufactured (within the meaning of paragraph (a)(1) of this section) during a model year by such manufacturer which are exported prior to the expiration of 30 days following the end of such model year.

(b) The average fuel economy of all nonpassenger automobiles that are manufactured by a manufacturer and are subject to S533.5(b) or to S533.5(c) shall be determined in accordance with procedures established by the Administrator of the Environmental Protection Agency under section 503(a)(2) of the Act.

42 F.R. 13807
March 14, 1977

Subpart A—General

§ 571.3 Definitions.

(a) *Statutory definitions.* All terms defined in section 102 of the Act are used in their statutory meaning.

(b) *Other definitions.* As used in this chapter—

"Act" means the National Traffic and Motor Vehicle Safety Act of 1966 (80 Stat. 718).

"Approved," unless used with reference to another person, means approved by the Secretary.

"Boat trailer" means a trailer designed with cradle-type mountings to transport a boat and configured to permit launching of the boat from the rear of the trailer.

"Bus" means a motor vehicle with motive power, except a trailer, designed for carrying more than 10 persons.

"Curb weight" means the weight of a motor vehicle with standard equipment; maximum capacity of engine fuel, oil, and coolant; and, if so equipped, air conditioning and additional weight optional engine.

"Designated seating capacity" means the number of designated seating positions provided.

"Designated seating position" means any plan view location intended by the manufacturer to provide seating accommodation while the vehicle is in motion, for a person at least as large as a fifth percentile adult female, except auxiliary seating accommodations such as temporary or folding jump seats.

"Driver" means the occupant of a motor vehicle seated immediately behind the steering control system.

"Emergency brake" means a mechanism designed to stop a motor vehicle after a failure of the service brake system.

"5th percentile adult female" means a person possessing the dimensions and weight of the 5th percentile adult female specified for the total age group in Public Health Service Publication No. 1000, Series 11, No. 8, "Weight, Height, and Selected Body Dimensions of Adults."

"'Firefighting vehicle' means a vehicle designed exclusively for the purpose of fighting fires."

"Fixed collision barrier" means a flat, vertical, unyielding surface with the following characteristics:

(1) The surface is sufficiently large that when struck by a tested vehicle, no portion of the vehicle projects or passes beyond the surface.

(2) The approach is a horizontal surface that is large enough for the vehicle to attain a stable attitude during its approach to the barrier, and that does not restrict vehicle motion during impact.

(3) When struck by a vehicle, the surface and its supporting structure absorb no significant portion of the vehicle's kinetic energy, so that a performance requirement described in terms of impact with a fixed collision barrier must be met no matter how small an amount of energy is absorbed by the barrier."

"Forward control" means a configuration in which more than half of the engine length is rearward of the foremost point of the windshield base and the steering wheel hub is in the forward quarter of the vehicle length.

"Gross axle weight rating" or "GAWR" means the value specified by the vehicle manufacturer as the load-carrying capacity of a single axle system, as measured at the tire-ground interfaces.

"Gross combination weight rating" or "GCWR" means the value specified by the manufacturer as the loaded weight of a combination vehicle.

"Gross vehicle weight rating" or "GVWR" means the value specified by the manufacturer as the loaded weight of a single vehicle.

"H point" means the mechanically hinged hip point of a manikin which simulates the actual pivot center of the human torso and thigh, described in SAE Recommended Practice J826, "Manikins for Use in Defining Vehicle Seating Accommodations," November 1962.

"Head impact area" means all non-glazed surfaces of the interior of a vehicle that are statically contactable by a 6.5-inch diameter spherical head form of a measuring device having a pivot point to "top-of-head" dimension infinitely adjustable from 29 to 33 inches in accordance with the following procedure, or its graphic equivalent:

(a) At each designated seating position, place the pivot point of the measuring device—

(1) For seats that are adjustable fore and aft, at—

(i) The seating reference point; and

(ii) A point 5 inches horizontally forward of the seating reference point and vertically above the seating reference point an amount equal to the rise which results from a 5-inch forward adjustment of the seat or 0.75 inch; and

(2) For seats that are not adjustable fore and aft, at the seating reference point.

(b) With the pivot point to "top-of-head" dimension at each value allowed by the device and the interior dimensions of the vehicle, determine all contact points above the lower windshield glass line and forward of the seating reference point.

(c) With the head form at each contact point, and with the device in a vertical position if no contact points exists for a particular adjusted length, pivot the measuring device forward and downward through all arcs in vertical planes to 90° each side of the vertical longitudinal plane through the seating reference point, until the head form contacts an interior surface or until it is tangent to a horizontal plane 1 inch above the seating reference point, whichever occurs first.

"Interior compartment door" means any door in the interior of the vehicle installed by the manufacturer as a cover for storage space normally used for personal effects.

"Longitudinal" or "longitudinally" means parallel to the longitudinal centerline of the vehicle.

"Motorcycle" means a motor vehicle with motive power having a seat or saddle for the use of the rider and designed to travel on not more than three wheels in contact with the ground.

"Motor-driven cycle" means a motorcycle with a motor that produces 5-brake horsepower or less.

"Multipurpose passenger vehicle" means a motor vehicle with motive power, except a trailer, designed to carry 10 persons or less which is constructed either on a truck chassis or with special features for occasional off-road operation.

MPV Defined

"Open-body type vehicle" means a vehicle having no occupant compartment top or an occupant compartment top that can be installed or removed by the user at his convenience.

"Outboard designated seating position" means a designated seating position where a longitudinal vertical plane tangent to the outboard side of the seat cushion is less than 12 inches from the innermost point on the inside surface of the vehicle at a height between the seating reference point and the shoulder reference point (as shown in fig. 1 of Federal Motor Vehicle Safety Standard No. 210) and longitudinally between the front and rear edges of the seat cushion.

"Overall vehicle width" means the nominal design dimension of the widest part of the vehicle, exclusive of signal lamps, marker lamps, outside rearview mirrors, flexible fender extensions, and mud flaps, determined with doors and windows closed and the wheels in the straight-ahead position.

"Parking brake" means a mechanism designed to prevent the movement of a stationary motor vehicle.

"Passenger car" means a motor vehicle with motive power, except a multipurpose passenger vehicle, motorcycle, or trailer, designed for carrying 10 persons or less.

"Pelvic impact area" means that area of the door or body side panel adjacent to any outboard designated seating position which is bounded by horizontal planes 7 inches above and 4 inches below the seating reference point and vertical transverse planes 8 inches forward and 2 inches rearward of the seating reference point.

"Pole trailer" means a motor vehicle without motive power designed to be drawn by another motor vehicle and attached to the towing vehicle by means of a reach or pole, or by being boomed or otherwise secured to the towing vehicle, for transporting long or irregularly shaped loads such as poles, pipes, or structural members capable generally of sustaining themselves as beams between the supporting connections.

"School bus" means a bus that is sold, or introduced in interstate commerce, for purposes that include carrying students to and from school or related events, but does not include a bus designed and sold for operation as a common carrier in urban transportation.

"Seating reference point" means the manufacturer's design reference point which—

(a) Establishes the rearmost normal design driving or riding position of each designated seating position in a vehicle;

(b) Has coordinates established relative to the designed vehicle structure;

(c) Simulates the position of the pivot center of the human torso and thigh; and

(d) Is the reference point employed to position the two dimensional templates described in SAE Recommended Practice J826, "Manikins for Use in Defining Vehicle Seating Accommodations," November 1962.

"Semitrailer" means a trailer, except a pole trailer, so constructed that a substantial part of its weight rests upon or is carried by another motor vehicle.

"Service brake" means the primary mechanism designed to stop a motor vehicle.

"Speed attainable in 2 miles" means the speed attainable by accelerating at maximum rate from a standing start for 2 miles on a level surface.

"Torso line" means the line connecting the "H" point and the shoulder reference point as defined in SAE Recommended Practice J787g, "Motor Vehicle Seat Belt Anchorage," September 1966.

"Trailer" means a motor vehicle with or without motive power, designed for carrying persons or property and for being drawn by another motor vehicle.

"Trailer converter dolly" means a trailer chassis equipped with one or more axles, a lower half of a fifth wheel and a drawbar.

"Truck" means a motor vehicle with motive power, except a trailer, designed primarily for the transportation of property or special purpose equipment.

"Truck tractor" means a truck designed primarily for drawing other motor vehicles and not so constructed as to carry a load other than a part of the weight of the vehicle and the load so drawn.

"Unloaded vehicle weight" means the weight of a vehicle with maximum capacity of all fluids necessary for operation of the vehicle, but without cargo or occupants.

"95th percentile adult male" means a person possessing the dimensions and weight of the 95th percentile adult male specified in Public Health Service Publication No. 1000, Series 11, No. 8, "Weight, Height, and Selected Body Dimensions of Adults."

[33 FR 19703, Dec. 25, 1968. Redesignated at 35 FR 5118, Mar. 26, 1970, and amended at 35 FR 5333, Mar. 31, 1970; 35 FR 11242, July 14, 1970; 35 FR 15222, Sept. 30, 1970; 36 FR 2511, Feb. 5, 1971; 36 FR 7058, Apr. 14, 1971; 36 FR 13926, July 28, 1971; 37 FR 3185, Feb. 12, 1972, 37 FR 10938, June 1, 1972; 38 FR 5636, Mar. 2, 1973; 40 FR 8953, Mar. 4, 1975; 40 FR 60035, Dec. 31, 1975; 42 FR 7144, Feb. 7, 1977]

§ 571.4 Explanation of usage.

The word "any," used in connection with a range of values or set of items in the requirements, conditions, and procedures of the standards or regulations in this chapter, means generally the totality of the items or values, any one of which may be selected by the Administration for testing, except where clearly specified otherwise.

Examples: "The vehicle shall meet the requirements of S4.1 when tested at any point between 18 and 22 inches above the ground." This means that the vehicle must be capable of meeting the specified requirements at every point between 18 and 22 inches above the ground. The test in question for a given vehicle may call for a single test (a single impact, for example), but the vehicle must meet the requirement at whatever point the Administration selects, within the specified range.

"Each tire shall be capable of meeting the requirements of this standard when mounted on any rim specified by the manufacturer as suitable for use with that tire." This means that, where the manufacturer specifies more than one rim as suitable for use with a tire, the tire must meet the requirements with whatever rim the Administration selects from the specified group.

"Any one of the items listed below may, at the option of the manufacturer, be substituted for the hardware specified in S4.1." Here the wording clearly indicates that the selection of items is at the manufacturer's option.

[36 FR 2511, Feb. 5, 1971]

§ 571.5 Matter incorporated by reference.

(a) *Incorporation.* There are hereby incorporated, by reference, into this part, all materials referred to in any standard in Subpart B of this part that are not set forth in full in the standard. These materials are thereby made part of this regulation. Materials subject to change are incorporated as they are in effect on the date of adoption of this part, unless the reference to them provides otherwise.

(b) *Availability.* The materials incorporated by reference, other than acts of Congress and matter published elsewhere in the FEDERAL REGISTER, are available as follows:

(1) *Standards of the Society of Automotive Engineers (SAE).* They are published by the Society of Automotive Engineers, Inc. Information and copies may be obtained by writing to: Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

(2) *Standards of the American Society for Testing and Materials.* They are published by the American Society for Testing and Materials. Information on copies may be obtained by writing to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

(3) *Standards of the American National Standards Institute.* They are published by the American National Standards Institute. Information and copies may be obtained by writing to: American National Standards Institute, 1430 Broadway, New York, New York 10018.

(4) *Data from the National Health Survey, Public Health Publication No. 1000, Series 11, No. 8.* This is published by the U.S. Department of Health, Education, and Welfare. Copies may be obtained for a price of 35 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

All incorporated materials are available for inspection at the National Highway Traffic Safety Administration, 400 Seventh Street SW., Washington, D.C. 20591.

[33 FR 19704, Dec. 25, 1968. Redesignated at 35 FR 5118, Mar. 26, 1970, and amended at 35 FR 5120, Mar. 26, 1970; 36 FR 1148, Jan. 23, 1971; 41 FR 52880, Dec. 2, 1976; 41 FR 56812, Dec. 30, 1976]

§ 571.7 Applicability.

(a) *General.* Except as provided in paragraphs (c) and (d) of this section, each standard set forth in subpart B of this part applies according to its terms to all motor vehicles or items of motor vehicle equipment the manufacture of which is completed on or after the effective date of the standard.

(b) [Reserved]

(c) *Military vehicles.* No standard applies to a vehicle or item of equipment manufactured for, and sold directly to, the Armed Forces of the United States in conformity with contractual specifications.

(d) *Export.* No standard applies to a vehicle or item of equipment in the circumstances provided in section 108(b)(5) of the Act (15 U.S.C. 1397 (b)(5)).

(e) *Combining new and used components.* When a new cab is used in the assembly of a truck, the truck will be considered newly manufactured for purposes of paragraph (a) of this section, the application of the requirements of this chapter, and the Act, unless the engine, transmission, and drive axle(s) (as a minimum) of the assembled vehicle are not new, and at least two of these components were taken from the same vehicle.

(f) *Combining new and used components in trailer manufacture.* When new materials are used in the assembly of a trailer, the trailer will be considered newly manufactured for purposes of paragraph (a) of this section, the application of the requirements of this chapter, and the Act, unless, at a minimum, the trailer running gear assembly (axle(s), wheels, braking and suspension) is not new, and was taken from an existing trailer—

(1) Whose identity is continued in the reassembled vehicle with respect to the Vehicle Identification Number; and

(2) That is owned or leased by the user of the reassembled vehicle.

[33 FR 19703, Dec. 25, 1968. Redesignated, 35 FR 5118, Mar. 26, 1970, and amended at 36 FR 7855, Apr. 27, 1971; 38 FR 12808, May 16, 1973; 40 FR 49341, Oct. 22, 1975; 41 FR 27074, July 1, 1976]

§ 571.8 Effective date.

Notwithstanding the effective date provisions of the motor vehicle safety standards in this part, the effective date of any standard or amendment of a standard issued after September 1, 1971, to which firefighting vehicles must conform shall be, with respect to such vehicles, either 2 years after the date on which such standard or amendment is published in the rules and regulations section of the FEDERAL REGISTER, or the effective date specified in the notice, whichever is later, except as such standard or amendment may otherwise specifically provide with respect to firefighting vehicles.

[36 FR 13927, July 28, 1971]

§ 571.9 Separability.

If any standard established in this part or its application to any person or circumstance is held invalid, the remainder of the part and the application of that standard to other persons or circumstances is not affected thereby.

[33 FR 19705, Dec. 25, 1968. Redesignated at 35 FR 5118, Mar. 26, 1970]

APPENDIX G

1978 ARIZONA UTILITY VEHICLE INJURY COLLISIONS REPORTED BY THE DEPARTMENT OF PUBLIC SAFETY

1978 ARIZONA UTILITY VEHICLE INJURY COLLISIONS REPORTED BY THE DEPARTMENT OF PUBLIC SAFETY

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
01/06/1315	Toyota Land Cruiser	UNK	UNK	UNK	Hit and run - ran down ramp delinators	
01/24/0730	1972 Toyota Land Cruiser	FJ40124057 H/T	18	M	Lost control (50mph) on ice - rollover	
04/02/2300	1977 Toyota Land Cruiser	FJ40250022 HT & Soft Top	47	M	Est. 0 stopped. Struck by 78 Datsun (drinking driver, left scene). $1500. damage to Datsun. No damage or injury to Jeep.	
04/11/1545	1977 Toyota Land Cruiser	FJ40239684	20	M	Est. 15mph hit vehicle #2 - failed to stop in time.	
04/24/0000	1974 Toyota Land Cruiser	FJ40183812 H/T	26	M	Est. 55 mph driver drinking/fell asleep - ran off road overturned.	
05/04/2345	1974 Toyota Land Cruiser	FJ40181516	33	M	Est. 30 mph struck vehicle '73 Ford while changing lanes.	
08/01/1530	1976 Toyota Land Cruiser	63450	23	F	Est. 5 mph ran into '70 Chrysler	No injuries
10/05/1845	1967 Toyota Land Cruiser	FJ4045575	26	M	Est. 40 mph hit '78 Chev. broadside at intersection. Phoenix P.D.	#4 inj. to Toyota driver. Fatal to Chev. driver. #4 inj to 31 yr. male Chev. pax. #3 to 40 yr. male Chev. pax. #3 to 27 yr. female Chev. pax.
12/09/1115	1979 Toyota Land Cruiser	FJ4078851	24	M	Est. 20 mph climbing Mt. Lemon - slid on ice Pima County S.D.	
12/29/2030	1977 Toyota Land Cruiser	FJ40250167	32	M	Est. 50 mph collided head on with 77 Chev. at 45 mph. Phoenix P.D.	Fatal to Chev. driver (45 yr. male),serious #4 inj. to Chev. female 40 yr, & #3 to 18 yr male Chev. pax (#3 inj. to Toyota driver)

DATE	YR.& BODY STYLE	VIN NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
01/09/0749	71 Toyota Land Cruiser	UNK	UNK	M	Ran into vehicle rear - 4 cars - 60 mph rollover 1 ejection (73 Chev.Blazer - 75 Int.Scout II)	
01/13/1440	73 Toyota Landcruiser	UNK	UNK	UNK	Rear -ended (stopped) by 2 other cars.	
01/12/1415	73 Toyota	UNK	UNK	UNK	X-road collision, hit Mustang	
01/13/0136	65 Toyota	UNK	UNK	UNK	Stopped for light rear-ended by VW.	
01/07/1850	74 Chevy Blazer	UNK	UNK	UNK	Both drivers DWI	No injuries
	77 Chevy Blazer 75 Chevy Blazer	UNK UNK	UNK 57	UNK M	Hit at inter-section (DOT vehicle) 20 mph collision	No injuries
01/19/1935	75 Chevy Blazer	CKY185F158253	19	M	"Ultra-Wide" tires skidded into rear of patrol car	
01/28/1210	74 Chevy Blazer	CKY184F182565	37	M	Overcorrected 55 mph towing trailer - overturned	
02/01/0220	70 Chevy Blazer	KS1805147180	33	M	Overturned - swerved 40 mph, alcohol factor?	
02/02/0735	74 Chevy Blazer	CKY184F114989	35	F	Collision 15 mph	
02/03/1050	71 Chevy S/W Blazer	KE1818673058	21	M	25 mph collision	
02/12/1745	74 Chevy Blazer	CKY184F122545	19	M	Rollover - alcohol DWI	
02/15/1759	76 Chevy Blazer	UNK	UNK	UNK	65 mph collision	
02/16/0645	74 Chevy Blazer	CKY184F161540	41	M	Uphill at 25 mph, lost traction, skidded on snow, overcorrected, collision 2nd vehicle (76 GMC)	
02/21/0720	74 Chevy Blazer	CKY164F102849	47	UNK	3 car accident	
02/22/0845	72 Chevy Blazer	CKE182F187949	23	UNK	Passing car which turned into Blazer	
03/02/0815	75 Chevy Blazer	CK4185F107784	61	M	15 mph skid snow, Jeep into Blazer	
03/02/1056	77 AMC Jeep Wagon	J7A15M2020862	46	M	K + Apache Indian Reservation McNay	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
03/03/0155	71 Chev Blazer	KE1815663530	56	M	DWI drove up embankment until rolled over.	
03/05/0830	73 Chev Blazer	CKY183F111965	25	M	30 mph est., ice, lost control, rollover.	
03/05/0900	77 Chev Blazer	CKR187F150188	43	F	35 mph est., ice, sideswiped 77 GMC tractor-trailer, no damage.	
03/05/1730	70 Chev Blazer	KE1145272021	36	M	20 mph est; snow, lost control, damaged in snowback.	
03/15/1810	77 Chev Blazer	CKR187F106640	32	M	Est. 65 mph, blinded by sun, overran rear of 71 Chev.	
03/19/1630	74 Chev. Blazer	CKY184F184157	22	UNK	Est. 50 mph, rocks kicked-up by passing vehicle (no collision)	
03/24/1800	73 Chev. Blazer	CKY183F181194	48	F	Est. 55 mph, lost control in wind of passing tractor-trailer - towing 13' cardinal travel trailer.	
04/02/0800	75 Chev. Blazer	CK4185F126275	UNK	UNK	No driver, rollover, driver stepped outside when went into reverse down 190'.	
04/08/0630	77 Chev. K-5 Blazer	CKL1872199490	22	M	50 mph lost control rolled down embankment 1½ times, rollover.	
04/08/1435	73 Chev Blazer	CKY183F1355998	38	F	Est. 50 mph lost control rolled over 1½ times	
04/08/1600	77 Chev Blazer	CKL187F224048	20	M	Hit by 78 Chev. faster moving vehicle.	
04/13/0740	74 Chev Blazer	CKY184F190239	24	M	Est. 2-4 mph started up at inter-section behind car which stopped, ran into it. (Ran into rear of Datsun 78, 2 dr cpe, 300-500 damage - no damage to Blazer)	
04/21/1552	69 Chev Blazer	BKE1495873521	53	UNK	Hit guard rail, towing trailer with bulldozer on it, lost control.	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
05/09/0810	75 Chev Blazer (hard-top)	IH57HSR521188	23	M	Est. 35 mph struck rear of stopped '75 Chev.	
05/27/1400	77 Chev Blazer	5CKR187F195405	32	M	Est. 45 mph lost control towing trailer, rolled over on rt. side.	(No injuries to driver or 4 pax.)
06/04/0145	73 Chev Blazer	CKY183F104090	22	M	Est. 65 mph drinking - lost control & ran off road	No injuries
06/11/1500	74 Chev Blazer	CKY184F151570	24	M	Est. 65 mph rollover, fell asleep, hit embankment.	#3 inj. to driver, #4 inj. to 3 pax.
07/15/0600	76 Chev Blazer	CKL186F217810	20	F	Est. 45 mph ran off road - rollover.	No injury
07/17/1645	70 Chev Blazer	KE1805174418	19	M	Est. 45 mph, hit 59 Chev. in rear, 3 cars involved.	
07/26/1055	73 Chev Blazer	CKY183F138638	29	F	Est. 45 mph inter-section collision with 77 Ford P.U.	No injury
08/04/2250	72 Chev Blazer	CKE1825166761	24	M	50 mph, rollover, rock embankment	4 injured
08/18/1240	77 Chev Blazer	CKR187F132216	21	M	Est. 50 mph, jacknifed when applied brakes, towing 70 Ford vehicle.	
08/30/1245	71 Chev Blazer	KE1815669669	63	M	Est. 35 mph - rollover. Drove off road to avoid vehicle, was towing 77 Firebird. Lost control & OT.	
08/30/1555	77 Chev Blazer K-5	CKR187F153648	23	M	Est. 60 mph - rollover. Struck 77 Dodge Van and overturned.	
09/04/2000	71 Chev Blazer	KE1815655390	30	M	Est 60 + mph, lost control, hit 2 other vheicles, including a 1978 Chev suburban.	
09/30/1815	73 Chev Blazer	CKY183F118177	57	UNK	Est. 65 mph, lost control went off road & rollover.	
10/12/1300	74 Chev Blazer	CKY184F167521	22	M	Est. 0 mph, struck from behind while on ramp, minor damage.	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
10/13/0630	77 Chev. Blazer	CKR1872179576	20	M	Est. 50 mph, rollover, fell asleep, ran through 50' barbed wire.	
10/15/1000	73 Chev Blazer	CKY18F105456	18	F	Struck in rear by 64 Ford Van, est. 25 mph.	
10/17/2045	78 Chev 4WD Sta Wag(Blazer?)	CKL1882121673	33	M	Est. 55 mph, rollover, fell asleep and overturned in median.	
10/19/0650	72 Chev Blazer	CKE182F167874	26	M	Est. 45 mph, hit by tire and wheel rolling down road.	
10/21/0012	71 Chev Blazer	KE1815652333	47	M	Est. 20 mph, intersection collision.	
10/21/0140	73 Chev Blazer	CKY18F109123	27	M	Est. 55 mph, hit by 69 Chevy while passed, minor damages.	
10/21/0700	73 Chev Blazer	CKY183F180702	32	M	Est. 15 mph, hit by 74 Mazda in turn.	
11/01/1600	78 Chev Blazer	CKL188Z198832	19	M	Est. 3 mph, hit rear of 74 Datsun	
11/05/1435	73 KS Chev Blazer	CKY183F126985	26	M	Est. 5 mph, X-section collision.	
12/02/1530	73 Chev Blazer	CKL188F149286	29	M	Est. 0 mph, ran into from behind by 73 Dodge truck.	
12/02/2030	78 Chev Blazer	CKL188Z206590	35	M	Est. 62 mph. Ran into rear of 72 Ford stopping suddenly.	
12/08/1830	74 Blazer	CKY184F129550	24	M	Est. 45 mph, rollover, lost control	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
01/09/1230	76 Jeep Pick-up	UNK	77	UNK	55 mph collision with 75 Nova	#4 injury
01/13/1415	75 CJ5 Jeep Ragtop	UNK	56	M	10 mph collision/ 2nd vehicle	No injuries.
01/13/2310	72 Jeep Wagoneer	UNK	35	M	Flipped end over end.	
01/15/1300	67 Jeepster Convert.	UNK	72	M	Skidded on ice.	No injuries
01/15/1300	76 Jeep Special	J6F83AE072513	26	M	Hit on side 15 mph/snow/2nd vehicle	2 inj.
01/16/0600	65 Jeep Sta. Wagon	1414C50381	30	M	Spun out on ice road hit guard rail - 40 mph	
01/17/0730	75 Jeep CJ5	JSF83AH022706	25	M	Skidded on ice, rollover, 1½ times "wearing seat belts"	Injury
01/18/0630	68 Jeep Comman-do Sta. Wag.	8705F173023	65	UNK	Left rear fender hit 5 mph by 2nd vehicle.	
01/20/0915	51 Jeep	RMC 1143	26	M	Lost control on ice and overturned.	
01/20/1600	73 CJ5	J3F8335TH72790	21	M	60 mph went off road, spun & rolled on side.	
01/21/1015	74 CJ5 Jeep	J4F835TA45585	22	UNK	Tire & axle came off at 55 mph - hit other car.	No injuries.
01/21/1540	70 Jeep (PO)	8513-17980)	56	UNK	Hit from rear.	
01/22/1400	69 Jeepster Comm.Roadster	8705F1750886	46	UNK	Towed trailer came off Jeep hitch.	
01/23/0910	72 Jeep Pick-up	J2F87HVE00078	28	M	2 mph inter-section collision.	
01/29/1921	76 "Special" Jeep AMC	J6F83AA085228	27	M	Rolled 1-3/4 times.	
01/30/1000	74 Jeep CJ5	J4F835TH87350	24	M	Ran into rear of Sta. Wagon	No injuries.
01/30/1245	75 AMC Jeep CJ5-open body	J5M83AA041476	29	M	Pulling cotton trailer, lost control, 15 mph, spun out.	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
02/01/0640	47 Willys Jeep	130426	55	M	Ice, fog - head on collision with 175 6MC stepvan, floatation tires	2 fatalities
02/12/1330	77 Jeep Sta. Wagon	J7A18MP020543	27	F	Stopped. Struck in rear	
02/14/0645	68 Jeep Wagon-eer SW4WD	1414C5109303	51	M	Tried to stop on ice, 15-25 mph, skidded into rock.	
02/17/1728	71 Jeep CJ5	8305037367653	35	M	Rear end into 2 other stopped vehicles.	
02/19/1430	76 Jeep Sta. Wag.	J6A15MN099734	64		Forced into embankment.	
02/20/1760	72 Jeep Sta. Wag.	J2F835TH32273	24		360^0 Rollover, rollbar.	
02/26/0110	74 Jeep AMC CJ5 Universal	JAF835TH09796	25	M	Missed curve, rollover, driver asleep?	
02/27/0940	76 CJ7 Jeep	UNK	32	M	73 Dodge motor home towing jeep, Jeep sideswiped 77 Datsun.	
02/28/1525	77 AMC Jeep CJ7 Special	J7M93EA085490	59	M	Rain - boulder fell into road onto Jeep.	
03/02/1056	77 AMC Jeep Wagon	J7A15M2020862	46	M	K + Apache Ind. Reserv. McNay	
03/02/0815	75 Chevy Blazer	CKY185F107784	61	M	15 mph skid snow Jeep into Blazer	
03/05/2015	75 AMC Jeep CJ5	J5F83AA657084	20	M	Rollover, est 40 mph	Fatal
03/07/1820	77 AMC Jeep Sta. Wag.	J4F835TH58579	36	M	Est. 20 mph, lost control off road, Rollover multiple times down 60^0 grade.	Fatal
03/16/1435	68 Jeep 5 ton milt. truck	348600-68-0327-10325 Kaizer USMC	21	M	Est. 45 mph, tire blew out, into concrete wall.	
03/18/0735	75 Jeep SP	JSF16MA047731	38	M	Est. 40 mph, skidded into ditch.	
03/19/2135	76 AMC Jeep Truck J-10(box)	J6A25MP073364	30	M	Driver DWI was hit by Jeep in hit & run. Est. 25 mph, police stopped vehicle for no current registration & no drivers lic.	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
03/20/1650	67 Jeep Special	8305C210723	33	M	Ran off curve, rollover. Ejected and fire.	Fatal
03/22/1605	57 Willys Jeep	37246	64		Est. 45 mph, hit in rear by overrunning 66 Mack tractor-trailer.	
03/23/2130	76 Jeep CJ7	J6F93EH05411	33		Est. 60+ mph 3 Rollover - alcohol.	
03/24/1545	77 AMC Jeep Hard Top CJ7	27893EH067434	22	M	Est. 35-40 mph, hit car (69 Chevy) in read - couldn't stop in time.	
03/28/1220	73 Jeep	UNK	18	M	Est. 35 mph, hit rear of car pushing it into third vehicle.	
03/29/1655	70 Jeep S/W Sta. Wag.	8705F1758788	19	F	Hit car while passing.	
03/30/1410	71 Jeep Gladiator Series 4WD	3408X19600793 J4600 Series	44	M	Unable to stop in time, est. 40 mph, DWI.	
03/30/1950	68 Jeep 4WD	8705F1727042	47	M	Est. 55 mph (Impacted Bull in Road) - killed bull.	
03/31/1555	70 Jeep USPO DJ5A	851363396	40	M	Est. 7 mph, left turn - hit.	
04/01/1105	68 Jeep Wagoneer SW4WD	1414C19300185	54	M	Est. 40 mph, slid into rear of 74 Chev. as making turn in snow.	
04/02/1650	75 Jeep Wagoneer U.S. Govt.	040746	53	M	Est. 55 mph, skidded in snow lost control, rolled over.	
04/02/2350	75 Jeep CJ5	J5F83AA041879	24	M	Est. 50 mph lost traction & overturned in median.	
04/05/1250	72 Jeep Wagoneer Std.	J2A1440N08724	55	F	Est. 2 mph struck car ahead at x-section which had started up and stopped again.	
04/05/1600	73 Jeep Spl.	J3F835TH13095	34	M	Est. 20 mph, unable to stop in time - hit '62 Merc. Comet.	
04/07/0860	78 Jeep P.U.	J8A45NN042037	25	M	Est 5 mph. Hit from behind by 73 VW Bug. "Vehicle No. 2 received substantial damage to front end & Veh. #2 (Jeep) received point transfer & minor scratches".	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
04/08/1550	78 AMC Jeep CJ5 (open body)	J8M93EA016023	29	M	Est. 25 mph skidded and collided with 77 Chev. P.U.	
04/08/1640	76 AMC Jeep CJ7 (open body)	JGF93EH102289	25	M	Lost control avoiding another vehicle & rolled over Roll-bar & Seatbelts.	
04/11/1200	74 AMC Jeep Wagoneer-Custon	J4A154CP80812	60	M	Est. 35 mph failed to stop in time. Hit rear of 77 Ford.	
04/13/2235	76 Jeep	UNK	22	M	Est. 55 mph - had been drinking - hit guardrail and spun around - appeared in stupor. Father owned Jeep.	
04/16/1630	72 Jeep Com-mando-Roadster	J2A87FVH38187	57	M	Est. 55 mph brakes on trailer caught fire - stopped off road.	
04/25/0117	69 Jeep	35666	50	M	Est. 45 mph/20 mph over curve, rollover, into canyon, alcolol factor - ejected occup.	Fatal
04/25/1715	70 AMC Jeep CJ5 Universal	8305017-364549	26	M	Est. 25 mph, blowing dust obscured vision and run into by 74 Ford.	
04/26/0545	77 AMC City CJ7 (open body)	J7F93EH123042	23	M	Est. 35 mph, struck boulder on curve avoiding 2nd vehicle. Ext. damage.	
05/01/1650	69 AMC Jeep	851311395	22	F	Est. 50 mph, Daughter hit shift lever, went into skid overturned on left side.	
05/04/0100	68 Jeep CJ5	83055239035	22	M	Est. 25 mph, missed curve, rolled over embankment.	
05/06/1045	68 Ariz.Natl. Gd. Ford Jeep	2R4860 MISIAI Military	32	M	50 mph, swerved, lost control overturned on rt. side.	
05/06/1705	77 AMC Jeep Wagoneer	J7A15MN012983	35	M	Est. 55 mph, struck in rear by overtaking 69 Chevy whose driver panicked and ran from scene.	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
05/07/1530	72 Jeep Wagoneer	J2A144CN19361	57	F	Est. 50 mph - struck in rear.	No injuries
05/11/0850	69 USPO Jeep DJ5A	P916627	31	F	0 mph. Stopped at inter-section, started up and stopped and 69 Ford struck rear end.	
05/16/1140	76 Jeep CJ5	J6F83EA001450	25	F	Stopped. Hit from behind, Est. 0.	
05/17/1637	73 Jeep	J3F35TH19637	20	F	Est. 60 mph, lost control - overcorrected rollover 2½ times.	Driver injury #4 & 1 male pax age 25 inj. #4.
05/18/1910	68 Jeepster Commando S/W	8705F1750848	31	M	Est. 50 mph. Jeep hit from rear by 73 MG convert. Jeep lost control and ended up in ditch.	No inj to driver, pax M 15 inj. #2.
05/19/1345	73 Jeep	UNK	18	M	Est. 55 mph off road into arroyo, overturned.	Driver inj. #4, 1 F pax. 18 inj. #4.
05/21/0230	73 Jeep CJ5	J3F835TH40354	22	M	Est. 50 mph. Lost control rollover on left side.	Driver no injury.
05/21/0300	76 Jeep CJ7	J6A93EH031851	21	M	Est. 55 mph, rollover on left side, lost control shoulder.	Driver no Injury. 1 pax M 21 no injury.
05/21/1950	78 Jeep Spl. CJ7	J8M93EA100816	32	M	Est. 36 mph rollover, factory STD rollbar Fiberglass top.	Fatal
05/26/1430	76 AMC Jeep CJ-7	J6F93EH019401	16	M	Est. 25 mph, hit another 69 Ford Pick-up on narrow curve, on a mountain road.	No inj. to driver.
05/29/1520	76 CJ7 Jeep	J6M93EA073558	21	M	Est. 35 mph, lost control on curve and rolled over, *equipped with rollbar & wearing seat belt	No injury.
05/31/0730	71 Jeep Wagon	8705F37069470	37	M	Est. 0 impact in passing stopped 73 Merc.	No injury.
06/02/0840	69 Jeep Sta. Wag.	8705F1753438	57	F	Est. 55 mph, left front wheel came off.	No injury.
06/02/1740	76 Jeep Wagon	JGF83EE072954	27	M	Est. 35 mph, lost control sharp curve Rollover.	Inj. #3 driver Inj. #3 F 24 yr. pax.

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
06/03/0144	76 Jeep CJ5	J6F83AH001532	43	M	Est. 25 mph, hit in rear by 69 Olds at 51 mph est.	Fatal
06/11/0115	76 Jeep CJ7	J6A93AH005472	50	M	Est. 55 mph, hit 73 Chev. in lane change.	No injury to Jeep driver (#3 inj. to Chev. 73 Driver age 24 M.)
06/19/0720	75 Jeep Sta. Wagon	J5A15MP010934	34	M	Est. 0 stopped, hit from rear by 65 Dodge	No injury to Jeep driver #3 inj. to driver of other vehicle 19 F.
06/21/1800	74 Jeep CJ5 (Conv.)	J4F835TA38544	35	UNK	Est. 45 mph inter-section collision with 63 Wagon Plymouth	No injury.
06/28/0330 06/28/2154	76 Jeep CJ7 75AMC PO Jeep DJ5D	T6593E4001613 DJ5D5000153	23 57	M UNK	Est. 45 mph, pax 22 F. "fell out" roolbar at 45 mph (3 cars hit by 73 Merc. Coug., hit 2nd vehicle & jumped median)	DWI Driver fatal.
06/30/2045	77 Jeep Conv. CJ5	J7F83EH071014	33	M	Est. 60 mph, tipped at 45° (side)	Fatal
07/01/2300	78 AMC Jeep CJ7	J8A93EH121041	19	M	Est. 50 mph, while being passed by Tractor-trailer drifted over and impacted.	No injury.
07/02/1210	64 Jeep Sta. Wag.	141422704	37	M	Est. 40 mph yielded to bus at freeway ramp.	#3 inj. to driver & child age 8 M
07/02/2000	76 Jeep CJ5 Conv.	J6F85EH081251	25	M	Est. 50 mph, ran off road and over corrected, and overturned.	No injury.
07/03/0130	73 Jeep CJ5	J3F835T1146722	24	M	Est. 35 mph, curve - lost control rollover (rollbar)	3 inj & 1 fatal
07/03/0750	73 Jeep Special	J3F835TA32134	19	M	Est. 55 mph, driver ejected, ran into rear of 76 Mazda - broke axle.	
07/03/1010	71 AMC Jeep CJ5 Universal	830501735140	21	M	Est. 35 mph, ran off road at off-ramp.	No injuries.
07/03/1315	75 AMC Jeep CJ5 Conv.	J5F833AE023923	36	F	Est. 50 mph, fell asleep. overcorrected. Rollover	#3 inj. driver. no pax.

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
07/08/1535	76 AMC Jeep CJ5 Conv.	J6F83AA085228	27	M	Est. 15 mph hit 77 Ford pick-up in rear.	No injuries.
07/09/1330	42 Willys Jeep	358116	UNK	UNK	Est. UNK speed., caught bumper of 74 Chev. on ramp.	No injuries.
07/11/0530	71 Jeepster	8705F17072959	19	M	Est. 55-70 mph. Rollover lost control.	#3 inj. to driver and #4 inj. to M 16 pax.
07/11/1255	75 AMC Jeep USDA CJ6 Open Body	J5F84CH059219	32	M	Est. 50-50 mph drove to left of center line, lost control (5 pax.)	
07/14/1400	AMC CJ5 Jeep	J4F835TA02230	28	M	276^{0} left curve, lost control, rolled (CJ5 Jeep parked) Rollbar & seat belt fastened, not ejected.	Fatal Driver died of fx neck and head injury.
07/15/1700	77 Jeep CJ5	J7F83EH073836	36	M	Est. 45 mph, ran into 73 Chev. on ramp	No injury.
07/16/1510	73 Jeep CJ5 Convert.	J3F835TH45630	29	M	Est. 55 mph lost control on curve rollover on left side, driver & pax. ejected, alcohol involved.	
07/22/1735	73 Jeep Wagoneer Custom	J8A15NP071316	64	M	Est. 28 mph, hit 76 Saab	No injury.
07/24/0930	73 Jeep Special Cloth Top	UNK	16	F	End over end 45', no speed given - too fast - 75' broadrail skid - airborne 27' and 20' before 1st impact.	2 fatal (including driver and 15 yr. F rolled over ejected - 16 yr.M ejected rear seat. Driver ejected.)
07/28/1840	69 Jeep CJ5 Universal	8305017356305	18	M	Est. 45 mph, hit embankment. Rolled 1½ times Rollover. Driver ejected.	#4 inj. driver
08/04/0250	78 Jeep CJ5 (open body)	J8F83EH079858	34	M	Est. 1 mph, crossing median - Pax. bumped head Straight down embankment.	
08/09/0745	72 Jeep CJ5	J3F835TH25630	29	M	Est. 40 mph Rollover on	Inj. leg.

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
08/12/1645	51 Willys Jeep (& 79 Blazer)	MUD43352	29	M	Est. 35 mph, towing 1979 Chev. Blazer which overturned.	
08/13/0630	76 Jeep-2 dr. Cherokee "S"	56A17MZ072404	53	M	Est. 50 mph, lost control towing 25' trailer, trailer overturned.	
08/18/1237	67 Jeep CJ5	8305A229896	63	M	Est. 0 mph, 3 vehicle collision.	
08/23/0950	70 Jeep Commando S/W	8705F1762382	47	M	Est. 0 mph, inter-section 1st vehicle stopped Jeep started up into it.	
08/26/1530	74 Jeep Renegade	2J4F835TH05038	17	M	No speed est. DWI (manslaughter charges) ran off highway & hit rock & embankment, rolled over. Age 30 pax. F	Age 22 F pax died 9/6/78 Age 23 F pax punctured lung, fx rib, fx collar bone.
08/23/2150	Jeep	UNK			Parked, hit by DWI	Fatal 9/9/78
08/31/0800	70 Jeep	45850DGD16307	35	M	Est. 0, hit in rear, 3 car collision.	
09/06/1000	67 Jeep	8705F1619312	47	UNK	Est. 40 mph Rollover, lost control towing 17' trailer.	
09/08/1705	73 Jeep	J4M144CN33977	32	M	Est. 40 mph, hit in rear by tractor-trailer.	
09/13/1855	78 AMC Jeep CJ5 Open Body	J8F83AE038061	25	M	Est. 35 mph, lost control in rapid lane change, rolled onto left side & hit 73 Chev. van, rotated 170°, ejected pax.	Fatal M 29, inj. pax F 26, F 52
09/15/1120	73 Jeep Wagoneer Custom	J3A154CP07451	43	M	Est. 25 mph, Flying gravel windshield crack.	
09/15/1635	66 Jeep P/U	100612	38	M	Est. 5-10 mph, scratched rear bumper when hit from behind.	
09/27/0650	78 Jeep CJ7 Open Body	J8F93EH015481	29	M	Est. 20 mph, hit rear of 76 Chev.	#4 inj. to Toyota driver. Fatal to Chev. driver. #4 to 31 M Chev Pax #4 to 4 M Chev. Pax #3 to 27 F Chev Pax.

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
10/05/2350	76 Jeep Sta. Wag.	J6A46XZ097830	31	M	Est. 50 mph, Rollover. Lost control. Driver had 1½ beers.	
10/07/1700	76 Jeep CJ5 Open Body	J6F83AA000409	42	M	Est. 0 mph. Side hit by semi-trailer passing on curve.	
10/08/0900	60 Willys Jeep	57548109840	60	M	Est. 5 mph Rollover. Hit soft shoulder at 5-8 mph on hunting trip mt. road 31' drop off-rolling Jeep Rollbar.	Fatal to pax 60M No inj to driver 60M
10/10/1835	73 Jeep CJ5	J3F835TH23794	23	M	Est. 5 mph being towed - hit by 76 Toyota wagon.	
10/13/0635	65 Jeep	UNK	17	M	Est. 60 mph, faulty steering & front suspension. Rollover.	4 inj.
10/15/1700	76 Jeep Sta. Wag.	J6F83AA029683	41	M	Est. 50 mph, transmission locked, lost control towing boat on trailer.	
10/16/0850	47 Willys Jeep	102575	24	M	Est. 35 mph Rollover hit guardrail.	3 inj.
10/20/0720	72 Jeep Commando	J2A87FVH34694	32	F	Est. 50 mph Rollover on side. Lost control overriding 18 wheeler on loose gravel.	
10/21/1345	76 Jeep Cherokee "S"	J6A17M2101993	38	M	Est. 50 mph. Hit other vehicle 77 Buick pulling out in front.	
10/21/2120	76 Jeep Open body	J6M83AA035736	25	M	Est. 16 mph, wheel locked up, skidded, Rollover 1½ times down embankment.	
10/22/0300	66 Jeep Sta. Wag.	100068	37	M	Est. 45 mph Rollover hit soft shoulder.	
10/27/1000	66 Jeep Wagon	104606	20	M	Est. 50 mph evasive action, hit median wall.	
10/27/1945	70 Jeep Conv.	8705F1757752	26	M	Est. 70 mph Rolled Over 2-1/4 times	Fatal 10/31/78 head
10/28/1150	63 Willys Jeep	5754815293	16	F	Collision inter-section.	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
10/31/1920	72 AMC Jeep CJ5	J2F835TH02198	25	M	Collision with oncoming 69 Plymouth. Est. 55 mph	
11/02/1510	76 Jeep CJ5	JSF83AH023065	28	M	Est. 15 mph. Struck slowing 78 olds from rear.	
11/05/1745	68 Jeep Wag	1414C19300422	41	M	Est. 45 mph, hit rear of car which jammed on brakes to avoid dog.	
11/08/1545	74 Jeep Wag.	J4A144CN36399	38	M	Est. 40 mph. Forced motorcycle off road. Hit and run.	
11/09/0545	73 Jeep CJ5	J3F83STA17856	23	M	Est. 40 mph. Struck rear of 78 Ford.	
11/09/1500	73 CJ5 Jeep	53A154CN15002	32	M	Est. 15 mph, 3 car collision Jeep in middle.	
11/11/0100	78 CJ5 Jeep	J8M83AA042074	23	M	Est. 55 mph., lost control when lost air in rear tire.	
11/12/0250	75 CJ5 Jeep	J3F83AH001327	23	F	Est. 10 mph. Slid into on curve by drinking driver of 75 Datsun.	
11/13/1140	74 Jeep CJ5	J4F835TH66398	19	M	Est. 5 mph, inter-section collision with 77 Chev	No inj.
11/14/1410	77 Jeep Wag.	J7A17MZ12670	40	M	Est. 30 mph. Slid on snow into stopped 77 Dodge	
11/16/1445	78 Jeep Wagoneer Custom	J815NZ026427	61	F	Est. 0 mph, inter-section, 3 car collision.	
11/25/1045	73 Jeep CJ5	J3F83STH38183	18	M	Est. 30 mph, hit from rear by 77 Ford Van slide on ice.	
11/26/0320	73 Jeep Wagoneer Custom	J3A154CP53385	21	M	Est. 50 mph. DWI driver went asleep and off road.	
11/26/0945	76 Jeep CJ5SP	J7F83EH003269	26	M	Est. 45 mph. Rollover.	
11/26/1415	79 Jeep CJ5SP	J9F83EH041719	22	M	Est. 20 mph. Minor collision.	No inj.
12/01/2335	77 Jeep CK5	J7F83EH013849	19	M	Est. 35 mph, Jeep hit hitch-hiker.	
12/02/1310	65 Kaiser Jeep	51391	17	M	Est. 30 mph, 3 vehicle collision.	None
12/02/1700	68 Jeep Comm. S/W	8705F1729820	25	M	Est. 50 mph, rollover slippery road.	
12/03/1155	78 Jeep Conv. CJ7 Open Body	J8F93EH147783	26	M	Est. 9 mph, snow, slid into by 78 Dodge.	
12/06/1525	74 Toyota Jeep	FJ40179448	28	M	Est. 50 mph Rollover.	
12/08/1750	75 Jeep CJ5	J5F83AA008532	45	F	Est. 40 mph	

SEE 1978 TAB DATA

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
01/09/0833	72 Jeep Pick-up			F	Inter-section collision into side of another vehicle.	
01/10/1527	74 Jeep CJS			M	50 mph rollover.	No injury.
01/10/1535	62 Willys Jeep			M	Inter-section collision - hit in rt. rear.	
01/10/2345	72 CJS Jeep Conv. body style			M	Rollover in backing - min. damage.	
01/10/2350	74 Jeep Wagoneer			M	Rear hit by vehicle passing.	
01/11/0300	67 Jeep				DWI - hit pole.	
01/11/1305	61 Jeep P/U				Inter-section collision	
01/11/1944	43 Ford Jeep	GPW115285			Struck at inter-section	Two injured.
01/11/0130	66 Jeep				Inter-section collision	
	62 Int'l Jeep				Left turn inter-section collision, 35 mph.	
01/13/2205	73 Jeep Sta. Wagon				Stopped - struck in rear.	
01/14/1315	64 Jeep Sta. Wagon				Towing motorcycle out of road and motorcyclist fell.	
01/15/0810	69 Jeep Sta. Wagon				Enterfrom stop street, hit rt. rear with left front. 25 mph.	No injuries.

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
01/09/1640	67 Ford Bronco 4x4	VISNLA43989	UNK	UNK	40 mph. hit ditch.	
01/10/1800	70 Ford Bronco	UNK	20	UNK	45 mph, missed curve, off embankment.	None
01/13/0700	66 Ford Bronco	UNK	38	F	Hit box (water heater) in road.	None
01/13/1640	72 Ford Bronco	UNK	38	F		
01/28/1000	67 Ford Bronco	LIISNLA31183	59	F	Towing horse trailer, left rear trailer wheel came off.	
01/29/1915	72 Ford Bronco	UNK	42	M		
02/28/2215	Ford Bronco	UNK	UNK	M	Hit and run by long-haired male in red/white Bronco.	
03/17/1430	72 Ford Bronco	L11SGLM63998	70	F	Est. 50+ mph, lost control towing trailer.	
03/17/1905	66 Ford Bronco Wagon	VISFL73247	19	M	Est. 45 mph, left turn & hit by 73 Dodge.	
04/04/1700	78 Ford Bronco	VISSLBE2564	23	M	Est. 40 mph pulling 39' travel trailer - strong wind caused loss of control.	
05/21/0215	76 Ford Bronco	V156LB63657	37	M	Est. 55 mph - lost control Rollover on rt. side.	#4 inj. driver only
06/18/1315	71 Ford Bronco	VISGLL44602	20	M	Est. 45 mph hit 72 Chevy Pick-up in lane change.	No injuries.
07/18/2300	78 Ford Bronco	VISHLAE8057	28	M	Est. 65 mph swerved off road into embankment. Driver struck head on windshild, seat belts not used, probably intoxicated & fell asleep.	Fatal
07/20/2130	78 Ford Bronco	VISHLAJ8071	34	M	Est. 55 mph, hit 75 GMC Pick-up being pushed without lights.	None

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
08/22/1300	66 Ford Bronco	VISNL853215	46	F	Est. 20 mph, brakes failed, ran into 74 Ford.	
09/04/1430	68 Ford Bronco	VISNL071094	30	M	Est. 20 mph, ran into rear of 76 Chev. pick-up.	None
09/21/1515	71 Bronco	VISGLK60755	17	M	Est. 55 mph. Rollover. Lost control in stopping.	
10/15/1820	78 Bronco	VISHLCB3916	27	M	Est. 45 mph Rollover. Inattention of driver. Went off embankment.	
10/27/0246	70 Ford Bronco	VISGLH12975	22	M	Est. 50 mph, Rolled 4-wheeling, DWI driver racing another DWI driver	Fatal (2) M 25 pax fatal F 21 pax no injury
10/28/2037	67 Ford Bronco	VISNLA20020	62	M	Est. 55 mph, Fatal head-on collision, police pursuit at 85-90 mph.	Fatal
11/11/1445	78 Ford Bronco	VISHLCA8832	46	M	Est. 40 mph, lost control on curve towing boat, hit rail.	
11/12/0600	74 Ford Bronco	VISGLT01503	18	M	Est. 30+ mph, lost control, Rollover in median.	
12/09/1115	78 Ford Bronco	VISSLAE8416	24	M	Est. 55 mph, Rollover & ejected.	Fatal to driver.
01/18/1920	74 GMC Jimmy	TKY184FS04154	27	M	60 mph, Rollover.	
03/01/2105	73 GMC Jimmy	TKY183F515016	18	M	Hit head-on.	Injury.
03/05/0730	76 GMC Jimmy	TKL186F518331	55	M	Est. 40 mph inter-section, hit by 70 Buick extensive damage.	
05/26/1405	73 GMC Jimmy	TKY163F510471	37	M	Est. 6 mph, hit by 75 Chev. making lane change.	No. injury to driver or 3 pax.
06/11/0145	77 GMC Jimmy	TKL187F500708	42	M	Est. 55 mph. Struck during lane change by DWI 78 Chrysler.	
09/23/0115	78 GMC Jimmy Hardtop	TKR1882524751	22	M	Est. 50 mph. Rock from tractor-trailer struck windshield.	
11/27/1600	UNK GMC Jimmy	UNK	26	M	Est. 20 mph, rollover.	
12/09/05100	78 GMC Jimmy	TKR1882528536	28	M	Rollover, est. 35 mph.	

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
01/27/1845	65 Int'l Travel-All 4-Dr	SB525587A	43	F	Rolled upside down, hit rock in road.	
03/13/1715	72 Int'l Travel-All	8170071+	78	M	5 mph, collision with truck & side of road.	
08/31/0815	68 Int'l Travel-All	283107H824727	62	F	Est. 50 mph, rollover, towing 40' house trailer, lost control.	
09/29/1410	75 Int'l Travel-All	ED14DEHB21335	64	UNK	Est. 55 mph, sideswiped passing car; towing 20' trailer.	
02/15/1005	72 Int'l Loadster 1700	1067201H234669	29	M	15 mph, inter-section collision	
02/18/1410	66 Int'l Sta. Wag.	683107H656352	41	UNK	Hit 60 mph, by reckless driver.	
03/06/1230	74 Int'l. Special	45850DGD33828	26	F	Est. 50 mph, evasive action to avoid tire rolling in road/hit 70 Ford Mov.	
02/17/1155	77 Dodge P/U 4x4	W14BF75101239	33	M	Ran off road - doesn't remember.	
02/17/2250	70 Ford P/U 4WD	F111YKG91882	22	M	Collision.	
03/03/0630	73 Chev. Suburban	CLY263F135890	29	M	Ice - lost control, spun out, 77 Chrysler.	
03/04/0900	75 Ford "RV" Rebuilt with RV body	T3709684	69	M	Hit state of snow.	
06/16/1745	68 GMC Suburban	CE10LZB11174	61	M	Est. 10 mph, left turn intersection collision w/65 Ford Falcon	Fatal
09/23/0115	75 GMC Carry-all	TLS166F510585	49	M	Est. 55 mph, flat tire, lost control, ran off highway, towing 32' trailer.	
01/11/0010	Ford 4WD Wagon		R.A. Wright		Rollover in snowbank - missed curve	
01/13/0820	Chev. Travell-All Truck					

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
02/18/2345	73 Int. Scout	683107H656352	30	UNK	Fender bender	
02/24/1749	61 Int. Scout	80FC23627A	26	M	15 mph, struck Toyota in rear lane change.	
02/27/0300	69 Int. Scout	782827G339525	19	M	Fell asleep ran into fence - broke axle.	
04/03/0232	65 Int. Scout	FC113925 (1A)	34	M	Est. 0, drinking driver stopped in road. Hit from behind.	
04/14/1600	75 Int. Scout	E0062EGD11057	24	M	Est. 65+, driver fell asleep, hit trees, across wash. "Nauted (6½') deep wash & made 1/2 turn in air landing on side."	Broke arm, neck/head inj.
04/25/1430	72 Int. Scout	A838806474945	23	F	Lost control when wind of passing tractor-trailer Overturned.	
04/30/0530	76 Int. Scout 4x4 Travel Top	F0102FGD34717	65	M	Est. 45 mph towing travel trailer. Trailer started swaying lost control into guardrail. Overturned on top. (Total loss).	
05/15/1110	65 Int. Scout	FC120984A	76	M	Est. 45 mph, hit by passing tractor-trailer on side.	
05/16/2230	76 Int. Scout	F0092FGD27441	32	M	Est. 55 mph. Ran o-f highway & hit parked 55 Ford 1 ton truck.	
05/28/0342	75 Int. Scout	50062ED032191	29	M	Est. 55 mph, hit head-on by 67 Chev. with driver asleep.	Scout driver + 4 inj.
06/07/2231	78 Int. Scout	H102HGD22803	39	M	Est. 45 mph head-on collision w/75 Chev.	Fatal - pax of Chev M 66 Driver received lac. face Driver of Chev. F 55 compound fx both low.legs & int. inj.
07/04/200	76 Int. Scout	F0062FGD43477	31	M	Est. 45 mph, hit by oncoming Chev at 40 mph.	Inj. #3 to 3 pax of Chev. + 2 to Chev. driver.

DATE	YR.& BODY STYLE	VIN. NO.	AGE	SEX	SPEED AND TYPE OF ACCIDENT	INJURIES
07/10/0805	66 Int. Scout	780905G1913370	42	M	Est. 50 mph, hit in rear by 78 Dodge P.U.	Driver inj. #3.
08/21/0417	77 Int.Scout II 4x4 Travel Top A	G0062GGD22802	30	M	Est. 70+, rt. front tire blew out rolled several times - fatally ejected driver.	Fatal
08/25/0900	73 Int. Scout	35858CGD15763	56	M	Est. 20 mph, minor damage to rear in collision.	No injuries.
09/08/0915	78 Int. Scout 4x4 Travel Top A	H0062HGD42672	26	M	Est. 55 mph, ran off road, evasive action, minor damage.	
09/30/1915	78 Int.Scout II 4x4 Travel Top B	H0102HB020498	51	UNK	Est. 55 mph., hit by 73 VW driver who fell asleep.	
10/02/1120	66 Int. Scout	7089056190508	UNK	UNK	Speed UNK. Ran off road, injured (but not at scene).	
10/29/1705	77 Int. Scout 4x4 Travel Top	G0063GGD25853	28	F	Est. 55 mph, Rollover, fell asleep & went into median.	
11/11/1400	72 Int. Scout 4x4	45850D26728	31	M	Est. 0 mph, collision with skidding 72 Pinto.	
12/07/1450	66 Int. Scout	FC102778A	35	M	Est. 50 mph, Rollover swerved to avoid truck.	No injuries.
01/14/1610	72 Int. Scout				3 car rear-end, damage left rear.	

APPENDIX H

UTILITY VEHICLE COLLISIONS
AUGUST 1977 - DECEMBER 1978
INVESTIGATED BY NEW MEXICO STATE POLICE

UTILITY VEHICLE COLLISIONS, AUGUST 1977 - DECEMBER 1978 INVESTIGATED BY NEW MEXICO STATE POLICE

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
11/8/2200	74 Bronco	U15GLT26980	42	M	Driver ran off road and overturned. Driver = B.	N.F.	X	N.A.
11/16/1100	74 Bronco	U15GLU65469	20	M	Driver lost control on road curve, ran off road, down embankment, rolledover. Driver = A, 2 Pax = A, 1 Pax = K.	F	X	Yes
11/19/2200	78 Bronco	U155LAG6442	17	M	Driver sped into small bend in road, lost control, ran off road, rolledover. Driver = O, 3 Pax = O.	N.F.	X	N.A.
12/5/0845	72 Bronco	U15GLN71273	38	F	Bronco was struck by second vehicle when that vehicle tried to pass. Driver = O.	N.F.		N.A.
12/21/2210	77 Bronco	U15GLQ27475	Unk (vehicle stolen & abandoned)	Unk	Reported: Vehicle went out of control for no apparent reason left roadway and overturned. Driver = minor abrasions.	N.F.	X	Unk
						N.F.=7,F=2	7	Yes=1
978								
2/16/1905 (1977-this case only)	77 Ford P-U Truck	F26HRY23765	24	M	Driver lost control of vehicle on ice-covered bridge, causing 3-car collision. Driver = O.	N.F.		N.A.
3/23/1825	69 Ford W/G	U15GLD97904	54	F	Vehicle was towing a trailer, lost control of vehicle and trailer, jacknifed and went off the road. Driver = O, 1 Pax = A.	N.F.		N.A.
5/7/1430	78 Ford W.G	U15HLAK1629	26	M	Fiat ran into the back of this vehicle which was stopped. Driver = O, 1 Pax = O.	N.F.		N.A.
10/25/0330	76 Ford Truck	F70EVC41648	37	M	Parked truck rolled into 2nd vehicle. Driver = O.	N.F.		N.A.
12/30/0600	72 Ford S/W Jeep	U15GLM80501	20	M	Driver said that they were going around the curve and the next thing they knew they were turning over on the road. Driver = B, 1 Pax = K.	F	X	N.A.
						N.F.=4,F=1	1	Yes=0

R = Rollover
N.A. = No Alcohol use

Injuries: NF = Non Fatal
O = No apparent injuries
C = Complaint-no visible injury
B = Visible injury
A = Incapacitated-carried from scene
K = Killed

(N.M. reports don't list speed of veh.)

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ACL.
1/20/1130	77 Int'l Scout	G006GGD32369	30	M	Driver was driving too fast for snowy road conditions, attempted to pass another vehicle, lost control and sideswiped that vehicle. Driver = 0.	N.F.		N.A.
3/20/1915	77 Int'l Scout	G0062GGD33877	31	M	Deer ran out in front of vehicle, was hit, minor damage to vehicle. Driver = 0.	N.F.		N.A.
4/2/1330	Int'l Carryall	E0140EHB18114	62	F	Driver lost control of vehicle in gust of wind while towing trailer. Driver = 0, 1 Pax = 0.	N.F.		N.A.
5/23/0645	71 Int'l Scout	882827G429953	28	M	Driver tried to avoid animal in the roadway and caused a collision with second vehicle. Driver = 0.	N.F.		N.A.
6/11/1310	77 Int'l Scout	G0092GGD26048	50	M	Scout was towing a trailer when vehicle from oncoming lane tried to pass, causing Scout to pull off road & then back on road, making trailer turn over.	N.F.		N.A.
6/26/1005	72 Int'l Scout	A8380G491557	21	M	Pedestrain ran in front of Scout. Driver = 0, Pedestrain = B.	N.F.		N.A.
7/11/1940	76 Int'l Scout	F0062FGD45285	30	F	Vehicle struck a large rock in roadway, causing damage to vehicle. Driver = 0, 2 Pax = 0.	N.F.		N.A.
8/5/1710	76 Int'l Scout	F0062FGD42806	28	F	Driver pulled in front of second vehicle while entering roadway, and was hit by second vehicle. Driver = 0.	N.F.		N.A.
9/30/2225	73 Int'l Travell-all	3H0H0CHB40171	33	M	Driver failed to stop at intersection and struck a chain link fence, stopped at a cement foundation. Driver = 0.	N.F.		Yes
10/12/2245	72 Int'l 2D	A83880G488327	46	M	Vehicle struck animal which was killed on impact. Driver = 0, 3 Pax = 0.	N.F.		N.A.
						N.F.=10,F=0	0	Yes=1
8/29/1045	75 Int'l Travell-all	E014EHB20939	54	F	Driver passed a truck and was returning to right lane, vehicle started to whip, lost control, overturned. Driver = 0, 2 Pax = 0.	N.F.	X	N.A.
10/1/1050	77 Int'l Scout	F0062FGD38179	26	M	Driver lost control of vehicle when it started to whip when going downhill. Towed trailer skidded around vehicle broke-loose and both rolledover. Driver = B, 1 Pax = B.	N.F.	X	N.A.
						N.F.=2,F=0	2	Yes=0
12/23/1747	73 GMC SW	TCE182F516963	20	M	Driver struck horse and rider in middle of right lane. Rider was killed. Driver = 0.	N.F. (to GMC driver)		N.A.
8/11/0730	77 GMC Jimmy	TKL1872520558	36	M	Driver was going too fast into construction zone causing chain collision with three other vehicles. Driver = 0, 3 Pax = 0.	N.F.		N.A.
7/31/0115	63 Toyota JP	E175892	19	M	Driver fell asleep ran off road and overturned. Driver = A, 1 Pax = B.	N.F.	X	Unk
7/22/unk 7/22/unk	78 Chev.P-U Truck 74 Blazer	1W8028R472624 CKY184F184602	Unk Unk	Unk Unk	These two vehicles were hit by another unidentified vehicle. Driver = Unk, Pax = Unk	N.F.	Unk	Unk
						N.F.=4,F=0	1	Yes=0

	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
8/18/2245	73 Jeep	Unk	23	M	Vehicle was weaving on road when driver of jeep was on-coming, collision and both vehicles were thrown off side of road. Driver = O.	N.F.		(other driver was drunk) N.A. Jeep driver
8/20/	76 CJ5 Jeep	J683AA057269	-		Driver abandoned stolen vehicle. Ran off road on curve & rolled over into side of river. Driver = Unk.	N.F.	X	Unk
8/25/2105	74 Jeep 4x4	J4F835TH96451	23	M	Vehicle went out of control trying to avoid object on road and skidded off road & rolled over. Driver & Pax thrown from vehicle & serious injuries. Driver = A, 1 Pax = A.	N.F.	X	N.A.
9/3/1300	75 Jeep CJ5	J5F83AH018105	15	F	Driver swerved & braked to avoid hitting a dog & another vehicle ran into the 1st.vehicle hitting the left rear. Driver = O, 3 Pax = O.	N.F.		N.A.
9/15/1210	73 Jeep	J3F835TH01549	34	M	Jeep vehicle collided with second vehicle (after leaving parking lot of school). Driver = O.	N.F.		N.A.
9/16/0330	76 Jeep	J6F83EA073924	26	F	Drinking driver ran off roadway during curve & rolled over into ditch. Serious injury to driver. Driver = A.	N.F.	X	Yes
9/16/1740	78 Willie Jeep	58M836A14135	27	M	Driver & passenger were fighting over control of vehicle, went out of control, skidded off road & rolled over. Driver = A, 3 Pax = A.	N.F.	X	N.A.
10/7/0100	74 Jeep	J4M835TA81751	16	F	Driver was speeding down an undeveloped road and lost control, hit a tree. Driver = C.	N.F.		Unk
10/17/0615	78 Jeep CJ5	J8F83AH061076	26	M	The vehicle was towing a U-haul trailer when the hitch broke and caused the vehicle to veer toward the median and rollover. Driver = O, 1 Pax = O.	N.F.	X	Unk
						N.F.=28,F=0	14	Yes = 4
7/31/1700	77 Jeep	J7M83FA033392	41	M	Jeep vehicle was hit by another jeep which was driving on the wrong side of the road. Driver = O, 4 Pax = O.	N.F.		N.A.
8/13/0930	74 Wagoneer Jeep	J4A154CZ09208	39	F	Collision with a forklift. Driver = O, 1 Pax = O.	N.F.		N.A.
8/13/2000	72 Jeep	J2F835TH50575	29	M	Driving fast, braked to avoid vehicle, brakes locked, Rolled over. Driver = B, 1 Pax = O.	N.F.	X	Unk

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
8/17/78	74 Blazer	CKY184F157167	36	M	Driver took evasive action to try missing horse, but struck horse and went into ditch. Driver = 0.	N.F.		N.A.
9/3/2030	78 Blazer	CKL1882114521	47	M	Driver (blinded by lights of oncoming car) hit a cow. Driver = 0.	N.F.		N.A.
9/18/1820	65 Blazer	CKY185F136158	37	F	Driver went off road & into culvert. Driver = 0, 3 Pax = 0.	N.F.		Yes
10/11/0200	73 Blazer	CKY183P113354	27	M	Drinking driver became confused in construction area and stopped car hitting guard rail and post. Driver = 0.	N.F.		Yes
10/14/1830	73 Blazer	CKY183F1897	22	M	Blazer collided with pick-up truck which had crossed over into right lane. Driver = 0, 1 Pax = A.	N.F.		N.A.
10/15/0215	76 Blazer	TKU186F501183	24	M	Driver avoided collision with antoher vehicle in his lane and collided with an adobe wall and utility pole. Driver = B.	N.F.		Unk
10/29/1550	78 Blazer	CKL188F192782	31	F	Driver lost control of Blazer and hit rear of semi. Driver = 0, 1 Pax = 0.	N.F.		N.A.
						N.F.=30,F=1	10	Yes=6
7/27/1840	72 Blazer	CKE182F16643	16	M	Driver of Blazer failed to yield right of way to vehicle #1 and caused collision. Driver = 0, 2 Pax = 0.	N.F.		N.A.
8/7/1500	74 Blazer	CKV184F163886	23	M	Blazer was parked when hit from behind. Driver = 0.	N.F.		N.A.
8/11/2045	71 Blazer	KE1815652730	56	M	Driver ran off road hitting fence and large post - Overturned. Driver = 0.	N.F.	X	Yes
8/12/2130	74 Blazer	CKY184F109200	23	M	Driver crossed over center line (high rate of speed) without headlights and collided with vehicle #1. Driver = A. (Other vehicle: Driver = K, 3 Pax = K, 1 Pax = A)	F, not Blazer		Yes
8/14/0100	72 Blazer	CKE182F17034	21	M	Driver lost control of vehicle, skidded, went off road and through fence. Driver = C.	N.F.		N.A.

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
8/25/2115	74 Jeep SW	J4A1170F94825	18	M	Other vehicle swerved across center line & struck Jeep in left front. Driver = 0, 1 Pax = 0.	N.F. to Jeep driver	X	N.A. Jeep driver
9/4/2215	74 Jeep CJ5	J4F835TH15067	15	M	Driver was going to fast for wet road conditions, failed to make curve, lost control of Jeep which went off road, and end over end down embankment. Rollover. Driver = 0.	N.F.	X	Unk
9/19/0200 0500	70 Jeep	1414C19306290	34	M	Went off road on curve and down embankment (rolling over twice). Driver thrown from Jeep. Driver = K.	F	X	Yes
9/30/1930	63 Jeep S/W	1414-14217	44	M	Driver swerved to miss animal on road, hit animal. Driver = 0.	N.F.		Unk
10/23/0225	69 Jeep S/W	1414019-303632	31	M	Driver lost control of Jeep & hit cement wall. Driver = C.	N.F.		Unk
11/1/0910	76 Toyota Jeep	FJ40226371	35	F	Vehicle skidded on ice, left road & went down embankment. Driver = 0.	N.F.		N.A.
11/8/1900	74 Jeep CJ5	J4F835TH08718	26	M	Drinking driver lost control of Jeep on snowy road and down embankment hitting wire fence. Driver = 0, 1 Pax = 0.	N.F.		Yes
11/31/1400	77 Jeep	J7F83EA048937	23	M	Other vehicle slid on ice into Jeep. Driver = 0, 1 Pax = 0.	N.F.		N.A.
11/27/1630	72 Jeep	J2F835TH50592	67	M	Driver said that the steering failed and he drove up a steep embankment, overturning ¼ onto road. Driver = B, 1 Pax = B, 1 Pax = C.	N.F.	X	Unk
11/29/1400	72 Willy Jeep	J2F835TH23670	35	M	Brakes locked and Jeep went out of control, skidded, rolled over. Driver = C, Pax = B.	N.F.	X	N.A.
11/30/2020	77 Scout Jeep	6006266034030	25	F	Driver travelling to fast to make turn, went out of control and slid into building. Driver = 0.	N.F.		N.A.
12/6/1800	74 Jeep	J4F835TH39298	50	M	Driver tried to make a left turn but lost control and overturned. Driver = 0.	N.F.	X	N.A.
12/17/1745	69 Jeep	1414019302805	53	F	Driver lost control of vheicle, ran off roadway, skidded broadside, overturned twice, driver ejected - fatal. Driver = K.	F	X	Unk
						N.F.=14,F=2	7	Yes=2

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
1/11/0230	74 Toyota Jeep	FJ40183849	20	M	Vehicle was travelling too fast to make curve, left road onto parking pull-off area, down embankment hitting large tree. Driver = 0 1 pax = 0	NF		N.A.
2/8/0808	77 RV Jeep	J7F93EA105102	21	M	Vehicle avoided oncoming car in right lane by braking onto roadside, went out of control, slid onto shoulder - flipped. Rollover. Driver = 0	NF	X	N.A.
2/16/1745	77 Jeep	J7M93AA032011	27	M	Icy road conditions, driver lost control, crossed center line, down embankment & Rolled over. Driver = 0, 1 Pax = 1 35 mph	NF	X	N.A.
2/20/1400	75 Jeep CJ5	J5M82AA022685	44	M	Vehicle was struck from behind-skid. Driver = C	NF		N.A.
3/18/1315	76 Jeep 4WD	J6F83AE018757	30	M	Collision by vehicles while both were driving in middle of road. Minor damage. Driver = 0, 1 Pax = 0	NF		N.A.
3/26/0230	74 Jeep Univ.	J4F835TA65907	32	M	Driver fell asleep, ran off road & hit rock embankment with left front of vehicle - overturned on right side - visible injury. Driver = B	NF	X	Unk.
3/30/1225	75 Jeep	J5F83AE058270	17	M	Driver spinning wheels while waiting to make U-turn lost control - collided with second vehicle. Driver = 0, Pax = 0	NF		N.A.
3/30/1530	72 Jeep CJ5	J3F835TH00237	18	M	Lost control - too fast on curve, left road - rolled over 2 times. Driver 0	NF	X	N.A.
3/21/1100	66 Willys Jeep S.W.	14145103317	28	M	Drinking driver turned into cafe parking lot and crashed into the cafe, poor brakes. Driver = 0	NF		Yes

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
4/15/1810	73 Convt. Jeep	J3F835TH14059	27	M	Making a turn, skidded off road and rolled over. Visible injury. Driver = B, 2 Pax = B.	NF	X	Yes
5/29/1900	73 CX Jeep	J3F835TK51314	20	M	Vehicle skidded out of control into curve, went up onto a bank on side of road & overturned 1½ landing on top. Visible injury. Driver = B, 1 Pax = B.	NF	X	Yes
6/3/2130	73 Jeep	J3F835TH67201	16	M	Vehicle speeding into intersection attempted to make left hand turh, lost control & ran down embankment hit arroya dirt wall. Visible injury. Driver = B, 2 Pax = B, 1 Pax = O	NF		Unk
6/10/1410	70 Jeep	1414C19309753	42	M	Driver ran off road & into a large hole hitting north wall. Driver = O, 1 Pax = B, 4 Pax = O.	NF		N.A.
6/12/0400	66 Jeep Wagon	1414C-102423	20	M	Lost control of vehicle and hit a tree. Driver = C.	NF		Unk
7/7/1030	78 Jeep	J8F93EH017253	72	M	Vehicle ran into rear of truck. Failed to stop in time to avoid collision. Serious injury to driver and pax. Driver = A, 1 Pax = A.	NF		N.A.
7/21/1244	73 Jeep	53F835TE21586	45	F	Driver attempted to avoid car which was coming from behind at fast speed. Made left hand turn sharply & turned on side. Driver serious injury. Driver = A.	NF	X	N.A.
7/23/1535	76 Jeep	J6F83AH056219	19	M	Driver turned over after attempting to make a right turn,when travelling too fast for road conditions. Driver = O, 1 Pax = O.	NF	X	N.A.
8/5/1500	77 CV Jeep	J7F3AA081323	22	F	Driver fell asleep & drove into median, steered right & skidded across lanes & rolled over 1½ times. Serious injury. Driver = A.	N.F.	X	N.A.
8/16/0930	76 Toyota Jeep	FJ40225542	24	F	Vehicle was struck by other vehicle which turned in front of 1st vehicle. Driver = O, 1 Pax = C.	N.F.		N.A.

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
1/1/1400	76 Blazer	CKL186F150535	30	M	Collision with other vehicle on curve. Minor damage. Driver = 0, 2 Pax = 0, 1 Pax = C.	N.F.		N.A.
1/26/0100	75 Blazer	CKY185F110708	51	M	75 Blazer was towing 78 Blazer. The 75 Blazer ran off road, lost control & skidded into ditch, and 78 Blazer broke away from 75 Blazer. Driver = 0.	N.F.		N.A.
1/20/0830	74 Blazer	CKY184F156013	19	M	Vehicle slid into curve and off embankment. Rollover. Driver = 0, 1 Pax = 0.	N.F.	X	N.A.
1/24/1700	77 Blazer	CKL1872147112	18	M	Vehicle slid to left guard rail on curve, parked vehicle and left. Vehicle #2 collided with #1 vehicle after it was parked. Driver = 0, 1 Pax = 0.	N.F.		N.A.
1/26/0900	76 Blazer	CKL186F176224	31	M	Driver fell asleep & vehicle left road hitting guard rails. Driver = 0.	N.F.		Yes
2/2/1445	76 Blazer	CKL186F207819	40	M	Driver lost control and travelled off bridge and rolled down. Driver = C.	N.F.	X	N.A.
2/7/1515	75 Blazer	CKY185F119372	41	M	Blazer ran into bus,while the bus made a left hand turn (non functioning left turn signal on bus). Driver = 0, 1 Pax = 0.	N.F.		N.A.
2/8/0820	74 Blazer	CKV184F162676	27	M	Driver hit an icy spot on road, lost control, slid down embankment, and rolled over. Driver = 0.	N.F.	X	N.A.
2/12/1710	76 Blazer	CKL186F208894	50	M	Vehicle #1 collided with Blazer (Blazer was towing trailer). Driver = 0, 3 Pax = 0.	N.F.		N.A.
2/14/2010	75 Blazer	CKY185F145803	24	F	Blazer collided with vehicle on snow-ice road. Driver = 0.	N.F.		N.A.
3/18/78	77 Blazer	CKL187F124347	18	M	Vehicle went out of control into median, back across road and off road into cement culvert. Driver = C, 3 Pax = C.	N.F.		N.A.
3/20/2045	71 Blazer	KE1815666470	56	F	Driver swerved to avoid cow in road, hit cow with right rear fender causing moderate damage. Driver = 0, 4 Pax = 0.	N.F.		N.A.

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
4/11/2000	77 Blazer	CKL187F105634	40	M	Speeding vehicle lost control went off road & up an embankment. Rollover 1½ times. Driver = C.	N.F.	X	Yes
4/16/1915	73 Blazer	CKY183F190470	31	M	Drunk driver left roadway into culvert, collided with cement abutment. Fatal. Victim fell our & Blazer rolled over him. Rollover. Driver = A, 1 Pax = K.	F	X	Yes
5/6/1130	75 Blazer	CKM185F172993	20	M	Blazer crossed over into oncoming lane, was hit by by oncoming vehicle. Driver - 0, 1 Pax = 0.	N.F.		N.A.
6/4/2330	73 Blazer	TKY183F502848	26	M	Driver lost control of vehicle ran off road and overturned (trying to avoid collision with livestock). Driver = 0.	N.F.	X	N.A.
6/5/1645	77 Blazer	CKL187F140600	29	M	Speeding driver ran into the back of Blazer. Driver = 0.	N.F.		Yes, driver of pick-up truck only.
6/13/1455	77 Blazer	CKL1872169534	22	M	Blazer was struck by vehicle #1. Both vehicles spun around. Driver = 0.	N.F.		N.A.
6/20/2330	73 Blazer	CKY184F145985	17	M	Driver lost control of Blazer and ran up a dirt embankment and overturned ¼ turn. Driver = 0, 1 Pax = 0.	N.F.	X	Yes
7/2/2100	77 Blazer	CKL1872179643	23	F	Driver swerved to avoid a dog and lost control, ran off road. Struck fence and into arroyo. Driver = B, 1 Pax = C.	N.F.		N.A.
7/16/1643	78 Blazer	TKV1882516926	15	M	Driver lost control of vehicle and went off road. Overturned. Driver = 0, 1 Pax = 0.	N.F.	X	N.A.
7/21/0935	72 Blazer	CKE1825147528	36	F	Driver lost control of vehicle and went off side of road (trailer in tow caused loss of control) and overturned. Driver = A, 1 Pax = B.	N.F.	X	N.A.
8/5/1730	77 Blazer	CKR187F101300	52	F	Driver lost control of vehicle and overturned. Driver = 0, 5 Pax = 0.	N.F.	X	N.A.
8/11/78	71 Blazer	KE1815677398	59	M	Driver tried to avoid hitting cow in roadway. Hit cow anyway. Driver = 0.	N.F.		N.A.

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
8/18/2000	72 Blazer	CKE1825141352	33	F	Driver collided with deer that jumped from foliage directly into the path of the vehicle. Driver = 0, 1 Pax = 0.	N.F.		Yes
8/22/0200	76 Blazer	CKU186F112587	22	M	Driver went off roadway and came back onto roadway - overturning 2½ times. Driver was thrown from Blazer. Driver = K.	F	X	Unk
8/28/1915	74 Blazer	CKY184F148269	16	F	Driver lost control of vehicle and overturned. Vehicle travelling too fast for road conditions. Driver = 0, 1 Pax = K, 3 Pax = C.	F	X	N.A.
9/4/2200	74 Blazer	CKY184F144536	25	M	Driver speed = 35. Driver swerved to avoid 3 deer standing in roadway and ran into irrigation ditch. Driver = 0, 1 Pax = 0.	N.F.		Unk
10/2/1110	72 Blazer	CKE182F187645	54	M	Blazer was towing travel trailer, wind caused it to fish-tail. Driver of Blazer lost control, ran off road and overturned twice. Driver = Unk.	Unk	X	N.A.
10/9/1605	77 Blazer	CKR1878153689	24	M	Driver trying to pass other vehicles veered off side of road to avoid collision with a semi, hit a cement embankment and went over it landing in ditch. Driver = 0, 3 Pax = 0.	N.F.		N.A.
10/16/0001	76 Blazer	CKU186F213399	42	M	Blazer was struck by a vehicle which failed to stop at stop sign. Driver = 0, 3 Pax = 0.	N.F.		N.A.
10/21/1730	73 Blazer	Unk	16	M	Blazer sideswiped vehicle #1 when trying to pass. Driver = 0, 2 Pax = 0.	N.F.		N.A.
10/22/1245	76 Blazer	CKL186F118776	21	F	Blazer speed = 65 mph. Driver left roadway, into median, overcorrected, vehicle overturned. Driver = K, 1 Pax = B.	F	X	N.A.
11/11/0100	77 Blazer	CKR187F131293	26	M	Driver was speeding into sharp curve, lost control, overturned, and skidded 100 feet. Driver = 0, 1 Pax = 0.	N.F.	X	N.A.

DATE	RY/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
12/16/1830	77 Blazer	CKL187Z203342	25	M	Driver was speeding into curve, went into skid and collided with fence on roadside. Driver = O.	N.F.		Yes
12/31/0705	77 Blazer	CKR187F117457	19	M	Driver swerved off road onto shoulder, overcorrected, slid broadside across the road and went down embankment <u>overturning</u> at least twice. Driver ejected from vehicle. Driver = A, 1 Pax = C.	N.F.	X	Yes
12/31/2245	76 Blazer	CKL186F107031	19	F	Driver failed to negotiate curve and ran off road, overcorrected and came back onto roadway, ran through guard rail and down into canyon. All occupants ejected from vehicle. <u>Overturned</u>. Driver = K, 2 Pax = K, 2 Pax = A.	K	X	Unk
						N.F.=14 F=4	8	Yes=5
01/23/0900	75 Bronco	U15GLR19404	33	F	Driver lost control on icy road, left road and <u>overturned</u>. Driver = O, 2 Pax = O.	N.F.	X	N.A.
01/20/0215	68 Bronco	U14NLD49737	23	M	Driver lost control on curved icy/snowpacked road, hit embankment <u>overturned</u> and travelled into a service tunnel on its side. Driver = A.	N.F.	X	Unk
2/8/0700	69 Bronco	U15GLE77749	41	M	Driver lost control of vehicle, slid off roadway and <u>overturned</u>. Speed was over limit for snow/ice conditions. Driver = O.	N.F.	X	N.A.
4/18/1345	75 Bronco	U15GIV43770	37	F	Driver lost control of vehicle on sharp curve, skidded into north - then south - then north-bound lane, colliding with side of mountain <u>overturning</u>. Driver = O.	N.F.	X	N.A.
4/23/1815	72 Bronco	U15GIN02667	16	F	Vehicle left roadway became airborne and <u>overturned</u>. Driver = B.	N.F.	X	N.A.
5/29/2300	70 4x4 Bronco	U15GLJ22249	26	M	Driver fell asleep, veered into oncoming lane, locked brakes and lost control - skidded. Blazer left road into culverts and <u>overturned</u>. Driver = O.	N.F.	X	Yes
6/18/2245	74 Bronco	U15GIU06123	21	M	Bronco was making a left hand turn without turn signals, second vehicle attempted to pass Bronco and collided. Driver = C, 1 Pax = O.	N.F.		N.A.
6/23/1051	72 Bronco	U15GLN25285	37	M	Driver overcorrected when tires left road on a curve and crossed center line hitting left front of 2nd vehicle. Driver = O.	N.F.		N.A.
7/19/1340	70 Bronco	U15GL43369	20	M	Bronco was towing another vehicle when wind from semi caused driver to lose control of Bronco, ran off road and overcorrected and <u>overturned</u>.	N.F.	X	N.A.
8/9/0355	78 Bronco	U15HLCE6427	29	M	Driver ran off road into median and <u>overturned</u>. Driver = B (fractured right ankle and abrasions)	N.F.	X	N.A.

DATE	YR/BODY STYLE	VIN #	AGE	SEX	SPEED/TYPE OF ACCIDENT	INJURIES	R	ALC.
8/23/1545	74 Bronco	U15GLS83273	43	M	Driver tried to avoid collision in traffic by swerving to right. Driver = C, 1 Pax = C.	N.F.		N.A.
9/5/0800	78 Bronco	U15HLC05129	39	M	Bronco slid into rear of 2nd vehicle which was stopped for a schoolbus. Driver = 0, 1 Pax = 0.	N.F.		N.A.
9/7/1615	73 Bronco	U15GLR64763	43	M	Bronco was struck, while backing out of post office driveway, by oncoming vehicle. Driver = 0.	N.F.		N.A.
9/15/2355	78 Bronco	U15HLBH5165	18	M	Driver lost control on curve and rolledover. Driver = C, 1 Pax = C, 2 Pax = 0.	N.F.	X	Unk
9/22/2230	78 Bronco	V1556CA5965	15	M	Both vehicles collided head on at top of hillcrest. Driver of Bronco was left of center. Driver = 0, 5 Pax = 0.	N.F.		N.A.
10/15/2115	74 Bronco	U15GLT08189	20	M	Driver overcorrected when vehicle started onto right shoulder of road, hit embankment and became airborne, overturned. Driver = A.	N.F.	X	N.A.
						N.F.=16,F=0	10	Yes=2
7/20/1530	68 Bronco	U15NLD33016	16	M	Driver was speeding into curve, skidded sideways, over-corrected, overturned onto top. Driver = 0, 3 Pax = 0.	N.F.	X	N.A.
8/25/1735	73 Bronco	U15GLS12636	17	M	Driver of Bronco was following antoher vehicle. Other vehicle braked and Bronco hit rear end of other vehicle causing skid marks. Driver = 0.	N.F.		N.A.
9/8/0900	76 Bronco	015GLA57454	56	M	Tires of Bronco were hit by construction machinery, driver lost control, ran down steep embankment overturning. Driver = A.	N.F.	X	N.A.
11/4/0830	73 Bronco	U15GLR42652	38	M	Driver of Bronco overcorrected (wtih trailer in tow) and went out of control, left roadway and rolledover. All occupants were ejected. Driver = K, 2 Pax = A, 1 Pax = C.	F	X	Unk

APPENDIX I

FATAL UTILITY VEHICLE COLLISIONS
INVESTIGATED BY COLORADO STATE POLICE
DURING 1977

FATAL UTILITY VEHICLE COLLISIONS
INVESTIGATED BY COLORADO STATE POLICE DURING 1977

DATE	YR. & BODY STYLE	VIN. NO.	AGE	SEX	EST.SPEED	ACCIDENT DESCRIPTION	INJURIES
09/04/0830	1972 JEEP CJ-5	J21835TH05663	24	F	75 mph	Lost control on left curve, continued 698 feet, struck embankment, airborne for 68 feet, spun, rollover for 24 feet. Both occupants ejected. Restraints not used. Roll-bar equipped.	Fatal, driver Fatal, RF pas.
07/10/0800	1967 Willys Jeep	8305A216989	44	M	65 mph	Lost control on left curve, skidded 189 feet on pavement, rolled 4 times for 300 feet, stopped on wheels. Lap belt installed and used. Roll-bar equipped.	Fatal, driver Serious injury, RF pas.
01/10/1730	1967 JEEP Wagoneer	8705F1614527	18	M	55 mph	Struck '75 Buick parked in Southbound lane while passing Northbound non-contact vehicle. Skidded 96 feet, bounced 11 feet backward after collision. Both vehicles remained on wheels. (No restraints or roll-bar on JEEP).	Serious injury, driver Fatal, driver (Buick)
6/26/2108	1960 Willys Jeep	57548108517	25	M	45 mph	Lost control on left curve, ran off road 44 feet. Rollover 1½ times for 76 feet, both occupants ejected. (Restraints not used; roll-bar equipped).	Serious injury, driver Fatal, 4-year-old CR pas.
03/06/0130	1973 JEEP CJ-5	J3F835TH15855	24	F	70 mph	Ran off right side of road, followed shallow ditch for 390 feet, struck and broke utility pole, rolled one time for 76 feet, came to rest on wheels. Driver ejected. (Restraints not used; roll-bar equipped).	Fatal, driver
10/2[illegible]/0120	1974 JEEP CJ-5	J4M835TE53852	26	M	45 mph	Lost control on right curve, ran off left side of road. Travelled 150 feet on left shoulder, collided with rock. rollover, came to rest on roof. Driver and RF passenger ejected. Restraints not used.	Serious injury, RF pas. Fatal, DR pas.
10/05/1910	1968 JEEP Wagoneer	1414CS110628	31	M	75 mph	Lost control on exit ramp, skidded 178 feet; steering overcorrection caused broadside skid of 98 feet. Ran off left side of ramp, rolled over 2½ times, came to rest on roof. All three occupants ejected. (No restraints).	Fatal, driver Serious injury, RF pas.

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09/04/0455	1973 Chevy Blazer	CK4183F172712	26	M	65+ mph	Ran off right side of road 278 feet, moving down embankment. Travelled up and over knoll becoming airborne for 76 feet. Rollover ½ time after moving an additional 81 feet. Driver pinned underneath (restraint in use). Passenger ejected (restraint not used).	Fatal, driver
11/29/0200	1970 Ford Bronco	U15QLJ34138	22	M	55 mph	Ran off right side of road on left curve for 107 feet, became airborne for 29 feet over dry creekbed; travelled 19 feet. Struck embankment and rolled over landing on right side. Restraints not used.	Fatal, driver
11/10/0910	1968 Kaiser Jeep	8305017243355	30	F	45 mph	Lost control on ice on slight right curve, skidded 37 feet into left lane, spun around once for 30 feet and encountered dry pavement in right lane, resulting in a 3/4 rollover as vehicle moved an additional 57 feet. Came to rest on right side. Three occupants ejected; restraints not used. Roll-bar equipped.	Fatal, driver Serious injury, RR pas.
11/05/	1968 Ford Bronco	U15NLC57979	23	M	45 mph	Ran off right side of road on left curve for 184 feet, hit tree; spun around once for 54 feet, came to rest on wheels. Restraints not used.	Fatal, RF pas.
10/13/2245	1962 Willys Jeep	57548143609	19	M	40 mph	Ran off right side of road, overcorrected to left and skidded 60 feet into left lane, striking oncoming car broadside. Spun around in right lane and rolled over for 37 feet, continued for 95 feet, rolled over 1¼ times. Came to rest on right side. Lap belts in use; roll-bar equipped.	Fatal, driver Fatal, RF pas.
08/25/0735	1977 Chevy Blazer	CL187Z146232	30	M	50 mph	Struck Dodge Colt broadside at intersection after skidding 32 feet; then skidded 101 feet at 45° angle to intersection, coming to rest in field on wheels. Restraint not used.	Serious injury, driver Fatal, driver (Colt)
08/28/0430	1973 Chevy Blazer	CKY183F160037	22	F	40 mph	Coming to "Y" intersection, driver bore left, then apparently decided to turn right instead. Resulting steering correction caused loss of control for 193 feet; vehicle ran off left side of road. Rolled over 1½ times down embankment for 50 feet; came to rest on roof. Restraint not used.	Fatal, driver

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09/06/1330	1974 JEEP CJ-5	J4M83FTA31049	26	F	40 mph	Lost control on left curve, skidded 106 feet, spun around clockwise once, continued on road 82 feet, ran off right side of road for 25 feet down embankment, rolled over 1-3/4 times; came to rest on right side. RF passenger partially ejected and pinned. No restraints used; roll-bar equipped.	Serious injury, driver Serious injury, CF pas. Fatal, RF pas.
09/03/0810	1972 JEEP CJ-5	J2F835TH12132	27	M	65 mph	Ran off right side of road, moved parallel to road 168 feet; returned to road for 66 feet, rolled over 2 times coming to rest on right side. Both occupants ejected. Restraints not used; roll-bar equipped.	Fatal, driver Serious injury, RF pas.
07/10/1330	1969 Toyota Land Cruiser	FJ4065660	34	M	25 mph	While turning left off state road onto secondary road, a Lincoln approaching from behind moved into left lane to pass Toyota. Resulting collision drove Toyota off right side of road for 94 feet; rolled over onto right side. Restraints not used.	Fatal, RF pas. Serious injuries, CF, RF, and LR passengers.
07/23/0315	1975 Chevy Blazer	CKY185F16812	42	M	80 mph	Lost control in right lane of interstate after swerving to avoid slower-moving vehicle in right lane. Ran off right shoulder, skidded 137 feet, struck guardrail and slid on top of it 94 feet; then struck bridge abutment, coming to rest on wheels. Restraints not used; roll-bar equipped.	Fatal, driver
08/14/0200	1975 Chevy Blazer	CK185F172480	50	F	55 mph	Ran off right side of road on left curve 202 feet; plunged down 40 foot embankment 142 feet; rolled over 2½ times, coming to rest on roof. Both occupants ejected. Restraints not used.	Serious injury, driver
04/23/2000	1974 International Scout	4585500G012638	41	F	60 mph	Entering right curve, vehicle moved into left lane for 481 feet, swerved back into right lane for 30 feet, ran off right side of road for 74 feet, re-entered roadway and rolled over 1½ times for 77 feet. Both occupants ejected; restraints not used.	Fatal, driver Serious injury, RF pas.
05/15/0400	1976 JEEP Renegade	J6M83EA071604	30	M	50 mph	Ran off right side of road 126 feet, struck right side of bridge, spun sideways 64 feet, struck bridge and rolled over 2¼ times for 91 feet. Came to rest on left side. Lap belt in use; roll-bar equipped. No upper torso restraint.	Fatal, driver

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05/27/0810	1976 JEEP CJ-7	J6F93AA016642	17	M	55 mph	Hit from behind by Chevy Malibu, vehicle slid broadside on roadway for 83 feet, rolled over ¼ times, slid 26 feet; rolled onto its top and slid 90 feet. Then ran off road for 126 feet, rollover one time. Passenger ejected. Both vehicles pulling trailers. JEEP restraints not used; roll-bar equipped.	Fatal, RF pas.
06/25/1645	1976 Ford Bronco	V15GLC000034	29	F	70 mph	Ran off right side of road for 160 feet, reentered roadway for 148 feet; lost control, ran off right side of road, rolling 2½ times for 146 feet. Came to rest on right side. Lap belt not used, driver ejected.	Fatal, driver
02/23/2140	1973 Chevy Blazer	CKV1836105993	31	M	50 mph	Driving down wrong side of road, vehicle hit Kenworth truck head-on, pushed back 40 feet by truck. Came to rest on wheels. Lap belt not used.	Fatal, driver
02/27/1010	1973 Chevy Blazer	CKY183F113165	38	M	50 mph	Hit Chevy pick-up head on while pick-up was passing in Blazer's lane. Both vehicles spun around, pointing in opposite directions and remained on wheels. Blazer's restraints not used.	Serious injuries, driver. RF and LR passengers Fatal, driver (Pick-up)
03/21/1455	1946 Willys Jeep	CJ2A31752	24	M	55 mph	Ran off right side of road onto shoulder for 36 feet, entered dirt shoulder for 81 feet. Ran 26 feet down embankment, rolled over end-over-end for 30 feet, coming to rest on left side. Driver ejected and pinned; restraints not used. Roll-bar equipped.	Fatal, driver
04/06/1530	1973 Chevy Blazer	CKY183F154885	19	M	60 mph	Ran off left side of road, followed ditch for 187 feet on four wheels and 96 feet on two wheels, rolled over 2 times for 116 feet, came to rest on wheels. All occupants ejected, restraints not used.	Fatal, driver Serious injuries, RR and RL pas.
04/17/0200	1973 Ford Bronco	U15GLQ66905	27	M	50 mph	On right curve, vehicle entered left lane and collided with oncoming car, then spun around and rolled ¼ time onto its right side. Lap belt in use.	Serious injury, driver
02/27/0540	1973 International Scout II	39858CGD21447	32	F	55 mph	On left curve downgrade, Scout lost control, spun once and skidded into left lane, hitting JEEP head-on. Lap belt used by Scout driver; no restraints used in JEEP.	Scout: Serious injury, driver
	1972 JEEP Wagoneer	V2A144CN52780	37	M	45 mph		JEEP: Fatal, driver Fatal, RF pas. Serious injury, CR pas.

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12/30/1950	1974 Chevy Blazer	CKY184997916	38	M	50 mph	Ran off road for 87 feet, skidded broadside back across road for 63 feet, rolled over onto top for 25 feet, stopped against tree. No restraints used.	Fatal, driver Serious injury, CR pas.
12/16/2345	1957 Willys Jeep CJ-5	5774812539	25	M	55 mph	Ran off right side of road on right curve for 264 feet, hit post. Crossed 71 feet to left side of road, ran off road 113 feet and rolled over onto roof. No restraints.	Fatal, driver
12/09/1530	1975 Chevy Blazer	CKY185F15380	44	M	60 mph	Lost control, ran off left side of road 93 feet, hit parked vehicle. Continued for 200 feet parallel to road, hit tree. Continued for 156 feet, crossing roadway and hitting utility pole broadside. Came to rest on wheels; all occupants ejected (no restraints used).	Fatal, LR pas.
12/01/1055	1975 Ford Bronco	U15CLV47732	67	M	40 mph	Ran off right side of road for 64 feet, re-entered roadway and skidded broadside for 94 feet across road. Rolled over 1½ times 23 feet down embankment; both occupants pinned in vehicle. Restraints not used.	Serious injury, driver Fatal, RF pas.
06/08/1915	1965 International Scout	58C4X4FC113306A	25	M	50 mph	Ran into a hydroplaning TR-7 broadside as the southbound TR-7 crossed into northbound Scout's path. Lap belt used.	Serious injury, driver Fatal, driver and RF pas. (TR-7)
06/02/1650	1971 Chevy Blazer	KE1815621704	17	M	45 mph	Hit southbound Chevy broadside after the Chevy had crossed into northbound traffic. No restraints used.	Serious injury, driver Fatal, driver (Chevy)
11/27/0345	1970 JEEP CJ-5	8305017362770	18	M	30 mph	After making left turn at intersection, vehicle ran off right side of road, moving parallel to road for 49 feet and striking a post, sign and bridge railing, after which it rolled over 3/4 time down a 10 foot embankment, coming to rest on left side. All occupants ejected; RF passenger pinned. No restraints used.	Fatal, RF pas.
09/02/1635	1968 Ford Bronco	U15NLC62387	21	M	60 mph	Driving down wrong side of road, Bronco struck left front of oncoming Chevy. A Kenworth truck, approaching behind the Chevy, swerved to avoid collision and hit Bronco broadside knocking it off right side of road. Bronco remained on its wheels; no restraints used.	Fatal, driver

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11/29/0745	1972 Chevy Blazer	DKE1825129077	33	F	20 mph	Skidded on ice into side of Plymouth stopped in left lane of road. No restraints used.	Fatal, driver (Plymouth).
04/25/1435	1967 JEEP	8705F1611511	19	M	Unknown	Ran off right side of highway; lost control while trying to re-enter roadway, rolled onto its left side, slid 65 feet then rolled over once coming to rest on left side. No restraints used.	Fatal, driver
09/04/0145	1973 JEEP CJ-5	J3F335TA60401	25	M	40 mph	Ran off right side of road on left curve and rolled over for 61 feet coming to rest on top in river. Driver ejected. No restraints used.	Fatal, RF pas.
09/03/0110	1970 Ford Bronco	U15GLG80694	38	M	60 mph	On right curve, vehicle crossed centerline into left lane for 76 feet, skidded sideways for 20 feet, ran off left side of road, and rolled over once for 76 feet; rolled over again for 46 feet and came to rest on its wheels. Both occupants ejected between roll-overs. No restraints used.	Fatal, driver Serious injury, RF pas.
04/24/1625	1967 JEEP Wagoneer	1414C106722	34	M	3 mph	Collided with westbound VW while turning left (East) from southbound lane of intersection. Wheels remained on road; restraints not used.	Fatal, driver (VW)
03/14/1028	1974 Ford Bronco	U15GLT12297	23	M	45 mph	Left front end of vehicle hit by train at trestle. No restraints used.	Fatal, driver
03/15/2215	1976 International Scout	A83880A505410	27	M	10 mph	Hit broadside by oncoming car while making a left turn. No restraints used	•
09/05/1200	1974 JEEP Cherakee		24	M	25 mph	Collided head-on with motorcycle traveling on wrong side of road. Lap belts and upper torso restraints in use.	Fatal, driver (motorcycle)
12/21/2335	1967 JEEP Wagoneer	141409478	16	M	"hi rate of speed"	Lost control and skidded 65 feet, rolled over 1¼ times, coming to rest on left side.	Fatal, driver
09/091732	1966 International Scout	FC160198A	21	M	25 mph	Lost control while attempting to turn right into driveway, skidded on grass. Rolled over onto roof; driver ejected; right front passenger pinned. No restraints used.	Fatal, RF pas.