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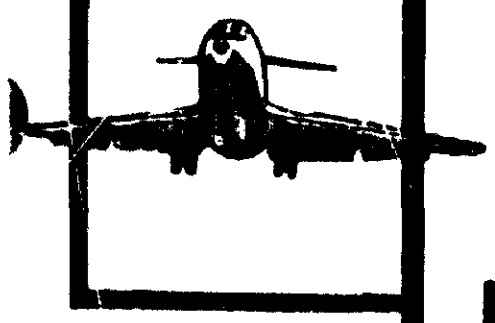
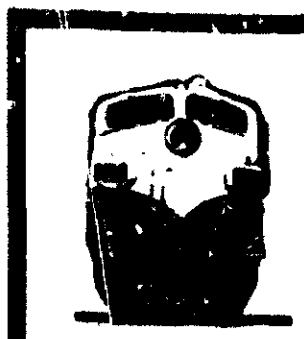
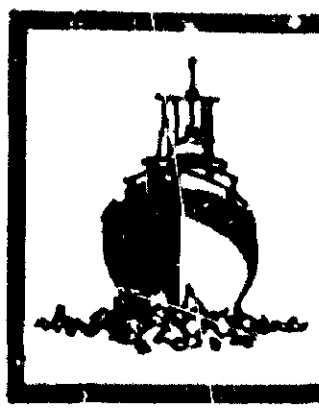
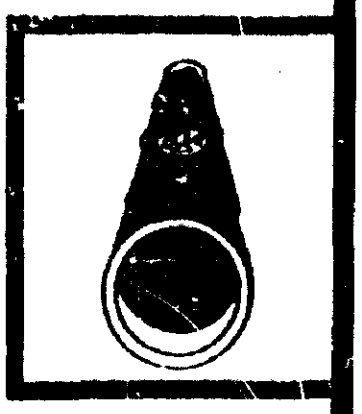
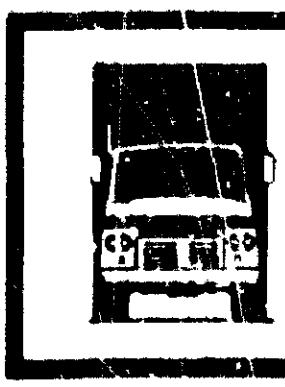










NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

MIDAS MINI MOTOR HOME/ AUTOMOBILE COLLISION,
U.S. ROUTE 69
NEAR McALESTER, OKLAHOMA
JULY 14, 1977

REPORT NUMBER: NTSB-HAR-78-2

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-HAR-78-2	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Highway Accident Report - Midas Mini Motor Home/Automobile Collision, U.S. Route 69, Near McAlester, Oklahoma, July 14, 1977		5. Report Date April 13, 1978
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2247B
		11. Contract or Grant No.
		13. Type of Report and Period Covered Highway Accident Report July 14, 1977
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract About 4:20 p.m., on July 14, 1977, a 1972 Ford sedan southbound on U.S. Route 69 about 19.4 miles south of McAlester, Oklahoma, went out of control on wet pavement, crossed the centerline sideways and collided with a northbound Midas Mini Motor Home. All six persons in the sedan were killed; the driver and right front passenger in the motor home were killed and the six other passengers of the motor home were injured.

The National Transportation Safety Board determines that the probable cause of this accident was a combination of the low skid resistance of the wet road surface and the lax operating maintenance by the owner of the Ford sedan which permitted the use of an unsafe tire and the imbalanced capability of the brake system. A factor contributing to the accident was the driver's unfamiliarity with the mechanical condition of the Ford sedan. Contributing to the severity of the injuries were the failure of the front seat occupants of the motor home to wear the available seat-belts, and the failure of the door latch assembly.

The Board made recommendations to the State of Oklahoma, the Federal Highway Administration, the National Highway Traffic Safety Administration, and the Motor Vehicle Manufacturers Association of the United States, Inc.

17. Key Words Skid resistance; coefficient of friction; smooth tire; wet highway; Midas Mini Motor Home; seatbelts; skid numbers; door latch assembly; RV appliance securement; vehicle maintenance; insoluble residue; asphalt.		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 35	22. Price A03-A01

NTSB Form 1765.2 (Rev. 9/74)

CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: April 13, 1978

MIDAS MINI MOTOR HOME/AUTO COLLISION, U.S. ROUTE 69, NEAR McALESTER, OKLAHOMA JULY 14, 1977

SYNOPSIS

About 4:20 p.m., on July 14, 1977, a 1972 Ford Sedan southbound on U.S. Route 69 about 19.4 miles south of McAlester, Oklahoma, went out of control on wet pavement, crossed the centerline sideways and collided with a northbound Midas Mini Motor Home. All six persons in the sedan were killed; the driver and right front passenger in the motor home were also killed and the six other passengers of the motor home were injured.

The National Transportation Safety Board determines that the probable cause of this accident was a combination of the low skid resistance of the wet road surface and the lax operating maintenance by the owner of the Ford sedan which permitted the use of an unsafe tire and the imbalanced capability of the brake system. A factor contributing to the accident was the driver's unfamiliarity with the mechanical condition of the Ford sedan. Contributing to the severity of the injuries were the failure of the front seat occupants of the motor home to wear the available seatbelts and the failure of the door latch assembly.

The Board made recommendations to the State of Oklahoma, the Federal Highway Administration, the National Highway Traffic Safety Administration, and the Motor Vehicle Manufacturers Association of the United States, Inc.

INVESTIGATION

The Accident

About 4:20 p.m., c.s.t., on July 14, 1977, a southbound 1972 Ford LTD 4-door sedan was approaching a northbound 1974 Midas Mini Motor Home on U.S. Route 69 about 19.4 miles south of McAlester, Oklahoma. Both vehicles were traveling in the appropriate travel lanes on the two-lane highway which was posted with a 55-mph speed limit.

The sedan had departed Wilburton, Oklahoma, about 2:30 p.m. and had been driven approximately 55 miles. The motor home had left Deer Park, Texas about 6:15 a.m. and had traveled approximately 387 miles.

As the vehicles approached in a heavy rainfall and moderately strong winds, the sedan began to slide, rotated counterclockwise and crossed the centerline into the path of the motor home. Evidence indicated that the sedan's left and right front wheels crossed the centerline approximately 49 and 30 feet, respectively, north of the point of impact. There was no evidence to indicate that the motor home braked or skidded before impact although the driver did steer 2° to 5° to the right.

The front of the motor home struck and penetrated the right side of the sedan at a point 43 inches rearward of the front corner. Both vehicles immediately began to rotate clockwise toward the northeast. The sedan skidded sideways approximately 28 feet while rotating about 98° before coming to rest facing south on the east side slope of the highway. (See figure 1.) At the same time, the motor home rotated approximately 153°, slid approximately 57 feet, overturned onto its left side, and slid 4 feet before coming to rest facing southeast on the paved east shoulder of the road. Based on the physical evidence at the scene, it was calculated that the preimpact speed of the sedan was 37 mph and its impact speed was 33 mph. The preimpact and impact speed for the motor home were the same -- 45 mph. There were no immediate witnesses to the accident. A motorist 1/4 mile behind the motor home could only estimate the motor home's speed at 45 mph to 50 mph and verify that it was raining.

Injuries to Persons

Injuries	Drivers	Passengers	Other
Fatal	2	6	0
Nonfatal	0	6	0
None	0	0	

Driver Information

The 29-year-old driver of the sedan held a valid operator's license issued by the State of Oklahoma with no restrictions. She was first licensed to drive on September 25, 1963. No previous accidents or traffic convictions appeared on her driver record. She was not the owner of the sedan. The owner was one of those who died in the sedan. This was the first trip the driver had made in the Ford.

The 41-year-old driver of the motor home held a valid operator's license issued by the State of Virginia with no restrictions. His driving record shows no previous accidents and one conviction for speeding issued on May 8, 1975.

Midas Mini Motorhome/Automobile Collision
U.S. 69 Near McAlester, Oklahoma
Collision Diagram
(Not to Scale)

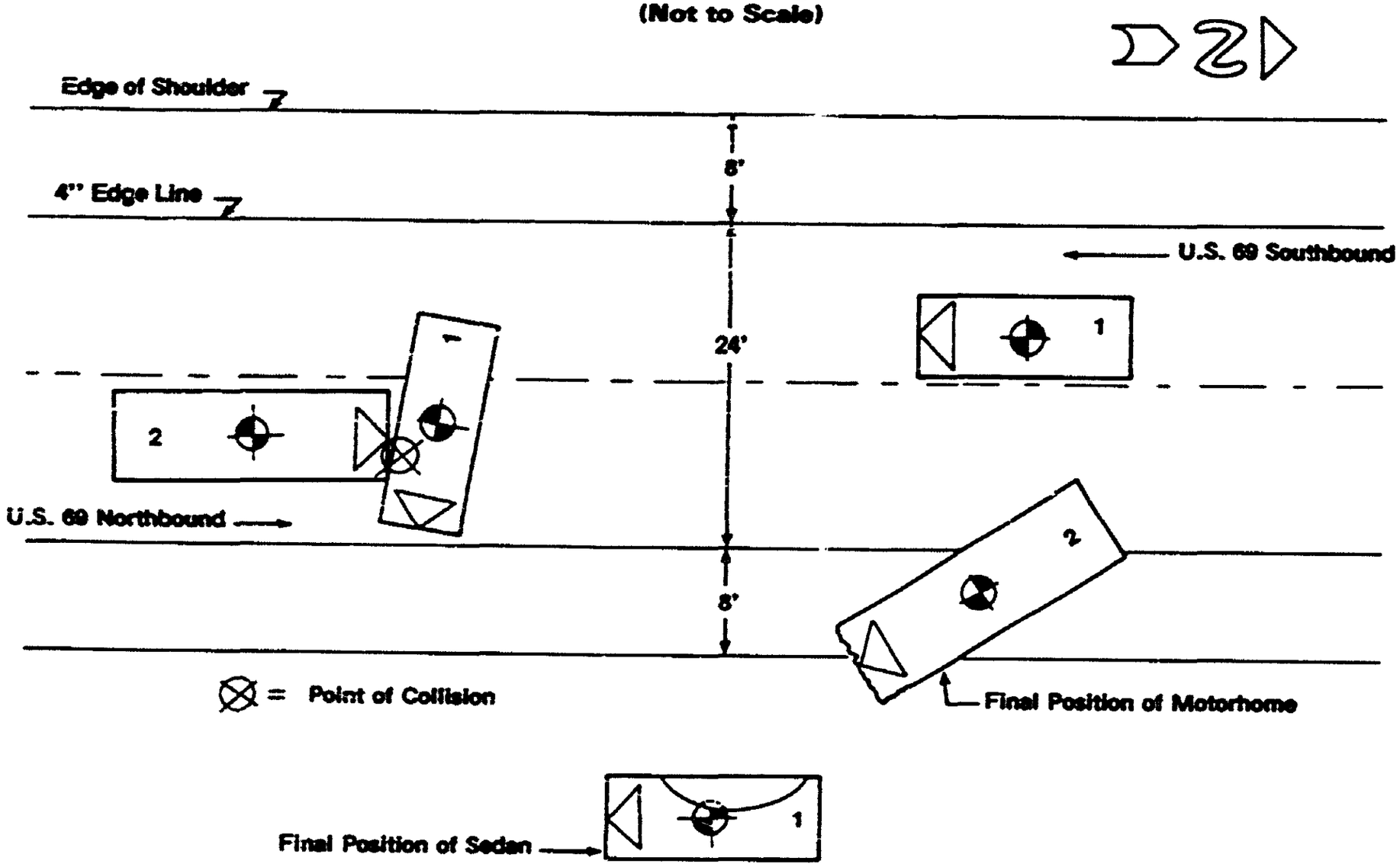


Figure 1. Diagram of collision between sedan (1) and motor home (2).

Vehicle Information and Damage

The 1972 Ford -- The 1972 Ford LTD 4-door sedan, VIN F2GL3H258300F, was owned by the passenger in the right front seat. The odometer registered 1,614 miles. It was last inspected in July 1976, under the Oklahoma periodic motor vehicle inspection program, when the odometer registered more than 92,000 miles. (The last three digits on the inspection report were illegible.)

The car was equipped with a model 351 V-8 engine, power steering, power brakes (front disc, rear drum) and air conditioning.

A postcrash mechanical inspection of the vehicle revealed that all tires were inflated except the right rear which was flattened in the collision. The tread depth on the tires measured: 8/32 inch - left front; 7/32 inch - right front; and 4/32 inch - right rear. The left rear tire tread pattern was completely worn away from the inner half of the tire. The tire pressure was 25 p.s.i. (See figures 2 and 3.) The front disc brake pads, discs, and hoses were in satisfactory condition.

The left rear brake linings were worn to the rivet heads. Collision damage prevented an assessment of the operating capabilities of the right rear wheel and brake assembly. The inner wear surface of the right rear brake drum was crusted with rust. There was no visible evidence of recent braking. Although the linings were damaged during impact and were defaced with foreign materials, they were thick enough to be operational. The right steering tie rod sleeve was broken by crash stress. The outboard end of the left tie rod had been disconnected by the tow truck operator to facilitate towing the vehicle from the scene. The right rear axle shaft was broken 3 inches inboard of the wheel mounting flange. The rear axle was displaced left until the left rear wheel and tire were outside of the rear quarter panel on the vehicle's left side. The fuel tank was punctured in the upper right-front corner. The windshield wipers stopped in approximately the middle of their sweep pattern.

The two right-side doors were crushed inward to about the centerline of the vehicle. (See figure 4.) Some of the welds connecting the B-pillar and the right-front door hinges to the body failed at impact. The A, B, and C-pillars and the chassis frame rails were crushed laterally. The right-front corner of the roof and the top of the A-pillar were crushed to within 4 inches of the vehicle's centerline and the roof buckled upward. The front, rear, and side windows were broken. The vehicle's electrical system and engine could not be tested because of the crash damage.

The Motor Home -- The 1975 Midas Mini Motor Home, Model 190-1, mounted on a Ford Econoline Cutaway Van Chassis, VIN E37HHW63485, was owned by the driver. The odometer registered 14,709 miles. The

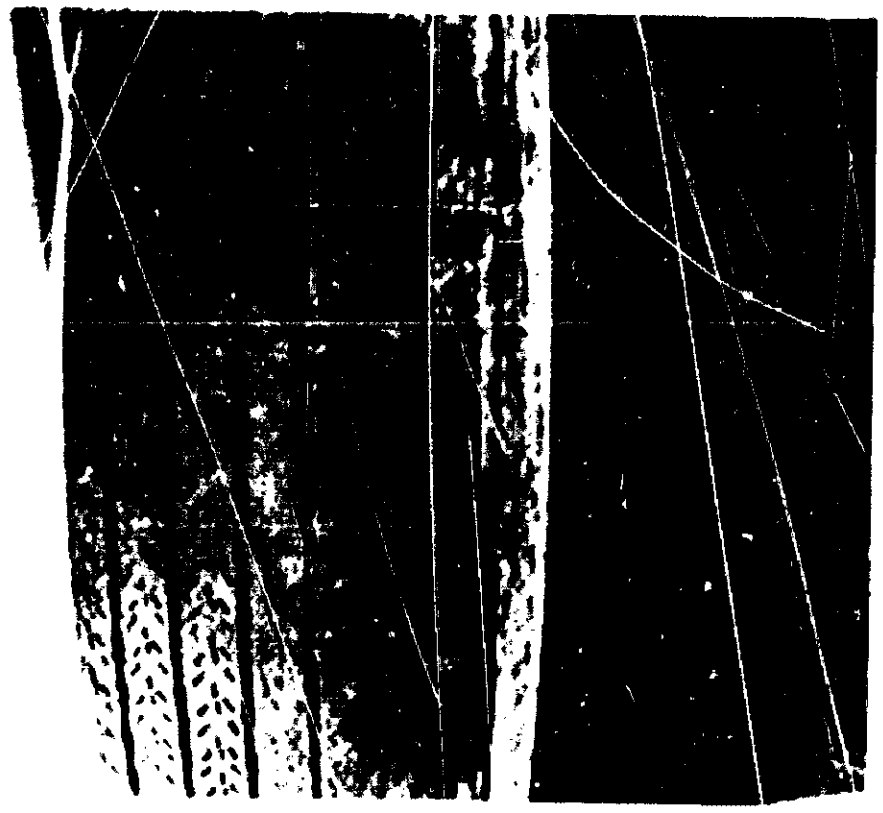


Figure 2. Left-rear tire of Ford sedan, photographed from the rear.

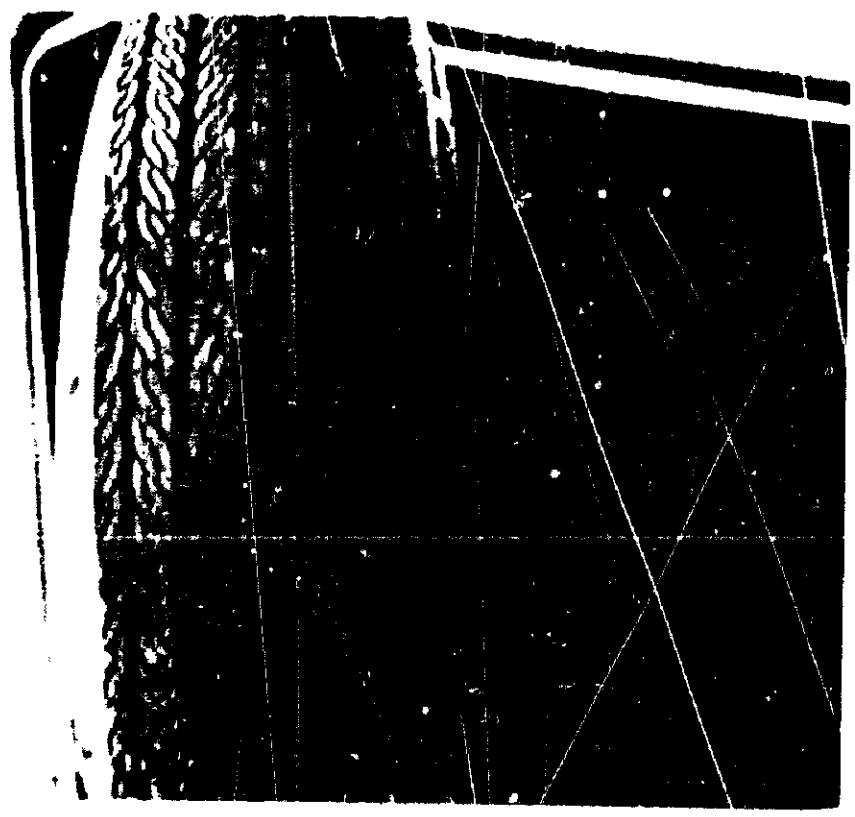


Figure 3. Left-front tire of Ford sedan, photographed from the front.

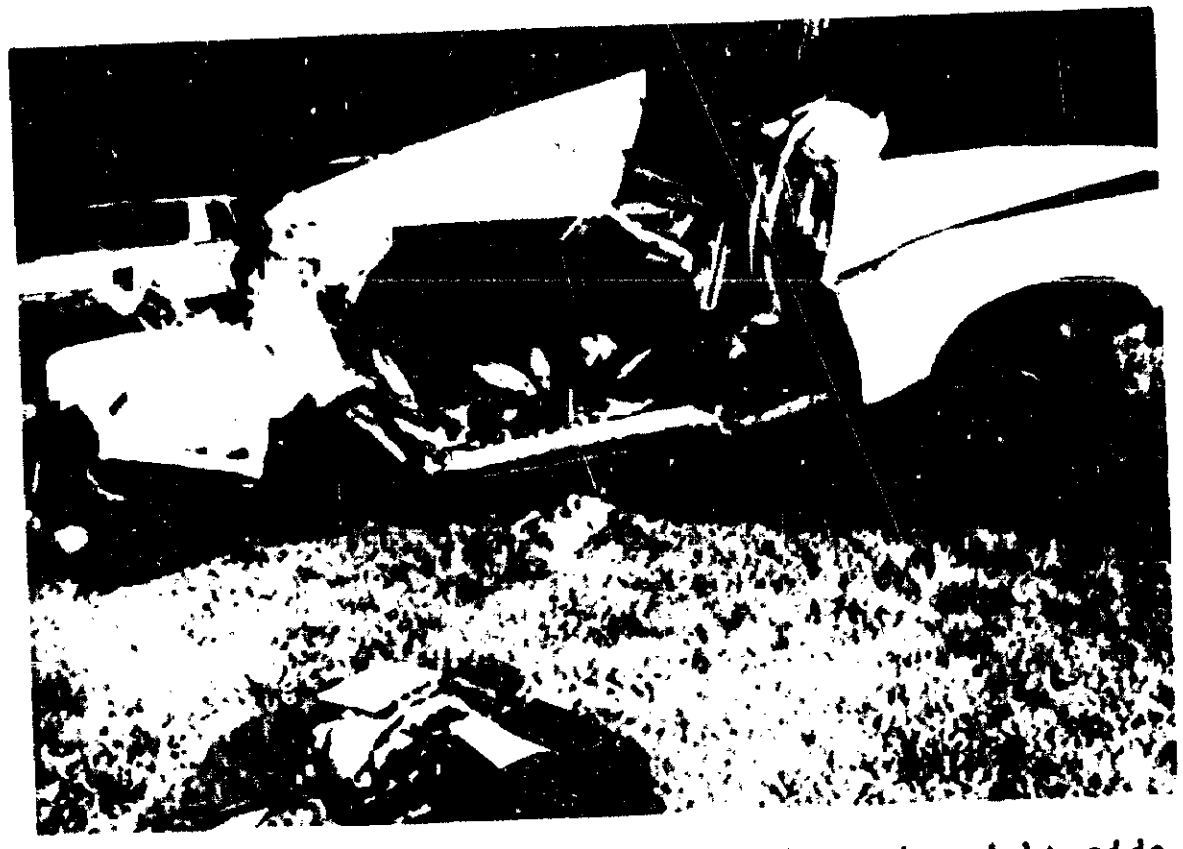


Figure 4. Ford sedan, photographed from the right side.

chassis was equipped with dual rear wheels, power brakes (disc front, drum rear), power steering, a V-8 engine, automatic transmission, and air conditioning. The vehicle was equipped with integral lap belts and shoulder belts for the front two seats only. The driving position, right-front passenger position, instruments, controls, and front doors were standard components provided for Ford vans. The remainder of the body was built by Midas International Industries and consisted of living sleeping quarters.

A postcrash inspection of the mechanical components of the motor home indicated that all of the tires had at least 4/32 inch of tread. All tires were inflated except for the left front which was flattened in the collision. The entire front of the motor home was compressed and pushed backward in an irregular pattern. (See figures 5 and 6.) The driver's door was open and pushed outward.

The left door's locking latch, manufactured by the Ford Motor Company, is typical of Ford automotive door latches. The striker enters the latch body and is captured in a slot formed by two rotating plates. Neither inspection nor operation of the door latch after the accident revealed any visible impairment of function. There was no obvious distortion of any part of the latch, except for the externally connected lever arm, which had a very slight twist. The actuating rod for the interior handle was bent and shortened by approximately 1 7/8 inches.

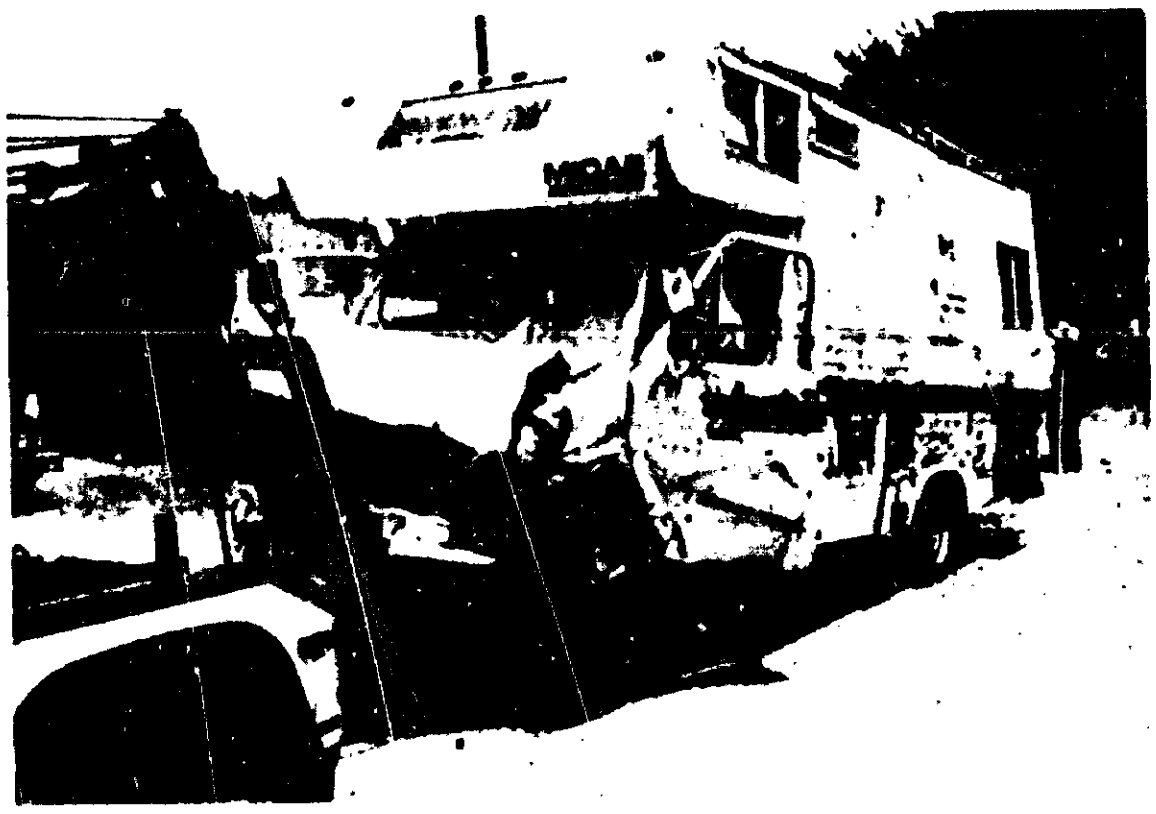


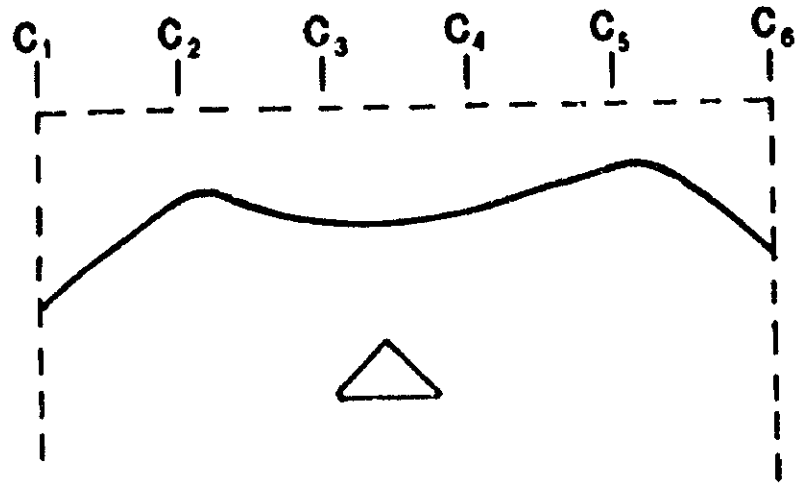
Figure 5. Midas Mini Motor Home, damaged cab and left-side door.

The original length of this rod was 12 3/4 inches and the distorted length was 10 7/8 inches. (See figure 7.)

Federal Motor Vehicle Safety Standard (FMVSS) No. 206 requires that a door latch be able to withstand an ultimate longitudinal load of 2,500 lbs in the fully latched position, and 1,000 lbs in the secondary latched position. (This later position is the attitude that exists between the latch and striker when the latch holds the door in a position less than fully closed.) When evaluated by calculation the latch must remain in the fully latched position when subjected to an inertia load of 30g from any direction. As stated in the Society of Automotive Engineers (SAE) Recommended Practice J839b "Side Door Latch Systems": "It is intended that all portions of the Recommended Practice will be periodically reviewed and revised as additional knowledge regarding vehicle latch performance under impact conditions is developed." The SAE tests developed for FMVSS 206 for door latch assemblies are not dynamic tests per se, but static laboratory tests of various components using test fixtures and procedures.

In response to a Safety Board request, NHTSA reported that they were unable to identify any accidents in their accident data file involving a door latch and that this level of detail is not recorded in most of their accident files.

Midas Motorhome
Crush Diagram



Profile A-Pillars to Front

C_1 = 21.6''	C_4 = 10.8''
C_2 = 8.8''	C_5 = 6.8''
C_3 = 12.5''	C_6 = 16.3''

Scale 1'' = 2'

Figure 6. Motor home front end deformation diagram.

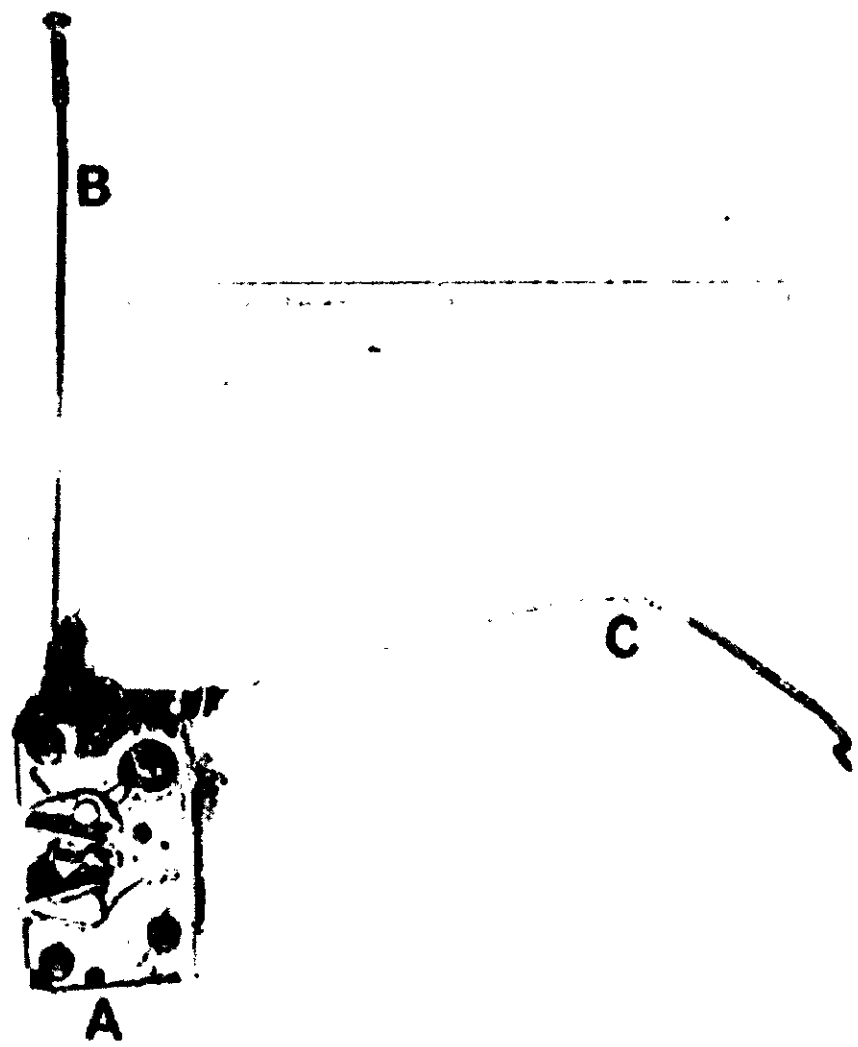


Figure 7. Left door latch assembly from Midas Mini Motor Home.
A. Latch assembly.
B. Door lock control rod and knob.
C. Link assembly door latch remote control rod.

The front disc brake pads were of adequate thickness and functional. The rear brake linings were worn to the rivets. The left front wheel was deformed and the hydraulic brake line was broken. The left front stabilizer bracket for the axle was broken and the left side bracket was cracked. The rear axle was out of alignment 5° to 10°.

The two forward seats had pulled loose from their anchorage and the back of the right front passenger seat failed. The refrigerator was pulled loose from its anchorage and had pinned the rear seat passenger in the debris. The table top and the cabinets on the upper left side also came loose. Other cabinets and the closet were destroyed in the collision.

The roof and side wall of the motor home had separated about 4 inches along approximately 8 feet of the left side. The walls and roof were constructed with nominal 2 x 2-inch lumber framing with rigid foam in the spaces between. An aluminum skin was bonded to the outside and wood paneling was bonded to the inside.

The motor home's propane gas distribution system and fuel system were not damaged in the collision. The electrical system could not be checked due to crash damage.

Highway Information

U.S. 69 is a north/south primary highway connecting the northeast section of Oklahoma with the Dallas-Fort Worth area of Texas. The segment of roadway at the accident site was constructed in the late 1950's. It is straight and level (with a grade of only +.40 percent), has two 12-foot driving lanes with 8-foot paved shoulders and a crown of 2 inches in 12 feet, and is bordered on each side with 4:1 slopes with grass. (See figure 8.) It has a posted speed limit of 55 mph. It has an average daily traffic volume (ADT) of 5,000 vehicles of which 30 to 35 percent are commercial vehicles. Pavement markings include a 4-inch yellow intermittent centerline and a 4-inch white edgeline, which were clearly visible. There are no sight distance restrictions for the driver of either vehicle. A visual inspection of the recently overlaid road surface revealed the presence of flushing. 1/ More than 5 miles of the road was overlaid recently with 1 inch of asphalt/concrete Oklahoma type-C mix. The "job mix formula" for the project--State-aid Project No. MC3(75) -- called for 5 percent asphalt with 93 percent and 44 percent passing through the 3/8-inch and No. 8 sieves, respectively. The project was completed on June 29, 1977, and a final inspection was made on July 5, 1977. There were no deficiencies noted and the project was accepted by the State.

1/ Also termed "bleeding," this is the upward movement of asphalt in an asphalt pavement resulting in the formation of a film of asphalt on the surface.

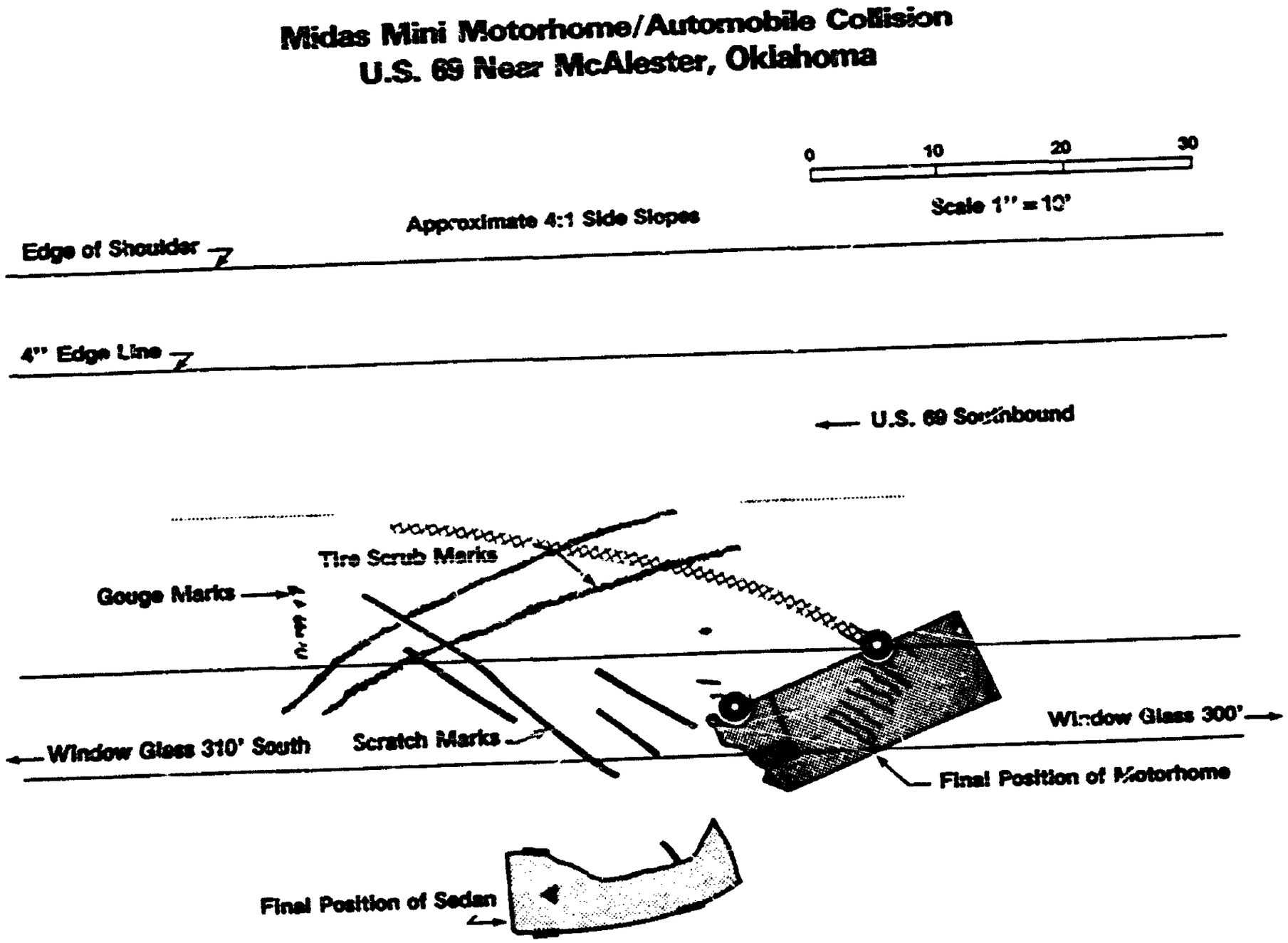


Figure 8. Postcrash diagram.

Comparison of the specifications of the Oklahoma type-C mix with the latest information from the Asphalt Institute and the American Association of State Highway and Transportation Officials (AASHTO) "Guidelines for Skid Resistant Pavement Design," (1976) indicates that the Oklahoma type-C mix is a dense graded mix with relatively little coarse texture. AASHTO's guide emphasizes that the coarse aggregates in a mix provide the major skid resistance at high speeds.

Federal Highway Administration (FHWA) does not permit the use of the Oklahoma type-C mix on Federal-aid projects unless there is a special provision for a minimum of 30 percent insoluble residue in the mix. There was no such provision for this mix. The use of insoluble residue is a common procedure in areas with a high percentage of carbonate aggregate (less than 5 percent insoluble residue) when it is known that such aggregates are generally found to be susceptible to polish.

Two tire scrub marks each approximately 37 feet long were found on the roadway. They started at the centerline and continued in a southeasterly direction across the northbound lane onto the east shoulder. (See figure 9.) Several gouge and scratch marks found in the immediate vicinity of the impact area lead toward the final resting locations of the vehicles. Also one tire scrub mark, approximately 37 feet long led from the left rear wheel of the motor home to within 8 feet of the impact area.

Tests and Research

Highway -- At the request of the Safety Board, the Oklahoma Department of Highways conducted locked-wheel skid tests on the 5.18 mile resurfaced section of U.S. Route 69 with emphasis on the vicinity of the accident. The Oklahoma skid trailer conformed to the requirements of the American Society for Testing and Material Methods' "Method of Skid Resistance Measurements,"(ASTM) E-274-77. The trailer had not been calibrated recently at a FHWA test center.

The tests were conducted on July 18 and 28, 1977. All tests were made at 40 mph for the inside wheel paths of the accident vehicles. On July 18 the test skid numbers for the accident site were 28 in the northbound lane and 27 in the southbound lane. On July 28, 1977, the test skid numbers were 25 for the northbound and 24 for the southbound lanes.

In order to assure the comparability of the test skid numbers to FHWA guidelines for coefficient of friction, the FHWA, at the request of the Safety Board, retested the road surface for the area of the 5.18 miles of overlay and a half-mile stretch of old pavement surface immediately south of the overlay. The FHWA skid trailer also conformed to the requirements of the ASTM E-274-77 and had been calibrated in July of 1976.

Figure 9. Accident site facing north (note scrub marks).

The FHWA skid tests were made on August 31, 1977. The pertinent results (see figure 10) show that the entire length of the overlaid road surface produced skid numbers lower than the old road surface immediately south of the overlay. The overlay area mean skid number was 23.4 northbound and 18.4 southbound compared to the old surface mean skid number of 45.9 northbound. The mean skid numbers for the inside wheel paths at the accident site were significantly lower--18.2 for northbound traffic (motor home) and 11.6 for southbound traffic (sedan).

Both dry and wet skid tests were made using the left-front tire and then the left-rear tire of the sedan on the FHWA skid trailer. The left-front tire's average of five skid tests was 26.5 (wet); the left-rear tire had an average of 11.6 (wet) after two tests.

The FHWA also conducted a modified sandpatch test and an outflow meter test on the actual accident site. (See appendix A.) The sand patch tests were made to determine texture depth. This test uses a measured quantity of fine sand that is leveled off above the pavement in a prescribed manner. The tests determined that the southbound inside-wheel path had a texture depth of 0.004 inch. Currently there are no Federal regulations requiring minimum texture depths. Galloway 2/ recommends a minimum surface macrotexture of 0.040 inch. While this was a limited research study, it does provide a figure for comparison purposes.

The outflow meter consists of a tube with a flange on the bottom. The flange rests on the pavement with a rubber ring interposed between the two. The assembly is weighted down to press the ring against the irregularities of the surface with about the same pressure that exists between the tire and pavement. This leaves the channels in the road surface open and the water in the tube will flow out through them. The time required for the water level in the tube to drop a measured distance is taken to measure the texture. 3/ In the inside-wheel path of the southbound lane, drainage times in three locations measured 286 seconds, 267 seconds, and 609 seconds. In parallel locations at the edge of the road surface the timings were: 11.12 seconds, 11.10 seconds, and 11.12 seconds. Again, there are no Federal regulations or guidelines relating to use or results of the outflow meter.

Highway Safety Program Manual No. 12, Highway Design, Construction, and Maintenance, Section III, Pavement Design and Construction, states:

> A. The skid resistance of pavement surfaces is important in maintaining vehicular control. Low skid resistance increases sharply the chances of skidding when the pavement is wet. As a general rule, low skid resistance also increases the possibility of hydroplaning....

2/ Galloway, B.M. et al., "Tentative Pavement and Geometric Design Criteria for Minimizing Hydroplaning," Report No. FHWA RD-75-11, pg. 159.

3/ National Cooperative Highway Research Program Report No, 14, "Skid Resistance," (1972), pg. 26.

Location	Number of tests*	Starting point	Mean test speed	Mean skid number
Inner travel path of northbound lane	17	.01 to 5.18	39.5	23.4
	4(old surface)	5.18 to 5.72	39.3	45.9
Inner travel path of southbound lane	15	.26 to 4.90	39.8	18.4
Inner travel path of northbound lane at accident site	5	1.82	39.6	18.2
Inner travel path of southbound lane at accident site	5	1.74 to 1.76	40.8	11.6
	5**	1.76 to 1.77	39.8	26.5
	2***	1.74 to 1.76	41.0	11.6
	2(dry)	1.76	40.5	66.7
	2(dry)**	1.78	38.7	64.2
	2(dry)***	1.78	40.2	66.1
Center of northbound lane at accident site	3	1.68 to 1.95	39.7	28.2
Center of southbound lane at accident site	3	1.58 to 1.81	40.6	29.9

* All tests were made on wet pavement with ASTM test tire, except where noted.

** Tests made with the left-front tire (inflated to 24 psi) from the automobile involved in the accident.

*** Tests made with the left-rear tire (inflated to 24 psi) from the automobile involved in the accident.

Figure 10. Selected Federal Highway Administration skid test data, 5.18-mile overlay, U.S. Route 69, August 31, 1977

B. State and local agencies...should require that in design and construction of all new pavements adequate standards of skid resistance be met.... A further goal is to design pavements to maintain these skid resistant qualities for...the service life of the pavement.

1. Wearing surface qualities should minimally include the following design and construction consideration:

****

(1) Aggregate size, shape, and hardness that will produce durable skid resistant surface.

(2) Composition of the paving mix to allow the pavement surface to develop its skid resistant qualities.

****

(2) Finishing the wearing surface to provide a durable skid resistant roadway.

The manual states that there is no nationally accepted minimum coefficient of friction of skid resistance. However, as a general guide the following minimum skid numbers are recommended: tested at 40 mph the road surface should have a minimum skid number of 33; for 50 mph, 32, and for 60 mph, 31. Further, the manual states "Road surfaces with a skid resistance value less than the interim skid numbers stated above, should be analyzed for corrective treatment."

The manual calls for States to have "methods for immediate spot improvement surface treatments on roadway sections with inadequate skid resistant characteristics."

Door Latch -- The Safety Board asked the National Highway Traffic Safety Administration (NHTSA) to identify the door latch manufacturer and to test it to determine if it met the requirements of FMVSS 206. The NHTSA declined to test the latch because they are neither authorized nor budgeted to test used equipment. They indicated that FMVSS 206 is only valid for new equipment. The NHTSA letter stated that the same configuration of latch was tested twice as part of a fiscal 1976 test program. It was tested for a Ford E-100 Van, 1976 model, (test report number 206DTB-76-018) and for Ford Granada and Monarch passenger cars (test report number 206DTB-76-027). In each test, according to the NHTSA, no failures were encountered and testing was stopped.

Meteorological Information

At the time of the accident, it was daylight and the skies were cloudy, horizontal visibility was less than 1 mile, and there were

moderate to heavy thunderstorms and gusty surface winds. The amount of rain between 4:15 p.m. and 4:33 p.m. is estimated to have been .24 to .54 inch and the temperature was estimated to have been 75° F.

Motorists in the area stated that it was raining moderate to hard at the time of the accident.

Medical and Pathological Information

The death certificates indicated that the deceased died of injuries received in the accident. There was no evidence of alcohol or drugs connected with either driver.

The injuries to the survivors are described in appendix B.

Survival Aspects

Five of the six survivors were transported to the hospital by private vehicles before the ambulance arrived. Ambulance and rescue personnel were dispatched from Atoka (19.7 miles south of the accident), McAlester (19.4 miles north of the accident, and Coalgate (32 miles southeast of the accident). The first ambulance arrived at the accident site between 5:00 p.m. and 5:10 p.m. The remaining survivor was transported to the Atoka Hospital.

The use of the available seatbelts by the occupants of the sedan would not have aided them in surviving the collision. Their major injuries were insured by the loss of cross-sectional integrity of the car body when the two right-side doors were crushed to the centerline of the vehicle and because the A and B pillars failed.

It is possible that both of the front seat occupants of the motor home might have survived the collision and vehicle overturn if they had been wearing the available restraints. The left side door of the motor home opened during the impact and the driver was partially ejected. f he had been restrained, he would not have been crushed between the door sill and the road. The forward and left lateral movement of the front seat passenger would have been restrained even though the seat anchorages failed, and she may not have received the severe head injuries when her head struck the dash and right side of the steering column.

There were no restraints available to the other occupants. The list of injuries is based on the report of the State Chief Medical Examiner's office and medical reports from the hospital. (See appendix B.) Seating positions were determined from interviews with survivors.

The Safety Board recommended in 1976 that the Recreational Vehicle Industry Association (RVIA) conduct a safety campaign to emphasize to the occupants of motor homes the benefits of seatbelts and urge

the manufacturers of motor homes to print information in the owners manual stressing the benefits of seatbelts. 4/ In August 1977 the RVIA published a pamphlet titled "RVIA says: Buckle Up for Safety," and a booklet, "The Way to Go," to be distributed through the membership and distributors. The two publications stress the owners awareness of the value of safety features, with emphasis on the installation and use of seatbelts. They have also urged that manufacturers include this data in their owner manuals.

ANALYSIS

The Accident

The sedan, traveling at a calculated 34 to 36 mph, entered the overlaid section of Route 69 in a heavy rain, which reduced the driver's visibility. The tires provided uneven traction with the road surface; the road surface in the left wheel path -- the path of the half-smooth left rear tire -- provided reduced skid resistance, and the rear brake system was only capable of uneven, limited effectiveness. As the two vehicles approached, any action by the sedan driver -- steering input, braking, or acceleration -- could have initiated its left side slide into the path of the motor home. The sedan driver probably did not know the condition of the vehicle's left rear tire or how the sedan would react to a brake application on a wet surface. It could not be determined what caused the sedan to slide.

By the time the motor home driver saw the approaching sedan start to slide in his direction, it was too late for any successful evasive action on his part.

Impact forces combined with a slight steering input to the right by the driver of the motor home to induce an immediate clockwise rotation of the motor home. At maximum engagement, the entire front of the motor home was in contact with the right side of the sedan. At this point the right-rear axle shaft on the sedan broke off 3 inches from the hub, allowing the right-rear portion of the vehicle to fall to and gouge the pavement.

Door Latch Failure

The impact and swiping action of the sedan across the right front corner of the motor home threw the driver and passengers of the motor home forward and to the left.

The forces resulting from the frontal impact with the sedan deformed rearward the left front and left side structural assembly of the motor home. The door, caught between the A and B pillars, was compressed longitudinally and bowed outward. When the door bowed outward, the longitudinal structures within the door -- including the link assembly door latch remote control rod -- bent to the same degree.

4/ "Highway Accident Report -- Collision of Winnebago Motor Home With Bridge Column, Near Monroe, Michigan, July 1, 1975." (NTSB-HAR-76-2).

The shortening of this rod through bowing produced the same action as moving the door handle to actuate the rod and open the latch. The latch opened and was held open permitting the door to open. While the motor home was rotating clockwise, the unlatched door was held closed by centrifugal force. As the motor home overturned onto its left side, the unrestrained driver fell against the unlatched door; the door opened and he fell through the partially open door of the motor home and was crushed.

Inspection and operation of the door latch mechanism by the NHTSA and Safety Board investigators found no impairment. There was no obvious distortion of any part of the latch, with the exception of the inner handle link assembly door latch remote control, which had been bent, shortening it approximately 1 7/8 inches.

Although the door lock and latch had been manufactured under FMVSS No. 206, the dynamic loading of the door latch and its attachments cannot be correlated with the static test loads required by the standard. Had the door remained closed, the driver might have survived the accident.

If such accidental door openings are to be prevented, failures of different types of door latch combinations and assemblies should be subjected to excessive loads and the effects of the loads studied. All possible loading configurations should be considered to determine the possible modes of failure. Dynamic impact testing in conjunction with static loadings would provide a more realistic simulation of actual loading conditions, by subjecting the door latch and all parts of its assembly to impact loads. This requires the restating of FMVSS 206 as a performance standard and the development of dynamic test requirements to assure that all types of loading be considered. In this accident, the latch itself did not fail, but the unprotected actuator rod was subjected to compression forces beyond its strength and failed. This failure defeated the precautions established to prevent unwanted opening of the latch. The tests required by a modified standard would discover this failure and require that the system be changed to avoid this failure.

The Highway

The Oklahoma type-C mix used to overlay the roadway at the accident site contained a low percentage of coarse aggregates. The mix also appears to have too much dust (material passing through a No. 200 sieve) resulting in the elimination or filling in of void space and poor drainage characteristics. This is indicated by the sandpatch and outflow meter tests.

"The test for acid insoluble constituents provides a good preliminary indication of the potential polish susceptibility of carbonate rock deposits

used or being considered for use in the production of aggregates." 5/ This is a "procedure designed to determine the type and amount of mineral matter within the particles of limestone (or dolomite) which cannot be dissolved in a dilute solution of hydrochloric acid." 6/

Probably the most serious skid problem encountered with asphalt pavement is bleeding (flushing). 7/ Flushing results from the upward movement of asphalt in an asphalt pavement resulting in the accumulation of asphalt on the surface. 8/

Since the skid resistance of pavement deteriorates with use, the HSPS No. 12 recommends that State and local agencies follow a systematic plan for checking skid resistance periodically at problem locations and on a sampling basis at other locations. The criteria proposed for including a location in the periodic schedule include: (a) High accident experience, (b) indications of excessive skidding, (c) potentially hazardous locations, (d) locations where traffic volumes are heavy, (e) locations where the pavement is constructed with materials known to polish rapidly, and (f) locations where the pavement is in poor condition.

The guidelines and criteria established by the standard do not provide any procedures or controls that would assure that newly constructed or overlaid road surfaces are safe for use by the motoring public. The first awareness the State has of an unsafe road surface is the occurrence of an abnormal number of accidents or excessive skidding.

Oklahoma's skid accident reduction program uses accident information to identify high accident locations, and locations where wet weather accidents are overly represented. When such locations are identified, skid tests are conducted to determine if the surface has a low coefficient of friction. This procedure follows the guidelines for checking skid resistance at problem locations, but does not provide for checks on a sampling basis at other locations.

An ideal procedure would require State and local highway departments to conduct skid resistance evaluations of all newly constructed or resurfaced roadways before they are opened to the public. An immediate evaluation of skid resistance performance should be another step in the quality control to assure that the road surface and texture comply with specifications and safety practices.

5/ Aggregates and Pavement Skid Resistance, Renninger, F.A. and Nichols, F. P., Jr., National Crushed Stone Association, 1972, pg. 7.

6/ Ibid., pg. 2.

7/ Transportation Research Board, Report No. 622, "Skidding Accidents," 1977, pg. 48.

8/ Asphalt Overlay and Pavement Rehabilitation, The Asphalt Institute, MS-17, November 1977, pg. 104.

There are procedures for testing surface texture that are not as sophisticated as the skid trailer. The sandpatch and outflow meter tests used to corroborate the skid tests in this accident investigation are simple tests and the necessary testing equipment is relatively inexpensive. They would provide a degree of assurance that, in the spots tested, the road surface was porous enough to let the surface water run off, and in that respect, whether the road was safe for travel. Then as available, the skid trailer could follow up to further determine the adequacy of skid resistance in compliance with the provisions of HSPS No. 12.

Results of the Oklahoma and FHWA skid tests clearly indicate that the coefficient of friction at the accident site only 9 weeks after it was resurfaced is well below the recommended minimum skid number of 32. This alone should be sufficient cause for any agency to take a closer look at some of its long-standing, standard construction practices. The continuous evaluation of materials, textures, and construction practices is necessary to insure that highway surfaces have skid resistant properties conducive to the safe operation of vehicles.

Vehicle Inspection

The post-accident examination of the sedan's right rear brake assembly revealed that the pistons in the wheel cylinder had rusted to the cylinder walls. When removed and inspected, the cylinder did function. Additionally, the rust encrusted surface of the brake drum did not indicate recent contact with the brake lining.

The sedan had been inspected under Oklahoma's annual Motor Vehicle Inspection Program (PMVI) in July 1976. From the time of the inspection to the time of the accident, the sedan had been driven approximately 9,600 miles in an 11-month period. Oklahoma's PMVI does not require that any of the vehicle wheels be pulled for brake, bearing, or axle inspection. Only pedal test is required.

A removal of a wheel and visual inspection of the brake assembly would help to insure that braking deficiencies are detected at the time of inspection.

Securement of Recreational Vehicle Appliances

Forces induced on the motor home at impact were sufficient to tear the refrigerator out of its mounting. The refrigerator, which was secured by four No. 8 wood screws around its base and two No. 8 wood screws at the lower rear of the refrigerator, broke from its surrounding wooden cabinet, tumbled about inside the vehicle, and came to rest on top of a passenger. Had this man needed immediate medical attention or had he needed to get out of the motor home due to fire or immersion, the refrigerator could have caused his death. Other cabinets within the motor home also broke apart at impact spilling their contents.

The Safety Board has recommended previously that the anchoring of appliances in recreational vehicles be strengthened. 9/ Better methods need to be devised to secure recreational vehicle appliances if we are going to reduce fatalities and injuries in these types of accidents.

CONCLUSIONS

Findings

1. The driver of the sedan was unfamiliar with the vehicle and may have been unaware of its mechanical condition.

2. The visibility of the drivers of both vehicles was limited due to the heavy rain immediately before the collision.

3. The southbound sedan slid sideways into the northbound lane into the path of the motor home.

4. The driver of the motor home did not have time for evasive action.

5. The inner handle door latch actuating rod on the left door of the motor home was bent during the collision, opening the latching mechanism, and keeping it in an unlatched position. This permitted the door to open and the driver to be partially ejected and crushed as the vehicle rolled onto its left side.

6. Had the driver and right-front passenger in the motor home been restrained in their seats, they probably would have survived the crash.

7. The displacement of the refrigerator during the accident injured and trapped a passenger.

8. Oklahoma's Periodic Motor Vehicle Inspection Program will not reveal unsafe conditions of vehicles such as loose ball joints, loose tie rods, loose steering, inoperable brakes, or the conditions which may precipitate loss of vehicle control.

9. Skid testing of the newly resurfaced section of roadway clearly indicates that the coefficient of friction was well below minimum recommendations for skid resistance.

10. Design procedures, construction materials, and maintenance practices should insure a pavement surface with sufficient skid resistant properties before it is opened for use by the public.

9/ "Highway Accident Report -- Collision of Winnebago Motor Home With Bridge Column, Near Monroe, Michigan, July 1, 1975." (NTSB-HAR-76-2)

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was a combination of the low skid resistance of the wet road surface and the lax operating maintenance by the owner of the Ford sedan which permitted the use of an unsafe tire and the imbalanced capability of the brake system. A factor contributing to the accident was the driver's unfamiliarity with the mechanical condition of the Ford sedan. Contributing to the severity of the injuries were the failure of the front seat occupants of the motor home to wear the available seatbelts and the failure of the door latch assembly.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board recommended:

-- to the Oklahoma Department of Transportation:

"Post warning signs conforming to the requirements of the Manual on Uniform Traffic Control Devices on the resurfaced 5.18-mile section of U.S. Route 69 to advise motorists that the surface is slippery when wet. These signs should be maintained until the skid resistance on the overlay surface is increased. (Class I, Urgent Action) (H-77-35)" (Issued January 10, 1978)

"Evaluate the pavement design and construction practices used on this project in order to eliminate any possibility for this condition to reoccur. (Class II, Priority Action) (H-77-36)" (Issued January 10, 1978)

"Expedite the application of necessary materials to remedy the low skid resistance condition on the 5.18-mile resurfaced section of U.S. Route 69. (Class II, Priority Action) (H-77-37)" (Issued January 10, 1978)

-- to the National Highway Traffic Safety Administration:

"Revise FMVSS 206 to require performance tests on door latch assemblies rather than the nondynamic, laboratory tests as described in the Society of Automotive Engineers Recommended Practice, SAE J8396. (Class II, Priority Action) (H-78-15)" (Issued March 22, 1978)

"Work with they Society of Automotive Engineers to devise methods of testing to demonstrate experimentally the satisfactory performance of latching systems. (Class II, Priority Action) (H-78-16)" (Issued March 22, 1978)

-- to the State of Oklahoma Department of Transportation:

"Have its skid trailer calibrated at a Federal Highway Administration test center as soon as possible and inform the Safety Board when the calibration is completed. (Class II, Priority Action) (H-78-17)"

-- to the Motor Vehicle Manufacturers Association of the United States, Inc.:

"Inform its members of the details of the unwanted actuation of the door latch and encourage them to consider ways to prevent such failures in the manufacture of future door-latch assemblies. (Class I, Urgent Action) (H-78-18)"

-- to the Federal Highway Administration:

"Develop expeditiously procedures to determine the skid resistant characteristics of newly constructed and resurfaced roadways before they are opened to the public. (Class II, Priority Action) (H-78-19)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ ELWOOD T. DRIVER
Member

April 13, 1978

APPENDIX A

RESULTS OF PAVEMENT SURFACE TESTS CONDUCTED ON 8-31-77 AT MILE POST 21.18, US 69, NEAR CHOCKIE, ATOKA COUNTY, OKLA.

Test Site Code	1/ Distance, North of The Point of Impact	2/ Texture Depth, Modified British Sand Patch, Inches	3/ British Portable Number, BPN	4/ Pavement Temp °F 5/ Wet	6/ Dry
		SOUTH BOUND			
		Edge of Pavement-13' From Center Line			
Edge 1	11'6"	0.018	59	108	128
" 2	18'3"	0.017	62	-	-
" 3	24'6"	0.013	59	-	-
		Inside Wheel Path-3' From Center Line			
IWP 1	11'6")	0.004 7/	58	92	120
" 2	18'3")		54	-	-
" 3	24'6")		56	-	-
		NORTH BOUND			
		Edge of Pavement-13' From Center Line			
Edge 1	11'6"	0.014	63	102	132
" 2	18'3"	0.013	64	-	-
" 3	24'6"	0.014	64	-	-
		Inside Wheel Path-4' From Center Line			
IWP 1	11'6")	0.004 7/	59	104	138
" 2	18'3")		59	-	-
" 3	24'6")		57	-	-

Notes:
1/ Measurements by NTSB Investigator.
2/ Described in American Concrete Paving Association ACPA Technical Bulletin No. 6, August, 1969.
3/ Conforms to ASTM E-303, utilizing ASTM E-501 standard rubber sliders.
4/ Using a Surface Temperature Dial Thermometer. (Arthur H. Thomas Co., Phila., Pa. Catalog No. 9318-F20).
5/ Recorded after BPN test.
6/ Recorded before wetting surface for BPN test.
7/ Applies to all 3 IWP sites. Pavement was too smooth to get an accurate test using the specified sand size (149-297 microns). Circular patch diameters exceeded 15 inches which would calculate to a texture depth of 0.0034 inches.

General Notes: Weather at time of testing: Sunny, clear, air temp about 89°F.
Pavement Surface Condition:
In wheel paths - smooth and flushed
Other than wheel paths - medium-textured, no flushing

APPENDIX A

Results of Outflow Meter Tests of Pavement Surface Conducted on 8/31/77 at Mile Post 21.18, U.S. 69, Near Chockie, Atoka County, Oklahoma

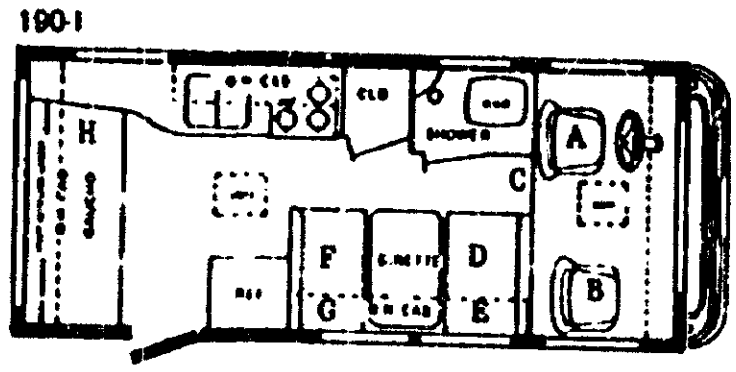
Test Site	Outflow Meter
South Bound - Edge 1	11.12 seconds
South Bound - Edge 2	11.10 seconds
South Bound - Edge 3	11.12 seconds
South Bound - IWP 1	609.00 seconds
South Bound - IWP 2	267.00 seconds
South Bound - IWP 3	286.00 seconds
North Bound - Edge 1	11.79 seconds
North Bound - Edge 2	12.48 seconds
North Bound - Edge 3	10.55 seconds
North Bound - IWP 1	447.00 seconds
North Bound - IWP 2	119.81 seconds
North Bound - IWP 3	51.48 seconds

Outflow Meter was a FHWA fabricated instrument following the description of a similar instrument developed by the California DOT, Division of Highways and reported in Research Report CA-DOT-TL-3126-9-74-10.

The test sites correspond to those used for the sand patch and BPT tests.

APPENDIX B

SEATED POSITIONS AND INJURIES OF OCCUPANTS OF MIDAS MINI MOTOR HOME



Seated Position	Occupants	Injuries
A. Driver	41-year-old male	respiratory failure due to multiple interthoracic injuries also had scalp lacerations
B. Right front	12-year-old female	skull and cerebral injuries (AIS-6) 1/
C. Kneeling behind and between A and B	31-year-old female	head concussion with loss consciousness and laceration on left leg (AIS-2)
D. Left forward table seat facing to the rear	5-year-old female	fractured distal left tibia (AIS-2)
E. Right forward table seat facing to the rear	9-year-old female	laceration to left wrist (AIS-2)
F. Left rear table seat facing forward	65-year-old female	left arm contusion, distention of abdomen, fracture right femur and lacerations (AIS-2)
G. Right rear table seat facing forward	55-year-old male	fractured left right finger, spinal injury, puncture wound right arm, laceration of chin (AIS-2)
H. Rear benchseat	27-year-old male	fractured mandible, 2-inch scalp laceration, and avulsion of several teeth (AIS-2)

1/ American Association of Automotive Medicine "Abbreviated Injury Scale 1976 Revision, Appendix B."

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX C

ISSUED: January 10, 1978

CORRECTED COPY

Forwarded to:

Mr. Richard A. Ward
Director
Oklahoma Department of Transportation
200 N. E. 21st Street
Oklahoma City, Oklahoma 73105

SAFETY RECOMMENDATION(S)

H-77-35 through 37

The National Transportation Safety Board is investigating the collision of a Midas Mini Motor Home and an automobile which occurred about 4:00 p.m. on July 14, 1977, on U.S. Route 69 north of Atoka, Oklahoma. The southbound automobile went out of control on wet pavement, crossed the centerline sideways, and collided with the northbound motor home. All six persons in the automobile were killed; the driver and right front passenger in the motor home were also killed, and the six other occupants of the motor home were injured. At the time of the accident the skies were cloudy, and visibility was estimated at less than 1 mile in moderate to heavy thunderstorms with gusty winds. Between 4:15 p.m. and 4:33 p.m., an estimated .24 to .54 inch of rain fell and the temperature was estimated to be 75° F.

The two-lane, two-way section of highway at the accident site was posted at 55 mph and had an average daily traffic volume of 5,000 vehicles; 30 to 35 percent were commercial vehicles. More than 5 miles of the road was overlayed recently with 1 inch of asphalt/concrete Oklahoma type-C mix. The "job mix formula" for the project--State-aid Project No. MC3(75)--called for 5 percent asphalt with 93 percent and 44 percent passing through the 3/8-inch and No. 8 sieves, respectively. The project was completed on June 29, 1977, and a final inspection was made on July 5, 1977. There were no deficiencies noted and the project was accepted by the State.

Comparison of the specifications of the Oklahoma type-C mix with the latest information from the Asphalt Institute and the American Association of State Highway and Transportation Officials (AASHTO) "Guidelines for Skid Resistant Pavement Design," (1976) indicates that the Oklahoma type-C mix is a dense graded mix with relatively little coarse texture. AASHTO's guide emphasizes that the coarse aggregates in a mix provide the major skid resistance at high speeds.

APPENDIX C

At the request of the Safety Board, the Oklahoma Department of Highways conducted locked-wheel skid tests on the 5.18-mile resurfaced section of U.S. Route 69 with emphasis on the vicinity of the accident. The tests were conducted on July 18 and 28, 1977. The Oklahoma skid trailor conformed to the American Society for Testing and Material Methods' "Method of Skid Resistance Measurements," (ASTM-E-274-77) requirements, but it had not been calibrated recently at one of the Federal Highway Administration (FHWA) test centers. All tests were made for the inside wheel paths of the accident vehicles at 40 mph.

On July 18, the skid numbers at the accident site were 28 in the northbound lane and 29 in the southbound lane. On July 28, the skid numbers were 25 in the northbound lane and 24 for southbound traffic.

The FHWA recommends that road surfaces that are skid-tested at 40 mph have a minimum coefficient of friction (skid number) of 32 for a mean traffic speed of 50 mph and a minimum skid number of 35 when the mean traffic speed is 30 mph. Lower numbers indicate less resistance to skid.

Because the Oklahoma skid trailer had not been calibrated recently, the Safety Board asked the FHWA to conduct additional skid tests over the same portion of roadway; these tests were conducted on September 1, 1977. The FHWA locked-wheel skid trailer, which met the ASTM-E-274-77 requirements, indicated that at 40 mph skid numbers ranged from 15.2 to 32.9. The averages of skid numbers from five tests performed at the accident site, was 23.0 in the northbound lane and 15.4 in the southbound lane, where the automobile went out of control. Additional tests made in the center of the lanes resulted in averages of 28.2 in the northbound lane and 28.8 in the southbound lane. Five tests made in each of the lanes at 30 and 60 mph resulted in skid number averages of 25.6 and 15.9, respectively, in the northbound lane, and 22.8 and 10.1, respectively, in the southbound lane. Four tests performed on the older section of pavement just north of the overlay project revealed an average skid number of 45.4.

Although the effect of the pavement surface on this accident has not been established, these skid tests clearly indicate that the coefficient of friction on the resurfaced road section is well below minimum recommendations for skid resistance. The Safety Board's investigation is continuing and additional facts, analysis, and findings will be issued in a report. In the interim, the National Transportation Safety Board recommends that the Oklahoma Department of Transportation:

> Post warning signs conforming to the requirements of the Manual on Uniform Traffic Control Devices on the resurfaced 5.18-mile section of U.S. Route 69 to advise motorists that the surface is slippery when wet. These signs should be maintained until the skid resistance on the overlay surface is increased. (Class I, Urgent Action) (H-77-35)

APPENDIX C

Evaluate the pavement design and construction practices used on this project in order to eliminate any possibility for this condition to reoccur. (Class II, Priority Action) (H-77-36)

Expedite the application of necessary materials to remedy the low skid resistance condition on the 5.18-mile resurfaced section of U.S. Route 69. (Class II, Priority Action) (H-77-37)

BAILEY, Acting Chairman, McADAMS, HOGUE, and KING, Members concurred in the above recommendations.

By: Kay Bailey
Chairman

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX D

ISSUED: March 22, 1978

Forwarded to:

Honorable Joan Claybrook
Administrator
National Highway Traffic Safety
Administration
Washington, D.C. 20590

SAFETY RECOMMENDATION(S)

H-78-15 and -16

The National Transportation Safety Board is investigating the collision of a motor home and an automobile about 4:00 p.m. on July 14, 1977, on U.S. Route 69 south of McAlester, Oklahoma. The automobile was southbound when it skidded on wet pavement and slid sideways across the centerline in front of the motor home. All six persons in the automobile were killed; the driver and one passenger in the motor home were also killed, and the six other passengers were injured.

The left door of the motor home opened during the impact and permitted the unrestrained driver to be ejected partially from the vehicle. When the vehicle overturned, it crushed the driver between the cab and the road surface. The left door's latch, manufactured by the Ford Motor Company, is typical of automotive door latches, wherein the striker enters the latch body and is captivated in a slot formed by two rotating plates. Neither inspection nor operation of the door latch after the accident revealed any visible impairment of function. There was no obvious distortion of any part of the latch, with the exception of the externally connected lever arm, which had a very slight twist. The actuating rod for the interior handle was bent and shortened by approximately 1 7/8 inches. The crushing of the door upon impact, which bent the rod, also unlatched the latching mechanism, and kept it unlatched. The original length of this rod was 12 3/4 inches and the distorted length was 10 7/8 inches.

APPENDIX D

When a vehicle body is distorted torsionally, the transverse load developed at the door latch assembly will cause a longitudinal door foreshortening due to the impact deformation of the door panel. This load acts the same as longitudinal compression forces developed in the vehicle structure under conditions of head-on or rear-end impact. When the door panel is impacted in such a way as to cause a foreshortening of the panel in the longitudinal direction, the latch is subject not only to longitudinal tensile loads but also to rotational displacement between the latch and striker, thus adversely affecting latch performance. The latch assembly should function to maintain proper engagement between the rotor and striker under load conditions.

Federal Motor Vehicle Safety Standard (FMVSS) No. 206 requires the latch to be able to withstand an ultimate longitudinal load of 2,500 lbs in the fully latched position, and 1,000 lbs in the secondary latched position, which is the attitude that exists between the latch and striker when the latch holds the door in a position less than fully closed. The standard also states that the latch must be able to withstand an ultimate transverse load of 2,000 lbs in the fully latched position and 1,000 lbs in the secondary latched position. These requirements indicate that the latch must remain in the fully latched position when subjected to an inertia load of 30g in any direction. The Society of Automotive Engineers (SAE), in its Recommended Practice J839b, has developed nondynamic, laboratory tests on door latch assemblies to meet the requirements of FMVSS No. 206. The interdependent components of the door latch system (including the door latch, striker assembly, outside handle, key cylinder, and any connecting mechanisms) require evaluation through a static test.

The actuation of the door latch is caused by the bending of the latch remote rod due to encroaching impact deformation of the door panel. Although some possible causes of accidental door openings have been anticipated prior to experimental testing, there could be other causes that can be discovered only by evaluating the dynamics of a door that opened under crash conditions.

The latch assembly should be evaluated in a dynamic test even though it normally functions only under brief, low dynamic loading conditions. Whereas a static testing procedure cannot simulate the brief loading time occurring under actual impact conditions, dynamic testing in conjunction with static loading offers a more realistic simulation of actual loading conditions. Dynamic testing could be done by subjecting the latch and actuating system components to impact loads. Therefore, the National Transportation Safety Board recommends that the National Highway Traffic Safety Administration:

APPENDIX D

Revise FMVSS 206 to require performance tests on door latch assemblies rather than the nondynamic, laboratory tests as described in the Society of Automotive Engineers' Recommended Practice, SAE J839b. (Class II, Priority Action) (H-78-15)

Work with the Society of Automotive Engineers to devise methods of testing to demonstrate experimentally the satisfactory performance of latching systems. (Class II, Priority Action) (H-78-16)

BAILEY, Acting Chairman, McADAMS, HOGUE, and KING, Members, concurred in the above recommendations.

By: Kay Bailey
Acting Chairman