

**VEHICLE GROUP CHAIRMAN'S
FACTAUL REPORT**

**MEXICAN HAT, UTAH
HWY-08-MH-012
JANUARY 6, 2008**

(8 Pages)



National Transportation Safety Board
Office of Highway Safety
Washington, DC 20594

VEHICLE GROUP CHAIRMAN'S FACTUAL REPORT

A. ACCIDENT

Type: Motorcoach, overturn
Date and Time: January 6, 2008 at about 8:02 p.m. MST
Location: Southbound, U.S. 163, near MP 29, Mexican Hat,
San Juan County, Utah
Vehicle: 2007 MCI, Model J-4500, 56-passenger motorcoach
Motor Carrier: BUSCO, Inc., DBA Arrow Stage Lines
Fatalities: 9
Injuries: 44
NTSB #: **HWY-08-MH-012**

B. VEHICLE GROUP

Larry L. Yohe, Senior Accident Investigator
National Transportation Safety Board
4760 Oakland Street, Suite 500
Denver, Colorado 80239
Email: YOHEL@ntsb.gov

Trooper James Curtis, Vehicle Safety Section
Utah Highway Patrol
P.O. Box 658
Monticello, Utah 84535
Email: jamescurtis@utah.gov

Dudley Feige, Safety Investigator
Federal Motor Carrier Safety Administration
116 E. Dakota
Pierre, South Dakota 57501
Email: Dudley.feige@dot.gov

Robert Zeaton, V.P. Product Safety Engineering
Motor Coach Industries
1700 East Golf Road
Schaumburg, Illinois 60173
Email: Bob.Zeaton@MCICoach.com

Gene Wordekemper, Director of Maintenance
Arrow Stage Lines
12295 East 37th Avenue
Denver, Colorado 80239
Email: gene@arrowstagelines.com

C. ACCIDENT SUMMARY

On January 6, 2008, at about 3:30 p.m. MST, a 2007 MCI 56-passenger motorcoach with 52 passengers on-board departed Telluride, Colorado, enroute to Phoenix, Arizona, as part of a 17-motorcoach charter. The motorcoach was returning from a three-day weekend of skiing. The motorcoaches were diverted to an alternate route that included U.S.191 and U.S 163 in Utah, due to the closure of Colorado State Route 145 because of snow. Colorado State Route 145 is the normal route used from Telluride to Phoenix.

At about 8:02 p.m. MST, the motorcoach was traveling southbound descending a 6 percent grade leading to a curve to the left, 1800 feet north of milepost 29, at a driver reported speed of 65 mph. After entering the curve, the motorcoach departed the roadway at a shallow angle striking the guardrail with the right rear wheel about 61 feet before the end of the guardrail.

The motorcoach began rotating in a counterclockwise direction as it descended an embankment. The motorcoach began to overturn and struck several rocks in a creek bed at the bottom of the embankment. The motorcoach came to rest on its wheels after overturning 360 degrees. During the rollover sequence, the entire roof of the motorcoach separated from the body and 51 of the 53 occupants were ejected. As a result, nine passengers were fatally injured and 43 passengers and the driver received various degrees of injuries from minor to serious.

The weather was cloudy and the roadway was dry at the time of the accident.

D. VEHICLE INSPECTION

The Utah Highway Patrol, while at the accident site, performed a limited inspection of the motorcoach. On January 7th, the day after the accident, S&S Garage transported the motorcoach to their facility, located at 50 N. Walnut Street, Green River, Utah. On the morning

of January 9th the motorcoach was transported to an indoor heated facility at Neilson Construction, located in a rural area near Price, Utah, where a vehicle examination and inspection was conducted. Participating in this inspection were personnel from the NTSB, Utah Highway Patrol, Federal Motor Carrier Safety Administration, Motor Coach Industries and Arrow State Lines. On the evening of January 10th, the motorcoach was transported back to the S&S Garage in Green River, Utah.

E. VEHICLE DESCRIPTION AND EXAMINATION

The involved vehicle was a 2007 MCI, model J-4500, 56-passenger, 3-axle, intercity motorcoach, manufactured by Motor Coach Industries of Winnipeg, Manitoba (Canada) in June of 2007. The motorcoach was powered by a Caterpillar; model C-13, 410 HP, 6-cylinder diesel engine, which was equipped with a Jacobs Engine Brake. The electronically controlled engine was equipped with an ECM (electronic control module), capable of recording certain vehicle movement information during a hard braking event.¹ The transmission was a ZF AS-Tronic, 10-speed, automated manual transmission² with a .778:1 gear ratio in 10th gear. The three axles were a steer axle, a dual-wheeled drive axle, and a non-steering auxiliary weight bearing axle, commonly referred to as a tag axle. All three axles were manufactured by ArvinMeritor and the drive axle had a 3.42:1 gear ration. The steer and tag axle had a GVWR (gross vehicle weight rating) of 16,500 pounds and the drive axle had a GVWR of 23,000 pounds. The motorcoach was equipped with a Meritor-WABCO 6-channel ABS braking system, but was not equipped with ESC (electronic stability control).

According to the engine ECM printout,³ the total vehicle mileage was 23,941.6. (According to the "Bus Driver's Vehicle Inspection Report" on the day of the accident, January 6, 2008, the driver had entered a "start mileage" of 23,746.) The motorcoach had a factory VIN (vehicle identification number) of 2M93JMDA87W064449, Nebraska registration plate number 125160 and company #1511. The motorcoach was approximately 45.6 feet long and had a wheelbase of 26.25 feet (315 in.)⁴, a front overhang of 6.52 feet (78.25 in.), a rear overhang of 12.52 feet (150.25 in.) and a width of 8.5 feet (102 in.)⁵ (The post-crash measurements of the wheelbase were 317 inches on the right side and 313 inches on the left side.) The GVWR (gross vehicle weight rating) was the motorcoach was 54,000 pounds.

The vehicle steering wheel had integrated electronic controls that included both the Jacobs Engine Brake and Cruise Control. Because these are touch-pad switches, their pre-crash position could not be determined by a physical examination. Further, according to the NTSB Vehicle Group Recorder Specialist, it could not be determined whether or not the Jacobs Engine Brake or the Cruise Control were "on" or "Off" at the time of the accident. With the assistance of personnel from MCI, the electric circuit for the headlights was checked and it could not be determined if the headlights were on "high" or "low" beam at the time of the accident.

¹ Although the Caterpillar ECM was capable of recording a "Quick Stop", the default value was set to "0" and no information was recorded. Refer to the Vehicle Group Recorder Specialist's Factual Report" for detailed information.

² The automated manual transmission has a clutch (similar to a manual transmission), although there is no clutch pedal in the driver compartment. The transmission shifts automatically with the assistance of electronic and air controls.

³ The ECM printout is included in the Vehicle Group Recorder Specialist's Factual Report.

⁴ The wheelbase on a 3-axle MCI motorcoach is from the center of the front axle to the center of the drive axle.

⁵ An engineer's drawing of the motorcoach, with measurements, is on Page "Intro-3" of the MCI J Series Maintenance Manual and is attached to this report.

(1) Brake System: The motorcoach was equipped with a conventional air brake system. Air is furnished by a Knorr-Bremse compressor and the coach was equipped with ArvinMeritor, model EX225, disc brakes on all three axles. The air brake chambers, from front to rear, were Type 24, Type 24/30⁶ and Type 20, respectively. Only the drive axle was equipped with a spring chamber parking brake. The vehicle was equipped with a 6-channel Meritor-WABCO ABS (antilock braking system). In this system, there is a wheel speed sensor and modulator valve for each wheel position, which is designated a 6S/6M configuration. The ABS ECU (electronic control unit) bore serial number 026483, part number 4461060730, and had D181 revised software. After contacting Meritor-WABCO engineering, the ECU was interrogated "on scene" during the vehicle inspection on January 10th and no fault codes were present, either active or stored.⁷

Due to some of the known circumstances concerning the accident occurrence, coupled with the fact the motorcoach had been driven less than 25,000 miles, only the front brakes were inspected and operationally checked. The front wheels/tires were removed from the coach. An operational check of the brakes was performed by applying the service brake (regular brake pedal) in the driver's compartment. (This check was done without adding air to the system, as there was still 70 psi of air in the system on January 9th at 3 p.m. during this test.) When rotating the hubs, they stopped when the brakes were applied. The automatic adjusting mechanism is integrated in the body of the disc brake system, thus there were no pushrods to be measured.

The rotors were without cracks and the rotor thickness was measured at 1.75 inches for the right front brake and 1.77 inches for the left. Both measurements were similar to the approximately 1.75 inches found on a new rotor.⁸ The brake pads were pulled and measured and none of the front brake pads were heat checked. The right inside pad measured .64 inch and the outside pad measured .62 inch. The left inside pad measured .62 inch and the right pad was .64 inch, all well within the legal wear limit of .125 inch (1/8th inch).⁹ The brake pad wear indicator pin, on both the left and right front brakes, protruded about 1/2 inch from the disc brake body.

(2) Steering System: The motorcoach was equipped with a ZF, Servocom Type 8098, integral power steering gearbox, which has a maximum operating pressure of 150 bar (2175 psi). The gear was manufactured by ZF Friedrichshafen AG in Germany. The steering fluid pressure was supplied to the steering gearbox with a Luk, model LF93, vane type, gear driven power steering pump that has a maximum operating pressure of about 2200 psi. The steering reservoir was checked by viewing the sight glass and was found to have adequate fluid. There were no indications of power steering fluid leaks.

The motorcoach is steered by an 18-inch, modular SmartWheel, manufactured by VIP (Vehicle Improvement products) of Antioch, Illinois. This steering wheel has touch pad integrated electronic controls on the face of the wheel to operate the Jacobs Engine Brake, Cruise Control and horn (see photo #5). The steering column has an adjustable tilt feature. The steering shaft has a U-bolt assembly at the top where it is mounted to the column, and a U-joint at the bottom, where it is secured to the miter box.¹⁰

⁶ For the drive tag axle, the first number refers to the size of the service brake chamber and the second number, the size of the spring brake chamber. In this case the drive axle had Type 24 service brakes and Type 30 spring (parking) brakes.

⁷ A copy of the ABS interrogation printout is attached to this report.

⁸ The limits of rotor wear is currently determined by manufacturers specifications, are there are currently no guidelines in the "North American Standard - Out of Service Criteria" as of the April 2008 edition.

⁹ Part II, Section 1, b.(3)(c), page 28, April 2008 edition of the "North American Standard - Out of Service Criteria."

¹⁰ A diagram of the steering wheel, steering column and steering shaft are illustrated on page 11B-5 of the 2003 edition of the MCI Maintenance Manual. (This drawing is attached to this report).

The miter box is a non-powered auxiliary gearbox. In this case the miter box transfers the steering forces from the input shaft, located at the top of the box, to a horizontally mounted intermediate shaft at the rear of the box, both of which are secured to the miter box with a U-joint assembly. The miter box contains beveled gears with the shafts intersecting at about 90 degrees and turn at a 1:1 ratio (see photo #6). The intermediate shaft (see photo #8), positioned horizontally, is connected to the ZF integral power steering gearbox.¹¹

During the investigation, the steering wheel was found to rotate freely and endlessly in either direction. An examination at the miter box revealed that the steering shaft was disconnected at the U-joint on top of the box and was offset from the miter box about 1¼ inch toward the front of the motorcoach (see photo #6). Further, the front upper spare tire truss, supporting the miter box, was found bowed upward near the front bulkhead (see photos #8 and 9). One of the inner flanges of the U-joint had the metal chipped away and one end of the cross pin had indentations (see photo #7). The fresh marking on the cross pin showed that it had been fully engaged in the U-joint (about 3/10 inch on both sides) all of which is consistent with accident damage. The front wheels were moved manually from left to right and back, axle stop to axle stop, and moved unimpeded. The remaining steering linkage was examined and found to be intact and without free play.

(3) Tires: The motorcoach was equipped with Firestone, model FS-400, size 315/80R22.5, radial tires. The tires have an "L" speed rating (75 mph) and "J" load rating (8270 pounds at 120 psi). A new Firestone FS-400 tire has a tread depth of 18/32nds inch. The following chart shows the tire position, tread depth and air pressure. (All air pressures were taken "cold" by the Utah Highway Patrol at the accident site prior to the motorcoach being towed):

<u>Position</u>	<u>Tread Depth</u>	<u>Air Pressure</u>	<u>Other Information</u>
1L	15/32nds inch	105 psi	None
1R	18/32nds inch	105 psi	None
2L (outside tire)	12/32nds inch	Deflated	Tire off bead
2L (inside tire)	13/32nds inch	105 psi	None
2R (outside tire)	12/32nds inch	Deflated	Tire off rim
2R (inside tire)	13/32nds inch	101 psi	None
3L	10/32nds inch	Deflated	Tire off bead
3R	13/32nds inch	Deflated	Tire off bead

(4) Recording Devices: The motorcoach was equipped with three devices capable of providing pre-crash information: the Caterpillar engine ECM, DriveCam II, and a Saucon GPS. (Note: Refer to the Vehicle Recorder Group Chairman's Factual Report for specific information about and of the recording devices.)

The engine ECM was removed on January 9th at about 3 p.m. and sent via Federal Express¹² to the NTSB Recorder Specialist on January 10th. The ECM has a "Quick Stop" feature, which would have the capability for recording the vehicle speed both prior to and during the accident occurrence. However, the braking default value was set to "0" mph, which had the effect of disabling the "Quick Stop" feature.

¹¹ Drawings found in the MCI Maintenance Manual, which illustrate the relevant steering linkage components are attached to this report. (2003 MCI Maintenance Manual)

¹² Federal Express Airbill number 8635-9260-0100.

The DriveCam II unit was found at the accident site. It was obtained from the Utah Highway Patrol on January 10th and send via Federal Express¹³ to the NTSB Vehicle Recorder Specialist. The NTSB Recorder Specialist then hand carried it to DriveCam in San Diego, California, for interrogation.

The Saucon GPS, which is hard wired directly to the main batteries, was mounted in an electrical panel on the left side of the Driver Compartment and was removed on January 10th and hand carried by the Vehicle Group Chairman to the NTSB in Denver. On February 6, 2008, it was sent via Federal Express¹⁴ to the NTSB Vehicle Recorder Specialist for further examination. While at the accident site, it was learned from Saucon technical personnel that the GPS information was not transmitting at the time of the accident due to the motorcoach being out of cell range. Further, the Saucon technician related that once power is interrupted, all stored information is lost. In this case the wires going to the Saucon unit were tested for power and were found to be without current, thus resulting in a power interruption.

F. DAMAGE OF MECHANICAL COMPONENTS

The following is an attempt to describe damage to the mechanical vehicle components, primarily below the floor level:

Front Axle

1. The left front axle lower radius rod was slightly bent
2. The tubes from both front shock absorbers (shock tubes) were disengaged from each other.
3. Steering shaft separated at U-joint connection at input shaft to the miter box (described in Steering section of this report).

Drive Axle

4. Lower left radius rod bent upward, resulting in the left wheelbase being shortened by about 4 inches.
5. At least 2 of the 4 shock tubes were separated. (According to the wrecker driver, all the shock tubes were separated, but one or two went back into place during the towing operation.
6. Upper V-link on right side had slight bend.
7. Upper V-link on left side bent.

Tag Axle

8. Both shock tubes disengaged.
9. Sway bar bent down in the middle.
10. Sway bar link on left side broken connection to body.
11. Sway bar link on left side broken connection at V-bar.
12. Both upper V-link bars bent, with the left bent more than the right.

¹³ Federal Express Airbill number 8635-9620-0111

¹⁴ Federal Express Airbill number 8626-4145-6136

Engine Compartment

13. Air conditioning compressor, located in right rear corner of the engine compartment, was dislodged from its original position.

G. MISCELLANEOUS INFORMATION

The headlight bulbs were all pulled and checked and no filament distortion was noted.

The video monitor display for the six TV monitors indicated the monitors were “on”, as they were wired directly to the battery. The rocker switch for the reading lights was “on”, but the rocker switch for the interior-general lights was in the “off” position.

According to the tow operator, he turned the battery main power switch “off” at about noon on January 7th when the coach was still in its original post-crash position.

There were no pre-crash mechanical defects found during the inspection of the motorcoach.

Larry L. Yohe
Senior Accident Investigator