



# National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

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In reply refer to: H-89-34

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On August 1, 1988, a chartered intercity bus loaded with 6 adult counselors and 39 children was traveling eastbound on U.S. Route 202 en route to Bar Harbor, Maine, for a fishing trip. About 11:20 a.m. eastern daylight time, approximately 6 miles from downtown Augusta, Maine, the bus suddenly swerved to the right and ran off the roadway. The bus continued over an embankment, struck several trees, and overturned on its left side before coming to rest. The busdriver was fatally injured and most of the passengers were injured. The weather was hazy and the road was dry.

The accident bus was a 1972 General Motors Corporation intercity parlor coach, Model P8M 4905A and was owned and operated by Brunswick Transportation Co., Inc. (Brunswick) of South Portland, Maine. Brunswick is a for-hire carrier of passengers in interstate commerce. It operates about 30 intercity buses, 8 school buses, and employs about 40 full-time busdrivers.

The National Transportation Safety Board's investigation revealed that the accident bus had a history of steering problems. A review of the maintenance records since 1985 indicated that the hydraulic booster cylinder (also referred to as a "ram"), a component of the "power steering booster cylinder assembly," was replaced six times (the function of the power steering booster assembly is to provide hydraulic assistance to the mechanical steering system when steering inputs are made by the busdriver). Another component, the "spool control valve," had been replaced twice since 1985--on June 4, 1985, and on July 13, 1988. Between December 17, 1987, and August 1, 1988 (the day of the accident), busdrivers, including the accident busdriver, recorded 10 complaints about the steering on bus 1000. Typical complaints from busdrivers indicated that there was "too much play in steering wheel," "steering needs serious attention, loose and pulls to right," "steering scares you (very screwed up)," and "still wanders around 50-55 m.p.h. on highway."

A postaccident vehicle examination was conducted by the Safety Board with the assistance of a Commercial Vehicle Enforcement Unit from the Maine State Police, an automotive engineer from General Motors Corporation, and the

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president of Brunswick. The mechanical examination included brakes, tires, unibody structure, and the steering system, and, except for the steering system, did not disclose any obvious mechanical problems with those systems. Because the front wheels were locked in a right turn position, a detailed inspection of the steering components was conducted. The inspection of the Vickers power steering booster assembly<sup>1</sup> was conducted at the Maine State Police Crime Laboratory in Augusta.

During the removal of the spool valve control body from the hydraulic booster cylinder of the accident bus, the vehicle examination team observed a 5/32-inch-long tip of a 1/16-inch drill bit and a 3/8-inch nut (resembling a lock nut) lying in the recess of the booster cylinder. Except for power steering fluid residue, no cotter pin, cotter pin fragments, or other particles, debris, or other material was found in the recess. Two holes had previously been drilled through the nut. A partially drilled 3/16-inch-wide hole (3/16-inch-deep) was located 1/4 inch from the thread end of the bolt. The installation of a cotter pin would have been impossible because the bolt hole was not completely drilled through.

For comparison, the vehicle examination team inspected the spool control valve, ball stud housing, and related components which had been removed from the accident bus by Brunswick mechanics during steering maintenance on July 13, 1988, 18 days before the accident as a result of the complaints concerning the steering of the accident bus. The external visual examination disclosed that the lock nut was threaded on the spool bolt, and a cotter pin was installed through the lock nut in a hole drilled through the bolt as specified by General Motors Maintenance Manual X-6814.

The foreman of the Brunswick maintenance facility in Brunswick, Maine, who was also the mechanic who overhauled the power steering booster assembly that was on the bus at the time of the accident, stated that he had overhauled 10 or more of these units over the years. He also stated that he would use an instruction manual for a task of this nature, but that he knew this system well enough so he would not need to closely follow every step in the manual. He said that he would, however, at least refer to handwritten notes in one of the manuals and was able to describe the procedure and the difficulties he experienced in rebuilding this part (which included breaking drill bits and adjusting the control valve so the bus steering would not wander or pull). He could not recall specifically breaking off a drill bit in this overhaul, but stated that it was very common to break them while drilling through the spool bolt.

The foreman said that he would not necessarily have used a new lock nut during the overhaul and that the one found lying in the recess of the

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<sup>1</sup>This system should not be confused with an earlier model Vickers "Power Steering Booster Cylinder" assembly, used on General Motors Corporation buses prior to 1963, which has four exteriorly mounted bolts along the entire length of the hydraulic cylinder, and contains an internal "spool control valve" which can be adjusted with a screwdriver.

cylinder during the booster cylinder assembly examination had been previously used. He could not account for why the power steering booster with the missing cotter pin and partially drilled bolt was considered to have been properly repaired and put into the parts inventory at Brunswick. He also stated that it was quite possible that he could have been distracted by other matters in the Brunswick maintenance facility while he was overhauling the part.

The two mechanics who installed the overhauled spool control valve on the accident bus at the Brunswick maintenance facility in South Portland on July 13, 1988, said the foreman of the South Portland facility reminded them to be careful about properly attaching the O-rings with adhesive to the cylinder side of the valve body; however, they were never cautioned about the lock nut and cotter pin. The foreman of the Brunswick facility, the Brunswick president, and the foreman of the South Portland facility stated that if a mechanic knew the system, he would notice that the cotter pin was missing and that holes in the nut should alert the mechanic that a cotter pin was required. The foreman of the South Portland facility said that even though he was very familiar with the part, he did not thoroughly check it because he believed that it had been properly overhauled in Brunswick. After the part was installed, two drivers road tested the accident bus. There were no problems identified with the steering during the test.

Procedures for inspecting and overhauling the booster cylinder assembly are in Section 16 of General Motors Maintenance Manual X-6814. The "Inspection" subheading (section 16, page 302) of the BOOSTER OVERHAUL section specifically states: "Discard all seals, wipers, scrapers, and bolt nut (21 and 35, fig. 8) and replace with new parts upon reassembly." References to the locknut and the spool bolt are illustrated in the "Power Steering Booster Cylinder Components" diagram in Figure 8, page 301, and listed as items numbered 35 and 21, respectively. Also, in the same section, under the subheading "Control Valve Assembly," are instructions for installing the spool inside the control valve. Item 4 on page 303, states in part, "Install nut (21) on bolt (35) and tighten securely." Item 6 specifies, "Drill one 0.078 inch-hole through center of nut and bolt, next to bottom of taper on nut. Install new cotter pin to hold nut in position."

On the day of the accident, the busdriver departed Brunswick's South Portland garage to meet his charter group, but returned instead to the garage. He complained to two mechanics about his concern that bus 1000 lacked engine power to climb the mountains on this trip and about the play in the steering. One mechanic said that he told the busdriver that he was not on duty and did not have authority to change the bus and that the busdriver should see another mechanic. The other mechanic stated that he had examined the accident bus on July 30, 1988, because of a complaint about its air conditioning and steering. The mechanic said that he repaired the air conditioning, road tested the bus, and made a basic visual inspection of the steering, but without disassembling the power steering unit. He did not place the bus on a lift or over a pit for this inspection. This mechanic, however, was not aware that the busdriver had driven bus 1000 that morning before making his complaint. The mechanic explained to the busdriver that the bus had been checked over, various parts had been replaced, and that

there was nothing wrong with the bus.

The mechanic stated that it is common for the busdrivers to complain about a bus in order to try to obtain a better one for their trips and that the accident busdriver had a reputation for doing this. The mechanic stated, "Had I thought the complaint was serious, I would have done something...." The mechanic also said that he told the busdriver, "There's nothing wrong with the bus that I can see ... I said the bus had been checked all over, which it had...." Later that day, while en route with his charter group, the busdriver also discussed the steering when he called Brunswick's general manager. The general manager said that although the busdriver discussed the play in the steering, he declined the general manager's offer for another bus.

Based on the vehicle examination and information obtained from Brunswick officials responsible for maintaining the accident bus, the Safety Board believes that the power steering booster assembly was not properly overhauled. Furthermore, because of the improper installation of the used nut on the spool bolt, the nut eventually loosened, creating abnormal steering characteristics. Consequently, the nut most likely came off the bolt as the accident busdriver was providing normal steering input. This circumstance resulted in a surge of approximately 1,000 pounds of hydraulic pressure into the steering system, causing the bus steering wheel to spin clockwise out-of-control, suddenly and without warning. This sudden surge created a hydraulic steering lock which the busdriver was unable to counter with normal steering input, and caused the bus to leave the highway.

The Safety Board believes that the overhauled steering assembly should have been repaired with a new original equipment replacement part, and that quality control procedures should have detected the improperly overhauled steering assembly before it was put into parts inventory or during its installation on the accident bus.

On May 26, 1989, the Safety Board discussed the responsibilities of the recently-hire full-time safety director with the general manager of Brunswick Transportation. He indicated that the safety director's main function was to help the company achieve and maintain compliance with the Federal Motor Carrier Safety Regulations.

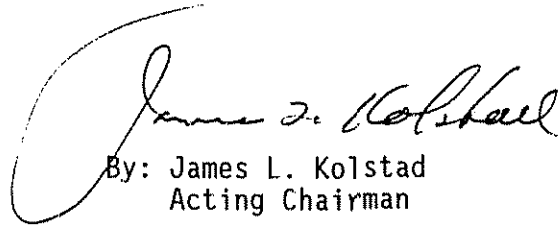
Among other duties, the safety director is also monitoring the vehicle defect slips to be certain they are completed by the drivers and that the indicated work is performed on the vehicle before it is put back in service. The president of the company, who is also the superintendent of maintenance, has instituted a program to personally inspect every critical vehicle component before it is released for installation in a vehicle.

As a result of its investigation of this accident, the National Transportation Safety Board recommends that the United Bus Owners of America and the American Bus Association:

Advise members of the circumstances of the accident in Augusta, Maine on August 1, 1988, and warn commercial bus operators about adherence to prescribed procedures when overhauling or servicing the "Power Steering Booster Cylinder" assembly on General Motors Corporation intercity buses, models 4106, 4107, 4108, 4903, 4905, and 4905A, along with a variety of General Motors Corporation transit and suburban buses manufactured between 1963 and 1975. This assembly, manufactured by Vickers, contains a separate "spool control valve" mounted against the hydraulic cylinder. (Class II, Priority Action) (H-89-34)

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "...to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations." (P.L. 93-633) The Safety Board is vitally interested in any actions taken as a result of its safety recommendations. Therefore, we would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendation H-89-34 in your reply.

KOLSTAD, Acting Chairman, BURNETT, LAUBER, NALL, and DICKINSON, Members, concurred in this recommendation.



By: James L. Kolstad  
Acting Chairman

