Y05 H-S14

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 14, 1988

In reply refer to: H-88-1 and -2

Mr. Robert E. Farris
Deputy Administrator
Federal Highway Administration
Washington, D.C. 20590

About 1:45 p.m. on May 4, 1987, while traveling eastbound on Interstate 10 (I-10) in Beaumont, Texas, a tractor-semitrailer operated by Graebel Van Lines, Inc., jackknifed in the center lane, veered leftward across the left lane and median strip, and struck a Trailways bus traveling westbound on I-10 in the left lane. A small fire which started in the bus below the driver's seating area was quickly extinguished by a passerby. The busdriver and 5 bus passengers sustained fatal injuries, 17 bus passengers sustained serious to minor injuries, and 6 bus passengers were not injured. The truckdriver and helper sustained moderate and minor injuries, respectively. It was raining at the time of the accident. 1/

With a rain intensity of 0.2 to 1.1 inch/hour, a cross slope of 0.02 foot/foot, a texture depth of 0.0042 inch, and a drainage path lane estimated to have been 48 feet, the road surface at the time of the accident probably was lightly flooded with a thin film of water 0.015 to 0.05 inch deep. The rainfall would have had a tendency to run down the 3.5 percent grade to the lower area of roadway (0.1 percent grade) rather than off the sides of the roadway.

The minimum tread thickness for two of the rear tractor tires was 2/32 inch. With this tread depth, the ability of the tires to channel surface water out of the tire footprint area would have been greatly reduced, particularly at high speed, and would have caused the tires to be more susceptible to hydroplaning. In addition, the tire inflation pressures for the

1/ For more detailed information, read Highway Accident Report--"Tractor-Semitrailer/Intercity Bus Head-on Collision, Interstate 10, Beaumont, Texas, May 4, 1987" (NTSB/HAR-88/01).

tractor rear tires varied considerably from 50 to 66 psi. Thus the tires mounted on the rear axle had different minimum speeds at which hydroplaning could occur. This condition could cause potential handling problems for any type of large vehicle operating in lightly flooded pavement situations. Because the condition of the tractor rear tires adversely affected the minimum speed of hydroplaning and the handling capability of the accident tractor-semitrailer during wet pavement operation, the Safety Board concludes that the poor condition of the tractor rear tires was causal in this accident.

The tractor was equipped with radial and bias ply tires with different inflation pressures on the front and rear axles; therefore, the minimum speed for total hydroplaning varied considerably. Based on tire data provided by the Goodyear Tire and Rubber Company, the Safety Board calculated the minimum hydroplaning speed for 10.00-20 new bias ply rear tires to be about 63 mph when pressurized to 50 psi. Using similar data for the 10.00 R-20 tires, the Safety Board calculated the minimum hydroplaning speed for the radial front tires to be about 70 mph when pressurized to 70 psi.

A 1984 study conducted by the Texas Transportation Institute (TTI) 2/ on hydroplaning of tractor-semitrailers determined that when highway lanes become flooded with a thin layer of water, the tractor tires can develop water drag forces. If the flooded pavement lane has differential water depths between the tractor right and left wheelpaths (created by the pavement cross slope), a rotational moment that develops about the tractor center of gravity (approximate position of fifth wheel) must be compensated for by rapid driver steering to maintain the tractor directional alignment in the traffic lane.

The TTI study also indicated that trucks are more susceptible to hydroplaning when they are equipped with smooth or badly worn tires, or are traveling on smooth (low friction) pavement surfaces. Vehicle tests indicated that the minimum speed for hydroplaning is further reduced when one or both of these factors are present.

Previous research on hydroplaning conducted by the National Aeronautics and Space Administration (NASA) Langley Research Center 3/ indicates that commercial vehicle operators should replace tires when about 85 percent of their original tread

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2/ "Truck Tire Hydroplaning-Empirical Confirmation of Horne's Thesis," Ivey, Don L., Texas A&M University, November 1984.
3/ Horne, Walter B., and Joyner, Upshur T., "Pneumatic Tire Hydroplaning and Some Effects on Vehicle Performance." 1965.

is worn away. Also, vehicle speed should be kept below the expected hydroplaning speed during wet pavement operation according to the tire pressure used, and tire pressures should be the same for all tires mounted on each axle. In addition, the research study indicates that pavement surfaces either should be treated with surface additives, grooving techniques, pavement texturing, or should be completely replaced when the original surface becomes worn smooth through aging or extensive traffic use.

With regard to the tractor involved in this accident, because of higher air pressure in the radial tires and good tread depth, the front tractor tires would have been able to negotiate the flooded surface without hydroplaning. However, because the rear tractor tires were in poor condition with minimal tread depth and lower tire pressure, when the rear tires entered the lightly flooded section, the cornering and braking forces on the rear tractor tires probably were reduced significantly (due to partial hydroplaning). The footprint area for the rear tires was partially lifted from the pavement surface. Also, because of initial water drag on all tractor tires, the tractor speed would have been partially reduced, and the semitrailer would have continued forward. Consequently, the loss of traction by the tractor rear tires and the road cross slope may have initiated a left turning moment about the fifth wheel, causing the rear of the tractor to rotate counterclockwise while the semitrailer continued in a straight alignment. This condition would have initiated a jackknife sequence. Moreover, the turning moment probably rotated the tractor so rapidly that the driver was unable to take corrective action.

The Safety Board concludes that the speed of the truck was too great for the highway conditions. As speed increases on wet pavement, available tire-to-pavement friction decreases. Also, high speeds increase vulnerability to dynamic hydroplaning. Therefore, any reduction in the travel speed of the tractor-semitrailer or increase in pavement friction would have improved the stability of the truck and would have reduced its vulnerability to hydroplaning.

Federal Motor Carrier Safety Regulations (FMCSR) (49 CFR Part 393) require a minimum tread depth of 4/32 inch on the front-axle tires and 2/32 inch on all tires mounted on any other axle. Therefore, the rear tractor tires met the minimum tread depth requirements and complied with the applicable FMCSR. However, tests conducted by the Safety Board in conjunction with the investigation of an accident near Luling, Texas, on November 16, 1980, 4/ indicate that the ability of a commercial tire to produce both braking and cornering traction on wet pavement is significantly reduced when the tire tread

4/ Highway Accident Report--"East Side Church of Christ Bus Skid and Overturn, U.S. Route 183, Near Luling, Texas, November 16, 1980" (NTSB/HAR-81/04).

depth is below 4/32 inch. Thus any demand which was made on the accident truck by the truckdriver, such as braking, turning, or even engine braking on wet pavement at highway speeds, could have exceeded the traction capabilities of the rear tires and could have precipitated the loss of control.

Commercial tires worn below a tread thickness of 4/32 inch should not be used for high-speed operation, particularly during wet pavement conditions. They are more susceptible to hydroplaning when inflation pressures are not properly maintained and may not generate adequate braking and cornering traction to maintain vehicle stability in high-speed maneuvers on wet pavement. In another accident investigation involving commercial vehicles, 5/ the Safety Board found that the inadequate tread depth of the rear tires was either a causal or contributing factor to the accident. Both the Luling and Ackerly accidents involved a loss of control on wet pavement at highway travel speeds.

The Federal Highway Administration (FHWA) is currently revising the existing vehicle inspection requirements specified in Part 393 of the FMCSR. These requirements also are being adopted in part or totally by most States through the Motor Carrier Safety Assistance Program. The Safety Board believes that this would be a good opportunity for the FHWA to reevaluate its current minimum tread depth requirements for commercial vehicles. The minimum tread depth criteria for a tire on any axle of a commercial vehicle should be at least 4/32 inch to ensure its safe operation, particularly in wet pavement and inclement weather conditions.

Therefore, the National Transportation Safety Board recommends that the Federal Highway Administration:

> Revise Sections 393.75(b) and (c) of the Federal Motor Carrier Safety Regulations to prohibit the use of tires worn below 4/32 inch on any axle of a commercial interstate vehicle. (Class II, Priority Action) (H-88-1)
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> Issue an On-Guard Bulletin to advise owners, operators, maintenance personnel, and State commercial vehicle inspectors of the problems associated with operating vehicles equipped with tires worn below 4/32-inch tread groove depths. (Class II, Priority Action) (H-88-2)

5/ Highway Accident/Incident Summary Reports--"Buses Owned or Chartered by Church Groups, accident near Ackerly, Texas, July 20, 1985" (NTSB/HAR-87/01/SUM).

Also, the Safety Board issued Safety Recommendations H-88-3 to bus manufacturers; H-88-4 to the United Bus Owners of America and the American Bus Association; H-88-5 to the United Bus Owners of America, the American Bus Association, and the American Trucking Associations, Inc.; and H-88-6 to Graebel Van Lines, Inc.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER, NALL, and KOLSTAD, Members, concurred in these recommendations.

By: Jim Burnett
Chairman