



# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

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**Date:** August 21, 2003

**In reply refer to:** A-03-40

Honorable Marion C. Blakey  
Administrator  
Federal Aviation Administration  
Washington, D.C. 20591

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On April 27, 2002, about 0300 local time (0900 universal coordinated time), a DC-10-40F, N141WE, operated by Centurion Air Cargo, Inc., sustained substantial damage to the left wing and all three of its hydraulic systems when pieces of ruptured tire from the left main landing gear penetrated the left wing lower access panel during takeoff from San Salvador International Airport, San Salvador, El Salvador. The flight crew continued with the takeoff but returned to the airport approximately 30 minutes later. There were no injuries to the three flight crewmembers and two mechanics on board. The flight was being operated as a 14 *Code of Federal Regulations* (CFR) Part 121 cargo flight from San Salvador to Guatemala City, Guatemala, on an instrument flight rules flight plan. The accident occurred in visual meteorological conditions.<sup>1</sup>

The flight crewmembers reported that, about the time of rotation during the takeoff roll, they heard a sound that they described as a thump or a bang. After the airplane became airborne, the number 1 and number 2 hydraulic systems completely lost pressure. The number 3 hydraulic system remained operable, and the flight crew was able to lower the landing gear and return to San Salvador for a landing on the takeoff runway, where the airplane was brought to a stop and shut down.

During postaccident examination of the airplane, the tread on the number 1 tire (in the outboard front position on the left main landing gear) was found damaged, but the tire continued to hold air pressure. The number 5 tire (in the outboard rear position on the left main landing gear) was found ruptured. Extensive damage was observed in the left wing, above the left main landing gear, that included fractured lines in the number 1 and 2 hydraulic systems (see figures 1 and 2); a severely dented line in the number 3 hydraulic system; and damaged mechanical

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<sup>1</sup> The Autoridad de Aviacion Civil, El Salvador, conducted the investigation of this accident. Under the provisions of Annex 13 to the Convention on International Civil Aviation, the National Transportation Safety Board participated in the investigation as an Accredited Representative for the State of Manufacture.

control cables, pulleys, pushrods, and electrical wiring. The lower wing access panel<sup>2</sup> that shields these components was completely destroyed (see figure 3) by the fragments from the number 5 tire. The tire pieces retained enough energy to exit through the upper wing skin, creating a hole measuring approximately 12 inches by 18 inches (see figure 4). A thrust reverser cascade from another airplane<sup>3</sup> was found left of the centerline on the takeoff runway, where the accident airplane's left main landing gear would have contacted it during the takeoff roll.



**Figure 1 –Damaged #1 Hydraulic System Lines**

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<sup>2</sup> The lower wing access panel is a lightweight, all-aluminum honeycomb structure that measures about 0.34 inch thick with an outer skin that measures about 0.016 inch thick. Boeing has indicated that it is currently working on a design change to strengthen the access panel that was breached in this accident. However, no schedule was provided for completing the change.

<sup>3</sup> It was determined that this part came from a Boeing 727 that took off immediately before the accident airplane.



**Figure 2 – Severed and Damaged #2 Hydraulic System Lines**



**Figure 3 – Damage to the Lower Wing Access Panel (view from below)**



**Figure 4 –Damage on the Upper Wing Caused by Exiting Debris**

All three hydraulic systems in the DC-10 provide power to the flight controls and landing gear. To provide for continued hydraulic functioning in case either or both of the number 1 and 2 systems are damaged, the lines for the number 3 system are physically separated from the lines for the other two systems. In addition, hydraulic fuses are installed in the portion of the number 3 hydraulic system that is located in the area of the horizontal stabilizer to ensure that sufficient capability remains to control the airplane in the event that all hydraulic lines in the number 2 engine area of the airplane are damaged. These fuses were added to all DC-10 airplanes following the July 19, 1989, accident involving United Airlines flight 232, which crashed at Sioux City, Iowa, after a catastrophic failure of the number 2 engine (mounted above the horizontal stabilizer) resulted in the loss of all three hydraulic systems.<sup>4</sup> The Safety Board notes, however, that these hydraulic fuses are only effective in preserving hydraulic system integrity if damage occurs in the tail area. No hydraulic fuses are installed in any other area of the aircraft.

As the April 27, 2002, accident in El Salvador demonstrates, the DC-10's hydraulic system lines are not adequately protected in the wing area in the event of a tire rupture. Tire rupture is a known risk in commercial aviation, and other airplane components are designed with this risk in mind (for example, 14 CFR Section 25.729(f) requires that essential equipment located in the wheel wells of transport-category airplanes be protected from the effects of a ruptured tire or loose tire tread). The Safety Board notes that the destructive potential of a tire rupture was demonstrated by the July 25, 2000, crash of Air France flight 4590, a Concorde. During takeoff from Roissy Charles de Gaulle Airport, shortly before rotation, the right front tire of the left landing gear ran over a strip of metal that had fallen off of another aircraft. The tire

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<sup>4</sup> See National Transportation Safety Board, *United Airlines Flight 232 McDonnell Douglas DC-10-10 Sioux Gateway Airport, Sioux City, Iowa, July 19, 1989*, Aircraft Accident Report NTSB/AAR-90/06 (Washington, DC: NTSB, 1990).

ruptured and pieces penetrated the aircraft's fuel tanks, resulting in a fire under the left wing. The aircraft crashed shortly afterwards. All 109 occupants on board were killed, as were 4 people on the ground.

The Safety Board is concerned that the current configuration of the DC-10 does not adequately ensure that one of the three redundant hydraulic systems will continue functioning in the event of a tire rupture and that this represents a potentially catastrophic failure mode. Although the lines for the number 3 system are physically separated from the lines for the number 1 and 2 systems, this separation was not sufficient to protect these systems in the El Salvador accident. A tire rupture during the critical takeoff phase of flight is of particular concern for these components because the wing area that contains lines for all three systems is within the debris field of high-energy tire fragments. With a slightly different trajectory, debris in an event similar to the one that occurred in El Salvador could sever all three hydraulic lines in the wing area, resulting in a complete hydraulic system failure and likely loss of the aircraft.

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

Require adequate protection of DC-10 hydraulic system components in the wing area from tire fragments in the event of a tire rupture. Such protection may include, but is not limited to, installing stronger wing access panels; shielding the hydraulic lines; installing fuses in the hydraulic lines in this area; or rerouting the hydraulic lines to provide greater separation between the systems. (A-03-40)

Chairman ENGLEMAN, Vice Chairman ROSENKER, and Members CARMODY, GOGLIA, and HEALING concurred with this recommendation.

By: Ellen G. Engleman  
Chairman