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InFO

Information for Operators

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An InFO contains valuable information for operators that should help them meet certain administrative, regulatory, or operational requirements with relatively low urgency or impact on safety.

Subject: Boeing DC-10 Airplane, All Series - Potential for Airplane Upsets Caused by Faulty Control Wheel Steering Sensor Input and Potential for Overshoots in Upset Recovery

Purpose: To ensure that flight crewmembers operating the Boeing DC-10 airplane are provided information about:

- the potential for airplane attitude upsets caused by faulty control wheel steering (CWS) sensor inputs
- the potential for overshoots in recovering from those upsets because of the airplane's lag in responding to manual control input by flightcrew in cruise flight conditions

This InFO has been developed in response to NTSB recommendations A-99-31 and supersedes Flight Standards Information Bulletin for Air Transportation (FSAT) 99-09.

Background: On May 10, 1998, an aircraft upset accident involving a DC-10-10 en route from Los Angeles, California, to Honolulu, Hawaii, resulted in serious injury to 3 flight attendants and minor injuries to 5 passengers and flight attendants. The upset was reported to have occurred when the control yoke moved backward without crew input. Immediately after the initial pitch up, the autopilot was disconnected. Flight Data Recorder (FDR) data revealed that the airplane went through four up-and-down pitch oscillations, the most severe attaining vertical accelerations of +1.84 to -0.12 Gs.

A. *NTSB Finding.* The NTSB investigation revealed that erroneous control outputs from the Number 1 autopilot resulted in the uncommanded pitch up. It was determined that the CWS was receiving uncommanded voltage signals caused by an intermittent short circuit within the CWS sensor. The short circuit was caused by contamination that bridged the gap between the two adjacent strain gauges within the sensor. The most likely source of the material contamination was metal particles from the wires connecting the strain gauges with the rest of the sensors.

B. *Upgraded Control Wheel Steering Sensor.* Beginning in 1975 and unrelated to the contamination problem, the NTSB found that the manufacturer incorporated a series of design changes in the CWS sensor and upgraded the material in the sensor's wires. There have been no reports of foreign material failures of the improved CWS sensors.

C. *Review of FDR Data.* Review of the FDR data by the NTSB revealed that four pitch oscillations took place after the autopilot was disconnected, while the airplane was being manually controlled by the flightcrew. The first was a nose-down pitch excursion that occurred immediately after the uncommanded pitch up. The peak airplane response lagged behind the peak flightcrew inputs by up to 1 second. This lag in airplane response contributed to a porpoising effect in which the flightcrew was continuously out of phase with the airplane's motion. The airplane made three complete nose-up and nose-down oscillations before returning to level flight.

Discussion:

A. *FAA Analysis.* Representatives of the FAA's Aircraft Certification Service (AIR) conducted a review of DC-10 control wheel sensor failures and found no evidence of material contamination that could lead to repetitive problems. Aircraft Certification Service did confirm that the replacement of the wires within the CWS sensors will improve the reliability of the sensors by minimizing possible material contamination. However, "it will not preclude the occurrence of other autopilot/control wheel steering sensor system failures with similar effects on the aircraft" because of the single-string design philosophy of the DC-10 autopilot. The single-string design philosophy does not preclude single-point failures from coupling into the autopilot that may cause pitch axis upsets.

B. *Boeing Flight Operations Bulletin.* A number of in-flight pitch upset incidents have occurred on DC-10 airplanes that resulted from a sudden autopilot disconnect caused by the pilot's effort to manually override the autopilot. The Boeing Company issued a Flight Operations Bulletin, Autopilot Bulletin No. DC-10-99-02A, dated September 15, 1999, to address this anomaly, and to provide information to flightcrews regarding the potential for airplane attitude upsets and recovery techniques.

C. *Selected Event Training.* To address issues related to "hazardous in-flight situations", the FAA encourages operators to address in their "simulator" training programs any in-flight hazards that might be encountered in the specific operator's line operations. These in-flight hazards include pitch attitude upsets.

Recommended action: Directors of safety, directors of operations and training managers should ensure that the information contained in this InFO is disseminated to their DC-10 flight crewmembers. In addition, each DC-10 operator should include Boeing Flight Operations Bulletin No. DC-10-99-02A information in their applicable training programs.