UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C.

ISSUED: October 18, 1973

Adopted by the NATIONAL TRANSPORTATION SAFETY BOARD
at its office in Washington, D. C.
on the 3rd day of October 1973

FORWARDED TO:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATIONS A-73-76 thru 78

The National Transportation Safety Board's initial investigation indicates that one or more faults in a Boeing 707-331B longitudinal control system might have been contributory to the cause of a recent accident involving Trans World Airlines Flight 742, on August 28, 1973. Although the investigation has not yet been completed, the Safety Board believes that the initial findings are sufficient to justify certain interim actions designed to preclude the serious consequences which may result from similar occurrences.

The subject accident occurred as the flight, en route from Honolulu to Los Angeles, was descending from cruise altitude approximately 35 miles west of the destination airport. Upon passing through flight level 220 at approximately 350 KIAS, the aircraft entered a porpoising oscillation which persisted for approximately 2 minutes. Over 50 pitching cycles were experienced, with peak acceleration forces at the aircraft c.g. of +2.4g and -0.3g. Unrestrained passengers and stewardesses in the aircraft were subjected to violent displacements. Of the 9 crewmembers and 141 passengers, 1 passenger sustained fatal injuries; 2 stewardesses and 2 passengers sustained serious injuries before the aircraft regained stabilized flight.

A review of records after this occurrence disclosed that the same B-707 aircraft had been involved in a similar accident on July 18, 1972, at Windsor Locks, Connecticut. In that accident, one stewardess was seriously injured when the aircraft experienced a series of pitch oscillations which

persisted for approximately 15 seconds. Although our findings at that time indicated an encounter with in-flight turbulence, we now have reason to believe that a longitudinal control system fault might have been contributory to that mishap as well.

The current investigation of the August 28th accident has consisted, thus far, of (1) an examination of those aircraft systems and components which could affect the longitudinal stability of the aircraft, and (2) a series of flight tests to evaluate the aircraft flight characteristics. Engineering, manufacturing, and flight test personnel from the Boeing Company were key participants in this activity.

The aircraft examination disclosed:

(1) an open circuit in one phase of the three-phase AC power at the stabilizer trim control relay, which would likely cause a degradation in the torque output of the stabilizer trim jackscrew motor, and

(2) excessive force was required at the elevator surface when it was subjected to the breakaway force check specified in the applicable Boeing 707 Maintenance Manual. More detailed inspection to determine the friction source revealed that many of the inboard and outboard seals between the elevator balance panels and stabilizer structure were compressed excessively.

The stabilizer trim control relay was replaced and the elevator breakout friction was brought to an acceptable level by lubrication of elevator hinge and balance panel mechanisms. The compression fit of the balance panel seals was not corrected.

The aircraft was then subjected to a flight characteristic evaluation by a Boeing pilot, accompanied by engineering personnel. The flight test included a series of elevator/stabilizer trade tests wherein variations of stabilizer trim were compensated by elevator deflection at different altitudes throughout the aircraft's speed range. Although the pilot did not induce an uncontrollable porpoise, he did note a significant anomaly in the control column force gradient during conditions of elevator down deflections. The characteristics noted were of a nature which tended toward longitudinal instability.

Two possible factors which are known to contribute to such a condition are:

(1) an abnormal variation in aerodynamic balance under certain conditions which can result in a near constant or even negative hinge moment versus deflection gradient for the elevator surface, and

(2) excessive control surface friction.

Since the elevator balance panel seal fit can adversely affect both of these elements, it became suspect, and the balance panels were reworked to achieve a fit corresponding to the maximum specified gap tolerance.

The aircraft was reflown and a significant change in the elevator force gradient characteristic was noted. The subjective evaluation of the pilot was that, although nearer to normal, the aircraft still exhibited low-force gradient characteristics at high elevator angular deflections under conditions of high dynamic pressure.

The ongoing investigation will be directed toward complete instrumentation to explore further the longitudinal flight characteristics of this aircraft.

Although our findings are incomplete, we believe that the facts developed thus far provide evidence that one or more control system faults can produce a longitudinal instability induced by either external disturbance or pilot control input under isolated conditions. We believe that this is more likely to occur if the aircraft is out of trim in a high dynamic pressure environment.

The Board is understandably concerned about the existence of other Boeing 707/720 aircraft which might exhibit similar undesirable characteristics if exposed to such conditions. We believe that a measurement of higher-than-normal elevator breakout forces might be indicative of such a problem.

In order to minimize the possibility of future occurrences of this nature, the Safety Board recommends that the Federal Aviation Administration initiate the following interim actions:

1. Issue an Air Carrier Operations Bulletin which describes the circumstances of this accident, applicable cautions regarding such instability, and recommended pilot procedure to reduce the possibility of a sustained high "g" oscillation, should an instability manifest itself.

2. Issue an Airworthiness Directive which would require:

   (a) that all Boeing 707/720 aircraft be subjected to an elevator breakout force check in accordance with the approved maintenance procedures at the next scheduled maintenance visit; and

   (b) that those aircraft on which the breakout friction determined in part (a) exceeds the maximum allowable values be subjected to further inspection to ensure that the elevator balance panel seal compression is not excessive.

3. Require changes in the approved Maintenance Manual for all Boeing 707/720 aircraft to:

   (a) specify a more precise method of measuring the net elevator hinge friction throughout the entire range of control surface travel; and

   (b) specify a more definitive method for adjusting the balance panel seals within the desirable tolerance. At present, the manual specifies a 0 ± 0.020-inch fit between the balance panel seal and the stabilizer structure. A -0.020-inch measurement implies seal compression which is extremely difficult to measure accurately.

Our technical staff is available for any further assistance they may be able to provide.

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: John H. Reed
Chairman