NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594

March 5, 2013

Systems Group Chairman's Factual Report – Braking System

ERA12FA567

A. ACCIDENT

Operator: Dewberry Air
Aircraft: Beechcraft 400, N428JD, Serial Number RJ-13
Location: Macon, GA
Date: Sept 18, 2012
Time: 10:03 AM

B. SYSTEMS GROUP

Chairman — Steven Magladry
National Transportation Safety Board
Washington, DC

Member — Kris Wetherell
Hawker Beechcraft
Wichita, KS

C. SUMMARY

On September 18, 2012, about 1003 eastern daylight time, a Beechcraft 400, N428JD, was substantially damaged when it overran runway 28 during landing at Macon Downtown Airport (MAC), Macon, Georgia. The airplane had departed from Charleston Air Force Base/International Airport (CHS), Charleston, South Carolina about 0930. Visual meteorological conditions prevailed and an instrument flight rules (IFR) flight plan had been filed. Both Airline Transport Pilots and one passenger sustained minor injuries. The corporate flight was conducted under the provisions of 14 Code of Federal Regulations Part 91.

The condition of most of the braking system was documented on scene. In addition, the power brake valve, wheel speed transducers, antiskid control box, and brakes were removed for further examination. The following summarizes those activities.

D. DETAILS OF THE INVESTIGATION

1.0 Braking System Description

1.1 General (Figure 1)

The main landing gear wheels are equipped with disc brakes installed on the main landing gear axles. Wheel braking action, with the exception of the emergency brake system, is initiated by the master cylinders. Displacement of each master cylinder piston transfers hydraulic pressure to the power brake anti-skid control valve via the mixing valves. The mixing valves provide a means of interconnecting the four master cylinders in parallel to permit actuation of the brakes from either the pilot's or copilot's rudder pedals. Hydraulic fluid is provided to the master cylinders from a pressurized hydraulic reservoir installed on the forward side of the forward pressure bulkhead. The power brake anti-skid control valve is used to release and apply hydraulic pressure to the main gear brake assemblies. The control valve's three modes of operation include "manual", "power" and "anti-skid".

2.1 Manual Mode

When 1,500 psi (105 kg/cm·) hydraulic pressure is not available to the power brake anti-skid control valve, hydraulic pressure from the master cylinders will hold the shuttle valves in the control valve open, thereby allowing hydraulic fluid pressure from the master cylinders to actuate the brake assemblies. The power brake anti-skid control valve acts only as plumbing and the anti-skid system is nonfunctional in the "manual" mode.

3.1 Power Brake Mode

When 1,500 psi (105 kg/cm·) of hydraulic pressure is available to the power brake anti-skid control valve, the internal shuttle valves are moved to the closed position and the control valve functions in the "power" mode. With the shuttle valves in the closed position, master cylinder hydraulic pressure is no longer applied to the brake assemblies, but to the metering valves inside the control valve. The metering valves apply the hydraulic system pressure to the brake assemblies at a 2:1 ratio, as compared to hydraulic pressure from the master cylinders. An accumulator installed just aft of the left hand (LH) main landing gear wheel well provides a fluid reserve to stabilize hydraulic pressure during pressure fluctuations of the hydraulic system. The accumulator is also equipped with an accumulator charging valve and pressure gauge. The "power" brake system will operate with or without anti-skid control.

4.1 Anti-Skid Power Brake Mode (Figure 2)

An anti-skid control system is installed on the airplane to electronically monitor and control the "power" brake system, thereby providing maximum braking efficiency on all runway surfaces through the prevention of wheel skidding. The anti-skid control system consists of the "power" brake system components, an anti-skid control box and both the LH and RH wheel speed transducers. The system also utilizes a hydraulic servo control valve, that is installed on the power brake anti-skid control valve, located in a compartment near the left main landing gear. The power brake anti-skid control box is located in the aft compartment and the wheel speed transducers are mounted inside the hubcaps of their respective main landing gear wheel assemblies.

5.1 Anti-Skid System Operation

The anti-skid system is powered through the switch placarded ANTI-SKID, ON-OFF-TEST on the center pedestal. When the ANTI-SKID switch is in the OFF position, the brake system functions in either the "manual" or "power" mode, as determined by the availability of 1,500 psi (105 kg/cm·) of hydraulic pressure to the power brake anti-skid control valve. When the ANTI-SKID switch is placed in the ON position, 28 VDC from the LH load bus is applied to the anti-skid control box. The momentary TEST position initiates a functional test of the anti-skid system.

Signals from each wheel speed transducer are input to the anti-skid control box where control calculations are performed. Should a transducer signal indicate a skid condition, the anti-skid control box provides a signal to the hydraulic servo control valve and reduces brake pressure on each side of the brake system simultaneously. The left and right brake pressures are reduced proportionally to maintain any differential braking inputs that the crew may be using.

The anti-skid control box contains both a touch-down-protection and valve-dump-detection circuit. The valve-dump-detection circuit monitors the anti-skid control valve command signals. If a valve-dump release command is received for an extended period of time (3.4 +/- 0.5 seconds), the valve-dump-detection circuit signals the anti-skid control box to illuminate the amber ANTISKID FAIL annunciator. The touch-down-protection circuit prevents the application of brake pressure by the crew until the wheels are on the ground or if a wheel spins up to 37 knots. The positions of two ground safety relays are monitored by the anti-skid control box to operate the touch-down protection circuit.

A loss of electrical power to either the anti-skid control valve or control box will disable anti-skid control. The system will continue operation in the "power" mode, without anti-skid control, providing 1,500 psi (105 kg/cm·) of hydraulic pressure is still available. If 1,500 psi (105 kg/cm·) of hydraulic pressure is not

available, the brake system reverts to the "manual" mode. The anti-skid system will not operate unless the brake system is in the "power" mode.

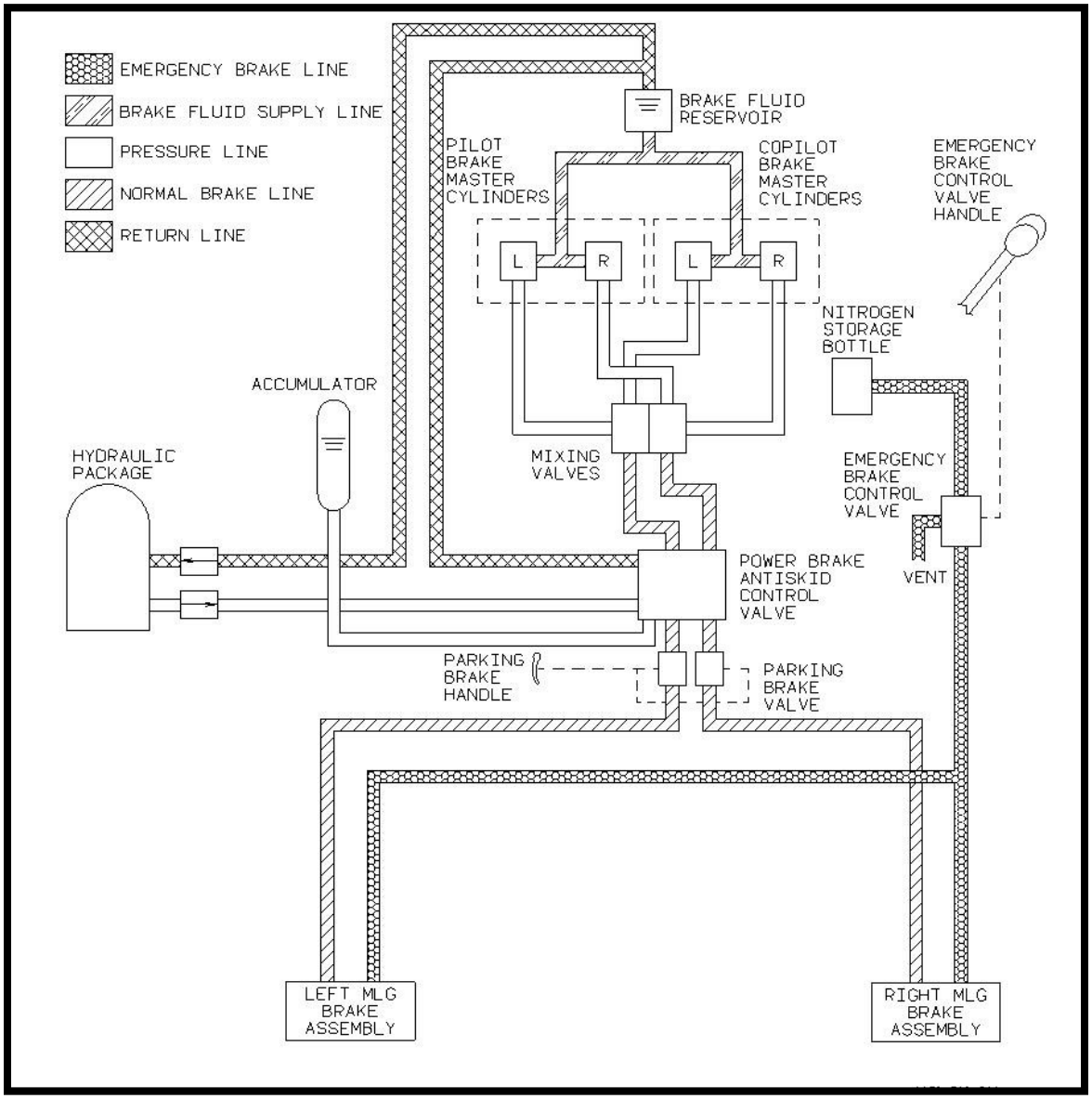

Figure 1 Brake System Overview Schematic

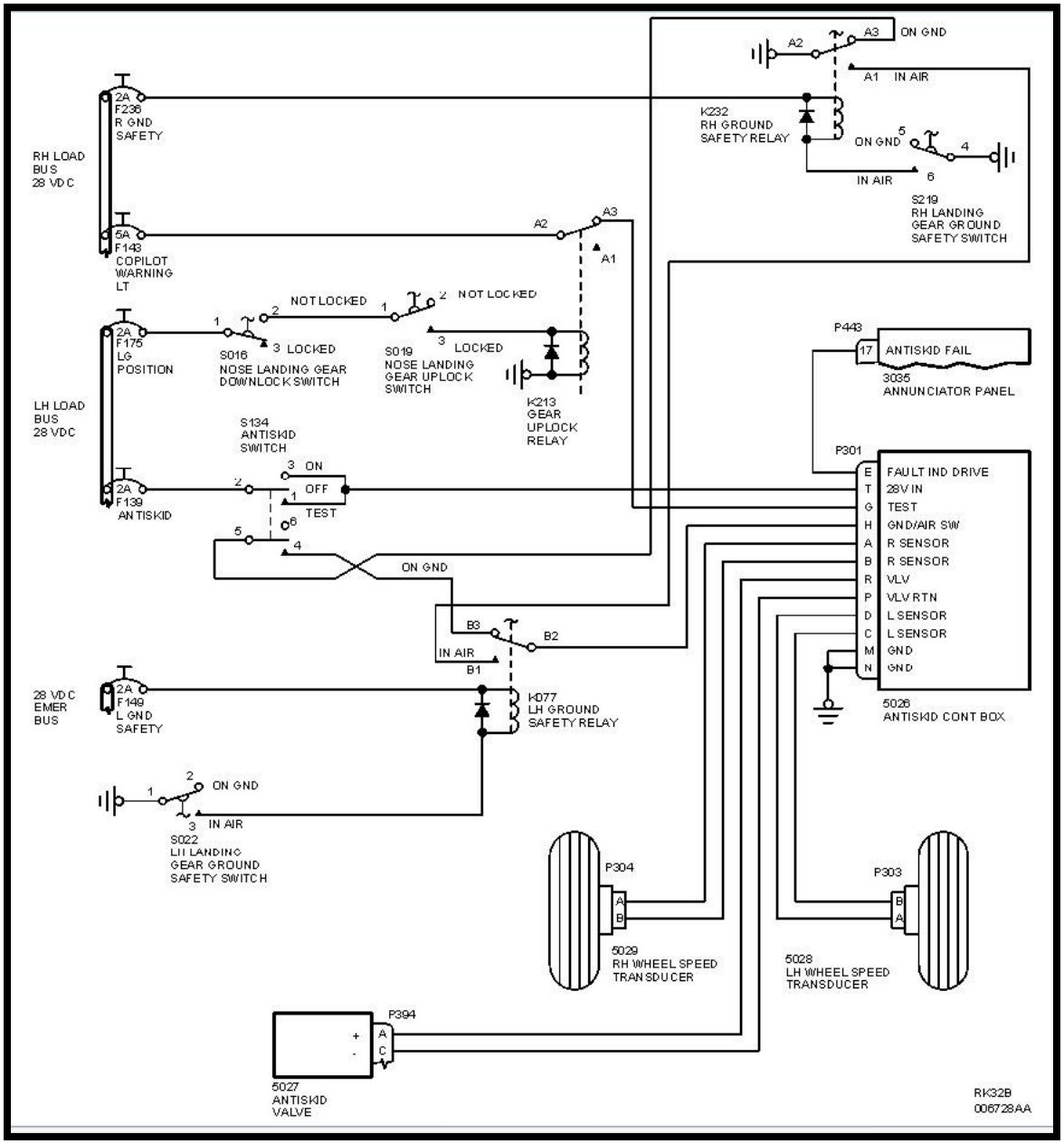

Figure 2 Antiskid System Schematic

2.0 Accident Airplane Brake System

1.1 Flight Deck Components

The brake pedal linkage was bent and the master cylinders were not accessible due to damage to the flight deck floor caused by impact with a tree.

The anti-skid switch on the pedestal in the flight deck was found in the ON position

2.1 Hydraulics

The hydraulic reservoir is mounted forward of the cargo compartment, accessed through the aft fuselage doors (840A/840B). The reservoir has a sight gauge mounted on it for viewing quantity. The sight guage indicated the reservoir to be above half full, however, the airplane was still at a nose down angle, and it was expected that the level was even higher than indicated. There was sufficient hydraulic fluid to supply hydraulic system pressure.

The hydraulic accumulator indicator showed approximately 1000 psi.

The emergency braking system nitrogen bottle indicated 1600 psi, and the emergency handle was bent, but not deployed. The safety wire was partially intact.

3.1 Wheels, Tires, and Brakes

The tires were Goodyear part number 247F63-3, left SN 12912961, right SN 12463205. The tires were still inflated and the pressures were checked: Left main 109.5 psi; right main 104.5 psi, nose 110 psi. On the main gear door a placard indicated the pressure should be 125 +/- 5 psi. The tread depth was checked: Left tire had 0.09 inches; Right tire had 0.08 inches. The tires were then deflated and removed from the landing gear. The tread was cleaned and inspected. There was no indication of significant flat spots or other damage.

The brakes were removed from the landing gear and visually examined. They did not appear to have any damage, and appeared to have a majority of the pad wear remaining. The brakes were later examined according to AMM 32-40-00-201 to determine the wear level. The brakes were pressurized to 300 psi with nitrogen gas, and the gap between the first pressure plate and brake housing was measured. For the left brake the gap was 0.14 inches and for the right it was 0.15 inches. A gap measurement of 0.433 inches represents a 90% worn brake. The measured gaps are consistent with minimal wear.

The ground safety switches (squat) were still intact on each of the main gears. The wiring from each switch was traced to a cannon plug in each wheel well and the appropriate wire was cut and exposed to measure continuity. The struts were then fully extended and continuity measured, then lifted so they would retract until the switch activated, and the strut extension was measured again at that point. According to AMM these results indicated that the ground safety switches operated correctly.

The Power Brake Valve, Crane part number 38-675, SN 181, the Antiskid Control Box, Crane Part number 43-511, SN 118, and both wheel speed transducers (Crane, Right PN 140-03110, SN 168, left SN1023) were removed and retained by the NTSB for later examination. During removal of the speed transducers it

was observed that the clips in the hubcaps were intact and connected to the sensors.

On November 27, 2012 the systems group consisting of NTSB, Hawker Beechcraft, and Crane representatives convened at Crane Aerospace and Electronics in Burbank, CA. to test the Crane components. The components were hand carried by the NTSB to Crane. The components were unpackaged and visually inspected. There was no damage observed on the parts except for some discoloration of the housing on the left wheel speed transducer.

Power Brake Valve

The power brake valve was tested according to Crane test procedure TP-38-675, rev F,1, Released 11/25/1986. All tests passed and the data sheets were retained by the NTSB.

Control Box

The control box was tested according to test procedure TP-42-511, Rev E, 1, released 9/15/1992. All tests passed and the data sheets were retained by the NTSB.

Wheel Speed Transducers

The wheel speed transducers were tested according to test procedure TP-40-92141, Rev C,1, Released 2/24/1995. All tests passed and the data sheets were retained by the NTSB.

Steven H. Magladry
NTSB