NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

Systems Group Chairman's Factual Report

September 29, 2006

A. ACCIDENT DCA06MA064

Location:	Blue Grass Airport, Lexington, Kentucky
Date:	August 27, 2006
Time:	0607 Local Time (EDT)
Aircraft:	Comair Flight 5191, a Bombardier Canadair CL-600-2B19-7472, N431CA

B. GROUP

Chairman:	Tom Jacky National Transportation Safety Board Washington, DC
Member:	Julio Figueroa Federal Aviation Administration (FAA) Louisville, KY
Member:	Darryn Fessel Air Line Pilots Association (ALPA) Erlanger, KY
Member:	J.D. Elovich Comair Erlanger, KY
Member:	Andre Tousignant Bombardier Aerospace Montreal, Canada
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C. SUMMARY

On August 27, 2006, about 0607 eastern daylight time, Comair flight 5191, a Bombardier CL-600-2B19 (CRJ-100), N431CA, crashed during takeoff from Blue Grass Airport, Lexington, Kentucky (LEX). The airplane, which had been cleared for runway 22, taxied onto runway 26 instead and ran off the end of runway 26. Of the 47 passengers and 3 crewmembers on board the airplane, 49 were killed, and 1 received serious injuries. The airplane was destroyed by impact forces and postcrash fire. The flight was operating under the provisions of 14 *Code of Federal Regulations* Part 121 and was en route to Hartsfield-Jackson Atlanta International Airport, Atlanta, Georgia (ATL).

The systems group met at the accident site from August 28, to August 31, 2006, to document the relevant airplane systems. The following airplane components were removed from the airplane and retained by the National Transportation Safety Board for further examination:

1) Enhanced Ground Proximity Warning System (EGPWS) Computer
Manufacturer: Honeywell
Part Number: 960-0329
Serial Number: Unknown

2) Horizontal Stabilizer Trim Control Unit (HSTCU)
Part Number: 7060-9
Serial Number: 358
Date: 09 06

3) Integrated Avionics Processor System Cabinet and 1 loose card
Serial Number: D02319

4) Spoiler Electronic Control Unit (SECU)
No Data Plate Recovered

5) Flight Control Panel
Manufacturer: Collins
Part Number: 822-0044-001
Serial Number: 365

D. DETAILS OF INVESTIGATION

The group identified and documented relevant systems of the airplane. The group documented the following categories:

1. Airframe

The airplane was destroyed by impact forces and post-impact fire.

Both wings were separated from the fuselage. The aft fuselage/empennage assembly had separated from the main fuselage and was found apart from the main fuselage. The main wing center section was separated from the fuselage and found approximately 50 feet from the fuselage.

Impact forces and post-crash fire damaged the main avionics compartment and the components installed in the compartment. The forward section of the fuselage wreckage was rotated during the investigation to provide access to the compartment. Much of the underside skin was separated from the airplane, which provided access to the compartment.

2. Auto Flight

The Integrated Avionics Processor System (IAPS) cabinet, serial number D02319, was located in the wreckage. One unidentified IAPS card was found separated from the IAPS cabinet.

3. Communications

The cockpit voice recorder (CVR) was recovered from the wreckage and transferred to the custody of the NTSB by the Federal Bureau of Investigation (FBI). The CVR was transported to the NTSB's Flight Recorder Laboratory in Washington, D.C. for readout.

4. Electrical Power

The airplane's battery was identified in the accident wreckage. The JB1, JB8, JB9, and JB5 junction boxes were also identified in the wreckage.

Each of airplane's four flight deck circuit breaker panels was identified in the wreckage. All circuit breakers were found closed except for the following, which were noted as damaged, missing, or open:

A. Circuit Breaker Panel 1 (CBP-1)

L ENG OIL PRESS (M-1) - Open
28 VDC Emergency Bus – Fire – EXT 1 – L ENG (R-2) - Open
28 VDC Emergency Bus – Fire – EXT 2 – R ENG (R-3) - Open
28 VDC Emergency Bus – Fuel SOV – R ENG (S-1) - Open
28 VDC Emergency Bus – APU BATT DIRECT FEED (S-6) - Open

B. CBP-2

Assessment of the position of the circuit breakers in rows A through E and J through N on this panel was not possible due to fire damage to the panel. All other circuit breakers on this panel were found closed.

C. CBP-3

Assessment of the position of the circuit breakers on CBP-3 was not possible due to impact damage.

D. CBP-4

28 VDC Essential Bus – INST FLOOD LTG (C-1) - Open
28 VDC Essential Bus – EMERG LTS (C-2) – Open
28 VDC Essential Bus – EICAS – DCU 1 CH A (C-10) - Open
28 VDC Essential Bus – EICAS – DCU 1 CH B (C-11) - Open

The air driven generator (ADG) assembly and attachment components were identified in the debris path. The ADG spinner and hub were found separated from the ADG.

5. Equipment & Furnishings

The flight deck observer's seat (jumpseat) was found stowed and latched.

6. Flight Controls

Each of the primary and secondary flight control systems were identified and examined. The extensive impact damage prevented examination of the flight control cable continuity.

A. Primary Flight Control Systems

1) Pitch Control and Pitch Trim Systems

Both left and right elevators were attached to the horizontal stabilizer. The left elevator had incurred impact damage to the outboard side. Each of the 3 hydraulic power control units (PCU) attachment linkages on each elevator were intact and secure. Additionally, both mid position left and right elevator PCUs were examined and found to be secure and undamaged.

a. Elevator Pitch Feel Control Unit

The elevator pitch feel control unit located in the upper vertical horizontal stabilizer was examined and was found secure with all attach points secure.

b. Horizontal Stabilizer Trim Actuator (HSTA)

The HSTA was examined to determine the horizontal stabilizer position. A visual inspection of the stabilizer indicated the stabilizer was in approximately

mid-range of its travel limits. The internal examination of the jackscrew revealed that the jackscrew was undamaged, clean and lubricated.

The group determined that, between the HSTA motor and the horizontal stabilizer gimbal assembly, 38 jackscrew threads were exposed. According to Bombardier Aerospace Engineering, 38 exposed threads converts to a horizontal stabilizer position of -4.8^{o} (according to Bombardier Aerospace Engineering, this value is equivalent to a flight deck trim indication of 6.8 units).

The horizontal stabilizer trim control unit (HSTCU), identified as part number 7060-9, serial number 358, and dated 09 06, was located in the wreckage.

2) Lateral Control System

Both the left and right ailerons were recovered. All attach fittings and associated components were identified.

3) Rudder Control System

The airplane's empennage was located in the wreckage against a tree. The vertical stabilizer was bent and crushed in the approximately the mid-span of the structure. The rudder was noted as attached to the vertical stabilizer. All hinge attachment points were secure. An internal examination of the three rudder hydraulic PCUs indicated that the lower (#2 hydraulic system) PCU centering rod was found broken.

B. Secondary Flight Control Systems

1) Flaps

The flaps selector lever in the flight deck was found in the 20^{o} detent (see Figure 1). The flap position indicator was missing, but comparison to an exemplar unit indicated the selector was in the 20^{o} position.

Figure 1 - Flap Selector

This airplane has four flaps, two on each wing. Each flap has two jackscrews, one on the inboard portion and one on the outboard portion of the flap. All 8 jackscrew assemblies were identified and examined to assess the flap position at the time of impact. The exposed jackscrew threads were counted to determine flap actuation. For the inboard flaps, each of the 4 jackscrews had approximately 21 screw threads exposed. All four of the outboard flap jackscrews had approximately 11 threads exposed.

The flap actuator measurements were provided to Bombardier Aerospace Engineering for conversion to flap setting. According to Bombardier Aerospace Engineering, in each case, the converted flap measurements were consistent with a 20º-flap setting.

A review of the preliminary data from the airplane's flight data recorder indicated that the flaps were recorded at the 20º position during the accident sequence.

2) Flight Spoilers

This airplane has two flight spoilers, one on each wing. Both of the flight spoilers were identified in the wreckage. No assessment of the flight spoiler position was possible. The flight spoiler selector lever in the flight deck was found in the retracted position.

The spoiler electronic control unit (SECU) was located in the wreckage. Due to fire and soot damage to the unit, no data plate information was recovered.

3) Ground Spoilers

This airplane has four ground spoilers, two on each wing. All the ground spoiler hydraulic power control units (PCUs) were identified in the wreckage. No assessment of the ground spoiler position was possible.

4) Spoilerons

This airplane has two spoilerons, one on each wing. Both of the spoilerons and associated PCUs were recovered in the wreckage. No assessment of the spoileron position was possible.

7. Indicating/Recording Systems

The forward portion of the flight deck was substantially damaged by impact damage (see Figure 2). The aft portion of the flight deck was subjected to post-crash fire.

Figure 2 - Damage to Flight Deck

The group examined the flight deck for switch positions and indications. The following information was noted:

A. Electrical Services Panel

DC Service – Off
Battery Master – On
DC External Power – Deselected
AC External Power – Missing
IDG 1 – Guarded, deselected
IDG 2 – Guarded, deselected
AC Essential Transfer – Deselected
Gen 1 – On (switch broken)
APU Gen – On
Gen 2 – On
AC Auto Transfer 1 – Deselected
AC Auto Transfer 2 – Selected On
DC Bus Tie 1 – Selected On
DC Bus Tie 2 – Selected On
DC Essential Tie - Deselected

B. Fire Detection and Firex Monitor Panel

1) Fire Detection Sub-Panel

LH Engine Fire Loop – Selected “Both”
LH Jet Pipe Fire Loop – Selected “ Loop B”
APU Fire Loop – Selected “Both”
RH Jet Pipe Fire Loop – Selected “Loop A”
RH Engine Fire Loop – Selected “Both”
Test Switch – Fire Detection – Center Selection

2) Firex Monitor Sub-Panel

Engine Bottle 1 – Norm
Engine Bottle 2 – Norm
APU Bottle – Norm
Cargo Bottle – Norm

C. External Light Panel

NAV Lights – On
Beacon Lights – On
Strobe Lights – On
Logo Lights – On
Wing Inspection Lights - On

D. Fuel Panel

L Engine Boost Pump – On
Gravity XFLOW – Off
R Engine Boost Pump – On
L Engine XFLOW – Off
Auto XFLOW Override – On
R Engine XFLOW – Off

E. Bleed Air Panel

Duct Monitor Test Switch – Normal
L 14^{th} Stage Shutoff Valve – Selected open
14^{th} Stage ISO Valve – Selected open
R 14^{th} Stage Shutoff Valve – Selected open
L 10^{th} Stage Shutoff Valve – Selected closed
APU Load Control Valve – Selected open
10^{th} Stage ISO Valve – Missing
R 10^{th} Stage Shutoff Valve – Selected closed

F. APU Panel

APU Power Fuel Switch – On
APU Start/Stop – On

G. Engine Ignition Panel

Ignition A Switch – Missing
Ignition B Switch - Deselected
L Engine Start Switch – Deselected
R Engine Start Switch – Deselected
L Engine Stop Switch – Deselected
R Engine Stop Switch – Deselected
Ignition A/B CONT Switch - Deselected

H. Hydraulics Panel

Hydraulics Pump 1B – Auto
Hydraulics Pump 3A – On
Hydraulics Pump 3B – Auto
Hydraulics Pump 2B – On

I. Pressurization Panel

(Fire damage noted on the right hand side of panel)

Emergency Depressurization Switch – Guarded, deselected
Manual Pressure Increase/Decrease Switch – Center Position
Cabin Rate Switch Selector – Full decrease
Pressurization Controller Switch – Out

J. Air Conditioning Panel

L Pack – On
R Pack – Off
Ram Air – Guarded, Off
L Manual Temperature Control Switch – Center
R Manual Temperature Control Switch – Center
L Pack and R Pack Manual Temperature Control Switch Light – Missing
L Pack Auto Temperature Control Knob – Full Cold
R Pack Auto Temperature Control Knob – Full Cold
Cargo Air Conditioning Switch – Fan

K. Anti-Ice Panel

Wing Anti Ice – Standby

Wing Overheat Test Switch Light – Deselected
Left Cowl Anti Ice – Off
Right Cowl Anti Ice – Off
Ice Detector Test Switch – Deselected
Left Windshield Heat – Off
Right Windshield Heat – Off
Windshield Overheat Test – Out, deselected
Left Probe Heat – On
Right Probe Heat – On

L. Miscellaneous Light Panel

Dome Light – Off
Standby Compass Light – Off
Overhead Lighting Panel – Mid-range

M. Landing Light Panel

Left Landing Light Switch – On
Nose Landing Lights Switch – On
Right Landing Light Switch – On
Recognition/Taxi Lights Switch - On

N. Passenger Signs and Emergency Lights Panel

No Smoking Sign Switch – On
Seat Belt Sign Switch – Off
Emergency Lights – Armed

O. Miscellaneous Overhead Items

Emergency Locator Transmitter (ELT) – Selected Armed
Passenger Oxygen – Guarded, off
Standby Compass - 350º (compass moves)

P. Center Console

Gain – Normal
Mode – WX (Weather) Selected
Backup Tuning Unit – Standby
Transponder Selected – 2
FMS Tune Inhibit – Off (normal setting)
Mach Trim – Button missing
Display Fan – Normal
ARINC Fan – Normal
Captain's Compass Switch – Mag selected

Captain's Slew Switch – Centered
Parking Brake – Off
Landing Gear Manual Release – ½ extended
Air Driven Generator Manual Release – Stowed

Q. Engine Control Panel

Left Speed Switch – On (normal)
Right Speed Switch – On (normal)
APR – Armed

R. Source Select Panel

ATTD HDG Switch – Normal
Air Data Switch – Normal
EICAS Switch – Normal
DSPL CONT Switch - Normal

S. Jumpseat Audio Control Panel

All Volume Switches - down/off
Radio Selector – COM1
Intercom Switch – Off
Speaker Switch – Off

First Officer's Radio Tuning Unit – No indication

T. First Officer's Audio Control Panel

Radio Selected – COM1
COM2 – Out

U. Captain's Audio Control Panel

Radio Selected – COM1
Monitoring COM2

V. Cargo Firex Panel

Normal Push Light – Guarded, out
Normal Bottle Arm (Push to discharge) – Out
Cargo Standby Light – Guarded, out
Cargo Standby (Push to discharge) – Out

First Officer's Compass – Mag selected
First Officer's Slew Switch – Neutral

X. Center Pedestal/Throttle Quadrant Panel

Thrust Levers – Full forward, unable to move
Thrust Reversers – Stowed and armed
Ground Lift Dumping – Manual, armed
Flight Spoilers Selector Lever – Retracted
Flap Selector Lever – Indicator missing, but comparison to exemplar unit indicates selector in 20º position.
Pitch Disconnect – stowed
Roll Disconnect – pulled, disconnected
Anti-skid – Off
Landing Gear Selector Handle – Up (latch lock broken)
Flight Management System (FMS) – Screen broken

Y. Glare Shield

The glare shield was separated from the airplane and found next to the large forward fuselage section of wreckage. The first officer's fire buttons were found separated from the glare shield.

First Officer's Stall Protection Switch – On

The flight control panel, (Collins part number 822-0044-001, serial number 365) was located separated from its flight deck rack and the glare shield. No indication was available.

Z. Miscellaneous

The first officer's electronic flight instrument system (EFIS) control panel, which includes the display control panel, air data reference panel, and display reversionary panel, was located next to the flight deck wreckage. The captain's EFIS control panel was located in the debris field. Both panels were broken. The panels do not provide any indications.

The first officer's clock was located in the flight deck wreckage. No indication was provided on the digital portion of the clock. The second hand indicated 54 seconds.

The standby altimeter and airspeed indicator (part number WL102AM55, serial number AK713, mods 1, 3, 4, 5 – 8, 10) was located in the debris field (flag 616). The indicated altimeter glass face was broken and missing, and indications were assessed as 520 feet, 30.11 inches Hg, and indicated airspeed 400 knots. The barometric setting knob could be rotated and changed the indicated barometric pressure setting, but did not change the indicated altitude.

The standby attitude indicator (Model number ADI-331K, part number 501-1567-10, serial number 1879, mods 1, 2, 3) was located in the debris field. The indicator's glass face was broken and missing, with no assessment of indication possible.

The 6 color cathode ray tube (CRT) electronic flight display units from the electronic flight instrument system were located in the wreckage. The CRT's in each of the displays were broken. All 6 were found separated from their installation racks, therefore, the installed position of each of the units was undetermined. Three of the display units were located next to the flight deck wreckage. The other 3 display units were located in the main wreckage path (one near flag 504[1], one near flag 615, and one near flag 616).

The flight data recorder (FDR) was recovered from the wreckage and transferred to the custody of the NTSB by the Federal Bureau of Investigation (FBI). The FDR was transported to the NTSB's Flight Recorder Laboratory in Washington, D.C. for readout.

8. Landing Gear

All three landing gear assemblies – left, right, and nose – were located in the wreckage path. The two main landing gear doors were identified on the airport property and a horse field adjacent to the airport property. The left and right main landing gear had separated from the aircraft and remained somewhat intact.

A. Left Main Landing Gear

The first landing gear found in the wreckage path was the left main landing gear; the side stay actuator had separated and was found nearby.

B. Right Main Landing Gear

The right main landing gear was located approximately 100 feet south of the main fuselage wreckage. The right main landing gear was located in a field adjacent to the field where the main wreckage was located. The gear was located at a latitude/longitude of:

38º 02.259" North 84º 36.919" West

Both tires were scorched and scrub marks were noted on the right inboard tire. The door linkage was attached but broken.

[1] The flag numbers refer to the wreckage distribution chart. See Structure's Group Chairman Factual Report for the chart.

C. Nose Landing Gear

The nose landing gear (NLG) was separated at the upper pivot main attachment fitting and found approximately 50 feet away from the fuselage. The left nose tire and wheel were separated and found approximately 50 feet southwest of the NLG. The remaining upper portion of the NLG was found in the main wreckage still attached to the forward fuselage.

D. Main Landing Gear Brakes

Both left and right main landing gear wheel and tire assemblies were found intact. No evidence of damage to the left and right brake units was noted.

9. Lights

The airplane's external lighting includes landing and taxi/recognition lights, navigation/position lights, wing inspection lights, anticollision strobe lights, anticollision beacon lights, and logo lights. The exterior lights controls are located on the LANDING LTS and EXTERNAL LTS panels in the flight deck.

The right wing landing and recognition/taxi lights were identified in the wreckage, on the right wing stub.

10. Navigation

The airplane's Enhanced Ground Proximity Warning System (EGPWS) Computer, part number 960-0329, serial number unknown) was located in the airplane wreckage.

11. Auxiliary Power Unit

The auxiliary power unit (APU) air inlet door was found in the open position. The APU firebox remained intact.

12. Doors

Approximately half of the top portion of the airplane's service door was consumed by post crash fire. The door was noted closed.

The flight crew escape hatch was identified in the wreckage, separated from the airplane. The main avionics compartment door was missing.

13. Windows

Both forward windshields were damaged and shattered (see Figure 2). No assessment of pre-existing condition of the windshields was possible.

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