Aviation Investigation Final Report

Location:	Hallandale, Florida	**Accident Number:**	ERA12LA356
Date & Time:	May 23, 2012, 15:47 Local	**Registration:**	N207JB
Aircraft:	CANADAIR LTD CL-600-2B16	**Aircraft Damage:**	Substantial
Defining Event:	Part(s) separation from AC	**Injuries:**	2 None
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

About 3 minutes into the positioning flight, at 3,000 feet, the flight crew heard a "loud bang" and became aware that the main passenger door had separated from the airplane. The pilot declared an emergency, diverted to a nearby airport, and landed without further incident. The separated passenger door was subsequently found on a nearby golf course.

The co-pilot reported in a written statement that he closed the main passenger door and checked for a green light to ensure that it was secure. In a subsequent interview, he reported that he "believed" that the door warning lights were working, but he could not positively recall seeing the "Door Safe" light illuminated after closing the door. He also did not remember activating the "Recall" switch before takeoff.

Ramp security video showed that the main passenger door appeared to close; it then re-opened momentarily and closed again before the airplane taxied out of the ramp area. The co-pilot reported that he re-closed the door because it did not secure on the first attempt. An examination of the recovered door and the door frame did not reveal evidence of a pre-existing mechanical malfunction or failure that would have precluded normal operation. The top half of the door was crushed from the impact with the ground, which prevented establishing the condition of door rigging before the accident. An examination of the fuselage revealed a skin puncture that matched the location of the door pull-out handle and is consistent with the door being in the open position when the puncture occurred. Although the door's external handle was found in the closed position, smudging on the fuselage was consistent with the handle's movement from the open to the closed position during impact with the fuselage.

Although it is apparent from the cockpit voice recording that the flight crew referenced the pilot checklist at some stages during ground operations, crew challenge and response items were sporadically mentioned. After the sound of the passenger door closing, neither crewmember mentioned the door warning lights. At no point during ground operations through the takeoff sequence were the doors, door warning lights, or master caution system mentioned. The co-pilot mentioned the "Annunciator" check in

the Before Takeoff checklist; however, no "Recall" response was noted on the recording. Activating the recall switch would have alerted the flight crew to an unsecured door before takeoff.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The failure of the co-pilot to properly close and latch the passenger door before departure, and the flight crew's failure to ensure that the door was secure by using the door warning system. Contributing to the accident was the flight crew's inadequate use of checklists.

Findings

Aircraft	Passenger/crew doors - Incorrect use/operation
Personnel issues	Use of equip/system - Flight crew
Personnel issues	(general) - Copilot
Personnel issues	Use of checklist - Flight crew

Factual Information

History of Flight

Enroute-cruise	Part(s) separation from AC (Defining event)

On May 23, 2012, about 1547 eastern daylight time, a Canadair Challenger 601-3R (CL-600-2B16), N207JB, was substantially damaged following separation of the main passenger door near Hallendale, Florida. The air transport pilot and commercial-rated co-pilot were not injured. The airplane was registered to a corporation and was operated by Majestic Jet Inc. under the provisions of 14 Code of Federal Regulations Part 91 as a positioning flight. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed. The flight originated at Opa Locka Airport (OPF), Opa Locka, Florida at 1543 and was destined for Pompano Beach Airpark (PMP), Pompano Beach, Florida.

The pilot reported in a written statement that, about 3 minutes into the flight, a "loud bang" was heard, a rush of air entered the cabin, and it became evident that the main cabin door had separated from the airplane. The flight was about 4 nautical miles (nm) south of Fort Lauderdale-Hollywood International Airport (FLL) at the time, so he elected to land the airplane there. He stated that the noise in the cockpit was so loud that they could not hear on the radio. The pilot landed the airplane on runway 10L without further incident.

The co-pilot reported in a written statement that, during ground operations, he closed the main passenger door and checked for a green light to ensure that it was secure. He performed the takeoff and was at the controls when the door separation occurred. The pilot took over the controls and performed an emergency landing on runway 10L at FLL.

In an interview with a Federal Aviation Administration (FAA) inspector after the accident, the co-pilot reported that he "believed" that the door warning lights were working, but he could not positively recall seeing the green "Door Safe" light illuminated after closing the door. He also did not remember activating the warning system "Recall" switch prior to takeoff.

Ramp security video footage revealed that a crewmember entered the airplane through the main

passenger door, the door closed, and then the door momentarily opened partially and closed again prior to departure. When questioned about this, the co-pilot reported that he re-closed the door because it did not secure on the first attempt.

Pilot Information

Certificate:	Airline transport	**Age:**	43
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	December 1, 2011
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	12300 hours (Total, all aircraft), 3500 hours (Total, this make and model), 9000 hours (Pilot In Command, all aircraft), 75 hours (Last 90 days, all aircraft)		

Co-pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	36
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	May 17, 2011
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	November 14, 2011
Flight Time:	2550 hours (Total, all aircraft), 65 hours (Total, this make and model), 1400 hours (Pilot In Command, all aircraft), 61 hours (Last 90 days, all aircraft), 25 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

The pilot held an airline transport pilot certificate with type ratings in the Cessna CE-500, Canadair CL-600, Boeing B747, McDonnell Douglas DC-10, and Gulfstream G-IV. He reported 12,300 hours total flight time, including 3,500 hours in the same make and model as the accident airplane.

The co-pilot held a commercial pilot certificate with ratings for airplane single engine land, airplane multiengine land, and instrument airplane. He also held a flight instructor certificate for airplane single engine land, airplane multiengine land, and instrument airplane. He reported 2,550 hours total flight time, including 65 hours in the same make and model as the accident airplane.

According to the FAA inspector, the co-pilot was hired by the operator on October 21, 2011. He was assigned to the CL-600 in February, 2012. Prior to his employment with the operator, he did not have any experience on pressurized or turbine-powered aircraft. He completed initial in-house training on the airplane on February 25, 2012, and that training was administered by the pilot. The co-pilot stated that he had received no formal training on the CL-600 other than that administered by the pilot. The training records did not specifically indicate any training on the operation of the main cabin door. The inspector's review of flight log information indicated that the co-pilot had logged 14 flights as a required crewmember, with a total flight time of 19.9 hours in the same make and model as the accident airplane.

Aircraft and Owner/Operator Information

Aircraft Make:	CANADAIR LTD	**Registration:**	N207JB
Model/Series:	CL-600-2B16	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	5194
Landing Gear Type:	Retractable - Tricycle	**Seats:**	11
Date/Type of Last Inspection:	March 1, 2012 Continuous airworthiness	**Certified Max Gross Wt.:**	45100 lbs
Time Since Last Inspection:		**Engines:**	Turbo fan
Airframe Total Time:	4966 Hrs at time of accident	**Engine Manufacturer:**	General Electric
ELT:	Installed, not activated	**Engine Model/Series:**	CF34 Series
Registered Owner:	MEDCP Aviation LLC	**Rated Power:**	
Operator:	Majestic Jet Inc.	**Operating Certificate(s) Held:**	None

The airplane was a low wing, retractable tricycle landing gear, transport category airplane. It was equipped with two General Electric CF34-3A1 engines.

The airplane arrived for maintenance at the Bombardier Hartford, Connecticut facility on June 20, 2008 and departed on January 5, 2012. Five repairs were documented in the area of the main passenger door, including a pressurization leak when the cabin was pressurized and a failure of the main door closed green light (PASS DR READY light) to operate. The repairs were documented and the airplane was eventually released for service. The maintenance entries and corrective actions are located in the Bombardier Field Notes, contained in the public docket for this investigation.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	FLL,9 ft msl	**Distance from Accident Site:**	5 Nautical Miles
Observation Time:	15:50 Local	**Direction from Accident Site:**	350°
Lowest Cloud Condition:	Few / 2000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	110°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.87 inches Hg	**Temperature/Dew Point:**	28°C / 22°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Opa Locka, FL (OPF)	**Type of Flight Plan Filed:**	IFR
Destination:	Pompano Beach, FL	**Type of Clearance:**	IFR
Departure Time:	15:43 Local	**Type of Airspace:**	

The 1550 surface weather observation for FLL included wind from 110 degrees at 10 knots, visibility 10 miles or better, few clouds at 2,000 feet, temperature 28 degrees C, dew point 22 degrees C, and altimeter setting 29.87 inches of mercury.

Airport Information

Airport:	Ft Lauderdale-Hollywood Intl FLL	**Runway Surface Type:**	Asphalt
Airport Elevation:	9 ft msl	**Runway Surface Condition:**	Unknown
Runway Used:	10L	**IFR Approach:**	None
Runway Length/Width:	9000 ft / 150 ft	**VFR Approach/Landing:**	Full stop

Wreckage and Impact Information

Crew Injuries:	2 None	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	25.988611,-80.131111

The main passenger door and associated hardware were found on a golf course at Hallendale, Florida. The impact site coordinates were N 25 59.31, W 080 07.87. Impact marks on the ground were consistent with the top of the door striking the ground first. The door sustained structural damage from ground impact.

An examination of the airframe, including the forward and aft upper latch spigots, forward and aft cams (pull in lever), forward and aft stops, forward and aft rollers, forward and aft upper tension buttons, forward and aft center latch spigots and proximity switches, and forward and aft lower tension buttons showed no evidence of visible anomalies or structural failure. The door's mechanical interface (hinge) was found severed. The door's electrical harness interface was found damaged as a result of the door leaving the airframe in flight. About two feet of electrical wiring were found dangling from connector P2MB. The severed wires contained four power wires that were exposed and were free to contact the airframe in flight. According to the manufacturer, contact with the airframe could create a short circuit and potentially trip circuit breakers CB-D17 and CB-B160, integral to the door warning system. These two circuit breakers were found open during the post-accident examination of the cockpit.

An examination of the external fuselage revealed a puncture in the skin that was similar in size and shape as the door pull out handle. The location was consistent with the pull out handle being in the open

position when the puncture occurred. The door pull out handle exhibited a bend of approximately 20 degrees opposite of its contour. The handle was found in its stowed position with the bend standing out and was difficult to extend when manipulated by hand. Its linkage to the internal and external handles was severed from tension loads.

A horizontal impression was found on the fuselage skin that was consistent in location, size and shape with the door's external handle. The horizontal orientation of the impression was consistent with the external handle being in the closed position after the door contact with the fuselage skin occurred. The forward end of the impression had a gouge 0.016" deep and approximately 0.700" high. The aft end of the impression had a gouge 0.005" deep, 1.950" long and 0.350" wide. The paint on the aft end of the impression was smudged consistent with motion towards the closed position.

An examination of the recovered main passenger door revealed that the upper half was crushed from ground impact. Due to the deformity of the door from ground impact, the door latch mechanism rigging was compromised and no attempt was made to establish if the door was rigged properly prior to the accident.

The forward and aft upper latch cams and proximity switches showed no evidence of visible anomalies or structural failure. The green alignment marks were present and visible. When the associated internal linkage was manipulated, the latch cams rotated in a normal manner. The forward and aft pull in levers, forward and aft tension fittings, and the forward and aft center latch cams showed no evidence of visible anomalies or structural failure. The green alignment marks on the center latch cams were present and visible.

The door internal handle showed no evidence of visible anomalies or structural failure. When operated by hand, the forward and aft center latch cams, the external handle, and the associated linkages operated in a normal manner.

Examination of the external handle revealed no evidence of visible anomalies or structural failure. When operated manually, the forward and aft center latch cams, the internal handle, and their associated linkages moved in a normal manner. When the handle was rotated to its closed position (horizontally)

relative to the door, the handle stowed normally in its stowed position.

The pushrod, connecting the upper latch cams and lower latch cams, was severed at the lower rod end, with evidence of bending overstress. The rod was housed in the upper portion of the door that was crushed from ground impact. The pushrod parts were removed and forwarded to the NTSB Materials Laboratory for a detailed examination.

The VHF number 1 external antenna, located on the belly of the aircraft, was severed, with about 80 percent of the antenna missing. A round impression, consistent with the size and shape of the main passenger door support leg, was found near the right side fuselage station 394.

Minor damage was found on the right wing leading edge adjacent to the right landing light.

Flight recorders

The cockpit voice recorder (CVR) and flight data recorder (FDR) were forwarded to the NTSB Vehicle Recorders Laboratory in Washington, DC for readout and examination.

The CVR was a L-3/Fairchild FA2100-1020, serial number 000244915. The two-hour recording contained good quality audio information. The unit was undamaged and the audio content was extracted without difficulty. A CVR group was formed, including the CVR Group Chairman and representatives from Bombardier and Majestic Jet.

The entire recording was not transcribed. The transcription began with the sound of a thunk and click, similar to a main cabin door closing, at 15:31:38 (HH:MM:SS). Three seconds later, a second click and thunk could be heard, consistent with the main cabin door closing and latching. There was no mention of door warning lights by either crewmember immediately after the door closing sounds.

At 15:34:18, there was a sound of an engine increasing, similar to an engine starting. No mention of a "Before Start" checklist was noted. At 15:35:42, a sound similar to a second engine start was noted. At 15:36:22, the "After Start" checklist was called for. At 15:37:40, the "Taxi" checklist was called for. At 15:43:06, the flight was issued takeoff clearance. At no point during the ground operations through the takeoff sequence were the doors, door warning lights, or master caution system mentioned. During the "Before Takeoff" checklist, the co-pilot mentioned the annunciator; however, the pilot did not respond with "Recall" as is listed in the checklist item.

For additional information on the CVR and its audio recording and transcript, refer to the Cockpit Voice Recorder Group Chairman's Factual report, located in the public docket for this accident investigation.

The FDR was a Loral/Fairchild F1000, serial number 00633. The FDR contained about 174.4 hours of data. The recorder was in good condition and the data were extracted normally from the recorder. A review of the data revealed that the vertical and horizontal acceleration parameters were not working.

The FDR data indicated the aircraft took off on a magnetic heading of about 92 degrees. During the entire flight, the aircraft commenced mostly left turns. At about 130 seconds after takeoff, the aircraft reached a maximum pressure altitude of 3,033 feet before beginning its descent. About 6.5 minutes later, the aircraft landed at a magnetic heading of about 95 degrees. For additional information on the FDR and its data, refer to the Flight Data Recorder Specialist's Factual Report, located in the public docket for this accident investigation.

Tests and Research

Integrity checks were performed on the main passenger door warning system and the aircraft master caution system. All lights associated with the door warning system were checked and illuminated when tested with the cockpit light test switch. No anomalies were found with the master caution light system, the "PASS DR READY" (passenger door ready) green light, or the "PASS DR UNLKD" (passenger door unlocked) amber light. An anomaly was found with the "PASS DR NOT RDY" (passenger door not ready) amber light. The light's designated ground was not available and the light would not illuminate when its circuitry was tested from the door interface. The PASS DR NOT RDY light illuminates only when the door T-handle is not stowed. According to the manufacturer, this anomaly would not affect the operation of the PASS DR READY (green) light as the PASS DR READY (green) light is an independent circuit.

The three sets of splices from the cabin door warning system were examined at the NTSB Materials Laboratory. Each submitted splice had wiring installed on only one side of the splice. Each splice was x-rayed to determine if wiring at some point was present on both sides of the splice. There was no evidence of marks, scratches or any other damage consistent with a wire having been installed and then pulled out. In addition, there were no remains of wiring present in the open end.

The integrity of the remaining door wiring harness found dangling from the airframe could not be verified because it was compromised (severed) when the main passenger door separated from the aircraft.

The pushrod, connecting the upper latch cams and lower latch cams, was sent to the NTSB Materials Laboratory for failure analysis. The rod was bent approximately 45° at the center and had fractured at one of the threaded ends. The pushrod also showed two dents approximately 3 inches from the opposite and intact end of the rod assembly. The threaded bolt showed compressed thread crests on one side and outstretched thread valleys on the other side. The majority of the original threaded surfaces bore a layer of rust-colored oxidation. This surface oxidation was not present on any of the fracture surfaces. Examination of the fracture surface revealed dimple rupture, which is indicative of overstress. The cracked areas in the stretched thread valleys also displayed dimple rupture. No other indications of other failure modes, including corrosion leading to fracture, were found. The observed features are consistent with bending overstress of the pushrod.

Additional Information

Aircraft Checklists

The flight crew utilized a FlightSafety International Quick Reference Handbook checklist during ground operations prior to takeoff. On page N-4, (Normal Start), checklist item number 5 stated, "Doors….Checked/Secured." On page N-6, (Before Takeoff), checklist item number 8 stated, "Annunciator….Recall."

Aircraft Systems

The following descriptions for the passenger/crew entrance door, door warning system, and master caution and warning system were obtained from the Canadair Challenger Maintenance Manual.

Passenger/Crew Entrance Door – Description

The entrance door for passengers and crew opens downward and outward and is manually controlled from inside or outside the aircraft.

Rollers are mounted on pull-in levers located on the fore and aft edges near the top of the door. Cams are secured to the fore and aft door frame in such a position to capture the rollers as the door approaches the closed position. This mechanism pulls the door into the full closed position to ease latch cam

engagement.

Guide plates are mounted below the pull-in levers on the door. These plates contact rollers mounted on the door frame and centralize the door as it closes.

Four latch cams on the door rotate around four spigots on the door frame to hold the door closed. Two cams are located at the top edge of the door and one on each side at approximately the mid-point. The latch cams are rotated by a handle and a system of push rods and torque tubes. The upper cams have a detent in which a spring-loaded pawl seats. The handle assembly consists of a single-lever internal handle located on the forward side of the stair and an external handle. The external handle stows into a recess in the outer skin of the door and in this position, the recess acts as a lock for the latching mechanism.

Door Warning System - Description

The passenger/crew door warning system in the flight compartment consists of two amber lights and a green light. The amber lights indicate that the door is unlocked and not ready; the green light indicates a door ready condition. The amber unlocked and not ready conditions activate the master caution system causing the amber DOORS annunciator to come on and the master caution lights to flash.

Proximity switches are mounted at each door latch. These switches, together with a proximity switch on the external door handle, cause the passenger/crew door UNLOCKED light to go out when the latches are in the fully latched position and the external handle is stowed. A proximity switch on the inner lever causes the passenger/crew door NOT RDY light to go out when the inner lever is stowed. Microswitches in a separate circuit sense when the inner lever and external handle are stowed. A green passenger/crew door READY light comes on to indicate that the external handle and T-handle are stowed.

The PASS DR NOT RDY (passenger door not ready) amber light comes on if the door T-handle is not

stowed. The PASS DR READY (passenger door ready) green light comes on when both the following microswitches are made: the door external handle stowed switch and the door T-handle stowed switch.

The PASS DR UNLKD (passenger door unlocked) amber light comes on if any of the following situations exists: the door external handle is not locked and stowed, the door center forward latch is not engaged, the door center rear latch is not engaged, the door upper forward latch is not engaged, or the door upper rear latch is not engaged.

Master Caution and Warning System - Description

The master caution and warning system serves two purposes: the first is to provide dimmable power for the aircraft system caution, warning and safe indication and advisory lights; the second is to provide an indication to the flight crew when certain system malfunctions occur. An additional indication is provided by the two flashing MASTER CAUTION PRESS TO RESET lights located on the glareshield, and by the appropriate annunciator on the 8 or 10 channel annunciator panels. The DOORS system annunciator is located on the 8 channel panel.

Annunciated caution lights cause the appropriate system annunciator on the 8 or 10 channel annunciator panel to come on and the MASTER CAUTION PRESS TO RESET lights to flash. The annunciator on the 8 or 10 channel annunciator panel identifies the system in which the malfunction has occurred.

Each annunciator legend has two lights installed side by side connected in parallel. The annunciator legend lights are reset by pressing the master caution switch/lights. Pressing the master caution switch, however, does not reset the system caution annunciators. The individual system light remains on and only goes out when the fault is cleared.

The 10 channel annunciator panel also contains a TEST/RECALL switch. When set to RECALL, the TEST/RECALL switch on the 10 channel annunciator panel applies 28 volts dc to the annunciator

switch. If a system fault still exists, after resetting the master caution and warning system, the annunciator switch applies a ground to the associated annunciator legend and a control signal to the master caution control circuit. The annunciator legend comes on and the two MASTER CAUTION PRESS TO RESET lights flash. The 28 volts dc recall signal is also applied to the 8 channel annunciator panel.

Cabin Pressurization System

The cabin pressurization mode selector was in the AUTO mode and the EMER DEPRESS switch was not selected.

Administrative Information

Investigator In Charge (IIC):	Hicks, Ralph
Additional Participating Persons:	Larry Hazel; FAA/FSDO; Miramar, FL Matt Franzac; Majestic Jet; Pompano Beach, FL Jimmy Avgoustis; Bombardier; Montreal QC Canada
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Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=83734

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