



# National Transportation Safety Board Aviation Incident Final Report

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<b>Location:</b>	Kansas, IL	<b>Incident Number:</b>	ENG171A006
<b>Date &amp; Time:</b>	11/29/2016, 0850 CST	<b>Registration:</b>	N367CA
<b>Aircraft:</b>	BOMBARDIER INC CL 600 2C10	<b>Aircraft Damage:</b>	None
<b>Defining Event:</b>	Uncontained engine failure	<b>Injuries:</b>	73 None
<b>Flight Conducted Under:</b>	Part 121: Air Carrier - Scheduled		

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## Analysis

The No. 1 engine experienced a catastrophic failure due to a separated high pressure turbine (HPT) 2<sup>nd</sup> stage blade. The separated blade subsequently damaged the HPT 2<sup>nd</sup> stage nozzle vanes, remaining HPT 2<sup>nd</sup> stage rotor blades, and all four stages of the low pressure turbine (LPT).

Metallurgical analysis of the HPT 2<sup>nd</sup> stage blades that separated below the platform concluded that the first blade to separate failed due to a high cycle fatigue crack that originated from an area of corrosion on the convex side. Six additional blades separated below the blade platform at high cycle fatigue cracks that had transitioned to overload due to impact damage from the initial blade release. The remaining blades in the HPT 2<sup>nd</sup> stage separated above the blade platform due to overload consistent with secondary impact damage. Multiple blades that separated above the blade platform also had fatigue cracks present below the blade platform that originated from areas of corrosion. The corroded areas contained elements including: sulfur, sodium, potassium, and phosphorus, which are common corrosive elements. The source of the corrosive elements could not be identified.

The engine water wash schedule was reviewed and according to GoJet Airlines, water washes are performed on their CF34-8C engines every 1,200 flight hours, or when engine trend data shows performance degradation. GE currently recommends water washing the engine at every -2A check, or about 1,600 flight hours. A GE service bulletin applicable to CF-348C engines is scheduled to be released in the first quarter of 2018 that increases the water wash interval to 2,000 flight hours or when engine trend data shows performance degradation.

## Probable Cause and Findings

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

The probable cause of the uncontained No. 1 (left) engine failure was a separated high pressure turbine 2<sup>nd</sup> stage blade that failed due to a fatigue crack that originated below the blade platform from an area of corrosion.

## Findings

Aircraft	Turbine section - Failure (Cause)
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## Factual Information

### HISTORY OF FLIGHT

On November 29, 2016, about 0850 central standard time, a GoJet Airlines Bombardier CRJ700, N367CA, equipped with two General Electric (GE) CF34-8C5B1 turbofan engines, experienced an uncontained No. 1 (left) engine failure during cruise (FL 340). The crew reported hearing a loud noise from the back of the airplane immediately followed by a No. 1 engine roll back and flame out. The crew declared an emergency, diverted to Lambert-St. Louis International Airport (STL), and made an uneventful single engine landing. The flight was being operated in accordance with 14 *Code of Federal Regulations* Part 121 and was a regularly scheduled flight from Cincinnati/Northern Kentucky International Airport (CVG) Covington Kentucky to Denver International Airport (DEN) Denver, Colorado as a Delta Air Lines connection. There were no reported injuries to the passengers or crew.

### DAMAGE TO AIRPLANE

There was no damage to the airframe. A penetration was observed in the No. 1 engine low pressure turbine (LPT) case, but the released debris did not penetrate the engine nacelle.

### TEST AND RESEARCH

#### Engine Disassembly

The incident engine, engine serial number (ESN) E965352, was shipped to Delta TechOps in Atlanta, Georgia for examination and disassembly. The LPT case had a penetration located at the 8 o'clock position, about 1 inch aft of the LPT flange, coincident with the high pressure turbine (HPT) 2<sup>nd</sup> stage rotor plane of rotation. The case material around the penetration was curled radially outward, away from the engine. Seven HPT 2<sup>nd</sup> stage blades were found separated below the blade platform and the remaining 61 blades exhibited impact damage and were separated above the platform at random locations along the blade span. Impact and thermal damage were observed on all four LPT rotor and nozzle stages.

#### Metallurgy

The complete set of 68 HPT 2<sup>nd</sup> stage rotor blades were sent to the GE materials laboratory in Lynn, Massachusetts for analysis. The seven blades that separated below the blade platform were all fractured at the shank upper radius and the fracture surfaces exhibited visual evidence of high cycle fatigue originating on the convex side from areas of corrosion. The 61 blades that were separated above the platform all failed due to overload, consistent with secondary damage. Of the 61 blades separated above the platform, multiple blades had corrosion and fatigue cracks present below the blade platform in the same general area as the blades that separated below the platform. The blade material composition and hardness levels met drawing specification.

The LPT case was sent to the GE materials laboratory in Evendale, Ohio for visual examination and material analysis. The case material composition and hardness levels met drawing specification. The LPT case penetration fracture surfaces had ductile dimples consistent with overload.

The NTSB materials laboratory reviewed both GE reports and concurred with all findings.

## History of Flight

Enroute-cruise	Powerplant sys/comp malf/fail Uncontained engine failure (Defining event) Engine shutdown
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## Aircraft and Owner/Operator Information

Aircraft Manufacturer:	BOMBARDIER INC	Registration:	N367CA
Model/Series:	CL 600 2C10 700C	Aircraft Category:	Airplane
Year of Manufacture:	2002	Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	10069
Landing Gear Type:	Retractable - Tricycle	Seats:	
Date/Type of Last Inspection:		Certified Max Gross Wt.:	1003 lbs
Time Since Last Inspection:		Engines:	2 Turbo Fan
Airframe Total Time:		Engine Manufacturer:	GE
ELT:	Installed, not activated	Engine Model/Series:	CF34 SERIES
Registered Owner:	DELTA AIR LINES INC	Rated Power:	9140 hp
Operator:	GoJet Airlines, LLC.	Operating Certificate(s) Held:	Flag carrier (121)
Operator Does Business As:	Delta Connection	Operator Designator Code:	

## Meteorological Information and Flight Plan

Conditions at Accident Site:	Unknown	Condition of Light:	Day
Observation Facility, Elevation:		Observation Time:	
Distance from Accident Site:		Direction from Accident Site:	
Lowest Cloud Condition:		Temperature/Dew Point:	
Lowest Ceiling:		Visibility	
Wind Speed/Gusts, Direction:	Calm	Visibility (RVR):	
Altimeter Setting:		Visibility (RVV):	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Covington, KY (CVG)	Type of Flight Plan Filed:	Unknown
Destination:	DENVER, CO (DEN)	Type of Clearance:	Unknown
Departure Time:		Type of Airspace:	Unknown

## Wreckage and Impact Information

Crew Injuries:	4 None	Aircraft Damage:	None
Passenger Injuries:	69 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	73 None	Latitude, Longitude:	39.502778, -87.930000

## Administrative Information

Investigator In Charge (IIC):	Robert Hunsberger	Adopted Date:	03/07/2018
Additional Participating Persons:	Sam Farmiga; GE Aviation; Cincinnati, OH Craig Quick; GE Aviation; Cincinnati, OH Robert Gilbert; GE Aviation; Cincinnati, OH Shannon Masters; Delta Air Lines; Atlanta, GA Sarah Riley; Delta Air Lines; Atlanta, GA		
Publish Date:	03/07/2018		
Note:	The NTSB did not travel to the scene of this incident.		
Investigation Docket:	<a href="http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=94480">http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=94480</a>		

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