Aviation Investigation Final Report

Location:	Los Angeles, California	**Incident Number:**	ENG14IA019
Date & Time:	July 11, 2014, 13:45 Local	**Registration:**	N139DL
Aircraft:	Boeing 767 332	**Aircraft Damage:**	Minor
Defining Event:	Fire/smoke (non-impact)	**Injuries:**	208 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

On July 11, 2014, a Boeing B-767-332, registration number N139DL, operated by Delta Air Lines (DAL), and powered by two General Electric (GE) CF6-80A2 turbofan engines, experienced a left engine (No. 1) fire during climb from Los Angeles International Airport (LAX), Los Angles, California. The flightcrew reported observing a left engine fire indication during climb and declared an emergency, performed the Quick Reference Handbook (QRH) engine fire procedures which included shutting down the affected engine, and an air turnback to LAX was initiated. The airplane made a successful and uneventful overweight single-engine landing at LAX and Aircraft Rescue and Fire Fighting (ARFF) personnel met the aircraft and observed no damage. The airplane taxied to the gate without incident. Delta maintenance personnel opened the left engine cowling and observed heat damage, scorching, and sooting.

An examination of the engine revealed that the fire damage was concentrated underneath the engine heatshield on the left side of the engine. Flow testing of the engine revealed a fuel leak from the integrated drive generator (IDG) fuel/oil heat exchanger main housing. This was determined to be the source of the flammable fluid leak. Metallurgical examination of the IDG fuel/oil heat exchanger found a through-wall fatigue crack but no anomalies were found at the crack initiation site. The portions of the IDG power feeder cables located underneath the engine heat shield and in the general vicinity of the IDG fuel/oil heat exchanger revealed evidence of chaffing and arc burns and exhibited a considerable amount of orange tape to bundle all the cables together. The accessory drive lube and scavenge pump pressure (supply) line support bracket exhibited evidence of melted material consistent with an arc burn. The locations of the arc burn on the support bracket and the power feeder cables were in-line with one another and were the source of the electrical spark that ignited the fuel. Review of the IDG power feeder cable installation below the engine heatshield on the event engine revealed that they were misrouted creating excessive slack and dangling below the support bracket. This excessive slack in the IDG power feeder cables created the situation where the cables could get pinched/wedged between the inside of the thrust reverse cowl and the accessory drive lube and scavenge pump pressure (supply) line support bracket when the thrust cowl is closed and latched, creating the environment for the IDG power feeder cables to chaff against the support

bracket. The excessive amount of tape used on the IDG power feeder cables suggests that maintenance personnel may have noticed this chaffing and added extra tape without realizing that the chaffing was caused from the thrust reverser pressing the IDG power feeder cables against the bracket or that the slack was contributing to the chaffing. DAL inspected their entire fleet of CF6-80A2 powered Boeing 767 and corrected any IDG power feeder cables that had been misrouted.

Probable Cause and Findings

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

The combination of fuel leaking from the integrated drive generator (IDG) fuel/oil heat exchanger and the coincident arcing of the IDG power feeder cables that ignited the leaking fuel. Contributing to the ignition of the fuel was the misrouting of the IDG power feeder cables, which resulted in chaffed cables that exposed the electrical wire that contacted a metal bracket, creating an arc.

Findings

Personnel issues	Modification/alteration - Maintenance personnel
Personnel issues	Repair - Maintenance personnel
Aircraft	Electrical pwr sys wiring - Incorrect service/maintenance
Aircraft	Electrical pwr sys wiring - Incorrect service/maintenance
Aircraft	Alternator-generator drive sys - Failure
Aircraft	Alternator-generator drive sys - Failure
Aircraft	Fuel - Related maintenance info

Factual Information

History of Flight

Initial climb	Fire/smoke (non-impact) (Defining event)
Initial climb	Powerplant sys/comp malf/fail
Initial climb	Engine shutdown
Initial climb	Loss of engine power (total)
Initial climb	Electrical system malf/failure

HISTORY OF FLIGHT

On July 11, 2014, 13:28 pacific daylight time, a Boeing B-767-332, registration number N139DL, operated by Delta Air Lines (DAL) as flight 101, and powered by two General Electric (GE) CF6-80A2 turbofan engines, experienced a left engine (No. 1) fire during climb at about flight level (FL) 190 (19,000 feet) from Los Angeles International Airport (LAX), Los Angles, California. The flightcrew reported observing a left engine fire indication during climb and declared an emergency, performed the Quick Reference Handbook (QRH) engine fire procedures which included shutting down the affected engine, and an air turnback to LAX was initiated. Upon shutting down the affected engine, the fire warning extinguished and no fire suppression bottles were discharged. The airplane made a successful and uneventful overweight single-engine landing at LAX, and Aircraft Rescue and Fire Fighting (ARFF) personnel met the aircraft and observed no damage. The airplane taxied to the gate without incident. Delta Maintenance personnel opened the left engine cowling and observed heat damage, scorching, and sooting. Of the 200 passengers, 8 crewmembers and one cockpit jump-seater on board the flight, no injuries were reported. The incident flight was a 14 *Code of Federal Regulations* (*CFR)* Part 121 domestic passenger flight from LAX to Hartsfield–Jackson Atlanta International Airport (ATL) Atlanta, Georgia. Day visual meteorological conditions prevailed at the time, and an instrument flight rules flight plan was filed.

ENGINE DAMAGE

Initial Visual Examination

The Powerplant Group, comprised of members from GE, Boeing, DAL, Air Line Pilots Association Member (ALPA), Federal Aviation Administration (FAA), and the National Transportation Safety Board (NTSB), convened at the DAL Technical Operations (TechOps) facility on July 21, 2014 to perform a detailed examination of the incident engine and completed its work on July 24, 2014. Examination of the engine revealed that the fire damage was concentrated under the engine heatshield from about the 6:00 o'clock position to the 8:30 o'clock position (aft looking forward) and forward of the accessory gearbox. The fire and thermal distress included melted and consumed electric wire insulation, melted and consumed accessory gearbox fire loop isolators, melted and consumed tubing P-clamps, exposed electric wire conductors, and soot deposits.

Leak Testing and Detailed Engine Disassembly

Wet motoring of the engine revealed a fuel leak from the integrated drive generator (IDG) fuel/oil heat exchanger main housing just aft of the forward weld (fuel inlet port) at about the 12:00 o'clock position (as installed on the engine). The unit, which is located below the engine heatsheild, was removed and additional leak tests and a fluorescent penetrant inspection confirmed a circumferential through-wall crack in-line with where the inner core is brazed into the main housing, a second crack indication adjacent to the through-wall crack, and no internal leak between the fuel and oil sides of the inner core. Removal of the IDG power feeder cables revealed evidence of chaffing and arc burn; this damage was not related to the fire damage that was observed overall as a result of the actual fire. The IDG power feeder cables were reinstalled and examination of the engine hardware along the path of the IDG power feeder cables from their IDG terminal block to the pass-through hole in the engine heatshield (this portion of the IDG power feeder cables are located below the engine heatshield in the fire zone) revealed that the accessory drive lube and scavenge pump pressure (supply) line support bracket, which is located on the front side of the accessory gearbox just below the hydraulic pump pad, exhibited evidence of melted material consistent with an arc burn. The location of the arc burn on the bracket was in-line with the arc burn observed in the IDG power feeder cables.

Examination of post event engine photos (prior to the removal of any parts) and matching the arc damage on the IDG power feeder cables with the accessory drive lube and scavenge pump pressure line support bracket revealed that the IDG power feeder cables (below the engine heatshield) were not tight and straight along their support bracket but exhibited slack and dangling below the support bracket. A review of the installation drawing from the various aircraft and engine maintenance manuals, along with other exemplar DAL 767 CF6-80A powered airplanes, revealed that there should be no slack in the IDG cables; instead the cables should run straight and tight along its support bracket and gently bend upward towards the cutout hole in the engine heatshield. The DAL work specific cards for the installation and routing of the IDG power feeder cables at the time of the event included sketches that showed the proper routing along the support bracket with no slack.

Along with the observed arc damaged, the IDG power feeder cables also exhibited a considerable amount of orange tape to bundle all the cables together. This excessive slack in the IDG power feeder cables created the situation where the cables could get pinched/wedged between the inside of the thrust reverse cowl and the accessory drive lube and scavenge pump pressure (supply) line support bracket when the thrust cowl is closed and latched creating the environment for the IDG power feeder cables to chaff against the support bracket. The excessive amount of tape used on the IDG power feeder cables suggests that maintenance personnel may have noticed this chaffing and added extra tape without realizing that the chaffing was caused from the thrust reverser pressing the IDG power feeder cables against the bracket or that the slack was contributing to the chaffing.

TEST AND RESEARCH

Metallurgical examination of the IDG fuel/oil heat exchanger at the NTSB Materials Laboratory in Washington DC found that the fracture surfaces of the circumferential through-wall crack showed features consistent with multiple fatigue crack initiation sites emanating from the inner diameter surface of the main housing and propagated radially outwards until it reached the outer diameter. A second fatigue crack location was also identified in the vicinity of the through-wall crack. This second crack location however was not a through-wall and exhibited cracks emanating from both the inner and outer diameter surfaces but did not link up to create a through-wall crack. No anomalies were detected in the area of either of the

cracks or at their fatigue crack origins. The microstructure of the base material of the housing was consistent with what was specified by the manufacturer.

IDG Power Feeder Cable Installation Instructions and Corrective Actions

Based on this event DAL: 1) updated their IDG power feeder work cards to provide additional information and guidance on the proper routing of the IDG cables both above and below the engine heatshield in order to clarify any potential confusion and to prevent future arcing events and 2) conducted a once-through-the-fleet inspection for misrouted IDG power feeder cables. The once-through-the-fleet inspection found 3 additional engines with misrouted IDG power feeder cables which, including the event engine and the other engine on the event airplane (both engines on N139DL had excessive slack in the IDG power feeder cables), brought the total number of affected engines to 5. DAL promptly corrected any non-conforming routing of the cables.

Information

Certificate:	**Age:**
Airplane Rating(s):	**Seat Occupied:**
Other Aircraft Rating(s):	**Restraint Used:**
Instrument Rating(s):	**Second Pilot Present:**
Instructor Rating(s):	**Toxicology Performed:**
Medical Certification:	**Last FAA Medical Exam:**
Occupational Pilot:	**Last Flight Review or Equivalent:**
Flight Time:	

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	N139DL
Model/Series:	767 332 332	**Aircraft Category:**	Airplane
Year of Manufacture:	1992	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	25984
Landing Gear Type:	Tricycle	**Seats:**	
Date/Type of Last Inspection:	Unknown	**Certified Max Gross Wt.:**	348220 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:		**Engine Manufacturer:**	GE
ELT:	Installed	**Engine Model/Series:**	CF6-80A2
Registered Owner:	DELTA AIR LINES INC	**Rated Power:**	0 Horsepower
Operator:	Delta Air Lines	**Operating Certificate(s) Held:**	Flag carrier (121)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Unknown	**Condition of Light:**	Day
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:		**Visibility**	
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	
Precipitation and Obscuration:			
Departure Point:	Los Angeles, CA (LAX)	**Type of Flight Plan Filed:**	IFR
Destination:	ATLANTA, GA (ATL)	**Type of Clearance:**	IFR
Departure Time:	13:16 Local	**Type of Airspace:**	Class A

Airport Information

Airport:	LOS ANGELES INTL LAX	**Runway Surface Type:**	
Airport Elevation:	125 ft msl	**Runway Surface Condition:**	Unknown
Runway Used:		**IFR Approach:**	Unknown
Runway Length/Width:		**VFR Approach/Landing:**	Unknown

Wreckage and Impact Information

Crew Injuries:	8 None	**Aircraft Damage:**	Minor
Passenger Injuries:	200 None	**Aircraft Fire:**	In-flight
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	208 None	**Latitude, Longitude:**	33.941665,-118.408332

Administrative Information

Investigator In Charge (IIC):	Scarfo, Jean-Pierre
Additional Participating Persons:	
Original Publish Date:	June 4, 2015
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=89657