NTSB Identification: ENG16IA027

Scheduled 14 CFR Part 121: Air Carrier operation of DELTA AIR LINES INC
Incident occurred Thursday, July 07, 2016 in Jamaica, NY
Probable Cause Approval Date: 07/19/2018
Aircraft: BOEING 757, registration: N706TW
Injuries: 157 Uninjured.

NTSB investigators traveled in support of this investigation and used data obtained from various sources to prepare this aircraft incident report.

An O-ring was severed when being installed on a fuel tube during maintenance. The damage degraded the O-ring sealing function at the right engine FFT-to-fuel OUT tube flange. During the next takeoff, high-pressure fuel flowed past the damaged seal and sprayed into the engine core compartment. The fuel contacted hot engine surfaces and ignited. The right nacelle fire detection system detected the fire and a right engine fire warning alerted in the cockpit. The flight crew shut down the right engine, which cut off the engine fuel supply. The fire extinguished after the fuel supply was stopped. The fire damaged the right engine external components and burned through the right nacelle inboard core cowl.

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

- Maintenance personnel's failure to ensure proper installation of a fuel tube O-ring, which resulted in an undercowl engine fire during initial climb.

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On July 07, 2016, about 1307 UTC, a Delta Air Lines (DAL) Boeing B752, N706TW, MSN 6804, experienced a right engine under cowl fire shortly after takeoff from John F. Kennedy International Airport at Jamaica, NY (JFK). The flight declared an emergency after receiving a right engine fire warning at approximately 400 feet agl. The flight crew reported shutting down the right engine and observing that the fire warning extinguished following engine shutdown. Neither fire bottle was discharged. The flight returned to JFK and landed without incident. Airplane damage was minor, and no injuries were reported. The airplane was being operated as a 14 CFR Part 121 scheduled flight from JFK to San Diego International Airport Lindbergh Field, San Diego, California (SAN). A post-incident airplane inspection found that the thermal damage was limited to the right nacelle. The nacelle damage included a hole in the inboard core cowl consistent with burn-through.

DAL reported that maintenance performed the morning of the flight included replacement of the right engine fuel flow transmitter (FFT).

AIRPLANE DAMAGE

Airplane damage was minor.

RECORDERS

Data downloaded from the airplane's flight data recorder showed that a right engine fire warning occurred about three seconds before lift-off and was active for about 45 seconds. The data also showed that the fire extinguisher switch was not activated and that engine parameter indications began dropping off about 55 seconds after the fire warning. All engine parameter data were lost approximately 24 seconds later. The loss of the engine signal data is consistent with wire damage noted during the engine examination.

FIRE

Airport rescue and firefighting units responding to the airplane did not detect an active fire.

The paint was blistered on the aft 11 inches of the thrust reverser cowl inner fan duct flowpath. The ablative coating on the inner surfaces of the thrust reverser cowl was intact between 12 and 3 o'clock and charred and fractured with some exposure of the underlying honeycomb structure between 3 and 12 o'clock. The skin at the aft end of the outboard core cowl was buckled between 4 and 6 o'clock. There was a 25-inch long (axial) hole in the inboard core cowl. The hole was 3.5 inches wide at the forward end and 14.5 inches wide at the aft end and included the aft edge of the pressure relief door cut-out. There were rough, matte-gray deposits adhering to the aft end of the exhaust nozzle outer surface between 4 and 10 o'clock.

The engine thermal distress was limited to the core compartment fire zone. Soot was deposited over the entire engine and there was general thermal distress to external components. The thermal damage was the most pronounced between 4 and 12 o'clock.

TESTS AND RESEARCH

Engine service history

The engine had accumulated 51,142 flight hours and 18,855 cycles since new and 3,871 hours and 965 cycles since its last shop visit. The records show there was recent maintenance to correct reports of an anomalous fuel flow signal. A July 6, 2016 FFT replacement did not correct the signal problem. Further maintenance was deferred in accordance with the airplane's minimum equipment list procedure. Another FFT was installed on July 7, 2016. A 10- to 15-minute post-maintenance engine check run showed normal fuel flow indications, and no leaks were observed. The airplane was released to service. The fire occurred during the next flight, shortly after takeoff.

Engine examination

Examination of the engine found no evidence of engine mechanical failure or uncontainment. Most of the engine's electrical harnesses, tube/harness insulation material and attachment hardware inside the core compartment exhibited some thermal distress, including melted or missing fire loop grommets, melted harness insulation, eroded P-clamp cushions and whitened and flaking flexible fuel line fire sleeves. The turbine case cooling line was ruptured 21.5 inches aft of the V-groove at 9 o'clock. The rupture was approximately two inches across and the fractured edges were petalled outward. The fan air valve actuator housing was heat-deformed and was partially consumed. The most severe fire damage was at the diffuser/HPT between 6 and 9 o'clock; bare wires were observed in this area, and engine burner temperature, turbine cooling air, and EGT signal wires and the aft lower fire loops were found separated. The sooting had the darkest appearance between 6 and 7 o'clock, where the FFT assembly shell was partially consumed by fire. A rubbery blue-colored substance was noted protruding from the top and left sides of FFT-to-fuel OUT tube joint.

It was determined during an evaluation at Delta Tech Ops (DTO) that the flammable fluid source for the fire was fuel leaking at the FFT-to-fuel OUT tube joint.

FFT assembly evaluation

The FFT, fuel IN line and fuel OUT line were removed as an assembly. Pressure was applied to the assembly and leakage was observed at the suspect joint. The fuel OUT tube was removed. The tube O-ring was found eroded and with a 90° arc of material missing. Both ends of the O-ring separation exhibited shallowly angled separations.

Re-test

A new P/N M25988/3-217 O-ring was lubricated and installed in the tube gland. The B757 AMM FFT installation procedure, Task 73-31-01-404-018-P00, included no instruction to lubricate the O-ring prior to installation and erroneously indicated that the O-ring should be installed onto the FFT rather than on the fuel tube. The tube was reassembled to the FFT and the retaining bolts were torqued to the minimum required torque per the engine manual (65 lb. in). B757 AMM Task 73-31-01-404-018-P00 does not provide the bolt attachment torque values.

The O-ring was retained for further evaluation.

Additional O-ring evaluation

The O-ring was submitted to the NTSB Materials Lab for material evaluation. Fourier Transform Infrared spectrometry found that the O-ring material conformed to the drawing specification.

O-ring failure mode evaluation

Parker Aerospace was asked to assess the O-ring separation. Parker reported that the similar angle/plane cuts on both ends of the O-ring is a commonly-observed damage condition that results from installation error.

Maintenance instruction review

Review of the B757 AMM FFT installation procedure noted the following:

a) AMM Task 73-31-01-404-018-P00 did not include an instruction to lubricate the tube O-rings prior to installation.

b) AMM Task 73-31-01-404-018-P00 incorrectly directs that the fuel IN and fuel OUT tube O-rings to be installed on the FFT rather than into the fuel tube O-ring glands.

c) AMM Task 73-31-01-404-018-P00 did not specify a torque value for the tube attachment bolts.

The FFT installation task used by the DAL technician to install the FFT directly aligned with the Boeing AMM and so included these omissions/errors.

Parker Hannifin Publication ORD5700, Parker O-Ring Handbook pg. 3-4, paragraph 3.1.5 states that "use of a suitable grease or oil during assembly helps protect the O-ring from damage by abrasion, pinching, or cutting" and "helps the O-ring to seat properly".