National Transportation Safety Board
Aviation Incident Final Report

Location:	Los Angeles, CA	**Incident Number:**	ENG06IA018
Date & Time:	06/02/2006, 1227 PDT	**Registration:**	N330AA
Aircraft:	Boeing 767-223(ER)	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	3 None
Flight Conducted Under:	Unknown		

Analysis

The Boeing 767 was undergoing a high-power test of the left-hand General Electric (GE) CF6-80C2 engine to troubleshoot a pilot's report of the engine being unable to make climb thrust. During the test, the engine experienced an uncontained failure of the high pressure turbine (HPT) stage 1 disk. Examination of the pieces of the disk revealed the disk failed from an intergranular fatigue crack that originated from a small depression on the blade slot bottom aft corner radius. There were two other intergranular fatigue cracks that originated from small depressions on other blade slot bottom aft corner radii. Intergranular fatigue cracks are typically associated with very high stresses that exceed the material's capability. GE issued service bulletins (SB) to require inspections of CF6-80A and -80C2 HPT stage 1 disks that the FAA mandated with airworthiness directives (AD), but the SBs and AD did not establish a compliance schedule. When the SBs and AD was revised to establish a compliance schedule, the schedule was such that disks with much higher cycles since new, than those that had previously failed or were found cracked, were permitted to remain in service. On August 26, 2006, the Safety Board issued safety recommendation A-06-60 through A-06-64, which addressed these deficiencies. The recommendations can be found at the following url address: http://www.ntsb.gov/recs/letters/2006/A06_60_64.pdf.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: The HPT stage 1 disk failed from an intergranular fatigue crack because of GE's inadequate design of the CF6-80 series HPT stage 1 disk. The inadequate design of the disk resulted in a high stress area in the blade slot bottom aft corner that was at or nearly at the material's capability so that there was no damage tolerance such that a small dent could cause a crack to initiate and propagate to failure. Contributing to the disk's failure was the FAA's failure to mandate an accelerated inspection schedule after a previous CF6-80A uncontained HPT stage 1 disk failure had occurred and after other CF6-80A HPT disks had been found during routine overhaul to have cracks in the blade slot bottom aft corners.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation: STANDING

Findings
1. (C) TURBINE ASSEMBLY,TURBINE WHEEL - FATIGUE
2. (C) ACFT/EQUIP,INADEQUATE DESIGN - MANUFACTURER
3. (F) ACFT/EQUIP,INADEQUATE DESIGN - FAA(OTHER/ORGANIZATION)

Factual Information

HISTORY

On June 2, 2006, at 1227 Pacific daylight time, an American Airlines Boeing 767/223(ER) was substantially damaged when the left engine, a General Electric (GE) CF6-80A, had an uncontained high-pressure turbine (HPT) stage 1 disk failure during a high-power ground run for maintenance on the ground at the Los Angeles International Airport (LAX), Los Angeles, California. In response to a write up by the pilots of the airplane's inbound flight to LAX that the left engine was lagging the right engine by about 2 percent during a climb from FL 360 to 380, maintenance personnel repositioned the airplane from the terminal to a run up pad to test the engine. The maintenance personnel on the airplane, after starting the engines, had accelerated both engines to maximum power with the electronic engine controls (EEC) ON. Although both engines were able to attain maximum power, left engine's power lever was about a full knob width further forward than the right engine's power lever. The maintenance personnel then turned the left engine's EEC OFF and made two idle-to-maximum power-to-idle power excursions. The mechanics on board stated that after the engine had attained maximum power and was decelerating the second time, they heard a loud bang that was followed by a fire on the left side of the airplane and a left engine fire warning in the cockpit. The maintenance personnel accomplished an emergency shutdown of the engines, discharged one fire bottle into the left engine's nacelle, and evacuated the airplane. Units from the nearby on-airport Los Angeles Fire Department fire station responded to the airplane and extinguished the fire within 20 seconds after they arrived on scene. The three maintenance personnel on board the airplane and two ground observers were not injured. Although the airplane and engines were substantially damaged, the Safety Board categorized this event as an incident rather than an accident because there was no intent for flight as defined by 14 CFR 830.2.

The examination of the left engine revealed that it had been cut in two at the HPT module with the front and rear sections of the engine hanging from the respective engine mounts. The HPT stage 1 and 2 disks were both missing from the engine. The HPT stage 2 disk was recovered essentially intact from the run up pad near the airplane. But the HPT stage 1 disk was found in four pieces that were recovered from the left engine's pylon, the belly of the airplane, the right engine's exhaust duct, and from a vacant lot, which was approximately 2,600 feet away from the airplane, on the south side of the airport across runways 7L/25R and 7R/25L. Liberated debris from the left engine resulted in numerous holes in the fuselage as well as the left and right wings that had numerous holes in the fuel tanks from where fuel leaked that fed the fire that burned the left wing and left side of the fuselage aft of the wing.

TESTS AND RESEARCH

The metallurgical examination of the broken pieces of the HPT stage 1 disk at the Safety Board's Materials Laboratory revealed the disk had failed from a radial rim-to-bore fracture that originated from an intergranular fatigue crack. The CF6-80A and -80C2 HPT stage 1 disk has 80 blade slots. The fatigue crack initiated from a small depression in the aft corner radius of blade slot bottom No. 31. The examination of the disk also revealed that there were two other blade slots, Nos. 30 and 72, that had intergranular fatigue cracks that had also initiated from small depressions in the aft corner radius. Intergranular fatigue cracks are associated

with very high stresses that exceed the material's capabilities. The examination of the disk confirmed the blade slots' aft corner radii conformed to the HPT stage 1 disk's engineering drawing requirements. In addition, the metallurgical examination determined the disk's hardness and grain structure conformed to the material's requirements. The cause of the disk burst was completely unrelated to the pilot's report of the engine being unable to make climb thrust.

The disassembly and examination of the engine did not reveal anything that could have caused the disk failure. A review of American Airlines' records on its two overhauls of the failed disk and on American Airlines' overhaul and repair procedures of CF6-80A and -80C2 HPT stage 1 disks in general did not reveal anything that could have caused the dents on the blade slot bottom aft corner radii from where the fatigue cracks initiated. In addition, a review of GE's CF6-80A and -80C2 HPT stage 1 disk manufacturing process and CF6-80A and -80C2 HPT module assembly procedure also did not reveal anything that could have caused the dents on the blade slot bottom aft corner radii.

Following a previous uncontained CF6-80C2 HPT stage 1 disk failure from a fatigue crack that originated in a blade slot bottom aft corner that occurred during a high-power run for maintenance and that was preceded by the finding of two -80C2 HPT stage 1 disks during routine overhaul inspection to have fatigue cracks progressing from the blade slot bottom aft corners, GE issued a service bulletin (SB) to inspect the CF6-80C2 HPT stage disk blade slot bottom aft corners. The SB was subsequently superceded with a SB that provided focused and enhanced inspection procedures to improve the probability of detecting a crack in the blade slot bottom aft corner area. However, the SBs only required the inspection to be accomplished when the HPT stage 1 disk was disassembled to the piece part level. When the FAA issued an airworthiness directive (AD) to mandate the inspections of the CF6-80C2 HPT stage 1 disks, the AD followed the SB and only required the inspection be accomplished when the HPT stage 1 disk was disassembled to the piece part level. GE then issued an SB that promulgated the focused and enhanced inspections being accomplished on the CF6-80C2 HPT stage 1 disks to the CF6-80A HPT stage 1 disks. Although SB required the CF6-80A HPT stage 1 disk inspections to be accomplished when the disk had been disassembled to piece part level, a CF6-80A HPT stage 1 disk was discovered to have a fatigue crack in a blade slot bottom aft corner shortly after the SB was issued. Following an in-flight uncontained failure of a CF6-80A HPT stage 1 disk from a fatigue crack that originated in a blade slot bottom aft corner, the FAA issued an AD to mandate the focused and enhanced inspection procedures for the CF6-80A HPT stage 1 disk blade slot bottom aft corners, but the AD only required the inspection to be accomplished when the disk had been disassembled to the piece part level. It was not until another CF6-80A HPT stage 1 disk was found to have a fatigue crack coming from a blade slot bottom aft corner that GE issued SBs for the CF6-80A and -80C2 disks that established a compliance schedule for the accomplishment of the focused and enhanced inspections of the blade slot bottom aft corners that the FAA mandated with an AD. Although the two previous disk failures had occurred at 7,547 and 12,485 cycles since new (CSN) and the five disks with cracks were found at 5,144, 9,532, 9,359, 9,058, and 9,459 CSN, the compliance schedule in the SBs and consequently the AD allowed the American Airlines HPT stage 1 disk that had 9,186 CSN when it failed to remain in service.

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Boeing	**Registration:**	N330AA
Model/Series:	767-223(ER)	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	22330
Landing Gear Type:	Tricycle	**Seats:**	167
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	350000 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Fan
Airframe Total Time:		**Engine Manufacturer:**	General Electric
ELT:		**Engine Model/Series:**	CF6-80A
Registered Owner:		**Rated Power:**	46930 lbs
Operator:	AMERICAN AIRLINES INC	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:	American Airlines	**Operator Designator Code:**	AALA

Meteorological Information and Flight Plan

Conditions at Accident Site:		**Condition of Light:**	
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:		**Visibility (RVR):**	
Altimeter Setting:		**Visibility (RVV):**	
Precipitation and Obscuration:			
Departure Point:		**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	

Airport Information

Airport:	Los Angeles (KLAX)	**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:	NA	**IFR Approach:**	Unknown
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	3 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-Ground
Total Injuries:	3 None	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	Jim Hookey	**Adopted Date:**	01/31/2008
Additional Participating Persons:			
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		