UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

A-10C, T/N 80-0282
75TH FIGHTER SQUADRON
MOODY AIR FORCE BASE, GEORGIA

LOCATION: 20 MILES NORTHWEST OF MOODY AIR FORCE BASE

DATE OF ACCIDENT: 26 SEPTEMBER 2011

BOARD PRESIDENT: COLONEL DOUGLAS H. STANDIFER

Conducted in accordance with Air Force Instruction 51-503

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR COMBAT COMMAND
JOINT BASE LANGLEY-EUSTIS VA

OFFICE OF THE VICE COMMANDER
205 DODD BOULEVARD SUITE 203
JOINT BASE LANGLEY-EUSTIS VA 23665-2788

JAN 0 9 2012

MEMORANDUM FOR ACC/JA

SUBJECT: Accident Investigation Board Report A-10, T/N 80-0282, 26 Sep 11, Moody AFB, GA

I have reviewed the Accident Investigation Board Report regarding the A-10, T/N 80-0282, 26 Sep 11, Moody AFB, GA. The report prepared by Colonel Douglas S. Standifer complies with the requirements of AFI 51-503 and is approved.

William J Rew
WILLIAM J. REW
Lieutenant General, USAF
Vice Commander

Attachment:
Accident Investigation Board Report

Agile Combat Power

EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION
A-10C, T/N 80-0282, MOODY AIR FORCE BASE, GEORGIA
26 SEPTEMBER 2011

On 26 September 2011 at approximately 1448 local time, the mishap aircraft (MA), an A-10C, T/N 80-0282, experienced dual engine failure during a Functional Check Flight (FCF) and impacted the ground approximately 20 miles northwest of Moody Air Force Base (AFB), Georgia. The Mishap Pilot (MP) ejected safely and sustained no significant injuries. The MA, operated by the 75th Fighter Squadron at Moody AFB, was destroyed upon impact with the loss valued at $14,708,772.19. Environmental clean-up costs are estimated to be $150,147.50. The MA impacted on private property consisting of a waste runoff site for an unused sand quarry. The impact left a 15-foot diameter crater, burned 5 acres of land, churned 1 acre of earth and destroyed 15 pine trees.

An FCF is flown to ensure airworthiness after major scheduled aircraft maintenance. At 15,000 feet, during the stalls and slats checks, the MP noted that the stall warning tones were not functioning properly. The MP elected to continue the FCF profile into the high altitude checks and under a combination of flight conditions of altitude, airspeed and angle of attack that could lead to an increased risk of aircraft stall and engine failure. There is no explicit guidance that prohibited the MP from continuing the FCF profile without a functional stall warning system. At 34,000 feet, the MP performed the high altitude checks. This was the first time the MP was performing checklist items in the aircraft at 25,000 feet and above. The MP slowed the MA for slat extension and looked over his right shoulder to observe the slats. Before the slats extended, the MP noticed the MA enter a stall with a slight right bank. The MP did an aircraft stall recovery; he then checked the engine gauges and noticed both were winding down. The MP followed the proper procedures to attempt to recover the engines and ultimately determined that both engines had completely failed. The MP then correctly executed the procedures for a dual engine failure. The MP attempted to restart the left and right engines multiple times without success. He continued his attempts until reaching an unpopulated area and ejected from the MA. Engineering analysis of external and internal engine parts, as well as the MP's testimony regarding the engine gauges, suggests that both engines seized while the MP flew the MA down to the optimum altitude for an APU assisted engine restart attempt. The MP's FCF upgrade training did not include the climb to 35,000 feet nor practicing the FCF checks at altitude. In addition, the MP had no experience and insufficient training about the intricacies and possible hazards of high altitude flight without a properly functioning stall warning system. Finally, the MP misprioritized his tasks by checking for slat extension over preventing the MA from stalling.

The board president found by clear and convincing evidence the cause of the mishap was the MA engines flaming out due to being flown under flight conditions where aircraft stall and engine failure were imminent; the engines never restarted, causing the MP to eject and the MA to impact the ground. Additionally, the board president found by a preponderance of evidence that the following factors substantially contributed to the mishap: (1) the MA engines failed to restart due to engine seizure; (2) there was insufficient guidance for the possibility of engine seizure after high altitude engine flameout; (3) there is no requirement for 35,000-foot checks during FCF upgrade training; (4) the combination of the MP's inexperience at flying above 23,000 feet and the MA's malfunctioning stall warning system; and (5) the MP misprioritized an FCF checklist item during the mishap flight over preventing the MA from stalling.

COMMONLY USED ACRONYMS AND ABBREVIATIONS

9 AF	9th Air Force
23 WG	23rd Wing
23 FG	23rd Fighter Group
75 FS	75th Fighter Squadron
ACC	Air Combat Command
ACES	Advanced Concept Ejection Seat
AFB	Air Force Base
AFE	Air Flight Equipment
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AGL	Above Ground Level
AIB	Aircraft Investigation Board
AOA	Angle of Attack
APU	Auxiliary Power Unit
ATAGS	Advanced Tactical Anti-G System
ATIS	Automated Terminal Information System
AWACS	Airborne Warning and Control System
BFM	Basic Fighter Maneuvers
CFETP	Career Field Education and Training Plan
DoD	Department of Defense
DTC	Data Transfer Cartridge
ECS	Environmental Control System
EOR	End of Runway
EPS	Emergency Power System
FCF	Functional Check Flight
FERB	Fuel Engine Relay Box
FITS	Fighter Index of Thermal Stress
FLCS	Flight Control System
GCAS	Ground Collision Avoidance System
HPT	High Pressure Turbine
HUD	Heads up Display
ICAWS	Integrated Caution, Advisory and Warning System
IFDL	Intra-Flight Data Link
ILS	Instrument Landing System
IMDS	Integrated Maintenance Data System
ITT	Inlet Turbine Temperature
IVSC	Integrated Vehicle Subsystem Controller
JAX Center	Jacksonville Air Route Traffic Control Center
JOAP	Joint Oil Analysis Program
KCAS	Knots Calibrated Airspeed
KTAS	Knots True Airspeed
L	Local
LPT	Low Pressure Turbine
MA	Mishap Aircraft
MAJCOM	Major Command
MCC	Mishap Crew Chief
MEF	Mission Execution Forecast
MFC	Main Fuel Control
MOA	Military Operating Area
MP	Mishap Pilot
MSL	Mean Sea Level
MW	Mishap Wingman
ND	Nose Down
NM	Nautical Miles
NOTAMS	Notices to Airmen
OPSUP	Operations Supervisor
ORM	Operational Risk Management
PHA	Physical Health Assessment
PLF	Parachute Landing Fall
PM1	Phase Maintainer 1
PM2	Phase Maintainer 2
PM3	Phase Maintainer 3
PM4	Phase Maintainer 4
QA	Quality Assurance
RPM	Revolutions per Minute
RTB	Return-To-Base
RWD	Right Wing Down
SADL	Situation Awareness Data Link
SIB	Safety Investigation Board
SOF	Supervisor of Flying
S/N	Serial Number
TACAN	Tactical Air Navigation
TAD	Tactical Awareness Display
TCTO	Time Compliance Technical Order
TEMS	Turbine Engine Monitoring System
T/N	Tail Number
TO	Technical Order
VG	Vane Guide
VFR	Visual Flight Rules
VVI	Vertical Velocity Indication

The above list was compiled from the Summary of Facts, the Statement of Opinion, the Index of Tabs and Witness Testimony (Tab V).

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 5 October 2011, Major General Roger A. Binder, Vice Commander, Air Combat Command (ACC), appointed Colonel Douglas H. Standifer as the Accident Investigation Board (AIB) President to investigate the 26 September 2011 mishap of an A-10C aircraft, Tail Number (T/N) 80-0282. An AIB was conducted at Moody Air Force Base (AFB), Georgia, from 1 November 2011 through 29 November 2011, pursuant to Air Force Instruction (AFI) 51-503. A Legal Advisor, Pilot, Maintenance Officer, Flight Surgeon, Recorder and two Functional Area Experts were also appointed to the AIB (Tab Y-3 to Y-7).

b. Purpose

This is a legal investigation convened to inquire into the facts surrounding the aircraft or aerospace accident, to prepare a publicly-releasable report and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings and for other purposes.

2. ACCIDENT SUMMARY

On 26 September 2011 at approximately 1448 local time (L), the mishap aircraft (MA), an A-10C, T/N 80-0282, experienced dual engine failure during a Functional Check Flight (FCF) and impacted the ground approximately 20 miles west/northwest of Moody AFB (Tab B-3). The Mishap Pilot (MP) ejected safely and sustained no significant injuries (Tabs V-1.12 and X-3). The aircraft was destroyed upon impact with the loss valued at $14,708,772.19 (Tab P-3). Environmental clean-up costs are estimated to be $150,147.50 (Tab P-5). The MA impacted on private property consisting of a waste runoff site for an unused sand quarry. The impact left a 15-foot diameter crater, burned 5 acres of land, churned 1 acre of earth and destroyed 15 pine trees (Tab P-7). Media interest was minimal and mostly confined to local news stations.

3. BACKGROUND

The 23rd Wing (23 WG), located at Moody AFB, owned the MA. The MA was operated by the 75th Fighter Squadron (75 FS). The 75 FS is a squadron within the 23rd Fighter Group (23 FG), which falls directly under the 23 WG. The 23 WG and its subordinate units are components of 9th Air Force (9 AF), which is a numbered air force within ACC (Tab CC-3 to CC-12).

a. Units and Organizations

(1) ACC

ACC, headquartered at Joint Base Langley-Eustis, Virginia, is a major command of the United States Air Force and primary force provider of combat airpower to America's warfighting commands. Its mission is to organize, train, equip and maintain combat-ready forces for rapid deployment and employment while ensuring strategic air defense forces are ready to meet the challenges of peacetime air sovereignty and wartime air defense. ACC operates fighter, bomber, reconnaissance, battle-management and electronic-combat aircraft. It also provides command, control, communications and intelligence systems and conducts global information operations. ACC's forces are organized under a direct reporting unit, three numbered air forces and one Air Force Reserve numbered air force. ACC's workforce is comprised of more than 80,000 active duty members and civilians, and when mobilized, more than 50,000 Air National Guard and Air Force Reserve members. In total, they operate more than 2,400 aircraft (Tab CC-3).

(2) 9 AF

9 AF, with headquarters at Shaw AFB, South Carolina, controls ACC fighter forces based on the east coast of the United States, and serves as the air component for a 25-nation area within the United States Central Command area of responsibility. 9 AF installations include Joint Base Langley-Eustis, Moody AFB, Shaw AFB and Seymour-Johnson AFB, North Carolina (Tab CC-4).

(3) 23 WG

The mission of the 23 WG is to organize, train and equip combat-ready forces to rapidly deploy and execute the Global Precision Attack, Personnel Recovery and Agile Combat Support Service Core Functions to meet worldwide combatant commander requirements. The wing executes worldwide close air support, force protection and peacetime and personnel recovery operations in support of humanitarian and U.S. national security interests, as well as in support of contingency operations across the globe. The 23 WG aircraft include the A-10C, HH-60G, HC-130P and HC-130J (Tab CC-7).

(4) 23 FG

The 23 FG directs the flying and maintenance operations for the U.S. Air Force's largest A-10C fighter group, consisting of two combat-ready A-10C squadrons and an operations support squadron. The Group ensures overall combat training and readiness for over 90 pilots and 180 support personnel. In response to the attacks of 11 September 2001, the 23 FG landed the first fighter aircraft inside of Afghanistan in March 2002 (Tab CC-11).

(5) 75 FS

The 75 FS is one of two combat-ready A-10C Thunderbolt II squadrons within the 23 FG. The squadron's nearly 35 pilots are dedicated to carrying out the close air support mission through the A-10C, which is specifically designed for long loiter time, accurate weapons delivery, austere field capability and survivability (Tab CC-12).

b. A-10C Thunderbolt II

The A-10C Thunderbolt II has excellent maneuverability at low air speeds and altitude, and is a highly accurate weapons delivery platform. The aircraft can loiter near battle areas for extended periods of time and operate under 1,000-foot ceilings with 1.5-mile visibility. The wide combat radius and short takeoff and landing capability permit operations in and out of locations near front lines. The upgraded A-10C reached initial operation capability in September 2007. Specifically designed for close air support, its combination of large and varied ordnance load, long loiter time, accurate weapons delivery, austere field capability and survivability has proven invaluable to the United States and its allies. The aircraft has participated in Operations DESERT STORM, SOUTHERN WATCH, PROVIDE COMFORT, DESERT FOX, NOBLE ANVIL, DENY FLIGHT, DELIBERATE GUARD, ALLIED FORCE, ENDURING FREEDOM and IRAQI FREEDOM (Tab CC-13 to CC-14).

4. SEQUENCE OF EVENTS

a. Mission

The mishap mission, flown on Monday, 26 September 2011, was planned as “DYNO 51,” a local full-profile FCF. An FCF is flown to ensure airworthiness after major scheduled aircraft maintenance. An FCF sortie consists of mandatory aircraft systems checks up to and including 35,000 feet (Tab BB-10). A locally directed safety chase aircraft “DYNO 52,” took off 30 minutes later. The FCF mission was authorized by the 75 FS Director of Operations through the AF IMT 4327, ARMS Fighter Flight Authorization (Tab K-4).

b. Planning

Mission planning was accomplished the previous Friday, but the sortie was cancelled due to weather (Tab V-1.2 to V-1.3). Mission planning for the mishap flight was updated, including current weather, Notices to Airmen, flight plans and telephonic coordination with Jacksonville Air Route Traffic Control Center (JAX Center). A coordination brief occurred between the MP (flying DYNO 51) and the Mishap Wingman (MW) (flying DYNO 52), covering pertinent items from AFI 11-2A-OA-10, Vol 3, with emphasis on the deconfliction plan in the Military Operations Area (MOA) and mutual support (Tab V-1.2 to V-1.3). The MP accomplished an Operational Risk Management (ORM) worksheet resulting in an overall score of 16, equaling “Low Risk.” The highest risk factor on this sortie was the FCF mission, rated at a score of 6 (Tab K-3). Takeoffs were planned half an hour apart due to end of fiscal year flying hour program management (Tab V-2.2).

c. Preflight

On 23 September 2011, the MP accomplished the FCF ground operations from the Technical Order (T.O.) 1A-10C-6CF-3 (Dash 6) checklist items up to, but not including, Taxi checks. At that point the MA was shut down and the mission was cancelled due to weather. The FCF portion of ground operations were unremarkable on that date (Tab V-1.2 to V-1.3).

On 26 September 2011, the MP re-accomplished manual reversion checks due to FCF mission requirements. Manual reversion is a secondary flight control mode that disconnects the flight controls from hydraulic power and uses manual linkages to control the aircraft. The rest of ground operations were accomplished through takeoff in accordance with the T.O. 1A-10C-1CL-1 (Dash 1) checklist. Ground operations were unremarkable (Tab V-1.3).

d. Summary of Accident

The MP took off from Moody AFB and proceeded northwest to the CORSAIR MOA. All items up to the 10,000 foot checks were uneventful. At 10,000 feet, the MP noted that he was not able to observe proper landing gear warning tones. Other checks at 10,000 feet were uneventful, so the MP proceeded to 15,000 feet for the next series of checklist items (Tab V-1.3 to V-1.4).

At 15,000 feet, during the stalls and slats checks, the slats occasionally appeared to extend late, at approximately the same time as the stall. The MP also noted that the stall warning tones would occur late, and sometimes not at all. He also noted that the tones would progress from not being present, skipping the steady tone and going directly to the chopped tone, coincident with aircraft stall, without the expected buffer between tones and stall. Additionally, the stick shaker, which provides stick agitation as a means of stall warning, appeared to be working normally in the landing configuration, but the tones were still not functioning properly. The remaining 15,000-foot and 18,000-foot checks were uneventful (Tab V-1.4 to V-1.5).

After accomplishing the 18,000-foot checks, the MP requested a climb with JAX Center and was subsequently cleared into the block Flight Level 240-350 (Tabs V-1.5 and N-16). The MP testified that he climbed to Flight Level 340 to accomplish the 35,000-foot checks (Tab V-1.5). The MP was given an eastbound vector, followed three minutes later by a 180 degree turn to west (Tab N-17 to N-18). Upon completing this westbound turn, the MP accomplished engine and environmental control system checks. The final checklist item at this altitude was to check for proper slat extension (Tab V-1.5 to V-1.6). The MP retarded throttles in order to slow the MA for slat extension and looked over his right shoulder to observe the slats (Tab V-1.22). Before the slats extended, the MP noticed the MA enter a stall with a slight right bank (Tab V-1.6). The MP advanced the throttles to maximum, lowered the nose and leveled the wings. After stall recovery, the MP checked the engine gauges and noticed both were winding down, with Inlet Turbine Temperatures decreasing below 200 degrees Celsius and engine tachometers decreasing below 30% (Tab V-1.22 to V-1.23).

Initially, the MP suspected that the engines were experiencing a compressor stall, so he retarded the throttles to a setting above idle and lowered the nose. After observing that the engines did not recover or respond to any additional throttle inputs, the MP determined that both engines had completely failed (Tab V-1.6).

The MP executed the boldface procedures for a dual engine failure, a procedure that all A-10 pilots are required to know by memory. The MP placed both throttles to the off position and switched to manual reversion. He elected to delay Auxiliary Power Unit (APU) start until within its start envelope (Tab V-1.6).

Then the MP turned south towards Moody AFB and the CORSAIR MOA. He picked up a best glide speed of 150 knots, based on his aircraft gross weight, while referencing his Dash 1 checklist. With only one operable radio, the MP switched to his squadron operations frequency and established contact with the MW (Tab V-1.6). The MW was able to find the MP and rejoined to a visual formation (Tab V-2.4). The MP successfully started the APU passing 17,000 feet. At this time, the MP was waiting to descend further into the engine start envelope (Tab V-1.6). Modeling in the A-10 simulator showed that an engine that has flamed out will windmill in the airstream and indicate approximately 8-10% engine core revolutions per minute (RPM) while in a 150 knot glide (Tab EE-3). While maintaining this glide, the MP activated the APU Generator, which now supplied all of the MA's electrical power requirements. Passing 15,000 feet, the engine had already cooled to beneath its maximum allowable temperature, so the MP attempted to start the left motor by placing the engine operate switch to "motor." The APU loaded as expected, indicated by APU exhaust gas temperature rising within limits, but the left engine core RPM indicator displayed 0% RPM and did not increase. The MP waited for approximately 20 seconds, looking for any increase in core RPM. The MP did not observe any increase, so he placed the throttle to idle, which commands engine start. Approximately 30 seconds after placing the throttle to idle, the engine still had not started. At this point, the MP continued with the checklist by placing the left throttle to off, left engine operate switch to "normal," crossfeed switch to "crossfeed" and the right engine operate switch to "motor." The APU loaded up for right engine start, but the right engine showed no indication of motoring. After placing the right throttle to idle, the right engine start sequence failed in the exact same manner as previously observed on the left engine, to include 0% RPM (Tab V-1.7).

The MP then requested a vector from the MW to the controlled bailout area, confirmed that his switches were set correctly in accordance with the checklist and reattempted a left engine restart followed by a right engine restart, with both attempts unsuccessful. Passing through 6,000 feet, the MP realized that he would not make the controlled bailout area, so he pointed the MA towards an unpopulated area. The MP attempted multiple restart attempts in the remaining glide time. At approximately 2,600 feet, the MP attempted to stop aircraft descent, assumed an ejection body position and ejected successfully from the MA (Tab V-1.8). The MP accomplished post-ejection checklist items, which were observed by the MW (Tab V-1.8 and V-2.5). The MA continued straight ahead for a few seconds, then rolled slowly to the right. The MW observed the MA completing approximately 90 degrees of right turn in a right bank, impacting the ground at approximately 60 degrees of dive in an upright attitude (Tab V-2.5 and V-2.11). The MA impacted in a waste runoff site for an unused sand quarry and erupted in a post-crash fire (Tab P-7).

The MP landed in an open field, contacted the MW via survival radio and began coordinating for his recovery (Tab V-1.8).

e. Impact

The MA impacted the terrain (See Figure 1) at approximately 1448L about 20 miles northwest of Moody AFB (Tab B-3). The MA was in a clean unarmed configuration for the FCF profile. The impact location was a sandy swamp area, sparsely covered by pine trees (Tab S-5 to S-6).

Figure 1. MA at Crash Site

f. Egress and Aircrew Flight Equipment

The ejection sequence was initiated in the Mode 1 range (below 15,000 feet and 250 +/- 25 knots equivalent airspeed) (Tab H-4 and H-6). The ejection sequence was well within the performance envelope of the system (Tab H-6). The only deficiency discovered was that the drogue parachute severance assemblies were fractured and expanded outside of normal tolerances, but this deficiency had no adverse effect on the ejection sequence (Tab H-5 to H-6). All inspections were accomplished and all survival equipment, including the personnel locator beacon, functioned effectively (Tab H-11 to H-12).

g. Search and Rescue

The MW remained airborne over the crash site in order to provide initial support. He established radio contact with the MP and assessed his initial condition to be good (Tab V-2.5 to V-2.6). The MP landed in a field next to a house, but the house was unoccupied. The MW then guided the MP to another nearby home, which was occupied. The MP walked to this home, made contact with the occupant and telephoned back to the 75 FS (Tab V-1.8). In the meantime, the MW was in contact with air traffic control personnel at Moody AFB, whom he directed to activate an emergency response (Tab N-22 and N-25).

Cook County, GA first responders reported to the crash site and made their way to the MP's location in a timely manner. They transported the MP via ambulance to a hospital located in Adel, GA (Tab N-38).

There were no difficulties or delays associated with initial response or subsequent securing of the crash site.

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

A thorough review of active and historical Air Force Technical Order (AFTO) Form 781 series aircraft maintenance forms revealed no discrepancies indicating engine, APU, stall warning system or slat anomalies on the MA (Tab D-8 to D-17 and D-24). A detailed review of the active AFTO 781 forms and AFTO 781 historical records for the time period 90 days preceding the mishap revealed no evidence of mechanical, structural or electrical discrepancies (Tab D-5 to D-24).

Integrated Maintenance Data System (IMDS) historical records for 90 days prior to the mishap were used to validate and confirm all form entries (Tab U-15). None of the open Time Compliance Technical Orders (TCTOs) in the active forms restricted the MA from flying (Tabs D-21 to D-23 and U-15). There is no evidence that TCTO compliance or aircraft forms and documentation were relevant to this mishap.

b. Inspections

An FCF is required upon completion of the Phase 2 Inspection (Tab D-10). A Phase 2 inspection is required every 1,000 aircraft hours (Tab D-19). The inspection was completed within the 1,000 hour requirement (Tab D-3 and D-19).

Maintenance personnel performed a Preflight inspection on the MA on the day of the mishap (Tab D-6). The preflight is required within 72 hours of the next flight, and was current at the time of the mishap. A production superintendent signed an exceptional release, which serves as a certification that the active forms were reviewed, ensuring the aircraft is safe for flight (Tab D-5).

c. Maintenance Procedures

Review of the MA's AFTO 781 series forms and IMDS revealed all required maintenance actions were in compliance with standard operating procedures (Tab D-5 to D-7 and D-18 to D-23). There is no evidence that maintenance procedures to the MA were relevant to the mishap.

d. Maintenance Personnel and Supervision

The training records for applicable 23 rd Equipment Maintenance Squadron maintenance personnel were reviewed and revealed no discrepancies. All personnel were adequately trained and supervised (Tab U-15).

e. Fuel, Hydraulic and Oil Inspection Analyses

Analysis of the fuel samples indicated oxygen-containing compounds with elements that consisted of dirt. Fuel samples also revealed metallic particles with elements that are consistent with magnesium/aluminum alloy (Tab U-6). The dirt elements are due to the mishap. The metallic particles are not relevant to the mishap. All fuel sample results are within technical data use limits (Tab U-3). The lubricating oil from the mishap engines and the hydraulic fluid were tested and were within limits (Tab U-4 to U-5 and U-9 to U-12). Joint Oil Analysis Program records indicate both engines were code Alpha, a designation given when there is no adverse negative trending analysis evident that would halt continued flying operations (Tab U-13 to U-14). There is no evidence to indicate that fluids were relevant to the mishap.

f. Unscheduled Maintenance

Review of AFTO 781 series forms and IMDS did not reveal any pertinent maintenance discrepancies.

6. AIRFRAME SYSTEMS

The airframe structure and systems of the MA depict a post-crash explosion and subsequent fire. Both the number one and number two engines took a significant amount of external fire damage after separating from their respective aircraft mounts at impact. All visual engine damage appears to be inflicted at aircraft/engine impact and from fire (Tab J-3). Due to the crash environment, the forward fuselage, cockpit and most of the avionics, including the Improved Electronic Processing Unit, were not recovered (Tab DD-5).

The following components and accessories of the systems were submitted for testing, tear down or engineering analysis:

a. Engine #1, TF34-100A, Serial Number (S/N) GE00206265

Figure 2. Engine #1

All iron components of Engine #1 (See Figure 2) were oxidized due to the heat from the fire and subsequent water immersion (Tab DD-5). The damage to the spinner, compressed against the front of the fan disc, indicate that the engine impacted the ground nose first, exposing portions of the engine to pooling of molten aluminum. From behind the engine looking forward, the fan blades in the 4 to 6 O'clock positions were broken at the platform, while the fan blades in the 6 to 8 O'clock position were buckled (Tab DD-6).

(1) Fan Module

The tips of the fan blades showed no abnormal bending, inferring low or no RPM at impact (Tab J-3).

(2) Low Pressure Turbine (LPT) Module

The LPT separated from the High Pressure Turbine (HPT) due to the crash. The number 6 and 7 bearings were intact, and evidence suggests low or no RPM apparent at impact (Tabs J-4 and DD-10).

(3) HPT components

The HPT rotor assembly exhibited discoloration indicative of operation at elevated temperatures. The first stage blades and disk were coated with heavy coking across the upper half of the rotor. Aside from coking, all surfaces are unremarkable and rub grooves are normal for time on aircraft (Tabs J-5 and DD-7 to DD-9).

(4) Compressor

Most compressor blades (See Figure 3) had water stains and discoloration, most likely caused by sediments in the crash site water. Some of the compressor blades were damaged, but the physical evidence reveals the damage occurred on impact and was not causal to the mishap (Tab DD-8 to DD-10).

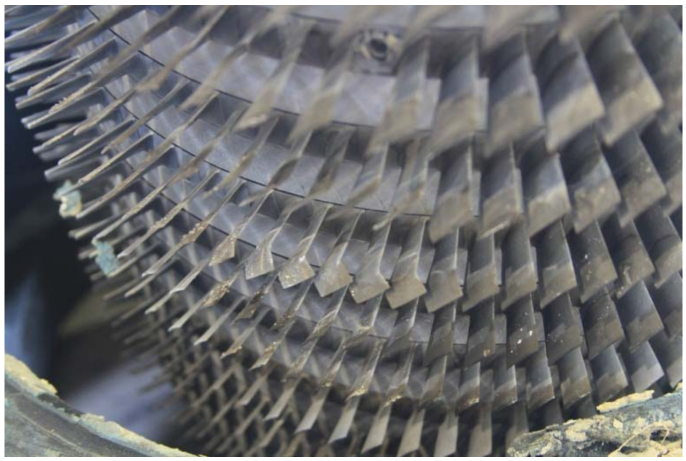
Figure 3. Engine #1 Compressor Blades

(5) Accessories

The accessory gear box fractured in multiple locations with only the Integrated Drive Generator still attached. The starter gear assembly was bent, but no torsional shear was indicated (Tab J-6). The Main Fuel Control (MFC) (See Figure 4) was taken to the fuel control overhaul facility at Fleet Reserve Center Southeast at Jacksonville Naval Air Station, Florida for disassembly and analysis. Analysis of the MFC depicts that there was a core speed of 20-21%, but this data neither conclusively supports nor disproves whether the engine was actually running (Tab DD-5, DD-11 and DD-19).


Figure 4. Engine #1 MFC

(6) Tachometer Generator

The Tachometer Generator (See Figure 5) had impact damage to its case. However, the shaft was intact and it rotated freely (Tab DD-11).

Figure 5. Tachometer Generators

(7) Vane Guide (VG) Actuators

One VG actuator was found for Engine #1. The TF-34 engineer disassembled the VG actuator (See Figure 6) and determined it to be closed at the time of impact, which implies that the engine core was turning at low or no RPM (Tab DD-12).

Figure 6. Engine #1 VG Actuator

b. Engine #2, TF34-100A, S/N GE00205328

Figure 7. Engine #2

Engine #2 (See Figure 7) suffered extensive damage in the crash, but was not exposed to temperatures as high as Engine #1. All iron components were oxidized. While some composite portions of the fan case were destroyed in the post-crash fire, some portions were intact. From behind the engine looking forward, the fan blades in the 5 to 7 O'clock positions were broken at the platform or below, while the fan blades in the 3 to 5 O'clock position had buckled. The front frame received significant damage; however, it was not melted (Tab DD-12 to DD-13).

(1) Fan Module

The tips of the fan blades showed no abnormal bending, inferring low or no RPM at impact (Tab J-3).

(2) LPT Module

The LPT separated from the HPT due to the crash. The blades are discolored from the post-crash fire, and evidence suggests low or no RPM at impact (Tab J-5 and DD-13).

(3) HPT components

The HPT rotor assembly exhibited discoloration indicative of exposure to elevated temperatures. The first stage blades and disk were coated with moderate coking across the upper half of the rotor. Aside from coking, all surfaces are unremarkable and any grooves are considered normal for time on aircraft (Tabs J-7 and DD-14 to DD-15).

(4) Compressor

Most compressor blades (See Figure 8) had stains due to mud and water, but the physical evidence shows no significant blade damage (Tab DD-16).

Figure 8. Engine #2 Compressor

(5) Accessories

The starter gear assembly is bent but no torsional shear is noted. The MFC (See Figure 9) was taken to the fuel control overhaul facility at Fleet Reserve Center Southeast at Jacksonville Naval Air Station for disassembly and analysis. Analysis of the MFC depicts that there was a core speed of 36-37%, but this data neither conclusively supports nor disproves whether the engine was actually running (Tab DD-5, DD-16 and DD-19).

Figure 9. Engine #2 MFC

(6)Tachometer Generator

The Tachometer Generator (See Figure 5) had impact damage to its case. However, the shaft was intact and rotated freely (Tab DD-18).

(7)VG Actuators

Both VG actuators were found for Engine #2. The TF-34 engineer disassembled the VG actuators (See Figure 10) and determined them both to be closed at the time of impact, which implies that the engine core was turning at low or no RPM (Tab DD-17).

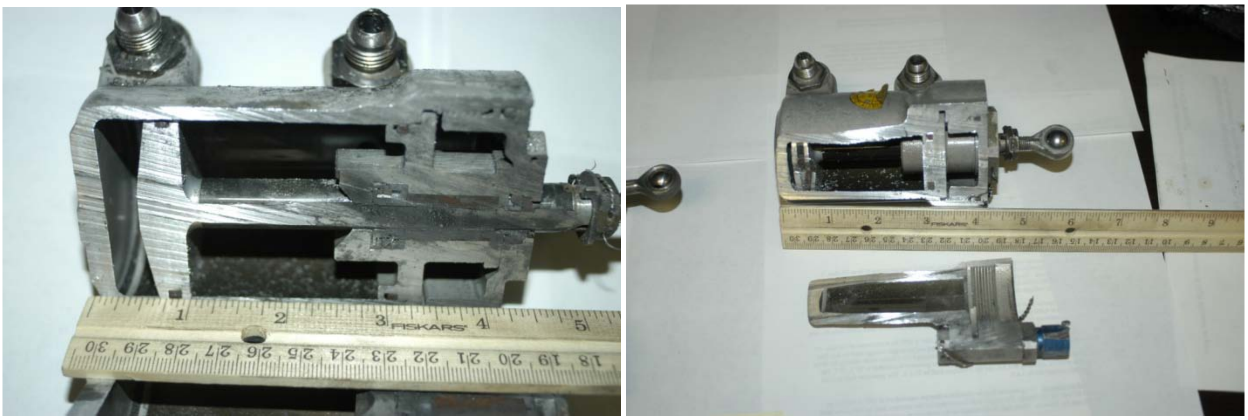

Figure 10. Engine #2: VG Actuator 1 (Left) and VG Actuator 2 (Right)

c. APU

The APU (See Figure 11) was severely damaged by crash forces. The MP testified that the APU gauges indicated it was fully powered when turned on during the mishap flight. (Tab V-1.5 to V-1.6). In addition, an aerospace engineer from the Ogden Air Logistics Center reviewed the MP's testimony, photos of the mishap APU and the technical evaluations of the MA engines conducted during the Safety Investigation Board and the AIB. The aerospace engineer certified that the APU was fully functional at the time of the mishap (Tab DD-3).

Figure 11. APU Turbine w/dirt removed (Left) and Remains of the APU (Right)

d. Fuel Engine Relay Box (FERB)

A normal engine start cycle sequence routes through the FERB. There is no single point of failure within the FERB which could result in both engines failing to start. Therefore, the engine start cycle sequence, via the FERB, is not a factor in this mishap (Tab DD-21).

7. WEATHER

a. Forecast Weather

The 23 OSS Weather Flight provided the mission execution forecast on 26 September 2011. Surface winds at Moody AFB were expected to be from the northeast at nine knots with a temperature of 32 degrees Celsius. Anticipated visibility was seven statute miles with cloud ceilings broken at 3,000 to 10,000 feet above ground level (AGL). The only forecasted hazards were isolated thunderstorms with maximum tops at 55,000 feet AGL (Tab F-5 to F-6).

Weather was not specifically briefed for the CORSAIR MOA, which is the area overlying the mishap impact site. The upper level winds were briefed to be generally from the southwest at a maximum of 20 knots from the surface up to Flight Level 230 (Tab F-6).

b. Observed Weather

Raw weather data observations were not available for the CORSAIR MOA. The MP testified that the skies were clear (Tab V-1.3). The MW testified thunderstorms were in the vicinity, but were not a factor during the mishap sequence (Tab V-2.4 and V-2.11).

c. Space Environment

Not applicable.

d. Operations

Weather was within operational parameters.

8. CREW QUALIFICATIONS

a. Mishap Pilot Training

The MP is a fully qualified A-10C Two-ship Flight Lead (Tab G-46). All necessary flight currencies were up-to-date and all required training for the planned mission was current in accordance with AFI 11-2A-OA-10, Volume 1 (Tab G-14 to G-19). On 14 June 2011, the MP completed his most recent instrument qualification in the A-10C (Tab G-3 to G-4). The MP completed his most recent mission qualification on 20 September 2011, but the Form 8 (Certificate of Aircrew Qualification) had not been completed prior to the mishap date since the Emergency Procedures Evaluation had not yet been accomplished in the simulator. The absence of this paperwork was not a factor to this mishap. The MP completed FCF upgrade training on 1 July 2011 and the mishap sortie was his first operational FCF (Tabs G-44 and V-1.9).

b. Mishap Pilot Experience

The MP holds a “Pilot” aeronautical rating with 1,034.6 hours of military flying time prior to the mishap (Tab G-8). Of this total, the MP had 783.4 hours of primary A-10 time. The MP had flown six sorties in the two weeks prior to the mishap. The MP flew his latest sortie on 22 September 2011, four days prior to the mishap (Tab G-10).

Recent flight time is as follows (Tab G-9 and Tab G-10):

	Hours	Sorties
Last 30 Days	13.9	7
Last 60 Days	24.4	13
Last 90 Days	33.7	19

9. MEDICAL

a. Qualifications

The MP was medically qualified to perform flying duties at the time of the mishap. The MP's annual Preventative Health Assessment (PHA) was current and a review of the Aeromedical Information and Medical Waiver Tracking System database showed no waivers. The MP had no physical or medical restrictions and was worldwide qualified at the time of the mishap (Tab X-3).

b. Health

The MP's hard copy and electronic medical records were reviewed. According to the PHA, dated 11 August 2010, the MP was cleared medically for flying duties (Tab X-3).

c. Toxicology

Toxicology testing was conducted immediately following the mishap for all persons involved. The blood and urine samples were submitted to the Office of the Armed Forces Medical Examiner for toxicology analysis. Samples were examined for levels of carbon monoxide and ethanol in the blood and traces of any drugs in the urine to include amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates and phencyclidine. The toxicology samples arrived at the testing location in good condition. Five samples yielded positive results; the MP's urine tested positive for amphetamines. The results are consistent with "Go Pills," which can be given to pilots for operational purposes. Based on consultation with the Director of the Forensic Toxicology Laboratory, Office of the Armed Forces Medical Examiner, impairment due to drugs or alcohol was not considered to be causal or contributory to the mishap (Tab X-3 to X-4).

d. Lifestyle

The MP indicated that there had been some increased stress in his life in the month prior to the incident. However, he indicated that the issues causing stress had been resolved prior to the incident. The MP indicated no increased stresses on the day of the accident (Tab V-1.2).

e. Crew Rest and Crew Duty Time

All aircrew are required to have proper crew rest prior to performing flying duties as outlined in AFI 11-202, Volume 3. Proper crew rest is defined as a minimum of a 12-hour non-duty period before the designated flight duty period begins. During this time, an aircrew member may participate in meals, transportation or rest as long as he or she has had at least 10 hours of continuous restful activity with an opportunity for at least 8 hours of uninterrupted sleep. The MP had an early show for his physical training test on the day of the mishap. He reported sleeping well the night prior and feeling well rested on the day of the mishap (Tab V-1.2).

10. OPERATIONS AND SUPERVISION

a. Operations

The week prior to the mishap, the MP was involved in re-deploying the 75 FS from temporary duty at Nellis AFB, Nevada. Upon returning, the MP resumed his duties as the Squadron Chief of Scheduling (Tab V-1.2). The mishap occurred on a Monday, which was the first flying day following a two-day weekend. The MP and MW were the only two planned flights of the day, which is a significantly lighter than normal flight schedule. The MP was a last-minute replacement after the originally scheduled FCF pilot informed the Operations Supervisor (OPSUP) that he would be unable to fly (Tab V-3.2). Since the MP had completed mission planning and ground operations three days earlier, he stated that he felt adequately prepared for the FCF mission (Tab V-1.2).

b. Supervision

The 75 FS has an active ORM program. The MP self-assessed his participation in this mission as "Low Risk." The single greatest risk identified by the MP was the FCF profile itself (Tab K-3).

Supervision for the FCF sortie was provided by the OPSUP. The OPSUP was acting as both Top 3 and Supervisor of Flying since the FCF sortie and escort aircraft were the only two flights planned that day (Tab V-3.2). Operations supervision was determined to be in accordance with AFI 11-418.

11. HUMAN FACTORS

AFI 91-204, Attachment 5, contains the Department of Defense Human Factors Analysis and Classification System which lists potential human factors that can play a role in aircraft mishaps. The following human factors were relevant to this mishap:

a. Causal

No human factors were causal in this mishap.

b. Contributory

(1) Procedural Guidance/Publications (OP003)

Procedural Guidance/Publications is a factor when written direction, checklists, graphic depictions, tables, charts or other published guidance is inadequate, misleading or inappropriate and this creates an unsafe situation.

Technical Order guidance addresses preventing engine failures by maintaining coordinated flight at high altitude and high angle of attack. The warning does not address the possibility of dual engine seizure and subsequent inability to restart the engines following an engine failure (Tab BB-26). As a result, the MP was not trained with respect to that possibility and was not fully trained to handle the consequences of a high altitude engine failure.

(2) Local Training Issues/Programs (SI003)

Local Training Issues/Programs are a factor when one-time or initial training programs, upgrade programs, transition programs or training that is conducted outside the local unit is inadequate or unavailable (etc) and this creates an unsafe condition.

AFI 21-101, Moody AFB Supplement, directs that FCF upgrade flights require only manual reversion and engine restart checks. Pilots are not required to perform all checklist items, including the 35,000-foot checks. The MP testified that prior to the mishap flight his average maximum altitude during daily operation is 18,000 feet. His personal maximum altitude prior to the mishap was 23,000 feet (V-1.22). Therefore, the MP was performing checklist items at 25,000 feet and above for the first time at the time of the mishap.

(3) Misperception of Operational Conditions (PC504)

Misperception of Operational Conditions is a factor when an individual misperceives or misjudges altitude, separation, speed, closure rate, road/sea conditions, aircraft/vehicle location within the performance envelope or other operational conditions and this leads to an unsafe situation.

The FCF profile required flight checks above 25,000 feet and 35,000 feet in accordance with AFI 21-101, Moody AFB Supplement. The MP had no experience flying the aircraft above 23,000 feet (Tab V-1.22). The MA had a malfunctioning stall warning system, which would have served as an additional safeguard (Tab V-1.25). Therefore, at 34,000 feet, the MP was unaware he was operating the MA in a region of the Engine Disturbance Area chart. The Engine Disturbance Area region includes a combination of flight conditions of altitude, airspeed and angle of attack that could lead to an increased vulnerability and risk of aircraft stall and engine failure (Tab BB-6).

(4) Task Misprioritization (AE202)

Task Misprioritization is a factor when the individual does not organize, based on accepted prioritization techniques, the tasks needed to manage the immediate situation.

The MP was looking over his right shoulder checking for slat extension when the MA stalled (Tab V-1.22). The MP misprioritized his tasks by checking for slat extension over preventing the MA from stalling.

c. Non-Contributory

All human factors were considered for their possible contribution to the mishap sequence. High interest non-contributory human factors include:

(1) Limited Total Experience (SP004)

Limited Total Experience is a factor when a supervisor selects an individual who has performed a maneuver, or participated in a specific scenario, infrequently or rarely.

The MP had limited total experience with FCF flights and higher altitude flights, he had passed his FCF pilot upgrade and he was an appropriate selection for the mission profile by his supervision (Tabs G-46 and V-1.22).

(2) Decision-Making During Operation (AE206)

Decision-Making During Operation is a factor when the individual through faulty logic selects the wrong course of action in a time-constrained environment.

The MP testified that despite having an ineffective stall warning system, he felt comfortable continuing the FCF above 15,000 feet (Tab V-1.5). Given his previous training, and lack of explicit guidance prohibiting continuation of the FCF profile, the MP's decision to continue was logical.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Directives and Publications

(1) AFI 11-2A/OA-10, Volume (Vol) 1, A/OA-10—*Aircrew Training*, 31 August 2006
(2) AFI 11-2A/OA-10, Volume 2, A/OA-10—*Aircrew Evaluation Criteria*, 16 November 2005
(3) AFI 11-2A/OA-10, Volume 3, A/OA-10—*Operations Procedures*, 11 February 2002
(4) AFI 11-202, Volume 3, *General Flight Rules,* 22 October 2010
(5) AFI 21-101, *Aircraft and Equipment Maintenance Management*, Incorporating Through Change 1, 16 August 2011

(6) AFI 21-101, Combat Air Force Supplement, *Aircraft and Equipment Maintenance Management*, 28 December 2010
(7) AFI 21-101, Moody AFB Supplement, *Aircraft and Equipment Maintenance Management*, 1 March 2009
(8) AFI 51-503, *Aerospace Accident Investigations,* 26 May 2010
(9) T.O. 1A-10C-1, *Flight Manual, USAF Series A-10C Aircraft,* 10 November 2008
(10) T.O. 1A-10C-6CF-1, *Acceptance and Functional Checkflight Manual, Supplemental Flight Manual, USAF Series A-10C Aircraft*, 10 November 2008
(11) T.O. 1A-10C-1CL-1, *Flight Crew Checklist, USAF Series A-10C Aircraft*, 10 November 2008
(12) T.O. 1A-10C-6CF-3, *Acceptance and Functional Checkflight Manual, USAF Series A-10C Aircraft*, 10 November 2010

b. Other Directives and Publications

(1) AFI 91-204, *Safety Investigations and Reports*, 24 September 2008, DOD HFACS
(2) T.O. 1A-10C-2-71TS-1, *Organizational Maintenance Troubleshooting - Power Plant/Auxiliary Power Unit, USAF Series A-10C Aircraft*, 1 January 2010

NOTICE: The AFIs listed above are available digitally on the AF Departmental Publishing Office internet site at: **http://www.e-publishing.af.mil.**

13. ADDITIONAL AREAS OF CONCERN

a. TF-34 Engine Seizure/CF-34 Core Lock Similarities

General Electric (GE) manufactures both the A-10C's TF-34 engine and the commercial aircraft CF-34 engine. The CF-34 engine has a known history of a condition known as core lock (Tab FF-4). Core lock is an unintended seizure of the core rotor. Rotor seizure is a result of unintended contact between internal engine parts. An aircraft engine operated at a high throttle setting for an extended period of time, followed immediately by a high altitude flameout and sustained low power setting or low aircraft airspeed can produce conditions that are favorable to core lock (Tab DD-29). These core lock conditions appeared to exist in this mishap and the sequence of events are similar to the Pinnacle Airlines Flight 3701 mishap on 14 October 2004.

Prior to the MA's engines flaming out and seizing, the MP had conducted a high power climb from 23,000 feet to 34,000 feet at 130-150 knots (Tab V-1.5). Power remained high until the MP conducted the slats checks at 120-130 knots, which was very close to stall speed at that gross weight and altitude (Tab V-1.11). The A-10 has no history of high altitude engine failure and seizure. Pinnacle Airlines Flight 3701 with CF-34 engines, operating under remarkably similar flight conditions as the MA, did experience engine failure and seizure (Tab FF-6 to FF-9).

Pinnacle Airlines Flight 3701 crashed after dual high altitude CF-34 engine failure and core lock. The National Transportation Safety Board conducted an investigation and concluded that the core lock engine condition, which prevented at least one engine from being restarted, was a contributing factor to that mishap (Tab FF-4).

The following are similarities between the mishaps involving the MA and Pinnacle Airlines Flight 3701: (1) the aircraft was flying with high power and at high altitude and the aircraft engines stalled; (2) the APU was fully operational throughout flight; (3) the engines would not restart with a fully loaded APU, even after the aircraft was flown at a speed and altitude at which the engines were supposed to restart; (4) MP testimony (A-10C mishap) and flight data recorder information (Flight 3701 mishap) revealed no indication of core RPMs; and (5) upon post-accident teardown, the internal portions of the engines showed no obvious signs of seizing (Tabs V-1.2 to V-1.8, FF-4 to FF-5 and FF-10).

The similarities between these two mishaps raise a concern that other TF-34 engines in our fleet may be at risk for a catastrophic seizure.

b. A-10C FCF Training

AFI 21-101 and AFI 21-101 CAFSUP-1 organize and direct the FCF program at each base. Each base develops their own program tailored to their mission and needs, to include FCF upgrade training. AFI 21-101, Moody AFB Supplement, is very thorough on the conduct of its FCF program. Moody requires a minimum of manual reversion and inflight engine restart to complete the FCF check out flight. There is no particular emphasis placed on any other checks in the FCF profile.

The MP testified that he had no experience flying above 25,000 feet (Tab V-1.22). The pilot that conducted the MP's FCF upgrade characterized the high altitude portion as a long climb with anticlimactic checks at 35,000 feet. The choice was made on the MP's upgrade not to climb to 35,000 feet and accomplish the checks (Tab R-4).

The AIB contacted nine current and qualified A-10C FCF pilots to determine if the exclusion of the high altitude portion during the MP's FCF upgrade training was the cultural norm or an anomaly. We spoke with all Chiefs of FCF at active duty Combat Air Force units, including the A-10 Depot Chief of Safety and a pilot with 10 years of FCF experience. Of the pilots we contacted, five flew the entire profile through the 35,000-foot checks with supervision. The other four planned to fly to 35,000 feet but were unable to do so for various reasons. All nine pilots had discussed the 35,000-foot checks, to include the warning about maintaining coordinated flight (Tab EE-5). The MP also discussed the same warning in his training (Tab V-1.10). Purposely choosing to skip the 35,000-foot check during the MP's FCF upgrade training appears to be an anomaly.

All of the A-10C FCF pilots had discussed or achieved high altitude flight during upgrade training. My impression is that emphasis was placed on methodical execution of the checklist versus maintaining coordinated flight while operating near the aircraft and engine stall envelopes. This mishap has shown operating in the engine disturbance area could have catastrophic results.

29 December 2011

DOUGLAS H. STANDIFER, Colonel, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

A-10C, T/N 80-0282, 20 Miles Northwest of Moody AFB GA
26 SEPTEMBER 2011

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report, if any, may not be considered as evidence in any civil or criminal proceeding arising from the accident, nor may such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.

1. OPINION SUMMARY

I find by clear and convincing evidence that the cause of the mishap was the Mishap Aircraft (MA) engines flaming out due to being flown in a region of a combination of flight conditions of altitude, airspeed and angle of attack that could lead to an increased vulnerability and risk of aircraft stall and engine failure. The engines never restarted, causing the Mishap Pilot (MP) to eject and the MA to impact the ground.

Further, I find by a preponderance of evidence that the following factors substantially contributed to the mishap: (1) the MA engines failed to restart due to engine seizure, which effectively prevented the engines from rotating and starting; (2) Technical Order (T.O.) 1A-10C-1, *Flight Manual, USAF Series A-10C Aircraft,* and T.O. 1A-10C-6CF-1, *Acceptance and Functional Checkflight Manual, Supplemental Flight Manual, USAF Series A-10C Aircraft*, do not discuss or provide guidance for the possibility of engine seizure after high altitude engine flameout; (3) Air Force Instruction (AFI) 21-101, Moody Air Force Base (AFB) Supplement, *Aircraft and Equipment Maintenance Management*, does not require 35,000-foot checks during Functional Check Flight (FCF) upgrade training; (4) the combination of the MP's inexperience at flying above 23,000 feet and the MA's malfunctioning stall warning system; and (5) the MP misprioritized an FCF checklist item over preventing the MA from stalling.

2. DISCUSSION OF OPINION

On Monday, 26 September 2011 at approximately 1448 local time, the MA, an A-10C, T/N 80-0282, experienced dual engine failure during an FCF and impacted the ground approximately 20 miles west/northwest of Moody AFB. An FCF is flown to ensure airworthiness after major scheduled aircraft maintenance. The MP ejected safely and sustained no significant injuries. The MA was destroyed upon impact with the loss valued at $14,708,772.19. Environmental clean-up costs are estimated to be $150,147.50. The MA impacted on private property consisting of a waste runoff site for an unused sand quarry. The impact left a 15-foot diameter crater, burned 5 acres of land, churned 1 acre of earth and destroyed 15 pine trees. Media interest was minimal and mostly confined to local news stations.

a. Cause: Engine Flameout and Failure to Restart

The mishap sortie was flown to complete an FCF that had begun the Friday before with ground checks up to, but not including, Taxi checks. The Friday sortie was canceled for weather. On the following Monday, the MP updated his flight planning and conducted a coordination brief with the Mishap Wingman (MW), who was airborne for mutual support. Operations were normal through departure.

At 10,000 feet, the MP noted that he was not able to observe proper landing gear warning tones, but this was not a factor in the mishap. Other checks at 10,000 feet were uneventful, so the MP proceeded to 15,000 feet for the next series of checklist items. At 15,000 feet, during the stalls and slats checks, the slats occasionally appeared to extend late, at approximately the same time as the stall. The MP also noted that the stall warning tones would occur late, and sometimes not at all, without the expected buffer between tones and stall. Additionally, the stick shaker, which provides stick agitation as a means of stall warning, appeared to be working normally in the landing configuration, but the tones were still not functioning properly. The remaining 15,000-foot and 18,000-foot checks were uneventful. The MP elected to continue the FCF profile into the high altitude checks and under a combination of flight conditions of altitude, airspeed and angle of attack that could lead to an increased risk of aircraft stall and engine failure. There is no explicit guidance that prohibited the MP from continuing the FCF profile without a functional stall warning system.

At 34,000 feet, the MP performed the high altitude checks. The MP retarded throttles in order to slow the MA for slat extension and looked over his right shoulder to observe the slats. Before the slats extended, the MP noticed the MA enter a stall with a slight right bank. The MP did an aircraft stall recovery and noted both engines were losing revolutions per minute (RPM) and Inlet Turbine Temperature (ITT). The MP attempted an engine compressor stall recovery with no effect. After observing that the engines did not recover or respond to any additional throttle inputs, the MP determined that both engines had completely failed. The MP then correctly executed the boldface procedures for a dual engine failure, electing to keep the Auxiliary Power Unit (APU) off until the MA was in the APU operating envelope.

The MP turned south and began to glide toward Moody AFB. The MP referred to his checklist and maintained his glide. Once in the APU operational envelope, the MP started the APU and engaged the APU generator. Once in the airstart envelope, the MP attempted a left engine start. The MP noted the ITT was below 200 degrees Celsius, core RPM at 0% and a fully loaded up APU; but there was no increase of core RPM. The MP determined that the left engine start had failed. He continued with the checklist and attempted a right engine start. The right engine also had an ITT below 200 degrees Celsius, core RPM at 0% and a fully loaded up APU; but there was no increase of core RPM. The right engine also failed to start. The MP attempted several more restart attempts while he headed toward an unpopulated area for ejection from the MA.

b. Substantially Contributing Factors

(1) Engine Seizure

The MP reported 0% core RPM with the APU loaded up on all engine restart attempts for the left and right engines. Engineering analysis of external engine components revealed no abnormal bending of the fan blades, which suggests little to no rotation at impact. Engineering analysis conducted on the internal engine parts revealed them to be in relatively undamaged condition with no indication of any rotation at impact. The vane guide actuators of both engines were in a closed position, inferring no core rotation. Engines depicted no torsional shear damage, which suggests there was no rotation at impact. Although the internal engine parts showed no signs of a violent engine seizure, a preponderance of the evidence, including the MP's testimony, suggests that both engines seized while descending to an APU assisted airstart envelope.

(2) Insufficient Information and Guidance

Neither T.O. 1A-10C-1 (Dash 1) nor T.O. 1A-10C-6CF-1 (Dash 6) has information on the possibility of engine seizure following flameout at high altitude. The guidance available is silent on what, if any, actions to take above 20,000 feet. Dash 1 procedures lead the pilot to glide to a lower altitude where an APU start can be accomplished. However, a restart is impossible if the engine has seized. The Dash 6 has limited emphasis on high altitude operational considerations and does not stress the possibility of dual engine seizure and subsequent inability to restart the engines following an engine failure.

(3) Local Training Issues/Programs

AFI 21-101, Moody AFB Supplement, directs that FCF upgrade flights require only manual reversion and engine restart checks. Pilots are not required to perform all checklist items, including the 35,000-foot checks. The MP's FCF upgrade training did not include the climb to 35,000 feet nor practicing the FCF checks at altitude. The high altitude portion of the FCF was characterized by the training pilot as "painful" and "anticlimactic."

The MP stated that prior to the mishap flight his average maximum altitude during daily operation was approximately 18,000 feet. His personal maximum altitude prior to the mishap was estimated to be 23,000 feet. The MP had only accomplished the high altitude checks in the simulator. Therefore, the MP was performing checklist items at 25,000 feet and above for the first time at the time of the mishap.

Based on the guidance and training he received, the MP's decisions and actions were logical and appropriate. However, insufficient emphasis was placed on flying the aircraft in a region where aircraft stall and engine failure were possible. Specifically, there was insufficient emphasis on high altitude aircraft or engine stall possibilities. The MP had not received any particular techniques to accomplish the high altitude checks and was ill-prepared for the mishap scenario, substantially contributing to this accident.

(4) Misperception of Operational Conditions

The FCF profile required flight checks at 25,000 feet and 35,000 feet in accordance with AFI 21-101, Moody AFB Supplement. However, the MP had no in-flight experience above 23,000 feet. The MA had a malfunctioning stall warning system, which would have served as an additional safeguard. Therefore, at 34,000 feet, the MP was unaware he was operating the MA in an envelope where aircraft stall and engine failure were imminent.

The MP had no experience and insufficient training about the intricacies and possible hazards of high altitude flight without a properly functioning stall warning system. This lack of knowledge led the MP to continue high altitude checks that more experienced pilots stated they would not do, substantially contributing to the mishap.

(5) Task Misprioritization

The MP was looking over his right shoulder checking for slat extension when the MA stalled. At the time, the MP was unaware he was operating the MA in a region where aircraft stall and engine failure were possible. The MP misprioritized his tasks by checking for slat extension over preventing the MA from stalling, substantially contributing to the mishap.

3. CONCLUSION

I developed my opinion by analyzing applicable Air Force directives, engineering analyses, consultation with technical experts, witness testimony and A-10C simulator modeling. I find by clear and convincing evidence that the cause of the mishap was the MA engines flaming out due to being flown in a region of a combination of flight conditions of altitude, airspeed and angle of attack that could lead to an increased vulnerability and risk of aircraft stall and engine failure. The engines never restarted, causing the MP to eject and the MA to impact the ground. Further, I find by a preponderance of evidence that the following factors substantially contributed to the mishap: (1) the MA engines failed to restart due to engine seizure; (2) there was insufficient guidance for the possibility of engine seizure after high altitude engine flameout; (3) there is no requirement for 35,000-foot checks during FCF upgrade training; (4) the combination of the MP's inexperience at flying above 23,000 feet and the MA's malfunctioning stall warning system; and (5) the MP misprioritized an FCF checklist item during the mishap flight over preventing the MA from stalling.

29 December 2011

DOUGLAS H. STANDIFER, Colonel, USAF
President, Accident Investigation Board

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report, if any, may not be considered as evidence in any civil or criminal proceeding arising from the accident, nor may such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.