UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

T-38C, 65-0337, 11 FEBRUARY 2011

50TH FLYING TRAINING SQUADRON
14TH FLYING TRAINING WING
COLUMBUS AIR FORCE BASE, MISSISSIPPI

LOCATION: ELLINGTON FIELD, HOUSTON, TEXAS

DATE OF ACCIDENT: 11 FEBRUARY 2011

BOARD PRESIDENT: COLONEL KURT W. MEIDEL

Conducted In Accordance With Air Force Instruction 51-503

EXECUTIVE SUMMARY

On 11 February 2011, at 2017 Central Standard Time, the Mishap Aircraft (MA), a T-38C, serial number 65-0337, sustained damage during an attempted landing on Runway 22 at Ellington Field, Houston, Texas. The MA and Mishap Pilot (MP) were assigned to the 14th Flying Training Wing, Columbus Air Force Base (AFB), Mississippi. The MP suffered minor injuries. The MA sustained damage to the landing gear, engines, right wing, and tail section totaling $2,139,672. The impact caused minor damage to the runway, but no damage to private property.

The MP was flying his fourth sortie of the day as a night solo continuation training sortie into Ellington Field on a squadron cross-country mission. The MP requested a visual approach to runway 17 Right. He did not sufficiently monitor his position and became geographically misoriented. As a result, when he was three miles from the airfield, the MP misidentified runway 22 as runway 17 Right. Due to Channelized Attention on the mismatch between what he was seeing outside and what his instruments indicated, he allowed his airspeed to decrease well below a safe airspeed and descended at an insufficient rate, placing him well above a normal glidepath. In an attempt to fix his glidepath, he developed an excessive sink rate. He did not detect his slow airspeed or excessive sink rate in time to prevent a runway impact of sufficient force to cause catastrophic damage to the MA's landing gear and right wing. The MP was unable to prevent the MA from departing the runway, incurring further damage. The MA came to rest 2,500 feet from the point of impact. The MP accomplished a safe ground egress.

The 50th Flying Training Squadron Commander originally approved the MP's cross-country plan to remain overnight at Charleston, South Carolina, to support a Reserve Officer Training Corps (ROTC) event he had organized for The Citadel. One week prior to the mishap, the commander changed his policy to require all cross-country pilots to remain overnight at Ellington. The commander informed the MP of the new policy; the MP could still support the Citadel event if his plan allowed him to stay at Ellington. The commander did not consider cancelling the MP's ROTC event. The MP still wanted to support the ROTC event and believed that his planned timeline, while aggressive, would allow him to safely arrive at Ellington. This policy change, combined with the MP's ROTC commitment, led to the MP flying a high-risk mission of a fourth sortie, solo, single-ship, for his first night arrival to Ellington.

The Accident Investigation Board (AIB) President found by clear and convincing evidence this accident was caused by the following: (1) Geographic Misorientation of the MP in relation to the landing runway, which led to a series of perception and performance errors that ultimately resulted in the runway impact; (2) the authorization and execution of a mission profile having an unnecessarily high level of risk relative to the real benefits. Operational Risk Management (ORM) was inadequate on three fronts: inadequate risk analysis of the overall cross-country weekend plan as well as the MP's individual plan, an inadequate risk assessment matrix, and a culture of risk tolerance in the squadron. Inappropriate supervisory policy, combined with inadequate ORM, led to the MP flying a high-risk mission profile. The AIB President also found by a preponderance of the evidence that the MP's fatigue substantially contributed to the mishap.

Under 10 U.S.C. §2254(d) the 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.

AIRCRAFT ACCIDENT INVESTIGATION
COLUMBUS AIR FORCE BASE, MISSISSIPPI
T-38C, S/N 65-0337, 11 FEBRUARY 2011

TABLE OF CONTENTS

COMMONLY USED ACRONYMS & ABBREVIATIONS

The list of commonly used acronyms and abbreviations below was compiled from the Executive Summary, Summary of Facts, Statement of Opinion, Index of Tabs, and witness testimony found at Tab V.

ACMI	Aircraft Maneuvering Instrumentation
ACMI	Air Combat Maneuvering Instrumentation
ADC	Area Defense Council
ADO	Assistant Operations Officer
AETC	Air Education and Training Command
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFMAN	Air Force Manual
AFROTC	Air Force Reserve Officer Training Corps
AFTO	Air Force Technical Order
AGL	Above Ground Level
AGR	Active Guard Reservist
AIB	Accident Investigation Board
ALO	Air Liaison Officer
AOA	Angle of Attack
ARMS	Aviation Resource Management System
ATC	Air Traffic Control
ATIS	Automated terminal Information System
°C	Degrees Celsius
Capt	Captain
Code 1	All systems operational
Col	Colonel
CST	Central Standard Time
CT	Continuation Training
CTO	Commercial Travel Office
DoD	Department of Defense
DO	Operations Officer
DNIF	Duties Not to Include Flying
EGI	Embedded Global Positioning System/Inertial Navigation System
EP	Emergency Procedure
EST	Eastern Standard Time
FAIP	First Assignment Instructor Pilot
FAS	Final Approach Speed
FBO	Fixed Base Operator
FCF	Functional check flight
FCIF	Flight Crew Information File
FCP	Front Cockpit
FDP	Flight Duty Period
FSO	Flight Surgeon Office
FTS	Flying Training Squadron
FTW	Flying Training Wing
FY	Fiscal Year
G	Force of Gravity at the surface of the earth. Approximately 32.2 ft/sec^2
GPS	Global Positioning System
HFACS	Human Factors Analysis and Classification System
HS	Horizontal Stablizer
HUD	Heads-Up Display
IAW	In Accordance With
IFF	Introduction to Fighter Fundamentals
IFF	Identification Friend or Foe
IFG	In-Flight Guide
IFR	Instrument Flight Rules
IG	Inspector General
ILS	Instrument Landing System
IMDS	Integrated Maintenance Data System
INS	Integrated Navigation System
IP	Instructor Pilot
IQC	Initial Qualification Course
JFTR	Joint Federal Travel Regulation
KCAS	Knots Calibrated Airspeed
lbs	pounds
LOX	Liquid Oxygen
Lt	Lieutenant
Lt Col	Lieutenant Colonel
MA	Mishap Aircraft
Maj	Major
MDP	Mission Display Processor
MEF	Meteorological Forecast
MFD	Multifunction Display
MLG	Main Landing Gear
MOA	Military Operating Area
MP	Mishap Pilot
MPA	Military Personnel Appropriations
MQF	Master Question File
MQT	Mission Qualification Training
MRI	Magnetic Resonance Imaging
MSL	Mean Sea Level
MS	Mishap Sortie
NLG	Nose Landing Gear
NM	Nautical Miles

NOTAMs	Notices to Airmen
NVG	Night Vision Goggle
OG	Operations Group
OI	Operating Instruction
OO-ALC	Ogden Air Logistics Center
OPR	Officer Performance Report
Ops	Operations
OPTEMPO	Operations tempo
ORM	Operational Risk Management
OSS	Operational Support Squadron
P-Mission	Student academics taught by an IP
PA	Public Affairs
PAPI	Precision Approach Path Indicator
PAPIs	Precision Approach Path Indicator
PIC	Pilot In Command
PIF	Pilot Information File
PIT	Pilot Instructor Training
PUBS	Publications
QC	Quality Control
QRC	Quick Reference Checklist
RAPCON	Radar Approach Control
ROTC	Reserve Officer Training Corps
RPM	Revolutions Per Minute
RSU	Runway Supervisory Unit
RTU	Reserve Training Unit
S/N	Serial Number
SA	Situational Awareness
SARM	Squadron Aviation Resource Manager
SAF	Secretary of the Air Force
SAV	Staff Assistance Visit
SELO	Standardization Evaluation Liaison Officer
SOF	Supervisor of Flying
Stan-Eval	Standardization and Evaluation
STAR	Standard Terminal Arrival
Sup	Supervisor
SUPT	Specialized Undergraduate Pilot Training
TACAN	Tactical Air Navigation
TCAS	Traffic Collision Avoidance System
TCTO	Time Compliance Technical Order
TDY	Temporary Duty
TIMS	Training Information Management System
T.O.	Technical Order
UCI	Unit Compliance Inspection
UHF	Ultra High Frequency
USAF	United States Air Force
UPT	Undergraduate Pilot Training
U.S.C.	United States Code
VFR	Visual Flight Rules
VHF	Very High Frequency
VTR	Video Tape Recorder
VVI	Vertical Velocity Indicator
Z	Zulu or Greenwich Mean Time (GMT)

AIRCRAFT ACCIDENT INVESTIGATION
COLUMBUS AIR FORCE BASE, MISSISSIPPI
T-38C, S/N 65-0337, 11 FEBRUARY 2011

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority. On 14 Mar 2011, Lieutenant General Douglas H. Owens, Vice Commander, Air Education and Training Command (AETC), United States Air Force (USAF), convened an Accident Investigation Board (AIB) in accordance with (IAW) Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, dated 26 May 2010, to investigate the 11 Feb 2011 mishap involving a T-38C aircraft, serial number (S/N) 65-0337, at Ellington Field, Houston, Texas (TX). (Tab Y-3 to Y-4) The following USAF personnel served on the AIB:

Colonel Kurt W. Meidel	Board President
Major Charles G. Glasscock	Pilot Member
Captain Robert J. Henley	Medical Member
Captain Christopher P. Sheridan	Legal Advisor
Mr. William R. Pyle	Maintenance Member
Technical Sergeant Tina M. Hall	Board Recorder

(Tab Y-3 to Y-13) The investigation was conducted at Columbus Air Force Base (AFB), Mississippi (MS) from 22 Mar 2011 to 20 Apr 2011.

b. Purpose. This was 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. (Tab BB-110, AFI 51-503)

2. ACCIDENT SUMMARY

On 11 Feb 2011, at 2017 Central Standard Time (CST) (all times referred to in this report are CST unless otherwise indicated), a T-38C, S/N 65-0337, hereinafter referred to as the Mishap Aircraft (MA), sustained damage as the pilot, Captain David M. Cook, hereinafter referred to as the Mishap Pilot (MP), attempted to land on Runway 22 at Ellington Field, Houston, TX. (Tabs J-3, K-3, K-5, V-43, DD-60) The MA and MP were assigned to the 14th Flying Training Wing (14 FTW) at

Columbus AFB, MS. (Tabs G-9, P-3, CC-15) The MP suffered minor injuries. (Tab X-4) The MA sustained damage to the landing gear, engines, right wing, and tail section. (Tab P-3 to P-5) The impact and subsequent runway departure caused minor damage to the runway and lighting system, but no damage to private property or structures. (Tabs S-15, Z-7)

The MP was flying a night, solo continuation training (CT) mission as his fourth flight of the day. (Tabs V-35, DD-81) The mishap sortie was uneventful until the MP contacted Houston Approach control. (Tab V-7, V-39) The MP requested a visual approach to runway 17 Right (17R). (Tab N-17) Prior to receiving clearance for the visual approach, the MP channelized his attention on visually acquiring the airfield. (Tab V-58 to V-59) As a result of this channelization, he failed to sufficiently monitor his position and became geographically misoriented. When cleared for the visual approach, his only visual reference of the airfield was a "void" in the cultural lighting and he turned to a heading he believed would position him for a five to six mile final approach for runway 17R. (Tab V-10, V-43, V-45, V-48) In reality he turned the MA to point almost directly at the airfield. (Tab DD-39) At this point he further channelized his attention outside the aircraft in an attempt to locate the runway environment. (Tab V-58 to V-59)

Approximately three miles from the airfield, the MP identified a runway that he presumed was runway 17R and began a turn to line up on that runway. (Tab V-43) In reality it was runway 22. (Tab V-43) His attention then became channelized on the inconsistencies between what he was seeing outside (runway 22) and what he expected to see for runway 17R, specifically ramp lights along the right side of the runway. (Tab V-12) He also realized what he was seeing outside did not correspond with the indications on his navigation instruments. (Tab V-13) Due to Channelized Attention and Geographic Misorientation, the MP descended at a rate that placed him well above a normal glidepath (See section 4 of this report for a discussion of glidepath.). (Tab V-45)

At just less than a mile from the runway, the tower controller told the MP he was lining up on runway 22 and cleared him to land on runway 22, which he already knew was suitable for landing a T-38. (Tab DD-37, DD-41) Due to his Geographic Misorientation, the MP believed he was three to four miles from the approach end of the runway. (Tab V-45) He believed he had time to correct his glidepath prior to landing. (Tab V-14, V-49 to V-50) Due to Channelized Attention on correcting his glidepath, a slow crosscheck (visual scan of flight instruments), and attempting to discern his airspeed using only "seat-of-the-pants" (auditory and tactile cues), the MP allowed his airspeed to decay below final approach speed. (Tab V-38, V-45 to V-46, V-50 to V-51) Less than one-quarter mile from the runway, he was on an even steeper glidepath and his airspeed was 16 knots below final approach speed. (Tabs L-20, DD-44) At about 90 feet above the ground, as the landing light illuminated the runway, the MP experienced "ground rush" (sudden recognition of descent rate) and attempted to go around. (Tabs L-20, V-14, V-51) Because he had allowed his airspeed to further decay to 23 knots below final approach speed (FAS) and his descent rate to increase to 1,500 feet per minute, he was unable to prevent a runway impact of sufficient force to cause catastrophic damage to the MA's landing gear and right wing. (Tab L-20 to L-21) The impact caused the right wheel to depart the aircraft and caused significant damage to the right wing and left main landing gear. (Tab J-3, J-9) Despite appropriate control inputs by the MP, the MA departed the runway more than 2,500 feet later, causing additional damage to the landing gear, wings, and tail section. (Tabs J-3, J-9, V-52 to V-53, DD-74)

3. BACKGROUND

The MA was maintained by DynCorp International, a government contractor employed to provide aircraft maintenance support and logistics services at Columbus AFB. (Tab CC-23) The MP was assigned to the 14th Operations Support Squadron (14 OSS) and attached to the 50th Flying Training Squadron (50 FTS) for flying duties. (Tabs V-4 to V-5) The 50 FTS is within the 14th Operations Group (14 OG). (Tab CC-17, CC-19) The 14 OG is a part of the 14 FTW, which is part of 19th Air Force (19 AF). (Tab CC-12 to CC-13, CC-17) 19 AF is a Numbered Air Force within AETC. (Tabs CC-7 to CC-8, CC-12)

a. Air Education and Training Command. AETC is one of ten major commands in the USAF. (Tab CC-4 to CC-5) Headquartered at Randolph AFB near San Antonio, TX, AETC provides basic military training, initial and advanced technical training, expeditionary training, flying training, survival, evasion, resistance and escape training, weapons director training, and professional military and degree-granting professional education. (Tab CC-6 to CC-11)

b. 19th Air Force. 19 AF, with headquarters at Randolph AFB, TX, conducts AETC's flying training and is responsible for training aircrews and air battle managers. 19 AF includes 25 active duty training locations and has operational oversight over three Air National Guard units. The Headquarters is responsible for the execution of USAF initial qualification and follow-on combat crew flying training programs with graduates reporting to war-fighting commands. It ensures compliance with the Headquarters AETC policies and instructions through clear, concise execution guidance to subordinate unites. 19 AF also conducts annual Aircrew Standardization and Evaluation Visits to its units to assess the effectiveness of its training programs. (Tab CC-12)

Eleven organizations provide specialized and joint undergraduate pilot training and joint undergraduate navigator training; introduction to fighter and bomber fundamentals training; air weapons controller and air battle management training; initial and instructor enlisted aircrew member training; initial upgrade, and advanced training for helicopter and special operations aircrews; tanker/airlift aircrews; fighter aircrews; and aircrew survival training for a total of more than 19,000 students annually. (Tab CC-12)

19 AF manages two 52-week pilot training programs; Joint Specialized Undergraduate Pilot Training by the 71st FTW at Vance AFB, Oklahoma, and Specialized Undergraduate Pilot Training (SUPT) by the 47th FTW at Laughlin AFB, TX and the 14 FTW at Columbus AFB, MS. (Tab CC-12) They also manage the Euro-NATO Joint Jet Pilot Training, a 55-week undergraduate pilot training program conducted by the 80th FTW at Sheppard AFB, TX. (Tab CC-13)

c. 14th Flying Training Wing. Columbus AFB is home of the 14 FTW. The wing's mission is SUPT in the T-6 Texan II, T-38C Talon and T-1A Jayhawk aircraft. Each day the wing flies an average of 350 sorties on its three parallel runways. In addition to the flying training mission, Columbus AFB maintains more than 300 highly-trained individuals capable of deploying at a moment's notice to support worldwide taskings and contingencies. (Tab CC-15)

d. 14th Operations Group. The 14 OG and its six squadrons are responsible for the 52-week SUPT mission at Columbus AFB. 14 OG also performs quality assurance for contract aircraft maintenance. (Tab CC-17)

e. 14th Operations Support Squadron. The mission of the 14 OSS is to train Airmen to have the skills to perform their job, prepare to deploy and ready to fight worldwide; and provide unrivaled visible support in training the world's best military pilots. 14 OSS provides support to SUPT to include ground and simulator training, academic instruction, contract quality assurance, air traffic control, flight records management, weather support, life support, airfield and airspace management, programming of 94,000 flying hours, transition and international officer management and SUPT special event oversight. (Tab CC-18)

f. 50th Flying Training Squadron. The T-38 advanced phase of undergraduate pilot training is conducted by 50 FTS. This phase consists of 110 hours of flight instruction in the Northrop T-38C. Training includes advanced aircraft handling, tactical navigation, fluid maneuvering and an increased emphasis in two- and four-ship formation. At the completion of training, the graduate is awarded the aeronautical rating of pilot. (Tab CC-19)

g. T-38C Talon. The T-38C Talon is a twin-engine, high-altitude, supersonic jet trainer used in a variety of roles because of its design, economy of operations, ease of maintenance and high performance. (Tab CC-20) The T-38C has swept wings, a streamlined fuselage and tricycle landing gear with a steerable nose wheel. Two independent hydraulic systems power the ailerons, rudder and other flight control surfaces. The T-38C incorporates a glass cockpit with integrated avionics displays, heads-up display (HUD) and an electronic "no drop bomb" scoring system. (Tab CC-20)

The T-38C needs as little as 2,300 feet of runway to take off and can climb from sea level to nearly 30,000 feet in one minute. The instructor and student sit in tandem on rocket-powered ejection seats in a pressurized, air-conditioned cockpit. (Tab CC-20)

AETC uses the T-38C to prepare pilots for front-line fighter and bomber aircraft such as the F-15C Eagle, F-15E Strike Eagle, F-16 Fighting Falcon, B-1B Lancer, A-10 Thunderbolt and F-22 Raptor. (Tab CC-20)

h. DynCorp International. DynCorp International provides organizational and intermediate level aircraft maintenance and logistics services for the USAF, AETC, and the 14 FTW at Columbus AFB, MS. The aircraft supported at Columbus AFB, include the T-38C, T-1, and T-6 used for the USAF SUPT program. Additional support includes base level Precision Measurement Equipment Laboratory operations and J-85 engine regionalization repair/overhaul activities. (Tab CC-23)

4. SEQUENCE OF EVENTS

a. Mission Coordination. During the weeks prior to the mishap, the MP requested and was approved for a cross country to remain overnight at Charleston AFB, South Carolina (SC) (KCHS) in order to facilitate his participation in the Air Force Reserve Officer Training Corps (AFROTC) Day on Saturday, 12 Feb 2011 at The Citadel in Charleston, SC. (Tab V-29 to V-30) The MP planned to coordinate with the AFROTC cadre during the afternoon of Friday, 11 Feb 2011. (Tab DD-52, DD-67) On Saturday, the MP planned a presentation to the AFROTC cadets regarding pilot training and a walk around of multiple T-1, T-6 and T-38 aircraft at Charleston AFB, SC. (Tab V-29 to V-30) On 4 Feb 2011, Lieutenant Colonel (Lt Col) Steven E. Ankerstar, the 50 FTS Commander, hereinafter referred to as the 50 FTS/CC, changed his cross-country policy (See section 10 of this report for a discussion of the cross-country policy.). (Tab V-407 to V-408) This change required the MP to remain overnight at Ellington Field, Houston, TX (KEFD) if he still wanted to go cross country. As a result, the MP changed his plan to allow him to both participate in the AFROTC Day and remain overnight at Ellington Field. (Tab V-75 to V-77)

b. Pre-mission and First Sortie. On 11 Feb 2011, the MP arrived for duty at the squadron and started his Flight Duty Period (FDP) at approximately 0745. (Tab V-31) He briefed and flew an uneventful 4-ship formation student sortie. (Tab V-79, V-642) This sortie, the first of the MP's day, departed Columbus AFB, MS at 0903 and returned at 1011. (Tab K-13) The MP then debriefed the sortie and instructed the student on his performance. (Tab V-643)

c. Mission. The cross country was scheduled as a series of continuation training (CT) sorties, using the callsign JIMBO 61, IAW AFI 11-2T-38, Volume 1, *T-38C Aircrew Training*, dated 20 Jan 2011. (Tabs V-418, BB-110, AFI 11-2T-38V1) The MP was solo, in the front cockpit (FCP) of the MA, for all cross-country sorties. (Tab V-35) The cross country was designed to enhance the MP's instrument and navigation flying proficiency. (Tab BB-110, AFI 11-2T-38V1) Additionally, the MP utilized the 11 Feb 2011 sorties to visit The Citadel in South Carolina to coordinate events for the AFROTC Day. (Tab V-19) Planned mission tasks for the mishap sortie included a night takeoff from Mobile Downtown Airport, Alabama (KBFM), cruise to the Houston vicinity and an approach and landing at Ellington Field. (Tab V-7 to V-8) The cross country was authorized by Lt Col Joseph Speed, the 50 FTS Director of Operations, hereinafter referred to as the 50 FTS/DO, via an AF IMT 4327a *Flight Authorization*. (Tab K-5)

d. Planning and Briefing. Mission planning was accomplished IAW the Navigation Checklist/Flight Planning section of the *50 FTS T-38C In-Flight Guide* (IFG) dated 1 Feb 2011. (Tab V-650) A mass cross-country briefing was conducted by the project officer for the cross country, First Lieutenant Hansel N. Rabell, at approximately 1030. (Tab V-546) The mass cross-country briefing was attended by Squadron Leader Mandetirra M. Bopanna, Indian Air Force, hereinafter referred to as JIMBO 62 (his cross-country callsign), who flew in formation with the MP on the first two sorties of the cross country prior to the mishap sortie. The MP could not attend the mass cross-country briefing due to his first sortie. The mass briefing subjects included weather, Notices to Airmen (NOTAMs), project officer comments and comments from 50 FTS/CC. (Tab V-546, V-650) JIMBO 62 relayed at least some of the information from the mass briefing to the MP prior to the flight briefing. (Tab V-61, V-650)

JIMBO 62 briefed the cross-country sorties with the MP IAW the Formation Briefing Guide and the Navigation Checklist contained in the IFG. (Tab V-61 to V-62) Many subjects were discussed during this initial briefing that applied to the mishap sortie. (Tab V-61 to V-62) The mishap sortie was flown single-ship. (Tab V-8, V-23, V-38) Therefore, the MP and JIMBO 62 jointly reviewed the Single Ship Briefing Guide contained in the IFG at Mobile Downtown Airport prior to the mishap sortie. (Tab V-63)

e. Second Sortie. Following the briefings, the MP and JIMBO 62 proceeded to the 50 FTS operations desk and received their "step" briefing IAW the *Striking Snakes Step Brief Guide* and *Cross Country Briefing Guide*. (Tab V-317 to V-318) The step briefing includes, but is not limited to, a discussion of the Operational Risk Management (ORM) chit (a small form used to record the ORM assessment), pilot currency, airfield status, and aircraft assignment. (Tab BB-15, BB-18 to BB-21) At the desk, they were told that the Training Integration Management System (TIMS) schedule database had crashed and they needed to re-input all of the data for their entire weekend before they could step to their aircraft. This resulted in an approximately 30 minute delay from their planned takeoff time. (Tab V-317 to V-318)

Once they had entered the data, the MP and JIMBO 62 stepped to their aircraft and proceeded uneventfully, as a formation with JIMBO 62 in the lead, to Charleston AFB. (Tab V-21, V-61) At Charleston AFB, the MP and JIMBO 62 borrowed a car from the Fixed Base Operator (FBO) and proceeded to The Citadel. (Tab V-78) The MP had originally planned to accomplish his Citadel coordination prior to the student Retreat Parade. (Tab DD-52) Due to the delay at Columbus AFB, the MP was unable to get to The Citadel prior to the start of the parade. At The Citadel, the MP viewed the end of the parade, completed his coordination, then returned to Charleston AFB with JIMBO 62 and returned the car to the FBO. (Tab V-78) The drive to The Citadel took an estimated 15-20 minutes each way and they spent approximately an hour at The Citadel. (Tab V-79) As a result of not accomplishing his coordination prior to the parade, the MP returned to Charleston AFB later than he had planned. (Tab V-28, V-33 to V-34, V-655)

f. Third Sortie. The MP and JIMBO 62 updated their mission planning, checked the weather and NOTAMs, and briefed their sortie from Charleston AFB to Mobile Downtown Airport IAW the Formation Briefing Guide of the IFG. (Tab V-63, V-78) They stepped to their aircraft and flew uneventfully except for strong headwinds that made the sortie take longer than expected. (Tab V-22, V-656) The formation arrived at Mobile Downtown Airport shortly after sunset. (Tab V-23, V-656) Sunset occurred at 1737 in Mobile, Alabama. (Tab W-3) The MP's timeline was now approximately 1.5 hours later than planned. (Tabs K-3, V-656)

g. Fourth Sortie Briefing and Preflight. The MP and JIMBO 62 were concerned about the time they were going to arrive at Ellington Field. (Tab V-28, V-665) To participate in the AFROTC event, they wanted to be back at Charleston AFB by 1000 Eastern Standard Time (0900 CST) on Saturday, 12 Feb 2011. (Tab V-28 to V-29) They wanted to get to Ellington Field as early as possible to start their mandated crew rest of 12 hours for the next day as prescribed by AFI 11-202, Volume 3, *General Flight Rules*, dated 22 Oct 2010,. (Tab V-28) For this reason, they confirmed the FBO personnel at Mobile Downtown Airport would give them a "quick turn" which means that the FBO personnel made every safe effort to get the aircraft ready quickly. (Tab V-27 to V-28) The MP and JIMBO 62 checked the weather and NOTAMs. (Tab V-24, V-651) Due to night-time restrictions, the MP and JIMBO 62 could not fly in formation. (Tab V-8, V-23, V-38) Therefore, they reviewed the Single Ship Briefing Guide in the IFG and discussed what time they thought they would leave Ellington Field the next morning. (Tab V-28, V-63) The MP called a new flight plan into the flight service station at about 1820. (Tab V-26, V-657 to V-658)

The MP performed an uneventful preflight of the aircraft IAW T.O. 1T-38C-1, *Flight Manual*, dated 29 Nov 2009. (Tab V-26) Originally, the MP was going to start his aircraft first, but when he stepped, the start cart (a ground unit which is required to provide air to motor the engine for start) was already connected to JIMBO 62's aircraft. As a result, the MP allowed JIMBO 62 to start first. (Tab V-124, V-651) As JIMBO 62 was about to taxi, the MP asked him to delay due to a problem starting the MA's left engine. JIMBO 62 then waited until the MP was ready to taxi, after a successful start. (Tab V-660) Due to darkness and their unfamiliarity with Mobile Downtown Airport at night, the MP followed JIMBO 62 to the runway, while JIMBO 62 received turn-by-turn taxi instructions from the Air Traffic Control (ATC) tower. (Tab V-27, V-660)

h. Takeoff and Enroute. In order to ensure ATC separation, the MP departed with approximately 20 Nautical Miles (NM) spacing behind JIMBO 62. (Tab V-7) The MP's takeoff was uneventful and occurred at 1916. (Tabs V-7, DD-58) The MP flew at a speed of approximately 0.92 Mach, in an effort to maintain his separation from JIMBO 62 while also arriving at Ellington Field as early as possible to start crew rest for the next day. (Tab V-38 to V-39) The MP felt the enroute portion went better than expected since the MP was allowed to complete an enroute descent into Houston rather than having to fly the Standard Terminal Arrival (STAR). The MP testified that an enroute descent is easier to fly than a STAR. (Tab V-39)

At about 1955, in the vicinity of Lake Charles, Louisiana (LA), ATC directed the MP to proceed direct to Ellington Field. He set Ellington Field as his Embedded Global Positioning

System/Inertial Navigation System (EGI) destination. At this point the MP realized he would not reach Ellington Field and shut down the MA's engines prior to the end of his FDP. (Tabs V-32, V-40 to V-41, DD-66) Lake Charles is 117 NM east-northeast of Houston. (Tab AA-3) From about 120 NM, it would generally take about 20 minutes to get to the airfield and land. (Tab V-606) The MA was descending from 26,000 feet mean sea level (MSL) at that time. (Tabs V-59, DD-66) The MP did not consider diverting to another airfield to shorten his FDP. (Tab V-41, V-59) He felt he needed to get to Ellington Field because "that's where the jet's supposed to be." (Tab V-59) For further discussion of the MP's FDP, see section 9 of this report.

Sometime prior to their arrival in Houston Approach's airspace, JIMBO 62 reported a problem with his oxygen gauge to the MP. (Tab V-9, V-660 to V-661, V-663) The MP and JIMBO 62 together determined that the problem was only a gauge malfunction. (Tab V-9, V-660 to V-661) Despite the problem only being a gauge malfunction, it was activating lights inside JIMBO 62's cockpit approximately every 7-8 seconds, which was a distraction. (Tab V-661 to V-662) In an attempt to minimize the amount of time with lights flashing in the cockpit and to get on the ground to start crew rest for the next day, JIMBO 62 elected to fly a visual approach. JIMBO 62 assumed that a visual approach would be faster than flying an instrument approach to Ellington Field. JIMBO 62 informed the MP of his decision to fly a visual approach. (Tab V-661)

i. Arrival in East Sector of Houston Approach Airspace. The MP checked in to the East Sector of Houston Approach Control at 2003. (Tab N-17) The MP was still behind JIMBO 62 as they entered the Houston Approach airspace. (Tab V-9, V-328) At some point, JIMBO 62 became aware that there were multiple aircraft with a JIMBO callsign on the same frequency and relayed that information to the MP. (Tab V-10, V-661) The MP elected to also perform a visual approach. (Tab V-10, V-54) He reported that there were communications issues due to the number of JIMBOs on frequency and radio transmissions that were missed or incorrectly responded to, so he wanted to minimize the number of vectors he would receive by accomplishing the visual approach. (Tab V-10, V-55) A thorough review of the transcripts and the audio recordings from both Houston Approach sectors does not reveal any evidence of aircraft missing radio calls nor responding incorrectly, except by the MP. (Tab DD-72) In addition, based on the transcripts, the MP had already decided to fly a visual approach prior to his first contact with Houston Approach Control. (Tabs N-17 through N-19, DD-71)

AF Manual (AFMAN) 11-217, Volume 1, *Instrument Flight Procedures,* dated 22 Oct 2010 states the following regarding visual approaches:

> A visual approach is conducted on an IFR flight plan and authorizes the pilot to proceed visually and clear of clouds to the airport. It is used to reduce pilot/controller workload and expedite traffic by shortening flight paths to the airport. In order to accept a visual approach, the pilot must have either the airport or the preceding identified aircraft in sight, and the approach must be authorized and controlled by the appropriate ATC facility. Before a visual approach can be authorized, the airport must have a ceiling at or above 1,000 feet and visibility 3 miles or greater, ATC must determine that it will be operationally beneficial and pilots must be able to proceed visually while remaining clear of clouds. Additionally, ATC will not issue clearance until the pilot has the airport or the preceding aircraft in sight. If the pilot has the airport in sight but cannot see the preceding aircraft, ATC may still clear the aircraft for a visual approach; however, ATC retains both aircraft separation and wake separation responsibility. After being cleared for a visual approach, ATC

expects the pilot to proceed visually and clear of clouds to the airport in the most direct and safe manner to establish the aircraft on a normal straight-in final approach. (Tab BB-110, AFMAN 11-217V1)

AFI 11-2T-38, Volume 3, *T-38 Operations Procedures*, Certified Current 3 Nov 2009 as supplemented by AETC Supplement 1, Change 1, dated 3 Mar 2010, has the following guidance regarding night approaches in the T-38:

3.21.7. **(Added-AETC)** The following additional night operations procedures apply (paragraphs 3.21.7.1 **(Added)** through **3.21.7.4 (Added)**):

3.21.7.1. **(Added-AETC)** Fly night overhead patterns only at the home base. (Lackland AFB is included for the 12th Flying Training Wing.)

3.21.7.2. **(Added-AETC)** All night landings require operational glidepath guidance (precision approach or visual glidepath guidance) as follows:

3.21.7.2.1. **(Added-AETC)** Unless required by a formal course syllabus or training associated with instructing that syllabus, the preferred night approach procedures (in descending order) are as follows:

3.21.7.2.1.1. **(Added-AETC)** Precision approach.

3.21.7.2.1.2. **(Added-AETC)** Nonprecision approach with an associated visual descent path indicator

3.21.7.2.1.3. **(Added-AETC)** VFR straight-in.

3.21.7.2.1.4. **(Added-AETC)** VFR rectangular pattern.

3.21.7.2.2. **(Added-AETC)** When available, use a visual descent path indicator to monitor glide slope position during visual approaches. Also use the instrument landing system (ILS) glide slope if available. (Tab BB-110, AFI 11-2T-38V3 AETC Supplement)

While a visual approach is not specifically listed in the AETC supplement, 50 FTS instructor pilots (IPs) interviewed by the AIB generally consider that a visual approach falls into the same category as a Visual Flight Rules (VFR) straight-in. (Tab V-316, V-353, V-390 to V-391, V-516, V-549 to V-550) Although the guidance does not appear to require pilots to complete a precision approach at night, most IPs stated they would execute a precision approach if it was available. (Tab V-316, V-353, V-391, V-516, V-550) In addition the guidance specifically states, "use the instrument landing system (ILS) glide slope if available." (Tab BB-110, AFI 11-2T-38V3 AETC Supp) The MP had the Ellington Tactical Air Navigation system (TACAN) tuned and selected as his Primary Navigation Source. He had the final approach course for the ILS to runway 17R set for his navigation course. (Tab V-43) He felt this would assist him on his visual approach more than selecting the ILS. Since he felt the TACAN would give him more situational awareness, the MP did not intend to select the ILS as his Primary Navigation Source; this would prevent him from using the ILS glide slope. (Tab V-49)

j. Ellington Sector of Houston Approach Airspace. The MA was handed off to the Ellington Sector of Houston Approach control at 2007. (Tab N-17) The Ellington Sector controller vectored the MP to the northwest, then at approximately 15 NM east-northeast of the field (*AIB Note: "B/E" in the Tab represents a bearing and distance to the published center of Ellington Field*), vectored the MP to a heading of 260°. (Tabs N-18, DD-39) Shortly thereafter, the ATC controller pointed out Ellington Field to the MP at his 10 o'clock position, 7 miles away. The MP acknowledged the radio call, but did not specifically report the field in sight. (Tab N-18) At that point (2015:38), the ATC controller cleared the MP for the visual approach to runway 17R and directed him to contact Ellington Tower. (Tabs N-19, DD-72) The MA was 5.7 NM northeast of the airfield center. (Tab DD-39) Over the next 14 seconds, the MA turned left to a heading of 230°. At this point, the MA was pointed almost directly at the airfield. (Tab DD-39) Although, at about 10 miles the MP had the approximate field location in sight (which he described as a "black hole" or "void" in the cultural lighting), he could not specifically identify a runway until less than 5 miles. (Tab V-10, V-43, V-48)

k. Ellington Tower Airspace. The MP contacted Ellington Tower and was cleared to land on runway 17R at 2016:13. (Tab DD-37) At that time, the MA was 3.4 NM north-northeast of the airfield, with a heading of 244°. (Tab DD-39) At 2016:18, the MA began a left turn to a 184° heading. (Tab L-36, L-37) The MP visually acquired a runway which he assumed was runway 17R (in reality, it was runway 22). (Tab V-43) However, the MP was unsure since the runway did not look like he expected. Specifically, he expected to see ramp lights to the right of the runway, but they were not there. (Tab V-12) In addition, the MP was comparing what he was seeing outside to his navigational instruments. He stated, "the instruments and what I was seeing was not making too much sense." (Tab V-13)

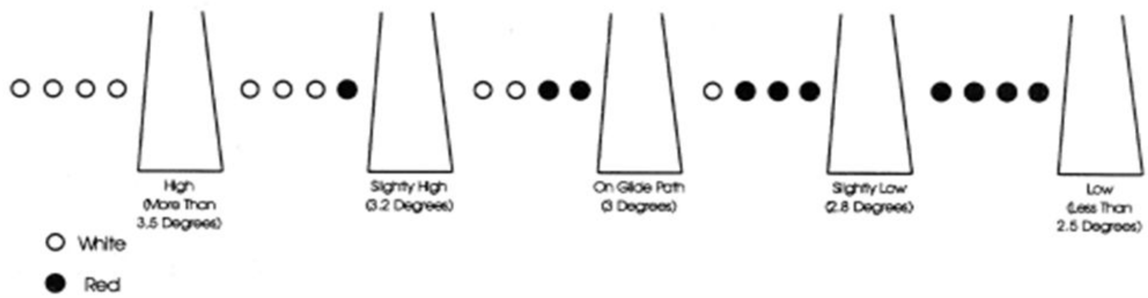
At 2016:29, the MP extended the landing gear and set the flaps to full down. (Tabs V-48, DD-58) The MP elected to perform a full-flap landing since he prefers to make his full-stop landings with full flaps. (Tab V-48) At that time, the MA was 1.9 NM from the approach end of the runway and 17° or approximately 0.5 NM right of the extended runway centerline. The MA had approximately 1,200 pounds of fuel onboard, which would drive a FAS of 162 knots calibrated airspeed (KCAS) and a touchdown speed (the speed at which the aircraft should land) of 137 KCAS. (Tabs BB-6, DD-58) The MA's flight parameters can be found in the table below.

Time	2016:29
Lt RPM, Rt RPM	52%, 58%
Airspeed (KCAS)	210
Altitude (feet AGL)	998'
Heading (degrees)	192°
Pitch (degrees)	-1.93°
Roll (degrees)	27.46° left
G loading (G)	1.23
AOA (dimensionless)	0.43
Distance from approach end	1.9 NM
Distance from runway centerline	17° (~0.5 NM)
Glidepath to runway threshold	5.25°
Glidepath to PAPI	4.82°
(Tabs L-17, L-37, DD-40, DD-58)	

AFMAN 11-251, Volume 1, *T-38C Flying Fundamentals*, dated 22 Oct 2010, paragraph 4.4.1.1 states that the desired glidepath is 3°, which equates to 300 feet above ground level (AGL) at 1 NM from the threshold. Based on this calculation, a 1° glidepath equates to 100 feet AGL at 1 NM. Therefore the MA was on a 5.25° glidepath at 1.9 NM from the runway threshold (998 feet divided by [1.9 NM times 100 ft/NM]). (Tab BB-110, AFMAN 11-251V1)

The Precision Approach Path Indicator (PAPI) is a ground-based lighting system positioned next to the runway that allows the pilot to see a glidepath that will aid in landing. The PAPI shows "high" anytime the aircraft is above a 3.5° glidepath. (Tab BB-57) The angle and runway point of intercept (distance from the threshold where an aircraft would land without flaring if on glidepath) of the PAPI glidepath will be coincident with the angle of the ILS glide slope unless otherwise noted on the associated instrument approach plate. (Tab BB-110, AFMAN 11-217V1) The Ellington Field ILS to runway 22 has a 3.00° glide slope with no noted differences for the PAPI and a threshold crossing height of 54 feet. (Tab DD-55) This equates to a runway point of intercept of 1,030 feet. (Tab BB-70) The MA's glidepath in relation to the PAPI has been calculated using the same formula from above, but adding 1,030 feet to the MA's distance from the runway threshold. Chapter 2-1 of the Aeronautical Information Manual provides an overall description of the PAPI system including this graphic: (Tab BB-57)

FIG 2-1-5
Precision Approach Path Indicator (PAPI)



The MA continued to a heading of 184° before beginning a gradual right turn to align with the runway. (Tab L-37) The MA's parameters at that time can be found in the table below.

Time	2016:34
Lt RPM, Rt RPM	52%, 55%
Airspeed (KCAS)	203
Altitude (feet AGL)	827'
Heading (degrees)	184°
Pitch (degrees)	-2.57°
Roll (degrees)	2.71° left
G loading (G)	0.99
AOA (dimensionless)	0.42
Distance from approach end	1.6 NM
Distance from runway centerline	15°(~0.41 NM)
Glidepath to runway threshold	5.17°
Glidepath to PAPI	4.67°
(Tabs L-17, L-37, DD-40, DD-58)	

Over the next few seconds, the MA's engines' percent of maximum revolutions per minute (RPM) increased. The flaps continued extending toward full flaps. At 2016:39, the MA's engines had reached a local peak of 77% and 81% RPM. (Tab DD-58) The MA's parameters at that time can be found in the table below.

Time	2016:39
Lt RPM, Rt RPM	77%, 81%
Airspeed (KCAS)	192
Altitude (feet AGL)	714'
Heading (degrees)	188°
Pitch (degrees)	-2.18°
Roll (degrees)	13.13° right
G loading (G)	1.09
AOA (dimensionless)	0.45
Distance from approach end	1.4 NM
Distance from runway centerline	11° (~0.28 NM)
Glidepath to runway threshold	5.10°
Glidepath to PAPI	4.55°
(Tabs L-18, L-38, DD-41, DD-58)	

At 2016:42, the MA was at 182 KCAS (20 knots above FAS). The MA's engines were slightly above idle (See Tab DD-80 for flight idle discussion.). The MA's pitch was decreasing toward -3.74°. (Tabs L-38, DD-58) The MA's parameters can be found in the table below.

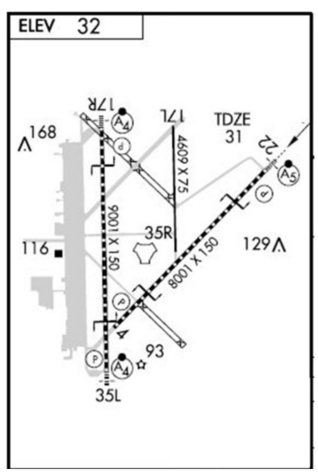
Time	2016:42
Lt RPM, Rt RPM	52%, 55%
Airspeed (KCAS)	182
Altitude (feet AGL)	632'
Heading (degrees)	194°
Pitch (degrees)	-2.65°
Roll (degrees)	13.59° right
G loading (G)	0.94
AOA (dimensionless)	0.49
Distance from approach end	1.2 NM
Distance from runway centerline	8° (~1,015 feet)
Glidepath to runway threshold	5.27°
Glidepath to PAPI	4.62°
(Tabs L-18, L-38, DD-41, DD-58)	

According to his testimony, in this time frame, the MP was attempting to establish himself on a 3° glidepath to the runway threshold, with the assistance of the PAPI. Specifically, the MP stated that at 2 NM, he applied a correction to get himself on glidepath. (Tab V-50 to V-51) The MP believed he had captured the 3° glidepath at approximately 1 NM. (Tab V-51) At 1.2 NM from the runway threshold, the MA was on a 4.62° glidepath in relation to the PAPI (See table above.). Less than 1 NM from the runway threshold, the MA was actually on a 4.41° glidepath in relation to the PAPI (See table below.).

The T-38C Angle-of-Attack (AOA) system displays "on-speed" from 0.55 to 0.65 AOA. It displays "slightly slow" from 0.65 to 0.75 AOA. It displays "slow" at or above 0.75 AOA. (Tab BB-4) The MP testified that he was not specifically using the AOA indications, but they seemed to be working correctly. (Tab V-50, V-92) At 2016:48, the MP would have received his first "on speed" indication from the AOA system. (Tab L-18) The MA's parameters at that time can be found in the table below.

Time	2016:48
Lt RPM, Rt RPM	54%, 57%
Airspeed (KCAS)	173
Altitude (feet AGL)	481'
Heading (degrees)	203°
Pitch (degrees)	-1.18°
Roll (degrees)	17.54° right
G loading (G)	1.14
AOA (dimensionless)	0.56
Distance from approach end (feet)	5,600'
Distance from runway centerline (feet)	390'
Glidepath to runway threshold	5.22°
Glidepath to PAPI	4.41°
(Tabs L-18, L-38, DD-41, DD-58)	

At 2016:45, the Ellington Tower controller began a transmission regarding the MA's position in relation to the airfield. Specifically, the controller informed the MP that he was lined up on runway 22 and cleared the MP to land on runway 22. (Tab DD-37)



During the radio call above, the MA's engines briefly powered up, reaching a peak of 84% and 85% RPM at 2016:54. (Tab DD-59) Also during the transmission, the MA's pitch increased to a peak of 4.22° and the MA's AOA rapidly increased to a peak of 0.69 at 2016:54. (Tab L-19, L-39) This change in pitch and power setting is consistent with the initial actions of a go around. This would be the first time the AOA system would display a "slightly slow" indication. The MA had slowed below FAS (161 KCAS, which is 1 knot below FAS) and never reached or exceeded FAS for the remainder of the flight. (Tab L-19 to L-22) The MA's parameters at 2016:54 are in the table below.

Time	2016:54
Lt RPM, Rt RPM	84%, 85%
Airspeed (KCAS)	161 (FAS-1)
Altitude (feet AGL)	358'
Heading (degrees)	215°
Pitch (degrees)	4.16°
Roll (degrees)	9.58° right
G loading (G)	1.24
AOA (dimensionless)	0.69
Distance from approach end (feet)	3,952'
Distance from runway centerline	~aligned
Glidepath to runway threshold	5.51°
Glidepath to PAPI	4.37°
(Tabs L-19, L-39, DD-42, DD-59)	

The MP modulated the MA's throttles repeatedly over the next 5 seconds. The lowest RPMs were 70% and 75% at 2016:55. (Tab DD-59) The highest RPMs were 82% and 85% at 2016:56. (Tab DD-59) The MA's flight parameters at 2016:56 are in the table below. Note that the G-force is at a local minimum and the AOA would indicate "on speed". (Tab L-19)

Time	2016:56
Lt RPM, Rt RPM	82%, 85%
Airspeed (KCAS)	158 (FAS-4)
Altitude (feet AGL)	337'
Heading (degrees)	216°
Pitch (degrees)	1.27°
Roll (degrees)	6.75° right
G loading (G)	0.83
AOA (dimensionless)	0.63
Distance from approach end (feet)	3,450'
Distance from runway centerline	~aligned
Glidepath to runway threshold	5.94°
Glidepath to PAPI	4.57°
(Tabs L-19, L-39, DD-43, DD-59)	

The MP reported he felt like he had reached and captured his FAS by about one-half mile from the runway threshold. (Tab V-51) His glidepath to the runway threshold had been varying between approximately 5° and 6°. (Tabs L-18 to L-19, DD-40 to DD-43) During a simulator recreation of the mishap, the power setting required to maintain airspeed on a 5.5° glidepath with gear and full flaps was 85% RPM. A shallower glidepath would require a higher power setting. (Tab DD-80) See section 4 (q) of this report for further discussion of the simulator results.

At 2017:01, the MP had reduced the MA's RPMs to 54% and 64%. The MA was at 0.648 AOA. This was the last time the MA would have displayed "on speed" indications on the AOA system. (Tab L-20)

Time	2017:01
Lt RPM, Rt RPM	54%, 64%
Airspeed (KCAS)	150 (FAS-12)
Altitude (feet AGL)	253'
Heading (degrees)	222°
Pitch (degrees)	1.12°
Roll (degrees)	3.72° right
G loading (G)	0.98
AOA (dimensionless)	0.648
Distance from approach end (feet)	2,032'
Distance from runway centerline	~aligned
Glidepath to runway threshold	7.57°
Glidepath to PAPI	5.02°
(Tabs L-20, L-40, DD-43, DD-59)	

At 2017:05, the MA briefly accelerated. It gained 1.5 knots from the previous second (144 KCAS) to reach 145.5 KCAS. (Tab L-20) The MP had set the MA's RPMs to 89% and 92% (the peak for the final approach) before reducing the power setting back to idle. (Tab DD-59 to DD-60) The MA's pitch, which had reached 4° at 2017:03, was at 1.9°. (Tab L-40) The MA was at 0.76 AOA. The AOA system would have displayed full "slow" indications. (Tab L-20) The MA's flight parameters are in the table below.

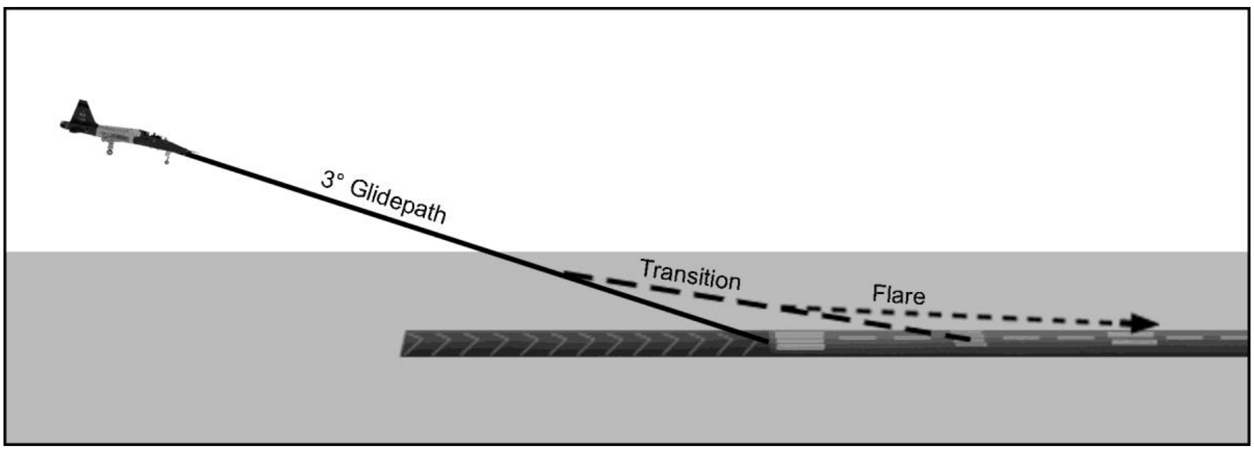
Time	2017:05
Lt RPM, Rt RPM	89%, 92%
Airspeed (KCAS)	145.5 (FAS-16.5)
Altitude (feet AGL)	182'
Heading (degrees)	223°
Pitch (degrees)	1.9°
Roll (degrees)	0.25°
G loading (G)	0.97
AOA (dimensionless)	0.76
Distance from approach end (feet)	1,170'
Distance from runway centerline	~aligned
Glidepath to runway threshold	9.46°
Glidepath to PAPI	5.03°
(Tabs L-20, L-40, DD-44, DD-59)	

Over the next few seconds, it appears the MP pushed forward on the flight control stick; the MA's G-force decreased to a minimum of 0.82G, the AOA decreased to 0.71 ("slightly slow" indications) and the pitch decreased to 0°. (Tab L-20, L-40) The G-force then briefly increased back to 1.03G before it decreased again to 0.90G. (Tab L-20) The pitch increased to 1.7° before it decreased again to 0.73°. (Tab L-20, L-40) The AOA steadily increased throughout, but the indications would have remained "slightly slow". (Tab L-20) Both engines continued decelerating toward idle and the airspeed continued to decay. (Tabs L-20, DD-59 to DD-60)

AFMAN 11-251, Volume 1 describes the transition phase of the approach to landing as:

> The transition phase is where the pilot transitions from maintaining glidepath, aimpoint, and airspeed to level flight in preparation for the flare. The transition involves both a power reduction and a pitch change. Gross weight, airspeed, winds, height above the runway, descent rate, and AOA affect the timing of the power reduction and the rate of pitch change. As the aircraft completes the transition, it must be positioned at the correct altitude, pitch, and airspeed to flare. (TAB BB-110, AFMAN 11-251V1)

See the accompanying graphic below for a side view of what the final approach to landing should look like. (Tab BB-110, AFMAN 11-251V1)



At 2017:09, the MA's engines were at flight idle. The MA was at 139 KCAS (23 knots below FAS) at 90 feet AGL. (Tab L-20) The MA was at 0.75 AOA ("slow" indications). (Tab L-20) The MP described using the runway threshold as his aimpoint. The MP described his transition phase as "normal". He also described having shifted his aimpoint to approximately 500 feet past the runway threshold and setting idle power at approximately the runway threshold. (Tab V-51) At this time, taking into account distance from the threshold and the MP's testimony, the MP should have already completed a transition to an aimpoint 500 feet past the runway threshold. The MA's glidepath to 500 feet past the approach end of the runway was more than 7°. (Tab BB-110, AFMAN 11-251V1) This was the closest to a 3° PAPI indication (4.2°) achieved by the MP, however the PAPI would still have indicated "high". (Tab BB-70) The MA's flight parameters are in the table below.

Time	2017:09
Lt RPM, Rt RPM	51%, 54%
Airspeed (KCAS)	139 (FAS-23)
Altitude (feet AGL)	90’
Heading (degrees)	224°
Pitch (degrees)	1.47°
Roll (degrees)	2.6°
G loading (G)	0.97
AOA (dimensionless)	0.75
Distance from approach end (feet)	273’
Distance from runway centerline	~aligned
Glidepath to 500 feet past runway threshold	7.08°
Glidepath to PAPI	4.20°
(Tabs L-20, L-40, DD-44, DD-60)	

At approximately this time, the MA’s landing light had begun illuminating the runway. The MP experienced “ground rush” as he recognized a large sink rate. (Tab V-51) He set the throttles to maximum afterburner and pulled back on the flight control stick in an attempt to arrest his sink rate. (Tab V-14) The MA’s AOA and pitch began increasing at 2017:09. (Tab L-20) The engines’ RPMs began increasing at 2017:10. (Tab DD-60) With the landing gear extended, the T-38C displays the Stall Warning when 0.80 AOA is reached or exceeded. (Tab BB-5) The MA would have begun displaying the Stall Warning indications at 2017:10 while at 61 feet AGL. (Tab DD-60) The MA’s airspeed and altitude continued to decrease while the AOA and pitch continued to increase. (Tab L-20 to L-21, L-40 to L-41) According to AFMAN 11-251, Volume 1, “an actual stalled condition is immediately preceded by heavy, low-frequency buffet, and in most cases, moderate wing rock. The actual stall is indicated by a combination of a very high sink rate, heavy buffet, and high AOA (above 1.0).” (Tab BB-110, AFMAN 11-251V1) The MA recorded 1.02 AOA at 0.4 seconds prior to impact. Therefore, the MA was stalled prior to impact. (Tabs J-17, L-21)

The MA’s descent rate was accelerating throughout the final seven seconds of flight. The MA recorded “weight on wheels” at 2017:12.771. (Tab DD-60) The table below shows the MA’s descent rate based on AGL altitude and time to impact.

Time	Time to impact	Altitude (feet AGL)	Descent rate (ft/s)	Descent rate (ft/min)
2017:05.421	7.35 sec	180	24.5	1,469
2017:09.221	3.55 sec	90	25.4	1,524
2017:10.421	2.35 sec	61	26.0	1,560
2017:11.421	1.35 sec	33	28.7	1,722
(Tab L-20 to L-21)				

l. Impact. At 2017:12, the MA impacted the runway. (Tab DD-60) The MA’s parameters at impact can be found in the table below. Engineering data places the maximum G-force attained at 7.36G. (Tab J-17)

Time	2017:12
Lt RPM, Rt RPM	81%, 96%
Airspeed (KCAS)	124
Altitude (feet AGL)	0’
Heading (degrees)	224°
Pitch (degrees)	9.95°
Roll (degrees)	3.49°
G loading (G)	2.73
AOA (dimensionless)	1.09
Distance from runway threshold (feet)	520’ past
Distance from runway centerline	Left main landing gear 3 feet right
(Tabs L-21, L-41, DD-60, DD-73)	

A hard landing, with less than 1,700 pounds of fuel on board, is defined as 590 ft/min. (Tab BB-8). The MA’s descent rate of at least 1,722 ft/min was more than 2.9 times the definition of a hard landing.

m. Runway skid. At impact, the right main landing gear wheel axle separated from the strut. The separated right wheel and axle departed the left side of the runway. (Tab J-3) The left main landing gear bent outboard. (Tab J-9) The stub of the right main landing gear then touched down on the runway. The right main stub supported the right side of the MA while dragging on the runway, creating sparks. (Tabs J-3, V-323)

Both engines reached at least 98% RPM at 2017:13. (Tab DD-60 to DD-61) The MA began accelerating and achieved a peak airspeed of 131 KCAS at 2017:14. (Tab L-21) (This is consistent with the MP having selected afterburner prior to impact.) The RPMs then began rapidly decreasing and the MA began decelerating again. (Tab DD-61) The MP reported that shortly after impact he retarded the throttles to idle. (Tab V-14) The MA continued down the runway in a 9-9.5° right bank due to the missing wheel and axle. (Tab L-41 to L-42)

Approximately 450 feet after touchdown, the MA started a gradual drift to the right on the runway. (Tab DD-73) The MP applied flight controls to control the drift and recovered runway alignment about 850 feet from the point of impact. (Tabs V-52 to V-53, DD-73) Approximately 1,200 feet from the point of impact, the MA again began to gradually drift and yaw toward the right side of the runway. (Tab DD-73) The MP reported that he tried all means available to keep the MA on the runway, including full left rudder and full left brake. The MP did not use the nose wheel steering system since he was above 65 knots ground speed. (Tab V-52 to V-53) At 2017:18, the Ellington Tower controller, seeing the sparks, queried, "You have a blown tire?" The MP responded in the affirmative. Ellington Tower initiated a crash response. (Tab DD-37)

The MP recognized he would be unable to keep the aircraft on the runway. (Tab V-52 to V-53) He reported the last airspeed he saw prior to runway departure was 100 KCAS. (Tab V-53) His personally pre-determined minimum airspeed for a ground ejection was 70 KCAS. (Tab V-14) The MP reported seeing a hill off the right side of the runway as he was considering ejecting from the MA. Due to proximity of the perceived hill, combined with a perceived steep right bank and fear that he would hit the hill upon ejection, the MP elected not to eject from the MA. (Tab V-15)

n. Runway Departure. At 2017:25, the MA's right main landing gear stub departed the runway surface 2,285 feet from the point of impact. (Tabs L-42, DD-74) The MA was traveling at 89 KCAS or 81 knots ground speed. The MA began yawing further to the right. (Tabs L-42, DD-45) The MA's nose wheel and right main landing gear stub independently impacted a concrete footing for a runway light. The nose landing gear sheared at the strut. (Tab J-3) The MA abruptly yawed to the right, reaching a maximum heading of 333°. The MA initially banked further to the right, reaching a maximum right bank of 13.73°. (Tab L-42) The left main landing gear then collapsed. (Tab J-3) This resulted in a rapid roll to the left. The maximum left bank was 19.28°. (Tab L-42) The left horizontal stabilizer dug into the dirt, resulting in an abrupt yaw back to the left and a rapid deceleration. (Tabs J-3, L-22, L-42) The MA came to rest at 2017:28, just 3 seconds after departing the runway, with a heading of 261°. (Tab L-22, L-42) The tail of the aircraft was 2,546 feet from the impact point and 96 feet to the right of the runway centerline (21 feet right of the edge of the runway). (Tabs K-24, DD-74)

o. Pilot Egress. No ejection was initiated during the mishap sequence. (Tabs J-3 to J-4, V-15) The MP shut down both engines and performed an uneventful emergency ground egress. The MP walked to a nearby runway light and attempted to flag down the fire department vehicles. (Tab V-15 to V-16) Fire department personnel located the MP approximately 150-300 feet from the MA. The MP told them he was uninjured. After the fire department personnel ensured the MA was safe to approach, they allowed the MP to get his belongings. He then was transported to the ramp in an airfield operations vehicle. (Tab R-97, R-99) The emergency was terminated at 2112. (Tab F-7)

p. Aircrew Flight Equipment. All required Aircrew Flight Equipment inspections were current IAW Technical Order guidance. The MP was wearing the appropriate life support equipment for the mission. All equipment was in good condition and functioned properly. (Tab H-9)

q. Simulator Analysis. The AIB used a T-38C simulator to recreate and investigate the MA's sequence of events. The AIB Pilot Member, with the help of the AIB President and Medical Member, executed six different scenarios on 6 Apr 2011. (Tab DD-77)

The following preconditions were used: The weather used was the reported weather at the actual impact time of the mishap: night, winds from 090° at 3 knots, no clouds, visibility 10 statute miles, altimeter 30.42 inHg and temperature 5°C. (Tab F-7) All airfield lighting was set to a brightness setting of 2 out of 5 to match the conditions present at the time of the mishap. (Tab V-329 to V-330)

The scenarios executed in the simulator were derived from the MA's Mission Display Processor (MDP) data, in an attempt to mimic the MA's ground track and flight parameters. In addition, for each scenario except Scenario 1, the AIB Pilot Member made one or more attempts to land the simulator – simulating the MP recognizing his flight parameters at the scenario start time and making appropriate corrections. (Tab DD-77)

(1) Scenario 1. Initial contact with Houston Approach - 2003:53: 096° from Ellington field at 59.1 NM, Altitude: 12,000 feet MSL, Pitch: 1.5°, Roll: 0.4° right, Heading: 280°, Airspeed: 367 KCAS, Fuel: 1,590 pounds (lbs). (Tab DD-39, DD-75) A script of radio communications was created from the various ATC transcripts found in Tab N to assist in mimicking the MA's ground track. Results: The AIB was able to approximately follow the MA's ground track and line up on runway 22. The AIB noted that at the point the MP was cleared to land on runway 17R, runway 22 was much more visually prominent. The AIB could see runway 17R, but it was not obviously a runway until the airfield lighting was turned up to setting 4 or 5. Based on experience by the AIB Pilot Member during a T-1 flight and numerous descriptions from the IP witnesses interviewed, the simulator appears to adequately represent the airfield lighting, but does not appear to adequately represent the cultural lighting. (Tabs N17 to N-19, V-10, V-135, V-274, V-512, DD-75 to DD-78)

(2) Scenario 2. Landing Gear extension – 2016:29: Latitude: N29.6431°, Longitude: W95.1319° (1.9 NM from runway threshold), Altitude: 998 feet AGL, Pitch: -2.02°, Roll: 27.79° left, Heading: 192°, Airspeed: 210 KCAS, Fuel: 1,200 lbs, Engine RPMs: 52%, 57% and decreasing. At outset, the landing gear and full flaps were extended. Results: Numerous attempts were made to exactly mimic the MA's flight parameters. One of the attempts did mimic the MA's parameters, many attempts resulted in errors of airspeed either too high or too low approaching the runway threshold. Three attempts were made to safely land the simulator, all successful. (Tabs L-17, L-37, DD-40, DD-58, DD-78)

(3) Scenario 3. Furthest left heading – 2016:34: Latitude: N29.6380°, Longitude: W95.3273° (1.6 NM from runway threshold), Altitude: 824 feet AGL, Pitch: -2.54°, Roll: 1.85° left, Heading: 184°, Airspeed: 203 KCAS, Fuel: 1,200 lbs, Engine RPMs: 52%, 54%, landing gear extended, flaps at 45% and extending. Results: Numerous attempts were made to mimic the MA's flight parameters. Three attempts were successful. The remaining attempts had airspeed errors as described in Scenario 2. Three attempts were made to safely land the simulator, all successful. (Tabs L-17, L-37, DD-40, DD-58, DD-78)

(4) Scenario 4. Landing clearance for Runway 22 issued – 2016:50: Latitude: N29.6250°, Longitude: W95.1360° (5,050 feet from runway threshold), Altitude: 430 feet AGL, Pitch: 1.17°, Roll: 17.7° right, Heading: 207°, Airspeed: 170 KCAS, Fuel: 1,200 lbs, Engine RPMs: 61%, 65% increasing toward 85%, landing gear extended, flaps full down. Results: Numerous attempts were made to mimic the MA's flight parameters. At least five attempts were successful at mimicking the MA's parameters. The remaining attempts resulted in airspeed deviations as described in Scenario 2. Five attempts were made to safely land the simulator, all successful. (Tabs L-18, L-38, DD-58, DD-78 to DD-79)

(5) Scenario 5. First AOA "Slow" indication – 2017:04: Latitude: N29.6167°, Longitude: W95.1428° (1,337 feet from runway threshold), Altitude: 198 feet AGL, Pitch: 2.933°, Roll: 2.67° right, Heading: 223°, Airspeed: 144 KCAS, Fuel: 1,190 lbs, Engine RPMs: 79%, 83% increasing toward 92%, then to idle prior to crossing runway threshold, landing gear extended, flaps full down. Results: Numerous attempts were made to mimic the MA's flight parameters. At least ten attempts were successful at mimicking the MA's parameters, including the impact. (Tabs L-20, L-40, DD-59, DD-79)

Ten attempts were made to safely land the simulator. All were successful, but the AIB Pilot Member noted that attempts to land in the first 1,000 feet of the runway were notably more difficult. (Tab DD-79)

(6) Scenario 6. Second AOA "Slow" indication & MP reported "Ground Rush"– 2017:09: Latitude: N29.6140°, Longitude: W95.1451° (273 feet from runway threshold), Altitude: 90 feet AGL, Pitch 1.47°, Roll: 2.59° right, Heading: 223°, Airspeed: 139 KCAS, Fuel: 1,190 lbs, Engine RPMs: 51%, 54%, landing gear extended, flaps full down. Results: Numerous attempts were made to mimic the MA's flight parameters, as well as numerous attempts to prevent a hard landing and/or crash. All attempts had similar results to the MA's flight parameters. The AIB Pilot Member attempted a variety of flight control inputs including those described by the MP and traffic pattern stall recoveries. The AIB Pilot Member was unable to prevent a hard landing on all attempts. (Tabs L-20, L-40, DD-44, DD-60, DD-79 to DD-80)

The AIB members noted that the simulator's engines accelerated from idle to approximately 98% RPM in approximately 2.5 seconds. (Tab DD-80) The MA's engines required 3.1 seconds and 2.7 seconds to reach 98% RPM. (Tab DD-60) Even using the faster acceleration of the simulator's engines, the AIB Pilot Member was only able to reduce the descent rate to 700 ft/min at touchdown. (Tab DD-80)

In most cases, the AIB Pilot Member briefly delayed increasing power to more closely replicate the MA's engines. The slowest descent rate noted was 900 ft/min; on that occasion, the G meter recorded 3.2G. The lowest G-force recorded was 2.7G; on that occasion, the descent rate just prior to impact was 1,100 ft/min. The worst recorded case was an 8.3G impact with an unknown descent rate; this resulted from applying afterburner and full nose-up flight controls and was an expected result. (Tab DD-80)

In addition to the scenarios above, the AIB members explored engine RPMs at flight idle. Idle RPM on the ground is 46-50%. In the air, due to airflow into the intakes, idle RPM will be higher by a varying amount. Therefore, there is no flight idle operations limit other than a minimum fuel flow. (Tab BB-7) The AIB members tested the simulator's flight idle RPMs at airspeeds ranging from 135 KCAS to 165 KCAS while at 50-500 feet AGL. The simulator's flight idle RPM was 50-51% and increased with airspeed. (Tab DD-80)

The AIB members also noted the RPM required to maintain FAS. While the simulator was configured with landing gear extended and full flaps, on a 5.5° glidepath, with 1,200 lbs of fuel onboard and at 162 KCAS, the engines needed to be at approximately 85% RPM to maintain FAS. (Tab DD-80)

r. Mishap Animation. The MA's MDP flight loads and Aircraft Maneuvering Instrumentation (ACMI) periodic data were analyzed and converted into several animations, which included the actual audio recordings from Ellington Tower. Each animation captures a different perspective of the MA during the sequence of events. Mr. Stephen Ames of Wright-Patterson AFB, Ohio (OH), generously donated his time and expertise to provide the AIB with the well-detailed animations. (Tab Z-7)

5. MAINTENANCE

a. Forms Documentation.

(1) Summary. Air Force Technical Order (AFTO) 781 and 95 series forms, which document all maintenance performed on the MA, were reviewed and verified with the Integrated Maintenance Data System (IMDS). (Tab D-3 to D-33) The historical records were complete and did not reveal any recurring maintenance problems with the MA. (Tab D-3 to D-33) There were no overdue time change items or aircraft Time Compliance Technical Orders (TCTO). Periodic Inspections were up to date with no discrepancies noted. (Tab D-12 to D-13) Compliance with and documentation of AFTOs, TCTOs, and maintenance historical records were not a factor in this mishap.

(2) Major Maintenance. A minor phase inspection was accomplished on the MA on 9 Nov 2010. The MA had flown 63 hours since its last inspection. (Tab D-3, D-11) There were no open inspection discrepancies in the AFTO Form 781A. (Tab D-9 to D-10) All major maintenance documentation was complete and was not a factor in this mishap. (Tab D-3 to D-33)

(3) Engines. The MA's number 1 (left) engine, S/N GE00231079, had approximately 11,281.4 hours of operation since manufacture. The MA's number 2 (right) engine, S/N GE00230938, had approximately 10,414.4 hours of operation since manufacture. (Tab D-3, D-11) Engine number 1 had 361.1 hours since the last phase inspection; engine number 2 had 456.7 hours. (Tab D-3) Scheduled maintenance and inspections for both engines were complied with and were not a factor in this mishap. (Tab D-3, D-11 to D-12)

b. Inspections. The last scheduled inspection for the MA was a 450-hour phase inspection completed at 14,840.1 airframe flight hours of operation. (Tab D-11) The total airframe flight hours of operation at the time of the mishap were 14,903.5 hours. (Tab D-3) A review of the AFTO Form 781K revealed no open discrepancies. However, there is a notation in the 781K indicating that a temporary repair to the MA's vertical stab leading edge was performed. (Tab D-14) Repair guidance for this discrepancy was authorized by Depot Disposition 107 request from 558 ACSG/ENC Hill AFB, Utah (UT). (Tab U-3 to U-5) There were no overdue inspections for the MA. (Tab D-12 to D-14) All inspections on the MA were complied with; inspections were not a factor in this mishap.

c. Unscheduled Maintenance. No unscheduled maintenance actions were performed on the MA since the last scheduled inspection through the last maintenance preflight inspection. (Tab D-3 to D-33) Unscheduled maintenance was not a factor in this mishap.

d. Maintenance Procedures. All maintenance procedures on the MA were conducted IAW applicable AFTOs and TCTOs. (Tabs D-3 to D-33, U-15 to U-16) The previous night's basic post-flight inspection, exceptional release and maintenance pre-flight inspections were accomplished and documented on the AFTO Form 781H; the MA was released for flight. (Tab D-7 to D-8) Maintenance procedures were not a factor in this mishap.

e. Fuel, Hydraulic, Oil, and Liquid Oxygen Inspection Analyses. Fuel, hydraulic, and oil samples were taken from the MA at Ellington Field after the mishap. (Tab U-6 to U-14) Additionally, samples were taken from the hydraulic cart, liquid oxygen cart and fuel truck that serviced the MA at Columbus AFB. (Tabs D-31 to D-33, U-6 to U-14) All samples taken were analyzed at the Air Force Petroleum Agency Laboratory at Wright-Patterson, AFB, OH. All samples met specification requirements and were not a factor in this mishap. (Tabs D-31 to D-33, U-6 to U-14)

f. Maintenance Personnel and Supervision. DynCorp Services, Inc., a private defense contractor, provides services and personnel to maintain the T-38C aircraft at Columbus AFB. (Tabs U-15 to U-16, CC-23) DynCorp maintenance personnel training records were reviewed; all personnel were found to be qualified and proficient in the performance of their duties. (Tab U-15 to U-16) Maintenance personnel and supervision were not a factor in this mishap.

6. AIRCRAFT AND AIRFRAME SYSTEMS

a. Condition of Systems. Engineers from the 506th Engineering Group, Ogden Air Logistics Center, Hill AFB, UT, conducted the inspections, analysis and testing on the MA at Ellington Field after the mishap. (Tab J-3 to J-19) The structural damage to the MA was severe and occurred as a direct result from the aircraft's hard landing and departure from the runway surface. (Tab J-3 to J-4) The heaviest impact damage was due to the right Main Landing Gear (MLG) penetrating through the upper wing skin. (Tabs J-4, J-7, Z-4) The location of the wing damage was at the 64.8 rib and the 44% and 66% spars to which the right MLG is attached. (Tabs J-7, Z-3) The aircraft sustained significant collateral damage as a result of departing the runway. (Tab J-3 to J-4) The following sections of the MA sustained damage: right wing; nose landing gear (NLG), both MLG; right flap, left horizontal stabilizer (HS), HS torque tube and boattail support structure. (Tabs J-3 to J-4, J-7 to J-15, Z-6)

(1) Initial MA Inspection. Initially the MA was inspected at the mishap site and the following damage observations were made. The wing, landing gear, fuselage aft section, both HS flight control surfaces, horizontal stabilizer, boattail, torque tube, both right and left flaps, and lower fuselage were all damaged. (Tabs J-3 to J-5, J-14, Z-5 to Z-6) Both the front and rear canopy were intact and open. (Tab J-4) The NLG and drag brace assemblies were connected but severed at the top of the lower junction of the piston. (Tab J-10 to J-11) The right MLG main landing gear assembly was partly intact with the upper portion of the MLG protruding through the top of the wing. (Tab J-8) The left MLG assembly was collapsed and appeared to be largely intact. (Tab J-9)

(2) Flight Control Surfaces and Cockpit Settings. The following items were noted during initial inspection of the MA. Flight control surfaces and cockpit settings were in the following positions after the aircraft came to rest:

- The left flap was detached from the aircraft. The right flap remained attached to the aircraft but its control mechanism was damaged.
- Ailerons were neutral but drooping.
- HS was heavily damaged on the left side.
- The rudder was near neutral.
- Speed brakes were level with each other but partially open.
- Both fuel shutoff switches were in the "NORMAL" position.
- The throttles were "OFF". The "OFF" lockout gate had been raised to place the throttles in the full "OFF" position.
- The speed brakes switch was in the "OPEN" position. (Tab J-4)

(3) In-Depth Hangar Inspection. The following aircraft components were visually inspected during an in-depth inspection in Building 1395 at Ellington Field. (Tabs J-6 to J-16, Q-4) Control surfaces, control surface actuators and motors, and the landing gear for the MA were visually inspected and functionally checked. All damage to the MA was consistent with impact damage as a result of the mishap. (Tab J-3 to J-19) The wing was visually inspected and the following damage was noted. The right upper wing surface was damaged due to the right MLG penetration. (Tabs J-5, Z-4) The damage location was at the 64.8 rib and the 44% and 66% spars to which the right MLG is attached. (Tabs J-7, Z-3, BB-9 to BB-11) The aircraft sustained significant collateral damage as a result of departing the runway. (Tab J-3 to J-4) Evidence of damage included:

- Broken right MLG at the strut location with approximately 8 inches of material from the end of the broken strut abraded off due to contact with the runway surface (Tab J-7 to J-8)
- Collapsed left MLG which was bent 30 degrees outward at the strut (Tab J-9)
- NLG broken off at the top portion of the lower junction of piston (Tab J-9)
- Both flaps and both ailerons sustained damage (Tab J-11 to J-13)
- Left HS was damaged (Tab J-13 to J-14)
- HS torque tube and boattail support structure were damaged (Tabs J-13 to J-14, Z-5 to Z-6)

b. Analysis. The engineers from the T-38 Systems Programs Office (SPO) of the proven aircraft division, Hill AFB, UT, determined the mishap sequence was as follows:

1. Before touchdown, the aircraft speed was too slow. The aircraft stalled. The minimum landing speed is 135 KCAS per the flight manual.
2. Three seconds prior to touchdown, the engine speed was increased, but it was too late to gain enough speed to recover from the stall prior to touchdown.
3. Upon touchdown, the aircraft sustained a high 7.36 G load. This load is approximately 2.3 times what the landing gear are designed to sustain.
4. After touchdown, the right MLG strut failed due to overstress and the wheel departed the aircraft.
5. The left MLG bent severely but the wheel did not break off.
6. The broken right MLG strut impacted the runway.
7. The G forces of landing partially damaged the right wing and caused structural rivets to "POP" off.
8. The landing gear retained enough strength to support the aircraft as it slid down the runway.
9. The engines were throttled back to idle two seconds after touchdown.
10. The aircraft veered off the right side of the runway approximately 2000 feet past the initial touchdown location.
11. The aircraft yawed right. Both the NLG and the right MLG impacted a concrete block and suffered additional damage.
12. The aircraft yawed more right.
13. The left MLG collapsed inward.
14. The aircraft tilted/rolled to the left.
15. The left HS and left side of the wing impacted the ground.
16. The left HS and both flaps sustained damage.
17. The aircraft yawed back to the left and came to a stop shortly thereafter.
18. The ejection handles remained in the down position.
19. The engines were shut down after the aircraft came to rest.
20. The speed brake switch was placed in the open position after the aircraft came to rest. This is proven because there was no abrasion on the brake surfaces and there was no debris inside the fuselage where the speed brake actuators are housed, indicating they were closed until the aircraft came to rest. However, the speed brake switch was in the open position upon inspection, indicating the switch was opened after the aircraft stopped moving. (Tab J-17 to J-18)

c. Testing. Visual inspections, functional check tests, and teardown analyses on the MLG, NLG, brake systems and the Nose Wheel Steering Assembly were performed at Ellington Field by engineers from the 417th Supply Chain Management Squadron (SCMS), Hill AFB, UT. (Tab J-21 to J-41)

(1) Main Landing Gear System. The runway tire marks of the NLG and both MLG assemblies were in their down and locked positions upon landing. The right MLG failed in the brake-flange-to-fork transition radius; resulting in right MLG wheel departing the MA strut. (Tab J-22 to J-23) The right tire was retrieved fully pressurized. (Tab J-8, J-37) The Materials Lab at Hill AFB determined the right MLG components failed in overload stress caused by excessive forces during aircraft touchdown. (Tab J-23, J-40) As a result of excessive landing force the left MLG absorbed the weight transition resulting in the left strut bending outward 30 degrees. (Tab J-9, J-21, J-23) Due to the 30 degree deformation of the strut, the left MLG tire was degraded and lost all pressurization. (Tab J-9) The brakes and nose wheel steering are considered to have no contribution to the MA's runway departure. (Tab J-40)

(2) Nose Landing Gear. Upon departing the runway the NLG struck a concrete footing for a runway light fixture and the NLG and wheel were sheared off of the MA. (Tab J-17, J-21, J-24 to J-26) Nose wheel tire pressure was released during the mishap. (Tab J-9) The NLG wheel and tire functioned IAW their design requirements. The NLG was determined by engineers from the 417th SCMS at Hill AFB to be operating within design requirements and did not affect normal functioning of the MA. (Tab J-40)

(3) Main Landing Gear Brake Stacks. The right and left landing gear brake stacks were disassembled and inspected. (Tab J-37 to J-39) The left wheel brake stack looked intact except for the bottom edge which experienced runway surface contact. (Tab J-37) The right wheel brake stack looked new but had some wear and tear evident. (Tab J-37, J-39) Both the left and right brake stacks operated within design limits and did not affect normal functioning of the brake system. (Tab J-37, J-39) No analysis was done on the brake system as they appeared to have normal wear and tear with no evidence of malfunction. (Tab J-37)

(4) Materials Lab Testing. The MLG strut and axle were sent to the 809 Maintenance Support Squadron (MXSS) Science and Engineering Laboratory (accredited by the American Association for Laboratory Accreditation) at Hill AFB, UT. (Tabs J-43, Q-4) Fracture surfaces were inspected under high magnification and a hardness survey was performed to identify possible property changes due to apparent heat damage. (Tab J-43) The laboratory determined that the failure of the MLG strut and axle was the result of overstress experienced during landing. Any heat induced damage was secondary to the overstress failure. (Tab J-49)

There was no evidence of mechanical or electrical problems with the MA prior to the mishap. There was no evidence of any aircraft malfunctions that would have caused the aircraft to stall unexpectedly. (Tab J-17)

7. WEATHER

a. Forecast Weather. The forecast weather on 11 Feb 2011 at 2017 at Ellington Field was: winds from 350° at 6 knots, sky clear and unrestricted visibility. (Tab F-6) Moonset was forecast at 0102 on 12 Feb 2011. (Tab F-3)

b. Observed Weather. The last weather observation before the mishap was recorded at 1950. The observed weather was winds from 190° at 3 knots with no gust, sky clear and visibility 10 statute miles. Temperature was reported to be 5°C. (Tab F-6) The Ellington Tower log shows the weather at 2016: Winds from 090° at 3 knots with no gust, sky clear and altimeter setting 30.42 inHg. Temperature was reported to be 5°C. (Tab F-7) Sunset was at 1806. Moonrise was at 1140 with 47.2% illumination. (Tab F-3)

c. Operations. Both the aircraft and airfield were being operated within their prescribed operations limitations. (Tab V-42, V-327)

8. CREW QUALIFICATIONS

a. Mishap Pilot. The MP joined the United States Air Force in 2002 through AFROTC. (Tab T-5) The MP received his pilot rating at Laughlin AFB, TX. (Tab T-6) From 2003 to 2005, the MP flew the B-1. Between 2005 and 2008, the MP was in a non-flying assignment. (Tab T-6) In October 2008, the MP returned to flying the B-1. (Tab T-6) He recorded a total of 1,129 hours in the B-1, including 381 hours at night. (Tab G-9 to G-10) In March 2010, the MP became qualified as a T-38C Instructor Pilot at Randolph AFB, TX. (Tab G-4 to G-5) The MP was then assigned to Columbus AFB, MS, where he received Mission Qualification Training and subsequently became qualified as a Functional Check Flight pilot. (Tab G-17 to G-33, G-41) As of 12 Feb 2011, he had logged 349.1 hours in the T-38C, including 225.6 hours of instructor time and 15.4 hours of night time. (Tab G-9) Since he graduated from pilot training, the MP had logged 1,478.6 hours of total time in USAF aircraft. (Tab G-10)

The MP was a current and qualified, experienced instructor pilot for the sortie being flown at the time of the accident. (Tab G-4 to G-7, G-15 to G-16, G-31, G-39). Monday through Thursday of the week of the mishap, the MP had flown three sorties. (Tab DD-81) His 30, 60, and 90 day flight history, prior to the mishap, was as follows:

Look back	Sorties	Hours	
30 days	15	14.4	
60 days	33	33.0	
90 days	52	50.7	(Tab G-11)

9. MEDICAL

a. Flying Qualifications. The MP was medically qualified for flying duties at the time of the mishap. The MP's most recent annual military Periodic Health Assessment was performed on 9 Sep 2010, and the MP's annual dental examination was performed on 22 Sep 2010. (Tab X-3) His medical records contained a current Air Force Form 1042, Medical Recommendation for Flying or Special Operational Duty, dated 9 Sep 2010. (Tab X-5)

Physical and medical qualifications were not factors in this mishap. (Tab X-3)

b. Health Prior to Mishap. The AIB Medical Member reviewed the medical and dental records of the MP. The MP's records reflected he was in good health and had no recent performance limiting illnesses prior to this mishap. Review of the Aeromedical Information Management Waiver Tracking System (AIMWTS) database, a computer system for tracking aircrew medical waivers, showed that MP did not have a medical waiver at time of the mishap. (Tab X-3)

The MP was in good health and had no recent medical or psychological conditions that contributed to the mishap. (Tab X-3)

c. Injuries. After the MA came to a complete stop, the MP successfully emergency egressed without assistance. After egress, he waited by a runway light. (Tab V-16) Ellington Field fire department personnel responded to the location; the emergency responders located the MP. They reported he felt fine and did not need medical attention. (Tabs R-97, R-99, V-99) The MP was seen by the Medical Administrative Officer and Flight Surgeon at Ellington Field for a physical examination and to obtain blood and urine samples. The MP denied injury on 11 Feb 2011 after the mishap and no further medical imaging or care was performed at that time. (Tabs V-98 to V-99, X-4, X-6)

In the days following the mishap, the MP reported worsening lower back pain. (Tabs V-99, X-4) An initial X-ray displayed a possible compression fracture in the MP's spine. A magnetic resonance imaging (MRI) scan revealed no fracture, but the MP did have "minimal annular bulging at L4-5 and L5-S1" (the lumbar region of his spine), which may or may not have been pre-existing. The MP was treated by the Columbus Flight Surgeon Office and referred to a spinal specialist. The MP's treatment plan developed by the spinal specialist was conservative medical management, including gradually increasing physical activity and follow-up only as needed. (Tab X-4)

d. Toxicology. Immediately following the mishap and in accordance with safety investigation protocols, blood and urine samples were collected and submitted to the Armed Forces Institute of Pathology in Washington, D.C. for toxicological analysis. There were no abnormalities noted for alcohol, illicit drugs, or toxins found in the blood or urine samples taken from the MP. (Tab X-3, X-6)

e. Lifestyle. No lifestyle factors were found to be relevant to the mishap. (Tabs X-3)

f. Crew Rest and Flight Duty Period. AFI 11-202, Volume 3, *General Flight Rules*, dated 22 Oct 2010, "prescribes mandatory crew rest and maximum Flight Duty Periods (FDP) for all personnel who operate USAF aircraft." (Tab BB-59) Paragraph 9.8 of AFI 11-202, Volume 3, requires pilots to have crew rest prior to their FDP. (Tab BB-64) AFI 11-202, Volume 3, paragraph 9.4.5 defines the Crew Rest Period as "normally a minimum 12-hour non-duty period before the FDP begins." (Tab BB-60) During this time, "aircrew require at least 10 continuous hours of restful activities (including an opportunity for at least 8 hours of uninterrupted sleep) during the 12 hours immediately prior to the FDP." (Tab BB-64) The MP reported 8 hours of restful sleep the night prior to the mishap. (Tab V-94) Crew rest was deemed not to be a factor in this mishap.

AFI 11-202, Volume 3 prescribes a maximum Flight Duty Period. Per paragraph 9.7.2 and Table 9.1, the maximum FDP for a "Single Control Aircraft" is 12 hours. (Tab BB-62 to BB-63) Paragraph 9.4.6 of AFI-11-202, Volume 3 defines the FDP as beginning "when an aircrew member reports for a mission, briefing, or other official duty and ends when engines shut down at the end of the mission, mission leg, or a series of missions." (Tab BB-60) The MP entered the 50 FTS for duty between 0740 and 0745 on 11 Feb 2011 for a flight briefing. (Tab V-31) Therefore, his FDP should have ended no later than 1945. His take-off time from Mobile Downtown Airport was 1916. (Tab DD-58) The mishap at Ellington Field occurred at 2017, at least 30 minutes beyond the prescribed end of his FDP. (Tab DD-60) The MP violated the Flight Duty Period requirements of AFI 11-202, Volume 3 in this mishap.

10. OPERATIONS AND SUPERVISION

a. Operational Tempo (OPTEMPO). The squadron's OPTEMPO was high at the time of the mishap. The annual student pilot load had increased from 72 students in Fiscal Year 2009 (FY09) to 99 students in FY10 and 118 students in FY11. (Tab V-374, V-379) IP manning had lagged behind authorized manning, decreasing the IP-to-student ratio. (Tab V-364 to V-365) Due to a significant reduction in Air Force Reserve Military Personnel Appropriations (MPA), the number of T-38 sorties flown by Reserve IPs had dropped by approximately 100 sorties per month. (Tab V-362) Additionally, the squadron's preparations for an upcoming Aircrew Standardization and Evaluation Visit and Unit Compliance Inspection required IPs to spend additional time on administrative duties. (Tab V-282 to V-283, V-504, V-595) Finally, due to poor weather the squadron was behind the timeline for student pilot training during the weeks prior to the mishap, requiring IPs to fly additional student sorties in order to recover. (Tab V-361 to V-362) These factors all caused an increase in the OPTEMPO during the weeks leading up to the mishap. (Tab V-282 to V-283, V-594 to V-595) The 50 FTS/CC had a heightened awareness of the increased OPTEMPO, but did not believe the squadron was overly strained or fatigued. (Tab V-362 to V-363)

b. Experience Level. The MP was certified as a T-38C IP on 19 Apr 2010 and was an experienced IP per the requirements specified in the AETC Supplement to AFI 11-2T-38, Volume 1, as indicated on his certification letter dated 24 Jun 2010. (Tab G-31, G-39) He had flown 332 T-38 sorties, accumulating nearly 350 hours of T-38 flight time including 225 hours of instructor time. (Tab G-9) The operations supervisor on duty during both the MP's departure for his morning student instructional sortie and his departure for the cross country had four months of experience as an operations supervisor. (Tab DD-48) The 50 FTS/DO was the weekend operations supervisor on duty for the remainder of the 11-13 Feb 2011 weekend, with 11 months of experience as an operations supervisor. (Tab DD-48) According to the 50 FTS Letter of Xs dated 10 Feb 2011, 90% of the squadron's IPs were experienced. (Tab T-3) Experience level was not a factor in this mishap.

c. Supervision. The 50 FTS/CC established the date for the cross country more than two months in advance. (Tab V-458) The 50 FTS/DO originally approved the MP's cross-country plan on a cross-country coordination worksheet dated 18 Jan 2011. (Tab DD-67) The 50 FTS/CC subsequently changed his approval on 4 Feb 2011 to require the MP to remain overnight at Ellington Field. (Tab V-408) The mishap flight was properly authorized on an AF IMT 4327a *Flight Authorization* signed by the 50 FTS/DO on 11 Feb 2011. (Tab K-5) All required currency and qualification items were up to date for the MP. (Tab K-11) The on-duty squadron operations supervisor briefed the MP using the 50 FTS "Striking Snake Step Brief" briefing guide. (Tabs V-318, BB-15, BB-18 to BB-21)

The MP's original plan, as approved by the 50 FTS/DO after consultation with the 50 FTS/CC, was to remain overnight at Charleston AFB on Friday and Saturday night to facilitate his participation in AFROTC events at The Citadel. That plan called for two sorties into Charleston

AFB on Friday afternoon, out-and-back sorties on Saturday afternoon from Charleston AFB, and two sorties on Sunday to return to Columbus AFB. (Tabs V-74, DD-67)

One week prior to the mishap the 50 FTS/CC notified the MP that he must remain overnight at Ellington Field if he wanted to go cross country. (Tab V-408) This decision was driven by two factors.

First, once word began to spread that the MP had been approved to remain overnight at a location other than the squadron-designated cross-country location for the weekend, other IPs began to make similar requests. (Tab V-404) The 50 FTS/CC wanted to keep everyone "centralized versus sending everybody out and about." (Tab V-421 to V-422)

Second, he was concerned about complaints regarding his squadron cross-country policy. (Tab V-421 to V-422) Lt Col David Easterling, who wanted to accompany the MP on his cross country to Charleston AFB, had previously complained to wing leadership about the 50 FTS/CC's cross-country fiscal policies. (Tab V-148 to V-149, V-376 to V-378) On a previous cross country, Lt Col Easterling had not been properly reimbursed for his lodging. (Tab V-148, V-377) At the time, the 50 FTS/CC had placed a cap on the maximum lodging that would be reimbursed for cross-country Temporary Duty (TDY) travel. (Tab V-376) While Lt Col Easterling's originally planned destination for that cross country fell below the cap, he had to change his destination due to weather. (Tab V-147) Lodging expenses at the new destination exceeded the squadron cap. (Tab V-147) The 50 FTS/CC only reimbursed Lt Col Easterling at the capped rate. (Tab V-148, V-376 to V-377) As a result of Lt Col Easterling's complaint, 50 FTS cross-country policy was changed and Lt Col Easterling later filed for and received proper lodging reimbursement. (Tab V-168, V-377) Despite this, Lt Col Easterling continued to have concerns about the squadron's cross-country fiscal policy. (Tab V-150)

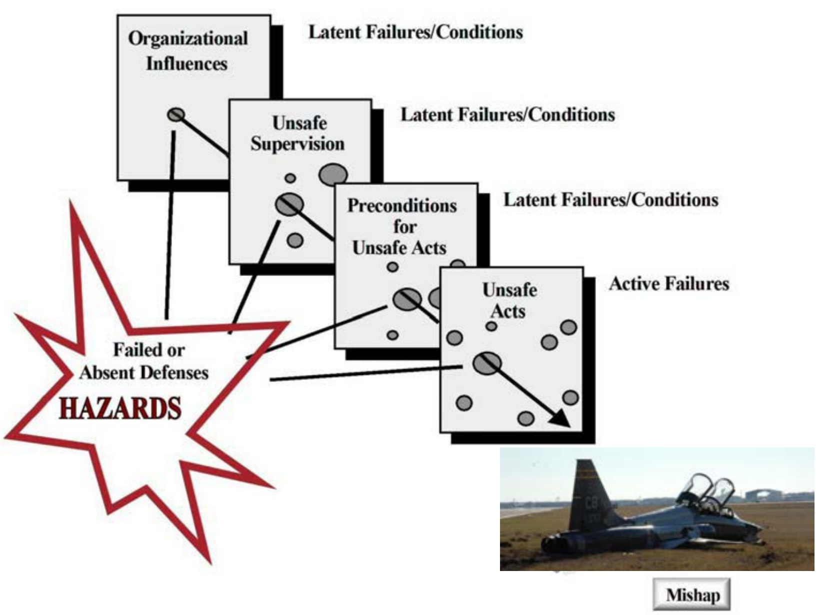
For the squadron cross country to Ellington Field, the 50 FTS/CC had established a policy that IPs would only be reimbursed five dollars for meals on Saturday. He deemed the meals to be provided, since food is available at the Ellington Field FBO for a minimal daily fee. (Tab V-381 to V-382) When Lt Col Easterling requested to accompany the MP to Charleston AFB to support the activities at The Citadel, the 50 FTS/CC informed him he would only be reimbursed for meals at the lower rate that had been established for Ellington Field. Additionally, the 50 FTS/CC informed Lt Col Easterling that he must also procure lodging in Charleston, SC at his own expense. The MP had already agreed to these stipulations for this trip. (Tab V-481 to V-483) Lt Col Easterling requested to be reimbursed to stay on-base at Charleston AFB and was able to show that the total TDY cost, using the lower per diem rate, would be about $20 more than an Ellington Field cross country. (Tab V-486 to V-493)

The 50 FTS/CC was concerned that Lt Col Easterling would stay off-base and/or claim full meals and lodging, thus incurring additional expenses against the squadron's TDY budget. He was also concerned that Lt Col Easterling might use this cross country as a venue to highlight his remaining concerns over the squadron's cross-country policy. (Tab V-157, V-407) He consulted with Colonel George Ross, 14 FTW Vice Commander, and Lt Col Robert Hume, 14 FTW Staff Judge Advocate. (Tab V-408) Both recommended that he modify his policy to pay everyone the full per diem rate for meals. (Tab V-408) Colonel Ross additionally recommended he allow Lt Col Easterling to stay on base at Charleston since the lodging cost was offset by the fact that the MP would be staying with friends at no cost. (Tab V-690)

On 4 Feb 2011, the 50 FTS/CC announced the policy change requiring everyone to remain overnight at Ellington Field, and allowing reimbursement at the full per diem rate. (Tab V-422) The 50 FTS/CC testified that he made the change because he was "tired of discussing the policy." (Tab V-421 to V-422) The 50 FTS/CC personally notified the MP that he would also be required to remain overnight at Ellington Field in accordance with the new policy, if he still wanted to go cross country. (Tab V-421 to V-422) 50 FTS/CC told the MP he could still accomplish his planned activities at The Citadel as long as he could make the timing work and remain overnight at Ellington Field. (Tab V-408) The MP's activities at The Citadel and the distance between Charleston AFB and Ellington Field resulted in the MP flying the mission into Ellington Field as his fourth sortie of the day, solo, single-ship, at night, at the end of his flight duty period, and as his first night arrival into Ellington Field since pilot training in 2003. (Tabs T-5, V-8, V-23, V-24 to V-25, V-32, V-35, V-38, V-40 to V-41, V-416 to V-417, DD-66, DD-81) Details regarding squadron supervision in relation to risk management are discussed in Section 11 below.

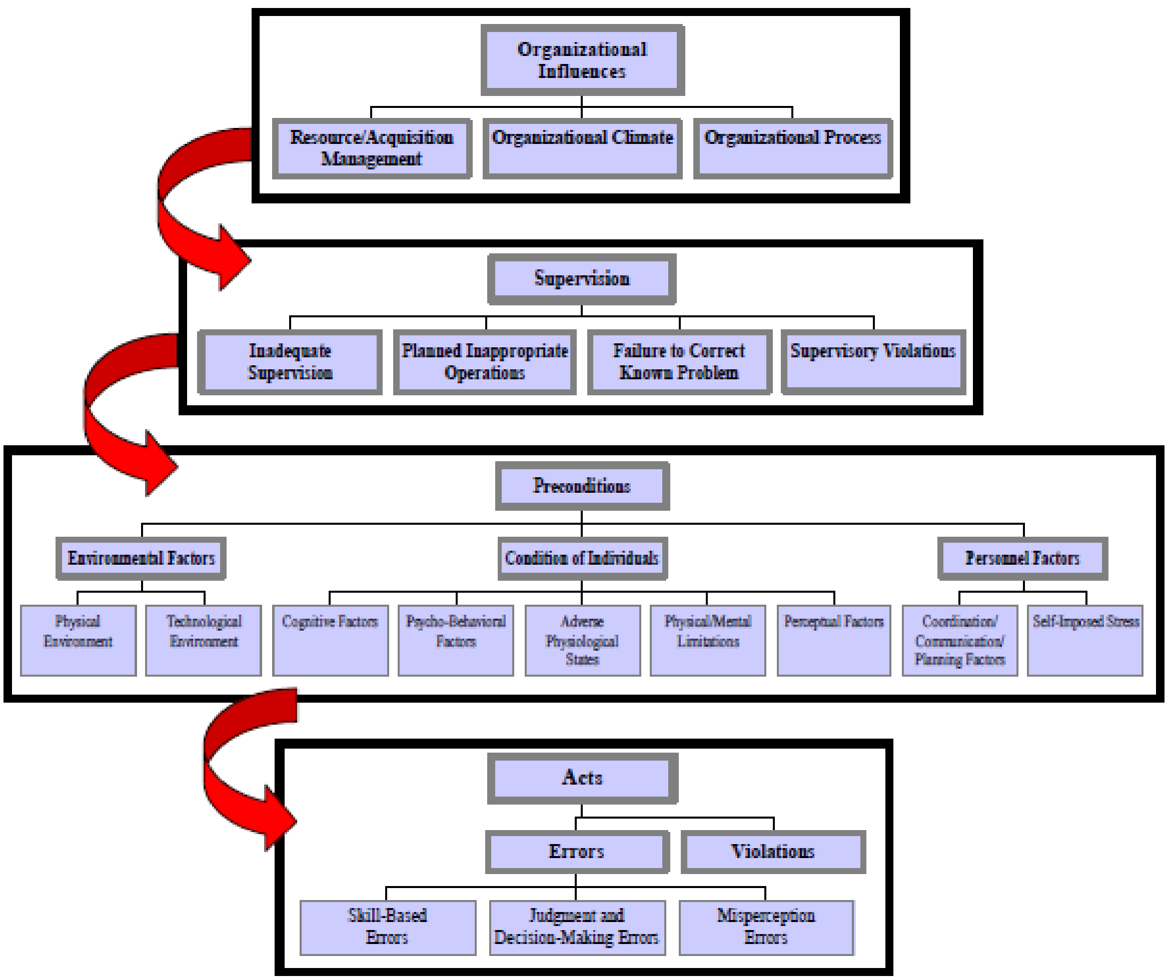
11. HUMAN FACTORS ANALYSIS

a. Overview. A human factor is any environmental factor or individual physiological factor a human being experiences that contributes to or influences performance during a task. The human factors analysis is an important piece of any aviation mishap investigation. "Human error at some level is identified as a causal factor in approximately 80-90% of mishaps, and is present but not causal in another 50-60% of all mishaps." It is rare that a single, identifiable human error is determined to be causal to a mishap. There are usually several human errors or factors that eventually lead to a chain of events or conditions that end up contributing to a mishap. (Tab DD-82 to DD-84)



Adapted from The "Swiss Cheese" Model (adapted from Reason, 1990) (Tab DD-85)

In 2003, the Department of Defense (DoD) developed a standardized mishap investigation and data analysis tool known as the Department of Defense Human Factors Analysis and Classification System (DoD HFACS). (Tab DD-82 to DD-83) This tool describes four main tiers of failures or conditions that may contribute to a mishap: 1) Acts; 2) Preconditions; 3) Supervision; and 4) Organizational Influences. (Tab DD-85) Acts are those factors that are most closely tied to the mishap, and can be described as failures or actions committed by the operator that results in human error or an unsafe situation. (Tab DD-87) Preconditions such as environmental factors, personnel factors or conditions of the operator may affect practices or actions of individuals, thus resulting in human errors or an unsafe situation. (Tab DD-88) Supervision is a factor in a mishap if the methods, decisions or policies of the supervisory chain of command directly affect practices, conditions, or actions of individuals and result in human error or unsafe situation. (Tab DD-111) Organizational Influences are factors in a mishap if communications, actions, policies or significant omissions by upper-level management directly or indirectly affect supervisory practices, conditions or actions of the operators resulting in system failure, human error or an unsafe situation. (Tab DD-114)



DOD HFACS Model (Tab DD-86)

The AIB considered all human factors contained in the DoD HFACS guide and analyzed them to identify relevant factors in this mishap. After reviewing all the factual evidence and witness testimonies, factors that were found to be relevant to this mishap were identified using the taxonomy and definitions set forth in the DoD HFACS guide, with the corresponding codes displayed for further reference as needed. (Tab DD-87 to DD-93) In this mishap, the AIB determined many facts overlapped multiple human factor definitions and did not clearly fall into only one definition according to the taxonomy. Where this occurs, the human factors involved are first identified, then the facts relating to those human factors are discussed together.

b. Acts and Preconditions related to the MP

Acts are those factors that are most closely tied to the mishap, and can be described as active failures or actions committed by the operator that result in human error or unsafe situation. (Tab DD-95)

Preconditions are factors in a mishap if active and/or latent preconditions such as conditions of the operators, environmental or personnel factors affect practices, conditions or actions of individuals and result in human error or an unsafe situation. (Tab DD-98)

1. **Excessive Motivation to Succeed**
   a. **Excessive Motivation to Succeed (PC212).** This is a factor when the individual is preoccupied with success to the exclusion of other mission factors leading to an unsafe situation. (Tab DD-102)

   b. **Task/Mission-In-Progress Re-Planning (PP111).** This is a factor when crew or team members fail to adequately reassess changes in their dynamic environment during mission execution and change their mission plan accordingly to ensure adequate management of risk. (Tab DD-109)

   c. **Discussion.** The MP originally planned a cross country to Charleston AFB to attend a ROTC event at his *alma mater*, The Citadel. (Tab V-29) On his original plan, the MP had planned two sorties to Charleston on Friday, 11 Feb 2011. (Tab V-74) He would then coordinate at The Citadel for the next day's events and remain overnight in Charleston, SC. (Tab V-23) On Saturday, 12 Feb 2011, the MP would make a presentation about pilot training and being a pilot in the Air Force to ROTC cadets at approximately 0800 Eastern Standard Time (EST). From there the MP and the cadets would proceed to Charleston AFB from approximately 1000 to 1200 EST to view the T-38, T-6 and T-1 aircraft that were being flown in on various cross-country sorties to Charleston AFB. (Tab V-28 to V-30) After the AFROTC Day events were completed, the MP planned to fly out-and-back sorties from Charleston AFB. (Tabs V-74, DD-67) On Sunday, 13 Feb 2011, the MP would fly two sorties returning to Columbus AFB. (Tab V-77)

   On Friday, 4 Feb 2011, the 50 FTS/CC announced a squadron cross-country policy change regarding remain overnight location and directed the MP to change his plans. The 50FTS/CC now required the MP to remain overnight at Ellington Field both nights if he still wanted to go cross country. He also told the MP that he could still accomplish his obligations at The Citadel as part of the continuation training cross country. (Tab V-75, V-408)

Therefore, the MP now had two goals. The first goal was to fulfill his obligations at The Citadel. The second goal was to comply with 50 FTS/CC's directive to remain overnight at Ellington Field. (Tab V-75 to V-77)

At no time did the MP consider opting out of the Citadel event. (Tab V-110) He developed and coordinated the event starting more than one month prior. (Tab V-110) As a result, he felt a professional obligation to follow through on the event. (Tab V-112)

The MP wanted to satisfy the mission requirement of remaining overnight at Ellington Field while incorporating the Citadel event. (Tab V-112 to V-113) The MP knew the schedule for 11 Feb 2011 was going to be tight, "…when the plan had changed for me being able to go to Charleston with my formation, that week it was known that that was going to be a long day, regardless..." (Tab V-36) Despite knowing his FDP was going to be tight, he did not consider staying at Mobile Downtown Airport; "the jet was to be in Ellington. And I still had time on my duty day." (Tab V-37)

On the ground at Mobile Downtown Airport, the MP realized he needed a quick turn. When he arrived at Mobile Downtown Airport, around 1800, he had accumulated multiple delays totaling 1.5 hours from the planned arrival. (Tab V-20, V-656) The MP and JIMBO 62 "were looking at the next day's events, because [they] needed to have 12 hours…before the next day's events." (Tab V-28) Because it was night, the MP was forced to re-plan the last leg to split the formation into two single-ship entities. The MP confirmed the FBO personnel were going to service their aircraft quickly. At about 1820, he called new flight plans in for himself and JIMBO 62 for a planned departure in the 1840 to 1850 timeframe. (Tab V-31 to V-32, V-658) With a planned 52 minutes enroute to Ellington Field, the MP expected to land 10 minutes prior to the end of his allowable FDP (which would end no later than 1945). (Tabs K-3, V-25, V-31) The MP and JIMBO 62 briefed their plan and expected the MP to start before JIMBO 62. (Tab V-651)

The MP experienced further delays when attempting to start his jet at Mobile Downtown Airport. The T-38 requires an external source to provide air to start the two engines and the only start cart at Mobile Downtown Airport was already connected to JIMBO 62's aircraft. As a result, the MP allowed JIMBO 62 to start first. Once the start cart was moved to his aircraft, one of the MA's engines failed to start on the first attempt. (Tab V-660) The MA's Mission Display Processor (MDP: the aircraft's central computer) was turned on at 1859. (Tab DD-58) Even if it was possible to takeoff immediately after MDP power up, based on the

MP's planned flight time of 52 minutes, it was no longer possible for the MP to arrive at Ellington Field within his allowed FDP. (Tab K-3) The MP actually departed at 1916. The MP had 17 minutes between MDP power-up and takeoff to realize he could no longer arrive at Ellington Field prior to the end of his FDP. (Tab DD-58) The MP did not adequately monitor the time in relation to his FDP while at Mobile Downtown Airport.

The MP's excessive motivation to succeed in both goals led to him flying a fourth sortie, flown entirely at night, and attempting to land more than 30 minutes beyond the end of his FDP. This combination of factors may have led to fatigue, as discussed below.

2. Fatigue

a. Fatigue – Physiological/Mental (PC307). This is a factor when the individual's diminished physical or mental capability is due to an inadequate recovery, as a result of restricted or shortened sleep or physical or mental activity during prolonged wakefulness. Fatigue may additionally be described as acute, cumulative, or chronic. (Tab DD-104)

b. Discussion. The MP testified that he had not had any problems with sleep or fatigue during the two weeks prior to the mishap. (Tab V-93 to V-95) Cumulative and chronic fatigue were not factors in this mishap.

The MP did not specifically more fatigued than usual leaving Mobile Downtown Airport or in the air on his final sortie to Ellington Field. (Tab V-37, V-98) Additionally, JIMBO 62 did not identify concerns of fatigue in the morning or prior to the fourth sortie. (Tab V-651 to V-652, V-659 to V-660) However, when asked if he felt fatigued, the MP testified:

> As it gets nighttime you're obviously going to be aware of your crosscheck and you know, I realized it was getting a little bit slower. Looking back on it, seeing that my instruments were not doing what I was expecting them to do and things like that, obviously I was, but at the time I did not notice any kind of effects or need or feel tired. (Tab V-37)

According to *Operational Risk Management of Fatigue Effects* by James C. Miller, Ph.D., states of wakefulness and sleepiness have direct effects on cognitive and physical performance effectiveness as individuals work across the day and night. "Fatigue in its many forms is often misrepresented as an unavoidable risk in military operations, and its severity is often underestimated by those affected." (Tab DD-10) Potential fatigue-related effects include cognitive impairment, slowed response time, narrowed attention, loss of situational awareness, and reduced interpersonal communications among others. (Tab DD-12 to DD-13, DD-32 to DD-33) Based on the MP's testimony, in hindsight, he self-identified several cognitive effects consistent with fatigue. (Tab V-37)

3. **In-flight Procedures and Decision Making**

   a. **Procedural (AE103).** This is a factor when a procedure is accomplished in the wrong sequence or using the wrong technique or when the wrong control or switch is used. This also captures errors in navigation, calculation or operation of automated systems. (Tab DD-95)

   b. **Risk Assessment – During Operation (AE201).** This is a factor when the individual fails to adequately evaluate the risks associated with a particular course of action and this faulty evaluation leads to inappropriate decision and subsequent unsafe situation. This failure occurs in real-time when formal risk-assessment procedures are not possible. (Tab DD-96)

   c. **Decision-Making during Operation (AE206).** This is a factor when the individual through faulty logic selects the wrong course of action in a time-constrained environment. (Tab DD-96)

   d. **Task/Mission-In-Progress Re-Planning (PP111).** This is a factor when crew or team members fail to adequately reassess changes in their dynamic environment during mission execution and change their mission plan accordingly to ensure adequate management of risk. (Tab DD-109)

   e. **Discussion.** The MP filed a flight plan departing Mobile Downtown Airport to Ellington Field via Lake Charles, LA. The MP and JIMBO 62 had planned and briefed an ILS approach (a precision approach) to runway 35L at Ellington Field. (Tab V-7 to V-8) The MP did not have a copy of the book that contains the Ellington Field instrument approach plates. (Tab V-24 to V-25) He obtained the ILS instrument approach plate for runway 17R, but only had a TACAN instrument approach plate for runway 22, as a backup. (Tab V-10) After leaving Mobile Downtown Airport with a night takeoff, the two aircraft proceeded separately direct to Lake Charles and then via ATC vectors to Ellington Field. (Tab V-8 to V-9) The two pilots learned from the Ellington Field Automated Terminal Information System (ATIS) the active runway was 17 Right, not 35 Left as originally planned. (Tab V-8)

   JIMBO 62 decided to fly a visual approach into Ellington Field due to an aircraft malfunction and his belief that a visual approach would enable him to land sooner. (Tab V-661 to V-662) The MP elected to mimic JIMBO 62 and perform a visual approach. He reported that there were communications issues due to the number of JIMBOs on frequency and radio transmissions that were missed or incorrectly responded to, so he wanted to minimize the number of vectors he would receive by accomplishing the visual approach. (Tab V-10, V-54) A thorough review of the transcripts and the audio recordings from both Houston Approach sectors does not reveal any evidence of aircraft missing radio calls nor responding incorrectly, except by the MP. In addition, based on the transcripts, the MP had already decided to fly a visual approach prior to his first contact with Houston Approach Control. (Tabs N-17 to N-19, DD-71) The MP felt comfortable flying a night visual approach because he had recently flown night visual approaches at Columbus AFB. (Tab V-54) He assessed only the benefits of the visual approach and weighed this against what is allowed by the AFIs. In his testimony, the MP did not report attempting to assess the risks of flying a visual approach into Ellington Field prior to making his decision. (Tab V-55 to V-57) Yet, the MP knew flying into Ellington Field was difficult, especially at night. "It's a dangerous place. If you've never flown into there, it's a dangerous place flying, at night, just because of the environmental [lights]." (Tab V-109)

According to the AFI 11-2T-38, Volume 3, AETC Supplement 1, the "preferred" night landing approach procedure is a precision approach (such as ILS). The visual approach falls below precision approach and non-precision approach in the preferential order. Additionally, this instruction states ILS glide slope will be used if available (See section 4 of this report.). The MP did not intend to use ILS glide slope guidance. (Tab V-49) Multiple IPs in the 50 FTS, including the 50 FTS/CC, testified they believe they must choose the most precise approach available, i.e. fly ILS approach if available. (Tab V-133, V-295, V-316, V-353, V-391, V-516, V-605) Furthermore, they would not choose to fly a visual approach on their first night arrival into a given airfield. (Tab V-295, V-314, V-347, V-353, V-516) The MP chose an approach procedure that other 50 FTS IPs would not have chosen when in the same situation.

The MP did not utilize an ILS to guide his approach into Ellington Field. (Tab V-44) The MP selected the Ellington TACAN as his Primary Navigation Source and set the final approach course for the ILS to 17R in his course window to help give an overall global picture of his location and to aid his approach into Ellington Field. (Tab V-10, V-12, V-43 to V-44) The MP turned toward the first runway he saw without realizing it was runway 22. However, the MP was unsure since the runway did not look like what he expected. Specifically, he expected to see ramp lights to the right of the runway, but they were not there. (Tab V-12) In addition, the MP was comparing what he was seeing to his navigational instruments. He reported that, "the instruments and what I was seeing was not making too much sense." (Tab V-12) Despite these discrepancies, he did not consider executing a go around. (Tab V-47)

4. Disorientation

a. Geographic Misorientation (PC107). This is a factor when the individual is at a latitude and/or longitude different from where he believes he is or at a lat/long unknown to the individual and this creates an unsafe situation. (Tab DD-101)

b. Spatial Disorientation (Type 1) Unrecognized (PC508). This is a failure to correctly sense a position, motion or attitude of the aircraft or of oneself within the fixed coordinate system provided by the surface of the earth and the gravitational vertical. Spatial Disorientation (Type 1) Unrecognized is a factor when a person's cognitive awareness of one or more of the following varies from reality: attitude; position; velocity; direction of motion or acceleration. Proper control inputs are not made because the need is unknown. (Tab DD-107)

c. **Spatial Disorientation (Type 2) Recognized (PC509).** This is a failure to correctly sense a position, motion or attitude of the aircraft or of oneself within the fixed coordinate system provided by the surface of the earth and the gravitational vertical. Spatial Disorientation (Type 2) is a factor when recognized perceptual confusion is induced through one or more of the following senses: visual; vestibular; auditory; tactile; proprioception or kinesthetic. Proper control inputs are still possible. (Tab DD-107)

d. **Misinterpreted/Misread Instrument (PC505).** This is a factor when the individual is presented with a correct instrument reading but its significance is not recognized, it is misread or is misinterpreted. (Tab DD-106)

e. **Discussion.** As stated above, the MP departed Mobile Downtown Airport, travelled directly to Lake Charles, and then to Ellington Field via radar vectors. (Tab V-7 to V-9) The MP selected the Ellington TACAN as his Primary Navigation Source and set the final approach course for the ILS to 17R as his final approach course to help give him overall situational awareness of his position and direction of travel relative to the runway. (Tab V-10 to V-11) During the approach into Ellington Field, he felt as if he was on a base leg (approximately perpendicular to final approach) for about a 5 NM final approach to runway 17R. (Tab V-43) Once the MP visually acquired a runway (in fact runway 22), the position of the runway was consistent with where he expected to find runway 17R. When asked if he felt he was on a base leg to runway 22, the MP testified, "When I picked up 22 I felt that was Runway 17… I was on base, you know, and I'm turning towards a dogleg here that's got to be it." (Tab V-46) However, he noticed his navigation instruments and the airfield lighting were inconsistent with what he expected and he did not believe his instruments. (Tab V-12) This is consistent with Misinterpreted/Misread Instruments. The MP had lost situational awareness and was, in fact, geographically misoriented. (Tab V-47) The MP realized his error only after the Ellington Tower controller communicated that he was approaching runway 22:

> Tower then informed me that it looked like I was lining up with Runway 22. That's about the time that my situational awareness got back to where it needed to be and that's why it was not looking correct outside, and why my instruments--they weren't lying to me. They were telling the truth as to [the] way I was lined up. (Tab V-13)

While the MP had regained situational awareness in relation to his heading, he was still geographically misoriented in relation to his distance from the runway. As the MP was establishing himself on final approach and receiving the radio call notifying him that he was landing on runway 22, he thought he was 3 to 4 NM from the runway. (Tab V-45) In fact, he was much closer (approximately 1 NM from the runway - See section 4 of this report.).

The MP knew he was steep and used the PAPI and his Heads-Up Display flight path marker to aid in his descent as he approached the runway. (Tab V-13 to V-14, V-49 to V-51) He believed the PAPI was telling him he was approaching with a normal glidepath (In fact, he never would have received any PAPI indications other than "high" – See section 4 of this report.). (Tab V-50) The MP had an excessive vertical velocity but did not realize this because he did not monitor his Vertical Velocity Indicator (VVI). (Tab V-52) The MP did not sufficiently monitor his airspeed and did not realize that it had decayed to 23 knots below FAS over the 18 seconds prior to impact (See section 4 of this report.). Both of these failures are consistent with Unrecognized Spatial Disorientation.

5. Channelized Attention

a. Channelized Attention (PC102). This is a factor when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others of a subjectively equal or higher or more immediate priority, leading to an unsafe situation. May be described as a tight focus of attention that leads to the exclusion of comprehensive situational information. (Tab DD-100)

b. Discussion. There is evidence of three distinct instances of Channelized Attention in this mishap: finding the runway, determining why the runway looked wrong, and fixing his glidepath.

First, the MP reported he was overly focused on "finding the field." (Tab V-58) At this point, other IPs reported that they would be attempting to line up on a 3 to 5 NM final. (Tab V-295, V-317, V-354) This may have led to the Geographic Misorientation discussed in this section.

Second, when he was cleared to land on runway 17R and visually acquired a runway (in fact, it was runway 22), the MP focused his attention upon determining why his visual cues did not match his expectations. He did not see the ramp lights which he expected to see to the right of the runway. (Tab V-12) The MP also noted that his navigational instruments did not display what he should have seen if he was lining up on runway 17R. (Tab V-12, V-58 to V-59) He became focused on looking for the ramp lights and his instrument approach plate trying to reconcile what he actually saw with his expectations. (Tab V-58 to V-59) This led to the MP failing to achieve an appropriate glidepath (See section 4 of this report regarding glidepath.).

Third, once he was informed he was lined up on runway 22, the MP became channelized on establishing an appropriate glidepath. (Tab V-47, V-50) He did not monitor his airspeed, allowing it to decay to 23 knots below FAS over the 18 seconds prior to impact (See section 4 of this report.). The MP's failure to recognize his slow airspeed is consistent with Channelized Attention.

6. **Visual Scan**
   a. **Breakdown in Visual Scan (AE105).** This is a factor when the individual fails to effectively execute learned/practiced internal or external visual scan patterns leading to unsafe situation. (Tab DD-95)

   b. **Discussion.** Ellington Field can be difficult to locate at night due to the dim lighting of the runway when contrasted with the intense cultural lighting of Houston and the bright lights of nearby industrial facilities. (Tabs V-10, V-48, V-58 to V-59, V-135, V-274, V-290 to V-291, V-512, DD-75 to DD-76) On approach to Ellington Field, the MP was cleared for the visual approach and instructed to contact the tower. At that time, he had visually acquired the "void" which he had identified as the airfield, but he did not have the runway lights in sight. (Tab V-10) The MP was cleared to land by Ellington Tower but the visual cues did not seem to line up with the MP's expectations based upon his navigational aids. (Tab V-12 to V-13) The MP then focused his attention on the visual scan outside of the cockpit and to his instrument approach plate for runway 17R on his kneeboard to provide better situational awareness. (Tab V-12 to V-13) He was initially monitoring his airspeed to determine when to lower his gear and flaps. (Tab V-12 to V-13) The MP stated, "I felt like had gotten back onto and captured a green speed [FAS] at short final." (Tab V-51) However, the MA's airspeed decayed below the appropriate FAS over the 18 seconds prior to impact (See section 4 of this report.). This discrepancy is consistent with a breakdown in visual scan.

7. **In-flight Perception**
   a. **Error due to Misperception (AE301).** This is a factor when an individual acts or fails to act based on an illusion; misperception or disorientation state and this act or failure to act creates an unsafe situation. (Tab DD-96)

   b. **Overconfidence (PC206).** This is a factor when the individual overvalues or overestimates personal capability, the capability of others or the capability of aircraft/vehicles or equipment and this creates an unsafe situation. (Tab DD-102)

   c. **Misperception of operable conditions (PC504).** This 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. (Tab DD-106)

   d. **Discussion.** The MP first picked up the runway environment, the "black hole where you would expect Ellington to be," about 10 NM from Ellington Field. (Tab V-43) At a perceived 5 NM he could see runway lights but was not lined up with the runway. (Tab V-44) When he thought he was still 3 NM from the runway, he did not have full situational awareness of the runway; he expected to see the ramp lights on the right side of the runway and they were absent. Additionally, his navigational instruments did not correlate with what he saw. (Tab V-44) The MP would have wanted a final approach of 5 to 6 NM but once he turned to his final approach, the runway came upon him quicker than expected. (Tab V-44 to V-45) Yet, he felt he was capable of landing the MA. (Tab V-47)

As the MP was establishing himself on final approach and receiving the radio call notifying him that he was landing on runway 22, he thought he was 3 to 4 NM from the runway. (Tabs V-45, DD-37) In fact, he was approximately 1 NM from the runway (See section 4 of this report). During this timeframe, he relied on how the jet felt when maneuvering to determine his airspeed. He felt he had not slowed down because the jet "will start to fly sloppy around final turn speeds…the jet still responded pretty well." (Tab V-45) In fact, based upon the MDP data, during the radio call he was slowing through 161 KCAS (1 knot below final turn speed). (Tabs L-19, DD-37) This misperception of his airspeed and overconfidence that he could determine his airspeed based solely upon the characteristics of flight led to a false sense of security; he did not monitor his airspeed which led to an unsafe situation.

8. Negative Transfer

a. **Negative Transfer (PC105).** This is a factor when the individual reverts to a highly learned behavior used in a previous system or situation and that response is inappropriate or degrades mission performance. (Tab DD-101)

b. **Discussion.** The MP chose to land with full flaps at Ellington Field. (Tab V-48) IPs have the option to land continuation training sorties with full or 60% flaps. (Tabs V-48, BB-71 to BB-72) However, Flight Crew Information File (FCIF) 10-019 part B which was published on 16 Apr 2010 at Columbus AFB required student sorties to land with 60% flaps, selecting full flaps when landing is assured on full stop landings. (Tab BB-71 to BB-72) Since he regularly flew with students at Columbus AFB, the MP routinely used 60% flaps for landings. When flying solo, the MP preferred to land full stop with full flaps because he believes this helps decrease the chance of landing fast or ballooning (climbing during the flare). (Tab V-48) At Ellington Field, the MP decided to land with full flaps, consistent with his stated preference. (Tab V-48) A full-flap final approach requires more thrust to maintain adequate airspeed. (Tab DD-80) While the MP was generally unaware of his airspeed (See Channelized Attention discussion in this section), when he did make power corrections, they were more consistent with a 60% flap final approach, which exacerbated his airspeed decay (See section 4 of this report.). (Tabs BB-71 to BB-72, DD-77 to DD-80)

9. Undercontrol

a. **Overcontrol/Undercontrol (AE103).** This is a factor when an individual responds inappropriately to conditions by either overcontroling or undercontroling the aircraft/vehicle/system. The error may be a result of preconditions or a temporary failure of coordination. (Tab DD-95)

b. **Discussion.** The MP felt his approach was high and fast and, therefore, decreased the throttle. (Tab V-51) He thought this correction put him back on normal approach speed at approximately one half mile to the end of runway and he increased the power to maintain his approach speed. (Tab V-13, V-51) At the threshold of the runway, he performed his normal approach procedure by pulling power back to idle and started to flare the aircraft. (Tab V-51) However, as discussed in section 4 of this report, he was below the appropriate FAS for 18 seconds prior to impact. By three seconds prior to impact, the MP had allowed the MA to slow to 23 knots below his FAS. (Tab L-21) Therefore, he undercontroled the aircraft on his approach into Ellington Field.

c. Human Factors Related to Supervision

Supervision is a factor in a mishap if the methods, decisions or policies of the supervisory chain of command directly affect practices, conditions, or actions of individuals and result in human error or unsafe situation. (DD-111)

1. **Oversight**
    - a. **Leadership/Supervision/Oversight Inadequate (SI001).** This is a factor when the availability, competency, quality or timeliness of leadership, supervision or oversight does not meet task demands and creates an unsafe situation. Inappropriate supervisory pressures are also captured under this code. (Tab DD-111)

    - b. **Discussion.** The 50 FTS/CC established the date for the cross country more than a month in advance. (Tab V-458) The 50 FTS/DO, in coordination with the 50 FTS/CC, originally approved the MP's six-sortie cross-country plan to remain overnight at Charleston AFB on a cross-country coordination worksheet dated 18 Jan 2011. (Tab DD-67) The 50 FTS/CC subsequently changed his approval on 4 Feb 2011 in conjunction with his change in policy that all CT cross-country missions for the weekend must remain overnight at Ellington Field. (Tab V-23, V-71, V-75, V-408) For this cross country, the 50 FTS/DO was not aware of many of the changes that had occurred to the overall squadron cross-country plan after he signed the coordination worksheet. He couldn't say for certain who was aware of the complete plan, but thought that the 50 FTS/CC was aware. (Tab V-611, V-613 to V-614) The fact that the squadron commander did not actively keep the squadron operations officer aware of the full plan is an indication of inadequate oversight of the mission.

2. **Supervision and Risk Assessment**
    - a. **Supervision – Policy (SI004).** This is a factor when policy or guidance or lack of a policy or guidance leads to an unsafe situation. (Tab DD-111)

    - b. **Risk Assessment – Formal (SP006).** This is a factor when supervision does not adequately evaluate the risks associated with a mission or when pre-mission risk assessment tools or risk assessment programs are inadequate. (Tab DD-112)

c. Authorized Unnecessary Hazard (SP007). This is a factor when supervision authorizes a mission or mission element that is unnecessarily hazardous without sufficient cause or need. Includes intentionally scheduling personnel for mission or operation that they are not qualified to perform. (Tab DD-112 to DD-113)

d. Unit/Organizational Values/Culture (OC001). This is a factor when explicit/implicit actions, statements or attitudes of unit leadership set unit/organizational values (culture) that allow an environment where unsafe mission demands or pressures exist. *AIB Note: This human factor is categorized under Organizational Influences of the DOD HFACS, but applies here when discussed at the unit (squadron) level.* (Tab DD-115)

e. Discussion. The 50 FTS/CC had a limited TDY budget. (Tab V-374 to V-375, V-384) Additionally, his student load had increased steadily since FY09. (Tab V-361) This increased student load, combined with his desire to send each student cross country, reduced the portion of his TDY budget available for IPs to go on CT cross-country trips. (Tab V-372, V-374) Therefore, the 50 FTS/CC wanted to minimize the cost of each CT cross country in order to maximize the number of IPs who could go on a CT cross country. (Tab V-376) At the same time, he wanted to maximize the training his IPs received while cross country. To achieve this goal, the 50 FTS/CC developed his CT cross-country weekend concept. The stated goal of these CT cross-country weekends was to complete CT requirements and/or gain proficiency in the aircraft. (Tab V-371 to V-372, V-381 to V-383) The CT cross-country weekend concept called for flying four times on Friday, four times on Saturday, and then two times on Sunday. (Tab V-380 to V-381, V-413 to V-414) A squadron CT cross-country weekend was accomplished under this guidance on 3-5 Dec 2010. (Tab V-381) Sixteen IPs logged more than 100 CT requirements. Four recent pilot training graduates accompanied the IPs and received training. (Tab DD-69 to DD-70) The 50 FTS/CC perceived the December 2010 cross country as very successful and highlighted the CT cross-country weekends as a squadron priority for 2011. (Tab V-367 to V-368, V-413, V-458)

However, outside of the CT cross-country weekends, flying four sorties in a day was rare in this squadron unless there was an extenuating circumstance such as retrieving an off-station aircraft. (Tab V-79, V-262, V-316, V-516) Furthermore, given the already high OPTEMPO (See section 10 of this report.) and long work days, multiple IPs chose not to participate in these CT weekends. (Tab V-123, V-261, V-314, V-346 to V-347, V-634) In fact, several IPs felt that the risk of this mission outweighed the benefits. (Tab V-123, V-152, V-261, V-632) Specifically, one IP said, “For me as an experienced T-38 instructor pilot, I did not feel that the benefit of flying four sorties in a day outweighed the risks of flying four sorties in a day.” (Tab V-261) Lt Col Grizzard, the Air Force Reserve flight commander associated with 50 FTS, stated:

> "[Flying four sorties] on back to back days, the first and second day of a cross country, it's going to ultimately lead to fatigue and the possibility of mistakes. To that end, these cross countries were never advertised to reservists, specifically the traditional reservists that I supervised." (Tab V-346 to V-347)

Finally, Lt Rabell testified that the 50 FTS/CC told IPs during the mass cross country briefing they would probably not want to go anywhere after flying four times since they would be tired. (Tab V-546)

The 50 FTS/CC saw the benefits of these cross-country weekends to be: completing continuation training requirements, pilot proficiency, hours for inexperienced IPs and making progress toward completing the Flying Hour Program. (Tab V-371, V-413, V-429 to V-430) Yet, one IP testified, "And for me as an instructor pilot with a lot of experience in the T-38, I don't think that flying a third or fourth sortie in a day or in a night or a tenth sortie on a weekend is going to make me a better pilot or instructor pilot." (Tab V-261) During the February 2011 CT cross-country weekend, numerous IPs were flying solo which required flying from the front cockpit. (Tab DD-69 to DD-70) AETC does not require any front cockpit training at all. (Tab BB-92 to BB-95) The 50 FTS/CC believed flying solo helped "[e]nsure pilot proficiency, front seat … gave me more instructional skills to be able to talk to references in HUD cross checks from the front seat that are difficult to keep fresh in your mind when you always fly in the back seat." (Tab V-371) The AETC guidance for CT and ID states, "Since the focus is on instructor development, ID sorties will be scheduled and flown dual to the absolute maximum possible." (Tab DD-74) Only one of 15 sorties that logged instructor development (ID) sorties was flown dual. (Tab DD-69 to DD-70)

An analysis of the risk versus benefit of the February 2011 cross country was never accomplished. When asked if they had weighed risks versus benefits, the 50 FTS/DO stated, "I'm not sure we ever specifically sat down and discussed the virtue versus vice, if you will, on that subject." (Tab V-615) When asked if any concerns over the risk of the 10-sortie weekends had reached his level, the 50 FTS/CC stated, "No, sir. We had talked about that in November for that type of plan and once we executed the plan and saw that in that particular instance a very successful execution. At that point … we had stopped addressing risk associated with it". (Tab V-413) Additional risk factors were present in February 2011 that had not been present in December 2010. The first additional risk factor was the higher number of aircraft flown solo. The plan called for 11 pilots (of which 3 were students) to depart Columbus in 10 aircraft, with 2 additional IPs scheduled to join the cross country on Saturday. (Tab DD-69 to DD-70) The second additional risk factor was later arrivals at Ellington Field driven by the initial departure time being moved from early in the day to the afternoon. (Tab V-410) While he was aware of these differences, the 50 FTS/CC did not see a need to take risk mitigation measures. (Tab V-410)

As mentioned previously, the 50 FTS/CC and 50 FTS/DO had approved the MP's original plan to remain overnight at Charleston AFB. However, once the squadron's policies changed, the 50 FTS/CC changed the MP's plans. The MP was now required to remain overnight at Ellington Field if he still wanted to go cross country. The MP discussed the change with the 50 FTS/CC and stated he still wanted to support the Citadel ROTC event. (Tab V-417) The 50 FTS/CC did not consider cancelling the MP's Citadel activities. (Tab V-417 to V-418) The 50 FTS/CC discussed the MP's plan with him, including servicing locations for his aircraft, and felt that the MP's plan would work, but did not ask what time the MP needed to be at The Citadel each day. The 50 FTS/CC "considered [the MP's] Saturday plan as aggressive" but agreed to continue to support the MP's Citadel events as long as the weather was not going to be a factor. (Tab V-417)

The night before the mishap, the 11 Feb 2011 schedule changed and the MP was scheduled for a student instructional sortie at 0900, the first 50 FTS takeoff time that day. (Tabs V-87, DD-81) As a result, the MP's new plan would now lead to his flight into Ellington Field being his fourth sortie of the day. The 50 FTS/CC and 50 FTS/DO were not aware the MP was going to be flying four sorties the day of the mishap. (Tab V-417, V-619) Yet, the MP had never flown four sorties in a day. (Tab V-79) On the day of the mishap, Lt Col Gordon Kimpel, another 50 FTS IP, was concerned regarding the expected length of the MP's day. He expressed his concern to an assistant operations officer (ADO). The ADO told him it could be done if it was planned correctly and chose not to elevate the concern to a higher level. (Tab V-569) Finally, the operations supervisor that gave the MP his step briefing from Columbus AFB was aware that the MP was flying four sorties that day. However, their ORM discussion only covered the first sortie of the MP's cross country. (Tab V-62 to V-63, V-64 to V-65, V-311)

Before each of these cross-country missions, each IP has to fill out an ORM chit based on the 50 FTS ORM Assessment worksheet. (Tab V-62, V-318) When starting a CT cross country, many IPs fill out the chit for the entire day. (Tab V-268, V-284, V-339, V-505, V-541) However, both the MP and the operations supervisor on duty were under the impression that the MP needed to fill out the ORM chit for only the sortie leaving Columbus AFB. (Tab V-26, V-311) There was no written guidance on what was expected. (Tab V-268, V-311, V-389)

The MP assessed his ORM at Mobile Downtown Airport before his flight to Ellington Field and it did not require operations supervisor approval. (Tab V-64) The AIB confirmed that a properly assessed ORM worksheet for the profile for the MP's last sortie would only require aircraft commander approval. No discussion with the operations supervisor or higher supervision was necessary. The worksheet only accounted for these hazards on the mishap sortie: fourth sortie of the day, night, and off-station sortie. (Tab K-25) The ORM worksheet does not take into account the following hazards that were present in this mishap: first *night* arrival into a given airfield, extended *time* into FDP, and the combination of solo and single-ship. (Tab K-25) The Vice-Wing Commander, Operations Group Commander, and Deputy Operations Group Commander all believe a sortie with this combination of hazards present should require supervisory approval. (Tab V-532 to V-533, V-681, V-693) In fact, the Vice-Wing Commander stated, “My opinion is that a fourth sortie at night needs to have squadron supervision for approval.” (Tab V-693) Furthermore, there is no mechanism present in the ORM matrix, other than total score, that elevates approval to a higher supervisory level. (Tab K-25)

Finally, there was a culture of risk tolerance related to CT among squadron supervision at the time of the mishap. The AIB found four specific examples that highlight this.
First, the 50 FTS/CC believed flying four CT sorties on back-to-back days was low risk. (Tab V-413) He stated, “the particular task loading in this airplane for going cross country—I believe there’s a small factor for the fourth sortie.” (Tab V-390) There was also a mindset among supervision that a day consisting of four CT sorties was less risky than a day consisting of three student pilot instructional sorties. Major Jeffrey Isgett, a squadron assistant operations officer, stated, “…instructor pilots under reasonable circumstances can manage four sorties in a day without a real increase—without any increase in risk over three sorties a day with students. We accept the risk of flying student sorties, with three students, on a daily basis.” (Tab V-302)

Second, as already discussed in this section, the successful execution of a similar cross country plan in December 2010 also led to a sense of reduced risk for the overall plan for the February 2011 cross country for the 50 FTS/CC. (Tab V-413, V-458)

Third, the ORM matrix rarely drove the mission decision authority above the aircraft commander for CT sorties. (Tab V-265, V-284, V-311, V-340, V-388, V-506, V-561, V-603) This may have led to a sense among squadron IPs that CT is always low risk.

Finally, there was frequent approval for solo, single-ship CT sorties and, at the time, there was blanket approval for solo aircraft on this cross country. (Tab V-9, V-313, V-389, V-508) Captain Matthew Eldredge, a flight commander in the 50 FTS, stated, “There is a blanket waiver that the [50 FTS/DO] threw down with that said that if there is a jet available for a solo IP--or solo instructor pilot, you were cleared to take that and do your instructor development from there.” (Tab V-508) This automatic approval may have led to a sense that a lack of mutual support does not impact risk.

d. Human Factors related to Organizational Influences

Organizational Influences are factors in a mishap if communications, actions, policies or significant omissions by upper-level management directly or indirectly affect supervisory practices, conditions or actions of the operators resulting in system failure, human error or an unsafe situation. (Tab DD-114)

1. **Procedural Guidance**
    a. **Procedural Guidance/Publications (OP003).** This 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. (Tab DD-116)

    b. **Discussion.** According to paragraph 3.21.7 of AETC Supplement 1 to AFI 11-2T-38 Volume 3, as well as paragraph 5.12.4 of AETC Supplement 1 to AFI 11-202, Volume 3, the preferred method for night approach in descending order is precision, non-precision with an associated visual descent path indicator, VFR straight-in, and VFR rectangular pattern. The same guidance also states, "Also use the instrument landing system (ILS) glide slope if available." (For the full text of paragraph 3.21.7 of AETC Supplement 1 to AFI 11-2T-38 Volume 3, see section 4 of this report.) The use of the word "preferred" leads to inconsistent interpretations of the guidance. For example, the MP and other IPs believe ILS approach at night, if available, is only preferred and not required. (Tab V-56, V-133, V-664) However, other IPs believe an ILS approach is required if available. (Tab V-295, V-316, V-353, V-391, V-566, V-589, V-605)

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications.

Available at http://www.e-publishing.af.mil:

(1) AFI 11-202 Volume 3, *General Flight Rules*, 22 Oct 2010, AETC Supplement dated 19 Nov 2010.
(2) AFI 11-2T-38 Volume 1, *T-38 Aircrew Training*, 20 Jan 2011 with holdover AETC guidance in message dated 2 May 2008
(3) AFI 11-2T-38 Volume 3, *T-38 Operations Procedures*, Certified current 3 Nov 2009, AETC Supplement, Change 1 dated 3 Mar 2010
(4) AFMAN 11-251 Volume 1, *T-38C Flying Fundamentals*, 17 March 2008, incorporating through Change 3.
(5) AFMAN 11-217 Volume 1, *Instrument Flight Procedures*, 22 Oct 2010.

Not available online:
(6) AFTO 1T-38C-1, *T-38C Flight Manual*, 29 Nov 2009
(7) *Blaze T-38 Standards*, 10 Jan 2011.
(8) *50 FTS In-Flight Guide*, 1 Feb 2011.

b. Maintenance Directives and Publications.

(1) AFTO 1T-38C, *Model T-38 Series General T.O.*
(2) AFTO 1T-38C-2-8, *Organizational Maintenance T-38C Landing Gear Systems*, 15 August 2008, Change 5 dated 15 January 2011.

(3) AFTO IT-38C-2-8CL-1, *Organizational Maintenance Removing/Installing Main Landing Gear Wheel and Nose Landing Gear Wheel Procedures Checklist*, 31 August 2006.

(4) AFTO 1T-38C-4-8, *Illustrated Parts Breakdown T-38C Landing Gear Systems*, 15 September 2008, Change 5 dated 15 January 2011.

c. Known or Suspected Deviations from Directives or Publications. The MP deviated from AFI 11-202, Volume 3, General Flight Rules, dated 22 Oct 2010; specifically paragraph 9.7.2, Maximum FDP and Table 9.1 Maximum FDP (Hours). (Tab BB-62 to BB-63) For a discussion of the facts regarding the MP's deviation from the AFI, see section 4 and section 9 of this report.

13. ADDITIONAL AREAS OF CONCERN

There were no additional areas of concern.

14. SIGNATURE AND DATE

KURT W. MEIDEL, Colonel, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

Under 10 U.S.C. §2254(d) the 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 this mishap was caused by the Mishap Pilot (MP) experiencing Geographic Misorientation in relation to the landing runway, stemming from his decision to fly a visual approach without having visually acquired sufficient airfield references. This misorientation initiated a series of perception and performance errors that ultimately led to a combination of excessive rate of descent and slow airspeed which was recognized too late to allow a safe landing or go-around. I also find by a preponderance of the evidence that the MP's fatigue substantially contributed to the mishap. The mishap sortie was the MP's fourth sortie of the day and he was more than 25 minutes beyond the end of his prescribed 12-hour Flight Duty Period. Several human factors issues contributed to the mishap that were either due to or exacerbated by fatigue. Additionally, I find by clear and convincing evidence this mishap was caused by the authorization and execution of a mission having an unnecessarily high level of risk relative to the real benefits. Operational Risk Management (ORM) was wholly inadequate for the combination of hazards present in this mishap. Inappropriate supervisory policy, combined with inadequate ORM, led to a high-risk mission profile. I find no evidence that training, maintenance, or condition of the Mishap Aircraft contributed to this mishap.

2. DISCUSSION OF OPINION

A. Geographic Misorientation. The mishap sortie was uneventful until the MP contacted Houston Approach control. The MP requested a visual approach to runway 17R. Prior to receiving clearance for the visual approach, the MP channelized his attention on visually acquiring the airfield. As a result of this channelization, he failed to sufficiently monitor his position and became geographically misoriented. When cleared for the visual approach, his only visual reference of the airfield was a "void" in the cultural lighting and he turned to a heading he believed would position him for a five to six mile final for runway 17R. In reality he pointed almost directly at the airfield. At this point he further channelized his attention outside the aircraft in an attempt to locate the runway environment.

Approximately three miles from the airfield, the MP identified a runway that he presumed was runway 17R and began a turn to line up on that runway. In reality it was runway 22. His attention then became channelized on the inconsistencies between what he was seeing outside (runway 22) and what he expected to see for runway 17R, specifically ramp lights along the right side of the runway. He also realized what he was seeing outside did not correspond with the indications on his navigation instruments. Due to Channelized Attention and Geographic Misorientation, the MP descended at a rate that placed him well above a normal glidepath.

At just less than a mile from the runway, the tower controller told the MP he was lining up on runway 22 and cleared him to land on runway 22. Due to his Geographic Misorientation, the MP believed he was three to four miles from the approach end of the runway. He believed he had time to correct his glidepath prior to landing. Due to Channelized Attention on correcting the glidepath, a slow crosscheck (visual scan of flight instruments), and attempting to discern his airspeed using only "seat-of-the-pants" (auditory and tactile cues), the MP allowed his airspeed to decrease below final approach speed. Less than one-quarter mile from the runway, he was on an even steeper glidepath and his airspeed was 16 knots below final approach speed. At about 90 feet above the ground, as the landing light illuminated the runway, the MP experienced "ground rush" (sudden recognition of descent rate) and attempted to go around. Because he had allowed his airspeed to further decay to 23 knots below final approach speed and his descent rate to increase to 1,500 feet per minute, he was unable to prevent a catastrophic impact with the runway. The impact caused the right wheel to depart the aircraft and caused significant damage to the right wing and left main landing gear. Despite appropriate control inputs by the MP, the Mishap Aircraft departed the runway more than 2000 feet later, causing additional damage to the landing gear, wings, and tail section.

B. Fatigue. I found by a preponderance of the evidence that the MP's fatigue substantially contributed to the mishap. While the MP did not recall feeling more fatigued than usual prior to takeoff, he acknowledged after the fact that his slow crosscheck and confusion were caused by fatigue. The mishap occurred about 12½ hours from the start of the MP's prescribed 12-hour maximum Flight Duty Period. The sortie was his fourth sortie of the day and was flown entirely at night. There were 18 human factors related to the MP's performance and decision-making that were present in this mishap. It is evident that fatigue contributed to many of these human factors. The human factors most relevant to the mishap that were impacted by fatigue were his Geographic Misorientation, slow crosscheck (internal visual scan), spatial disorientation, and mistrust of his instruments. The MP's decision-making was also impacted by his fatigue, namely his failure to consider the risks of flying the visual approach as his first night approach into the airfield.

C. Authorization and Execution of High-Risk Mission. Additionally, I find by clear and convincing evidence this mishap was caused by the authorization and execution of a mission with an unnecessarily high level of risk relative to the real benefits. Inadequate ORM, combined with inappropriate supervisory policy, led to the high-risk mission profile.

(1) Operational Risk Management. Operational Risk Management for the mishap sortie was inadequate on three fronts: inadequate risk analysis of the overall cross-country weekend plan as well as the MP's individual plan, an inadequate risk assessment matrix, and a culture of risk tolerance in the squadron.

(a) Risk Analysis. First, there was inadequate risk analysis of the overall cross-country plan. The plan called for 10 aircraft and 11 pilots (of which 3 were students) to depart on Friday with 2 additional Instructor Pilots (IP) planning to join the cross country on Saturday. Each aircraft was to fly four sorties on Friday and Saturday and two sorties on Sunday. At no time during the planning process was there a deliberate ORM analysis of the plan, weighing the risks associated with the plan against the benefits. Outside of these cross-country weekends, it was rare for an IP to fly four sorties in one day. Many of the sorties were to be flown solo, at night, after a long day. There was a mindset that a day consisting of four continuation training (CT) sorties was generally less risky than a day consisting of three student pilot instructional sorties. While this risk analysis is arguably correct, ORM requires a comparison of risk against benefit. The benefits of the cross country as it was planned did not justify the risk. The large number of solo aircraft reduced the effectiveness of the training. Air Education and Training Command (AETC) guidance specifies that instructor development (ID) sorties should be flown dual to the absolute maximum extent possible. Of 31 CT sorties flown, only one was flown as a dual ID sortie. While there is some value to gaining pilot proficiency flying solo from the front cockpit, AETC does not require any front cockpit training at all, and the number of sorties planned to be flown solo by each IP during this cross country led to quickly diminishing returns. Since very few IPs accomplished formation area work and instrument approaches cannot be logged solo in clear weather, 25 of the 31 CT sorties did not log a purposeful ID sortie at all. Overall, the risks of this cross country were high and the benefits were minimal.

The MP's individual plan was also never assessed from an ORM perspective above the MP's level. The Squadron Commander was aware that the MP had activities planned in Charleston, South Carolina, on both Friday afternoon and Saturday morning and that cross-country departures were scheduled for the afternoon on Friday instead of the usual morning departures. Despite this, he did not gather all of the details of the MP's planned itinerary and discuss the risk versus benefit of the plan. In fact, neither the 50th Flying Training Squadron Commander (50 FTS/CC) nor Operations Officer (50 FTS/DO) was aware that the MP was flying an early morning student sortie, resulting in a 4-sortie day. On the morning of the mishap, an IP expressed concern over the MP's planned itinerary to an assistant operations officer, who chose to leave the risk mitigation in the hands of the MP rather than gather the information to analyze the risk at his level or refer it to a higher level. While the operations supervisor who conducted the pre-departure briefing for the MP was aware the MP would be flying four sorties, their ORM discussion focused only on the first cross-country sortie and did not specifically address fatigue or flight duty period. While all levels of supervision had some awareness of the demands of the MP's plan, there was no supervisory involvement in the risk assessment.

(b) ORM Matrix. Second, the squadron ORM matrix used by the MP to evaluate the risk of his mission did not elevate the mission approval authority above the aircraft commander for the combination of hazards present. Specific hazards present in this mishap include night, first night arrival into a given airfield, fourth sortie of the flight duty period, extended time into flight duty period, combination of solo and single ship (lack of mutual support), and off-station sortie. Based on the design of the matrix, the resulting total ORM score for all of the MP's cross-country sorties, including the mishap sortie, was below the threshold that would require operations supervisor approval. In fact, the matrix was poorly designed in that a CT sortie would rarely require operations supervisor approval. There is no mechanism in the squadron's ORM tools or assessment processes, other than total score from the ORM matrix, that would drive a mission to a higher approval authority.

(c) Culture of Risk Tolerance. Finally, at the time of the mishap, there was a culture of risk tolerance related to CT among squadron supervision that bled through to the squadron. The 50 FTS/CC's cross-country guidance to attempt to get four sorties on both Friday and Saturday establishes that he believed flying four CT sorties on back-to-back days was low risk. The successful execution of a similar cross country plan in December 2010 also led to an artificial sense of reduced risk for the overall plan. The fact that the ORM matrix almost never drove the mission approval authority above the aircraft commander for CT sorties led to a sense that CT is always low risk. Finally, the frequent approval of solo, single ship CT sorties, and the blanket approval for solo aircraft on this cross country in particular, led to a sense that a lack of mutual support does not significantly impact risk.

A full and deliberate ORM analysis of the cross country plan, considering both risks and benefits of the overall plan and the MP's plan in particular, was never accomplished. A properly conducted ORM assessment would have shown that the real benefits of the authorized mission did not justify the risks.

(2) Supervisory policy. Supervisory policy also contributed substantially to the authorization and execution of the high-risk mission. The MP's original plan to remain overnight at Charleston AFB was initially approved by both the 50 FTS/DO and the 50 FTS/CC. That plan called for two cross-country sorties to be flown into Charleston AFB on Friday, an out-and-back from Charleston AFB on Saturday afternoon, and two sorties flown Sunday returning to Columbus AFB. One week prior to the mishap, the 50 FTS/CC notified the MP that he must remain overnight at Ellington Field if he wanted to go cross country. The pilot originally planning to accompany the MP on his cross country had previously complained to wing leadership about the 50 FTS/CC's cross-country fiscal policies. The 50 FTS/CC was concerned this pilot might use this cross country as a venue to highlight his remaining concerns over squadron cross-country policies. The 50 FTS/CC also wanted to avoid any partiality (or perception thereof) associated with approving the MP to remain overnight at a location other than Ellington Field, when he had refused similar requests from other IPs. Requiring the MP to remain overnight at Ellington Field was unnecessary and resulted in the MP flying the high-risk mission profile on the day of the mishap.

3. CONCLUSION

I find by clear and convincing evidence this mishap was caused by the Mishap Pilot experiencing Geographic Misorientation in relation to the landing runway, stemming from his decision to fly a visual approach without having visually acquired sufficient airfield references, which ultimately led to an unsafe and unrecognized combination of excessive rate of descent and slow airspeed. Additionally, I find by a preponderance of the evidence that the Mishap Pilot's fatigue substantially contributed to the mishap. Finally, I find by clear and convincing evidence this mishap was caused by the authorization and execution of a mission having an unnecessarily high level of risk relative to the real benefits, due to a combination of inadequate ORM and inappropriate supervisory policy.

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