UNITED STATES AIR FORCE ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 06-3178

15TH RECONNAISSANCE SQUADRON
432D WING
CREECH AIR FORCE BASE, NEVADA

LOCATION: FORWARD OPERATING BASE (FOB), AFGHANISTAN

DATE OF ACCIDENT: 20 AUGUST 2011

BOARD PRESIDENT: MAJOR GARDNER J. JOYNER

Conducted IAW Air Force Instruction 51-503
Abbreviated Accident Investigation pursuant to Chapter 11

EXECUTIVE SUMMARY

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B, T/N 06-3178
FORWARD OPERATING BASE (FOB), AFGHANISTAN
20 AUGUST 2011

On 20 Aug 11, at approximately 15:36 Zulu (Z) time, an MQ-1B Predator remotely piloted aircraft, T/N 06-3178, impacted the ground approximately 1.7 miles southwest of a forward operating base (FOB) in Afghanistan after approximately 17.2 hours of a surveillance mission. The mishap remotely piloted aircraft (MRPA) was forward deployed from the 432d Air Expeditionary Wing, Creech Air Force Base (AFB), Nevada. The MRPA was operated by the 3d Special Operations Squadron, Cannon AFB, New Mexico. The MRPA, one air to ground Hellfire missile and one missile rail were destroyed on impact. Two civilian residential structures were also damaged. The total damage to U.S. Government property was assessed to be $3,844,825.00. There were no injuries or damage to other government or civilian property as a result of the mishap.

On 19 Aug 11, at approximately 22:27Z, after normal pre-flight checks, the MRPA taxied and departed the FOB. Handover from the Launch and Recovery Element (LRE) to the Mission Control Element (MCE) was uneventful. On 20 Aug 11, at approximately 15:18Z, the Mission Control Element Pilot (MCEP) was hand-flying the MRPA with the altitude hold on at 18,000 feet (ft) mean sea level (MSL) when he noticed the MRPA had lost approximately 3,000 to 4,000 ft and was descending at approximately 1,200 ft per minute. The MCE crew began troubleshooting the emergency and decided to return to base. The MCE Mission Director notified the LRE crew that the MRPA was "falling out of the sky" and they needed to get prepared to take it immediately. The LRE crew immediately stepped to the Ground Control Station to prepare to recover the MRPA. At approximately 15:31Z the LRE conducted an emergency takeover and gained control of the MRPA. When the LRE took control of the MRPA, it was approximately 4,880 ft MSL and approximately five miles from the FOB. After confirming the engine was out, the Mishap Pilot (MP) made the determination that the MRPA did not have enough altitude to reach the FOB and directed the Mishap Sensor Operator (MSO) to find an alternate place to land the aircraft. The MSO located a rural, non-populated area, and the MP turned in that direction. However, due to the rapid descent rate, the MRPA was unable to reach the designated landing site and crashed in a civilian residential area.

The Abbreviated Accident Investigation Board (AAIB) President determined, by clear and convincing evidence, the cause of the mishap was a broken variable pitch propeller quill shaft. The broken quill shaft forced the mishap MRPA's propeller to an abnormal angle which generated increased drag and caused the MRPA to rapidly descend. By the time the MCEP was able to diagnose the emergency, take action, and handoff the MRPA to the LRE crew, the MRPA had lost too much altitude and was unable to reach the FOB. Furthermore, the AAIB President found, by a preponderance of the evidence, the lack of USAF maintenance guidance defining the serviceable life of a MQ-1B VPP quill shaft substantially contributed to the mishap.

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

SUMMARY OF FACTS AND STATEMENT OF OPINION

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B, T/N 06-3178
FORWARD OPERATING BASE (FOB), AFGHANISTAN
20 AUGUST 2011

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COMMONLY USED ACRONYMS AND ABBREVIATIONS

3 SOS	3rd Special Operations Squadron
432 WG	432d Wing
A1C	Airman First Class
AAIB	Abbreviated Accident Investigation Board
ACC	Air Combat Command
AEW	Air Expeditionary Wing
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFSAS	Air Force Safety Automated System
AFSOC	Air Force Special Operations Command
AFTO	Air Force Technical Order
AGL	Above Ground Level
AGM	Air to Ground Missile
AIB	Aircraft Investigation Board
AISI	American Iron and Steel Institute
AOR	Area of Responsibility
Attach	Attachment
ATC	Air Traffic Control
ATIS	Automated Terminal Information System
AZ	Arizona
CAPS	Critical Actions and Procedures
Capt	Captain
CAS	Close Air Support
Col	Colonel
CRM	Crew Resource Management
DL	Downlink
DNIF	Duties Not Including Flying
DoD	Department of Defense
DoD-HFACS	DoD Human Factors Analysis and Classification System
DVR	Digital Video Recorder
EP	Emergency Procedure
FAE	Functional Area Expert
FOB	Forward Operating Base
FOS	Flight Operations Supervisor
FPM	Feet Per Minute
ft	Feet
GA	General Atomics
GCS	Ground Control Station
GDT	Ground Data Terminal
GRG	Grid Reference Guide
HAT	Height Above Target
HDD	Heads-down Display
HQ	Headquarters
HUD	Heads-up Display
ICAO	International Civil Aviation Organization
IDO	Intelligence Director of Operations
IAW	In Accordance With
IMDS	Integrated Maintenance Data System
IPI	In Progress Inspection
ISR	Intelligence, Surveillance, and Reconnaissance
ITC	Intelligence, Surveillance, and Reconnaissance Tactical Coordinator
JG	Job Guide
KIAS	Knots Indicated Airspeed
L	Local Time
LA	Legal Advisor
LR	Launch and Recovery
LRE	Launch and Recovery Element
LRT	Launch and Recovery Training
Lt Col	Lieutenant Colonel
Maj	Major
MAJCOM	Major Command
MC	Mission Coordinator
MD	Mission Director
MDS	Mission Design Series
MCE	Mission Control Element
MCEP	Mission Control Element Pilot
MCESO	Mission Control Element Sensor Operator
mIRC	My Internet Relay Chat
MISREP	Mission Report
MOS	Mishap Operations Superintendent
MP	Mishap Pilot
MQT	Mission Qualification Training
MRPA	Mishap Remotely Piloted Aircraft
MSA	Minimum Safe Altitude
MSL	Mean Sea Level
MSO	Mishap Sensor Operator
MX	Maintenance
MXI	Maintenance Inspector
MXT	Maintenance Technician
NM	Nautical Miles
NOTAMS	Notices to Airmen
OEF	Operation Enduring Freedom
Ops Tempo	Operations Tempo
ORM	Operational Risk Management
PHA	Physical Health Assessment
PPSL	Predator Primary Satellite Link
RBB	Rack Bridge Bearing
ROC	RPA Operations Center
RPA	Remotely Piloted Vehicle
RPM	Revolutions Per Minute
RS	Reconnaissance Squadron
RSO	Remote Split Operations
RW	Reconnaissance Wing
RTB	Return to Base
SII	Special Interest Items
SIPR	Secret Internet Protocol Router
SOF	Special Operations Forces
SOS	Special Operations Squadron
S/N	Serial Number
SPINS	Special Instructions
SRA	Senior Airman
SSgt	Staff Sergeant

TCTO	Time Compliance Technical Order	USA	United States Army
T/N	Tail Number	USAF	United States Air Force
TO	Technical Order	VIT	Variable Information Table
TOD	Technical Order Data	VPP	Variable Pitch Propeller
UAS	Unmanned Aircraft System	VVI	Vertical Velocity Indicator
UAV	Unmanned Aerial Vehicle	WFHQ	Warfighting Headquarters
U.S.	United States	Z	Zulu

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 7 Oct 11, Lieutenant General William J. Rew, Vice Commander, Air Combat Command (ACC) appointed Major Gardner J. Joyner to conduct an Abbreviated Aircraft Accident Investigation (AAIB) of the 20 Aug 11 crash of an MQ-1B Predator aircraft, tail number (T/N) 06-3178, near a forward operating base (FOB), in Afghanistan. The investigation was conducted at Cannon Air Force Base (AFB), New Mexico (NM), from 4 Jan 11 through 25 Jan 11, pursuant to Chapter 11 of Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, 26 May 2010. The following United States Air Force (USAF) personnel served as AAIB members: Major Gardner J. Joyner, Captain (Redacted), Legal Advisor (LA), and Airman First Class (A1C) (Redacted), Recorder (Tab Y-3). Capt (Redacted), MQ-1B pilot, was detailed as a Functional Area Expert (Tab Y-5).

b. Purpose

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

2. ACCIDENT SUMMARY

On 20 Aug 11, at approximately 15:36 Zulu (Z) time, the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, T/N 06-3178, an asset of the 432d Wing, Creech AFB, Nevada (NV), impacted a residential area approximately 1.7 nautical miles southwest of a forward operating base (FOB) in Afghanistan (Tabs C-3, V-9.5). The MRPA, one air to ground (AGM) Hellfire missile, and one missile rail were destroyed (Tab P-2). Two civilian residential structures were also damaged and the owners were compensated for their loss by the U.S. Army foreign claims commission shortly after the mishap (Tabs P-3, S-4 to S-7). The total damage to U.S. Government property was assessed to be $3,844,825.00 (Tab P-2). There were no injuries or damage to other government or civilian property reported.

3. BACKGROUND

a. Units and Organization

(1) Air Combat Command (ACC)

ACC is the primary force provider of combat airpower to America's warfighting commands. To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management, and electronic-combat aircraft. It also provides command

and control, communications and intelligence systems, and conducts global information operations. As a force provider, ACC organizes, trains, equips and maintains combat-ready forces for rapid deployment and employment while ensuring strategic air defense forces are ready to meet the challenges of peacetime air sovereignty and wartime air defense. ACC numbered air forces provide the air component to U.S. Central, Southern and Northern Commands, with Headquarters (HQ) ACC serving as the air component to Joint Forces Commands. ACC also augments forces to U.S. European, Pacific and Strategic Command (Tab CC-3).

(2) Air Force Special Operations Command (AFSOC)

AFSOC's mission is to present combat ready Air Force Special Operations Forces to conduct and support global special operations missions. AFSOC provides Air Force special operations forces (SOF) for worldwide deployment and assignment to regional unified commands. The command's SOF are composed of highly trained, rapidly deployable Airmen, conducting global special operations missions ranging from precision application of firepower, to infiltration, exfiltration, resupply and refueling of SOF operational elements. AFSOC's unique capabilities include airborne radio and television broadcast for psychological operations, as well as aviation foreign internal defense instructors to provide other governments military expertise for their internal development. The command's special tactics squadrons combine combat controllers, special operations weathermen and pararescuemen with other service SOF to form versatile joint special operations teams. The command's core missions include battlefield air operations, agile combat support, aviation foreign internal defense, information operations, precision aerospace fires, psychological operations, specialized air mobility, specialized refueling, and intelligence, surveillance and reconnaissance (ISR) (Tab CC-7).

(3) 12th Air Force (12 AF)

HQ 12 AF is located at Davis-Monthan AFB, Tucson, Arizona (AZ). 12 AF is one of four numbered air forces assigned to Air Combat Command. The 12 AF mission is to provide combat ready forces to ACC, train and equip 10 combat wings and one RED HORSE squadron. Additionally, 12 AF is responsible for the operational readiness of 19 12 AF-gained units of the Air Force Reserve and Air National Guard in the western and midwestern United States. 12 AF is also leading the way in bringing the Chief of Staff of the Air Force's Warfighting Headquarters (WFHQ) concept to life. The WFHQ is composed of a command and control element, an Air Force forces staff and an Air Operations Center. Operating as a WFHQ since Jun 04, 12 AF Force has served as the Air Force model for the future of Combined Air and Space Operations Centers and WFHQ Air Force forces (Tab CC-11).

(4) 432d Wing (432 WG)

The 432 WG, stationed at Creech AFB, NV, flies the MQ-1B Predator and MQ-9 Reaper remotely piloted aircraft (RPA) systems to provide real-time ISR, and precision attack against fixed and time-critical targets to support American and coalition forces worldwide. The 432 WG, also conducts initial qualification training for aircrew, intelligence, weather, and maintenance personnel who will fly and support RPA systems. The wing's organization includes two groups, six RPA flying squadrons, an operational support squadron, and two maintenance squadrons (Tab CC-15).

(5) 27th Special Operations Wing (27 SOW)

The 27 SOW at Cannon AFB, NM, is one of two Air Force active duty Special Operations wings within AFSOC. The 27 SOW's mission is to plan and execute specialized and contingency operations using advanced aircraft, tactics, and air refueling techniques to infiltrate, exfiltrate, and resupply special operations forces and provide ISR, and close air support (CAS) in support of SOFs. In addition, the 27 SOW brings distinctive intelligence capabilities to the fight, including ISR, predictive analysis, and targeting expertise to joint special operations forces and combat search and rescue operations (Tab CC-17).

(6) 3rd Special Operations Squadron (3 SOS)

The 3 SOS accomplishes global special operations tasking as a member of the Air Force component of United States Special Operations Command. It directly supports theater commanders by providing precision weapons employment and persistent ISR. It also plans, prepares, and executes MQ-1B Predator missions supporting SOFs. The 3 SOS is located at Cannon AFB, NM. The squadron is the first RPA squadron within AFSOC (Tab CC-19).

b. Aircraft: MQ-1B Predator

(1) Mission

The MQ-1 Predator is an armed, multi-mission, medium-altitude, long endurance RPA that is employed primarily in a killer/scout role as an intelligence collection asset and secondarily against dynamic execution targets. Given its significant loiter time, wide-range sensors, multi-mode communications suite, and precision weapons, it provides a unique capability to autonomously execute the kill chain (find, fix, track, target, engage, and assess) against high value, fleeting, and time sensitive targets. Predators can also perform the following missions and tasks: ISR, CAS, combat search and rescue, precision strike, buddy-lase, convoy/raid over watch, route clearance, target development, and terminal air guidance. The MQ 1's capabilities make it uniquely qualified to conduct irregular warfare operations in support of Combatant Commander objectives (CC-21).

(2) Features

The Predator is part of an Unmanned Aircraft System (UAS), not just an aircraft. A fully operational UAS consists of four sensor/weapon equipped aircraft, a GCS, a Predator Primary Satellite Link (PPSL), and spare equipment along with operations and maintenance crews for deployed 24-hour operations (Tab CC-21).

The basic crew for the Predator is a rated pilot to control the aircraft and command the mission and an enlisted aircrew member to operate sensors and weapons plus a mission coordinator, when required. The crew employs the aircraft from inside the GCS via a line-of-sight data link or a satellite data link for beyond line-of-sight operations (Tab CC-21).

The MQ-1B Predator carries the Multi-spectral Targeting System, which integrates an infrared sensor, a color/monochrome daylight TV camera, an image-intensified TV camera, a laser designator and a laser illuminator into a single package. The full motion video from each of the imaging sensors can be viewed as separate video streams or fused together. The aircraft can employ two laser-guided air to ground (AGM) 114 Hellfire missiles which possess a highly accurate, low collateral damage, and anti-armor and anti-personnel engagement capability (Tab CC-21).

The system can be deployed for worldwide operations. The Predator aircraft can be disassembled and loaded into a container for travel. The GCS and PPSL are transportable in a C-130 Hercules (or larger) transport aircraft. The Predator can operate on a 5,000 by 75 ft hard surface runway with clear line-of-sight to the ground data terminal (GDT) antenna. The antenna provides line-of-sight communications for takeoff and landing. The PPSL provides over-the-horizon communications for the aircraft and sensors (Tab CC-22).

The primary concept of operations, Remote Split Operations (RSO), employs a launch and recovery GCS for takeoff and landing operations at the forward operating location while the Continental U.S.-based crew executes command and control of the remainder of the mission via beyond-line-of-sight links. RSO results in a smaller number of personnel deployed to a forward location, consolidates control of the different flights in one location, and as such, simplifies command & control functions as well as the logistical supply challenges for the weapons system (Tab CC-22).

The aircraft has an ARC-210 radio, an APX-100 IFF/SIF with Mode 4, and an upgraded turbocharged engine. The latest upgrades, which enhance maintenance and performance, include notched tails, split engine cowlings, braided steel hoses and improved engine blocks (Tab CC-22).

(3) Background

The Predator system was designed in response to a Department of Defense requirement to provide persistent ISR information combined with a kill capability to the warfighter (Tab CC-22).

In April 1996, the secretary of defense selected the U.S. Air Force as the operating service for the RQ-1 Predator system. The "R" is the Department of Defense designation for reconnaissance aircraft. The "M" is the DOD designation for multi-role, and "Q" means unmanned aircraft system. The "1" refers to the aircraft being the first of the series of remotely piloted aircraft systems (Tab CC-22).

A change in designation from "RQ-1" to "MQ-1" occurred in 2002 with the addition of the AGM-114 Hellfire missiles, enabling reaction against ISR, CAS and interdiction targets. The Predator UAS continues to provide required armed ISR capabilities to overseas contingency operations warfighters. During August 2011, Predator passed its one millionth total development, test, training and combat hours mark; a significant accomplishment for the USAF (Tab CC-22).

4. SEQUENCE OF EVENTS

a. Mission

On 20 Aug 11, the MPRA was performing a classified tasking in the OEF area of responsibility (Tabs C-3, V-7.6).

b. Planning and Preflight

On 20 Aug 11, at approximately 13:15Z, the MCE crew, the MCE Pilot (MCEP) and MCE Sensor Operator (MCESO), arrived at the 3 SOS operations center and attended a mandatory flight briefing (Tabs V-7.1, V-7.6, V-8.4-8.5). The flight briefing included intelligence data, operational readiness measurement (ORM) information, notices to airmen (NOTAMS), expectations, weather, and safety concerns (Tabs V-7.4, V-8.5). After the flight briefing, the MCEP and MCESO attended a crew briefing with the Mission Coordinator (MC), which covered more specific information regarding the location of the aircraft the mission (Tabs 7.5, V-8.6). Once the crew brief was complete, the MCEP and MCESO stepped to the GCS and were briefed by the loosing MCE crew regarding the status of the mission (Tabs V-7.5, V-8.7).

c. Summary of Accident

On 20 Aug 11, at approximately 15:18Z, the MRPA was circling on the southeast side of its designated orbit and operating on cruise frequencies, but inside the FOB line-of-sight frequency range (Tab EE-3). The MCEP was hand-flying (manual operation vice autopilot) the MRPA with the heading, airspeed, and altitude hold modes on. The altitude hold was set at 18,000 ft MSL and the minimum safe altitude (MSA) indicator was set at 17,000 ft MSL (Tabs V-8.10, EE-3). Therefore, the MRPA's MSA indicator was set to turn the altitude reading on the MCEP's heads-up display (HUD), and both the MCEP and MCESO's heads-down display (HDD), from white to yellow when the altitude reached 17,500 ft MSL, and from yellow to red when the altitude reached 17,000 ft MSL or below (Tabs V-1.6, V-7.6, V-9.7, V-8.10).

At 15:18:23Z, the MRPA suddenly began losing altitude (Tab EE-13). By 15:21:08Z the MRPA had dropped 3,400 ft to an altitude of 14,570 ft MSL. At this time, the MRPA's vertical velocity indicator (VVI) indicated the MRPA was dropping at approximately 1,165 ft per minute (FPM) (Tab EE-14).

During the 2 minute and 45 second timeframe, the MCEP's attention was fixated on his tracker display as he was working to keep the MRPA in a good viewing position of a vehicle after it had driven through an areas of buildings and trees (Tabs V- 8.9, V-8.22, EE-3). Additionally, during this timeframe the MCEP's attention was "divided among various screens" in the GCS and he was "busy" preparing to comply with a new classified tasking (Tabs V-8.9, V-8.22).

At approximately 15:21:08Z, the MCEP noticed the altimeter was red and reading between 14,000-15,000 ft MSL. At this time, the MRPA was still on the southeast side of its designated orbit, approximately 20 nautical miles southwest of the FOB, inside the FOB's line-of-sight frequency range, and generally pointing towards the FOB (Tabs EE-3, V-8.10). The MCEP immediately notified the MCESO and together they began troubleshooting (Tab V-8.12). The MCEP also notified the Mission Coordinator (MC) who, in turn, notified the Mission Director (MD) there was an emergency and the aircraft had dropped a few thousand feet (Tabs V-2.1, V-4.1, V-8.12). The MD and MC were physically located in a separate building than the MCEP and MCESO however, they were all able to communicate via interphone headset (Tabs V-3.2, V-3.3, V-3.5, V-4.1). The MD then contacted the MCEP via headset to find out what was going on directly from the crew (Tab V-4.1). The MCEP told the MD that the MRPA had lost a few thousand feet of altitude due to a suspected Variable Pitch Propeller (VPP) failure (Tab V-4.5). The MD asked the MCEP which LRE GCS was the nearest to the location of the aircraft and if the MCE crew needed him to coordinate with the LRE crew (Tab V-4.1). The MCEP informed the MD that the nearest LRE GCS was the FOB and requested he notify the LRE of the situation (Tab V-4.1).

The MD then removed his headset and called the FOB LRE via SIPR phone and notified the MP that they had an emergency aircraft losing altitude fast (Tab V-4.1). The MD requested the LRE crew immediately get set up in the GCS so the MCE crew could hand-back the MRPA (Tabs R-3, V-4.6, V-9.1). The MP acknowledged and requested specifics regarding the emergency situation and all non-standard information be passed to the their GCS (Tab R-3). The MP then notified the MSO of the emergency and they immediately stepped to the LRE GCS and initiated setup in preparation to take control of the MRPA (Tabs V-2.1, 9.1).

After the MD spoke with the LRE crew he put his headset back on and monitored the situation through his headset and live video feed (Tabs V-4.1, EE-3). The MCEP continued troubleshooting by disengaging the MRPA's altitude hold and using a squadron-created training aid document to help identify the malfunction and the correct emergency checklist (Tabs V-8.13, EE-3, EE-21, EE-22). The MCEP initially thought that the malfunction could be a VPP Rack Bridge Bearing (RBB) failure. However, knowing that the VPP RBB Failure Checklist required turning off the engine, and that a RPA pilot had recently caused a mishap by turning off a functioning engine improperly, the MCEP was unwilling to turn off a potentially good engine without being absolutely sure the malfunction was a VPP RBB failure (Tabs V-8.16, EE-3). Therefore, the MCEP decided to continue to troubleshoot using the process detailed in the training aid rather than immediately run the VPP RBB Failure checklist and turn off the engine (Tabs V-8.16, EE-3, EE-4).

The MCESO then used the MRPA's camera to inspect the engine area at the rear of the aircraft and noted that the MRPA's propeller appeared to be functioning (Tabs V-7.9, EE-14). By

15:22:38Z, the MCEP was en route back to the FOB and had radioed ATC and declared an emergency (Tabs V-8.12, EE-14). At this time (4 minutes and 15 seconds since the initial drop in altitude), the MPRA had dropped 5,312 ft to an altitude of 12,658 ft MSL with a negative VVI of 1,225 FPM (Tab EE-14). At 15:22:46Z, the MCEP again contacted ATC and declared an emergency (Tab EE-14).

While the LRE crew was getting setup, the MC posted in the standard mIRC room that the malfunction could be a "VPP rack ridge failure or prop servo failure" (Tabs EE-19, V-9.1). The LRE crew was very busy getting setup in the GCS and did not have time to request further details from the MCE crew (Tab R-3). Further, the LRE crew expected the MCE crew to relay specific information regarding the emergency and all non-standard information to the LRE GCS as the MP had previously requested (Tabs R-3, V-9.2).

At 15:28:13Z, the LRE crew requested that the MCE crew change the MRPA downlink (DL) frequencies to a specific FOB frequency (Tab EE-19). A few seconds later, the MC acknowledged the request from the LRE crew (Tab EE-19).

At this point, relying on the process outlined in the squadron training aid guide, the MCEP began running the Propeller Servo Overheat/Servo Failure Checklist (Tabs V-8.17, BB-8, EE-21, EE-22). The MCE crew was a few steps into the checklist when the MCEP concluded the malfunction was not a servo failure, but was in fact a VPP RBB failure. The MCE crew then switched to the VPP RBB Failure Checklist (Tabs V-8.16, V-8.24 EE-4).

In accordance with (IAW) the VPP RBB Failure Checklist, the MCEP turned off the MRPA's engine (Tabs V-8.17, BB-9). At 15:28:44Z, a notification appeared on the MRPA's HUD reading "Engine killed" confirming the MRPA's engine had been turned off (Tab EE-14). As a result of the engine being turned off, the negative VVI rapidly decreased stabilizing between 300 and 400 FPM (Tabs EE-4, EE-15). Immediately prior to the engine being turned off the negative VVI was 1039 and had been averaging a negative VVI of approximately 1125 FPM since the MRPA initially began losing altitude (Tabs EE-13 to 15).

At 15:28:59Z, the MC informed the LRE crew that the MRPA was dropping altitude "too fast" and that they needed to take the MRPA "now" and a few seconds later the MC requested the LRE crew take the MRPA "ASAP" (Tab EE-19). The LRE crew acknowledged the MC's requests and attempted to locate the MRPA using the local FOB DL frequencies (Tabs V-2.1, V-2.3, V-9.2, EE-19). The LRE crew was unable to locate the MRPA because the MCE crew had not changed the DL frequencies to the local FOB DL frequencies and was still operating on cruise frequencies (Tabs V-2.1, V-2.3, V-8.18, V-9.2).

At 15:29:56Z, the LRE requested the location of the MRPA (Tab EE-19). Soon after, the LRE requested the MCE relay the MRPA's current DL frequency so they could match their GCS frequencies, locate the MRPA, and take control of the MRPA (Tabs V-2.3, V-9.3, EE-19). At 15:30:29, the MC relayed to the LRE crew that the MRPA was still operating on cruise frequencies (Tab EE-19).

The LRE crew then requested the MCE crew relay any GCS non-standard settings because they were attempting to gain more situational awareness of the emergency and preparing to take control of the MRPA (Tabs R-3, EE-20).

At 15:31:15Z, the LRE crew took control of the MRPA (12 minutes and 52 seconds after the MRPA initially began losing altitude) (Tab EE-15). The MRPA was approximately five nautical miles to the southwest of the FOB (Tab EE-3). The MRPA had lost 13,090 ft, was at 4,880 ft MSL (approximately 3,080 ft above ground level) and had a negative VVI of 383 FPM (Tab EE-15). At 15:31:29Z, the LRE crew notified the MCE crew they had control of the MRPA (Tab EE-20). When the LRE's took control of the MRPA their situational awareness was extremely low because the information relayed to them by the MCE crew was limited and they were unable to monitor the MRPA's HUD and HDD data because the MCE crew had not changed the aircraft's DL frequencies as requested (Tabs V-9.2, V-9.3).

Immediately after taking over the MRPA, the LRE crew noticed the aircraft was descending faster than expected, the air speed was very slow, and there were many yellow and red warnings, one of which indicated the engine was off (Tab V-2.1). The LRE crew asked the MCE crew if they had turned off the engine and the MC confirmed that the MCE crew had turned off the engine (Tab EE-20).

The LRE was attempting to fly the MRPA to the FOB when the MSO noticed that the MRPA's battery volts were low. Therefore, they needed to lower the landing gear because if the battery volts continued to drop they would be unable to lower the landing gear (Tabs R-6, R18). The MP lowered the landing gear and the MSO used the MRPA's camera to visually confirm the landing gear was down (Tabs V-9.5, EE-15).

The LRE crew continued to take steps in an attempt to safely land the MRPA at the FOB. However, when the MRPA was at approximately 2,300 ft MSL (approximately 500 ft AGL), and 3-4 nautical miles from the FOB, the MP realized that they were not going to make it to the FOB and directed the MSO to locate an alternate location to land the MRPA (Tabs R-7, R-18). The MRPA was over a city so the MSO used the MRPA's camera to locate an open field to land the MRPA and the MP initiated a turn towards the field (Tabs R-3, V-2.2).

d. Impact

On 20 Aug 11, at approximately15:36Z, the MRPA impacted a residential area approximately 1.7 nautical miles southwest of the FOB (Tabs C-3, R-3). The MRPA, one AGM Hellfire missile, and one missile rail were destroyed on impact (Tab P-2). There were no fatalities or injuries. Two civilian residential structures were also damaged (Tabs P-2, P-3, S-4 to S-7). The U.S. Army Foreign Claims Commission made a payment to compensate the owners of the damaged residential structures shortly after the mishap. The total damage to U.S. Government property was assessed to be $3,844,825.00 (Tab P-2).

e. Egress and Aircrew Flight Equipment (AFE)

Not applicable.

f. Search and Rescue (SAR)

Not applicable.

g. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

The Air Force Technical Order (AFTO) 781 series forms for the MRPA were documented IAW applicable maintenance guidance and indicated there were no outstanding maintenance issues that would have prevented the MRPA from flying on 19 Aug 11 (Tabs D-2 to D-92). Further, per the AFTO Form 781K, there were no delayed discrepancies that would required the aircraft to be grounded on 19 Aug 11 (Tab D-88). On 19 Aug 11, the Production Superintendent, the individual who approves an aircraft for flight, approved the MRPA for flight after reviewing all applicable maintenance forms and data for the MRPA noting that nothing was out of the ordinary (Tabs D-14, R-37).

b. Maintenance Inspections and Procedures

All MRPA maintenance inspections and procedures were completed and documented IAW applicable maintenance guidance and there were no overdue Aircraft Time Compliance Technical Orders (TCTO) directing modification or inspection of the MRPA (Tab D-88). On 17 Aug 11 (three days prior to the mishap), the MRPA underwent a 60-hour engine inspection IAW the applicable maintenance guidance and technical orders (TO) (Tabs D-22, D-83).

A 60-hour inspection is completed after every 60 hours of RPA flight time (Tab V-6.1). It is an inspection of the aircraft’s motor that includes, but is not limited to, changing the oil, sparkplugs, oil filter, and checking the radiator and coolant fluid levels (Tab V-6.1). To facilitate the maintenance of the RPA’s motor during a 60-hour inspection it is necessary to remove the VPP assembly (Tab V-5.3). Before the VPP assembly is reinstalled, the VPP quill shaft is visually inspected for damage and to ensure it is in working condition (Tab V-5.1).

In this case, the VPP assembly was removed on 17 Aug 11 as part of the 60-hour inspection and the VPP quill shaft was visually inspected for damage prior to reattachment of the VPP assembly (Tab V-5.1). No damage to the VPP quill shaft was discovered and it appeared to be in working condition (Tab V-5.2). The VPP assembly was removed and reassembled IAW all applicable maintenance procedure and TO guidance (Tab V-5.2). The removal and reassembly of the VPP assembly was accomplished by a qualified maintenance technician and inspected by a qualified maintenance inspector (Tabs D-23, V-5.2, V-6.1, EE-17). Further, after reassembling the MRPA, but prior to releasing it for flight, a successful operational check was performed on the engine (Tabs V-5.2, V-5.3).

Currently, there is no USAF maintenance or TO guidance defining the serviceable life of the MQ-1B VPP quill shaft (Tab EE-25). The VPP quill shaft is visually inspected during the 60-

hour engine inspection however, because the VPP quill shaft is not considered part of the engine it typically remains with the aircraft even when the VPP servo, propeller, or engine is changed (Tab DD-5). Therefore, it is likely that the failed VPP quill shaft was the originally installed quill shaft and had been used in the MRPA for approximately 10,243.4 flight hours (Tabs D-2, EE-25, DD-5).

The manufacturer of the MQ-1B, had an internal document defining the MQ-1B VPP quill shaft serviceable life at less than 10,243.4 flight hours (Tabs BB-5, DD-10). However, at the time of the mishap no USAF maintenance or TO guidance defined the serviceable life of the quill shaft (Tab EE-25).

c. Maintenance Personnel and Supervision

The MRPA was maintained at the FOB by Battlespace Flight Services, LLC, contracted by the USAF to provide deployed maintenance support on the MQ-1B weapon system (Tab EE-17).
The contract maintenance personnel who performed the VPP removal, reassembly, and quill shaft inspection, of the MRPA were trained and qualified to perform those duties (Tab EE-17).

d. Fuel, Hydraulic and Oil Inspection Analyses

Not applicable.

e. Unscheduled Maintenance

Not applicable.

6. AIRCRAFT AND AIRFRAME

a. VPP Quill Shaft

The VPP quill shaft, which is part of the MRPA's VPP assembly, is the control shaft which extends through the engine reduction gear housing and is connected from the VPP servo to the VPP rack bridge. Moving the quill shaft inward or outward from the rack bridge changes the pitch of the propeller blade (Tab BB-14).

b. Datalogs and Recovered Hardware Analysis

An analysis of the MRPA's datalogs and recovered hardware determined the following:

(1) The quill shaft connecting the variable pitch propeller (VPP) broke, allowing aerodynamic loads to push the propeller to a flat or negative propeller blade angle. With the abnormal propeller angle and with the engine running, a large increase in drag was generated which caused the aircraft to lose significant altitude before the pilot was able to diagnose the failures and set engine ignition cold. By that time, the aircraft had lost too much altitude and was unable to reach the runway (Tab DD-4).

c. Metallurgical Analysis

A metallurgical analysis of the MRPA's VPP quill shaft determined the following:

(1) the VPP quill shaft fractured at the reduced diameter between the spline and the threaded portion of the shaft (Tab DD-13);

(2) the central area of the fracture contains beach marks indicative of fatigue crack propagation (Tab DD-13);

(3) The relative size of the fatigue region compared to the final overload fracture area indicates that the fracture location was one of low nominal stress but with a severe stress concentration (Tab DD-13);

(4) there were no defects of any kind in the quill shaft (Tab DD-16);

(5) there were no defects in the microstructure of the quill shaft (Tab DD-7);

(6) the quill shaft was made from American Iron and Steel Institute (AISI) 8620 alloy steel as required (Tab DD-16);

(7) The fracture originated at the top edge and propagated through the shaft to the bottom edge (Tab DD-15);

(8) Parallel fatigue micro-cracks are evident in the fracture location along with beach marks (Tab DD-15);

(9) The fracture region contained localized areas which were extremely flat followed by rough areas. (Tab DD-15); and

(10) The smooth (flat) areas are indicative of lower cyclic stress while the rough areas indicate higher stress areas (tab DD-15).

7. WEATHER

a. Forecast Weather

The following was the forecasted weather for the FOB on 20 Aug 11 at 1530Z: 1) winds 090 degrees at 9 knots; 2) temperature high of 101 degrees Fahrenheit and low of 81 degrees Fahrenheit; 3) no icing, turbulence, or windshear; 4) five statute miles visibility; and 5) haze, with a scattered ceiling at 6,000 ft (Tab W-3).

b. Observed Weather

The following was the observed weather for the FOB on 20 Aug 11 at 1530Z: 1) winds 090 degrees at 8 knots; 2) temperature of 88 degrees Fahrenheit; 3) barometric altitude of 29.76; 4) no icing, turbulence, or windshear; 5) unlimited visibility; and 6) no significant cloud cover (Tab F-3).

c. Space Environment

There is no evidence any adverse conditions in the space environment were a factor in the mishap.

d. Operations

Weather at the time of the mishap was within the MRPA's operational limits (Tabs F-3, W-3).

8. CREW QUALIFICATIONS

a. MCE Pilot (MCEP)

(1) Training

The MCEP was qualified in the MQ-1B as a pilot since 23 Feb 11 (Tab G-24). The MCEP was involved in an unrelated incident on 7 July 11 in which he fired a Hellfire missile outside of intended parameters. As a result, his supervision put him in supervised status until he successfully completed additional training. He successfully completed the required additional training on 9 July 2011 and was taken off supervised status at that time (Tabs G-22, G-23).

(2) Experience

At the time of the mishap, the MCEP had a total flight time of 992.2 hours, with 221.2 hours in the MQ-1B (Tab G-39). The MQ-1B was the MCEP's second assigned aircraft after the EC-130H (Tab G-39). The MCEP pilot was not designated as an "experienced" crewmember (had less than 500 hours flying the MQ-1B). The MCEP's flight time for the 30, 60, and 90 days prior to the mishap were as follows (Tab T-7):

	Hours	Sorties
Last 30 Days	37.5	8
Last 60 Days	120.2	21
Last 90 Days	171.4	34

b. MCE Sensor Operator (MCESO)

(1) Training

The MCESO was qualified in the MQ-1B as a sensor operator since 8 Apr 10 (Tab G-49).

(2) Experience

At the time of the mishap, the MCESO had a total flight time of 786.0 hours in the MQ-1B (Tab G-52). The MCESO was designated as an "experienced" crewmember. The MCESO's flight time for the 30, 60, and 90 days prior to the mishap were as follows (Tab T-9):

	Hours	Sorties
Last 30 Days	25.9	6
Last 60 Days	95.7	20
Last 90 Days	114.2	29

c. LRE Pilot (MP)

(1) Training

The MP was qualified in the MQ-1B as a pilot since 22 Jun 09 (Tab T-3).

(2) Experience

At the time of the mishap, the MP had a total flight time of 1420.9 hours in the MQ-1B (Tab G-12). The MP was designated as an "experienced" crewmember. The MP's flight time for the 30, 60, and 90 days prior to the mishap were as follows (Tab G-8):

	Hours	Sorties
Last 30 Days	24.3	29
Last 60 Days	41.6	40
Last 90 Days	95.2	51

d. LRE Sensor Operator (MSO)

(1) Training

The MSO was qualified in the MQ-1B as a sensor operator since 28 Jan 09 (Tab T-5).

(2) Experience

At the time of the mishap, the MSO had a total flight time of 1778.4 hours in the MQ-1B (Tab G-21). The MSO was designated as an "experienced" crewmember. The MSO's flight time for the 30, 60, and 90 days prior to the mishap were as follows (Tab G-16):

	Hours	Sorties
Last 30 Days	23.7	29
Last 60 Days	53.9	58
Last 90 Days	76.6	84

9. MEDICAL

At the time of the mishap, the MCEP, MCESO, MP and MSO had current flight physicals, no known illnesses or injuries, and were medically qualified to perform flying duties (Tab EE-7).

a. Health

Medical records of the MCEP, MCESO, MP and MSO were reviewed by the AAIB. Preventative Health Assessments (PHAs) and flight physicals were current for all of the above members (Tab EE-7). No members had been issued a certificate restricting flight duties or "Duties Not Including Flying" (DNIF). There were no pending or expired medical waivers for any of the members. The members had no medical conditions that were relevant or could have contributed to the mishap. None of the members were on any medications other than those which were previously recommended, ground tested, and approved and prescribed by licensed medical providers (Tab EE-7). There was no evidence that medication was a factor in the mishap (Tab EE-7).

b. Toxicology

On 20 Aug 11, blood and urine samples of the MCEP and MCESO were collected at Cannon AFB, NM (Tab EE-7). On 25 Aug 11, the toxicology samples were received by Armed Forces Medical Examiner System, Division of forensic Pathology, Rockville, Maryland. The blood and urine samples were tested for the presence of ethanol, and drugs of abuse (amphetamine, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates and phencyclidine). All toxicology testing resulted in negative findings for ethanol and drugs of abuse (Tab EE-7).

At the time of the mishap, the MP and MSO were operating at a deployed location that did not have a USAF flight surgeon however, had a U.S. Army (USA) flight surgeon. As such, a USAF flight surgeon at another FOB worked with the USA flight surgeon to obtain lab work for the MP and MSO (Tabs EE-7, EE-8). The samples were sent to the Division of Forensic Toxicology, Armed Forces Examiner System, Rockville, MD (Tabs EE-7, EE-9). However, per the Deputy Chief, of Laboratory Operations for the Armed Forces Medical Examiner System, the samples were never received by the Armed Forces Medical Examiner System (Tabs EE-8, EE-10). It is the AAIB's conclusion that the urine and blood samples for the MP and MSO were lost (Tabs EE-8, EE-10).

c. Lifestyle

No lifestyle factors were found to be relevant to this mishap.

d. Crew Rest and Crew Duty Time

Air Force Instructions require pilots to have proper "crew rest" prior to performing in-flight duties and adhere to proper duty time requirements as defined in AFI 11-202, Volume 3, *Flying Operations-General Flight Rules*, Chapter 9, 22 Oct 10. No crew rest or crew duty time requirements were violated nor found to be a factor in the mishap. Further, there was no evidence that fatigue was a factor in the mishap (Tab EE-7).

10. OPERATIONS AND SUPERVISION

a. Operations

There is no evidence the operational tempo was a factor in the mishap.

b. Supervision

There is no evidence supervision was a factor in the mishap.

11. HUMAN FACTORS

a. Overview

A DoD taxonomy was developed to identify hazards and risks, called DoD Human Factors Analysis and Classification System (DoD-HFACS), referenced in Attachment 5 of AFI 91-204, *Safety Investigations and Reports*, 24 Sept 08. DoD-HFACS describes four main tiers of human factors: 1) Acts; 2) Preconditions; 3) Supervision; and 4) Organizational Influences (AFI 91-204, attach 5).

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 (AFI 91-204, attach 5).

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 (AFI 91-204, attach 5).

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 individual and result in human error or an unsafe situation (AFI 91-204, attach 5).

Organizational Influences are factors in a mishap if the communications, actions, omissions or policies of upper-level management directly or indirectly affect supervisory practices, conditions or actions of the operator(s) and result in system failure, human error or an unsafe situation (AFI 91-204, attach 5).

After reviewing the facts from the investigation, including witness testimony, the human factors that were relevant to the mishap are enumerated and discussed below. The DoD-HFACS taxonomy nanocodes are also included for reference (AFI 91-204, attach 5).

b. Acts

(1) AE204 Necessary Action – Delayed

Necessary Action – Delayed is a factor when the individual selects a course of action but elects to delay execution of the actions and the delay leads to an unsafe situation (AFI 91-204, attach 5). This occurred when the MCEP initially diagnosed the malfunction as a VPP failure however, delayed running the VPP RBB Failure Checklist. The MCEP delayed the necessary action of running the VPP RBB Failure Checklist because he was hesitant to turn off the MRPA's engine (a required VPP RBB Failure checklist item) and did not want to repeat a recent mishap where a MQ-1B pilot incorrectly diagnosed a malfunction as a VPP failure (Tabs V-8.16, EE-3, EE-4).

c. Preconditions

(1) PC102 Channelized Attention

Channelized Attention 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. It may be described as a tight focus of attention that leads to the exclusion of comprehensive situational information (AFI 91-204, attach 5). This occurred when the MCEP failed for approximately 2 minutes and 45 seconds to notice the MRPA was rapidly descending. At the time, his attention was channelized on the GCS tracker display because he was actively working to keep the MRPA in a good viewing position of a vehicle (Tabs V-8.9, 8.22, EE-3, EE-4, EE-13 to 15).

(2) PC214 Response Set

Response set is a factor when the individual has a cognitive or mental framework of expectations that predispose them to a certain *course of action* regardless of other cues. This occurred when the MCE crew failed to change their DL frequencies as requested by the LRE crew (Tabs V-9.2, V-9.3). IAW standard handoff procedures, the LRE crew expected the MCE crew to change their DL frequencies to the local DL frequencies while, the MCE crew expected, that because it was an emergency situation, the LRE crew would change their frequencies to the cruise frequencies (Tabs V-8.18, V-7.11, V-7.12, V-9.2)

(3) PC506 Expectancy

Expectancy is a factor when the individual expects to perceive a certain reality and those expectations are strong enough to create a false perception of the expectation (AFI 91-204, attach 5). This occurred in two instances: 1) when the MC, unaware the MCE crew was busy running emergency checklists, expected the MCE crew to be monitoring the mIRC; and 2) when the LRE crew, relying on the MC's acknowledgement, expected the MCE crew to change their DL frequencies as requested (Tabs V-8.18, EE-20-21, V-2.3, V-9.3).

(4) PP106 Communicating Critical Information

Communicating critical information is a factor when known critical information was not provided to appropriate individuals in an accurate or timely manner (AFI 91-204, attach 5). This occurred in two instances: 1) when the MCE crew failed to notify the LRE crew that they had turned off the MRPA's engine; and 2) when the MCE crew failed to notify the LRE crew of precisely what emergency checklist they were running and how many of the checklist items they had completed (Tabs V-9.2 to V-9.5, V-7.12, V-7.11).

d. Supervision

None identified.

e. Organizational

(1) OP003 Procedural Guidance/Publications

Procedural Guidance/Publications is a factor when written direction, checklists, graphic depictions, tables, charts or other published guidance is inadequate, misleading or inappropriate and this creates an unsafe situation (AFI 91-204, attach 5). At the time of the mishap, the USAF did not have maintenance or TO guidance defining the serviceable life of a VPP quill shaft (Tab EE-25). When the VPP quill shaft broke, it had 10,243.4 flight hours; which is much greater than the manufacturer's recommended serviceable life (Tabs D-2, DD-4, DD-5, EE-25, BB-5). The lack of USAF maintenance guidance defining the serviceable life of the quill shaft resulted in exceeding the manufacturer's defined serviceable life and the quill shaft breaking due to fatigue.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Governing Directives and Publications

(1) TO 1Q-1(M)B-2-61-GS-00-1, *Technical Manual, Propeller, MQ-1B Remotely Piloted Aircraft*, 31 Jan 11
(2) TO 1Q-(M)B-1-CL-1, *Flight Crew Checklist, USAF Series MQ-1B System*, 13 Dec 10
(3) To 1Q-1(M)B-2-61JG-00-1, *Job Guide, Propeller, MQ-1B Remotely Piloted Aircraft*, 31 Jan 11
(4) 3 SOS Training Aid, *MQ-1 Loss of Power in Flight*, 13 Feb 11
(5) AFI 51-503, *Aerospace Accident Investigations*, 26 May 10*
(6) AFI 91-204, *Safety Investigations and Reports*, 24 Sept 08*
(7) AFI 11-202, Volume 3, *Flying Operations-General Flight Rules,* Chapter 9, 22 Oct 10*
(8) AF IMT 711B, *USAF Mishap Report*, 8 Nov 03* (Tab B-3)

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

b. Known or Suspected Deviations from Directives or Publications

During the investigation, it was discovered that the MCE and LRE crews omitted checklist items during the hand-off of the MA during the emergency situation. Some examples are the MCE crew not changing the MCE GCS DL frequencies to the LRE DL frequencies and the LRE crew not turning on the LRE GCS digital video recording equipment when they entered the LRE GCS (Tabs N-2, V-2.3). All of the omitted checklist items were carefully reviewed by the AAIB, and none were found to have contributed to the mishap.

13. ADDITIONAL AREAS OF CONCERN

None.

26 JANUARY 2012

GARDNER J. JOYNER, Major, USAF
President, Abbreviated Accident Investigation Board

STATEMENT OF OPINION

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B, T/N 06-3178
FORWARD OPERATING BASE (FOB), AFGHANISTAN
20 AUGUST 2011

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

1. OPINION SUMMARY

I find by clear and convincing evidence that the cause of the mishap was a broken variable pitch propeller (VPP) quill shaft. The broken quill shaft forced the mishap remotely piloted aircraft's (MRPA) propeller to an abnormal or negative angle which generated increased drag and caused the MRPA to rapidly descend. By the time the Mission Control Element Pilot (MCEP) was able to diagnose the emergency, take action, and handoff the MRPA to the launch and recovery element (LRE) crew, the MRPA had lost too much altitude and was unable to reach the FOB.

Furthermore, I find by a preponderance of the evidence that the lack of USAF maintenance guidance defining the serviceable life of an MQ-1B VPP quill shaft substantially contributed to the mishap.

2. DISCUSSION OF OPINION

a. Cause: Failed VPP quill shaft

Approximately 17 hours into the mishap flight, the MPRA's VPP quill shaft broke at the reduced diameter between the spline and the threaded portion of the shaft. Metallurgical analysis found, the central area of the break contained beach marks, which are indicative of fatigue crack propagation. The relative size of the fatigue region indicates the facture location was one of low stress but with severe stress concentration. The VPP quill shaft was made of 8620 alloy steel, which is the required material for this part.

The fracture originated at the top edge and propagated through the shaft to the bottom edge. Parallel fatigue micro-cracks are evident in the fracture location along with beach marks. The fracture region contained localized areas which were extremely flat followed by rough areas. The smooth (flat) areas are indicative of lower cyclic stress while the rough areas indicate higher stress areas. There were no defects in the microstructure found which could have contributed to the quill shaft failure.

3. CONTRIBUTING FACTOR

a. Lack of USAF maintenance guidance defining the serviceable life of the MQ1-B VPP quill shaft

Currently, there is no USAF maintenance or technical order (TO) guidance regarding the serviceable life of the MQ-1B VPP quill shaft. The quill shaft is visually inspected during the 60-hour engine inspections however, because the VPP quill shaft is not considered part of the engine it typically remains with the aircraft even when the VPP servo, propeller, or engine is changed. Since there are no maintenance records to the contrary, it is presumed that the MRPA's VPP quill shaft was the originally installed part and had approximately 10,243.4 flight hours at the time of the mishap.

During my investigation, I discovered that the manufacturer of the MQ-1B, General Atomics (GA), had an internal document defining the MQ-1B VPP quill shaft serviceable life. The internal document defined the serviceable life at less than 10,243.4 flight hours; however, the USAF was not privy to the above-mentioned GA document.

4. CONCLUSION

I arrived at my opinion by examining the GA Contractor Report, Metallurgical Investigation Report, witness testimony, MCE heads-up display recording, internet relay chat logs, applicable technical data, and by consulting with subject matter experts. All evidence is consistent that the broken VPP quill shaft caused the propeller to fail in a negative pitch position. The negative pitch position caused the MRPA to descend rapidly with vertical velocities of 1,200 feet per minute or greater. By the time the MCEP was able to diagnose the emergency, take action, and handoff the MRPA to the LRE crew, the MRPA had lost too much altitude and was unable to reach the FOB.

26 JANUARY 2012

GARDNER J. JOYNER, Major, USAF
President, Abbreviated Accident Investigation Board