# UNITED STATES AIR FORCE
# ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

**MQ-1B, T/N 07-3210**
**432D WING**
**CREECH AIR FORCE BASE, NEVADA**

**LOCATION: EASTERN AFGHANISTAN**
**DATE OF ACCIDENT: 14 JULY 2014**
**BOARD PRESIDENT: LT COL SHERYL A. OTT**

**Abbreviated Accident Investigation, conducted pursuant to Chapter 11 of Air Force Instruction 51-503**

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

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

20 JAN 2015

# ACTION OF THE CONVENING AUTHORITY

**The Report of the Abbreviated Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 14 July 2014 mishap, near Kandahar Air Base, Afghanistan, involving an MQ-1B, T/N 07-3210, assigned to the 432d Wing, Creech Air Force Base, Nevada, complies with applicable regulatory and statutory guidance; on that basis it is approved.**

**JAMES N. POST III**
**Major General, USAF**
**~~Vice~~ Commander**

**EXECUTIVE SUMMARY**
**ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION**

**MQ-1B, T/N 07-3210**
**EASTERN AFGHANISTAN**
**14 JULY 2014**

On 14 July 2014, at 0938 Zulu time (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, tail number (T/N) 07-3210, assigned to the 432d Wing (WG), Creech AFB, Nevada, and operated by the 178th Reconnaissance Squadron (178 RS), 119th Wing (119 WG), North Dakota (ND) Air National Guard (ANG), Fargo, ND, impacted the ground approximately 190 nautical miles (nm) northeast of Kandahar Air Base (AB), Afghanistan. The MRPA's munitions were expended prior to impact. The MRPA was destroyed upon impact with the loss valued at $4.6 million. No injuries, deaths or damage to private property resulted from the mishap.

On 14 July 2014, at 0011Z, after normal preflight checks, the MRPA departed Kandahar AB, Afghanistan. The Launch and Recovery Element handed off the MRPA to the Mission Control Element (MCE) uneventfully at 0026Z. Three 178 RS MCE crews flew the MRPA's assigned mission tasking with no abnormal indications for 8.6 hours before the mishap crew (MC) took control of the aircraft at 0900Z. At 0924Z, the MRPA's engine, which had been operating normally, ceased producing thrust, with all engine parameters falling below even the idle range. This caused the MRPA to begin an uncommanded descent at 800 – 1,000 feet per minute. The MC analyzed the indications and ran the appropriate checklists. The MC expended their munitions in a location away from any people or buildings, as directed by the Combined Forces Air Component Commander. With insufficient thrust from the engine to remain airborne, the MC selected an uninhabited area for a controlled impact into terrain. The MRPA impacted the ground at 0938Z.

The Abbreviated Accident Investigation Board (AAIB) President found, by clear and convincing evidence, that the cause of this mishap was an engine failure that rendered the aircraft incapable of producing sufficient thrust to remain airborne. A specific root cause of the engine failure could not be determined, since the MRPA was not recovered.

The AAIB President developed her opinion by analyzing factual data from historical records, flight data logs, manufacturer reports, maintenance records, witness testimony, Air Force directives and guidance, and Air Force Technical Orders; by conducting flight simulations and an in-person visit to the mishap squadron facilities and ground control station; and through consultation with maintenance and other subject matter experts.

# SUMMARY OF FACTS AND STATEMENT OF OPINION
# MQ-1B, T/N 07-3210
# 14 JULY 2014

## TABLE OF CONTENTS

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 12 AF | Twelfth Air Force |
| 119 WG | 119th Wing |
| 178 RS | 178th Reconnaissance Squadron |
| 432 AEW | 432d Air Expeditionary Wing |
| 432 WG | 432d Wing |
| 457 AS | 457th Airlift Squadron |
| 5Ws | Who, What, When, Where, Why |
| 62 ERS | 62d Expeditionary Reconnaissance Squadron |
| AAIB | Abbreviated Accident Investigation Board |
| AB | Air Base |
| ACC | Air Combat Command |
| AF | Air Force |
| AFB | Air Force Base |
| AFCENT | Air Force Central Command |
| AFE | Aircrew Flight Equipment |
| AFI | Air Force Instruction |
| AFPET | Air Force Petroleum Agency |
| AFSEC Rep | Air Force Safety Center Representative |
| AFSEC/SEC | Air Force Safety Center/ Flight Safety Office |
| AFTO | Air Force Technical Order |
| AGM | Air to Ground Missile |
| ANG | Air National Guard |
| AO | Aeronautical Order |
| ATO | Air Tasking Order |
| ATT | At This Time |
| AVGAS | Aviation Gas |
| A1C | Airman First Class |
| BD | Battle Director |
| BFS | Battlespace Flight Services |
| BP | Board President |
| BPO | Basic Postflight |
| C | Celsius |
| CAPS | Critical Action Procedures |
| Capt | Captain |
| CAOC | Combined Air Operations Center |
| CC | Commander |
| CCO | Operations Director |
| CF | Carried Forward |
| CFACC | Combined Forces Air Component Commander |
| CHT | Cylinder Head Temperature |
| CIV | Civilian |
| C/W | Complied With |
| DEG | Degree |
| Det | Detachment |
| DO | Director of Operations |
| DoD | Department of Defense |
| DP | Deployed Position |
| D/R | Disregard |
| EGT | Exhaust Gas Temperature |
| EPE | Emergency Procedure Evaluation |
| ER | Exceptional Release |
| ERS | Expeditionary Reconnaissance Squadron |
| F | Fahrenheit |
| FA | Flight Authorization |
| FL | Flight Level |
| FLIF | Flight Crew Information File |
| FMC | Fully Mission Capable |
| FPM | Feet Per Minute |
| Ft | Feet |
| G | Gravity |
| GA | General Atomics Aeronautical Systems, Inc. |
| GCS | Ground Control Station |
| GMT | Greenwich Mean Time |
| HRS | Hours |
| HUD | Heads-Up Display |
| IAP | International Airport |
| IAW | In Accordance With |
| IFE | In Flight Emergency |
| INSP | Inspection |
| IR | Infrared |
| ISR | Intelligence, Surveillance, and Reconnaissance |
| IO | Investigating Officer |
| JA | Judge Advocate |
| JBAD | Jalalabad |
| KAF | Kandahar Airfield |
| KDAR | Kandahar |
| KIAS | Knots indicated airspeed |
| Kts | Knots |
| LA | Legal Advisor |
| LLC | Limited Liability Company |
| LOS | Line of Sight |
| LRE | Launch and Recovery Element |
| LREP | Launch and Recovery Element Pilot |
| LRESO | Launch and Recovery Element Sensor Operator |
| Lt | Lieutenant |
| Lt Col | Lieutenant Colonel |
| Maj | Major |
| MAJCOM | Major Command |
| MAP | Manifold Air Pressure or Manifold Absolute Pressure (used interchangeably) |
| MC | Mishap Crew |
| MCE | Mission Control Element |
| MCT | Manifold Charge Temperature |
| MDS | Mission Design Series |
| MIC | Mission Intelligence Coordinator |

| | |
|---|---|
| mIRC | Military Internet Relay Chat |
| MM | Medical Member |
| MOS | Mishap Operations Supervisor |
| MP | Mishap Pilot |
| MRPA | Mishap Remotely Piloted Aircraft |
| MSEO | Mishap Safety Observer |
| MSgt | Master Sergeant |
| MSL | Mean Sea Level |
| MSO | Mishap Sensor Operator |
| MTS | Multispectral Targeting System |
| MX | Maintenance |
| MXG | Maintenance Group |
| MXM | Maintenance Member |
| MXPx (1 through 5) | Maintenance Person 1 |
| ND | North Dakota |
| NDN | No Discrepancies Noted |
| NM | Nautical Miles |
| NOTAM | Notice to Airmen |
| NV | Nevada |
| OG | Operations Group |
| OPS | Operations |
| OpsSup | Operations Superintendent |
| ORM | Operational Risk Management |
| OSS | Operations Support Squadron |
| OWS | Operational Weather Squadron |
| P | Pilot |
| PCM | Primary Control Module |
| PHA | Physical Health Assessment |
| PM | Pilot Member |
| PPSL | Predator Primary Satellite Link |
| PR | Pre-flight |
| PSI | Pounds Per Square Inch |
| QA | Quality Assurance |
| Rec | Recorder |
| RAP | Ready Aircrew Program |
| RPA | Remotely Piloted Aircraft |
| RPA LNO | Remotely Piloted Aircraft Liaison Officer |
| RPM | Revolutions Per Minute |
| RS | Reconnaissance Squadron |
| RTB | Return To Base |
| R2 | Remove and Replace |
| SAR | Search and Rescue |
| SATCOM | Satellite Communications |
| SCM | Secondary Control Module |
| SEO | Safety Observer |
| SEPT | Simulated Emergency Procedure Training |
| SIB | Safety Investigation Board |
| S/N | Serial Number |
| SO | Sensor Operator |
| TCTO | Time Compliance Technical Order |
| T/N | Tail Number |
| TO | Technical Order |
| UAS | Unmanned Aerial System |
| UAV | Unmanned Aerial Vehicle |
| U.S. | United States |
| U.S.C. | United States Code |
| USAF | United States Air Force |
| VPP | Variable Pitch Propeller |
| VVI | Vertical Velocity Indication |
| WEZ | Weapons Employment Zone |
| Wg | Wing |
| WILCO | Will Comply |
| WOC | Wing Operations Center |
| Z | hours in Greenwich Mean Time/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 17 October 2014, Major General James N. Post III, Vice Commander, Air Combat Command (ACC), appointed Lieutenant Colonel (Lt Col) Sheryl A. Ott to conduct an aircraft accident investigation of a mishap that occurred on 14 July 2014 involving a MQ-1B aircraft in eastern Afghanistan. The abbreviated aircraft accident investigation board (AAIB) was conducted in accordance with (IAW) Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, Chapter 11, at Nellis Air Force Base (AFB), Nevada (NV), from 24 October 2014 through 18 November 2014. A legal advisor and recorder were also appointed as members of the board (Tab Y-3 through Y-4).

### 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 14 July 2014, at approximately 0938 Zulu time (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, tail number (T/N) 07-3210, assigned to the 432d Wing (432 WG), Creech AFB, NV, and operated by the 178th Reconnaissance Squadron (178 RS), 119th Wing (119 WG), North Dakota (ND) Air National Guard (ANG), Fargo, ND, impacted the ground approximately 190 nautical miles (nm) northeast of Kandahar Air Base (AB), Afghanistan (Tabs AA-3, AA-12, GG-3). The MRPA's munitions were expended prior to impact (Tabs AA-12, AA-14). The MRPA was destroyed upon impact with the loss valued at $4.6 million (Tabs P-3, X-3, HH-3 through HH-5). No injuries, deaths or damage to private property resulted from the mishap (Tab X-3).

## 3. BACKGROUND

The MRPA belonged to the 432 WG, Creech AFB, NV (Tab AA-3). The 432 WG falls under ACC as the major command (MAJCOM) and Twelfth Air Force (12 AF) as the numbered air force (Tab CC-3, CC-6). The mishap crew (MC), consisting of the mishap pilot (MP) and mishap sensor operator (MSO), are assigned to the 178 RS, 119 WG, Fargo ANG Base, ND (Tab G-2 through G-21). Additionally, at the time of the mishap, the MRPA was forward deployed to Afghanistan and was maintained by Battlespace Flight Services (BFS), Limited Liability Company (LLC) (Tabs D-6, CC-14).

**a. 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, control, communications, and intelligence systems, and conducts global information operations (Tab CC-3 through CC-5).

**b. Twelfth Air Force (12 AF)**

12 AF is responsible for the combat readiness of 10 active-duty wings and one direct reporting unit. The subordinate commands operate more than 818 aircraft with more than 65,000 uniformed and civilian Airmen. The command is also responsible for the operational readiness of 12 AF-gained wings and other units of the Air Force (AF) Reserve and ANG (Tab CC-6 through CC-8).

**c. 432d Wing (432 WG)/432d Air Expeditionary Wing (432 AEW)**

The 432 WG and its associated deployed unit, the 432d Air Expeditionary Wing, also known as the "Hunters," consists of combat-ready Airmen who fly remotely piloted aircraft (RPA) in direct support of the joint force warfighter. The RPA system provides real-time reconnaissance, surveillance, and precision attack against fixed and time-critical targets. The Hunters conduct RPA training for aircrew, intelligence, weather, and maintenance personnel (Tab CC-9 through CC-10).

**d. 119th Wing (119 WG)**

The mission of the 119 WG, ND ANG, is two-fold. Its state mission, under the command of the Governor, is to support state and local authorities in civil emergencies. Under the federal mission, the unit is available for mobilization and immediate integration into the United States (U.S.) Air Force (Tab CC-11 through CC-12).

**e. 178th Reconnaissance Squadron (178 RS)**

The 178 RS is a unit of the ND ANG's 119th Wing, located at Fargo ANG Base, ND. The 178th is equipped with the MQ-1B Predator, a medium-altitude, long-endurance, remotely piloted aircraft (Tab CC-13).

**f. Battlespace Flight Services (BFS)**

BFS provides organizational maintenance support for MQ-1B aircraft and systems to sustain the combat and training capability

at tasked locations worldwide. The primary objective of BFS is to provide qualified management and supervisory personnel at U.S. MQ-1B operating locations, and a level of support for their personnel that allow them to accomplish their objective. Support includes aircraft maintenance, supply support, command, control, communications, computer, intelligence, surveillance, and reconnaissance (ISR) systems, quality assurance, and an environmental, safety, and health program (Tab CC-14 through CC-15).

### g. MQ-1B, Predator

The MQ-1B Predator is an armed, multi-mission, medium-altitude, long-endurance RPA that is employed primarily 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, the Predator provides a unique capability to perform strike, coordination and reconnaissance missions against high-value, fleeting and time-sensitive targets. Predators can also perform the following missions and tasks: ISR, close air support, combat search and rescue, precision strike, buddy-lase, convoy/raid overwatch, route clearance, target development and terminal air guidance. The MQ-1B's capabilities make it uniquely qualified to conduct irregular warfare operations in support of combatant commander objectives. The MQ-1B Predator system consists of an aircraft (with sensors), a ground control station (GCS), a Predator Primary Satellite Link (PPSL), and operations and maintenance personnel for deployed 24-hour operations. The basic crew for the MQ-1B Predator is one pilot and one sensor operator. The crew flies the MQ-1B Predator from inside the GCS via a line of sight (LOS) radio data link and via a satellite data link for beyond-LOS flight. A ground data terminal antenna provides LOS communications for takeoff and landing, while the PPSL provides beyond-LOS communications during the remainder of the mission (Tab CC-16 to CC-21).

## 4. SEQUENCE OF EVENTS

### a. Mission

On 14 July 2014, the MRPA was performing an ISR tasking in Afghanistan (Tabs K-2, AA-3, AA-5, AA-14). The mission was authorized by Air Forces Central Command (AFCENT) through the daily Air Tasking Order (ATO) (Tabs K-2, AA-5 through AA-6). The launch and recovery element (LRE) crew consisted of a pilot and sensor operator who launched the MRPA from Kandahar AB, Afghanistan, at 0011Z (Tabs V-7.2, 8.1 through 8.3, AA-3). During the course of the mission, the MRPA was handed off to three separate mission control element (MCE) crews, all of whom were assigned to the 178 RS, ND ANG (Tab AA-3, AA-5). The MC took control of the aircraft at approximately 0900Z (Tabs AA-3, V-12.1, V-13.1).

### b. Planning

The MC arrived prior to their scheduled shift start time to accomplish all required preflight mission planning (Tabs V-11.2, V-12.2, V-13.1 through V-13.3). The MC's pre-mission briefing was conducted with the mishap operations supervisor (MOS) and the mission

intelligence coordinator (MIC) IAW Air Force instructions and covered: weather, threats (none noted), notices to airmen (NOTAMs), and standards and crew contracts (Tabs V-11.2, V-12.2, V-13.3). Additionally, the MC received a standard crew change briefing from the previous crew prior to taking command of the MRPA, updating them on the mission, current operating environment and aircraft status (Tabs V-9.1, V-10.1, V-12.1 through V-12.2, V-13.3). There is no evidence to suggest mission planning was a factor in this mishap.

**c. Preflight**

Maintenance person #5 (MXP5) properly inspected and MXP3 released the MRPA for flight (Tabs U-4, V-4.1, V-5.1). The LRE crew accomplished a standard launch, during which the engine parameters were normal (Tab V-6.2, V-7.2, V-8.1 through V-8.3). There is no evidence to suggest preflight procedures were a factor in this mishap.

**d. Summary of Accident**

On 14 July 2014, the MRPA took off at 0011Z (Tab AA-3). The mission proceeded as planned, with no aircraft or engine anomalies detected until 0924Z (Tabs J-2, V-6.2, V-7.2, V-8.2 through V-8.3, V-9.1, V-10.1, V-12.1, V-13.1, AA-15).

At 0924:59Z and 19,000 feet (ft) mean sea level (MSL), the engine quit producing thrust and all engine parameters went from the normal operating range to below idle (Tabs J-2 through J-7, DD-3 through DD-11). Specifically, the manifold air pressure (MAP) (an indication of the boost produced by the turbocharger) decreased to static air pressure (no boost) and the propeller pitch angle decreased to minimum, putting the least resistance on the engine, but also resulting in minimal thrust (Tab DD-4 through DD-6). These parameters did not recover for the remainder of the sortie (Tab DD-4 through DD-6). Several other engine parameters indicated severely deficient performance, to include: reduced exhaust gas temperatures (EGT); engine speed in revolutions per minute (RPM); oil pressure; alternators ceasing to produce current with batteries leaking current; and abnormal turbo and oil temperatures (Tab DD-4 through DD-6). The aircraft began an uncommanded descent at approximately 800 feet per minute (fpm) (Tabs DD-5, V-12.1). Several warnings appeared on the MC's head's-down displays (Tab V-12.1 through V-12.2, V-13.1 to V-13.2).

Based on these indications of an engine failure, the MP immediately took the aircraft out of its preprogrammed loiter (autopilot modes remained on), initiated a turn towards the closest recovery airfield and declared an emergency with the controlling agency (Tabs V-12.1, V-13.1, AA-12). In performing these actions, the MP accomplished the first two steps of the Technical Order (TO) 1Q-1(M)B-1 Engine Failure checklist critical action procedures (CAPs) – "1. GLIDE – ESTABLISH, 2. LANDING SITE – SELECT" (Tab V-12.1, V-13.1, TO 1Q-1(M)B-1). Prior to accomplishing the third step of the CAPs – "3. THROTTLE – 25%" – the MP noted that the engine RPM had recovered and was fluctuating around 4,000 RPM, the alternators were back on-line, though the MAP remained at ambient pressure (Tabs V-12.1, V-13.1, DD-14). These indications – RPM above windmilling (free spinning) speed accompanied by MAP at only ambient (rather than boosted) pressure – are more typical of just a turbocharger failure rather than complete engine failure (Tab V-12.1 through 12.2). Therefore, the MC stopped the Engine

Failure checklist and referenced TO 1Q-1(M)B-1 Turbocharger/MAP Sensor Failure checklist instead (Tabs V-12.1, V-13.1 through V-13.2, DD-8 through DD-9).

As soon as the aircraft rolled out on a heading toward the nearest divert airfield, the MC assessed that the MRPA would be unable to clear the high terrain between the MRPA and the divert airfield in its thrust-deficient condition (Tabs V-12.2, V-13.1, AA-12). Accordingly, the MP turned the aircraft back towards Kandahar AB, planning to fly the approximately 200 nm distance via the areas of lowest terrain (Tabs V-13.1, AA-12).

In accordance with the Turbocharger/MAP Sensor Failure checklist, the MP switched to the backup MAP sensor (Tabs V-12.1, V-13.1, DD-9). This did not change the engine performance, as all three MAP sensors were reporting the same ambient pressure (Tab V-12.1, V-13.2). Approximately three minutes after the initial engine rollback, the engine speed again momentarily decreased below 1,500 RPM causing the alternators to again momentarily cease producing current (Tab DD-6). Oil quantity had decreased significantly and the oil pressure was close to 0 pounds per square inch (psi) (Tab DD-6). Based on the erratic engine parameters and consistent descent rate of 800 – 1,000 fpm, the MC concluded the engine had failed and ceased running the Turbocharger/MAP Sensor failure checklist (Tabs V-12.1 through V-12.2, V-13.1 through V-13.2).

Due to the distance from Kandahar and the inability of the aircraft to maintain altitude, the MC queried the Combined Air Operations Center (CAOC) for disposition instructions for the aircraft and the munitions on board (Tab V-11.1, V-12.1 through V-12.2). The MC suspended troubleshooting the engine failure in order to focus on locating a safe and appropriate location to dispense the munitions (Tab V-11.1, V-12.1 through 12.2, V-13.1 through V-13.3). At 0932Z the Combined Forces Air Component Commander (CFACC) directed the MC to expend their ordnance in an unpopulated area through the RPA liaison at CAOC (Tab AA-12). The MC expended the munitions, monitoring the site until impact at 0936Z (Tabs V-12.1 through V-12.2, V-13.1 through V-13.2, AA-12, AA-14). No injuries or damage to property occurred when the munitions impacted the ground (Tabs V-12.1, V-13.1 through V-13.2, AA-14).

In order to locate a suitable weapon impact site and provide terminal guidance for the munitions, the MC was required to focus the MRPA's video on the impact site (Tabs V-12.2, V-13.2). Only after the munitions had detonated, with the aircraft less than 2,000 ft above the ground, was the MC able to move the video's field of view to select a suitable location for a controlled impact (Tabs V-12.2, V-13.2, HH-5). Ensuring that the aircraft or weapons did not cause injuries or damage upon impact required the full attention of the crew and precluded further attempts to run checklists or troubleshoot the engine malfunction (Tab V-11.1, V-12.1 through V-12.2, V-13.1 through V-13.2).

At 0938Z the MRPA impacted the ground (Tab DD-6). Shortly afterward, another airborne asset was able to provide video coverage of the wreckage and confirmed the impact had caused no injuries or damage to people or property (Tab X-3).

### e. Impact

The MRPA impacted the ground at 0938Z in eastern Afghanistan (Tabs AA-14, DD-6). At the time of the impact, the MRPA's landing gear was down, its engine was rotating but failing to produce sufficient thrust for level flight, and its airspeed was approximately 70 knots indicated airspeed (KIAS) (Tab HH-5).

### f. Egress and Aircrew Flight Equipment (AFE)

Not applicable.

### g. Search and Rescue (SAR)

Not applicable.

### h. Recovery of Remains

Not applicable.

## 5. MAINTENANCE

### a. Forms Documentation

A Permanent Modification Directive (ACC Mod Control #13-241, released 28 Oct 2013) directed the replacement of the MQ-1B oil return line (Tabs U-19, DD-10). This modification reduced crankcase pressure and was issued in an effort to reduce the number of turbocharger failures linked to high crankcase pressure (Tabs U-19, DD-10). The modification was performed on the MRPA 29 November 2013 and documented in the corresponding Air Force Technical Order (AFTO) 781, pending the official release of the time compliance technical order (TCTO) (Tabs U-20, DD-10).

The AFTO 781 series forms for the MRPA were documented IAW applicable maintenance guidance, except as noted below (Tabs D-3 through D-20, U-3 through U-18). Prior to the mishap sortie, T/N 07-3210 had flown 9011.3 total hours (hrs) and its rebuilt engine E2105 had 1157.0 total hrs (Tab D-2).

The forms indicated no outstanding issues that would have prevented the MRPA from flying 14 July 2014 (Tabs U-3 through U-9). There were no recurring maintenance problems documented in the AFTO 781 Forms (Tabs D-3 through D-20, U-3 through U-18). The MRPA diverted into Jalalabad AB, Afghanistan, for an aircraft fuel malfunction on 2 July 2014 (Tabs D-5, D-21, V-1.1 through V-1. 4). The last 60-hour inspection prior to the mishap was performed at Jalalabad AB, Afghanistan (Tabs D-21 through D-26, V-1.1 through V-1.4). Documentation of the maintenance performed at Jalalabad AB – the basic postflight (BPO), pre-flight (PR) inspection, 60-hour inspection, replacement of the fuel return tray, and replacement of the cowl servo – was missing from the MRPA's AFTO 781 at Kandahar AB (Tabs D-3 through D-20, U-3 through U-18, V-3.3). However, this maintenance was appropriately documented in the electronic

maintenance database, indicating it was performed (Tab D-21 through D-28). There is no evidence to suggest that the missing documentation was a factor in this mishap.

**b. Inspections**

All maintenance inspections were completed and documented IAW applicable regulations and TOs, expect as noted above (Tabs D-3 through D-20, U-3 through U-18). On 5 July 2014, a Jalalabad AB maintenance team member (MXP1) performed a 60-hour inspection on the MRPA, with no discrepancies noted (Tabs D-26, V-1.1 through V-1.4). The MRPA's next 60-hour inspection was not due for another 18 hours of flight time (Tab D-5). On 12 July 2014, a Kandahar AB maintenance team member, MXP5, satisfactorily completed a PR inspection on the MRPA (Tabs U-4, V-5.1). There is no evidence to suggest that inspections were a factor in this mishap.

**c. Maintenance Procedures**

The engine was overhauled in May 2014 and installed in the MRPA 25 June 2014 (Tab D-2, D-5). The MRPA had flown 92.0 hours since the overhauled engine was installed, prior to the mishap flight (Tab D-2). The MRPA was not due for any scheduled maintenance (Tabs U-6, U-9). There is no evidence to suggest maintenance procedures were a factor in this mishap.

**d. Maintenance Personnel and Supervision**

Civilian contractors with BFS maintained the MRPA at Kandahar AB, Afghanistan, and serviced the aircraft when it diverted to Jalalabad AB (Tabs D-3 through D-20, U-3 through U-18, V-1.1 through V-1.4, V-3.3, V-4.1, V-5.1). A review of the training records for the maintenance crew showed they were trained, experienced and certified to complete their tasks (Tab T-12). Additionally, MXP1 and MXP5 received adequate supervision while maintaining the MRPA (Tabs D-21 through D-28, V-3.4). MXP3, a maintenance superintendent, signed off the MRPA's Exceptional Release prior to the flight (Tab V-3.1 through V-3.7). There is no evidence to suggest maintenance or supervision of maintainers was a factor in this mishap.

**e. Fuel, Hydraulic, and Oil Inspection Analyses**

According to work cards for maintenance – TO 1Q-1(M)B-6WC-1 and TO 1Q-1(M)B-6WC-2 – fluid analysis is not part of the pre-flight or 60-hour engine inspection. The MRPA was refueled prior to the mishap (Tab U-5, U-16). The MRPA's oil was serviced and inspected by a maintenance crew prior to the mishap and no discrepancies were reported (Tabs U-16, V-3.5, V-5.1).

Fuel samples were taken from the servicing fuel carts following the mishap (Tab DD-4). The fuel samples failed to meet specifications due to high electrical conductivity, color, sediment and gum (Tab DD-4, DD-7, DD-9). As the MRPA was not recovered, no fluid analysis from the MRPA was accomplished after the mishap. However, General Atomics Aeronautical Systems, Incorporated (GA), the MRPA's manufacturer, assessed that although the fuel was out of limits on several criteria, fuel quality most likely did not contribute to the loss of turbocharger boost during the mishap flight (Tab DD-4, DD-7, DD-9).

### f. Unscheduled Maintenance

Due to mechanical problems, the MRPA diverted into Jalalabad AB, Afghanistan, during a mission on 2 July 2014 after the MRPA's fuel pressure dropped to zero three times (causing an associated drop in RPM) when the fuel pumps switched between pump 1 and pump 2 (Tabs D-21, V-1.1). A maintainer at Jalalabad, MXP1, replaced the fuel tray on 5 July 2014 to correct this deficiency (Tabs D-27, V-1.2). On 7 July 2014, MXP2 replaced an intermittent engine cowl flap (Tab D-27 through D-28).

## 6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

### a. Structures and Systems

The MRPA impacted terrain at 8,340 ft MSL and was not recovered (Tabs GG-3, HH-5). As a result, no structural or systems evaluation could be accomplished (Tab DD-4 through DD-8).

### b. Evaluation and Analysis

The MRPA was flying at 19,000 ft MSL at 75 KIAS, when engine parameters suddenly deviated from normal values (Tab J-2). Because no wreckage from the MRPA was recovered, failure analysis focused on the data saved in the data logger files (Tab DD-4 through DD-8). The data logger files contain a time-stamped record of the status of aircraft systems transmitted throughout the flight from the MRPA to the GCS (Tab L-2 through L-7). The manufacturer, GA, analyzed the mishap using the data loggers (Tabs J-2 through J-7, DD-3 through DD-11). This analysis concluded that apart from the engine components, the MRPA's systems (e.g., GCS satellite link, navigation, and flight controls) were operating normally up until the point of impact (Tabs J-2 through J-3, DD-6).

At 0924:58Z, the MRPA's engine ceased producing thrust, exhibiting minimum propeller pitch, minimum EGT, minimum oil pressure and sub-idle engine speed (causing the alternators to fall off-line), coincident with a fall in MAP from boosted to ambient pressure (Tab DD-4 through DD-6). The function of the MQ-1B's turbocharger is to provide engine boost, which increases engine power over that of a normally-aspirated engine (Tab V-3.2). The MQ-1B fleet has experienced a high rate of turbocharger failures (Tabs U-19, V-1.2, DD-4, DD-10). Though most turbocharger failures do not result in a roll-back of engine parameters to sub-idle, GA concluded this mishap sequence most likely began with a turbocharger failure, which was followed by an oil leak (Tab DD-4, DD-8). The cause of the hypothesized turbocharger failure and loss of engine power could not be determined from data log analysis (Tab DD-8). The data logger files did not indicate a change in normal acceleration fluctuations, as GA engineers would expect to see during a catastrophic failure, such as a broken connecting rod (Tab DD-8 through Tab DD-9). GA engineers posited that high crankcase pressure on a previous flight may have resulted in oil coking deposits in the turbocharger and caused a seizure (Tab DD-4). During the mishap, oil leaking through the turbocharger may have entered the air induction system, further decreasing combustion (Tab DD-8). The cause of the oil leak was unable to be determined, but GA evaluated that the oil leak could have been caused by a blown out seal elsewhere in the

engine (Tab DD-8). The aircraft continued an uncommanded descent at 800 to 1,000 fpm until it impacted the ground (Tab HH-5).

## 7. WEATHER

### a. Forecast Weather

The Wing Operations Center (WOC) weather team forecasted scattered to broken clouds, with trace to light icing in the area at 17,000 ft – 20,000 ft MSL (Tab F-2). Isolated rain showers and virga (light rain) were forecasted to possibly move into the area (Tab F-2).

### b. Observed Weather

Actual weather, as noted in the aircraft's data logs, was: clear of clouds and icing with moderate turbulence (Tab F-3). The temperature was negative 5 degrees Celsius at flight level 19,000 ft (FL190) and winds were from the west at 10 knots (Tab F-3). Increasing turbulence was evident, but did not exceed moderate turbulence (Tab F-2 to Tab F-3)

### c. Space Environment

There is no evidence to suggest that the space environment was a factor in this mishap.

### d. Operations

There is no evidence to suggest any system was being operated outside of its prescribed operational weather limits.

## 8. CREW QUALIFICATIONS

### a. Mishap Pilot (MP)

The MP was a current and qualified MQ-1B senior pilot (Tab G-2, G-4, G-23). The MP has been qualified in the MQ-1B since 22 June 2011 (Tab G-29). The MP had 1214.0 hrs of total time in the MQ-1B and 3928.0 hrs of grand total time, including previous time in other airframes (Tab G-3).

Recent flight time is as follows (Tab G-4):

| | Hours | Sorties |
|---|---|---|
| Last 30 Days | 23.4 | 10 |
| Last 60 Days | 36.1 | 16 |
| Last 90 Days | 56.6 | 23 |

There is no evidence to suggest the MP's qualifications were a factor in this mishap.

### b. Mishap Sensor Operator (MSO)

The MSO was a current and qualified MQ-1B sensor operator (Tab G-12, G-13, G-54). The MSO has been qualified in the MQ-1B since 17 November 2006 (Tab G-54). The MSO had 2566.0 hrs of total time in the MQ-1B and 2566.0 hrs of grand total time (Tab G-12).

Recent flight time is as follows (Tab G-13):

| | Hours | Sorties |
|---|---|---|
| Last 30 Days | 27.2 | 10 |
| Last 60 Days | 47.2 | 17 |
| Last 90 Days | 61.5 | 24 |

There is no evidence to suggest the MSO's qualifications were a factor in this mishap.

## 9. MEDICAL

### a. Qualifications

At the time of the mishap, the MC was fully medically qualified for flight duty (Tab EE-3). Although the MP had an indefinite waiver for excessive refractive error, the MP's visual acuity continued to be correctable to 20/20 (Tab EE-3). There is no evidence that this medical condition or waiver contributed to the mishap (Tab EE-3).

### b. Health

There is no evidence to suggest the health of the MC contributed to the mishap (Tab EE-3).

### c. Toxicology

After the mishap, the MC was ordered to provide toxicology samples (Tab EE-3). All toxicology was unremarkable and was not a factor in the mishap (Tab EE-3).

### d. Lifestyle

All operational risk management (ORM) scores for the MC were within acceptable limits (Tab AA-11). No lifestyle factors were found to be relevant to the mishap (Tabs AA-11, EE-3).

### e. Crew Rest and Crew Duty Time

Air Force regulations require aircrew members have proper crew rest prior to performing flight duties. AFI 11-202, Volume 3, *General Flight Rules*, 22 October 2010. AFI 11-202, Volume 3, paragraph 9.4.5, defines normal crew rest as a minimum 12-hour non-duty period before the designated flight duty period begins. During this time, the aircrew member may participate in meals, transportation, or rest, as long as he or she has the opportunity for at least eight hours of uninterrupted sleep. AFI 11-202, Volume 3, paragraph 9.8.

There is no evidence to suggest crew rest was a factor in the mishap (Tab V-12.2, V-13.3).

## 10. OPERATIONS AND SUPERVISION

### a. Operations

At the time of the mishap, operations (ops) tempo for the MC was normal for RPA MCE operations (Tabs V-12.2, V-13.3, AA-11, HH-5 through HH-6). There is no evidence to suggest ops tempo contributed to the mishap.

### b. Experience Level

The MP and MSO were experienced RPA crew members and current and qualified in their crew positions, as defined by AFI 11-2MQ-1 Volume 1 (Tab G-2 through G-66). There is no evidence to suggest the experience level of any crewmember contributed to the mishap.

### c. Supervision

On the day of the mishap, the MC received their daily briefing as they came on shift from the MOS (Tab V-11.1, V-12.2, V-13.3). The MOS offered additional assistance by entering the GCS to personally assist the MC (Tab V-11.1, V-12.1, V-13.2). There is no evidence to suggest supervision contributed to the mishap.

## 11. HUMAN FACTORS

There is no evidence to suggest human factors were a factor in this mishap.

## 12. GOVERNING DIRECTIVES AND PUBLICATIONS

### a. Publicly Available Directives and Publications Relevant to the Mishap

(1) AFI 51-503_AFGM2013-02, *Aerospace Accident Investigations*, 5 December 2013
(2) AFI 91-204, *Safety Investigations and Reports*, 12 February 2014
(3) AFI 11-202, Volume 1, *Aircrew Training*, 22 November 2010
(4) AFI 11-202, Volume 2, *Aircrew Standardization/Evaluation Program*, 18 October 2012
(5) AFI 11-202, Volume 3, *General Flight Rules*, 22 October 2010
(6) AFI 11-2MQ-1, Volume 1, *MQ-1 – Aircrew Training*, 21 January 2010
(7) AFI 11-2MQ-1, Volume 2, *MQ-1 – Crew Evaluation Criteria*, 8 January 2013
(8) AFI 11-2MQ-1&9, Volume 3, *MQ-1 and MQ-9 – Operations Procedures*, 1 November 2012

**NOTICE:** All directives and publications listed above are available digitally on the Air Force Departmental Publishing Office website at: http://www.e-publishing.af.mil.

**b. Other Directives and Publications Relevant to the Mishap**

(1) T.O. 1Q-1(M)B-1, *Flight Manual – USAF Series MQ-1B System*, 19 December 2013, Change 1 – 5 May 2014, S-75 – 6 May 2014
(2) T.O. 1Q-1(M)B-1CL-1, *Flight Crew Checklist - All, USAF Series MQ-1B System*, 19 December 2013, Change 1 – 5 May 2014, S-75 – 6 May 2014
(3) T.O. 1Q-1(M)B-6, *Aircraft Scheduled Inspection and Maintenance Requirements, USAF Series, MQ-1B Remotely Piloted Aircraft*, 21 January 2010, Change 8 – 25 June 2014
(4) T.O. 1Q-1(M)B-2-72GS-00-1, *General System Engine Reciprocating – USAF Series, MQ-1B Remotely Piloted Aircraft*, 24 August 2014
(5) T.O. 1Q-1(M)B-2-72JG-40-1, *Technical Manual Job Guide – Organizational Maintenance, Engine Reciprocating, Exhaust and Turbocharger – USAF Series MQ-1B Remotely Piloted Aircraft*, 8 September 2014 [Note: although this TO came into effect after the mishap, there is no evidence of material changes in this technical order when compared to its predecessor, dated 8 June 2010 (through Change 7, 29 April 2014)]
(6) T.O. 1Q-1(M)B-6WC-1, *Inspection Workcards – Preflight, Thruflight, Basic Postflight, Combined Basic Postflight/Preflight Inspection Requirements – USAF Series, MQ-1B Remotely Piloted Aircraft*, 31 July 2012, Change 4 – 30 June 2014
(7) T.O. 1Q-1(M)B-6WC-2, *Inspection Workcards – Aircraft Periodic Inspections and Maintenance Requirements – USAF Series, MQ-1B Remotely Piloted Aircraft*, 1 November 2013, Change 2 – 30 June 2014

**c. Known or Suspected Deviations from Directives or Publications**

There are no known or suspected deviations from directives or publications by crew members or others involved in the mishap.

## 13. ADDITIONAL AREAS OF CONCERN

Not applicable.

18 November 2014

SHERYL A. OTT, Lt Col, USAF
President, Abbreviated Accident Investigation Board

# STATEMENT OF OPINION

**MQ-1B, T/N 07-3210**
**Eastern Afghanistan**
**14 July 2014**

*Under 10 U.S.C. § 2254(d) the opinion of the accident investigator 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

On 14 July 2014, at approximately 0938 Zulu time (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, tail number (T/N) 07-3210, assigned to the 432d Wing (WG), Creech AFB, Nevada, and operated by the 178th Reconnaissance Squadron (178 RS), 119th Wing (119 WG), North Dakota (ND) Air National Guard (ANG), Fargo, ND, impacted the ground approximately 190 nautical miles (nm) northeast of Kandahar Air Base (AB), Afghanistan. The MRPA's munitions were expended prior to impact. The MRPA was destroyed upon impact with the loss valued at $4.6 million. No injuries, deaths or damage to private property resulted from the mishap.

I find by clear and convincing evidence the cause of this mishap was an engine failure that rendered the aircraft incapable of producing sufficient thrust to remain airborne.

I developed my opinion by analyzing factual data from historical records, flight data logs, manufacturer reports, maintenance records, witness testimony, Air Force directives and guidance, and Air Force Technical Orders; by conducting flight simulations and an in-person visit to the mishap squadron facilities and ground control station; and through consultation with maintenance and other subject matter experts.

## 2. CAUSE

At 0924:58Z, with the MRPA at 19,000 feet mean sea level, the mishap crew (MC) was alerted by various warnings and indications that the engine had rolled back to sub-idle parameters: Aural and visual warnings appeared; the manifold absolute pressure (MAP) had dropped to ambient; the propeller pitch was at minimum angle; the exhaust gas temperatures, engine speed in revolutions per minute (RPM) and oil pressure all indicated below idle; and the alternators had dropped off line, with current supplied from the batteries. The aircraft began an uncommanded descent at 800 – 1,000 feet per minute. The engine failed to produce the thrust required to arrest the descent and premature contact with the ground became inevitable. Though most turbocharger failures do not result in a roll-back of engine parameters to sub-idle, this mishap sequence most likely began with a turbocharger failure, which precipitated an oil leak. The

cause of the turbocharger failure and loss of engine power could not be determined. Oil leaking through the turbocharger may have entered the air induction system, further decreasing combustion. The specific cause of the oil leak was also unable to be determined.

## 3. CONCLUSION

Fourteen minutes after the first abnormal engine indications, the MRPA impacted the ground. The combat environment compelled the MC to spend a majority of this short time focused on avoiding collateral damage from the munitions' or aircraft's impacts, as opposed to troubleshooting the engine failure. This prioritization was in line with the commander's intent for combat operations in Afghanistan.

By clear and convincing evidence, I find that the MRPA's engine failed. The resulting loss of thrust prevented the MRPA from reaching a suitable landing location. Therefore, the MC expended the munitions and deliberately controlled the MRPA's impact into terrain, avoiding any collateral damage.

18 November 2014

SHERYL A. SCOTT, Lt Col, USAF
President, Abbreviated Accident Investigation Board

# INDEX OF TABS