

UNITED STATES AIR FORCE
ABBREVIATED AIRCRAFT
ACCIDENT INVESTIGATION
BOARD REPORT



MQ-1B, T/N 99-3057
432D WING
CREECH AIR FORCE BASE, NEVADA



LOCATION: AFGHANISTAN

DATE OF ACCIDENT: 25 JUNE 2014

BOARD PRESIDENT: LT COL DANIEL C. JOHNSEN

**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

24 DEC 2014

ACTION OF THE CONVENING AUTHORITY

The Report of the Abbreviated Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 25 June 2014 mishap, near Jalalabad Air Base, Afghanistan, involving an MQ-1B, T/N 99-3057 assigned to the 432d Wing, Creech Air Force Base, Nevada complies with applicable regulatory and statutory guidance and on that basis is approved.


JAMES N. POST III
Major General, USAF
Vice Commander

EXECUTIVE SUMMARY
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION

MQ-1B, T/N 99-3057
AFGHANISTAN
25 JUNE 2014

On 25 June 2014, at 0917 hours zulu (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B aircraft, tail number 99-3057, forward deployed to Jalalabad Air Base (AB) (JBAD) from the 432d Wing, Creech Air Force Base (AFB), Nevada, experienced a turbocharger failure resulting in altitude loss while conducting a mission in support of Operation ENDURING FREEDOM and impacted high terrain in the mountains north of JBAD. At the time of the mishap, the MRPA was being operated by a mission control element (MCE) from the 27th Special Operations Wing, Cannon AFB, New Mexico. The MRPA was destroyed on impact. Estimated cost of aircraft and munition damage is \$4.82 million. There were no injuries or damage to other government or private property.

The mishap pilot (MP) noticed indications of a turbocharger failure as he attempted to level the MRPA at 19,000 feet (ft) Mean Sea Level (MSL) after a descent from 20,500ft MSL. The Mishap MCE performed appropriate emergency checklists, pointed the MRPA toward the nearest launch and recovery element at JBAD, and began planning a recovery route through the mountains. Due to reduced engine power, the MRPA continued a slow descent to 8,650ft MSL before impacting a mountain side at 0917Z. The wreckage was not recovered.

The Abbreviated Accident Investigation Board (AAIB) President determined, by clear and convincing evidence that the cause of the mishap was a turbocharger failure occurring as power was increased in an attempt to level off at 19,000ft MSL. The exact cause of the turbocharger failure was unable to be determined without recovered wreckage. The subsequent loss of engine performance forced a low altitude recovery through mountainous terrain.

The AAIB President found, by a preponderance of evidence that significantly contributing factors to the loss of the MRPA were a combination of severe turbulence and a lower than anticipated maximum performance altitude. The MP defaulted to an altitude range of 10,000-12,000ft MSL as a basis for selecting the recovery route, the top half of the full range of communal understanding of turbocharger failed performance (8,000-12,000ft MSL). The MRPA was incapable of maintaining this altitude range due to a high density altitude (DA) and downdrafts produced by severe turbulence. Had the MP known the MRPA could not maintain altitude within his range, he would have conducted a more thorough analysis of terrain clearance. Based on a lack of performance data as well as standard training and operating procedures that do not adjust for a higher DA, the MP could not be expected to know the MRPA would level off lower than his anticipated altitude range. Even if performance data did exist, and a maximum performance altitude could have been calculated, dynamic atmospheric conditions in the mountain passes would have jeopardized terrain clearance along any selected recovery route.

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.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-1B, T/N 99-3057
25 June 2014

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ACRONYMS AND ABBREVIATIONS

3 SOS	3rd Special Operations Squadron	LRE	Launch and Recovery Element
12 AF	12th Air Force	Lt Col	Lieutenant Colonel
27 SOW	27th Special Operations Wing	MAJCOM	Major Command
432 WG	432d Wing	MAP (MEP Transcript Error)	Manifold Absolute Pressure
A1C	Airman First Class	MCE	Mission Control Element
AAIB	Abbreviated Accident Investigation Board	MD	Mission Director
AB	Air Base	mIRC (MERK Transcript Error)	Microsoft Internet Relay Chat
AC	Aircraft	MIC	Mission Intelligence Coordinator
ACC	Air Combat Command	MMCE	Mishap Mission Control Element
AF	Air Force	MP	Mishap Pilot
AFB	Air Force Base	MRPA	Mishap Remotely Piloted Aircraft
AFE	Aircrew Flight Equipment	MSO	Mishap Sensor Operator
AFI	Air Force Instruction	MSL	Mean Sea Level
AFSOC	Air Force Special Operations Command	NCO	Noncommissioned Officer
AFTO	Air Force Technical Order	nm	nautical miles
AGM	Air-to-Ground Missile	OAT	Outside Air Temperature
AIB	Accident Investigation Board	OEF	Operation ENDURING FREEDOM
ATC	Air Traffic Controller	ORM	Operational Risk Management
AoA	Angle of Attack	PA	pressure altitude
Capt	Captain	POC	Point of Contact
CMR	Combat Mission Ready	PPSL	Primary Predator Satellite Link
DA	density altitude	ROC	RPA Operations Center
DoD	Department of Defense	RPA	Remotely Piloted Aircraft
VVI (DVI, BBI Transcript Error)	Vertical Velocity Indicator	RPM	revolutions per minute
fpm	foot/feet per minute	RTB	return-to-base
ft	foot/feet	SAR	Search and Rescue
FL	flight level	SIB	Safety Investigation Board
GA	General Atomics	SO	Sensor Operator
GCS	Ground Control Station	SOF	Special Operations Forces
Hg	inches of mercury	T/N	Tail Number
IAS	Indicated Airspeed	TV	Television
IO	Investigating Officer	USSOUTHCOM	United States Southern Command
ISB	Interim Safety Board	VFR	Visual Flight Rules
ISR	Intelligence, Surveillance and Reconnaissance	VSI	Vertical Speed Indicator
ITC	ISR Tactical Controller	WG	Wing
JBAD	Jalalabad AB	WOC (LOC Transcript Error)	Wing Operations Center
KIAS	knots indicated airspeed	Z	Zulu
KU	Ku band		
L	local time		

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 23 October 2014, Major General James N. Post III, Vice Commander, Air Combat Command, appointed Lieutenant Colonel Daniel C. Johnsen as the Abbreviated Accident Investigation Board (AAIB) President to investigate the 25 June 2014 accident involving an MQ-1B Predator aircraft, tail number 99-3057 (Tabs Y-3 to Y-4). An AAIB was conducted at Creech Air Force Base (AFB), Nevada, from 13 November 2014 to 25 November 2014, in accordance with Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, Chapter 11 (Tabs Y-3 to Y-4). A legal advisor and a recorder were also appointed to the AAIB (Tabs Y-3 to Y-4).

b. Purpose

This is a legal investigation convened to inquire into the facts surrounding the aircraft accident 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 25 June 2014, at 0917 hours Zulu (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B aircraft, tail number 99-3057, forward deployed to Jalalabad Air Base (AB) (JBAD) from the 432d Wing, Creech AFB, Nevada, experienced a turbocharger failure resulting in altitude loss while conducting a mission in support of Operation ENDURING FREEDOM (OEF) and impacted high terrain in the mountains north of JBAD (Tabs Q-4, DD-6). At the time of the mishap, the MRPA was being operated by a mission control element (MCE) from the 27th Special Operations Wing, Cannon AFB, New Mexico (Tabs K-2 to K-3). The MRPA was destroyed on impact (Tab P-4). Estimated cost of aircraft and munition damage is \$4.82 million (Tab P-4). There were no injuries or damage to other government or private property (Tabs P-2 to P-3). The wreckage was not recovered (Tab DD-4).

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 (Tab CC-3). To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management, and electronic-combat aircraft (Tab CC-3). It also



provides command and control, communications and intelligence systems, and conducts global information operations (Tab CC-3). 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 (Tab CC-3). ACC numbered air forces provide the air component to U.S. Central, Southern and Northern Commands, with Headquarters ACC serving as the air component to Joint Forces Commands (Tab CC-3). ACC also augments forces to U.S. European, Pacific and Strategic Commands (Tab CC-3).

(2) Air Force Special Operations Command (AFSOC)

AFSOC's mission is to organize, train and equip Airmen to execute global special operations (Tab CC-7). AFSOC provides Air Force special operations forces (SOF) for worldwide deployment and assignment to regional unified commands (Tab CC-7). 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 (Tab CC-7). AFSOC's unique capabilities include airborne radio and television broadcast for Military Information Support Operations, as well as aviation foreign internal defense instructors to provide other governments military expertise for their internal development (Tab CC-7). The command's special tactics squadrons combine combat controllers, special operations weathermen, pararescuemen, and tactical air control party with other service SOF to form versatile joint special operations teams (Tab CC-7). The command's core missions include battlefield air operations, agile combat support, aviation foreign internal defense, information operations/military support operations, precision strike, specialized air mobility; command and control; and intelligence, surveillance and reconnaissance (ISR) (Tab CC-7).



(3) 12th Air Force (12 AF)

Twelfth Air Force is responsible for the readiness of eight active duty wings and one direct reporting unit (Tab CC-10). These subordinate commands operate more than 600 aircraft with more than 55,000 uniformed and civilian Airmen (Tab CC-10). The command is also responsible for the operational readiness of 17 Twelfth Air Force-gained wings and other units of the Air Force Reserve and Air National Guard (Tab CC-10).



(4) 432d Wing (432 WG)

The 432 WG "Hunters" consists of combat-ready Airmen who fly RPAs in direct support of the joint warfighter (Tab CC-14). The Hunters conduct RPA training for aircrew, intelligence, weather, and maintenance personnel (Tab CC-14). The 432 WG flies and maintains the MQ-1B Predator and MQ-9 Reaper RPAs to support the United States and coalition war-fighters (Tab CC-14).



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

The 27 SOW at Cannon AFB, New Mexico, is one of two Air Force active duty Special Operations wings within AFSOC (Tab CC-15). The primary mission of the 27 SOW 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 in support of SOF (Tab CC-15). The wing's core missions include close air support, agile combat support, information operations, precision aerospace firepower, forward presence and engagement, ISR operations, and specialized aerospace mobility (Tab CC-15). The 27 SOW is a pivotal component of AFSOC's ability to provide and conduct special operations missions ranging from precision application of firepower to infiltration, exfiltration, resupply and refueling of SOF (Tab CC-15). In addition, the 27 SOW brings distinctive intelligence capabilities to the fight, including ISR, predictive analysis, and targeting expertise to joint SOF and combat search and rescue operations (Tab CC-15).



(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 (Tab CC-18). It directly supports theater commanders by providing precision weapons employment and persistent ISR (Tab CC-18). It also plans, prepares, and executes MQ-1B Predator missions supporting SOF (Tab CC-18).



b. Aircraft: MQ-1B Predator

The MQ-1B Predator is an armed, multi-mission, medium-altitude, long-endurance RPA that employed primarily as an intelligence-collection asset and secondarily against dynamic execution targets (Tab CC-20). Given its significant loiter time, wide-range sensors, multi-mode communications suite, and precision weapons, it provides a unique capability to perform strike, coordination and reconnaissance against high-value, fleeting, and time-sensitive targets (Tab CC-20). 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 (Tab CC-20). The MQ-1B's capabilities make it uniquely qualified to conduct irregular warfare operations in support of combatant commander objectives (Tab CC-20).

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 as well as a mission coordinator, when required (Tab CC-20). The crew employs the aircraft from inside the ground control station (GCS) via a line-of-sight data link or a satellite data link for beyond line-of-sight operations (Tab CC-20).



Figure 1. Inside the GCS

The Predator carries the Multi-Spectral Targeting System, which integrates an infrared sensor, color/monochrome daylight TV camera, image-intensified TV camera, laser designator and laser illuminator (Tab CC-20). The full-motion video from each of the imaging sensors can be viewed as separate video streams or fused (Tab CC-20). The aircraft can employ two laser-guided AGM-114 Hellfire missiles that possess highly accurate, low-collateral damage, and anti-armor/anti-personnel engagement capabilities (Tab CC-20).

4. SEQUENCE OF EVENTS

a. Mission

On 25 June 2014, the MRPA was authorized by a classified Air Tasking Order to conduct a combat support mission in the OEF area of responsibility (Tabs Q-4 to Q-5).

b. Planning

On 25 June 2014, at 0600Z, the Mishap MCE (MMCE) consisting of the Mishap Pilot (MP) and Mishap Sensor Operator (MSO) arrived at the 3 SOS operations center to attend standard pre-mission briefings (Tabs R-10, R-33). The mass briefing was standard with no risk factors noted (Tabs R-10, R-33). After the mass brief, the MMCE conducted a crew brief with the Mission Intelligence Coordinator (MIC) before stepping to the GCS to assume duties from the previous crew (Tab R-33). Nothing out of the ordinary was noted during the turnover brief with the previous crew, to include aircraft status (Tabs R-10, R-33, R-38).

c. Preflight

Preflight checks and launch were conducted by an LRE at JBAD with no maintenance discrepancies (Tabs D-3 to D-13). The MMCE assumed duties from the previous crew just prior to the MRPA being re-tasked to a location approximately 160nm northeast of JBAD to replace another MQ-1B experiencing maintenance issues (Tabs R-6, R-34).

d. Summary of Accident

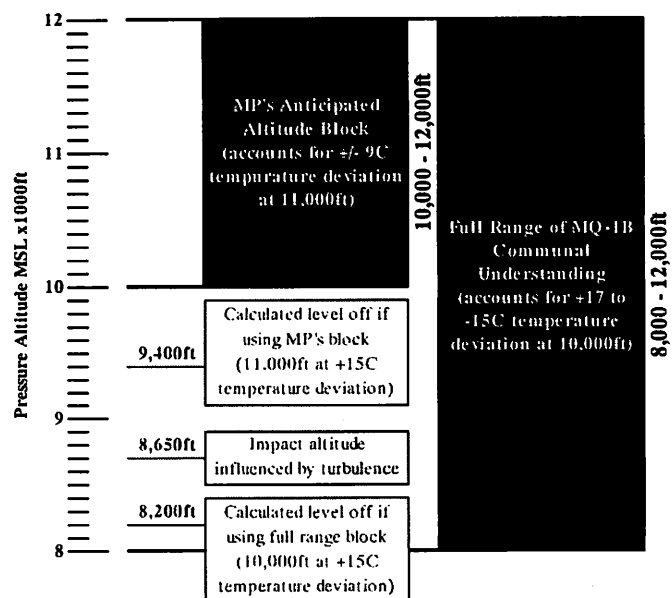
While loitering at 19,000 feet (ft) Mean Sea Level (MSL), northeast of JBAD, the MRPA was re-tasked to a location farther north to replace another MQ-1B experiencing maintenance issues (Tab R-6). The MRPA climbed to 20,500ft MSL and transited for approximately an hour and 30 minutes before beginning a descent to its requested altitude of 19,000ft MSL (Tabs R-6, R-34). The MRPA autopilot attempted to level off at 19,000ft MSL without success (Tabs R-34, DD-6). As power was increased to level off, engine revolutions per minute (RPM) increased to 5,500 RPM while manifold absolute pressure (MAP) stayed below static pressure, indicating a turbocharger malfunction (Tabs R-10, DD-6). The MP called for the "Turbocharger/MAP Sensor Failure" checklist and turned the MRPA toward the south to recover at the nearest LRE at JBAD in anticipation of a low altitude return to base (RTB) (Tabs R-7, R-34, BB-4). The checklist was accomplished correctly, but did not result in improved engine performance (Tabs R-34 to R-35, R-84, R-87, DD-9). The MP then began formulating a plan to RTB through the mountains to JBAD (Tabs R-7, R-84).

Technical Order (T.O.) 1Q-1(M)B-1-1 does not contain any data for turbocharger failed engine performance. Due to lack of data and the commonality of turbocharger failures, the MQ-1B community has adopted an anticipated pressure altitude (PA) range of approximately 8,000-12,000ft MSL for this malfunction (depending on density altitude (DA)), in between which multiple variations exist depending on the operator (Tabs R-7, R-8, V-3). Variations of 8,000-11,000ft, 8,000-12,000ft, and 10,000-12,000ft MSL were cited during the investigation (Tabs R-7, R-8, V-3). This anticipated altitude range is usually not adjusted for DA (Tab V-3). The MP anticipated 10,000-12,000ft MSL based on what he had heard from other pilots regarding turbocharger failure, and used this as a basis for the RTB route selection through the mountains (Tab R-7). Severe turbulence and a high DA in the mountains would later reveal this anticipated altitude range to be inadequate (Tabs R-7, R-9, R-35, BB-5, DD-19).

AFH 11-203, Volume 1, section 4.8 and 4.9 describe the difference between PA and DA. PA is based on a standard day atmosphere of 15 degrees Celsius (C) at sea level with a lapse rate of approximately -2C per 1,000ft above sea level. Standard atmosphere conditions rarely occur. DA adjusts pressure altitude for non-standard temperatures by using observed outside air temperature (OAT). If OAT is warmer than standard atmosphere temperature, DA will be higher than PA, generally resulting in poorer aircraft performance. T.O. 1Q-1(M)B-1-1 contains a DA chart in Figure A1-5 (Tab BB-5).

The MP's anticipated recovery altitude range was 10,000-12,000ft MSL, the top half of the full range of communal understanding (8,000-12,000ft MSL) (Tabs R-7, R-8, V-3). Using Figure A1-5, this altitude range incorporates a +/- 9C temperature deviation at 11,000ft MSL (Tab BB-5). At the onset of the turbocharger failure at 19,000ft MSL, OAT was -8C, a +15C temperature deviation from standard atmosphere (Tabs BB-5, DD-19). Figure A1-5 can be used to adjust the anticipated altitude range for DA by assuming a standard lapse rate resulting in a +15C temperature deviation at 11,000ft MSL (Tabs V-3, BB-5). This produces an anticipated level off altitude of 9,400ft MSL (Tab BB-5). Before encountering the worst of the downdrafts, this is approximately where the MRPA leveled off (Tabs R-7, R-9, R-85).

The full altitude range of communal understanding incorporates a +17 to -15C temperature deviation at 10,000ft MSL (Tab BB-5). Using the same method, a 10,000ft altitude adjusted for +15C temperature deviation produces an expected level off altitude of 8,200ft MSL (Tabs BB-5, DD-19). Influenced by turbulence, the MRPA impacted terrain at 8,650ft MSL (Tab S-2). In this case, the full range or lower variations of the communal understanding covered the effects of a higher DA (Tabs BB-5, DD-19). Though available to crews, using Figure A1-5 in the MQ-1B Performance Data to adjust communal understanding



for DA is outside normal training and operating procedures (Tab V-3).

OAT at impact was 22C, a +24C temperature deviation, making DA approximately 11,400ft MSL (Tabs BB-5, DD-19). This temperature deviation was higher than could have been anticipated given OAT at 19,000ft MSL, yet the MRPA was performing well enough to remain within the parameters of the full altitude range of communal understanding (Tabs R-7, S-2, BB-5, DD-19).

Throughout the initial descent from 19,000ft MSL, a more experienced break crew was assisting the MMCE (Tabs R-34, R-83, R-84, V-4). A break crew consists of a pilot and sensor operator (SO) who provide MCEs the opportunity to leave the GCS for short periods of time for physiological needs (Tabs R-83 to R-84, R-88). The break crew and MSO were coordinating with external agencies for the RTB while the MP planned a route through the mountains (Tab R-7). The MMCE, MIC, and break crew utilized multiple tools and techniques to share and check the route of flight for terrain clearance to make sure the recovery plan would work (Tabs R-9, R-34, R-83, V-4). At the break pilot's suggestion, the MP shed some electrical load in an attempt to improve engine performance (Tab R-11, R-86). Angle of attack (AoA) and stall warnings were turned off as well to prevent exacerbating altitude loss due to automatic control inputs by the MRPA's autopilot in response to turbulence (Tab R-8, R-85).

AFH 11-203, section 9.7 describes mechanical turbulence as air near the surface flowing over rough terrain or other obstructions, such as mountain ranges, which create turbulent atmosphere. Downdrafts in mountainous areas, caused by air currents spilling over and rushing down the leeward sides, produce extremely dangerous flying conditions. The MP was aware of the dangers of these flight conditions, but deemed it unavoidable due to the location of the MRPA at turbocharger failure and the resultant low altitude recovery (Tab R-7, R-87).

Due to turbulence and a high DA, the MRPA continued a slow descent through the MP's anticipated altitude range until reaching 9,500ft MSL (Tabs R-7, R-9, R-35, BB-5, DD-19). At this time the MRPA began to encounter moderate to severe turbulence with +/- 1,000 feet per minute (fpm) fluctuations in vertical speed indications (VSI, the rate at which an aircraft is climbing or descending) while attempting to remain level (Tab V-4). The MRPA was able to maintain altitude in the vicinity of 9,500ft MSL (+/- 500ft) until turbulence increased, and downdrafts caused altitude to drop to roughly 8,700ft MSL (+/- 200ft) (Tab R-7, R-9, R-85).

Had the MP known the MRPA could not maintain altitude within his anticipated altitude range, he would have loitered further north, above lower terrain, and conducted a more thorough analysis of terrain clearance (Tab R-9). Even if performance data existed, and a maximum performance altitude could have been calculated, or the MP had utilized Figure A1-5 as previously described, dynamic atmospheric conditions in the mountain passes would have jeopardized terrain clearance along any selected recovery route (Tabs V-3, V-4, BB-5).

Once the MRPA was unable to maintain 9,500ft MSL, the selected route was jeopardized (Tab R-7, R-85). Reverse routing at this point was impractical as points initially passed were now too high for the MRPA's current performance altitude (Tab V-4). The MP and MIC continued to check terrain clearance as the MSO used the MRPA's camera to scan terrain (Tab R-34, R-37, R-

85). During the final five minutes of flight, the MMCE, MIC and break pilot were attempting to determine the best of their remaining options with very little time, altitude, and maneuvering airspace at their disposal (Tabs R-7, R-38, R-86, S-2). Ultimately, the MRPA was too low and performance limited to avoid terrain (Tabs R-9, R-86, S-2).

e. Impact

The MRPA impacted high terrain on 25 June 2014 at 0917Z, in the mountains north of JBAD (Tab Q-4). At the time of impact, the MRPA was at 8,650ft MSL (Tab S-2).

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 review of the MRPA's maintenance documentation, recorded in the Air Force Technical Order (AFTO) 781 series revealed no contributing factors to the mishap (Tab D-2 to D-13). AFTO Forms 781A, 781H, and 781J revealed no maintenance discrepancies, only standard preflight maintenance activities and accomplishment of a 60-hour engine inspection (Tab D-3 to D-8). AFTO Form 781J for 24 June 2014 revealed total MRPA airframe time of 12,484.5 hours, total engine time of 185 hours, and 942 total landing gear cycles (Tab D-8).

b. Inspections

A 60-hour engine inspection was complied with after the MRPA's sortie on 22 June 2014 (Tabs D-8, U-10). No discrepancies were noted in the turbocharger or wastegate (Tabs U-11, DD-8). The mishap sortie was the second flight after this inspection (Tab D-8). All pre-flight inspections were complied with (Tab D-3 to D-7).

c. Maintenance Procedures

Preflight inspections, servicing operations, and launch procedures were accomplished without incident (Tabs D-2 to D-13, R-10, R-33).

d. Maintenance Personnel and Supervision

Maintenance records show the maintenance crew conducted the 60-hour engine inspection, preflight inspections, and launch procedures on the MRPA prior to the mishap (Tab D-3 to D-13). All preflight servicing and maintenance was correctly documented by properly trained, qualified, and supervised military and civilian maintenance personnel (Tab D-3 to D-13).

e. Fuel, Hydraulic, and Oil Inspection Analyses

Maintenance documentation shows proper servicing and correct levels of fluids in the aircraft at takeoff (Tabs D-7, U-4). Since the wreckage was not recovered, no post-accident fluid samples were obtained from the MRPA (Tab DD-4). Data logs indicate fuel and oil systems operated normally throughout the mishap flight (Tabs R-39, R-88, DD-8).

f. Unscheduled Maintenance

Maintenance documentation revealed no unscheduled maintenance for the engine or turbocharger after the 60-hour inspection (Tabs D-5 to D-7, U-5 to U-21).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

The MRPA wreckage was not recovered (Tab DD-4).

b. Evaluation and Analysis

General Atomics (GA) analyzed data logger files from the GCS (Tab DD-3 to DD-19). The GA report concluded turbocharger failure occurred as the aircraft attempted to level off after a descent, indicated by an increase in engine power settings while MAP remained below static pressure (Tab DD-4). As a result, the MRPA was unable to maintain altitude (Tab DD-4). The MRPA's engine continued to operate, providing enough power to achieve a shallow descent during the final segment of flight (Tab DD-8). Prior to the turbocharger failure, no abnormal indications were present (Tab DD-8). Engine oil and turbocharger oil indications were normal before and after the turbocharger failure (Tab DD-8).

GA was unable to determine the root cause of the turbocharger failure without recovered hardware, however, the failure sequence had symptoms similar to other MQ-1B turbocharger failures caused by oil coking due to excessive crankcase pressure (Tab DD-4). Coking is the process by which oil undergoes severe oxidative and thermal breakdown at high temperatures resulting in solid residue (Tab DD-4, DD-8). Turbocharger failures occur most often after long descents as oil coking deposits in the journal bearings can prevent the turbocharger impeller from spinning when power is increased (Tab DD-8). Maintenance records indicate a 60-hour engine inspection was conducted on the MRPA two days before the mishap with no discrepancies noted (Tab DD-8).

Data logs confirm the MMCE acted in accordance with the “Turbocharger/MAP Sensor Failure” emergency procedures checklist (Tabs DD-9, BB-4). The MMCE switched to the backup MAP sensor after the rapid decrease in MAP (Tab DD-9). Wastegate control was managed in accordance with emergency procedures (Tab D-9). During the different wastegate settings, no significant changes in engine performance were indicated in the data logs (Tab DD-9).

7. WEATHER

a. Forecast Weather

The forecast weather at JBAD and Bagram AB indicated gusty winds out of the north, unrestricted visibility, and no hazardous weather (Tab F-1). There was no surface forecast weather for the impact area (Tab F-1).

b. Observed Weather

The observed weather reports at JBAD and Bagram AB were similar to forecast weather and indicated no hazardous conditions (Tab F-2). There was no observed surface weather report for the impact area (Tab F-2). Moderate to severe turbulence was encountered as the MRPA descended into mountainous terrain on the RTB route (Tabs R-7, R-35, R-85 to R-86).

c. Operations

There is no evidence to suggest the MRPA was being intentionally operated outside of its prescribed operational weather limits.

8. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was current and had been qualified in the MQ-1B since 29 July 2013 (Tab G-3). The MP had a total flight time of 573.2 hours in the MQ-1B (Tab G-5). The MP’s flight time during the 90 days before the mishap was as follows (Tab G-9):

	Hours	Days
Last 30 Days	69.7	10
Last 60 Days	146.2	23
Last 90 Days	266.1	41

b. Mishap Sensor Operator

The MSO was current and had been qualified in the MQ-1B since 2 December 2013 (Tab G-38). The MSO had a total flight time of 383.3 hours, all in the MQ-1B (Tab G-40). The MSO’s flight time during the 90 days before the mishap was as follows (Tab G-42):

	Hours	Days
Last 30 Days	104	14
Last 60 Days	213.6	32
Last 90 Days	308.6	49

9. MEDICAL

a. Qualifications

At the time of the mishap, MMCE crewmembers were fully medically qualified for flight duty.

b. Health

There is no evidence to suggest the health of MMCE crewmembers contributed to the mishap.

c. Toxicology

The medical clinic at Cannon AFB, New Mexico, collected blood and urine samples from the MMCE after the mishap (Tab EE-3 to EE-4). All toxicology testing resulted in negative findings (Tab EE-3 to EE-4).

d. Lifestyle

All operational risk management (ORM) scores for the MMCE were in the moderate category for this mission (Tab T-7). No lifestyle factors were found to be relevant to the mishap.

e. Crew Rest and Crew Duty Time

Aircrew members are required to have proper crew rest, as defined in AFI 11-202, paragraph 2.1, Volume 3, *General Flight Rules*, 7 November 2014, prior to performing in-flight duties. AFI 11-202 defines normal crew rest as a minimum 12-hour non-duty period before the designated flight duty period begins. ORM sheets indicate the MMCE met the AFI requirements for crew rest and crew duty time for the flight (Tab T-7). There is no evidence to suggest crew rest and crew duty time were factors in this mishap.

10. OPERATIONS AND SUPERVISION

a. Operations

There is no evidence to suggest operations tempo was a factor in this mishap.

b. Supervision

A Mission Director in the Wing Operations Center was providing general oversight to the MMCE and other MCEs during the mishap (Tabs R-83, V-4). There is no evidence to suggest that mission oversight was a factor in this 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, *Aerospace Accident Investigations*, 26 May 2010
- (2) AFI 51-503, *Aerospace Accident Investigations, Air Combat Command Supplement*, 5 September 2013
- (3) AFI 91-204, *Safety Investigations and Reports*, 24 September 2008
- (4) AFI 11-202, Volume 3, *Flying Operations-General Flight Rules*, 7 November 2014
- (5) AFI 11-203, Volume 1, *Flying Operations-Weather for Aircrews*, 12 January 2012

NOTICE: All AFIs 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
- (2) T.O. 1Q-1(M)B-1-1, *Flight Manual – Appendix A, Performance Data, USAF Series, MQ-1B Remotely Piloted Aircraft*, 29 November 2010, Change 1, 10 December 2012

c. Known or Suspected Deviations from Directives or Publications

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

13. ADDITIONAL AREAS OF CONCERN

MQ-1B performance data for a turbocharger failure has not been flight-tested for inclusion in the performance data despite the relatively high frequency of this malfunction. The warning under step seven of the T.O. 1Q-1(M)B-1 “Turbocharger/MAP Sensor Failure” checklist alludes to a sustainable altitude with a failed turbocharger, but makes no mention of what that altitude may be or what atmospheric factors to consider. Crews are solely reliant on variations of a communal understanding of maximum performance altitude based on historic data points, which may naturally incorporate small density altitude adjustments in their ranges, but do not directly factor

in non-standard atmospheric conditions, potentially resulting in lower than anticipated performance. Though performance data for a turbocharger failure would have certainly aided critical decision making on this mission, there is no evidence to suggest its use would have ultimately prevented the mishap due to dynamic atmospheric conditions encountered in the mountain passes.

22 December 2014

DANIEL C. JOHNSEN, Lt Col, USAF
President, Abbreviated Accident Investigation Board

STATEMENT OF OPINION

**MQ-1B, T/N 99-3057
AFGHANISTAN
25 JUNE 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 25 June 2014, at 0917 hours zulu (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B aircraft, tail number 99-3057, forward deployed to Jalalabad Air Base (AB) (JBAD) from the 432d Wing, Creech Air Force Base (AFB), Nevada, experienced a turbocharger failure resulting in altitude loss while conducting a mission in support of Operation ENDURING FREEDOM and impacted high terrain in the mountains north of JBAD. At the time of the mishap, the MRPA was being operated by a mission control element (MCE) from the 27th Special Operations Wing, Cannon AFB, New Mexico. The MRPA was destroyed on impact. Estimated cost of aircraft and munition damage is \$4.82 million. There were no injuries or damage to other government or private property. The wreckage was not recovered.

I determine by clear and convincing evidence that the cause of the mishap was a turbocharger failure occurring as power was increased in an attempt to level off at 19,000 feet (ft) Mean Sea Level (MSL). The exact cause of the turbocharger failure was unable to be determined without recovered wreckage. The subsequent loss of engine performance forced a low altitude recovery through mountainous terrain.

I find by a preponderance of evidence that significantly contributing factors to the loss of the MRPA were a combination of severe turbulence and a lower than anticipated maximum performance altitude. . The MP defaulted to an altitude range of 10,000-12,000ft MSL as a basis for selecting the recovery route, the top half of the full range of communal understanding of turbocharger failed performance (8,000-12,000ft MSL). The MRPA was incapable of maintaining this altitude range due to a high density altitude (DA) and downdrafts produced by severe turbulence. Had the MP known the MRPA could not maintain altitude within his range, he would have conducted a more thorough analysis of terrain clearance. Based on a lack of performance data as well as standard training and operating procedures that do not adjust for a higher DA, the MP could not be expected to know the MRPA would level off lower than his anticipated altitude range. Even if performance data did exist, and a maximum performance altitude could have been calculated, dynamic atmospheric conditions in the mountain passes would have jeopardized terrain clearance along any selected recovery route.

I developed my opinion by analyzing factual data from engineering analysis, witness testimony, flight data, maintenance records, and Air Force technical orders.

2. CAUSE

I determine by clear and convincing evidence that the cause of the mishap was a turbocharger failure occurring as power was increased in an attempt to level off at 19,000ft MSL. The exact cause of the turbocharger failure was unable to be determined without recovered wreckage. General Atomics (GA) stated the symptoms of this turbocharger failure were similar to other turbocharger failures caused by oil coking due to excessive crankcase pressure. Oil coking in the journal bearings can seize the turbocharger impeller, resulting in reduced engine power.

The subsequent lower engine performance forced a low altitude recovery through mountainous terrain to the nearest launch and recovery element (LRE) at JBAD. The MRPA's performance was limited such that terrain clearance could not be maintained along the recovery route.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

I find by a preponderance of evidence that significantly contributing factors to the loss of the MRPA were a combination of severe turbulence and a lower than anticipated maximum performance altitude.

a. Lower than Anticipated Maximum Performance Altitude

Pressure altitude (PA) is based on a standard day atmosphere equating to 15 degrees Celsius (C) at sea level with a lapse rate of approximately -2C per 1,000ft above sea level. Standard atmosphere conditions are a baseline and rarely occur in reality. DA adjusts pressure altitude for non-standard temperatures by using observed outside air temperature (OAT). If OAT is warmer than standard atmosphere temperature, DA will be higher than PA, generally resulting in poorer aircraft performance.

Performance data and/or official guidance referencing turbocharger failure in the MQ-1B does not exist. Due to lack of data and the commonality of turbocharger failures, the MQ-1B community has adopted an anticipated altitude of approximately 8,000-12,000ft MSL for this malfunction, in between which multiple variations exist depending on the operator. This altitude is a PA, and normally not adjusted for DA. Though available to crews, using Figure A1-5 in the MQ-1B performance data to adjust for DA is outside normal training and operating procedures.

The MP's anticipated recovery altitude range was 10,000-12,000ft MSL, the top half of the full range of communal understanding (8,000-12,000ft MSL). The MP's altitude range incorporated a +/- 9C temperature deviation at 11,000ft MSL. At the onset of the turbocharger failure at 19,000ft MSL, OAT was -8C, a +15C temperature deviation from standard atmosphere. Using Figure A1-5 in the MQ-1B performance data, 11,000ft adjusted for a +15C temperature deviation produces an expected level off altitude of 9,400ft MSL. Before encountering the worst of the downdrafts, this is approximately where the MRPA leveled out.

The full range of communal understanding incorporates a +17 to -15C temperature deviation at 10,000ft MSL. Using the same method, a 10,000ft altitude adjusted for +15C temperature deviation produces an expected level off altitude of 8,200ft MSL. A pilot using the full range or lower altitude variation of the communal understanding may have anticipated a lower performance altitude and selected a different recovery route. Had the MP known the MRPA would not be able to maintain altitude within his anticipated range, he would have conducted a more thorough analysis of terrain clearance. Once in the mountains, high points already passed along the route and lack of turn radius clearance in the narrow valleys precluded reverse routing to reevaluate. Even if performance data did exist, and a maximum performance altitude could have been calculated, dynamic atmospheric conditions in the mountain passes would have jeopardized terrain clearance along any selected recovery route.

b. Severe Turbulence

Mechanical turbulence is caused by obstructions, such as mountain ranges, which alter straight-line winds. Dwindrafts in mountainous areas, caused by air currents spilling over and rushing down the leeward sides, produce extremely dangerous flying conditions. The MP was aware of the dangers of these flight conditions, but deemed it unavoidable due to the location of the MRPA at turbocharger failure and the resultant low altitude recovery.

Approaching 9,500ft MSL, the MRPA began to encounter moderate to severe turbulence indicated by large fluctuations in vertical speed indications (VSI, the rate at which an aircraft is climbing or descending) and knots indicated airspeed (KIAS). The MMCE and break crew noted increased turbulence and downdrafts as the MRPA entered the impact area. These atmospheric conditions were additionally detrimental to the MRPA's ability to maintain terrain clearance in a high DA environment.

4. CONCLUSION

By clear and convincing evidence I find the cause of the mishap was a turbocharger failure resulting in reduced engine performance and a low altitude recovery through mountainous terrain. Further, I find by a preponderance of evidence that significantly contributing factors to the loss of the MRPA were severe turbulence and a lower than anticipated maximum performance altitude while executing the recovery route through the mountains.

22 December 2014

~~DANIEL C. JOHNSEN~~, Lt Col, USAF
President, Abbreviated Accident Investigation Board

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