UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 00-3068

11th Reconnaissance Squadron
432d Air Expeditionary Wing
Creech Air Force Base, Nevada

LOCATION: Creech Air Force Base, Nevada

DATE OF ACCIDENT: 28 April 2009

BOARD PRESIDENT: Lieutenant Colonel Gary A. Toppert

Conducted IAW Air Force Instruction 51-503, Chapter 11

EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B, T/N 00-3068, CREECH AIR FORCE BASE, NEVADA
28 APRIL 2009

On 28 April 2009, at 0804:49 local (L) time, the mishap remotely piloted aircraft (MRPA), a MQ-1B Predator, tail number 00-3068, crashed 1 ½ miles west of Creech Air Force Base, Nevada, approximately 1 ½ minutes after takeoff. The crash site was uneven desert terrain with scrub brush. The MRPA's structure and mechanical components were damaged as a result of the mishap. The estimated cost of repair is $543,178.30. This includes replacement cost for the engine and training hellfire missile and repair cost for the multi-spectral targeting system (MTS-A) and other structural damage. There were no injuries and there was no damage to other government or private property.

After normal maintenance and pre-flight checks, the MRPA taxied and departed at 0803:22L. Approximately 1 minute into the flight, the MRPA's engine began to oscillate. The MRPA was travelling at a speed of 74 knots indicated airspeed and at an estimated altitude of 240 feet above ground level. As the engine speed oscillated between 5633 and 1145 revolutions per minute, the MRPA quickly approached stall speed and began to descend at a high rate. The MRPA impacted the ground 29 seconds after the first engine oscillation. The MRPA rolled across uneven desert terrain with scrub brush for 4 seconds. Its landing gear then collapsed, causing it to spin before coming to rest 6 seconds after initial impact.

The Accident Investigation Board (AIB) President determined by clear and convincing evidence that the cause of the mishap was the failure of the Manifold Absolute Pressure (MAP) reference vacuum line that became disconnected at a "T" fitting. The AIB President determined that the installation of the vacuum line was in accordance with Air Force technical orders (T.O.). The T.O.s did not provide guidance on length or routing of the vacuum lines. However, the vacuum line attached to the plenum was cut too short based upon the location of the "T" fitting, which put extra tension on the carburetor vacuum lines. The extra tension caused the plenum vacuum line to work itself loose from the "T" fitting. At 0804:20L the vacuum line disconnected in flight. This resulted in loss of reference MAP supplied to the carburetors, leaning the air fuel mixture entering the engine's cylinders. The lean mixture caused the engine to begin oscillating, which caused the MRPA to rapidly lose airspeed and altitude. Due to the low airspeed and altitude and having no engine power, the mishap pilot was unable to take action to prevent the MRPA from impacting the ground. In the 29 seconds the mishap pilot had to react, he maintained control of the MRPA, analyzed the situation, and selected the most appropriate landing location. Immediately prior to impact, he pulled the MRPA's nose up to try to protect the MTS-A attached to the front of the MRPA. The MTS-A was functioning subsequent to the mishap and has been assessed to be repairable. Due to the terrain the MRPA landed on, damage to the structure and engine of the aircraft was unavoidable.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-1B, T/N 00-3068
28 APRIL 2009

TABLE OF CONTENTS

COMMONLY USED ACRONYMS AND ABBREVIATIONS

11 RS	11th Reconnaissance Squadron
432 WG	432d Wing
432 OG	432d Operations Group
ACC	Air Combat Command
AEW	Air Expeditionary Wing
AF	Air Force
AFB	Air Force Base
AFETS	Air Force Engineering and Technical Services
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AGL	Above Ground Level
AIB	Aircraft Investigation Board
ALT	Altitude
BFS	Battlespace Flight Services
BSA	Basic Surface Attack
C	Centigrade
CAMS	Consolidated Aircraft Maintenance System
COMACC	Commander Air Combat Command
CONUS	Continental United States
Dash 1	T.O. 1Q-1(M)B-1 Flight Manual
EGT	Exhaust Gas Temperature
GA ASI	General Atomics Aeronautical Systems, Incorporated
GCS	Ground Control Station
GDT	Ground Data Terminal
HUD	Heads Up Display
In Hg	Inches of Mercury
IPI	Initial Process Inspection
IQT	Initial Qualification Training
KIAS	Knots Indicated Airspeed
kPa	Vapor Pressure
KTL	Key Task List
L	Local Time
Lbs	Pounds
LOS	Line of Sight
LR	Launch and Recovery
LRE	Launch and Recovery Element
MAJCOM	Major Command
MAP	Manifold Absolute Pressure
MDT	Mountain Daylight Time
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSL	Mean Sea Level
MSO	Mishap Sensor Operator
MTS	Multi-spectral Targeting System
NV	Nevada
PSI	Pounds per Square Inch
RPM	Revolutions Per Minute
SAT	Satellite
SATCOM	Satellite Communications
SPMA	Sensor Processor Modem Assembly
TCTO	Time Compliance Technical Order
T/N	Tail Number
T.O.	Technical Order
UAS	Unmanned Aerial System
U.S.	United States
U.S.C.	United States Code
USAF	United States Air Force
VPP	Variable Pitch Propeller
VSI	Vertical Speed Indication
WG	Wing

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, PURPOSE, AND CIRCUMSTANCES

a. Authority

On 10 June 2009, Major General R. Michael Worden, Vice Commander, Air Combat Command, United States Air Force (USAF), appointed Lieutenant Colonel Gary A. Toppert as the Accident Investigation Board (AIB) President to investigate the 28 April 2009 crash of a MQ-1B Predator, tail number (T/N) 00-3068, near Creech Air Force Base (AFB), Nevada (NV). An abbreviated AIB was conducted at Nellis AFB, NV, from 10 June 2009 through 22 June 2009, pursuant to Chapter 11 of Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*. Technical Advisors appointed to the AIB were Lieutenant Colonel James P. Moffett (Maintenance Member), Captain Jason R. Smith (Legal Advisor) and Technical Sergeant Dustin L. Smith (Recorder). (Tab T-3)

b. Purpose

The purpose of this investigation is to provide a publicly releasable report of the facts and circumstances surrounding the mishap, to include a statement of opinion on the cause or causes of the mishap; to gather and preserve evidence for claims, litigation, disciplinary, and administrative actions; and for other purposes. This report is available for public dissemination under the Freedom of Information Act, Title 5, United States Code, Section 552.

c. Circumstances

The AIB was convened to investigate the accident involving a MQ-1B Predator, T/N 00-3068, assigned to the 11th Reconnaissance Squadron (RS), 432d Wing (WG), Creech AFB, NV, which crashed on 28 April 2009. (Tab T-3) The Class level of the accident cannot yet be determined due to repair estimates that are still pending.

2. ACCIDENT SUMMARY

After normal maintenance and pre-flight checks, the mishap remotely piloted aircraft (MRPA) taxied and departed from Creech AFB runway 26 at approximately 0803 local (L) time for a training mission. Approximately one minute into the flight, the MRPA began to experience engine oscillations. The MRPA quickly lost airspeed approaching stall speed. The mishap crew (MC) consisting of the mishap pilot (MP) and mishap sensor operator (MSO) could not prevent the rapid descent of the MRPA. 29 seconds after the first engine oscillation, the MRPA impacted uninhabited terrain 1 ½ miles off the west end of runway 26. The estimated cost of repair for the MRPA is $543,178.30. (Tab P-3,7-8) This includes replacement cost for the engine and training hellfire missile and repair cost for the multi-spectral targeting system (MTS-A) and other structural damage. There were no injuries or damage to personal property.

3. BACKGROUND

The MRPA was an asset of the 11 RS, 432 WG, Creech AFB, NV. (Tab B-3) The 432 WG has dual reporting responsibilities to Ninth Air Force and USAF Central Command at Shaw AFB, South Carolina, as well as to Twelfth Air Force and USAF Southern Command at Davis-Monthan AFB, Arizona. (Tab Z-3)

a. 432d Wing

The 432 WG, also known as the 432d Air Expeditionary Wing "Hunters", consists of combat-ready Airmen who fly the MQ-1B Predator and MQ-9 Reaper aircraft to support United States and Coalition warfighters. The 432 WG conducts unmanned aircraft system (UAS) initial qualification training for aircrew, intelligence, weather, and maintenance personnel. The 432 WG oversees operations of the 432d Operations Group (432 OG), 432d Maintenance Group, 11 RS, 15th Reconnaissance Squadron, 17th Reconnaissance Squadron, 30th Reconnaissance Squadron, 42d Attack Squadron, 432d Aircraft Maintenance Squadron (432 AMXS), 432d Maintenance Squadron, and the 432d Operations Support Squadron. The 432 WG is the Air Force's first UAS wing. (Tab Z-3)

b. 11th Reconnaissance Squadron

The 11 RS operates the MQ-1B remotely piloted aircraft, a medium-altitude multi-sensor armed reconnaissance platform. The 11 RS is the formal training unit that conducts all Predator aircrew initial qualification training as well as instructor upgrade training. (Tab Z-5)

c. MQ-1B Predator System

The MQ-1B Predator aircraft is a medium-altitude, long endurance, remotely piloted aircraft. Its primary mission is interdiction and conducting armed reconnaissance against critical perishable targets. (Tab Z-7)

The MQ-1B Predator is a fully operational system, not just an aircraft. This system consists of four 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. They fly 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 Z-7)

The aircraft is equipped with a color nose camera (generally used by the pilot for flight control), a day variable-aperture television camera, a variable aperture infrared camera (for low light/night), and other sensors, as required. The cameras produce full-motion video. The MQ-1B Predator also carries the Multi-Spectral Targeting System which integrates electro-optical, infrared, laser designator and laser illuminator into a single sensor package. (Tab Z-7)

The MQ-1B Predator is manufactured by General Atomics Aeronautical Systems Inc. (GA ASI) headquartered in San Diego, California. (Tab Z-8)

4. SEQUENCE OF EVENTS

a. Mission

The mission was a MQ-1B Initial Qualification Training (IQT) sortie conducted by the 11 RS. Launch and recovery of the MRPA was to be accomplished from a GCS at Creech AFB with the MC handling launch duties. (Tab R-7) Launch and recovery operations are conducted by a LOS radio link using a Ground Data Terminal located on the ground at the airfield. The MP and MSO were instructors assigned to the 11 RS. (Tab G-3, G-83) Both instructors had students who were scheduled to accomplish a Basic Surface Attack BSA-1 syllabus sortie. (Tab R-7) The MC was responsible for launching the MRPA followed by 1 hour and 50 minutes of BSA-1 training in Restricted Area R-4806 before handing off the MRPA to a follow-on crew via satellite data-link. (Tabs K-3 thru K-5, R-7)

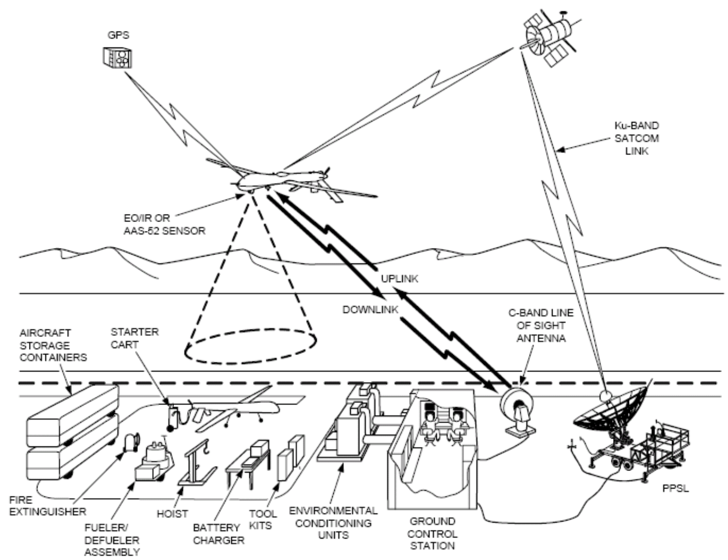


Diagram displaying typical system components of MQ-1B Predator

b. Planning

The MC performed mission planning and briefing to include launch and BSA procedures with their MQ-1B IQT students. (Tab R-7) The mission planning was normal. (Tab K-6, R-7)

c. Preflight

The MP and MSO stepped from the Operations Desk at 0645L. (Tab V-5.1) The MP proceeded to the flightline and performed the operational pre-flight checks on the MRPA and two other aircraft then joined the MSO in the GCS. (Tab R-3) The MRPA's engine was started at 0735L with no anomalies noted. (Tabs R-3, R-6) The MP began taxi of the MRPA at 0753L. The MP and MSO did not note any problems with the MRPA during taxi. (Tabs R-3, R-6)

d. Summary of Accident

The MRPA taxied into position on runway 26 for a static takeoff. Takeoff roll and initial climb were uneventful. The MSO noted the engine Manifold Absolute Pressure (MAP) at 38 inches of Mercury (In Hg) at the time of rotation at 0803:22L. (Tab R-6) Flight data confirms engine speed and MAP remained approximately 5500 revolutions per minute (RPM) and 38-39 In Hg, respectively, from takeoff until the first engine oscillation. (Tab J-7) During climb out the MP turned on the sensor processor modem assembly (SPMA) in preparation for switching control of the MRPA from radio link to satellite data-link. (Tab R-4) At 0804:20L the MRPA was travelling at 74 KIAS and climbing at 320 feet per minute (fpm). (Tab J-11) The MRPA was at an estimated altitude of 240 feet above ground level (AGL). (Tabs J-6, J-7, J-11, J-12, R-4) Suddenly, the engine speed began to decay. (Tabs J-6, J-7, J-11, J-12, R-4) The MP's first indication of loss of engine speed was a warning buzzer. (Tab R-4) The MP looked at the heads-down display (HDD) and noted the engine speed had dropped to 2600 RPM, then it spiked back to 5500 RPM before falling again. (Tab R-4) In response to the engine speed decaying, propeller pitch automatically decreased from 30.5 degrees to 20 degrees. The propeller pitch remained at 20 degrees for the remainder of the flight. (Tab J-12) At this time the MRPA was at 66 KIAS and 0 feet vertical speed indication (VSI). (Tab J-11) The MP thought the SPMA might be causing the engine problems, so he turned it off. (Tab R-4) Then, the MP looked back up and noted that airspeed had dropped to 61 KIAS, 4 KIAS above stall and 10 KIAS below glide speed. (Tab R-4) At this point the MRPA was at 220 feet AGL and -600 feet VSI. (Tab J-11) The MSO noted the RPMs fluctuated in conjunction with the MAP which had dropped and did not come back up. (Tab R-7) Following the third engine oscillation, the MSO noted the MRPA was passing 180 feet AGL with a 500 fpm and increasing sink rate. (Tab R-7) As the MRPA was passing through 100 feet AGL, the MP called the air traffic control tower to declare an emergency. (Tab R-4) The tower acknowledged the emergency and diverted other aircraft in the pattern. (Tab N-10) The MP kept the throttle position at 100% throughout oscillations. (Tabs J-12, R-4) The MRPA's engine oscillations occurred once every five seconds and were nearly identical in magnitude and form ranging from 5633 RPM to 1145 RPM. A total of seven oscillations were recorded with five taking place in flight and two after impact. (Tab J-12) During the rapid descent, the MP maintained control of the MRPA and analyzed the situation. (Tab R-4) He attempted to select a landing location somewhat flat and void of rocks. (Tab R-4)

e. Impact

At 0804:49L, the MRPA impacted uninhabited terrain 1½ miles off the west end of runway 26. (Tabs B-3, S-4) The MP raised the nose of the MRPA just before impact in an effort to minimize damage to the MTS-A. (Tab R-7) The right and left main landing gears (MLG) touched down first with the MRPA in a four degrees nose high attitude. (Tab R-1.1) The MRPA rolled out on the uneven desert terrain with scrub brush for approximately 4 seconds before striking heavier brush. Once the MRPA ran into the heavier brush, the left MLG sheared off and the nose landing gear (NLG) and right MLG collapsed. (Tab S-9, S-10) The MRPA continued to slide for an additional 2 seconds swinging approximately 160 degrees in a counterclockwise direction before it came to rest. (Tab S-5, S-9) The MP then turned off the engine power switch. (Tab R-4) The impact damaged the MRPA's structure and engine. The MSO noted that the MTS-A was still operating. The supplier of the MTS-A, Raytheon, assessed the damage and determined that it was repairable. (Tab R-7) The training hellfire damage sustained damage, but it has not been determined if it is repairable. The estimated cost of repair for the MRPA is $536,178.30. (Tab P-3) This includes $67,348 for engine replacement, $7,000 for replacement of a training hellfire missile, $268,830.30 for structural repairs, $200,000 for MTS-A repairs.

f. Life Support Equipment, Egress and Survival

Not applicable.

g. Search and Rescue (SAR)

Not applicable.

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

All forms were documented in accordance with (IAW) Technical Order (T.O.) 00-20-1. There were no open discrepancies noted on the aircraft maintenance forms.

Delayed discrepancies are those maintenance discrepancies identified as requiring correction at a future date. There was one delayed discrepancy in the aircraft maintenance forms for a small chip/dent on the left aileron trailing edge approximately 2 feet from the wing tip. It was speed taped as a short term fix, and the MRPA was assessed to be fully mission capable. (Tab D-21) There is no evidence to suggest that this delayed discrepancy contributed to the mishap.

b. Inspections

All scheduled inspections were accomplished within scheduled time limits, and there were no overdue aircraft Time Compliance Technical Orders (TCTO). The next scheduled inspections for the MRPA were a 28 day dry-cell nicad battery reconditioning that was due on 6 May 2009 and a right hand tail servo time change that was due after 50 more engine hours. (Tab D-19)

c. Maintenance Procedures

On 23 April 2009, the MRPA was removed from service for a 1080 hours engine time change IAW T.O. 1Q-1(M)B-6. (Tab D-36) Engine serial number E9145 was replaced with engine serial number E8231. (Tab D-36) There are three different engines available for MQ-1B Predators: block 5, block 10 and block 15. Engines E9145 and E8231 were both block 5 engines. Engine E8231 was overhauled by Battlespace Flight Services (BFS) employees, operating under the 432 AMXS Raven Flight, on 11 November 2008. (Tab D-44 thru D-47) The engine change was completed IAW T.O. 1Q-1(M) B-2-72JG-00-1. (Tab D-36) In process inspections (IPI) and Quality Assurance (QA) inspections were completed IAW T.O. 1Q-1(M) B-2-61JG-00-1. (Tab D-36, D-37) After the engine installation was completed, an engine run for operational checks was completed IAW T.O. 1Q-1(M)B-2-72CL-1. (Tab D-38) No defects were found. (Tab D-38)

Engine E8231 had undergone 360 and 720 hour inspections on 11 November 2008 IAW T.O. 1Q-1(M) B-6 WC-2. (Tab D-44, D-46) The engine had 706.4 hours on it at the time. (Tab D-3) These inspections involve an overhaul of the engine. A work card for the 360 hour inspection has a caution that states, “Vacuum Tubing must be secure to prevent chafing. Tubing must not be crushed to prevent engine malfunction.” (Tab X-4) Item 11 on the work card requires new vacuum tubing to be installed from the plenum chamber to the “T” fitting, from the “T” fitting to each carburetor, and from the plenum chamber to the fuel pressure regulator. (Tab X-4) No guidance is provided on length to cut the tubing or routing for the tubing. After the 360 and 720 hour inspections were completed, a QA inspection was accomplished on the engine with no defects noted. (Tab D-47)

After engine E8231 was overhauled, it was placed into the Supply system. (Tab D-8) On 23 April 2009, engine E8231 was issued from Supply to be installed on the MRPA. The engine change was completed IAW technical data. (Tab D-36) Engine run and leak check were completed with no discrepancies noted. (Tab D-36 thru D-38) The MRPA was returned to service on 23 April 2009. (Tab D-8) Preflight inspections were completed on 23 April 2009. (Tab D-8) On 27 April preflight inspections were again completed along with pre- and post-load, battery and tire inspections. (Tab D-15 thru D-17)

No other maintenance procedures were relevant to this mishap.

d. Maintenance Personnel and Supervision

Engine E8231 was overhauled by BFS employees. The employees who performed the overhaul were qualified on these tasks. (Tab G-12) The AIB could not verify the qualifications of the employee who inspected the completed work as he had been terminated from BFS. (Tab G-180)

The MRPA was maintained by employees of BFS assigned to 432 AMXS Raven flight. The 1080 hour engine change was completed by two BFS employees. One was a Mechanic (Mech) III, and one was a Mechanic I in training. (Tab AA-6, AA-8) There were also two QA Inspectors observing the engine change. (Tab V-1.4) The Mech I and Mech III were trained and qualified to perform the task. The post installation engine run was performed by another fully qualified Mech III on the next shift. (Tab AA-4)

The training records for the maintenance personnel who performed relevant maintenance on the MRPA show that they were properly qualified on the maintenance tasks performed. There is no evidence to suggest that qualifications or supervision of personnel were a factor in the mishap.

e. Fuel, Hydraulic and Oil Inspection Analysis

Maintenance personnel properly serviced fuel tanks and oil reservoirs IAW technical data.

The MRPA's fuel load was listed on the Air Force Technical Order Form 781A Information Notes and the 781H as having 303 pounds of fuel in the forward tank and 203 pounds in the aft tank for a total of 506 pounds of fuel prior to takeoff on 28 April 2009. (Tab D-14) The Air Force Petroleum Laboratory at Wright-Patterson AFB tested a fuel sample from the MRPA. The sample failed the vapor pressure (kPa) test. Acceptable range is 38.0 to 49.0 kPa, and the sample result was 34.3 kPa. Although the vapor pressure was low it was not a factor in the mishap. (Tab U-3, U-4)

On 23 April 2009, the oil level was checked on the MRPA and found to be full at 8 quarts. An oil sample was taken from the MRPA subsequent to the mishap for testing. The findings could not be analyzed as there was no previous oil sample testing from the MRPA and no established technical data to compare the sample results against. (Tab D-3)

There is no evidence to suggest petroleum, oils or lubricants contributed to the mishap.

f. Unscheduled Maintenance

There were no unscheduled maintenance actions on the MRPA.

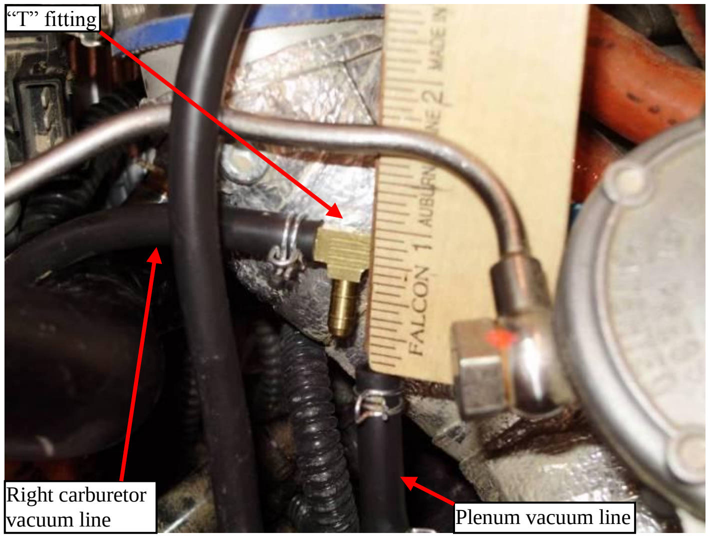
6. AIRCRAFT AND AIRFRAME

a. Condition of Systems

The MRPA's structure and engine were damaged as a result of the mishap. (Tab S-7)

Aircraft structural damage includes: left and right wing; left and right tail; vertical stabilizer; left and right MLG; NLG; left and right fillet; engine cowling; numerous mounts and attachments; bulkheads 5, 6, 7, and 10; aft fuel door; and upper and lower fuselage skin damage. (Tab P-4) The $1.2 million MTS-A sustained minimal damage, and has been deemed repairable. (Tab S-7, S-10, S-18) The training hellfire missile was damaged when it became dislodged from the rail. (Tab S-10) Repair cost will exceed replacement cost.

A thorough inspection of the engine after the mishap revealed that the MAP reference vacuum line disconnected from plenum chamber at a "T" fitting. There was approximately one half inch between the end of the vacuum line connected to the plenum and the "T" fitting.



The block 5 engine is a carbureted engine. Carburetors cannot precisely meter the amount of fuel entering the carburetor venturi and being fed to the engine with changes in air pressure. Air pressures vary at different altitudes. The MAP reference vacuum line allows the carburetor to more precisely meter the amount of fuel entering the carburetor venture to account for variations in air pressure at different altitudes. On the MQ-1B Predator manifold pressure is produced by a turbocharger driven by engine exhaust metered by a wastegate. As MAP increases the air entering the carburetor becomes denser allowing more fuel to be metered into the venturi resulting in increased engine power. If the vacuum line opens, i.e. becomes disconnected, the pressure sensed by the carburetors become that of the ambient (from the surrounding environment) atmosphere. If the MAP is higher than the ambient pressure, the amount of fuel metered into the venturi will decrease. This will lean the air fuel mixture entering the engine cylinders, which will lead to engine oscillations and decrease power.

The "T" fitting that connects the MAP reference vacuum line is situated such that the foot connects to a rubber vacuum line attached to the engine plenum and the arms connect to rubber vacuum lines for the left and right carburetors. The vacuum lines from the "T" fitting to the carburetors were cut to a length to allow for no slack, and as such they were under tension. This is to avoid rubbing and chafing. The section of vacuum line from the plenum to "T" fitting was installed IAW Air Force technical orders, but it was cut to a length that required pulling the "T" fitting one half inch toward the plenum to connect the vacuum line to the "T" fitting. This placed additional tension on the carburetor vacuum lines.

b. Testing

While the MQ-1B Predator is airborne, it constantly transmits the status of aircraft systems and sensors to the GCS, where the flight data is recorded. Flight data is recorded against a time stamp (in seconds) that begins during aircraft preflight when the aircrew powers on the recorders. The MRPA's flight data was retrieved from the GCS and provided to GA ASI for analysis. (Tab J-3 thru J-5, J-16 thru J-17)

c. Functionality of Equipment

The flight data shows that approximately 1 minute after takeoff the MRPA began experiencing multiple engine oscillations between 1145 RPM and 5633 RPM in 5 second intervals. (Tabs J-7, J-12) Exhaust gas temperature (EGT) steadily declined and MAP decayed from 38 In Hg to no more than 27 In Hg during the recorded surges. (Tab J-4) As the airspeed of the MRPA approached near stall speed, the MRPA became less responsive to control inputs from the MP. (Tab J-4, J-15)

The GCS was inspected subsequent to the mishap and determined to have been functioning properly at the time of the mishap. (Tab J-16, J-17)

d. Post Mishap Component Testing

A different MQ-1B Predator with a block 5 engine was tested to see how it would react if the MAP reference vacuum line were disconnected while the engine was running. The test results were captured in the aircraft's flight data. This data revealed that the aircraft experienced a loss of engine performance similar to the MRPA. (Tab W-4)

7. WEATHER

The surface winds at Creech AFB at the time of the mishap were blowing from the north at 5 knots. This did not affect the launch of the MRPA. Weather was within operational limits, and there was no evidence to suggest weather was a factor in the mishap. (Tabs F-14, N-9)

8. CREW QUALIFICATIONS

a. Mishap Pilot

(1) Training

The MP has been a qualified MQ-1B pilot since 17 November 2006. He upgraded to mission instructor pilot on 16 November 2008. Additionally, the MP was qualified as a launch and recovery (LR) pilot since 23 April 2007 and as a LR instructor pilot since 17 March 2009. (Tab G-3)

(2) Experience

The MP's total flight time is 2698.5 hours, which includes 1148.7 hours in the MQ-1B. (Tab G-6) Prior to flying the MQ-1B, the MP was a C-130 pilot. (Tab G-6) He had completed 7 MQ-1B launches since 1 October 2008 with his last one being on 13 April 2009. (Tab G-15)

The MP's flight time during the 90 days before the mishap is as follows (Tab G-7):

MP	Hours	Sorties
Last 30 Days	15.2	9
Last 60 Days	22.2	13
Last 90 Days	49.4	25

b. Mishap Sensor Operator

(1) Training

The MSO has been a qualified MQ-1B sensor operator since 13 July 2005. (Tab G-149) He completed his instructor sensor operator upgrade training on 6 August 2006. (Tab G-147) Additionally, the MSO was qualified as a LR sensor operator since 15 October 2007 and as a LR instructor since 3 April 2008. (Tab G-83)

(2) Experience

The MSO's total MQ-1B flight time is 1397.8 hours. Prior to flying the MQ-1B, the MSO was an AC-130 sensor operator from 1996 to 2005. No records are available showing his active duty flying time. (Tab G-84, G-144)

The MSO's flight time during the 90 days before the mishap is as follows (Tab G-85):

MSO	Hours	Sorties
Last 30 Days	24	12
Last 60 Days	31.6	16
Last 90 Days	56.7	28

There is no evidence to suggest crew qualifications were a factor in this mishap.

9. MEDICAL

a. Qualifications

At the time of the mishap, all personnel were fully medically qualified for flight duty without medical restrictions or waivers.

b. Health

The 72-hour histories, and 14-day histories for the MP and MSO revealed no significant health concerns. There is no evidence to suggest that the health of the MP or the MSO were relevant to the mishap.

c. Toxicology

Immediately following the mishap, commanders directed toxicology testing for all personnel involved in the flight and the launch of the MRPA. Blood and urine samples were submitted to the Armed Forces Institute of Pathology (AFIP) for toxicological analysis. This testing included carbon monoxide and ethanol levels in the blood and drug testing of the urine.

Carboxyhemoglobin saturations of zero to three percent are expected for non-smokers and three to ten percent for smokers. Saturations above ten percent are considered elevated and are confirmed by gas chromatography. The carboxyhemoglobin saturation in the blood samples of MP and MSO were within normal limits.

AFIP examined the blood for the presence of ethanol at a cutoff of twenty milligrams per a deciliter. AFIP detected no ethanol in the blood of the MP or MSO.

Furthermore, AFIP screened the urine of MC members and maintenance members for amphetamine, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates and phencyclidine by immunoassay or chromatography. AFIP detected none of these drugs in the MP, MSO or maintenance members. (Tab Y-3 thru Y-13)

d. Lifestyle

There is no evidence that unusual habits, behavior or stress on the part of the MP, MSO or maintenance crew members contributed to this mishap. Witness testimonies, 72-hour histories, and 14-day histories revealed no evidence that suggests lifestyle factors, including unusual habits, behavior or stress contributed to the mishap.

e. Crew Rest and Crew Duty Time

Air Force Instructions require pilots have proper "crew rest," as defined in AFI 11-202, Volume 3, *General Flight Rules*, 16 February 2005, 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 (FDP) begins. During this time, an 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.

A review of the duty cycles of the MP and MSO leading up to the mishap indicated that they had adequate crew rest. The MP and MSO complied with the crew rest and duty day requirements on the day of the mishap. None of the crew indicated they suffered from stress, pressure, fatigue or lack of rest prior to or during the mishap sortie. The MP and MSO also stated that they were adequately rested and not suffering from any illnesses at the time of the mishap. (Tab K-7) There is no evidence to suggest that fatigue was a factor in this mishap.

10. OPERATIONS AND SUPERVISION

The operations tempo was moderate for the 11 RS at the time of the mishap. Permanent party instructors fill normal deployment rotations in support of Operation ENDURING FREEDOM and Operation IRAQI FREEDOM. Sorties flown by the 11 RS are broken into two hour blocks. Instructors typically fly two of these two hour blocks per week. There were no issues with supervision in the 11 RS at the time of the mishap. There is no evidence to suggest that operations tempo or supervision were a factor in the mishap.

11. HUMAN FACTORS

A human factor is any environmental or individual physical or psychological factor a human being experiences that contributes to or influences his performance during a task. There is no evidence to suggest that any human factors contributed to this mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications

1. Air Force Instruction (AFI) 11-2MQ-1, Volume 1, MQ-1 Crew Training, 4 May 2007
2. AFI 11-2MQ-1, Volume 2, MQ-1 Crew Evaluation Criteria, 28 November 2008
3. AFI 11-2MQ-1, Volume 3, MQ-1 Operations Procedures, 29 November 2007
4. AFI 11-202, Volume 3, General Flight Rules, 5 April 2006
5. AFI 11-401, Aviation Management, 7 March 2007, incorporating Change 1, 13 August 2007
6. AFI 11-418, Operations Supervision, 21 October 2005, incorporating Change 1, 20 March 2007
7. T.O. 1Q-1(M)B-1, USAF Series MQ-1B and RQ-1B Systems, 1 November 2003, incorporating Change 13, 8 April 2009
8. T.O. 1Q-1(M)B-1CL-1, USAF Series MQ-1B and RQ-1B Systems Flight Checklist, 1 November 2003, incorporating Change 15, 8 April 2009

b. Maintenance Directives and Publications

1. AFI 21-101, Aircraft and Equipment Maintenance Management, 29 June 2006
2. T.O. 00-20-1, Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures, 30 April 2003, incorporating Change 4, 1 September 2006
3. 1Q-1(M)B-6, MQ-1B Technical Manual, Aircraft Scheduled Inspection and Maintenance Requirements, 21 August 2008
4. 1Q-1(M)B-2-72JG-00-1, MQ-1B Job Guide, Engine Reciprocating, General – Volume I, 1 September 2007
5. 1Q-1(M)B-2-53JG-00-1, MQ-1B Job Guide, Fuselage, Structures – General, 1 December 2006
6. 1Q-1(M)B-2-05JG-10-1, MQ-1B Job Guide, Aircraft General Ground Handling, 1 December 2006, incorporating Interim Operational Supplement, 17 April 2007

7. 1Q-1(M)B-6WC-1, MQ-1B Inspection Workcard, Preflight, Thruflight, Basic Postflight, Combined Basic Postflight/Preflight Inspection Requirements, 15 January 2007, incorporating Change 1, 5 March 2007
8. 1Q-1(M)B-6WC-2, MQ-1B Inspection Workcard, Aircraft Periodic Inspections and Maintenance Requirements, 21 August 2008

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

c. Known or Suspected Deviations from Directives or Publications

There are no known or suspected deviations from directives or publications by the MC or maintenance members.

13. NEWS MEDIA INVOLVEMENT

The 432 WG Public Affairs office issued a short official press release for this mishap. There has been local media coverage and no national media coverage. One news article was posted in the Las Vegas Review Journal. (Tab Z-9)

14. ADDITIONAL AREAS OF CONCERN

None.

22 June 2009

GARY A. TOPPERT, Lieutenant Colonel, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

MQ-1B, T/N 00-3068, ACCIDENT
28 APRIL 2009

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 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 failure of the Manifold Absolute Pressure (MAP) reference vacuum line that supplied both carburetors on the mishap remotely piloted aircraft's (MRPA) engine. The MAP reference vacuum line disconnected at the plenum side of the "T" fitting approximately one minute after takeoff when the MRPA was at an estimated 240 feet above ground level (AGL). The loss of actual MAP vacuum to both carburetors impacted the fuel to air ratio being supplied to all four engine cylinders. As a result the engine speed initially dropped from 5500 revolutions per minute (RPM) and began oscillating between 1145 RPM and 5633 RPM. The loss of engine power resulted in a loss of airspeed leading to a high sink rate. The MRPA impacted the ground 29 seconds after the initial drop in engine speed. In this short time span the mishap pilot maintained control of the MRPA, analyzed the situation, selected the most appropriate landing location and performed a landing that prevented total loss of the MRPA.

2. DISCUSSION OF OPINION

A thorough inspection of the post crash engine revealed the "T" fitting had pulled approximately one half inch away from the end of the vacuum line connected to the plenum chamber. The "T" fitting is situated such that the foot connects to a rubber vacuum line attached to the engine plenum and the arms connect to rubber vacuum lines for the left and right carburetors. The vacuum lines from the "T" fitting to the carburetors were under tension. The section of vacuum line from the plenum to the "T" fitting was installed in accordance with Air Force technical orders (T.O.). The T.O.s did not provide guidance on length or routing of the vacuum lines. However, the vacuum line attached to the plenum was cut too short based upon the location of the "T" fitting. Connecting the plenum line required pulling the "T" fitting one half inch toward the plenum placing additional tension on the vacuum lines attached to the carburetors. The resultant force allowed the "T" fitting to pull free of the plenum vacuum line.

The MRPA was approximately one minute into flight at an estimated altitude of 240 feet AGL with 74 knots of indicated airspeed (KIAS) when the MAP reference vacuum line separated. With the vacuum line open, the pressure sensed by the carburetors became that of the ambient atmosphere. This resulted in a decrease in the amount of fuel being metered into the venturi and leaned the air fuel mix entering the cylinders. With less fuel being supplied, engine speed rapidly declined.

In response to the initial engine speed rollback, the variable pitch propeller automatically adjusted from 30.5 degrees to 20 degrees pitch and the wastegate opened decreasing turbocharger output in an effort to maintain engine speed. The leaned air fuel mixture and wide open throttle led to engine oscillations. Flight data revealed that the MRPA's engine oscillations occurred once every five seconds, were nearly identical in magnitude and form, and varied between 1145 RPM and 5633 RPM. A total of seven oscillations were recorded with five taking place in flight and two after impact.

Within six seconds of initial rollback, the MRPA's airspeed had dropped to 61 KIAS, only 4 knots above stall speed. As a result of this slow speed and lack of engine power, the MRPA rapidly developed a sink rate in excess of 500 feet per minute resulting in the MP being unable to take action to prevent the MRPA from impacting the ground. Passing through 100 feet AGL, the MP called the tower to declare an emergency. Prior to impact the MP raised the nose of the MRPA and touched down on the main landing gear followed by the nose landing gear. This prevented the MTS-A from being destroyed. Other damage was unavoidable due to the rough terrain the MRPA landed on.

I arrived at my opinion by examining the MRPA and associated components; an Engineering Memorandum from General Atomics Aeronautical Systems, Incorporated; recorded MRPA flight data; witness testimony; and recorded test data from a similarly induced failure on an engine during a ground run. All evidence points to a failure of the MAP reference vacuum line. In the 29 seconds from initial engine failure to impact, the mishap pilot properly maintained control of the MRPA, analyzed the situation, selected the most appropriate location to land and performed a landing that prevented total loss of the MRPA.

22 June 2009

GARY A. TOPPERT, Lieutenant Colonel, USAF
President, Accident Investigation Board

INDEX OF TABS