UNITED STATES AIR FORCE
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 03-3122

18TH RECONNAISSANCE SQUADRON
432D AIR EXPEDITIONARY WING
Creech Air Force Base, Nevada

LOCATION: Kandahar AB, Afghanistan

DATE OF ACCIDENT: 30 January 2012

BOARD PRESIDENT: Lieutenant Colonel Paul Hibbard

CONDUCTED IAW AIR FORCE INSTRUCTION 51-503
Abbreviated Accident Investigation pursuant to Chapter 11

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

OFFICE OF THE VICE COMMANDER
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MAY 2 2 2012

MEMORANDUM FOR ACC/JA

SUBJECT: Abbreviated Accident Investigation Board Report MQ-1B, T/N 03-3122, Kandahar, Afghanistan, 30 January 2012

I have reviewed the Abbreviated Accident Investigation Board Report regarding the MQ-1B, T/N 03-3122, Kandahar, Afghanistan, 30 January 2012. The report prepared by Lieutenant Colonel Paul Hibbard complies with the requirements of AFI 51-503 and is approved.

WILLIAM J. REW
Lieutenant General, USAF
Vice Commander

Attachment:
Abbreviated Accident Investigation Board Report

Agile Combat Power

EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION

MQ-1B, 03-3122
KANDAHAR AB, AFGHANISTAN
30 JANUARY 2012

On 30 January, 2012, at approximately 1000 hours Zulu (Z) time, the mishap remotely piloted aircraft (MRPA), a MQ-1B Predator, tail number (T/N) 03-3122, operated by the 18th Reconnaissance Squadron (RS), 432d Wing (WG), Creech Air Force Base (AFB), made a forced landing just outside the perimeter fence of Kandahar Air Base (AB). The crash site was an unpopulated area adjacent to the base. There were no injuries and there was no damage to other government or private property. The estimated loss is valued at $4.5 million and includes the MRPA and one AGM-114 Hellfire missile.

After normal preflight checks, the MRPA taxied and departed from a forward operating location at 0632Z. During flight, the Mission Control Element (MCE) crew, mishap crew #1 (MC1), observed abnormal engine temperature indications. The abnormal temperature indications worsened, accompanied by a significant loss of thrust and an uncommanded descent in altitude. MC1 began an emergency diversion to the closest suitable divert field, Kandahar AB. At 0922Z, MC1 lost video feed and positive flight control of the MRPA, but monitored flight data as it began a slow descending right-hand spiral through a full circle. At 0933Z, the Launch and Recovery Element (LRE) crew at Kandahar AB, mishap crew #2 (MC2), regained positive flight control of the MRPA and guided it to a forced landing.

The Abbreviated Accident Investigation Board (AAIB) President found, by clear and convincing evidence, the cause of the mishap was a loss of coolant. During the mishap flight, the coolant pump supply line failed, releasing the engine's coolant. As the coolant supply decreased, the Cylinder Head Temperature increased excessively. Heat expansion of the cylinders permitted compressed gases from the combustion chambers to "blow by" the pistons, reducing power output and preventing sustained flight.

The AAIB President found, by a preponderance of evidence, that a significantly contributing factor to the loss of the MRPA was the failure to detect damage during a 60-hour engine inspection on 26 January 2012 on the coolant pump supply line and the oil cooler-to-oil pump oil line, which were routed in a manner that permitted friction chafing. Additionally, the AAIB President found, by a preponderance of evidence, that a significantly contributing factor to the loss of the MRPA was Mishap Pilot #2's (MP2) unintentional "hostile takeover" of the MRPA at 0922Z, when MP2 failed to ensure the Line-of-Sight control link transmitter was unpowered as MP2 turned the ground antenna toward the MRPA. The 1,200 feet of altitude lost in the ensuing unintentional spiral prevented a safe recovery of the crippled aircraft.

COMMONLY USED ACRONYMS AND ABBREVIATIONS

AAIB	Abbreviated Accident Investigation Board
ACC	Air Combat Command
AEW	Air Expeditionary Wing
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFSC	Air Force Specialty Code
AGL	Above Ground Level
AIB	Accident Investigation Board
AMXS	Aircraft Maintenance
AoA	Angle of Attack
ATC	Air Traffic Control
ATO	Air Tasking Order
AZ	Arizona
BFS	Battlespace Flight Services
BPO/PR	Basic Postflight/Preflight
C	Celsius
CBA	Collective Bargaining Agreement
CDC	Career Development Course
CHT	Cylinder Head Temperature
CMR	Combat Mission Readiness
CONUS	Continental United States
Dash 1	T.O. 1Q-1(M)B-1, USAF Series MQ-1B Systems, 3 Dec 2010.
DNIF	Duties Not Including Flying
EGT	Exhaust Gas Temperature
EMI	Electric Module Ignition
EP	Emergency Procedure
ERS	Expeditionary Reconnaissance Squadron
ETA	Estimated Time of Arrival
FAE	Functional Area Expert
FDP	Flight Duty Period
FOB	Forward Operating Base
GA ASI	General Atomics Aeronautical Systems, Incorporated
GCS	Ground Control Station
GDT	Ground Data Terminal
HARM	Host Aviation Resource Management
HUD	Heads-up Display
IAW	In Accordance With
IFE	In-flight Emergency
IP	Instructor Pilot
IPI	Initial Process Inspection
IR	Infrared
ISB	Interim Safety Board
ISR	Intelligence, Surveillance and Reconnaissance
IPI	Initial Process Inspection
ISB	Interim Safety Board
ISR	Intelligence, Surveillance and Reconnaissance
ISARC	Intelligence, Surveillance, and Reconnaissance Center
KIAS	Knots Indicated Airspeed
kPa	Vapor Pressure
KM	Kilometers
L	Local Time
LA	Legal Advisor
LNO	Liaison Officer
LOS	Line of Sight
LR	Launch and Recovery
LRE	Launch and Recovery Element
MAJCOM	Major Command
MAP	Manifold Absolute Pressure
MC	Mission Coordinator
MCE	Mission Control Element
MIC	Mission Intelligence Coordinator
mIRC	Mission Internet Relay Chat
MM	Mishap Maintainer
MMIC	Mishap Mission Intelligence Coordinator
MAP	Manifold Air Pressure
MM	Mishap Maintainer
MO	Mishap Observer
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSL	Mean Sea Level
MSO	Mishap Sensor Operator
MTS	Multi-spectral Targeting System
MX	Maintenance
N/A	Not applicable
NV	Nevada
NM	Nautical Miles
OAT	Outside Air Temperature
OG	Operations Group
OPS SUP	Operations Supervisor
ORM	Operational Risk Management
PCL	Point, Click, Loiter
PPSL	Predator Primary Satellite Link
PSI	Pounds per Square Inch
ROZ	Restricted Operating Zone
RPA	Remotely Piloted Aircraft

RPM	Revolutions per Minute	SQ	Squadron
RS	Reconnaissance Squadron	SU	Supported Unit
RTB	Return to Base	TCTO	Time Compliance Technical Order
RS	Reconnaissance Squadron		
SA	Situational Awareness	T/N	Tail Number
SA	Situational Awareness	T.O.	Technical Order
SAT	Satellite	UAS	Unmanned Aerial System
SATCOM	Satellite Communications	US	United States
SIB	Safety Investigation Board	U.S.C.	United States Code
SOC	Squadron Operations Center	USAF	United States Air Force
SOS	Special Operations Squadron	VA	Virginia
SPINS	Special Instructions	VPP	Variable Pitch Propeller
SPMA	Sensor Processor Modem Assembly	WOC-D	Wing Operations Center-Director
		WG	Wing
		Z	Zulu Time

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 15 March 2012, Lieutenant General William Rew, Vice Commander, Air Combat Command (ACC), United States Air Force (USAF), appointed Lieutenant Colonel Paul Hibbard as the Abbreviated Accident Investigation Board (AAIB) President to conduct an aircraft accident investigation of the 30 January 2012 crash of a MQ-1B Predator aircraft, tail number (T/N) 03-3122 (Tab Y-3). An AAIB, pursuant to Chapter 11 of Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, dated 26 May 2010, was conducted at Nellis Air Force Base (AFB), Nevada, from 16 March 2012 through 21 April 2012. The following board members were also detailed: a Legal Advisor (LA), a Recorder (Rec), a Pilot Functional Area Expert (FAE), and a Maintenance FAE. (Tab Y-3, Tab Y-5).

b. Purpose

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

2. ACCIDENT SUMMARY

The Mishap Remotely Piloted Aircraft (MRPA), a MQ-1B Predator, T/N 03-3122, experienced a loss of thrust on 30 January 2012 and impacted the ground at 1000Z near Kandahar AB, Afghanistan (Tab Y-3, Tab V-1.9-10, 12, Tab N-3). No injuries were reported and no other government or private property was damaged (Tab P-2). The aircraft was damaged beyond repair with a loss valued at $4.5 million including the destruction of one AGM-114 Hellfire missile (Tab P-2). At the time of the mishap, the Mission Control Element (MCE) crew, Mishap Crew #1 (MC1), was composed of Mishap Pilot #1 (MP1) and Mishap Sensor Operator #1 (MSO1) (Tab K-4). A MQ-1B Instructor Pilot, Mishap Observer (MO), was also assisting the MCE from inside the Ground Control Station (GCS) (Tab V-3.23, V-5.2). The Launch and Recovery (LRE) crew, Mishap Crew #2 (MC2), was composed of Mishap Pilot #2 (MP2) and Mishap Sensor Operator #2 (MSO2) (Tab K-5).

3. BACKGROUND

The 18th RS is a component of the 432d Wing (WG) (Tab CC-10), based at Creech AFB, NV. The 432d WG is a component of 12th Air Force (AF) (Tab CC-5) and USAF Southern Command, headquartered at Davis-Monthan AFB, Arizona (AZ) (Tab CC-5). The 12th AF is a component of ACC, Headquartered at Langley AFB, Virginia (VA) (Tab CC-5).

a. Air Combat Command (ACC)

Air Combat Command is a major command of the United States Air Force and primary force provider of combat airpower to America's warfighting commands. Its mission is to organize, train, equip, and maintain combat-ready forces for rapid deployment and employment while ensuring strategic air defense forces are ready to meet the challenges of peacetime air sovereignty and wartime air defense. ACC operates fighter, bomber, reconnaissance, battle-management, and electronic-control aircraft and provides command, control, communications, and intelligence systems and conducts global information operations. Over 67,000 active duty members, 13,500 civilians, and when mobilized, 50,000 Air National Guard and Reserve members compose ACC, and its units operate 1,800 aircraft (Tab CC-3).

1. 12th Air Force (12th AF)

12th Air Force controls ACC's conventional forces in the western United States and has the warfighting responsibility for U.S. Southern Command as well as the U.S. Southern Air Forces. It manages all Air Force assets and personnel in the AFSOUTH AOR, which includes Central and South America. 12th Air Force has worked closely with nations in the Caribbean, Central and South America in the Global War on Terrorism by providing forces to OEF, OIF, and Operation NOBLE EAGLE, and it also has supported efforts to stem the flow of illegal drugs into the U.S. and neighboring countries. 12th Air Force directs 10 active duty wings and one direct reporting unit as well as 13 gained wings and other units of the Air National Guard and Reserve (Tab CC-6).

2. 432d Wing

The 432d WG, also known as the 432d Air Expeditionary Wing (AEW) "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 432d WG conducts remotely piloted aircraft (RPA) initial qualification training for aircrew, intelligence, weather, and maintenance personnel. The 432d WG oversees operations of the 432d Operations Group (OG), 432d Maintenance Group, 11th RS, 15th RS, 17th RS, 18th RS, 30th RS, 42d Attack Squadron, 432d Aircraft Maintenance Squadron (AMXS), 432d Maintenance Squadron, and the 432d Operations Support Squadron (Tab CC-8).

3. 18th Reconnaissance Squadron

The 18th RS provides combatant commanders with persistent intelligence, surveillance and reconnaissance (ISR), full-motion video, and precision weapons employment. Global operations architecture supports continuous

MQ-1B Predator employment providing real-time actionable intelligence, strike, interdiction, close air support, and special missions to deployed war fighters (Tab CC-10).

b. MQ-1B Predator System

The MQ-1 Predator is an armed, multimission, medium-altitude, long endurance remotely piloted aircraft (RPA) that is employed primarily in a killer/scout role as an intelligence collection asset and secondarily against dynamic execution targets. The MQ-1's capabilities make it uniquely qualified to conduct irregular warfare operations in support of Combatant Commander objectives. (Tab CC-11).

The Predator is part of an Unmanned Aircraft System, or UAS, not just an aircraft. A fully operational UAS consists of four sensor/weapon equipped aircraft, a ground control station (GCS), a Predator Primary Satellite Link (PPSL), and spare equipment along with operations and maintenance crews for deployed 24-hour operations (Tab CC-11).

The basic crew for the Predator is a rated pilot to control the aircraft and command the mission and an enlisted aircrew member to operate sensors and weapons plus a mission coordinator, when required. The crew employs the aircraft from inside the GCS via a line-of-sight (LOS) data link or a satellite data link for beyond LOS operations (Tab CC-11).

The MQ-1B Predator carries the Multi-spectral Targeting System (MTS), which integrates an infrared sensor, a color/monochrome daylight TV camera, an image-intensified TV camera, a laser designator and a laser illuminator into a single package. The full motion video from each of the imaging sensors can be viewed as separate video streams or fused together. The aircraft can employ two laser-guided AGM-114 Hellfire missiles which possess a highly accurate, low collateral damage, and anti-armor and anti-personnel engagement capability (Tab CC-11).

The system can be deployed for worldwide operations. The Predator aircraft can be disassembled and loaded into a container for travel. The GCS and PPSL are transportable in a C-130 Hercules (or larger) transport aircraft. The Predator can operate on a 5,000 by 75 foot (1,524 meters by 23 meters) hard surface runway with clear line-of-sight to the ground data terminal antenna. The antenna provides line-of-sight communications for takeoff and landing. The PPSL provides over-the-horizon communications for the aircraft and sensors (Tab CC-12).

The primary concept of operations, Remote Split Operations, employs a GCS for takeoff and landing operations at the forward operating location while the Continental United States (CONUS) based crew executes the mission via beyond-line-of-sight links (Tab CC-12).

The aircraft has an ARC-210 radio, an APX-100 IFF/SIF with Mode 4, and an upgraded turbocharged engine. The latest upgrades, which enhance maintenance and performance, include notched tails, split engine cowlings, braided steel hoses and improved engine blocks (Tab CC-12).

4. SEQUENCE OF EVENTS

a. Mission

The Mission Control Element (MCE) Mishap Crew (MC1) consisted of Mishap Pilot #1 (MP1) and Mishap Sensor Operator #1 (MSO1) (Tab K-4). The Launch and Recovery Element (LRE) Mishap Crew (MC2) consisted of the LRE Mishap Pilot #2 (MP2) and Mishap Sensor Operator #2 (MSO2) (Tab K-5). MC1 was assigned to the 18th Reconnaissance Squadron (RS), 432d WG, Creech AFB, NV (Tab V-1.2, Tab V-3.2, Tab AA-3). MC2 was forward deployed to the combat theater, with MP2 assigned to the 3d Special Operations Squadron, 27th Special Operations Wing, Cannon AFB, NM and MSO2 assigned to the 15th RS, 432d WG, Creech AFB, NV (Tab V-2.2, V-4.1, AA-3). The MRPA launched from the forward deployed location under the command of a LRE and transferred control to a MCE crew (Tab V-7.1). MC1 assumed control of the MRPA from the first MCE crew at approximately 0800Z (Tab V-7.1, AA-3). Hand-off operations with the MC1 were uneventful and the first MCE crew cited no abnormalities with the MRPA. (Tab V-7.1)

b. Planning

MC1 attended a mass brief conducted at the beginning of their shift by the Operations Supervisor where they received updates on the ongoing missions, weather, and practiced an "Emergency Procedure of the day" (Tab V-1.6, Tab V-3.7-10). After the mass brief, MP1 briefed MC1 on expectations and responsibilities (Tab V-1.6, 8). MC1 received a mission brief from the Mission Intelligence Coordinator (MIC) concerning the current location of the MRPA and mission specifics (Tab V-1.6, 8, Tab V-3.11). MC1 stepped to their respective crew positions to accept a change-out brief from the crew currently operating the MRPA (Tab V-1.7, Tab V-3.11, Tab V-7.1). A current and qualified MQ-1B Instructor Pilot, Mishap Observer (MO), entered the GCS to observe the mission (Tab V-3.23).

MC2 received a brief of the weather, Operational Risk Management, and a practice "Emergency Procedure of the day" from their Operations Supervisor at Kandahar AB (Tab V-2.6-8, Tab V-4.2). The brief noted that weather was clearing and the crew would be performing launches to resume mission operations (Tab V-2.6, 9, V-4.2).

c. Preflight

No evidence suggests the MRPA preflight activities were abnormal in any way or affected the outcome of the mishap.

d. Summary of Accident

The MRPA departed from the forward operating location at 0632Z on 30 Jan 2012 (Tab AA-3). After an uneventful hand-over from the LRE at approximately 0650Z, an MCE crew operated the MRPA for approximately one hour, swapping out with MC1 at approximately 0800Z (Tab

AA-3). MC1's mission proceeded without abnormality until MSO1 recognized a high Cylinder Head Temperature (CHT) warning (Tab V-3.12). MP1 steered the aircraft for an immediate return to the launching base (Tab V-1.8). MC1 determined from the high CHT and low coolant temperature that the aircraft was most likely experiencing an Engine Overheat due to a coolant leak and that Engine Failure was possible (Tab V-1.8-9, Tab V-5.2). MSO1 verbalized the introductory Notes of the Engine Overheat checklist but MC1 did not accomplish the Engine Overheat checklist items (Tab V-1.14, 16). MC1 continued to analyze the situation by training the camera to examine the aft portion of the aircraft in day television and infrared settings and discovered a warm liquid dripping from the engine compartment (Tab V-1.8-9).

Additional associated high temperature warnings illuminated (Tab V-3.13). Almost simultaneously, the aircraft began to lose altitude (Tab DD-5). MSO1 combined the many high temperature indications with the loss of performance and stated that they had lost the engine (Tab V-3.12-13). MP1 executed the Engine Failure Critical Action Procedures, turned the aircraft toward the closest suitable divert, Kandahar AB, and declared an emergency with Air Traffic Control (Tab V-5.2, Tab V-1.9). MP1 decided each step after the CAPS was not applicable because they still had a working engine with reduced thrust (Tab V-1.9-10). The MRPA was 68 nautical miles (nm) from Kandahar AB at 16,700' above field elevation and was descending at a rate of 220' per nautical mile (Tab EE-3).

MO assisted MC1 as required to reduce the workload on MP1 (Tab V-1.16-17, Tab V-3.25, Tab V-5.3). MO also reminded MP1 to change the emergency mission and the ground antenna information to the new landing field, Kandahar AB (Tab V-1.16). These critical recovery settings tell the MRPA where to fly if it loses satellite control link from the MCE and where to point its LOS directional antenna (Tab V-5.2-3). At 0918Z, the MRPA leveled out and appeared to hold approximately 11,400' above field elevation for approximately four minutes (Tab EE-3).

To establish context, the following paragraph describes a normal hand-back from a MCE to the LRE. During a normal hand-back, the MCE notifies the LRE of their estimated time of arrival, planned fuel remaining at hand-back, and operational status of the aircraft (Tab O-3). The MCE will match camera settings with the LRE (required for both crews to view video) and program a mission that will continue to fly towards the airfield regardless of whether or not the aircraft is receiving a valid control link (Tab O-3-4, Tab V-1.7, V-2.8). If a control link is still absent, the last point of the programmed mission tells the aircraft to execute the emergency mission (Tab V-1.15). As the aircraft nears the airfield, the LRE crew will request the MCE crew turn on the aircraft's LOS transmitters to broadcast the video signal (Tab V-3.10). The LRE crew can then search for the aircraft LOS video signal by steering the ground antenna toward the aircraft with the GCS LOS control link transmitter OFF (Tab V-2.8, 20, Tab BB-8). After receiving the video signal, the LRE crew continues their checklists and informs the MCE when they are ready to take control of the aircraft (Tab O-4, Tab V-2.8). The MCE crew disables their satellite control link and informs the LRE crew (Tab O-4, Tab V-2.8). The aircraft continues to fly the programmed mission without a command link (Tab V-1.7). The LRE crew then turns ON their LOS control link transmitter and confirms LOS control of the aircraft (Tab V-2.8, Tab O-4). The checklist cautions that inadvertent aircraft link is a dangerous condition that could occur if crews do not follow the aircraft handover procedures (Tab BB-8). This background information is provided to assist the reader in understanding the importance of the LOS control link transmitter to a normal hand-back procedure.

MC1 notified the Wing Operations Center (WOC) via instant chat of their planned divert to Kandahar (Tab V-1.9). The WOC then notified the Kandahar LRE Operations Supervisor of the incoming emergency aircraft (Tab V-6.2). MC2 had just finished their GCS setup for the impending launch of a different aircraft (Tab V-2.9, Tab V-4.2). This setup includes the pilot setting their LOS control link transmitter to **ON** (Tab BB-8, Tab V-2.20). At that time, the LRE Operations Supervisor directed MC2 to prepare to take an incoming aircraft with "Engine Failure" (Tab V-6.2). Due to a perception that time was critical, MC2 made the decision to modify their current GCS settings instead of rebooting and reloading (Tab V-6.2, V-2.21). However, MP2 did not reset the LOS control link transmitter to **OFF** (Tab V-2.20)**.** When MSO2 applied power to the ground antenna via the circuit breaker, their GCS began broadcasting a valid LOS control link signal on the correct frequencies for the MRPA (Tab V-2.20). Continuing with their setup, MP2 asked the LRE Operations Supervisor for the MRPA's current position and requested MC1 to turn on MRPA's LOS transmitters to broadcast the MRPA's video signal (Tab V-1.10, Tab V-2.9). MC2 then attempted to point the ground antenna in the MRPA's direction manually to receive the video signal (Tab V-2.10). At this point, the MRPA had the potential for a safe recovery (Tab V-1.11, Tab V-3.17).

At 0922Z, MC1 lost video feed and positive flight control of the MRPA but maintained good telemetry feedback from the MRPA (Tab V-1.10-11) due to the MRPA registering the presence of a valid LOS control link signal from the LRE ground station (Tab V-2.20, Tab DD-7).

After losing the video at 0922Z, MC1 monitored the MRPA flight data and observed the MRPA enter a wings-level slight right hand yawing turn and travel in a circular ground track slowly losing 1,600 feet of altitude over the next eleven minutes (Tab V-1.10-11, Tab DD-7, Tab EE-3). During this period, the MRPA completed a full circle, crossing its own ground track again after eight minutes, having travelled 11.5 nautical miles and having lost 1,230 feet of altitude (Tab EE-3). This unintentional spiral turn put the safe recovery of the MRPA in jeopardy (Tab V-1.11-12). At 0933Z, MC2 realized they had control of the aircraft when they unintentionally made inputs to the flight controls and camera ball and observed a consistent response (Tab V-2.10, Tab V-4.3, Tab EE-3). MP2 immediately steered the aircraft toward Kandahar AB, now 35 nautical miles away (Tab V-2.11, Tab DD-7, Tab EE-4). MC2 reviewed engine temperature indications, diagnosed a coolant leak and executed the Engine Overheat and Engine Failure checklists (Tab V-2.15, Tab V-4.3). Engine performance continued to be degraded and the aircraft did not sustain level flight for the remainder of the sortie (Tab DD-7, Tab EE-4). MC2 considered the possibility of intentionally crashing the MRPA in a low collateral damage area to avoid loss of life or property damage (Tab V-2.12, Tab V-4.3). MP2 believed the MRPA might still be recoverable, continued the slow descent toward Kandahar AB, and declared an emergency with the Radar Approach Control agency (Tab V-2.11, Tab N-5). The most direct route to Kandahar AB penetrated some small cumulus clouds, which did not appreciably affect the aircraft's descent rate or controllability (Tab V-2.12, Tab EE-4, see para 7. Weather).

As the MRPA neared the airfield terminal area, the Tower Local Controller advised MP2 of the arresting cable position and cleared MP2 for an opposite direction landing (Tab N-3). MP2 acknowledged the position of the arresting cable and clearance to land (Tab N-3). At 0959Z, approximately 1 nautical mile from the approach end and 250' above the field, MP2 lowered the landing gear and started a left bank for final approach, but determined landing on the runway was no longer safely possible (Tab V-2.14, Tab N-3). MP2 selected a suitable forced landing area just outside the perimeter and guided the aircraft to impact (Tab V-2.14). Testimony from MP1, MP2 and the MO (all current and qualified MQ-1B pilots) agreed that an extra 500-1,000 feet of altitude would have been sufficient to safely recover the aircraft (Tab V-1.12, V-2.15, V-5.3).

e. Impact

The MRPA, T/N 03-3122, impacted the terrain at approximately 1000Z on 30 January 2012 less than 100 yards from the perimeter fence of Kandahar AB (Tab S-2, Tab N-3). Photographs show where the aircraft came to rest with the fuselage largely intact, the flight control surfaces separated and little or no fire damage (Tab S-3).

f. Egress and Aircrew Flight Equipment (AFE)

This section is not applicable.

g. Search and Rescue (SAR)

This section is not applicable.

h. Recovery of Remains

This section is not applicable.

5. MAINTENANCE

a. Forms Documentation

All aircraft forms were up to date and signed off correctly in accordance with the Air Force Instruction 00-20-1.

b. Inspections

The aircraft inspections were documented and up to date. The last major inspections performed on the aircraft were a 60-hour engine inspection on 26 January 2012, an 150-hour airframe inspection on 28 January 2012, and a combined basic postflight/preflight (BPO/PR) on 28 January 2012 (Tabs D-3, D-4, U-4). No evidence suggests the 150-hour airframe inspection and the BPO/PR had any connection to the aircraft accident.

c. Maintenance Procedures

Maintenance records indicate the engine was new when installed on 26 July 2011 (Tab U-13). The oil cooler-to-pump line and radiator-to-water pump lines were installed and secured in such a manner as to permit unrestrained contact (DD-8). There is no evidence to suggest that coolant or oil lines were replaced during the lifetime of the engine. Maintenance records document eight

60-hour inspections from engine installation until the mishap (Tab U-6-13). A gap in maintenance documentation shows 126 flight hours elapsed between the fourth and fifth documented 60-hour inspections, during which at least one additional undocumented 60-hour inspection was likely accomplished (Tab U-10-12). On 26 January 2012, the MRPA received its last 60-hour engine inspection (Tab D-3). Post mishap inspection of the engine found significant damage to the oil cooler-to-pump line and the radiator-to-water pump lines (Tab DD-6, 8). The lines were removed and sent to the Air Force Research Lab for analysis. The analysis found evidence that the oil line and the coolant lines were touching each other (Tab J-13, Tab DD-8). The result of this contact led to the failure of the coolant line (Tab DD-8). Maintenance Expert (ME) 2's testimony states that the amount of damage present on the coolant line could not have occurred in the intervening 26 flight hours of operation between the last 60-hour inspection and the mishap (Tab V-10.2). ME1's testimony directly conflicts with this assessment, stating the damage could have occurred after the last 60-hour inspection (Tab V-9.2). In considering this conflicting testimony, the Board President found that ME1 had a conflict of interest as an employee of the servicing maintenance contractor, which may have colored his assessment. The Board President assessed not only that as a military member in an unassociated MQ-1 unit, ME2 had no potential conflict of interest, but also that ME2's experience exceeded that of ME1. In this context, the preponderance of the evidence shows that the damage would have been present during the last 60-hour inspection. The 60-hour inspection calls for the Maintenance technician to inspect all coolant hoses, fuel and oil lines for damage, security, or leaks on the engine (Tab BB-4). In interviewing ME1 or ME2, nothing suggested that the maintenance procedures, Technical Order guidance or location of these damaged lines would have prevented the detection of the damage during a routine 60-hour engine inspection.

d. Maintenance Personnel and Supervision

Maintenance Records indicate that Mishap Maintainer 1 (MM1) and Mishap Maintainer 2 (MM2) were the personnel involved in the last 60-hour inspection prior to the mishap (Tab D-3). MM1 was the maintainer who signed the "corrected by" block on the AFTO form 781A, and MM2 signed the "inspected by" block on the 781A (Tab D-3). They were properly trained to conduct 60-hour engine inspections (Tab EE-5-6). The quality of maintenance supervision was adequate and did not contribute to the mishap.

e. Fuel, Hydraulic and Oil Inspection Analyses

A fuel sample was taken from aircraft. Results were negative for anything that would have related to the cause of the accident (J-5).

An oil sample was taken from the aircraft after the accident. The results from the oil sample returned with no indications that it would have any direct cause of the accident (J-2-4).

f. Unscheduled Maintenance

The only unscheduled maintenance performed was a Variable Pitch Propeller (VPP) removal and replacement. The VPP assembly was changed due to the rack bearing discovered bad upon removal for the 60-hour inspection (Tab U-3). The changing of this part did not contribute to the accident.

6. AIRCRAFT AND AIRFRAME

a. Structures and Systems

A coolant leak originated from the coolant supply line just forward of the water pump assembly (Tab J-6). The coolant line was directly chafing on the oil pump-to-cooler line (Tab DD-8). The loss of coolant resulted in excessively high Cylinder Head Temperature and oil temperatures (Tab DD-5). With the engine cooling fan set to AUTO, the cowl flap position and cooling fan operation are controlled by coolant temperature. As the coolant level decreased the coolant temperature sensor began reading the lower temperature of the air in the radiator and prevented the cowl flap/cooling fan's operation, aggravating the high engine compartment temperatures (Tab DD-6-7). The result of this severe over temperature condition was a loss of thrust produced by the engine (Tab DD-7).

"Blow by" is a condition where the piston rings are not creating a proper seal against the cylinder wall due to heat expansion of the cylinder walls (Tab DD-7-8). This "blow by" gap allowed pressure to be lost during the compression and burn strokes of the engine cycle (Tab DD-8). Additionally, the loss of air due to "blow by" artificially enriched the fuel/air mixture, leaving heavy carbon deposits on the pistons, valves and spark plugs (Tab DD-8). This coating fouled the spark plugs, further decreasing the engine performance (Tab DD-8). These conditions resulted in the engine no longer producing the needed power to sustain level flight (Tab DD-8).

b. Evaluation and Analysis

The coolant and oil lines were sent to the Air Force Research Laboratory for evaluation. The evaluation supports the fact that the oil line and the coolant line had been chafing against each other (Tab J-13). This evaluation was conducted by AFRL/RXSA - Materials Integrity Branch, Wright-Patterson Air Force Base (Tab J-6).

7. WEATHER

The mishap sortie was the first sortie after the conclusion of a break in flying due to adverse weather conditions (Tab V-2.4, V-4.1) Forecast and observed weather for the mishap sortie presented no unusual challenges (Tab V-1.6, Tab V-3.8, Tab V-4.20). During the mishap emergency recovery sequence, MC2 penetrated small cumulus clouds with no adverse impact. MP2 and MSO2 testified to significant losses in altitude while penetrating these clouds (Tab V-2.12, V-4.3). Review of the datalogs showed that the altitude loss during the six minutes of cloud penetration (0941-0947Z) was nearly identical to next six minutes (0947-0953Z) of clear air penetration (Tab EE-3). Winds aided the mishap crews by providing a tailwind, effectively extending the range of the crippled aircraft (Tab V-1.10).

8. CREW QUALIFICATIONS

a. Mishap Pilot 1 (MCE)

(1) Training

MP1 has been a qualified MQ-1B pilot since 17 August 2011 (Tab G-3).

(2) Experience

At the time of the mishap, MP1's total flight time was 238.7 hours, which included 238.2 hours in the MQ-1B (Tab G-5). MP1's recent flight time is as follows (Tab G-6).

	Hours	Sorties
Last 30 Days	33.4	8
Last 60 Days	82.6	20
Last 90 Days	127.9	34

MP1's qualifications were not contributory to this mishap.

b. Mishap Sensor Operator 1 (MCE)

(1) Training

MSO1 has been a qualified MQ-1B Sensor Operator since 7 May 2009 (Tab G-87). MSO1 most recently conducted a periodic re-evaluation as a MQ-1B Sensor Operator on 13 December 2011 (Tab G-38).

(2) Experience

At the time of the mishap, MSO1's total flight time was 2259.9 hours, all of it in the MQ-1B (Tab G-45). MSO1's recent flight time is as follows (Tab G-40).

	Hours	Sorties
Last 30 Days	14.4	6
Last 60 Days	53.9	21
Last 90 Days	105.8	33

MSO1's qualifications were not contributory to this mishap.

c. Mishap Pilot 2 (LRE)

(1) Training

MP2 has been a qualified MQ-1B pilot since 26 October 2010 (Tab G-86). MP2 has been a qualified Launch and Recovery pilot since 20 September 2011 (Tab G-86). MP2 most recently conducted a periodic re-evaluation as a MQ-1B pilot on 6 October 2011 (Tab G-86).

(2) Experience

At the time of the mishap, MP2's total flight time was 535.1 hours, which included 532.0 hours in the MQ-1B (Tab G-17). MP2's recent flight time is as follows (Tab G-18).

	Hours	Sorties
Last 30 Days	24.7	53
Last 60 Days	53.1	135
Last 90 Days	77.2	202

MP2's qualifications were not contributory to this mishap.

d. Mishap Sensor Operator 2 (LRE)

(1) Training

MSO2 has been a qualified MQ-1B Sensor Operator since 14 January 2011 (Tab G-59). MSO2 has been a qualified Launch and Recovery Sensor Operator since 30 August 2011 (Tab G-57).

(2) Experience

At the time of the mishap, MSO2's total flight time was 670.1 hours, all of it in the MQ-1B (Tab T-3). MSO2's recent flight time is as follows (Tab G-40).

	Hours	Sorties
Last 30 Days	30.8	65
Last 60 Days	62.7	147
Last 90 Days	87.5	220

MSO2's qualifications were not contributory to this mishap.

9. MEDICAL

a. Qualifications

At the time of the mishap, MP1, MSO1, MP2 and MSO2 were fully medically qualified for flight duty (Tab V-1.4, Tab V-2.4, Tab V-3.4, Tab V-4.1). MSO2 possessed a duty limiting medical waiver that did not affect the performance of duties as a Sensor Operator (Tab V-4.1).

b. Health

There is no evidence to suggest that the health of MC1 or MC2 were relevant to the mishap.

c. Toxicology

Immediately following the mishap, local commanders directed toxicology testing for MC1, MC2, and the launching maintenance crew. All toxicology testing was normal and not a factor to the mishap (Tab EE-7-24).

d. Lifestyle

MSO1's self-assessed Operational Risk Assessment score was higher than almost all other crew members' scores in the unit on the day of the mishap (Tab K-6). MSO1 testified that this was due to the unusual circumstance of being both an Imagery Analyst and Sensor Operator (Tab V-3.7). As a full-time Sensor Operator, MSO1 was expected to also pass Career Development Courses as an Imagery Analyst in which MSO1 had no practical experience (Tab V-3.7). MSO1 had demonstrated difficulty in passing these courses which contributed to the elevated long-term stress level (Tab V-3.7). MSO1 was also in the process of separating from Active Duty (Tab V-3.5), though MSO1 testified that this was not an added stress factor (Tab V-3.6). MSO1's Operational Risk Assessment total score did not surpass the level that required command attention or supervisory action (Tab K-6, Tab V-3.7). No lifestyle factors were found to be relevant to the mishap.

e. Crew Rest and Crew Duty Time

AFI require air crew have proper "crew rest," as defined in AFI 11-202, Volume 3, General Flight Rules, 22 Oct 10, 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. MC1 and MC2 complied with the crew rest and duty day requirements on the day of the mishap (Tab V-1.5, V-2.5, V-3.6, V-4.1-2). With the exception of MP2, neither MC1 nor MC2 indicated they suffered from stress, pressure, fatigue or lack of rest prior to or during the mishap sortie (Tab V-1.5, V-3.5-6, V-4.2). MP2 testified to feeling fatigued that day, but that it did not affect any crew performance during the mishap sequence (Tab V-2.5-6). MP2's Operational Risk Management self-assessment that day showed a fatigue score of 1, i.e. "wide awake", on a scale of 0-5 (Tab K-8). There is no evidence to suggest that fatigue was a factor in this mishap.

10. OPERATIONS AND SUPERVISION

MC1, MC2, MO and the Kandahar Operations Supervisor all testified that the Operational Tempo was moderately high, but sustainable and that the base environment supported effective operations (Tab V-1.4-5, V-2.4-6, V-3.4-6, V-4.1, V-5.1, V-6.1). Operations tempo and operations supervision was not found to be a factor in this 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.

AFI 91-204, *Safety Investigations and Reports,* 24 September 2008, Attachment 5, contains the Department of Defense Human Factors Analysis and Classification System, which lists potential human factors that can play a role in aircraft mishaps. The following human factors were relevant to this mishap:

a. **Contributory**

(1) **Human Factor 1**

AE102 Checklist Error
Checklist Error is a factor when the individual, either through an act of commission or omission makes a checklist error or fails to run an appropriate checklist and this failure results in an unsafe situation.

- MC1 did not complete the Engine Overheat checklist, which directs the pilot to turn on the engine cooling fan and reduce the electrical load on the alternators (Tab V-1.14, Tab BB-9, Tab DD-7). Use of the cooling fan by the MC2 resulted in a decrease in oil temperature, but by that time, significant engine damage had already occurred (Tab DD-7). See Also: PC405 and PC506
- MC2 unintentionally left their LOS control link transmitter set to ON instead of setting to OFF as directed in the set-up checklists (Tab V-2.21, Tab BB-8). The unrecognized assumption of control resulted in a wings level, descending, rudder turn through a full circle and altitude loss of over 1,200 feet (Tab V-1.11-12, Tab EE-3-4). This unintended maneuver resulted in an unrecoverable loss of altitude required for a safe landing (Tab V-1.12). See Also: AE203 and OP004

(2) **Human Factor 2**

AE203 Necessary Action – Rushed
Necessary Action – Rushed is a factor when the individual takes the necessary action as dictated by the situation but performs these actions too quickly and the rush in taking action leads to an unsafe situation.

- During MP2's rack reconfiguration, MP2 rushed through loading the presets for the new aircraft and left the LOS control link transmitter set to ON (Tab V-2.21). This led to an unrecognized assumption of control of the MRPA that resulted in a wings level, descending, rudder turn through a full circle and altitude loss of over 1,200 feet (Tab V-1.11-12, Tab DD-7, Tab EE-3). This unintended maneuver resulted in an unrecoverable loss of altitude required for a safe landing (Tab V-1.12) See Also: OP004

(3) **Human Factor 3**

PC405 Technical/Procedural Knowledge
Technical/Procedural Knowledge is a factor when an individual was adequately exposed to the information needed to perform the mission element but did not absorb it. Lack of knowledge implies no deficiency in the training program, but rather the failure of the individual to absorb or retain the information. (Exposure to information at a point in the past does not imply "knowledge" of it.)

- Though aware of the engine cooling fan's capabilities (Tab V-1.13), MP1 failed to turn on the engine coolant fan (Tab DD-7). Use of the cooling fan by the MC2 resulted in a decrease in oil temperature, but by that time, significant engine damage had already occurred (Tab DD-7).

(4) Human Factor 4

PC506 Expectancy

Expectancy is a factor when the individual's expects to perceive a certain reality and those expectations are strong enough to create a *false perception* of the expectation.

- MC1 initially analyzed cockpit engine indications, referenced Technical Order data and correctly diagnosed the situation as a loss of coolant-induced Engine Overheat (Tab V-1.9). MC1 expected an Engine Failure was imminent (Tab V-1.9, Tab V-3.13, Tab V-5.2). This expectancy led MSO1 and eventually MC1 to the false perception that the loss of altitude and additional high engine temperatures indicated an engine failure instead of realizing these were logical effects of an engine overheat (Tab V-3.13). MP1 executed the Engine Failure checklist and did not resume or complete the Engine Overheat checklist (Tab V-1.14). Timely execution of the Engine Overheat checklist could have reduced the damage done to the combustion system and reduced the electrical load on the engine (Tab DD-7, Tab BB-9).
- In accordance with normal procedure, MC2 expected to have their LOS control link transmitter set to OFF and to see the LOS video from the aircraft without taking control of it (Tab V-2.8). Their expectation became a false perception when they captured the LOS video signal from the aircraft and perceived that the actions taken by the aircraft were the result of MC1 satellite control inputs instead of their own (Tab V-4.3). Their false perception resulted in an unrecoverable loss of altitude required for a safe landing (Tab V-1.11-12).

(5) Human Factor 5

OP004 Organizational Training Issues/Programs

Organizational Training Issues/Programs are a factor when one-time or initial training programs, upgrade programs, transition programs or other training that is conducted outside the local unit is inadequate or unavailable (etc) and this creates an unsafe situation. (Note: the failure of an individual to absorb the training material in an adequate training program does not indicate a training program problem. Capture these factors under PC401 "Learning Ability/ Rate" or PC405 "Technical/Procedural Knowledge." The failure of an individual to recall learned information under stress or while fatigued despite attending an adequate training program does not indicate a training program problem. Capture these factors under PC402 "Memory/Ability lapses" or other cognitive factors such as PC104 "Confusion," PC106 "Distraction," PC105 "Negative Transfer" or one of the forms of Fatigue, etc.)

- Due to the design and capabilities of the MQ-1B Predator weapons system, any Emergency Procedure originating with an MCE will normally terminate with the LRE (Tab V-2.18, Tab V-4.4, Tab V-6.3). Training does not adequately instruct the handoff of information to the LRE concerning the nature of emergency aircraft, status of critical systems, checklist procedures already accomplished, desired plan for the next crew to accomplished, or nonstandard hand back settings (Tab V-2.18, Tab V-4.4). Lack of training in time-critical emergency coordination between MCE and LRE crews led to misinformation getting to the LRE about the actual status of the aircraft and an unnecessarily elevated sense of urgency that contributed to MP2 leaving the LOS control link set to ON during his setup (Tab V-2.10,18-19, Tab V-4.4, Tab V-6.3).

(6) Human Factor 6

PC101 Inattention
Inattention is a factor when the individual has a state of reduced conscious attention due to a sense of security, self-confidence, boredom or a perceived absence of threat from the environment which degrades crew performance. (This may often be a result of highly repetitive tasks. Lack of a state of alertness or readiness to process immediately available information.)

- MM1 and MM2 conducted the last 60-hour inspection on the MRPA (Tab D-3). Expert testimony states that the amount of damage present on the coolant line would have been present during the 60-hour inspection of 26 January 2012 and that the damage should have been detected during the conduct of a normal 60-hour inspection (Tab V-10.2).

b. Non-Contributory

(1) Human Factor 1

OC003 Perceptions of Equipment
Perceptions of Equipment is a factor when over or under confidence in an aircraft, vehicle, device, system or any other equipment creates an unsafe situation.

- MSO1 had under confidence in the Predator system stating multiple times that the aircraft was acting on its own accord after they lost video in the GCS (Tab V-3.14, 16). This under confidence inhibited effective troubleshooting and Crew Resource Management in the cockpit because of the assumption that there was nothing to be done about the situation at hand (Tab V-3.16).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications

1. AFI 11-2MQ-1, Volume 1, MQ-1 Aircrew Training, 21 January 2010*
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, 22 October 2010*
5. AFI 11-401, Aviation Management, 10 December 2010*
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 Systems and RQ-1B Systems, 13 December 2010
8. T.O. 1Q-1(M)B-1CL-1, USAF Series MQ-1B and RQ-1B Systems Flight Checklist, 1 December 2010

b. Maintenance Directives and Publications

1. AFI 21-101, Aircraft and Equipment Maintenance Management, 26 July 2010*
2. T.O. 00-20-1, Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures, 1 September 2010, ACC SUP 1, 14 December 2007
3. 1Q-1(M)B-6, MQ-1B Technical Manual, Aircraft Scheduled Inspection and Maintenance Requirements, 21 January 2010, Change 1, 28 April 2011
4. 1Q-1(M)B-2-72JG-00-1, MQ-1B Job Guide, Engine Reciprocating, General – Volume I, 10 June 2010
5. IQ-1(M)B-2-53JG-00-1, MQ-1B Job Guide, Fuselage, Structures – General, 26 May 2011
6. IQ-1(M)B-2-53JG-00-1, MQ-1B Job Guide, Aircraft General Ground Handling, 15 February 2011
7. T.O. 1Q-1(M)B-2-93GS-00-1, General System Surveillance, 26 May 2011
8. T.O.1Q-1(M)B-5-1, Basic Weight Checklist, USAD Series, MQ-1B Remotely Piloted Aircraft, 26 March 2010
9. T.O. 1Q-1(M)B-2-05JG-10-1, Ground Handling USAF Series, MQ-1B Remotely Piloted Aircraft, 15 February 2011
10. T.O. 1Q-1(M)B-6WC-1, Preflight, Thruflight, Basic Postflight, Combined Basic Postflight/Preflight inspection requirements, ASAF Series, MQ-1B Remotely Piloted Aircraft, 21 January 2010, incorporating change 1, 15 February 2011
11. T.O. 1Q-1(M)B-6WC-2, Aircraft Periodic Inspection and Maintenance Requirements, USAF Series, MQ-1B Remotely Piloted Aircraft, 21 January 2010, incorporating change 2, 15 February 2011

* Available on http://e-publishing.af.mil

13. ADDITIONAL AREAS OF CONCERN

None.

21 APRIL 2012

PAUL A. HIBBARD, Lt Col, USAF
President, Abbreviated Accident Investigation Board

STATEMENT OF OPINION

MQ-1B, 03-3122
KANDAHAR AB, AFGHANISTAN
30 JANUARY 2012

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

1. OPINION SUMMARY

I find by clear and convincing evidence that the cause of the mishap was a loss of coolant due to the failure of the coolant pump supply line. As the coolant supply decreased, the Cylinder Head Temperature climbed excessively. Heat expansion of the cylinders permitted compressed gases from the combustion chambers to "blow by" the pistons, artificially enriched the fuel-air mixture and fouled the spark plugs, reducing power output and preventing sustained flight. The Mishap Remotely Piloted Aircraft (MRPA) began to descend at a rate of 220 feet per nautical mile. At the moment the coolant pump supply line failed, the MRPA possessed enough altitude (16,700' above field elevation) to safely recover at Kandahar Airbase (AB) 68 nautical miles away.

I find by a preponderance of evidence that a substantially contributing factor in the mishap was the failure to detect the friction chafing damage between the oil cooler-to-pump line and the radiator-to-water pump lines during the last 60-hour engine inspection. Expert testimony states the extent of damage detected post-mishap would most likely have been present during this inspection. Further, I find by a preponderance of evidence that a substantially contributing factor in the mishap was Mishap Pilot #2's (MP2) unintentional "hostile takeover" of the MRPA at 0922Z when MP2 failed to ensure the Line of Sight (LOS) control link transmitter was unpowered as MP2 turned the ground antenna toward the MRPA. After the unrecognized and unintentional "hostile takeover," the MRPA began a slow spiraling descent, and lost 1,600 feet of altitude over eleven minutes. At 0933Z, the Launch and Recovery Element (LRE) crew, Mishap Crew #2 (MC2), regained positive flight control of the MRPA and guided it towards Kandahar AB. Less than one nautical mile from the runway, MP2 assessed a safe landing on the runway was no longer possible, aborted the landing attempt and controlled the aircraft to an unpopulated forced landing site just outside the base perimeter fence. MQ-1B, T/N 03-3122, crashed when it impacted the terrain with the loss of the aircraft and payload valued at $4.5 million. There were no injuries or other property damage.

2. DISCUSSION OF OPINION

a. Cause: Failure of Coolant Pump Supply Line

Post-flight analysis of the oil cooler-to-pump line and the radiator-to-water pump lines discovered damage on the coolant line generated by chafing due to unrestricted contact between the lines. During the mishap flight, the inner wall of the coolant line was finally compromised. As the coolant level depleted, the Cylinder Head Temperature climbed, and exceeded the necessary level to illuminate warnings in the Mission Control Element (MCE) Ground Control Station (GCS). The turbocharger oil temperature and oil temperature soon increased excessively as well. Without coolant circulation, the radiator-sensed coolant temperature remained low and prevented the cowl flap/cooling fan's operation in automatic mode, further aggravating the high engine compartment temperatures. The result of this severe over temperature condition was a loss of thrust produced by the engine. "Blow by" is a condition where the piston rings are not creating a proper seal against the cylinder wall due to heat expansion. This "Blow by" gap allowed pressure to be lost during the compression and burn strokes of the engine cycle. Additionally, the loss of air due to "blow by" artificially enriched the fuel/air mixture, leaving heavy carbon deposits on the pistons, valves and spark plugs. This coating fouled the spark plugs, further decreasing the engine performance. When the coolant line failed, premature contact with the ground became inevitable.

b. Contributing Factor: Failure to Detect Coolant Line Damage

On 16 July 2011, a new engine was installed in the MRPA that included initial installation of the coolant pump supply line and the oil cooler-to-oil pump oil line. Maintenance records show the coolant line was not replaced from the time of the installation to the mishap. Therefore, the coolant pump supply line and the oil cooler-to-oil pump oil line were routed at the time of installation in a manner that permitted friction chafing between these lines. During the final 60-hour maintenance inspection, conducted on 26 January 2012, the continuously increasing friction chafing damage was unrecognized. Expert testimony states the amount of damage present on the coolant line could not have occurred in the 26 flight hours of operation leading up to the mishap and would most likely have been present during the last 60-hour inspection. A 60-hour Engine Inspection calls for the maintenance technician to inspect all fuel lines, oil lines, and coolant hoses for damage, security, or leaks. These actions were likely neglected or missed on the 60-hour inspection of 26 January 2012.

c. Contributing Factor: Premature Activation of Line of Sight Control Link.

While attempting to recover the crippled aircraft, at 0922Z, the Mission Control Element (MCE) crew, Mishap Crew #1 (MC1), experienced a loss of positive control and video feed from the MRPA. MC1 could monitor aircraft flight parameters but was unable to alter the aircraft flight path or sensor settings. The MRPA entered a slight right hand turn and travelled in a circular ground track slowly losing 1,600 feet of altitude over the next eleven minutes. During this period, the MRPA completed a full circle, crossing its own ground track again after eight minutes, having travelled 11.5 nautical miles and having lost 1,230 feet of altitude. At 0933Z, MC2 regained positive flight control of the MRPA approximately 35 nautical miles from Kandahar AB. Testimony from Mishap Pilot #1 (MP1), MP2 and the Mishap Observer (all current and qualified MQ-1B pilots) agreed that an extra 1,000 feet of altitude would have been sufficient to safely recover the aircraft. The fact that the aircraft lost 1,230 feet in the spiral supports the assertion that a safe recovery would have been possible if MC1 had not lost positive aircraft control. The cause of the loss of control was the unintentional and unrecognized "hostile takeover" of the MRPA by MP2. In his rush to save the MRPA, MP2 rapidly reconfigured his

GCS settings, but did not cross-check or failed to verify the LOS control link transmitter power in accordance with the checklist. He matched frequency settings with the MRPA and turned the ground antenna toward the aircraft in hopes of detecting the MRPA's downlink signal. In this case, the LOS control link transmitter was ON. MC2 realized they had control at 0933Z and began an emergency recovery. Unfortunately, the aircraft no longer possessed sufficient range with the compromised engine to execute a safe recovery.

I arrived at my opinion by examining the MRPA components, General Atomics Memorandum, recorded MRPA flight data, photos of the MRPA wreckage, an Air Force Research Laboratory analysis and witness testimony. All evidence points to a failure of the Coolant Pump Supply Line, which decreased the engine's performance due to high temperature-induced combustion chamber "blow by." Evidence suggests the coolant line failure could have been avoided if the damaged line had been detected during the MRPA's final 60-hour engine inspection. Finally, if the MRPA had not experienced an eleven-minute loss of positive flight control, MC2 might have safely recovered the MRPA in its crippled state. However, the loss of over 1,200 feet of altitude and eleven nautical miles of forward ground track during the unintentional control loss placed the aircraft in an unrecoverable position.

21 APRIL 2012 PAUL A. HIBBARD, Lt Col, USAF
President, Abbreviated Accident Investigation Board

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