UNITED STATES AIR FORCE ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 08-3237

20TH RECONNAISSANCE SQUADRON
432D WING
CREECH AIR FORCE BASE, NEVADA

LOCATION: CENTCOM AOR

DATE OF ACCIDENT: 27 MAY 2015

BOARD PRESIDENT: LT COL SAMMUEL C. BERENGUER

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

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

OFFICE OF THE VICE COMMANDER
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11 JAN 2016

ACTION OF THE CONVENING AUTHORITY

The Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 27 May 2015 mishap, near the CENTCOM Area of Responsibility, involving an MQ-1B, T/N 08-3237, assigned to the 20th Reconnaissance Squadron, 432nd Wing, Creech Air Force Base, Nevada, complies with applicable regulatory and statutory guidance; on that basis it is approved.

\\Signed\\

JERRY D. HARRIS, JR.
Major General, USAF
Vice Commander

EXECUTIVE SUMMARY
AIRCRAFT ACCIDENT INVESTIGATION

MQ-1B, T/N 08-3237
CENTCOM AOR
27 MAY 2015

On 27 May 2015, at approximately 0900 hours Zulu (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B, tail number 08-3237, assigned to and operated by the 20th Reconnaissance Squadron, located at Whiteman Air Force Base (AFB), Missouri, 432d Wing, Creech AFB, Nevada, while on a mission in the United States Central Command (CENTCOM) Area of Responsibility (AOR), experienced engine failure and was ditched into nearby terrain. The wreckage was not recovered. Total loss of government property is valued at $2,806,523. There were no injuries or damage to other government property (US or foreign) or civilian property.

On 27 May 2015, at 0252Z, after normal pre-flight checks, the MRPA departed for a mission in the CENTCOM AOR. The launch and transition to the mission control element was uneventful. The first indications of an engine problem occurred approximately four hours into the sortie. The Mishap Sensor Operator (MSO) received system warnings of high temperature in the engine cylinder head. The Mishap Crew (MC) began troubleshooting and saw additional system warnings on their Heads Down Display for low engine coolant temperature. The MC assessed an engine coolant leak and began to run the engine overheat checklist. Step 2 of the engine overheat checklist is to move the fan into the manual position, prior to turning the engine cooling fan on. This step was not accomplished. Without the fan working, the engine began a steady increase in temperature.

The increased heat in the engine compartment and the steady decline in altitude culminated in an overheated engine that lost power. Because of the low altitude, the aircraft was in an unrecoverable state. The MP, upon authorization from higher headquarters, flew the aircraft into the ground.

The Abbreviated Accident Investigation Board (AAIB) Board President (BP) found by a preponderance of the evidence that the cause of the mishap was engine failure, due to loss of engine coolant. The AAIB BP found by a preponderance of the evidence that one factor substantially contributed to the mishap: interference while performing the engine overheat checklist.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-1B, T/N 08-3237
27 MAY 2015

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

20 RS	20th Reconnaissance Squadron
432 WG	432d Wing
432 AEW	432d Air Expeditionary Wing
432 MXG	432d Maintenance Group
AIB	Accident Investigation Board
AAIB	Abbreviated Accident Investigation Board
ACC	Air Combat Command
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFSEC Rep	Air Force Safety Center Representative
AFTO	Air Force Technical Order
AIB	Accident Investigation Board
AMU	Aircraft Maintenance Unit
ATO	Air Tasking Order
BFS	Battle Flight Services, LLC
CAF	Combat Air Force
CAMS	Core Automated Maintenance System
CAOC	Combat Air Operation Center
CAPT	Captain
CENTCOM	Central Command
CC	Commander
CHT	Cylinder Head Temperature
Civ	Civilian
CLS	Contractor Logistics Support
COR	Contracting Officer Representative
CRS (is ERS)	Expeditionary Reconnaissance Squadron
CSAR	Combat Search and Rescue
CT	Continuation Training
CTR	Contractor
Det	Detachment
DO	Director of Operations
Docs	Documents
DoD	Department of Defense
DVD	Digital Video Recorder
E-mission	Emergency Mission
ECT	Engine Cooling Temperature
EGT	Exhaust Gas Temperature
EOD	Explosive Ordnance Disposal
EP	Emergency Procedure
EP SIM	Emergency Procedure Simulator
F	Fahrenheit
FCIF	Flight Crew Information Files
GA	General Atomics
GCS	Ground Control Station
GMT	Greenwich Mean Time
HDD	Heads-Down Display
HFACS	Human Factors and Classification System
hrs	Hours
HUD	Heads-Up Display
IAW	In Accordance With
IMDS	Integrated Maintenance Data System
Intel	Intelligence
IOS	Intelligence Operations Supervisor
JST	Job Standard
Lt Col	Lieutenant Colonel
LRE	Launch and Recovery Element
Maj	Major
MAP	Manifold Air Pressure
MC	Mishap Crew
MCC	Mission Commander
MCE	Mission Control Element
MCT	Manifold Control Temperature
MFP	Maintenance Pre-Print
MFR	Memorandum for Record
MGCS	Mishap Ground Control Station
MIC	Mission Intelligence Coordinator
MMx (1 or 2)	Maintenance Member x
MO	Missouri
MO	Mission Observer
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSO	Mishap Sensor Operator
MX	Maintenance
MXPx (1 and 2)	Maintenance Person x
NCO	Noncommissioned Officer
NAV	Navigation
NV	Nevada
Ops	Operations
ORM	Operational Risk Management
OTI	On-Time Inspection

Px (1 or 2)	Pilot x
PIC	Pilot-In-Command
PMATS	Predator Mission Aircrew Training Simulator
PSO-1	Pilot Sensor Operator-1
QA	Quality Assurance
QAE	Quality Assurance Evaluator
QA Supt	Quality Assurance Superintendent
RL	Return Link
RPM	Revolutions Per Minute
RS	Reconnaissance Squadron
RTB	Return to Base
SEPT	Simulator Emergency Procedure Training
SIB	Safety Investigation Board
SIB P	Safety Investigation Board Board President
SIB IO	Safety Investigation Board Investigating Officer
SIB MM	Safety Investigation Board Medical Member
SIB MXS	Safety Investigation Board Maintenance Member
SIB Rec	Safety Investigation Board Recorder
SIPR	Secure Internet Protocol Router
SL	Site Lead
SOx (1 and 2)	Sensor Operator x
SOC	Squadron Operations Center
SMSgt	Senior Master Sergeant
SPMA	Sensor Processor Modem Assembly
SrA	Senior Airman
TDY	Temporary Duty
TSgt	Technical Sergeant
T/N	Tail Number
TO or T/O	Technical Order
US	United States
USAF	United States Air Force
VIT	Variable Information Table
VSOP	Voice Over Secure Internet Protocol
WCE	Work Card Entry
WG	Wing
WOC/WOC D/AWOC	Wing Operations Center Director
Z	Zulu

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 5 October 2015, Major General Jerry D. Harris Jr., Vice Commander, Air Combat Command (ACC), appointed Lieutenant Colonel (Lt Col) Sammuel C. Berenguer to conduct an abbreviated aircraft accident investigation of a mishap that occurred on 27 May 2015 involving an MQ-1B remotely piloted aircraft in the United States Central Command (CENTCOM) Area of Responsibility (AOR) (Tab Y-3). The abbreviated aircraft accident investigation was conducted in accordance with (IAW) Air Force Instruction (AFI) 51-503, *Aerospace and Ground Accident Investigations*, Chapter 11, at Creech Air Force Base (AFB), Nevada (NV) from 22 October – 13 November 2015 (Tab Y-3). A legal advisor and recorder were also appointed as members of the board (Tab Y-3).

b. Purpose

In accordance with AFI 51-503, *Aerospace and Ground Accident Investigations*, this accident investigation board conducted a legal investigation to inquire into all the facts and circumstances surrounding this Air Force aerospace accident, prepare a publicly releasable report, and obtain and preserve all available evidence for use in litigation, claims, disciplinary action, and adverse administrative action.

2. ACCIDENT SUMMARY

On 27 May 2015, at approximately 0900 Zulu (Z), the mishap remotely piloted aircraft (MRPA), MQ-1B Predator, tail number 08-3237, assigned to and operated by the 20th Reconnaissance Squadron (20 RS), located at Whiteman AFB, Missouri (MO), 432d Wing (432 WG), Creech AFB, NV, while on a mission in the CENTCOM AOR experienced engine failure and was ditched into nearby terrain (Tabs AA-4, AA-5, DD-3, and EE-46 to EE-47). The wreckage was not recovered (Tab P-2 to P-3). Total loss of government property is valued at $2,806,523 (Tab P-4). There were no injuries or damage to other government property (US or foreign) or civilian property (Tab P-2 to P-3).

3. BACKGROUND

The MRPA was assigned to the 20 RS, 432 WG, Creech AFB, NV (Tab AA-4). The mishap crew (MC) was assigned to the 20 RS, located at Whiteman AFB, MO (Tab AA-4). The MC consisted of the mishap pilot (MP) and the Mishap Sensor Operator (MSO) (Tab V-3.6 and V-9.18). Additionally, at the time of the mishap, the MRPA was forward deployed to the CENTCOM AOR and was maintained by Battlespace Flight Services (BFS), Limited Liability Company (LLC) (Tab D-2).

a. Air Combat Command (ACC)

ACC is the primary force provider of combat airpower to America's warfighting commands. To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management, and electronic-combat aircraft. It also provides command, control, communications, and intelligence systems, and conducts global information operations (Tab CC-2 to CC-5).

b. 432nd Wing (432 WG)/432nd Air Expeditionary Wing (432 AEW)

The 432 WG and its associated deployed unit, the 432 AEW, also known as the "Hunters," consists of combat-ready Airmen who fly remotely piloted aircraft (RPA) in direct support of the joint force warfighter. The RPA system provides real-time reconnaissance, surveillance, and precision attack against fixed and time-critical targets. The Hunters conduct RPA training for aircrew, intelligence, weather, and maintenance personnel (Tab CC-6 to CC-7).

c. 20th Reconnaissance Squadron (20 RS)

20 RS is a tenant unit at Whiteman AFB, MO, assigned to the 432 WG at Creech AFB, NV. 20 RS flies MQ-1B Predator remotely piloted aircraft. It provides persistent intelligence, surveillance and reconnaissance and full motion video for real-time actionable intelligence and precision weapons employment in combat operations. (Tab CC-8 to CC-9).

d. Battlespace Flight Services (BFS)

BATTLESPACE FLIGHT SERVICES, LLC

BFS provides organizational maintenance support for MQ-1B aircraft and systems to sustain the combat and training at tasked locations worldwide. The primary objective of BFS is to provide qualified management and supervisory personnel at U.S. MQ-1B operating locations, and a level of support for their personnel that allow them to accomplish their objective. Support includes aircraft maintenance, supply support, command, control, communications, computer, intelligence, surveillance, and reconnaissance (ISR) systems, quality assurance and an environmental, safety and health program (Tabs CC-11 to CC-12).

e. MQ-1B, Predator

The MQ-1B Predator is an armed, multi-mission, medium-altitude, long-endurance RPA employed primarily as an intelligence-collection asset and secondarily against dynamic execution targets. Given its significant loiter time, wide-range sensors, multi-mode communications suite and precision weapons, the Predator provides a unique capability to perform strike, coordination and reconnaissance missions against high-value, fleeting and time-sensitive targets. Predators can also perform the following missions and tasks: ISR, close air support, combat search and rescue, precision strike, buddy-lase, convoy/raid overwatch, route clearance, target development and terminal air guidance. The MQ-1B's capabilities make it uniquely qualified to conduct irregular warfare operations in support of combatant commander objectives. The MQ-1B Predator system consists of an aircraft (with sensors), a ground control station, a Predator Primary Satellite Link (PPSL), and operations and maintenance personnel for deployed 24-hour operations. The basic crew for the MQ-1B Predator is one pilot and one sensor operator. The crew flies the MQ-1B Predator from inside the GCS via a line of sight (LOS) radio data link and via a satellite data link for beyond-LOS flight. A ground data terminal antenna provides LOS communications for takeoff and landing, while the PPSL provides beyond-LOS communications during the remainder of the mission (Tab CC-13 to CC-18).

4. SEQUENCE OF EVENTS

a. Mission

On 27 May 2015, the MRPA was authorized by a classified CENTCOM Air Tasking Order to conduct a combat support mission in the CENTCOM AOR (Tab K-2 and K-4). The launch and recovery element (LRE) included a pilot (P1) and sensor operator (SO1), assigned to 20 RS (Tab Q-4). The LRE launched the MRPA from an air base in the CENTCOM AOR, at 0252Z (Tabs K-4 and AA-5). At 0303Z, the LRE handed the MRPA off to a mission control element (MCE) crew, Pilot 2 (P2) and Sensor Operator 2 (SO2) assigned to 20 RS and located in the mishap ground control station (MGCS) at Whiteman AFB, MO (Tabs V-3.1, V-5.1, V-9.1, and AA-5). P2 and SO2 transferred control of the MGCS and the MRPA to the MC at 0500Z (Tabs V-5.1 and AA-5). The MC consisted of MP and MSO (Tab AA-5).

b. Planning

On 27 May 2015, at approximately 2300 Central Standard Time (approximately 0500Z), the MC arrived at 20 RS prior to their scheduled shift start time to accomplish all required preflight mission planning and to attend standard pre-mission briefings (Tab V-3.1 and V-9.1). The briefings included an update from the previous shift; the current crew mission; an emergency procedure of the day; and any special interest items (Tab V-3.1). The pre-mission briefings were conducted by the Mission Commander (MCC), the Mission Intelligence Coordinator (MIC), and the MP IAW AFIs (Tab V-3.1 and V-9.1). As the supervisor, the MCC was responsible for monitoring mission crews and supporting each of their mission needs (Tab V-2.1 and V-6.1). Additionally, the MCC observes the aircraft status through a screen and can communicate with the mission crew through an intercom (Tab V-2.1 and V-6.1). An operational risk management (ORM) worksheet was conducted for the sortie (Tab AA-3). The risk for the sortie was assessed as "moderate" due to the MP's experience level and transition in work schedules (Tabs V-3.1 and AA-3). Supervision mitigated this risk at the appropriate level because of the MP's extensive prior experience in another airframe, and because there was a planned break during the sortie (Tab AA-3). There is no evidence to suggest mission planning was a factor in this mishap.

c. Preflight

On 26 May 2015, Maintenance person one (MXP1) properly charged the MRPA's batteries and inspected the MRPA within required guidelines (Tab D-40). MXP2 released the MRPA for flight (Tab D-37). The LRE completed all Go-No-Go items that included gathering Notices to Airmen, flight plans, aircraft configuration, and a weather assessment (Tabs F-3 and R-4 to R-5). Additionally, the LRE accomplished a standard preflight walk-around inspection and a pre-launch check for no leaking oil or fluid (Tab R-4 to R-5 and R-9). The MRPA then departed for a mission in the CENTCOM AOR (Tab R-4). There is no evidence to suggest that preflight procedures were a factor in this mishap.

d. Summary of Accident

Engine start, taxi, and takeoff were all uneventful (Tabs R-4 to R-5 and R-9). The MRPA took off at 0252Z (Tab AA-5). LRE handed the MRPA off to the MCE without issue (Tab V-5.1). During the climb, the P2 noted a brief warning light (Tab V-5.1). He acknowledged the issue, discussed it with SO2 and made the decision to continue with the mission (Tab V-5.1). There is no evidence this issue recurred (Tab V-5.1). The MRPA was still enroute to the mission area when handoff was initiated with the MC (Tab V-3.1 and V-5.1). The P2 and SO2 completed a proper handoff IAW the checklist, which was uneventful (Tab V-3.1 and V-5.1). MP2's handoff included his assessment of his previous issue (Tab V-5.1). There were no other known issues with the aircraft up to this point (Tab V-3.1 and V-5.1). The MP controlled the MRPA through the remainder of the flight (Tab V-3.3).

Approximately four hours into the mishap flight, the MRPA coolant temperature started rapidly decreasing and the cylinder head temperature (CHT) started rapidly increasing (Tab DD-3). When the coolant temperature decreased, cold enrichment (an increase in fuel flow to the engine) started, as designed, and the engine cooling fan current decreased (Tab DD-4). The engine cooling fan current remained at the decreased rate for the rest of the flight and the cowl flap position moved to fully closed (Tab DD-4).

The MSO noted the high CHT warning indication on the Heads Down Display (HDD) (Tab V-9.1). The HDD is a screen that the pilot views in order to see the status of the aircraft as well as to change switches (Tab V-2.2). The MC began troubleshooting the indications and saw an additional warning for low Engine Cooling Temperature (ECT) (Tab V-3.2 and V-9.1). A sharp divergence between CHT and ECT indicates a loss of coolant (Tab DD-8). The MC assessed an engine coolant leak and began using the engine overheat checklist (Tab V-3.2 and V-9.1). The MC turned the MRPA sensor to the back of the aircraft to check for a leak during the engine overheat checklist and later reviewed the engine failure checklist (Tabs V-3.2, V-9.1 and EE-3 to EE-4).

With coolant loss, the engine overheated (Tab DD-3). In order to cool off the engine, the MRPA has an engine cooling fan (Tab DD-9). In addition to the engine cooling fan, the MRPA has a cowl flap, which increases air flow to the engine compartment when open (Tab DD-4 and DD-9). The cooling fan was set to "automatic" mode the entire flight (Tab DD-4). Automatic control of the engine cooling fan and cowl flap is determined by coolant temperature (Tab DD-4). The fan is energized when coolant temperature exceeds a certain degrees Fahrenheit (F)

(DD-4). Fan speed increases linearly with coolant temperature until 100% fan speed is reached at a certain degrees F (Tab DD-4). The cowl flap also increasingly opens per a schedule between certain coolant temperature degrees F (Tab DD-4). If fan operation is in the “manual” mode, the mission crew can manually command the engine cooling fan “on” or “off” (Tab DD-4). The cowl flap does not have its own manual control (Tab DD-4). The cowl flap is commanded fully open when the cooling fan is manually turned “on” and the cowl flap is fully closed when the fan is manually turned “off” (Tab DD-4). The MP can verify whether the fan is “on” or “off” through the variable information table (VIT) (Tab V-2.2). The VIT panel provides a display that specifically shows amperage to the cooling fan (Tab V-2.2). This display would have shown an increase in amperage level if the fan was on (Tab V-2.2).

Because of the coolant loss, the MP initiated a return to base (RTB) approximately five minutes after the first warning indication (Tabs DD-4, V-3.2, V-6.1, and V-9.1). The MC coordinated with air traffic control for a RTB and notified the MCC that they would not be available for their mission (Tab V-3.2, V-6.1, and V-9.1). The Mission Observer (MO) was asked by the MP to provide another set of eyes in the MGCS (Tab V-3.2, V-4.1, and V-6.1). The MO is an MQ-1 instructor pilot and was working in the squadron as the break pilot (Tab V-4.1). This position provides a break or opportunity for each pilot to have an hour to an hour-and-a-half break for eating or transitioning (Tab V-4.1). The MO provided support to the MC as they completed necessary checklist items (Tab V-3.2 and V-4.1).

At some point after the coolant temperature started to decrease, the MP turned the engine cooling fan to “on” (Tabs DD-4 and Tab V-3.2). However, no changes to the fan or cowl flap position occurred because the cooling fan was in “automatic” mode (Tab DD-4). The MC expected that the engine cooling fan would be running for the duration of the sortie, which would be true if the MP placed the fan “on” in manual mode (Tab V-3.2 and V-4.1). Because it remained in auto, the fan never sufficiently turned on, nor did the cowl flap fully open to cool the engine (Tab DD-4).

At some point, communication between the MGCS and the MRPA was lost and subsequently reestablished (Tab DD-5). When communication was reestablished, the Manifold Air Pressure (MAP) 1 sensor was in a failed state, reporting the maximum reportable value (Tab DD-5). The backup MAP 2 sensor reading was in use by the aircraft for engine control and was reporting an erroneously high value (Tab DD-5). As a consequence, injector pulse width was adjusted (Tab DD-5). Injector pulse width is set to a specific value during an overboost condition, indicated by MAP exceeding certain values (Tab DD-5). With no fuel injection to the cylinders, no combustion was occurring (Tab DD-5). The EGT reading of all four cylinders was at the minimum reportable value (Tab DD-5). The loss of engine thrust caused the MRPA to begin to descend (Tab DD-5).

The MP was able to fly out of this condition when the engine sensors provided valid indications (Tabs V-3.3 and Tab DD-5). The MP maintained the MRPA at a low throttle setting because of the heat warnings received (Tab V-3.3, DD-9).

During the last 90 minutes of flight, the increased heat in the engine compartment and the coolant affected the reliability of the engine sensors (Tab DD-9). Combustion was interrupted several times during the final 30 minutes of flight but eventually ceased (Tab DD-6). The MP had already surrendered significant altitude trying to maintain the engine sensors within limits (Tab V-3.3). At this point, the cowl flap closed completely and remained closed for the rest of the flight (Tab DD-6). Eventually, the engine ceased working (Tab DD-5, DD-9, and DD-10).

When the engine failed, given the low altitude, the MRPA was in an unrecoverable state, so the MP received authorization to fly the MRPA into the ground in a hard landing (Tabs V-3.3 and EE-46 to EE-47). The MRPA impacted the ground and was not recovered (Tab P-2 to P-3). Total loss to the United States Government is $2,806,523 (Tab P-4). There were no other injuries or damage to other government or civilian property (Tab P-2 to P-3).

e. Impact

The MRPA impacted the ground at approximately 0900Z in the CENTCOM AOR (Tab AA-5). The MRPA was not recovered (Tab P-2 to P-3).

f. Egress and Aircrew Flight Equipment (AFE)

Not applicable (Tab H-2).

g. Search and Rescue (SAR)

The MRPA was not recovered (Tab P-1 to P-3).

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

The Air Force Technical Order (AFTO) 781 series forms for the MRPA were documented IAW applicable maintenance (MX) guidance (Tab D-3 to D-46). The forms indicated no outstanding issues that would have prevented the MRPA from flying on 27 May 2015 (Tab D-3 to D-46). Prior to the mishap sortie, T/N 08-3237 had flown 11716.8 total hours (hrs), and its current engine, serial number E3216, had approximately 115 hours (Tab D-2).

AFTO 781 series forms for the MGCS were documented IAW applicable MX guidance (Tab D-76 to D-120). Also, the MGCS was initially impounded to perform a 28-day operational check as a precaution following the mishap, but it was deemed airworthy on 2 June 2015 (Tab D-79 and D-89 to D-90). There is no evidence to suggest that the maintenance of this MGCS was a factor in this mishap.

b. Inspections

All MRPA maintenance inspections were completed and documented IAW applicable regulations and Technical Orders (TOs) (Tab D-15 to D-32). The engine's last 60-hour inspection was completed on 25 May 2015 by BFS (Tab D-2). No defects were noted to the engine or engine subsystems during the 60-hour inspection, and the MRPA was returned to service (Tab D-33 to D-46). There is no evidence to suggest that inspections were a factor in this mishap.

c. Maintenance Procedures

The MRPA's engine was replaced on 18 May 2015 (Tab D-3). Prior to the mishap flight, the MRPA had flown 115 hours since the engine change (Tab D-2). There is no evidence to suggest that maintenance procedures were a factor in this mishap.

d. Maintenance Personnel and Supervision

Civilian contractors with BFS LLC maintained the MRPA in the CENTCOM AOR (Tab D-33). The maintenance personnel were trained and qualified (Tabs U-2 and V-8.1). Supervision signed off on the exceptional release for the MRPA (Tab D-37). There is no evidence to suggest maintenance or supervision of maintainers was a factor in this mishap.

e. Fuel, Hydraulic, and Oil Inspection Analyses

The MRPA was refueled, and the MRPA's oil was serviced and inspected prior to the mishap flight with no discrepancies reported (Tab D-38 to D-39). Fuel samples were taken from the servicing fuel carts following the mishap and were within specifications (Tab J-2 to J-3). There is no evidence to suggest that fuel, oil quality, or servicing was a factor in this mishap.

f. Unscheduled Maintenance

Following the engine change on 18 May 2015, no unscheduled maintenance was performed on the MRPA (Tab D-2 to D-75).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

The MRPA was not recovered (Tab P-2 to P-3). As a result, no structural or systems evaluation could be accomplished.

b. Evaluation and Analysis

The MRPA operated normally during the first 3.75 hours of the mishap flight (Tab DD-3). Coolant temperature started rapidly decreasing and CHT started rapidly increasing (Tab DD-3). The manufacturer, General Atomics (GA), analyzed the mishap and provided a detailed report (Tab DD-2 to DD-12). Without wreckage, GA analyzed the information saved in the datalogs, which contain a time-stamped record of the aircraft systems' status (Tab DD-2 to DD-12).

GA concluded that the MRPA experienced a coolant leak mid-flight and eventual failure of the engine (Tab DD-3). Datalog analysis determined that the engine failure (approximately two hours after the coolant leak started) was most likely due to erratic fuel injection and/or lack of ignition (Tab DD-3). The fuel and ignition systems in the engine bay were likely damaged by high heat and/or leaked coolant (Tab DD-3). The source of the coolant leak and any damage to the engine or critical components in the engine bay could not be determined (Tab DD-3).

7. WEATHER

a. Forecast Weather

The weather briefing provided to the crew was classified Tab F-2).

b. Observed Weather

The weather observed at the time of the mishap showed winds from the southwest at seven knots gusting at fifteen knots with clear skies and unlimited visibility (Tab F-3).

c. Space Environment

Not applicable.

d. Operations

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

8. CREW QUALIFICATIONS

a. Mishap Pilot (MP)

The MP was a current and qualified MQ-1B pilot (Tab G-3). MP had 420.8 hours in the MQ-1B since 19 May 2014 and 2088.6 total hours including previous airframes (Tab G-5).

Recent flight time is as follows (Tab G-5):

	Hours	Sorties
Last 30 Days	88.4	18
Last 60 Days	139.7	31
Last 90 Days	206.2	47

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

b. Mishap Sensor Operator (MSO)

The MSO was a current and qualified MQ-1B sensor operator (Tab G-8). The MSO had 889.0 hours in the MQ-1B since 3 January 2014 and 889.0 total hours (Tab G-10).

Recent flight time is as follows (Tab G-10):

	Hours	Sorties
Last 30 Days	57.1	11
Last 60 Days	92.4	21
Last 90 Days	149.0	40

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

The MP and MSO were both inexperienced at the time of the mishap

c. Mishap Observer (MO)

Though not part of the MC, the MO was present for a period of time in the MGCS while the MC dealt with the MRPA. The MO was a current and qualified MQ-1B instructor pilot (Tab G-13). MO had 1204.7 hours in the MQ-1B since 7 May 2013 and 2356.4 total hours including previous airframes (Tab G-15 to G-16).

Recent flight time is as follows (Tab G-16):

	Hours	Sorties
Last 30 Days	58.8	11
Last 60 Days	90.9	22
Last 90 Days	154.8	39

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

d. Mission Commander (MCC)

Though not part of the MC, the MCC provided supervision to the MGCS during the entire mishap sequence (Tab EE-3 to EE-47). The MCC was a current and qualified MQ-1B mission pilot (Tab G-19). MCC had 676.5 hours in the MQ-1B since 23 July 2013 and 1456.7 total hours including previous airframes (Tab G-22).

Recent flight time is as follows (Tab G-22):

	Hours	Sorties
Last 30 Days	13.1	7
Last 60 Days	17.8	10
Last 90 Days	70.3	28

This was the MCC's first tour as a mission commander (Tab V-6.1). There is no evidence to suggest the MCC's qualifications were a factor in this mishap.

9. MEDICAL

a. Qualifications

At the time of the mishap, the MC was medically qualified for flight duty (Tab G-6 and G-11).

b. Health

There is no evidence to suggest the health of the MC contributed to the mishap (Tab T-3 to T-20).

c. Pathology

Toxicology results were negative for the MC (Tab T-3 and T-12).

d. Lifestyle

There is no evidence to suggest the lifestyle of the MC contributed to the mishap (Tab T-4 to T-11 and T-13 to T-20).

e. Crew Rest and Crew Duty Time

AFI 11-202, Volume 3, *General Flight Rules,* dated 7 November 2014, para. 2.1 requires that aircrew members have proper crew rest prior to performing flight duties (Tab BB-4). Specifically, normal crew rest is defined as a minimum of 12 non-duty hours before the flight duty period begins and includes time for meals, transportation, and rest (Tab BB-3 and BB-4). The MC arrived to work with the appropriate crew rest (Tab T-4 to T-11 and T-13 to T-20). There is no evidence to suggest crew rest was a factor in the mishap.

10. OPERATIONS AND SUPERVISION

a. Operations

At the time of the mishap, operations tempo for the MC was considered high, due to low manning (Tab V-2.1). There is no evidence to suggest operations tempo contributed to the mishap.

b. Supervision

On the night of the mishap, the MC received their daily briefings as they came on shift from the MCC and the MIC (Tab V-3.1 and V-9.1). The MC was current and qualified in all required items tracked by Aviation Resource Management personnel (Tab AA-6). This included completion of required ORM, regular testing, event currencies, Flight Crew Information Files (FCIF) and the MC was medically cleared to fly (Tabs G-6, G-11, and AA-6). There is no evidence to suggest supervision contributed to the mishap.

11. HUMAN FACTORS ANALYSIS

a. Introduction

The AAIB considered all human factors as prescribed in the Department of Defense Human Factors Analysis and Classification System 7.0 (DoD HFACS 7.0) (Tab BB-5 to BB-6). The AAIB identified one human factor relevant to the mishap: Interference (Tab BB-6).

b. Interference

Interference is a factor when an individual is performing a highly automated/learned task and is distracted by another cue or event that results in an interruption and subsequent failure to complete the original task or results in skipping steps in the original task (Tab BB-6).

Upon learning that the engine was overheating, the MC began running the engine overheat checklist, while at the same time, MP coordinated with the MCC for an extra set of eyes (Tab V-3.2, V-4.1, and V-6.1). Subsequently, the MC was distracted when the engine oil temperature went out of limits, and the MC decided to return to base prior to completing the engine overheat checklist (Tab EE-4 to EE-9). The MC performed Step 1: set the throttle in order to maintain a safe altitude (Tab EE-4). However, the MC did not perform Step 2: turn the engine cooling fan to "manual," then "on" (Tab DD-9). The MP began coordinating for the emergency return, which interfered with the MSO's description of Step 2 (Tab EE-4 and EE-15). The MP never completed Step 2 (Tab DD-9). Two times during the flight, the MP stated that the fan was on to the MCC and the MSO during cursory reviews (Tab EE-20 and EE-32 to EE-33). However, the engine cooling fan remained in the automatic position the entire flight (Tab DD-4).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

(1) AFI 11-202, Volume 3, *Flying Operations- General Flight Rules*, 7 November 2014
(2) AFI 51-503, *Aerospace and Ground Accident Investigations*, 14 April 2015

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

b. Other Directives and Publications Relevant to the Mishap

(1) T.O. 1Q-1(M)B-1, *Flight Manual USAF Series MQ-1B System*
(2) Department of Defense Human Factors Analysis and Classification System 7.0

c. Known or Suspected Deviations from Directives or Publications

Not applicable.

\\Signed\\

13 NOVEMBER 2015

SAMMUEL C. BERENǴUER, Lt Col, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

MQ-1B, T/N 08-3237
UNDISCLOSED LOCATION
27 MAY 2015

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

1. OPINION SUMMARY

On 27 May 2015, at approximately 0900 hours Zulu (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B, tail number 08-3237, assigned to and operated by the 20th Reconnaissance Squadron, located at Whiteman Air Force Base (AFB), Missouri, 432d Wing, Creech AFB, Nevada, while on a mission in the United States Central Command (CENTCOM) Area of Responsibility (AOR), experienced engine failure and was ditched into nearby terrain. The wreckage was not recovered. Total loss of government property is valued at $2,806,523. There were no injuries or damage to other government property (US or foreign) or civilian property.

On 27 May 2015, at 0252Z, after normal pre-flight checks, the MRPA departed for a mission in the CENTCOM AOR. The launch and transition to the mission control element was uneventful. The mishap crew (MC) consisted of the mishap pilot (MP) and the Mishap Sensor Operator (MSO). A mission observer (MO), an MQ-1B instructor pilot, came on the scene during the mishap and remained until the aircraft impacted the ground. The MP controlled the MRPA during the mishap. The MC and MO were current and qualified MQ-1B mission aircrew. The MP and MSO were not yet experienced in the airframe.

The first indications of an engine problem occurred approximately four hours into the sortie. The Mishap Sensor Operator (MSO) received system warnings of high temperature in the engine cylinder head. The MC began troubleshooting and saw additional system warnings on their Heads Down Display for low engine coolant temperature. The MC assessed an engine coolant leak and began to run the engine overheat checklist. Step 2 of the engine overheat checklist is to move the fan into the manual position, prior to turning the engine cooling fan on. This step was not accomplished. Without the fan working, the engine began a steady increase in temperature.

When the leak of coolant began, the indications provided to the MC included a drop in engine cooling temperature (ECT) and an increase in cylinder head temperature (CHT). The large difference between CHT and ECT indicated a loss of coolant. With coolant loss, the engine will begin to overheat. In order to cool off the engine, the MRPA has an engine cooling fan and a cowl flap, which together increase air flow to the engine compartment when open. The cooling fan was set to “automatic” mode the entire flight. Automatic control of the engine cooling fan and cowl flap is determined by coolant temperature. The fan is energized when coolant temperature exceeds a certain degrees Fahrenheit (F). Fan speed increases linearly with coolant temperature until 100% fan speed is reached at a certain degrees F. The cowl flap also increasingly opens per a schedule between certain coolant temperature degrees F. If fan operation is in the "manual" mode, the mission crew can manually command the engine cooling fan "on" or "off." The cowl flap does not have its own manual control. The cowl flap is commanded fully open when the cooling fan is manually turned "on" and the cowl flap is fully closed when the fan is manually turned "off."

At some point during the initial mishap sequence, the MP placed the engine fan switch to "on" but the engine cooling fan was never set to manual. Because of this, the fan never sufficiently turned on, nor did the cowl flap fully open to cool the engine.

At some point, communication between the MGCS and the MRPA was lost and subsequently reestablished. When communication was reestablished, the engine was reporting an erroneously high value in one of its manifold pressure sensors. The engine requires correct sensor inputs in order to function properly. As a consequence, no combustion was occurring. The loss of engine thrust caused the aircraft to begin to descend. The MP was able to fly out of this condition when the engine sensors provided valid indications. The MP remained at a low throttle setting because of the heat warnings received.

Within the last 90 minutes of flight, CHT exceeded limits and stayed that way for the remainder of the flight. The increased heat in the engine compartment and the leaked coolant continued to affect the reliability of the engine sensors. The MP had already surrendered significant altitude trying to maintain the engine sensors within limits.

Because of the unreliability of the sensors, combustion was interrupted several times during the final 30 minutes of flight, causing a significant loss in altitude and the engine eventually ceased. Because of the low altitude, the aircraft was in an unrecoverable state. The MP, upon authorization from higher headquarters, flew the aircraft into the ground. The MRPA impacted the ground and was not recovered. Total loss to the United States Government is $2,806,523. There were no other injuries or damage to other government or civilian property.

I find by a preponderance of the evidence that the cause of the mishap was engine failure, due to loss of engine coolant. I find by a preponderance of the evidence that one factor substantially contributed to the mishap: interference while performing the engine overheat checklist.

I developed my opinion by performing a flight simulation, analyzing historical records, flight data logs, manufacturer reports, maintenance records, witness testimony, Air Force directives and guidance, and Technical Orders.

2. CAUSE

I find by a preponderance of the evidence that the cause of the mishap was engine failure, due to loss of engine coolant.

The first indications of an engine problem occurred approximately four hours into the sortie. The MC assessed an engine coolant leak and began to run the engine overheat checklist. The large difference between CHT and ECT indicated a loss of coolant. With coolant loss, the engine overheated. This overheated condition caused combustion to be interrupted during the flight. Without combustion, the engine could not continue working. When combustion ceased altogether, the engine stopped working. At this time, the MP was flying the MRPA at a low altitude because of the engine warnings received. Once the engine stopped working, the MRPA was unrecoverable.

3. SUBSTANTIALLY CONTRIBUTING FACTOR

I find by a preponderance of the evidence that one factor substantially contributed to the mishap: interference while performing the engine overheat checklist.

Interference is a factor when an individual is performing a highly automated/learned task and is distracted by another cue or event that results in an interruption and subsequent failure to complete the original task or results in skipping steps in the original task.

Upon learning that the engine was overheating, the MC began running the engine overheat checklist, while at the same time, MP coordinated with the mission commander (MCC) for some help. Subsequently, indications that the engine oil temperature went out of limits, and a need to coordinate for returning to base interfered with completion of the engine overheat checklist. The MC performed Step 1: set the throttle in order to maintain a safe altitude. However, the MC did not perform Step 2: turn the engine cooling fan to "manual," then "on." Two times during the flight, the MP stated to the MCC and the MSO that the fan was on. This could have been verified by looking at the amperage to the cooling available on the variable information table (VIT) display.

4. CONCLUSION

I find by a preponderance of the evidence that the cause of the mishap was engine failure, due to loss of engine coolant. I find by a preponderance of the evidence that one factor substantially contributed to the mishap: interference while performing the engine overheat checklist.

\\Signed\\

13 November 2015

SAMMUEL C. BERENGUER, LT COL, USAF
President, Accident Investigation Board

INDEX OF TABS