UNITED STATES AIR FORCE
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 08-3245

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

LOCATION: USCENTCOM AOR

DATE OF ACCIDENT: 7 JANUARY 2016

BOARD PRESIDENT: LT COL THOMAS W. HANCOCK

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

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24 MAY 2017

ACTION OF THE CONVENING AUTHORITY

The Report of the Abbreviated Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 7 January 2016 mishap involving MQ-1B, T/N 08-3245, 20th Attack Squadron, 432d Wing, Creech Air Force Base, Nevada, complies with applicable regulatory and statutory guidance; on that basis it is approved.

//SIGNED//

JOHN K. MCMULLEN
Major General, USAF
Vice Commander

EXECUTIVE SUMMARY
AIRCRAFT ABBREVIATED ACCIDENT INVESTIGATION

MQ-1B Predator, T/N 08-3245
USCENTCOM AOR
7 JANUARY 2016

On 7 January 2016, at approximately 1000 hours Zulu (Z), while conducting a combat support mission in the United States Central Command (USCENTCOM) area of responsibility (AOR), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator aircraft, tail number (T/N) 08-3245, forward deployed from the 432d Wing, Creech Air Force Base (AFB), Nevada, experienced a primary control module (PCM) failure resulting in loss of aircraft control. The MRPA impacted the ground and was destroyed. At the time of the mishap, the MRPA was operated by the mishap mission control element (MMCE) from the 20th Attack Squadron (20 ATKS), Whiteman AFB, Missouri. The estimated cost of aircraft and munition damage is $5,090,368. There were no injuries or reported damage to other government or private property.

At about 0900Z, the MRPA received several warning messages including "Payload Power Board Lost," "Left/Right Aileron Failure," "Left/Right Tail Failure," "Engine Computer Failure," "Engine Err (communication error)," "FC Thru-put," and "Alt MSL." Shortly thereafter, telemetry in the return datalink was lost; however, the heads up display (HUD) video showed the aircraft flying a gradual descent, without response to pilot commands.

Evidence indicated significant malfunctions. An unplanned increase in the flight computer workload indicated a breakdown of the flight computer memory had occurred. The computer memory is essential to running the computer code that controls overall aircraft function. The degraded flight code execution ultimately resulted in at least one unplanned flight computer reset. The reset was followed by a loss of return datalink telemetry and, most likely, an accompanying loss of command datalink received at the aircraft. The degraded flight code also likely corrupted the emergency mission that was automatically uploaded by the aircraft after the warnings began but before the flight computer reset. After the flight computer reset and the command datalink was lost, the aircraft began to execute a corrupted emergency mission and flew toward an unplanned, erroneous waypoint and altitude. The MRPA flew a continuous sequence of pitch angle changes resulting in a gradual descent until ground impact.

The Abbreviated Accident Investigation Board (AAIB) President found by a preponderance of the evidence the cause of the mishap was an anomaly within the PCM (flight computer) causing it to reset, lose command datalink, and execute a corrupt emergency mission. The corrupt emergency mission commanded the MRPA into an unplanned gradual descent until ground impact.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-1B Predator, T/N 08-3245
7 JANUARY 2016

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ACRONYMS AND ABBREVIATIONS

12 AF	12th Air Force
20 ATKS	20th Attack Squadron
432 WG	432d Wing
AAIB	Abbreviated Accident Investigation Board
A/C	Aircraft
ACC	Air Combat Command
AF	Air Force
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AGL	Above Ground Level
AOR	Area of Responsibility
AIB	Accident Investigation Board
ATC	Air Traffic Control
ATKS	Attack Squadron
C2	Command and Control
CENTCOM	United States Central Command
COMACC	Commander, Air Combat Command
Comm	Communications
CSAR	Combat Search and Rescue
DoD	Department of Defense
EP	Emergency Procedures
fpm	Foot/Feet per Minute
ft.	Foot/Feet
GA	General Atomics
GCS	Ground Control Station
HDD	Heads-Down Display
HFACS	Human Factors Analysis & Classification System
HUD	Heads-Up Display
IAW	In Accordance With
IFR	Instrument Flight Rules
IO	Investigating Officer
IP	Instructor Pilot
IR	Infrared
ISB	Interim Safety Board
ISR	Intelligence, Surveillance, Reconnaissance
KIAS	Knots Indicated Airspeed
L	Local Time
LR	Launch and Recovery
LRE	Launch and Recovery Element
MCC	Mission Commander
MCE	Mission Control Element
MIC	Mission Intelligence Coordinator
MIP	Mishap Instructor Pilot
MCC	Mission Commander
MMCE	Mishap Mission Control Element
MO	Mishap Observer
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSO	Mishap Sensor Operator
nm	Nautical Miles
ORM	Operational Risk Management
PCM	Primary Control Module
PIC	Pilot in Command
POC	Point of Contact
PPSL	Predator Primary SATCOM Link
PSO1	Pilot/Sensor Operator Position 1
RPA	Remotely Piloted Aircraft
RTB	Return to Base
RX	Receive/Reception
SAR	Search and Rescue
SARM	Squadron Aviation Resource Manager
SATCOM	Satellite Communication
SIB	Safety Investigation Board
SO	Sensor Operator
T/N	Tail Number
TX	Transmit/Transmission
USAF	United States Air Force
VFR	Visual Flight Rules
VVI	Vertical Velocity Indictor
WG	Wing
WOC	Wing Operations Center
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 V).

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 10 January 2017, Major General John K. McMullen, Vice Commander, Air Combat Command, appointed Lieutenant Colonel Thomas W. Hancock as the Abbreviated Accident Investigation Board (AAIB) President to investigate the 7 January 2016 accident involving an MQ-1B Predator aircraft (A/C), tail number (T/N) 08-3245 (Tab Y-3 to Y-4). An AAIB was conducted at Nellis Air Force Base (AFB), Nevada, from 11 January 2017 to 10 February 2017, in accordance with the provisions of Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, Chapter 11 (Tab Y-3 to Y-4). A legal advisor and a recorder were also appointed to the AAIB (Tab Y-3 to Y-4).

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 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 7 January 2016, at approximately 1000 hours Zulu (Z), while conducting a combat support mission in the United States Central Command (USCENTCOM) area of responsibility (AOR), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator aircraft, tail number (T/N) 08-3245, forward deployed from the 432d Wing, Creech Air Force Base (AFB), Nevada, experienced a primary control module (PCM) failure resulting in loss of aircraft control (Tabs P-4, Q-5, and DD-4). The MRPA impacted the ground and was destroyed (Tab DD-8). At the time of the mishap, the MRPA was operated by the mishap mission control element (MMCE) from the 20th Attack Squadron (20 ATKS), Whiteman AFB, Missouri (Tab V-3.1, V-4.1, and V-5.1). The estimated cost of aircraft and munition damage is $5,090,368.00. There were no injuries or reported damage to other government or private property (Tab P-4).

At about 0900Z, the MRPA received several warning messages including “Payload Power Board Lost,” “Left/Right Aileron Failure,” “Left/Right Tail Failure,” “Engine Computer Failure,” “Engine Err (communication error),” “FC Thru-put,” and “Alt MSL” (Tab DD-4). Shortly thereafter, telemetry in the return datalink was lost; however, the heads up display (HUD) video showed the aircraft flying a gradual descent, without response to pilot commands (Tabs V-3.2, V-4.1, V-5.2, and DD-4).

Evidence indicated significant malfunctions (Tabs V-3.1, V-4.1, and DD-4). An unplanned

increase in the flight computer workload indicated a breakdown of the flight computer memory had occurred (Tab DD-4). The computer memory is essential to running the computer code that controls overall aircraft function (Tab DD-4). The degraded flight code execution ultimately resulted in at least one unplanned flight computer reset (Tab DD-4). The reset was followed by a loss of return datalink telemetry and, most likely, an accompanying loss of command datalink received at the aircraft (Tab DD-4). The degraded flight code also likely corrupted the emergency mission that was automatically uploaded by the aircraft after the warnings began but before the flight computer reset (Tab DD-4). After the flight computer reset and the command datalink was lost, the aircraft began to execute a corrupted emergency mission and flew toward an unplanned, erroneous waypoint and altitude (Tab DD-4). The MRPA flew a continuous sequence of pitch angle changes resulting in a gradual descent until ground impact. (Tabs V-3.2, V-5.1, and DD-4).

3. BACKGROUND

a. Air Combat Command (ACC)

To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management and electronic-combat aircraft (Tab CC-3). It also provides command, control, communications and intelligence systems, and conducts global information operations (Tab CC-3). As a force provider and Combat Air Forces lead agent, ACC organizes, trains, equips and maintains combat-ready forces for rapid deployment and employment while ensuring strategic air defense forces are ready to meet the challenges of peacetime air sovereignty and wartime air defense (Tab CC-3). Additionally, ACC develops strategy, doctrine, concepts, tactics, and procedures for air and space-power employment (Tab CC-3). The command provides conventional and information warfare forces to all unified commands to ensure air, space and information superiority for warfighters and national decision-makers (Tab CC-3). The command can also be called upon to assist national agencies with intelligence, surveillance and crisis response capabilities (Tab CC-3). ACC numbered air forces provide the air component to U.S. Central, Southern and Northern Commands, with Headquarters ACC serving as the air component to Joint Forces Commands (Tab CC-3). ACC also augments forces to United States European, Pacific, Africa-based and Strategic Commands (Tab CC-3).

b. Twelfth Air Force (12 AF)

12 AF, or Air Forces Southern, headquartered at Davis-Monthan AFB, Arizona, controls ACC's conventional fighter and bomber forces based in the western United States and also serves as the air component for United States Southern Command (Tab CC-5). In its numbered air force role, 12 AF is responsible for the combat readiness of ten active-duty wings and one direct reporting unit (Tab CC-5). These subordinate commands operate more than 800 aircraft with more than 64,000 uniformed and civilian Airmen (Tab CC-5). The command is also responsible for the operational readiness of gained wings and other units of the Air Force Reserve and Air National Guard (Tab CC-5).

c. 432d Wing (432 WG)

The 432 WG "Hunters" consists of combat-ready Airmen who fly remotely piloted aircraft (RPA) in direct support of the joint warfighter (Tab CC-13). The Hunters conduct RPA training for aircrew, intelligence, weather, and maintenance personnel (Tab CC-13). The 432 WG flies and maintains the MQ-1B Predator and MQ-9 Reaper RPAs to support United States total force components and combatant commanders (Tab CC-13 and CC-18).

d. 20th Attack Squadron (20 ATKS)

The 20 ATKS provides persistent intelligence, surveillance, and reconnaissance, and full motion video for real-time actionable intelligence and precision weapons employment in combat operations, using unmanned aircraft (Tab CC-16).

e. MQ-1B Predator

The MQ-1B Predator is an armed, multi-mission, medium-altitude, long-endurance RPA that is employed primarily as an intelligence-collection asset and secondarily against dynamic execution targets (Tab CC-18). Given its significant loiter time, wide-range sensors, multi-mode communications suite, and precision weapons, it provides a unique capability to perform strike, coordination and reconnaissance against high-value, fleeting, and time-sensitive targets (Tab CC-18). Predators can also perform the following missions and tasks: intelligence, surveillance, and reconnaissance, close air support, combat search and rescue, precision strike, buddy-lase, convoy/raid overwatch, route clearance, target development, and terminal air guidance (Tab CC-18). The MQ-1B's capabilities make it uniquely qualified to conduct irregular warfare operations in support of combatant commander objectives (Tab CC-18).

The Predator carries the Multi-spectral Targeting System, which integrates an infrared sensor, color/monochrome daylight TV camera, image-intensified TV camera, laser designator and laser illuminator (Tab CC-18). The full-motion video from each of the imaging sensors can be viewed as separate video streams or fused (Tab CC-18). The aircraft can employ two laser-guided Hellfire missiles that possess high accuracy, low-collateral damage anti-armor/anti-personnel engagement capabilities (Tab CC-18).

The aircraft is employed from a ground control station (GCS) via a line-of-sight datalink or a satellite datalink for beyond line-of-sight operations (Tab CC-19). 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 inside the GCS (Tab CC-18).

4. SEQUENCE OF EVENTS

a. Mission

On 7 January 2016, the MRPA was authorized by an Air Tasking Order to conduct a combat support mission in the USCENTCOM AOR (Tab K-2).

b. Planning

On 7 January 2016, at around 0720Z, the MMCE consisting of the mishap pilot (MP) and mishap sensor operator (MSO) attended a mass brief within the 20 ATKS (Tab V-3.1 and V-4.1). The briefing was uneventful, with no risk factors noted (Tab V-3.1 and V-4.1). Weather slides briefed at the mass brief indicated no significant weather in the AOR (Tab V-3.1 and V-4.1).

c. Preflight

Preflight checks and launch were conducted by a launch and recovery element (LRE) with no maintenance discrepancies (Tab D). The GCS maintenance forms were reviewed by the MMCE with no discrepancies noted (Tab V-3.1). The MRPA had been flying without incident for about 5 hours when the MMCE took control (Tab V-3.1).

d. Summary of Accident

The MP and the MSO proceeded to the GCS at around 0755Z and gained control of the MRPA uneventfully at around 0800Z (Tab V-3.1). About one hour after the MMCE took command of the MRPA, they noticed their first warning cautions on the heads down display (Tab V-3.2 and V-4.1). The MRPA was heading in a northwest direction with heading and altitude holds engaged (Tab V-3.2). Several cautions appeared all at once and the MMCE noticed the altitude indicator and vertical velocity indicator (VVI) on the main display were oscillating, or rapidly fluctuating (Tabs V-3.2 to V-3.3 and DD-7). However, the MRPA was actually in straight and level flight (Tabs V-3.2 and DD-5). Cautions indicated included "Payload Power Board Lost," "Left/Right Aileron Failure," "Left/Right Tail Failure," "Engine Computer Failure," "Engine Err (communication error)," "FC Thru-put," and "Alt MSL" (Tab DD-5). Additionally, the MMCE remembered the following cautions: "Tail Computer Left/Right Lost," "Return Link Lost," "Engine Computer Lost," "PCM Right/Left Lost," and "Wing Control Module Lost" (Tab V-3.2 and V-4.1). The MMCE had never experienced these cautions before and the technical orders (TO) did not have specific emergency procedures for them (Tabs V-3.2, V-4.2, V-5.1, DD-5, and DD-13). The MMCE determined the primary PCM had failed (Tab V-3.2, V-4.1, and V-5.1). The PCM acts as the "brains" for the aircraft and controls numerous functions such as antennae selection, engine functions, flight controls, inertial navigation system (INS), global positioning system (GPS), and cameras (Tab V-3.2 and V-5.1).

The MMCE relied on two datalinks for operation of the aircraft: (a) command datalink (the inputs from the pilot and sensor operator to the aircraft) and (b) return datalink (the telemetry from the aircraft, which allows the MMCE to monitor or view what the MRPA is actually doing via the main displays on the multifunction workstation (MFW) within the GCS (Tab V-3.1). If command datalink is lost, either unintentionally or intentionally (by affirmatively muting command datalink), then the MRPA should automatically fly to its planned emergency mission waypoint (Tab V-3.1 to V-3.2 and V-4.1).

The MMCE commanded a left-hand turn back to the LRE base and started to troubleshoot the cautions (Tab V-3.2, V-4.1, and V-5.1). The heading after the turn back to base was roughly 180 degrees (Tab V-3.2). The mission intelligence coordinator (MIC) declared an emergency to command and control (C2) and stated the MMCE's intentions to return to base (RTB) (Tab V-

3.2). At that time, the mishap observer (MO) arrived at the GCS to help with the emergency as a safety observer (Tab V-3.2 and V-5.1). After the MP initiated the RTB, the MMCE remained in aircraft control for about 2-3 minutes when the MMCE lost command datalink (Tab V-3.2). Along with the loss of command link, the HUD data froze for the remainder of the mishap (Tabs V-3.2, V-4.1, and DD-7). The MMCE could still monitor the MRPA via the return datalink video feed (Tab V-3.2 and V-4.1). The MMCE noticed the MRPA was not executing its planned emergency mission profile. Instead, the MRPA started a descent and a slight turn to the right on its own (Tabs V-3.2 and DD-7).

The MO continued to research the cautions in the expanded section of the TO (Tab V-3.2 and V-5.1). The MMCE ran two separate checklists during the final few minutes of the mishap sequence: the controllability emergency checklist and the lost datalink emergency checklist (Tab V-3.2 and V-5.1 to V-5.2). However, the MMCE could not run the controllability checklist because they no longer had control of the MRPA (Tab V-3.2 and V-5.2). The MP tried changing settings on the MRPA such as airspeed hold, altitude hold, and throttle settings, without success, as the MRPA was unresponsive (Tab V-3.2 and V-5.1). Finally, the MP affirmatively disabled command link and had the Predator primary SATCOM link (PPSL) mute the command datalink in accordance with the checklist (Tab V-3.2 and V-4.1). However, in this case, the emergency mission was corrupted and caused the MRPA to continue its descent on its own towards an unplanned, corrupted waypoint. The MRPA continued the slight right-hand turn, and rolled out on a heading of roughly 150 degrees (Tabs V-3.2, DD-4, and DD-11). The MMCE could not verify an exact heading due to the HUD's frozen state (Tab V-3.2 and V-4.1).

e. Impact

The MRPA continued to descend and impacted the ground approximately 15 to 20 minutes after the first cautions were observed, when all video feed was lost (Tab V-3.3). The MRPA was destroyed and not recovered (Tabs V-3.3 and DD-8).

f. Egress and Aircrew Flight Equipment (AFE)

Not Applicable.

g. Search and Rescue (SAR)

Not Applicable.

h. Recovery of Remains

Not Applicable.

5. MAINTENANCE

a. Forms Documentation

A review of the MRPA's maintenance documentation, recorded in the Air Force Technical Order (AFTO) 781 series revealed no relevant discrepancies (Tabs D and DD-7). AFTO Form 781H for 7 January 2016 revealed total MRPA airframe time of 8,555.8 hours (Tab D-6).

b. Inspections

All maintenance inspections were current and complied with (Tabs D-9 and DD-8).

c. Maintenance Procedures

Preflight inspections, servicing operations, and launch procedures were accomplished without incident (Tabs D-7 to D-10, V-3.1, and DD-8).

d. Maintenance Personnel and Supervision

All preflight servicing and maintenance was correctly documented by properly trained, qualified, and supervised military and civilian maintenance personnel (Tab D-7 to D-10).

e. Fuel, Hydraulic, and Oil Inspection Analyses

Maintenance documentation shows proper servicing and correct levels of fluids in the aircraft at takeoff (Tab D-7 to D-8). Post-accident fluid samples were not obtained from the MRPA because the aircraft was not recovered (Tabs V-3.3 and DD-8).

f. Unscheduled Maintenance

Maintenance documentation revealed no unscheduled maintenance (Tabs D-9 to D-10 and DD-8).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

The MRPA was never recovered so an evaluation of its structures and systems was not done (Tabs V-3.3 and DD-8).

b. Evaluation and Analysis

According to the GA report, the MRPA received several warning messages including "Payload Power Board Lost," "Left/Right Aileron Failure," "Left/Right Tail Failure," "Engine Computer Failure," "Engine Err (communication error)," "FC Thru-put," and "Alt MSL." (Tab DD-5). Most likely, this was due to an anomaly within the PCM flight computer (Tab DD-4). This anomaly was initially indicated by a period of increased flight computer workload and erroneous barometric altitude data (Tab DD-4). According to GA, the cause of the flight computer failure could not be determined without returned hardware (Tab DD-4).

The abnormally high flight computer workload led to a degraded flight code execution, which caused the PCM to reset at least once (Tab DD-4). The reset was followed by a loss of return datalink telemetry and most likely, a loss of command link (Tab DD-4). The degradation also likely corrupted the emergency mission that was automatically uploaded by the aircraft after the anomaly began but before the PCM reset (Tab DD-4). The repeated sequence of pitch angle changes was likely caused by the autopilot responding to erroneous barometric altitude data, and/or repeated flight computer resets (Tab DD-4).

7. WEATHER

a. Forecast Weather

Weather slides briefed during the mass brief around 0720Z indicated nothing that would influence the mission (Tab V-3.1, V-4.1, and V-5.1). For the remainder of the mission, there is no evidence that suggests weather played a significant role in this mishap (Tab V-3.1, V-4.1, and V-5.1).

b. Observed Weather

After gaining the MRPA, the MMCE noted no significant weather in the AOR that would influence the mission (Tab V-3.1, V-4.1, and V-5.1, DD-7).

c. Operations

No evidence suggest that the MRPA was operated outside of its prescribed operational weather limitations.

8. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was current and had been qualified in the MQ-1B since 24 October 2013 (Tab G-2). At the time of the mishap, the MP had a total flight time of 1458.6 hours in the MQ-1B (Tab G-3). The MP's flight time during the 90 days before the mishap was as follows (Tab G-4):

	Hours	Sorties
Last 30 Days	78.5	19
Last 60 Days	176	42
Last 90 Days	220.7	57

b. Mishap Sensor Operator

The MSO was current and had been qualified in the MQ-1B since 23 July 2013 (Tab G-15). At the time of the mishap, the MSO had a total flight time of 1150.2 hours in the MQ-1B (Tab G-16). The MSO's flight time during the 90 days before the mishap was as follows (Tab G-17):

	Hours	Sorties
Last 30 Days	59.5	21
Last 60 Days	139	44
Last 90 Days	154.2	52

9. MEDICAL

a. Qualifications

At the time of the mishap, MMCE crewmembers were fully medically qualified for flight duty (Tab EE-3 to EE-4).

b. Health

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

c. Toxicology

The medical clinic at Whiteman AFB, Missouri, collected blood and urine samples from the MMCE after the mishap (Tab EE-5 to EE-8). All toxicology testing resulted in negative findings (Tab EE-5 to EE-8).

d. Lifestyle

There is no evidence to suggest lifestyle factors were a factor in the mishap (Tab R-5 to R-11, Tab R-14 to R-20).

e. Crew Rest and Crew Duty Time

Aircrew members are required to have proper crew rest prior to performing in-flight duties, defined as a minimum of 12-hours non-duty time before the designated flight duty period begins (Tab BB-4). The MMCE met crew rest requirements (Tab V-3.1, V-4.1, and V-5.1). There is no evidence to suggest crew rest and crew duty time were factors in the mishap.

10. OPERATIONS AND SUPERVISION

a. Operations

There is no evidence to suggest operations tempo contributed to the mishap (Tab V-3.1, V-4.1, and V-5.1).

b. Supervision

On the day of the mishap, the MMCE received their daily mass briefing as they came on shift around 0720Z (Tab V-3.1, V-4.1, and V-5.1). Shortly after, the MMCE conducted their crew mission briefing (Tab V-3.1 and V-4.1). The MMCE was current on their go/no-go requirements and their operational risk management (ORM) was signed off and approved prior to proceeding to the GCS (Tabs V-3.1, V-4.1, and G-38).

11. HUMAN FACTORS ANALYSIS

There is no evidence to suggest human factors contributed to this mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

(1) AFI 51-503, *Aerospace Accident Investigations*, 14 April 2015
(2) AFI 51-503, Aerospace Accident Investigations, Air Combat Command *Supplement*, 28 January 2016
(3) AFI 11-2MQ-1&9, Volume 1, *MQ-1&9, Aircrew Training*, 23 April 2015
(4) AFI 11-2MQ-1&9, Volume 3, MQ-1 AND MQ-9, Operations Procedures, 28 August 2015
(5) AFI 11-202, Volume 3, *General Flight Rules*, 7 November 2014
(6) AFI 91-204, Safety Investigations and Reports, 12 February 2014, Corrective Actions Applied 10 April 2014, Attachment 6, *DoD Human Factors Analysis and Classification System*, Version 7.0

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) AFTO 1Q-1(M)B-1, Flight Manual – USAF Series MQ-1B System, 11 February 2016

c. Known or Suspected Deviations from Directives or Publications

There is no evidence to suggest that any directive or publication deviations occurred during this mishap.

//SIGNED//

10 February 2017

THOMAS W. HANCOCK, Lt Col, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

MQ-1B PREDATOR, T/N 08-3245
USCENTCOM AOR
7 JANUARY 2016

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 7 January 2016, at approximately 1000 hours Zulu (Z), while conducting a combat support mission in the United States Central Command (USCENTCOM) area of responsibility (AOR), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator aircraft, tail number (T/N) 08-3245, forward deployed from the 432d Wing, Creech Air Force Base (AFB), Nevada, experienced a primary control module (PCM) failure resulting in loss of aircraft control. The MRPA impacted the ground and was destroyed. At the time of the mishap, the MRPA was operated by the mishap mission control element (MMCE) from the 20th Attack Squadron (20 ATKS), Whiteman AFB, Missouri. The estimated cost of aircraft and munition damage is $5,090,368. There were no injuries or damage to other government or private property.

At about 0900Z, the MRPA received several warning messages including "Payload Power Board Lost," "Left/Right Aileron Failure," "Left/Right Tail Failure," "Engine Computer Failure," "Engine Err (communication error)," "FC Thru-put," and "Alt MSL." Shortly thereafter, telemetry in the return datalink was lost; however, the heads up display (HUD) video showed the aircraft flying a gradual descent, without response to pilot commands.

Evidence indicated significant malfunctions. An unplanned increase in the flight computer workload indicated a breakdown of the flight computer memory had occurred. The computer memory is essential to running the computer code that controls overall aircraft function. The degraded flight code execution ultimately resulted in at least one unplanned flight computer reset. The reset was followed by a loss of return datalink telemetry and, most likely, an accompanying loss of command datalink received at the aircraft. The degraded flight code also likely corrupted the emergency mission that was automatically uploaded by the aircraft after the warnings began but before the flight computer reset. After the flight computer reset and the command datalink was lost, the aircraft began to execute a corrupted emergency mission and flew toward an unplanned, erroneous waypoint and altitude. The MRPA flew a continuous sequence of pitch angle changes resulting in a gradual descent until ground impact.

I find by a preponderance of the evidence the cause of the mishap was an anomaly within the PCM (flight computer) causing it to reset, lose command datalink, and execute a corrupt emergency mission. The corrupt emergency mission commanded the MRPA into an unplanned gradual descent until ground impact.

I developed my opinion by analyzing factual data from historical records, flight data logs, manufacturer reports, maintenance records, witness testimony, Air Force directives and guidance, and Air Force

Technical Orders (AFTOs).

2. CAUSE

I find by a preponderance of the evidence the cause of the mishap was an anomaly within the PCM (flight computer) causing it to reset, lose command datalink, and execute a corrupt emergency mission. The corrupt emergency mission commanded the MRPA into an unplanned gradual descent until ground impact.

a. PCM Anomaly – Lost Command Link and Executed a Corrupt Emergency Mission

The MRPA received several warning messages including "Payload Power Board Lost," "Left/Right Aileron Failure," "Left/Right Tail Failure," "Engine Computer Failure," "Engine Err (communication error)," "FC Thru-put," and "Alt MSL." Most likely, this was due to an anomaly within the PCM flight computer. This anomaly was initially indicated by a period of increased flight computer workload and erroneous barometric altitude data. According to General Atomics (GA) analysis, the cause of the flight computer failure could not be determined without analysis of the mishap aircraft wreckage.

The abnormally high flight computer workload led to a degraded flight code execution, which caused the PCM to reset at least once. The reset was followed by a loss of return datalink telemetry and, most likely, a loss of command datalink received at the aircraft. The degradation also likely corrupted the emergency mission that was uploaded to the aircraft after the anomaly began but before the PCM reset. The repeated sequence of pitch angle changes and oscillations was likely caused by the autopilot responding to erroneous barometric altitude data, and/or repeated flight computer resets.

While the MMCE executed multiple courses of action in attempt to regain control of the MRPA, all actions failed. Once the PCM reset and the corrupt emergency mission was automatically loaded by the aircraft, it is unlikely the MMCE could have done anything to regain control of the MRPA.

3. CONCLUSION

I find by a preponderance of the evidence the cause of the mishap was an anomaly within the PCM (flight computer) causing it to reset, lose command datalink, and execute a corrupt emergency mission. The corrupt emergency mission commanded the MRPA into an unplanned gradual descent until ground impact. The evidence indicates that the crew responded appropriately and in accordance with the established emergency procedures. There is nothing to indicate that the crew, or anyone else, could have anticipated the PCM failure or otherwise recovered the aircraft.

//SIGNED//

10 February 2017

THOMAS W. HANCOCK, Lt Col, USAF
President, Accident Investigation Board

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