UNITED STATES AIR FORCE ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-9A, T/N 11-4144
432D WING
CREECH AIR FORCE BASE, NEVADA

LOCATION: CENTCOM AOR

DATE OF ACCIDENT: 12 DECEMBER 2014

BOARD PRESIDENT: LT COL DANIEL C. JOHNSEN

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

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

OFFICE OF THE VICE COMMANDER
205 DODD BOULEVARD SUITE 203
JOINT BASE LANGLEY-EUSTIS VA 23665-2788

ACTION OF THE CONVENING AUTHORITY

The Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 12 December 2014 mishap, at the United States Central Command Area of Responsibilties, involving an MQ-9A, T/N 11-4144, assigned to the 432nd Wing, Creech Air Force Base, Nevada, complies with applicable regulatory and statutory guidance; on that basis it is approved.

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

EXECUTIVE SUMMARY
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION

MQ-9A, T/N 11-4144
CENTCOM AOR
12 DECEMBER 2014

On 12 December 2014, at approximately 1737 hours Zulu (Z), an MQ-9A remotely piloted aircraft (RPA), tail number 11-4144, forward deployed to the United States Central Command (CENTCOM) Area of Responsibility (AOR) from the 432d Wing, Creech AFB, Nevada, experienced a starter-generator failure while conducting an Air Tasking Order mission. Subsequent backup battery depletion en route to the emergency launch-and-recovery element (LRE) precluded any attempt to safely recover the aircraft and the mishap RPA (MRPA) was ditched into nearby mountainous terrain. At the time of the starter-generator failure, the MRPA was being controlled by a mission control element (MCE) operating from the 28th Bomb Wing, Ellsworth AFB, South Dakota. There were no injuries or damage to other government or private property. Estimated cost of aircraft, onboard equipment and munitions damage is $14.1 million. The wreckage was not recovered.

The MMCE had assumed control of the MRPA from the LRE, performed system checks, and a conducted a short period of weapons training, when the MRPA experienced a short loss of satellite return link. Upon reestablishing link, the mishap pilot (MP) noticed a "Battery Sourcing Current" warning, coupled with voltage readings indicating the starter-generator had failed. The mishap MCE performed appropriate emergency checklists, turned off non-essential aircraft systems to conserve battery power, and programmed a route of flight to the emergency LRE before turning off the satellite link. When the emergency LRE established uplink and gained control of the MRPA, battery voltage was too low to attempt a safe recovery to the airfield. Supervision directed the emergency LRE to ditch the MRPA in the mountains.

The Abbreviated Accident Investigation Board (AAIB) President determined, by a preponderance of evidence, the cause of the mishap was a failure of the starter-generator. As a direct result of the starter-generator failure, backup battery power depleted to the point where the emergency LRE could not safely recover the aircraft and the MRPA was ditched into nearby mountainous terrain. The exact cause of the starter-generator failure was unable to be determined without recovered wreckage.

The AAIB President found, by a preponderance of evidence, two factors substantially contributed to this mishap: 1) a delay in uploading the applicable software version at the emergency LRE; and 2) not pre-configuring the landing gear for recovery prior to turning off the satellite link.

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

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-9A, T/N 11-4144
12 DECEMBER 2014

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

103 ATKS	103d Attack Squadron
12 AF	12th Air Force
1Lt	1st Lieutenant
28 BW	28th Bomb Wing
432 ATKS	432d Attack Squadron
432 WG	432d Wing
451 EAMXS	451st Expeditionary Aircraft Maintenance Squadron
A10	A-10 Warthog
A1C	Airman First Class
AAIB	Abbreviated Accident Investigation Board
ACC	Air Combat Command
ACFT	Aircraft
AF	Air Force
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AGL	Above Ground Level
AIB	Accident Investigation Board
AGM-114	Air-to-Ground Missile (Hellfire)
ANG	Air National Guard
AOR	Area of Responsibility
ATC	Air Traffic Control
ATO	Air Tasking Order
B-1B	B-1B Lancer
BPO/PR	Basic Post-flight / Pre-flight Inspection
C2	Command and Control
CAC	Typo for CAOC
CAOC	Combined Air Operations Center
Capt	Captain
CDC	Career Development Course
CENTCOM	Central Command
CRC	Control and Reporting Center
DO	Director of Operations
E-3	Airman First Class
E-4	Senior Airman
E-5	Staff Sergeant
E-7	Master Sergeant
EGT	Exhaust Gas Temperature
EP	Emergency Procedure
EPE	Emergency Procedure Evaluation
FCIF	Flight Crew Information File
Flt	Flight
GA	General Atomics
GBU	Guided Bomb Unit
GCS	Ground Control Station
Gen	Generator
HUD	Head-Up Display
Hrs	Hours
IAW	in accordance with
IMDS	Integrated Maintenance Data System
Intel	Intelligence
IOS	Intelligence Operations Supervisor
IP	Instructor Pilot
IQT	Initial Qualification Training
ISB	Interim Safety Board
ISR	Intelligence, Surveillance, and Reconnaissance
ITC	ISR Tactical Controller
JTAC	Joint Terminal Air Controller
Ku Band	Kurtz-under Band
LR	Launch-and-Recovery
LRE	Launch-and-Recovery Element
Lt or LT	Lieutenant
Maj	Major
MCC	Mission Crew Commander
MCE	Mission Control Element
MDS	Mission Design Series
MI	Michigan
MIC	Mission Intelligence Coordinator
MMCC	Mishap Mission Crew Commander
MMCE	Mishap Mission Control Element
MME	Mishap Maintenance Expediter
MMIC	Mishap Mission Intelligence Coordinator
MMP	Mishap Maintenance Production Superintendent
MMS	Mishap Maintenance Specialist
MMXCC	Mishap Maintenance Crew Chief
MMWCC	Mishap Maintenance Weapons Crew Chief
MOC	Maintenance Operations Center
MP	Mishap Pilot
MQT	Mission Qualification Training
MRPA	Mishap Remotely Piloted Aircraft

MSgt	Master Sergeant	SIB	Safety Investigation Board
MSO	Mishap Sensor Operator	SN	Serial Number
MTS	Multi-Spectral Targeting System	SOC	Squadron Operations Center
N/A	not applicable	SOP	Standard Operating Procedures
NCO	Noncommissioned Officer	SPMA	Sensor Processor Modem Assembly
NM	nautical miles	SrA	Senior Airman
O-2	First Lieutenant	SSgt	Staff Sergeant
OEF	Operation ENDURING FREEDOM	TCTO	Time Compliance Technical Order
OFP	Operational Flight Program	Tech	Technician or Technical
OIF	Operation IRAQI FREEDOM	TDY	Temporary Duty
ORM	Operational Risk Management	T/N	Tail Number
PCS	Permanent Change of Station	UAV	Unmanned Aerial Vehicle
RF	Radio Frequency	USAF	United States Air Force
RPA	Remotely Piloted Aircraft	Vmg	minimum landing gear voltage
RPM	revolutions per minute	WOC	Wing Operations Center
RTB	return to base	Z	Zulu
SAR	Search and Rescue	ZEUS	An integrated source feed monitor
SA	Situation Awareness	Zulu	Greenwich Mean Time

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 11 May 2015, Major General Jerry D. Harris, Jr., Vice Commander, Air Combat Command, appointed Lieutenant Colonel Daniel C. Johnsen to conduct an abbreviated accident investigation of a mishap that occurred on 12 December 2014 involving an MQ-9A remotely piloted aircraft (RPA) in the United States Central Command (CENTCOM) Area of Responsibility (AOR). The abbreviated accident investigation was conducted in accordance with Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, Chapter 11, at Ellsworth Air Force Base (AFB), South Dakota, from 14 May 2015 to 29 May 2015. Also appointed to the Board were the Legal Advisor (Major) and Board Recorder (Staff Sergeant) (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 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 12 December 2014, at approximately 1737 hours Zulu (Z), the mishap remotely piloted aircraft (MRPA), an MQ-9A Reaper, tail number 11-4144, forward deployed to the CENTCOM AOR from the 432d Wing, Creech AFB, Nevada, experienced a starter-generator failure while conducting an Air Tasking Order (ATO) mission (Tabs K-3, Q-5, R-42, and Y-3 to Y-4). Subsequent backup battery depletion en route to the emergency launch-and-recovery element (LRE) precluded any attempt to safely recover the aircraft and the MRPA was ditched into nearby mountainous terrain (Tab R-40 to R-41). At the time of the starter-generator failure, the MRPA was being controlled by a mission control element (MCE) operating from the 28th Bomb Wing, Ellsworth AFB, South Dakota (Tab K-2). There were no injuries or damage to other government or private property (Tabs P-2 to P-5, and Q-5). Estimated cost of aircraft, onboard equipment and munitions damage is $14.1 million (Tab P-4 to P-5). The wreckage was not recovered (Tab DD-4).

3. BACKGROUND

The MRPA belonged to the 432d Wing, 12th Air Force, Air Combat Command stationed at Creech AFB, Nevada (Tab Q-5). The MMCE was operating out of the 432d Attack Squadron, 28th Bomb Wing, 12th Air Force, Air Combat Command stationed at Ellsworth AFB, South

Dakota (Tab K-2). The emergency LRE was a non-Air Force agency operating at a different location in the CENTCOM AOR (Tab R-39 to R-40).

a. Air Combat Command (ACC)

ACC is the primary force provider of combat airpower to America's warfighting commands (Tab CC-3). To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management and electronic-combat aircraft (Tab CC-3). It also provides command and control, communications and intelligence systems, and conducts global information operations (Tab CC-3). As a force provider 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). ACC numbered air forces provide the air component to U.S. Central, Southern and Northern Commands, with Headquarters ACC serving as the air component to Joint Forces Commands (Tab CC-3). ACC also augments forces to U.S. European, Pacific, Africa-based and Strategic Commands (Tab CC-3).

b. 12th Air Force (12 AF)

Twelfth Air Force is responsible for the readiness of nine active duty wings and one direct reporting unit (Tab CC-4). These subordinate commands operate more than 600 aircraft with more than 55,000 uniformed and civilian Airmen (Tab CC-4). The command is also responsible for the operational readiness of 17 Twelfth Air Force-gained wings and other units of the Air Force Reserve and Air National Guard (Tab CC-4).

c. 432d Wing (432 WG)

The 432 WG "Hunters" consists of combat-ready Airmen who fly RPAs in direct support of the joint warfighter (Tab CC-5). The Hunters conduct RPA training for aircrew, intelligence, weather, and maintenance personnel (Tab CC-5). The 432 WG flies and maintains the MQ-1B Predator and MQ-9 Reaper RPAs to support the United States and coalition war-fighters (Tab CC-5).

d. 28th Bomb Wing (28 BW)

The 28 BW guarantees expeditionary combat power for America (Tab CC-6). Every Airman in the wing, whether sustaining people, maintaining weapons and equipment, generating aircraft, pulling a trigger, or operating a network, provides combat power for our nation (Tab CC-6). The 28 BW is home to 27 B-1B Lancers (Tab CC-6). In 2012, the wing also began flying MQ-9 Reaper missions from ground control stations (GCS) on Ellsworth AFB when the 432nd Attack Squadron stood up (Tab CC-6).

e. 432d Attack Squadron (432 ATKS)

The 432 ATKS employs MQ-9 Reaper aircraft in support of combatant commanders' requirements including precision reconnaissance, air interdiction, close air support, and strike coordination (Tab CC-7).

f. Aircraft: MQ-9A Reaper (Predator B)

The MQ-9 Reaper is an armed, multi-mission, medium-altitude, long-endurance RPA employed primarily as an intelligence-collection asset and secondarily against dynamic execution targets (Tab CC-8). 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-8). Reapers can also perform the following missions and tasks: intelligence, surveillance, reconnaissance, close air support, combat search and rescue, precision strike, buddy-laser, convoy/raid overwatch, route clearance, target development, and terminal air guidance (Tab CC-8).

The Reaper is part of a remotely piloted aircraft system (Tab CC-8). A fully operational system consists of several sensor/weapon-equipped aircraft, GCS, Predator Primary Satellite Link, and spare equipment along with operations and maintenance crews for deployed 24-hour missions (Tab CC-8).

The basic crew consists of a rated pilot to control the aircraft and command the mission, and an enlisted aircrew member to operate sensors and weapons as well as a mission coordinator, when required (Tab CC-8). The primary concept of operations, remote split operations, employs an LRE for take-off and landing operations at the forward operating location, while the MCE based in continental United States executes command and control of the remainder of the mission via beyond-line-of-sight links (Tab CC-8).

The MQ-9A baseline system carries the Multi-Spectral Targeting System, which has a robust suite of visual sensors for targeting (Tab CC-8). The full-motion video from each of the imaging sensors can be viewed as separate video streams or fused (Tab CC-8). The unit incorporates a laser range finder/designator, which precisely designates targets for employment of laser-guided munitions, such as the Guided Bomb Unit-12 Paveway II (Tab CC-8). The MQ-9A can also employ four laser-guided missiles, Air-to-Ground Missile-114 Hellfire, which possess highly accurate, low-collateral damage, anti-armor and anti-personnel engagement capabilities (Tab CC-8).

4. SEQUENCE OF EVENTS

a. Mission

On 12 December 2014, the MRPA was authorized by a classified CENTCOM ATO to conduct a combat support mission in the CENTCOM AOR (Tabs Q-5 and R-42).

b. Planning

On 12 December 2014, at 1400Z, the Mishap MCE (MMCE) consisting of the Mishap Pilot (MP) and Mishap Sensor Operator (MSO) arrived at the 432 ATKS to attend pre-mission briefings (Tabs R-12 and R-15). The MMCE and mishap mission crew commander (MMCC) attended a mass brief and the MP briefed the particulars of the mission out of the inflight guide (Tabs R-12 and R-44). Mission planning and briefings were standard with nothing out of the ordinary (Tab R-12).

c. Preflight

Preflight checks were accomplished with only minor delayed discrepancies (maintenance discrepancies that do not affect safety of flight) (Tab D-3 to D-13). The MRPA was launched by an LRE at the deployed location without incident (Tabs R-12 and R-67). The MMCE assumed control of the MRPA from the LRE as it was climbing to an altitude of 23,000 feet (Tab R-4).

d. Summary of Accident

After checking aircraft systems and conducting a practice bomb run, the MMCE started to fly the MRPA to the designated operating area (Tab R-4). At approximately 1630Z the MRPA experienced a short loss of satellite return link, lasting approximately one minute (Tab R-5). This is commonly referred to as a “link hit”, during which time the operator is able to input commands, but cannot verify response or current system information from the aircraft (Tab R-5). Shortly after return link was reestablished, the MP noticed a “Battery Sourcing Current” warning (Tab R-5). This warning indicated a starter-generator malfunction and that the backup batteries were now powering aircraft systems (Tab R-5).

The MQ-9A is an all-electric airplane, utilizing electric motors to steer the aircraft and move components such as the landing gear (Tabs R-6 and R-39). In the event the starter-generator fails, backup batteries provide power for approximately one hour of flight (Tabs R-5 to R-6, and R-39).

The MP immediately turned back toward the deployed location, as the MRPA was positioned near equidistant from home station and the pre-briefed emergency LRE (Tabs R-6 and R-12). The MMCC entered the GCS immediately after seeing the warning on the system feed from the squadron operations center (SOC) (Tab R-39). Assisted by the MMCC, the MP compared flight time to both locations and elected to fly to the emergency LRE (Tabs R-6 and R-39). Flight time to the emergency LRE was approximately 35 minutes due to a tailwind versus approximately one hour to get back to the deployed location due to a headwind (Tab R-6). Once headed toward the emergency LRE, the MMCE began performing the generator failure emergency checklist in the technical order and turned off non-essential aircraft systems to conserve battery power (Tabs R-6 to R-7, and R-40). The generator failure checklist is a long and involved emergency checklist (Tab R-40).

Per standard protocol, the MMCC sent a safety observer into the GCS to assist the MMCE (Tabs R-28 and R-40). The MMCC then returned to the SOC to coordinate by telephone with the emergency LRE (Tab R-43). During this coordination, the MMCC did not pass information on the MRPA's Operational Flight Program (OFP) software version (Tab R-43 to R-44). There are multiple OFP software versions in the MQ-9A fleet and the emergency LRE was not using the same software as the MMCE (Tabs R-43 to R-44, and V-2.1). Official guidance does not direct passing OFP software version information to the LRE in an emergency, listing only "other pertinent information as required" (Tab BB-4). Changing the OFP software in the GCS takes approximately 5-10 minutes (Tab V-2.2). If the LRE does not use the same software versions as the MCE, it may take longer to locate the software and familiarize with associated checklists to be ready to gain control and operate an aircraft (Tabs R-40 and V-2.2).

Back in the GCS, the MRPA's battery voltage was lower than expected and the MMCE became concerned that there was not enough battery power remaining to maintain satellite link with the MRPA all the way to the emergency LRE (Tabs R-7 to R-8, and R-41). In a low electrical power emergency, the MCE has the ability to upload a route of flight and permanently turn off the satellite link to send the aircraft to its destination (Tabs R-7 and R-40). Under this condition, the MCE has no control over the aircraft, and it will fly the programmed routing until a LRE establishes line-of-sight (LOS) uplink (a direct link with the aircraft from a ground transmitter/receiver) (Tabs R-10 and R-40). This is a last ditch effort to conserve battery power (Tabs R-10, R-40, and V-2.2).

While the MMCE was programming a route of flight to the emergency LRE in preparation for turning off the satellite link, the MRPA experienced another link hit lasting approximately two minutes (Tabs R-8 to R-9, R-28, DD-6). During this link hit, the MRPA began executing its preloaded emergency return back to the deployed location (Tabs R-8 to R-9, and R-28). Depending on how the aircraft is programmed, if return link is not reestablished in a predetermined amount of time, the aircraft will execute an emergency return mission back to base (Tabs R-9 and R-28). Upon reestablishing return link again, the MMCE was able to upload the route of flight to the emergency LRE and turn off the satellite link at 1647Z (Tab R-28 to R-29). The MMCE and MMCC monitored the MRPA's position using external sources fed into their displays (Tabs R-7 and R-40).

The MP did not lower the landing gear prior to sending the MRPA on its routing to the emergency LRE and turning off the satellite link because the MP believed there would be enough battery power available to lower the landing gear when the emergency LRE gained control (Tab V-3.1). The landing gear must be lowered above a certain battery voltage (minimum landing gear voltage, or Vmg) so as not to completely drain the batteries, resulting in loss of aircraft control (Tab V-2.1 to V-2.2). If operating on battery power, and the aircraft is sent without satellite link to a LRE with intent to land, lowering the landing gear above Vmg and prior to turning off the satellite link pre-configures the aircraft for landing in the event battery voltage is below Vmg at the LRE (Tab V-2.1 to V-2.2). If the aircraft is too far away to get to a LRE before battery power is depleted, and the aircraft will be intentionally crashed, the position of the landing gear is inconsequential (Tab V-2.2). The generator failure checklist addresses lowering the landing gear prior to Vmg and official squadron guidance lists the landing gear setting as one of the pieces of information passed to the LRE; however, neither document directs the pilot to lower the landing gear in this situation (Tabs V-2.1 to V-2.2, and BB-4).

The MRPA loitered for approximately 20 minutes near the emergency LRE before LOS uplink was established (Tab V-3.2). Battery voltage was below Vmg and the emergency LRE's supervision directed them to ditch the MRPA in the mountains (Tab R-40 to R-41). The emergency LRE controlled the MRPA approximately 11 minutes before impact (Tab R-39). The MRPA lasted approximately one hour and seven minutes from the start of the mishap sequence of events (Tab R-40).

e. Impact

The MRPA impacted the ground at approximately 1737Z in the mountains near the emergency LRE, approximately one hour and seven minutes after the starter-generator failed (Tabs R-6, R-29, and R-40).

f. Egress and Aircrew Flight Equipment (AFE)

Not Applicable.

g. Search and Rescue (SAR)

Not Applicable.

h. Recovery of Remains

Not Applicable.

5. MAINTENANCE

a. Forms Documentation

A review of the MRPA's maintenance documentation, recorded in the Air Force Technical Order (AFTO) 781 series, revealed no contributing factors to the mishap (Tab D-2 to D-13). AFTO Forms 781A, 781H, and 781J revealed standard preflight maintenance activities and no related maintenance discrepancies (Tab D-3 to D-8). AFTO Form 781J for 12 December 2014 revealed total MRPA airframe time of 2,097.5 hours, total engine time of 8,178.7 hours, and 560 total landing gear cycles (Tab D-8).

b. Inspections

The last scheduled inspection was a 2,000-hour engine inspection accomplished 28 November 2014 with no discrepancies (Tab D-2).

All pre-flight inspections were complied with (Tab D-3 to D-7).

Aircraft ground equipment used on the MRPA prior to launch (light cart, power cart and battery charger/conditioner) were checked for proper operation on 17 December 2014 with no discrepancies (Tab D-23).

c. Maintenance Procedures

Preflight inspections, servicing operations, and launch procedures were accomplished without incident (Tabs D-3 to D-13, R-47, and R-53).

d. Maintenance Personnel and Supervision

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

e. Fuel, Hydraulic, and Oil Inspection Analyses

Maintenance documentation shows proper servicing and correct levels of fluids in the aircraft at takeoff (Tab D-5 to D-7). Since the wreckage was not recovered, no post-accident fluid samples were obtained from the MRPA (Tab DD-4).

f. Unscheduled Maintenance

Maintenance documentation revealed no mishap-related unscheduled maintenance (Tab D-5 to D-7).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

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

b. Evaluation and Analysis

General Atomics (GA) analyzed data logger files from the MMCE and emergency LRE GCSs (Tab DD-3 to DD-25). The GA report concluded MRPA experienced a failure of the starter-generator, preceded by several minutes of erratic voltage (Tab DD-4). GA was unable to determine the exact cause of the failure without recovered hardware; however, the failure sequence had symptoms similar to other MQ-9A starter-generator failures (Tab DD-4). There were no indications the batteries had provided electrical power prior to the starter-generator failure (Tab DD-5).

Erratic starter-generator output likely caused the first return link hit through system circuitry protecting systems from overvoltage (Tab DD-9). A spike in generator output may have caused the second return link hit after the starter-generator was reconnected to the electrical system by the MMCE commanding generator resets (Tab DD-9 to DD-10).

7. WEATHER

a. Forecast Weather

Forecast weather indicated low cloud layers with no hazardous conditions (Tab F-2).

b. Observed Weather

Observed weather reports were similar to forecast weather (Tab F-2).

c. Space Environment

Not applicable.

d. Operations

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

8. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was current and had been qualified in the MQ-9A since 17 September 2013 (Tab G-9). The MP had a total flight time of 469.1 hours in the MQ-9A (Tab G-7). The MP's flight time during the 90 days before the mishap was as follows (Tab G-7):

	Hours	Sorties
Last 30 Days	18.6	6
Last 60 Days	38.5	57
Last 90 Days	63.8	118

b. Mishap Sensor Operator

The MSO was current and had been qualified in the MQ-9A since 19 August 2014 (Tab G-22). The MSO had a total flight time of 144.6 hours in the MQ-9A (Tab G-20). The MSO's flight time during the 90 days before the mishap was as follows (Tab G-20):

	Hours	Sorties
Last 30 Days	58.2	16
Last 60 Days	99.8	30
Last 90 Days	186.9	33

9. MEDICAL

a. Qualifications

After a review of the MMCE crewmembers' medical records, the MMCE crewmembers were determined to be fully medically qualified for flight duty (Tab T-3).

b. Health

After a review of Preventative Health Assessment and Individual Medical Readiness, Composite Healthcare System, Armed Forces Health Longitudinal Technology Application, and Aeromedical Information Management Waiver Tracking System databases, there is no evidence to suggest the health of MMCE crewmembers or mishap maintenance personnel contributed to the mishap (Tab T-3).

c. Toxicology

The medical clinic at Ellsworth AFB, South Dakota, collected blood and urine samples from the MMCE and maintenance personnel after the mishap (Tab T-3). All toxicology testing resulted in negative findings (Tab T-3).

d. Lifestyle

No lifestyle factors were found to be relevant to the mishap (Tabs R-15 to R-23, and T-3).

e. Crew Rest and Crew Duty Time

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

10. OPERATIONS AND SUPERVISION

a. Operations

Operations tempo for the three days prior to the mishap consisted of 8-hour shifts for the MMCE with duty day beginning at 1400Z (Tab R-14 to R-15). There is no evidence to suggest operations tempo was a factor in this mishap.

b. Supervision

The MMCC in the SOC was providing general oversight to the MMCE during the mishap (Tab R-39). There is no evidence to suggest that mission oversight was a factor in this mishap.

11. HUMAN FACTORS ANALYSIS

There is no evidence to suggest human factors were a factor in 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*, 5 September 2013
(3) AFI 91-204, *Safety Investigations and Reports*, 12 February 2014
(4) AFI 11-202, Volume 3, *Flying Operations-General Flight Rules*, 7 November 2014

NOTICE: All AFIs 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) Technical Order 1Q-9(M)A-1, *Flight Manual, USAF Series, MQ-9A Aircraft,* 9 January 2014, Change 1, 2 May 2014
(2) ASI-08372, *2402.0.0 Software Release Overview, USAF Series MQ-9A Aircraft, Serial Numbers 004, 006, 008, and Above,* 7 August 2014
(3) *Reaper Attack Guide, 432d Attack Squadron,* October 2013

c. Known or Suspected Deviations from Directives or Publications

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

29 May 2015

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

STATEMENT OF OPINION

MQ-9A, T/N 11-4144
CENTCOM AOR
12 DECEMBER 2014

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

1. OPINION SUMMARY

On 12 December 2014, at approximately 1737 hours Zulu (Z), an MQ-9A remotely piloted aircraft (RPA), tail number 11-4144, forward deployed to the United States Central Command (CENTCOM) Area of Responsibility (AOR) from the 432d Wing, Creech AFB, Nevada, experienced a starter-generator failure while conducting an Air Tasking Order mission. Subsequent backup battery depletion en route to the emergency launch-and-recovery element (LRE) precluded any attempt to safely recover the aircraft and the mishap RPA (MRPA) was ditched into nearby mountainous terrain. At the time of the starter-generator failure, the MRPA was being controlled by a mission control element (MCE) operating from the 28th Bomb Wing, Ellsworth AFB, South Dakota. Estimated cost of aircraft, onboard equipment and munitions damage is $14.1 million. There were no injuries or damage to other government or private property. The wreckage was not recovered.

I determine, by a preponderance of evidence, the cause of the mishap was a failure of the starter-generator. The exact cause of the starter-generator failure was unable to be determined without recovered wreckage.

I find, by a preponderance of evidence, two factors substantially contributed to this mishap: 1) a delay in uploading the applicable software version at the emergency LRE; and 2) not pre-configuring the landing gear for recovery prior to turning off the satellite link.

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

2. CAUSE

I determine, by a preponderance of evidence, that the cause of the mishap was a failure of the starter-generator. As a direct result of the starter-generator failure, backup battery power depleted to the point where the emergency LRE could not safely recover the aircraft and the MRPA was ditched into nearby mountainous terrain. The exact cause of the starter-generator failure was unable to be determined without recovered wreckage. General Atomics stated the symptoms of this starter-generator failure were similar to other starter-generator failures preceded by erratic voltage.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

I find, by a preponderance of evidence, two factors substantially contributed to this mishap: 1) a delay in uploading the applicable software version at the emergency LRE; and 2) not pre-configuring the landing gear for recovery prior to turning off the satellite link.

a. Software Version Upload Delay

The MQ-9A fleet operates multiple versions of Operational Flight Program (OFP) software. While coordinating with the emergency LRE, the MMCC overlooked passing information on the MRPA's OFP software version. Official squadron guidance does not specifically direct to pass the OFP software version to the LRE in an emergency, listing only "other pertinent information as required". The emergency LRE was not using the same OFP software version as the MMCE, and it may have taken longer than the normal 5-10 minutes to locate the software and familiarize with associated checklists to be ready to operate the MRPA.

The MRPA had been loitering approximately 20 minutes near the emergency LRE before line-of-sight uplink (a direct link with the aircraft from a ground transmitter/receiver) was established. Had the MMCC passed the MRPA's OFP software version during his initial coordination, the emergency LRE may have been able to gain control of the MRPA with higher battery voltage, and may have been able to safely recover the aircraft.

b. Landing Gear Pre-configuration

Lowering the landing gear below a certain battery voltage (minimum landing gear voltage, or Vmg) risks losing complete electrical power and aircraft control. During a low electrical power emergency, if the aircraft is sent without link to an emergency LRE with intent to land, lowering the landing gear above Vmg and prior to turning off the satellite link is a prudent decision. The MP did not pre-configure the MRPA based on distance to fly and the belief that there would be enough power available upon reaching the emergency LRE to lower the landing gear. The MP could not have foreseen the delay in uploading software at the emergency LRE; however, the decision to leave the landing gear up in a relatively low voltage condition and unable to monitor further battery depletion did not set-up the emergency LRE for success. Had the MP lowered the landing gear when voltage was sufficient, the emergency LRE may have been able to recover the aircraft with battery voltage at or below Vmg.

These two factors worked in concert to develop the MRPA's unrecoverable condition. If the emergency LRE was able to upload the applicable software more expeditiously, they may have been able to lower the landing gear upon taking control of the MRPA. Conversely, if the MP would have lowered the landing gear prior to turning off the satellite link, the risk of losing aircraft control due to low voltage would have been removed and perhaps the emergency LRE would have attempted to land the aircraft. Breaking either of these links in the chain of events may have prevented the MRPA's unrecoverable condition when the emergency LRE gained control.

The MP did not fail to abide by technical order directives nor was the MMCC negligent in adhering to official guidance. Optimum conditions and foresight were necessary to effect a safe recovery in an extremely time sensitive and complex emergency procedure.

4. CONCLUSION

By a preponderance of evidence, I find the cause of the mishap was a failure of the starter-generator. Further, I find by a preponderance of evidence, two factors substantially contributed to this mishap: 1) a delay in uploading the applicable software version at the emergency LRE; and 2) not pre-configuring the landing gear for recovery prior to turning off the satellite link.

29 May 2015

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

INDEX OF TABS