UNITED STATES AIR FORCE
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 06-3164

196TH RECONNAISSANCE SQUADRON
432D WING
CREECH AIR FORCE BASE, NEVADA

LOCATION: CENTCOM AOR

DATE OF ACCIDENT: 1 MARCH 2015

BOARD PRESIDENT: LT COL DEAN E. BERCK

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

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.

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AUG 14 2015

ACTION OF THE CONVENING AUTHORITY

The Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 1 March 2015 mishap, near CENTCOM Area of Responsibility, involving an MQ-1B, T/N 06-3164, 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
AIRCRAFT ACCIDENT INVESTIGATION

MQ-1B, T/N 06-3164
CENTCOM AOR
01 March 2015

On 1 March 2015, at 0736:28 Zulu time (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, tail number 06-3164, assigned to the 432d Wing, Creech Air Force Base, Nevada, and operated by the 196th Reconnaissance Squadron (RS), 163d Reconnaissance Wing, March Air Reserve Base, California, experienced an electrical short circuit, lost satellite return link, and was lost approximately in the CENTCOM AOR. The short caused total electrical failure, inhibiting sustained flight. The MRPA was not recovered. Estimated cost of the mishap is $3.9 million. No injuries, deaths or damages to private property were reported from the mishap.

On 1 March 2015, at 0503Z, after normal preflight checks, the MRPA departed an air base in the CENTCOM AOR. The Launch and Recovery Element (LRE) handed off the MRPA to the first 196th RS mission control element (MCE) uneventfully at 0547Z. The first MCE then transferred control to the mishap crew (MC) at approximately 0700Z who confirmed that an appropriate emergency mission profile was loaded in case of a lost link event.

The MRPA had been flying for two hours and thirty-three minutes when numerous electrical cautions illuminated between 0736:22Z and 0736:28Z. At 0736:28Z, the aircraft's satellite return link ceased transmitting. The MC performed appropriate lost link emergency checklists, noted the time of 0736Z, and calculated the expected return time, should the aircraft perform its emergency return profile. Ground radars tracked the MRPA until approximately 0741Z and after numerous attempts to restore the link, it was determined that the MRPA would not recover on its own, and recovery efforts began.

The Abbreviated Accident Investigation Board (AAIB) President determined, by a preponderance of the evidence that the cause of this mishap was a short circuit in one of the MRPA's Printed Wiring Boards (PWB) that exceeded the electrical generation capacity of both alternators and then drained both batteries leading to total electrical failure. Without electrical power, the aircraft could not maintain satellite link or sustain flight and therefore prevented the MRPA from flying its emergency lost link profile and caused it to crash.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-1B, T/N 06-3164
01 MARCH 2015

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ACRONYMS AND ABBREVIATIONS

12 AF	Twelfth Air Force
432 WG	432d Wing
432 AEW	432d Air Expeditionary Wing
163 RW	163d Reconnaissance Wing
196 RS	196th Reconnaissance Squadron
A	Amperes
AAIB	Abbreviated Accident Investigation Board
AB	Air Base
A/C	Aircraft
ACC	Air Combat Command
ACCSUP	Air Combat Command Supplement
AETC	Air Education and Training Command
AF	Air Force
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	`Air Force Instruction
AFPD	Air Force Policy Directive
AFTO	Air Force Technical Order
AGM	Air to Ground Missile
AIB	Accident Investigation Board
AMXS	Aircraft Maintenance Squadron
ANG	Air National Guard
AOR	Area of Responsibility
ARB	Air Reserve Base
ATC	Air Traffic Control
ATTN	Attenuation
BFS	Battlespace Flight Services
CA	California
Capt	Captain
DAR	Dual Alternator Regulator
DC	Direct Current
FCIF	Flight Crew Information Files
Fl	Flight Level
ft	Feet
GA	General Atomics
GCS	Ground Control Station
GMCEP	Gaining Mission Control Element Pilot
HDD	Heads Down Display
hrs	Hours
HUD	Heads-Up Display
IAW	In Accordance With
IFOC	Inflight Operational Check
ISR	Intelligence, Surveillance and Reconnaissance
IMDS	Integrated Maintenance Data System
KIAS	Knots Indicated Air Speed
L	Local Time
LCT	Link Communication Technician
LLC	Limited Liability Corporation
LOS	Line of Sight
Lt Col	Lieutenant Colonel
LRE	Launch and Recovery Element
MA	Mishap Aircraft
Maj	Major
MAJCOM	Major Command
MC	Mishap Crew
MCE	Mission Control Element
MIC	Mission Intelligence Coordinator
MMCE	Mishap Mission Control Element
MGCS	Mishap Ground Control Station
mIRC	military Internet Relay Chat
MIL-HDBK	Military Handbook
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSO	Mishap Sensor Operator
MSL	Mean Sea Level
MX	Maintenance
MXPx (1 through 5)	Maintenance Person 1
NAI	Notional Area of Interest
NV	Nevada
OEF	Operation Enduring Freedom
ORM	Operational Risk Management
OS	Operations Supervisor
OSx	Operations Supervisor
POC	Predator Operations Center
PCL	Point Click Loiter
PCM	Primary Control Module
PPSL	Predator Primary Satellite Link
PWB	Printed Wiring Board
RF	Radio Frequency
RL	Return Link
RS	Reconnaissance Squadron
RPA	Remotely Piloted Aircraft
RW	Reconnaissance Wing
SAR	Search and Rescue
SATCOM	Satellite Communications
SCIF	Sensitive Compartmented Information Facility
SIB	Safety Investigation Board
SIPR	Secret Internet Protocol Router Network
SO	Sensor Operator
SPMA	Sensor Processor Modem Assembly
SSRA	System Safety Risk Assessment
TCTO	Time Compliance Technical Order
T/N	Tail Number
T.O.	Technical Order
USAF	United States Air Force
V	Volts
VIT	Variable Information Tables
WG	Wing
WOC	Wing Operations Center
Z	Zulu

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 3 June 2015, Major General Jerry D. Harris Jr., Vice Commander, Air Combat Command (ACC), appointed Lieutenant Colonel (Lt Col) Dean E. Berck to conduct an abbreviated aircraft accident investigation of a mishap that occurred on 1 March 2015 involving an MQ-1B remotely piloted aircraft (RPA) in the CENTCOM AOR and piloted by aircrew via satellite communication from March Air Reserve Base (ARB), California (CA). The abbreviated aircraft accident investigation board (AAIB) was conducted in accordance with (IAW) Air Force Instruction (AFI) 51-503, *Aerospace and Ground Accident Investigations*, Chapter 11, at Nellis Air Force Base (AFB), Nevada (NV), from 8 June 2015 - 8 July 2015. A legal advisor and recorder were also appointed as members of the board (Tab Y-2).

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 actions, and adverse administrative action.

2. ACCIDENT SUMMARY

On 1 March 2015, at 0736:28 Zulu time (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, tail number 06-3164, assigned to the 432d Wing, Creech Air Force Base, Nevada, and operated by the 196th Reconnaissance Squadron (RS), 163d Reconnaissance Wing, March Air Reserve Base, California, experienced an electrical short circuit, lost satellite return link, and crashed in the CENTCOM AOR (Tabs Q-4 through Q-6, DD-4, EE-3). The MRPA was not recovered. The estimated cost of the mishap is $3.9 million (Tabs EE-3, P-4). No injuries, deaths or damages to private property were reported from the mishap (Tab EE-3).

3. BACKGROUND

The MRPA belonged to the 432d Wing (WG), 12th Air Force, Air Combat Command stationed at Creech AFB, NV (Tab AA-3). The mishap crew (MC), consisting of the mishap pilot (MP) and mishap sensor operator (MSO), are assigned to the 196 Reconnaissance Squadron (RS), 163d Reconnaissance Wing, March Air Reserve Base (ARB), California (CA) (Tab G-2 through G-21). Additionally, at the time of the mishap, the MRPA was forward deployed to CENTCOM AOR and was maintained by Battlespace Flight Services (BFS), Limited Liability Company (LLC) (Tabs D-6, CC-14).

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-3 through CC-6).

b. Twelfth Air Force (12 AF)

Twelfth AF is responsible for the combat readiness of ten active-duty wings and one direct reporting unit. The subordinate commands operate more than 818 aircraft with more than 65,000 uniformed and civilian Airmen. The command is also responsible for the operational readiness of 12 AF-gained wings and other units of the Air Force Reserve and Air National Guard (ANG) (Tab CC-7 through CC-9).

c. 432d Wing (432 WG)/432d Air Expeditionary Wing (432 AEW)

The 432d WG and its associated deployed unit, the 432d Air Expeditionary Wing, 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-10 through CC-11).

d. 163d Reconnaissance Wing (163 RW)

The 163d RW is a tenant unit at March ARB, Moreno Valley, CA, which provides dedicated, disciplined and diverse Guardsmen ready to defend the state, nation, and local communities from any threats that compromise the safety, security and well-being of citizens and allies (Tab CC-12 through CC-13).

e. 196th Reconnaissance Squadron (196 RS)

The primary mission of the 196 RS is to support the war on terrorism by providing reconnaissance, flying the MQ-1B Predator, 24 hours a day, 7 days a week (Tab CC-14).

f. Battlespace Flight Services (BFS)

BFS provides organizational maintenance support for MQ-1B aircraft and systems to sustain the combat and

BATTLESPACE
FLIGHT SERVICES, LLC

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-15 to CC-16).

g. 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 (GCS), a Predator Primary Satellite Link (PPSL), and operations and maintenance personnel for deployed 24-hour operations. The basic crew for the MQ-1B Predator is one pilot and one sensor operator. 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-17 to CC-22).

4. SEQUENCE OF EVENTS

a. Mission

On 1 March 2015, the MRPA was authorized by a classified CENTCOM Air Tasking Order to conduct a combat support mission in the CENTCOM AOR (AOR) (Tab K-2). The launch and recovery element (LRE) consisted of a pilot and sensor operator who launched the MRPA from an air base in the CENTCOM AOR, at 0503Z (Tab K-2). During the course of the mission, the MRPA was handed off to a mission control element (MCE) crew, assigned to the 163d RW and located in the mishap ground control station (MGCS) at March ARB, CA (Tabs G-5 and G-13). At 0700Z, the initial MCE crew (MCE1) transferred control of the MGCS and the MRPA to the mishap crew (MC) (Tab R-39). The MC consisted of an Air National Guard (ANG) mishap pilot and ANG mishap sensor operator on Title 10 orders (Tabs T-3, T-6).

b. Planning

On 1 March 2015, at 0400Z, the MC arrived at the 196th RS prior to their scheduled shift start time to accomplish all required preflight mission planning and attended standard pre-mission

briefings (Tabs V-1.1, V-2.1). The crew was given standard pre-mission briefings by the Operations Supervisor and the Mission Intelligence Coordinator (MIC) IAW Air Force instructions (Tabs V-1.1, V-2.1). There is no evidence to suggest mission planning was a factor in this mishap.

c. Preflight

Maintenance person (MXP) number one properly topped off MRPA's batteries and inspected the MRPA (Tab D-6). MXP2 released the MRPA for flight (Tab D-3). The launch and recovery element (LRE) accomplished a standard preflight inspection (Tab V-9.3). During start procedures, the navigation system improperly initialized and therefore, aircraft power was cycled to reset it (Tab V-9.1). Otherwise, at 0503Z, the MRPA was launched from the deployed location uneventfully and began its climb to altitude (Tab V-9.1). The LRE noted high turbocharger oil temperature indications while in the climb to altitude and, therefore reduced the engine's power setting to maintain a normal temperature range (Tab V-9.2). Reducing throttle settings and continuing the mission is a standard practice in the AOR (Tabs V-1.1, V-2.1). LRE then performed handover to MCE1 at 0547Z, communicating the need to continue climbing at the reduced engine power setting (Tab V-9.2). At 0700Z, MCE1 transferred control of the MGCS and the MRPA to the mishap crew (MC) (Tab R-39). The mission proceeded as planned, with no further anomalies detected until 0736:22Z (Tabs DD-5, V-1.1, AA-13).

d. Summary of Accident

On 1 March 2015, at 0736:22Z and level at 12,000 feet (ft) mean sea level (MSL), the MGCS displayed numerous electrical fault indications (Tabs V1.1, V-2.1, AA-13, FF-6). The cautions included "Battery – Leaking Current," "Battery 1 amps – high," "Battery 2 amps – high," "System amps – high," "Flight Computer – volts low," and "Battery 1 – volts low" (Tabs AA-13, FF-6). The MQ-1B displays cautions and warnings as "high – yellow" and "high – red" respectively (Tab FF-6). These indications together point to a power draining short circuit event for which there is no specific checklist (Tabs BB-3 through BB-6, FF-6, DD-4). The aircrew analyzed the situation as probable alternator failure or dual alternator failure, but were unable to take appropriate checklist steps in the six seconds before the satellite datalink that allows the aircrew to control the MRPA from the other side of the world ceased transmitting at 0736:28Z (Tabs V-1.1, V-2.1, AA-13, FF-6).

The mishap crew first ran the lost satellite datalink checklist because no other checklists could be completed or commands sent to the MRPA without the satellite datalink (Tabs V-1.1, V-2.1, AA-13). The MC summoned the on-duty link communications technician (LCT), as directed in step one of the lost link checklist (Tabs V-8.2, BB-6). The LCT confirmed the MGCS link settings were correct, that the MGCS was still sending an appropriate command link signal and that there was indeed no return link signal from the MRPA (Tabs V-8.2, V-8.3). The MP noted the current time of 0736Z and calculated the expected time for the MRPA to complete its lost link emergency routing and return to base (Tabs AA-13, V-8.3). Meanwhile, radar control in the region tracked the MRPA until approximately 0741Z when the MRPA's track disappeared from the radar controller's screen (Tab EE-3). At approximately 0940Z, after numerous attempts to re-establish satellite link and the expiration of the MRPA's possible battery life, the MRPA was declared lost (Tabs V-8.2, V-8.3, BB-8).

e. Impact

The MRPA was not recovered (Tab EE-3).

f. Egress and Aircrew Flight Equipment (AFE)

Not applicable.

g. Search and Rescue (SAR)

A second RPA searched for the MRPA and found possible wreckage, but personnel sent to the scene found only a local burn pit (Tab EE-3). The MRPA was not recovered (Tab EE-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 guidance (Tabs D-3 through D-97). Prior to the mishap sortie, T/N 06-3164 had flown 16,389.2 total hours, 939 sorties and its current engine E2479 had 72 hours (Tab D-2).

The forms indicated no outstanding issues that would have prevented the MRPA from flying on 1 March 2015 (Tabs D-4 through D-83). Turbo oil temperature spike was a recurring write up documented in the forms and at the time of the sortie, there was a request for an inflight operational check (IFOC) (Tab D-6). However, according to MXP4 and a visual inspection of an MQ-1B by AAIB members, the turbo oil lines are not proximal to components of the aircraft electrical power bus (Tab V-6.1). There is no evidence to suggest that turbocharger oil temperature was a factor in this mishap.

The Air Force Technical Order (AFTO) 781 series forms for the MGCS were documented IAW applicable maintenance guidance, except MXP3 performed a Thru-Flight inspection on the MGCS IAW Technical Order (TO) 1Q-1(M)B-2-2, Section III, Paragraph 4.7.2 with zero discrepancies noted, but then logged the inspection in the AFTO 781 series forms as a Pre-Flight (Tabs D-107 through D-130, V-5.2). The discrepancy has been corrected (Tab V-5.2). Also, the MGCS was initially impounded until the cause of the satellite datalink termination could be determined, but deemed worthy of controlled RPAs by 2200Z on 2 March 2015 (Tabs D-130, EE-3). There is no evidence to suggest that the MGCS was a factor in this mishap.

b. Inspections

All MRPA maintenance inspections were completed and documented IAW applicable regulations and TOs (Tabs D-2 through D-106). The engine's last 60-hour inspection and the

aircraft's last 150-hour inspection were complied with on 17 February 2015 at the base by BFS (Tab D-2). There is no evidence to suggest that inspections were a factor in this mishap.

c. Maintenance Procedures

The MRPA's engine was replaced on 13 February 2015 (Tab D-33). Prior to the mishap flight, the MRPA had flown 70 hours since the engine change (Tab D-3). Additionally, on 28 February, IAW AFTO 781 forms, both batteries were replaced as required after 28 days of use, with good operational checks (Tabs D-7, D-8). BFS MXP1 topped off both batteries within twelve hours to flight IAW TO 1Q-(M)B-2-12JG-10-1-12-12-01-010 (Tab D-6). There is no evidence to suggest that maintenance procedures were a factor in this mishap.

d. Maintenance Personnel and Supervision

Civilian contractors with BFS maintained the MRPA in the CENTCOM AOR (Tab U-3). A review of the training records for the maintenance crew showed they were trained, experienced and certified to complete their tasks (Tab U-3). Maintenance personnel received adequate supervision and training while maintaining the MRPA (Tab U-3). MXP2, a maintenance superintendent, signed off the MRPA's exceptional release prior to flight (Tab D-3). 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 (Tabs D-4, D-16). Fuel samples were taken from the servicing fuel carts following the mishap and were within specifications (Tab J-2). There is no evidence to suggest that fuel or oil quality or servicing was a factor in this mishap.

f. Unscheduled Maintenance

Other than the engine change on 13 February 2015, no unscheduled maintenance was performed on the MRPA in the month prior to the mishap flight (Tabs D-2 through D-106).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

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

b. Evaluation and Analysis

The MRPA was orbiting at 12,000 ft MSL at 72 KIAS, when the MRPA's electrical current increased from a normal operating level to abnormally high over a period of 11 seconds beginning at 0736:17, indicating a short circuit (Tabs FF-3 through FF-6, AA-13). Without wreckage, failure analysis focused on the information saved in the data logs, which contain a time-stamped record of aircraft systems' status (Tabs FF-3 through FF-5). The manufacturer,

General Atomics (GA), analyzed the mishap using the data logs and provided a detailed report (Tab DD-4).

GA concluded that the MRPA appeared to operate normally until a unique electrical short circuit (labeled a "slow burn" by GA due to the extensive length of time from initial surge to max current) caused a loss of total electrical power (Tabs DD-4, DD-7). The system current began increasing at 0736:17Z and, at 0736:26Z, reached a peak draw of 237A with batteries one and two dropping rapidly (Tabs AA-13, FF-3 through FF-6). At 0736:28Z, total voltage measured across the MRPA's power bus (the MRPA's system of electrical wires and circuit boards that provide electricity to all aircraft components requiring electricity) was 21.2V, less than the voltage required to support normal SATCOM equipment (specifically, the Sensor Processor Modem Assembly and the SATCOM dish) (Tabs AA-13, FF-3 through FF-6, BB-8). At that time, 0736:28Z, the return signal of the satellite datalink from the MRPA was lost with battery voltages continuing to trend downwards and pending total electrical failure likely (Tabs AA-13, FF-3 through FF-6). Without electrical power, the MRPA could no longer sustain level flight (Tab DD-4).

GA concluded that a "slow burn" short circuit, likely through printed wiring board (PWB) insulation material, was more likely than metal-to-metal short circuits based on the gradual and relatively steady increase to the short's maximum current draw over eleven seconds (Tabs DD-7, FF-3, FF-4). A metal-to-metal short circuit would have been characterized by multiple, sudden spikes in current as conductors made contact, created the short, were damaged by arcing, separated and then repeated over the course of several milliseconds (Tab DD-7).

GA concludes that a PWB connected to the MRPA's power bus was the likely source of the short (TAB DD-7). GA points to either a manufacturing defect in the single layer of insulation between power and ground planes or a short circuit in a capacitor connected to a PWB that would have created heat, and a corresponding breakdown of said insulation, as the possible sources of the "slow burn" short circuit (Tab DD-7). GA reports, this is the only known "slow burn" short circuit known to have occurred on an MQ-1B in flight (Tab DD-4).

7. WEATHER

a. Forecast Weather

The forecasted weather called for low clouds at the planned takeoff time causing the 432d Wing Operations Center to delay the MRPA's takeoff time to 0500Z when the forecast called for few clouds at 6,000 ft above ground level with unlimited visibility (Tab EE-3, W-2).

b. Observed Weather

MC did not observe weather within 30 minutes of the mishap (Tab AA-13).

c. Space Environment

No space weather impacts noted (Tab AA-13).

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 senior instructor pilot (Tab G-5). MP had 3752.2 hours in the MQ-1B since 28 May 2008 and 5277.4 total hours including previous airframes (Tab G-3).

Recent flight time is as follows (Tab G-4):

	Hours	Sorties
Last 30 Days	25.6	8
Last 60 Days	89.2	24
Last 90 Days	135.4	39

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-13). The MSO had 2370.6 hours in the MQ-1B since 31 January 2008 and 2374.4 total hours (Tab G-11).

Recent flight time is as follows (Tab G-12):

	Hours	Sorties
Last 30 Days	25.8	8
Last 60 Days	49.2	14
Last 90 Days	49.2	14

There is no evidence to suggest the MSO'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 (Tabs AA-6 through AA-10).

b. Health

There is no evidence to suggest the health of the MCE contributed to the mishap (Tabs R2 through R25).

c. Pathology

Toxicology results were negative for the MC (Tabs T-9, T-10).

d. Lifestyle

All operational risk management (ORM) scores for the MC were within acceptable limits (Tabs AA-3, AA-4). No lifestyle factors were found to be relevant to this mishap (Tabs R-2 through R-25).

e. Crew Rest and Crew Duty Time

Air Force regulations require aircrew members have proper crew rest prior to performing flight duties. AFI 11-202, Volume 3, *General Flight Rules*, 7 November 2014, AFI 11-202, Volume 3 paragraph 2.1 defines normal crew rest as a minimum of 12 non-duty hours before the flight duty period begins and includes time for meals, transportation, and rest (AFI 11-202, p. 12). The MC arrived to work with the appropriate crew rest (Tabs V-1.2, V-2.1). 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 normal (Tabs V-1.2, V-2.1). There is no evidence to suggest operations tempo contributed to the mishap.

b. Supervision

On the night of the mishap, the MCE received their daily briefings as they came on shift from the Operations Supervisor and the MIC (Tabs V-1.1, V-2.1). The mishap crew was "in the green" on all required GO/NO-GO items tracked by Aviation Resource Management personnel (Tab AA-6 through AA-10). This included completion of required ORM, regular testing, event currencies, Flight Crew Information Files (FCIF) and medically cleared to fly (Tabs AA-3, AA-4, AA-6 through AA-12). There is no evidence to suggest supervision contributed to the mishap.

11. HUMAN FACTORS

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 And Ground Accident Investigations,* 14 April 2015
(2) AFI 51-503_ACCSUP_I, *Aerospace And Ground Accident Investigations,* 05 September 2013
(3) AFI 91-204, *Safety Investigations and Reports,* 12 February 2014
(4) AFI 11-202, Volume 1, *Aircrew Training,* 22 November 2010
(5) AFI 11-202, Volume 2, *Aircrew Standardization/Evaluation Program,* 18 October 2012
(6) AFI 11-202, Volume 3, *General Flight Rules*, 07 November 2014
(7) AFI 11-2MQ-1, Volume 1, *MQ-1 Aircrew Training,* 21 January 2010
(8) AFI 11-2MQ-1, Volume 2, *MQ-1 Crew Evaluation Criteria,* 28 November 2008
(9) AFI 11-2MQ-1&9, Volume 3, *MQ-1 And MQ-9 Operations Procedures,* 01 November 2012

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-1S-77, *Flight Manual – USAF Series MQ-1B System,* 19 December 2013, Change 1 – 5 May 2014, incorporating IS-77 – 8 December 2014
(2) T.O. 1Q1(M)B-1CL-1, *Flight Crew Checklist – All, USAF Series MQ-1B System,* 19 December 2013, Change 1 – 5 May 2014, incorporating IS-75 – 6 May 2014
(3) MIL-HDBK-516B, *Department of Defense Handbook for Airworthiness Certification Criteria,* 26 September 2005
(4) T.O. 1Q-1(M)B-6, *Aircraft Scheduled Inspection and Maintenance Requirements, USAF Series, MQ1B Remotely Piloted Aircraft,* 21 January 2010, Change 8 – 25 June 2014
(5) T.O. 1Q-1(M)B-2-24GS-00-1, *Electrical Power – USAF Series MQ-1B Remotely Piloted Aircraft*, Change 2 – 10 November 2014
(6) T.O. 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentaion, Policies, And Procedures*, 15 June 2011

c. Known or Suspected Deviations from Directives or Publications

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

13. ADDITIONAL AREAS OF CONCERN

Not applicable.

08 JULY 2015

DEAN E. BERCK, Lt Col, USAF
President, Abbreviated Accident Investigation Board

STATEMENT OF OPINION

MQ-1B, T/N 06-3164
CENTCOM AOR
01 March 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 1 March 2015, at 0736:28 Zulu time (Z), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, tail number 06-3164, assigned to the 432d Wing, Creech Air Force Base, Nevada, and operated by the 196th Reconnaissance Squadron, 163d Reconnaissance Wing, March Air Reserve Base, California, experienced an electrical short circuit and lost satellite datalink in the CENTCOM AOR. The MRPA crashed and was not recovered at a loss of $3.9 million. No injuries, deaths or damages to private property were reported from the mishap.

I find by a preponderance of the evidence that the cause of this mishap was a short circuit in one of the MRPA's Printed Wiring Boards (PWB) that exceeded the electrical generation capacity of both alternators and then drained both batteries leading to total electrical failure. Without electrical power, the aircraft could not maintain satellite link or sustain flight and therefore prevented the MRPA from flying its emergency lost link profile and caused it to crash.

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, Air Force Technical Orders and through consultation with maintenance and other subject matter experts.

2. CAUSE

I find by a preponderance of the evidence that the cause of this mishap was a short circuit in one of the MRPA's Printed Wiring Boards (PWB) that exceeded the electrical generation capacity of both alternators and then drained both batteries leading to total electrical failure. At 0736:17 on 1 March 2015, data logs from the mishap ground control station (MGCS) show the MRPA level at 12,000 feet mean sea level with all indications normal. Between 0736:21Z and 0736:26Z, the MGCS displayed numerous electrical fault indications to the mishap crew (MC), initially analyzed as a possible alternator failure. At 0736:26Z, the electrical draw on the batteries rose sharply and the system current peaked well above normal, indicating a short circuit. Meanwhile the available voltage was rapidly decreasing towards the minimum required to sustain satellite link. At 0736:28Z, the MGCS suddenly lost all data from the MRPA when its satellite return

signal ceased. Ground radar stations in the region were able to track the MRPA for another five minutes before the MRPA was last seen on radar at approximately 0741Z. The MQ-1B requires direct current (DC) power to operate the primary control module and the flight control surfaces. Therefore, the subsequent loss of power inhibited the MRPA's ability to fly its emergency recovery profile.

The crew initially ran the lost link checklist and noted a possible alternator failure. The on-duty link communications technician (LCT) was summoned who confirmed GCS link settings were correct, that the GCS was still sending an appropriate command link signal and that there was no return signal from the MRPA. The mishap pilot (MP) noted the time of 0736Z and calculated the expected time for the MRPA to complete its lost link emergency routing and return to base. At 0940Z, after numerous attempts to re-establish link and the expiration of the MRPA's possible battery life, the MRPA was declared lost.

3. CONCLUSION

By a preponderance of the evidence, I find the cause of the mishap was total electrical failure due to a short circuit in one of the MRPA's printed wiring boards, exceeding the alternators' electrical generation capacity and draining the batteries.

08 JULY 2015

DEAN E. BERCK, Lt Col, USAF
President, Abbreviated Accident Investigation Board

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