UNITED STATES AIR FORCE ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 07-3207

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

LOCATION: CENTCOM AOR

DATE OF ACCIDENT: 28 APRIL 2015

BOARD PRESIDENT: LT COL CHRISTOPHER M. OLSEN

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

07 JUN 2016

ACTION OF THE CONVENING AUTHORITY

The Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 28 April 2015 mishap, in the United States Central Command Area of Responsibility, involving an MQ-1B, T/N 07-3207, 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

United States Air Force Abbreviated Accident Investigation Board Report

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

MQ-1B, T/N 07-3207
CENTCOM AOR
28 April 2015

On 28 April 2015, at approximately 0116 hours Local (L), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, tail number 07-3207, assigned to the 432d Wing, Creech Air Force Base, Nevada, and operated by personnel from the 20th Reconnaissance Squadron at Whiteman Air Force Base, Missouri, exited the runway during initial takeoff from an airbase in the United States Central Command Area of Responsibility. The MRPA sustained extensive damage after it exited the runway and came to rest. Damage to the MRPA was estimated at $4.66 million. No injuries, deaths or damage to private property were reported from the mishap.

On 27 April 2015, the mishap crew (MC) reported for duty, received a pre-mission brief, and was assigned two missions for their shift. The MC conducted a successful landing of a remotely piloted aircraft for their first mission. The MC stepped for their second mission at approximately 0030L (28 April 2015) to launch the MRPA. After establishing initial link communication with the MRPA on the default 'wake-up' frequency, the mishap pilot did not switch to the assigned operating frequency. Unbeknownst to the MC, the Ground Data Terminal (GDT) Transmitter #1 (Tx1) was operating in a significantly degraded state, although sufficient to control the MRPA throughout ground operations. At the time of the attempted takeoff, two other GDTs in relatively close physical proximity to the MC's GDT were operating on the same or very similar frequency, creating a cluttered radio frequency environment.

During takeoff roll, the mishap pilot (MP) was correcting for left drift by adding right rudder when the MPRA lost sufficient uplink signal and attempted autonomous takeoff on the high-speed lost link profile. The MC was alerted to the lost link condition of the MRPA and executed the 'Link Failure Below 2,000 Feet AGL or on the Ground' Critical Action Procedure (CAP). The mishap sensor operator was slow to execute the CAP. During this delay, uplink control was momentarily restored, transmitting the MP's right rudder command. This input sent the MPRA sharply back across centerline, toward the right edge of the runway, and into a position from which a successful autonomous lost link takeoff would be highly unlikely given the limited directional control it had available. Uplink was lost again, the aircraft departed the runway onto uneven ground, and it was unable to attain takeoff speed before the landing gear and tails were sheared off.

The Abbreviated Accident Investigation Board (AAIB) President found by a preponderance of the evidence that three substantially contributing factors contributed to the mishap. Improper frequency selection and degraded Tx1 output power combined to create the environment in which the MRPA lost uplink signal and the delayed CAP execution allowed an abrupt command input to be received by the MRPA, substantially decreasing its chances of successfully completing an autonomous lost link takeoff.

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-1B, T/N 07-3207
28 APRIL 2015

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

11 RS	11th Reconnaissance Squadron
12 AF	Twelfth Air Force
20 RS	20th Reconnaissance Squadron
3rd SOS	3rd Special Operations Squadron
432 WG	432d Wing
432 OG	432d Operations Group
451 AEG	451st Air Expeditionary Group
AAIB	Abbreviated Accident Investigation Board
ACC	Air Combat Command
ACCSUP	Air Combat Command Supplement
Acft	Aircraft
AFB	Air Force Base
AFCENT	Air Force Central Command
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFRES	Air Force Reserves
AFTO	Air Force Technical Order
AGL	Above Ground Level
AGM	Air-to-Ground Missile
AMC	Air Mobility Command
AMRAAM	Advanced Medium-Range Air-to-Air Missile
ANG	Air National Guard
AOR	Area of Responsibility
ATO	Air Tasking Order
BFS	Battlespace Flight Services
BP	Board President
CAOC	Combined Air and Space Operations Center
CAP	Critical Action Procedure
CC	Commander
CENTCOM	United States Central Command
Comm	Communications
COS	Chief of Safety
CTAF	Common Traffic Advisory Frequency
Demo	Demonstrate
DO	Director of Operations
DoD	Department of Defense
DVR	Digital Video Recorder
E-mission	Emergency Mission
EP	Emergency Procedures
ER	Exceptional Release
ERS	Expeditionary Reconnaissance Squadron
FCIF	Flight Crew Information Files
FOIA	Freedom of Information Act
Freq	Frequency
Ft	Feet
GA	General Atomics
GCS	Ground Control Station
GDT	Ground Data Terminal
HFACS	Human Factors Analysis and Classification System

Hrs	Hours
IAW	In Accordance With
Interim IO	ISB Investigating Officer
IP	Instructor Pilot
ISB	Interim Safety Board
ISR	Intelligence, Surveillance and Reconnaissance
Kts	Knots
L	Local Time
LEO	Low Earth Orbit
LLC	Limited Liability Corporation
LNO	Liaison Officer
LOS	Line of Sight
Lt Col	Lieutenant Colonel
LR	Launch and Recovery
LRE	Launch and Recovery Element
MAF	Mobility Air Force
MAJCOM	Major Command
Maj Gen	Major General
MC	Mishap Crew
MCE	Mission Control Element
MFR	Memorandum for Record
MFW	Multi-Function Workstation
MGCS	Mishap Ground Control Station
MHz	Megahertz
Min	Minimum
mIRC	military Internet Relay Chat
MO	Missouri
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSO	Mishap Sensor Operator
MTS	Multi-spectral Targeting System
NOTAM	Notice to Airmen
NV	Nevada
Ops	Operations
Ops Sup	Operations Supervisor
ORM	Operational Risk Management
PCS	Permanent Change of Station
PPSL	Predator Primary Satellite Link
Pred	MQ-1B Predator
PRO SUPER	Production Supervisor
RF	Radio Frequency
RL	Return Link
RM	Risk Management
RPA	Remotely Piloted Aircraft
RPM	Revolutions per minute
SAR	Search and Rescue
SFO	Simulated Flameout
SIB	Safety Investigation Board
SO	Sensor Operator
SOC	Squadron Operation Center
SOF	Supervisor of Flying

T/N	Tail Number	Vul	Vulnerability Period
T.O.	Technical Order	WARN SELF	Warnings, Stability, Emergency Mission, Links and Flaps
Tx1, Tx2	Transmitter #1, #2	WG	Wing
USAF	United States Air Force	WOC	Wing Operations Center
U.S.C.	United States Code		
Vs	Versus		

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 24 February 2016, Major General (Maj Gen) Jerry D. Harris, Jr., Vice Commander, Air Combat Command (ACC), appointed Lieutenant Colonel (Lt Col) Christopher M. Olsen to conduct an abbreviated aircraft accident investigation of the 28 April 2015 mishap of an MQ-1B aircraft, tail number (T/N) 07-3207, in the United States Central Command (CENTCOM) area of responsibility (AOR) (Tab Y-3). The abbreviated aircraft accident investigation was conducted in accordance with (IAW) Air Force Instruction (AFI) 51-503, *Aerospace and Ground Accident Investigations*, Chapter 11, at Nellis Air Force Base (AFB), Nevada (NV), from 30 March through 19 April 2016. A legal advisor and recorder were also appointed as members of the board (Tab Y-3). On 9 March 2016, Maj Gen Harris issued an amended convening order detailing Lt Col Olsen along with a new legal advisor and recorder (Tab Y-5).

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, to prepare a publicly releasable report, and to obtain and preserve all available evidence for use in litigation, claims, disciplinary action, and adverse administrative action.

2. ACCIDENT SUMMARY

On 28 April 2015, at approximately 0116 local time (L), the mishap remotely piloted aircraft (MRPA), an MQ-1B, T/N 07-3207, assigned to the 432d Wing, Creech AFB, NV, and operated by the 20th Reconnaissance Squadron (20 RS), Whiteman AFB, Missouri (MO) lost its Ground Data Terminal (GDT) line of sight (LOS) antenna link, departed the runway on initial takeoff and crashed in the CENTCOM AOR (Tabs Q-5 to Q-6 and DD-4). The MRPA sustained extensive damage with the loss valued at $4.66 million (Tabs P-2 and Q-6). There were no injuries or damage to other government or civilian property (Tabs P-2 and Q-6).

3. BACKGROUND

The MRPA belonged to the 432d Wing, 12th Air Force (Air Forces Southern), Air Combat Command stationed at Creech AFB, NV (Tab Q-5). The MC, consisting of the mishap pilot (MP) and mishap sensor operator (MSO), were assigned to the 20 RS, Whiteman AFB, MO (Tab G-8 and G-17). Additionally, at the time of the mishap, the MRPA was forward deployed to CENTCOM AOR and was maintained by Battlespace Flight Services (BFS) (Tab U-3).

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 (Tab CC-3). It also provides command control, communications, and intelligence systems, and conducts global information operations (Tab CC-3).

b. Twelfth Air Force (12 AF)

Twelfth AF is responsible for the combat readiness of seven active-duty wings and one direct reporting unit (Tab CC-9). The subordinate commands operate more than 360 aircraft with more than 20,300 uniformed and civilian Airmen (Tab CC-9). The command is also responsible for the operational readiness of seventeen 12 AF-gained wings and other units of the Air Force Reserve (AFRES) and Air National Guard (ANG) (Tab CC-9).

c. 432d Wing (432 WG)

The 432 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 (Tab CC-13 to CC-14). The 432 WG is charged with unmanned precision attack and intelligence, surveillance, and reconnaissance combat missions and conducts training for RPA aircrew (Tab CC-14).

d. 432d Operations Group (432 OG)

The 432 OG employs remotely piloted aircraft in Combat Air Patrols 365 days a year in support of combatant commander needs and deploys combat support forces worldwide (Tab CC-15). The 432 OG currently oversees global operations of six squadrons, including the 20th Reconnaissance Squadron (Tab CC-15).

e. 20th Reconnaissance Squadron (20 RS)

The 20 RS is a tenant unit at Whiteman AFB, MO, and is part of the 432 OG at Creech AFB, NV (Tab CC-16). The primary mission of the 20 RS is to provide persistent intelligence, surveillance and reconnaissance and full motion video for real-time actionable intelligence and precision weapons employment in combat operations using unmanned aircraft, including the MQ-1B (Tab CC-17).

f. Battlespace Flight Services (BFS)

BFS provides organizational maintenance support for MQ-1B aircraft and systems to sustain the combat and training at tasked locations worldwide (Tab CC-19). The primary objective of BFS is to provide qualified management and supervisory personnel at MQ-1B operational locations, and a level of support for their personnel that allow them to accomplish their objective (Tab CC-19). 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 (Tab CC-19).

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 (Tab CC-21). Given its significant loiter time, wide-range sensors, multi-mode communications suite and precision weapons, the Predator provides a unique capability to perform strike, cooadination and reconnaissance missions against high-value, fleeting and time-sensitive targets (Tab CC-21). Predators can also perform the following missions and tasks: ISR, close air support, combat search and rescue, precision strike, buddy-lase, convoy and raid overwatch, route clearance, target development and terminal air guidance (Tab CC-21). The MQ-1B's capabilities make it uniquely qualified to conduct irregular warfare operations in support of combatant commander objectives (Tab CC-21). 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 (Tab CC-21). The basic crew for the MQ-1B Predator is one pilot and one sensor operator (Tab CC-21). The crew flies the MQ-1B Predator from inside the GCS via an LOS radio data link and via a satellite data link for beyond-LOS flight (Tab CC-21). 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-21).

4. SEQUENCE OF EVENTS

a. Mission

On 27 April 2015, the MRPA was authorized by a classified CENTCOM Air Tasking Order (ATO) to conduct a combat support mission in the CENTCOM AOR (Tab K-3). At 0116L, (28 April 2015) (2246 Greenwich Mean Time (GMT), the MC launched the MRPA from an air base in the CENTCOM AOR (Tabs Q-5, R-3 and R-16). The MC consisted of a MP and MSO from the 20 RS operating out of the mishap ground control station (MGCS) at an air base in the CENTCOM AOR (Tabs G-9, G-18, V-1.1 and V-2.1).

b. Planning

On the day of the mishap, the MC arrived for work at 1815L (27 April 2015), accomplished all required preflight mission planning, and attended the daily pre-mission brief delivered to all crews who would fly during that shift (Tabs Q-5, R-8, V-1.1, and V-2.1). Keeping with the standard practice of providing continuity to the incoming shift, the outgoing Operations Supervisor (Ops Sup) delivered this pre-mission brief (Tab V-1.1 and V-2.2). The briefing elements included weather, notices to airmen (NOTAMs), and other operational elements relevant to that day's missions (Tabs V-1.1, V-2.2, V-3.1, and BB-28 to BB-31). An operational risk management (ORM) worksheet was accomplished prior to the sortie, and the risk was assessed as low for both the MP and MSO (Tab AA-4 to AA-5).

Key mission data, including assigned callsign, uplink and downlink frequencies and mission times were displayed at the Operations Desk on a large monitor (Tab V-3.1 to V-3.2). The daily ATO prescribed much of this key data, with local downlink frequencies being deconflicted and assigned by the Ops Sup and communicated via Skynet (Tab V-3.1 to V-3.2). Skynet is a web portal for all geographically-separated RPA units to transfer information back-and-forth (Tab V-3.1). There is no evidence to suggest mission planning was a factor in this mishap.

c. Preflight

The MC was assigned two missions for their shift and received a pre-departure brief from the Ops Sup IAW governing regulations at approximately 1830L (27 April 2015) (Tabs R-8 and V-2.1 to V-2.2). At approximately 2230L, the MC conducted the first mission of their shift, preforming a successful landing operation of an MQ-1B (Tab R-3 and R-16). The weather was within operational limits (Tab F-2). The MRPA was inspected and released by maintenance personnel for flight (Tab D-4 and D-7). The MP reviewed the Air Force Technical Order (AFTO) 781 series maintenance forms for the MRPA and GCS and found no discrepancies (Tab R-3). The Ops Sup performed the pre-flight inspection and walk-around of the MRPA and no discrepancies were noted (Tab R-3).

At approximately 0015L (28 April 2015), the MC stepped for their second mission (Tabs Q-5 and V-1.3). Ground operations, including the MRPA and MGCS start sequence, were conducted between approximately 0020L and 0115L (Tab DD-18). The procedures to operate a RPA include establishing a radio frequency (RF) link between the GCS and RPA on an initial 'wake-up' (default) frequency, common to all RPAs (Tab V-1.3). Once this initial link is established, standard procedure directs the pilot to switch the GCS/RPA communication to the assigned uplink frequency which was previously deconflicted from other RPA operating frequencies to prevent signal confliction (Tab V-1.3). The 'Aircraft Initial Link' checklist was completed by the MC, but neither the MP nor MSO recall what frequency was input, but the General Atomics (GA) technical report states the system operated from start-up through taxi and attempted takeoff on the default frequency (Tabs V-1.3, V-2.2, DD-9, and DD-31).

d. Summary of Accident

During the start sequence, the MP did not switch the GDT Transmitter #1 (Tx1) from the default frequency to the assigned mission frequency as directed by the checklist (Tabs BB-4 and DD-9).

The MGCS and MRPA were communicating effectively at this point, but still on the default frequency (Tab DD-9 to DD-11). The MC accomplished the C-band Link Test pre-flight check IAW the checklist and experienced no unexpected performance degradation (Tabs R-3 and DD-10 to DD-11). GDT Tx1 was correctly selected for taxi and takeoff in accordance with checklist procedures (Tabs BB-5 and DD-5).

The MC experienced signal degradation during the taxi from the parking ramp to the end of the runway, but this was reported as a regular occurrence due to the spatial orientation of the parking ramp, GDT antennae, and taxi route (Tab V-1.3). The indicators of this degradation subsided and the MC continued to taxi with sufficient control (Tab V-1.3). After an approximate twenty-minute delay at the end of the runway for rubber removal (a normal process during which rubber residue deposited on the runway by landing aircraft is removed), the MC taxied the MRPA onto the runway and initiated the takeoff (Tab V-1.4).

The MC attempted takeoff of the MRPA at 0115L (Tab DD-18). At this time, 3 of the 6 local GDTs were powered on and transmitting on the same or similar frequencies, creating a cluttered RF environment (Tab DD-31). The MQ-1B Flight Manual states uplink frequencies should be separated by a minimum of 5 megahertz (Tab BB-8).

Approximately 20 seconds into the takeoff roll, the uplink signal was interrupted, initiating the Lost Link profile (Tab DD-20). This happened just after the MRPA exceeded the 40 knot transition speed, triggering the high-speed lost link logic, which commands the RPA to continue the takeoff by selecting full power and maintaining the previously input magnetic runway heading (Tab V-1.4).

During the takeoff roll, the MRPA started to gently drift left of center line (Tab V-1.4). The MP added a right rudder command to counter the drift but observed the MRPA was not responding to his commands to correct to centerline (Tabs R-4 and V-1.4). This was because the MRPA had already stopped receiving uplink commands (Tab DD-20). While the MP was analyzing the apparent non-responsiveness of the MRPA, he continued to add right rudder commands (Tabs R-3 and V-1.4). Almost simultaneously, the lost link logic initiated, producing warnings in the GCS alerting the MC to the lost link condition of the MRPA (Tabs N-6 and DD-20). Two seconds later, the MP commanded "Uplink/Command Link – Off," expecting the MSO to perform the Critical Action Procedure (CAP) and move the GDT power switch to the off position (Tabs N-6, R-4, BB-6, BB-12, and V-1.4).

Over a 6 second period, the MP verbalized the CAP twice, directed the MSO to "Get up," and verbalized the CAP a third time (Tab N-6). The MSO verbally responded on the third command, stood up, and turned off the GDT power switch IAW the 'Link Failure Below 2,000 Feet AGL or on the Ground' checklist (Tabs N-6, V-2.4, and BB-6). This procedure functions to prevent pilot input signals from being transmitted to the RPA which may interfere with the RPA's lost link logic takeoff attempt (Tabs V-2.4 and BB-12).

Approximately 8 seconds elapsed between the initiation of lost link logic and the GDT power switch being moved to the off position (Tabs DD-20 and N-6). During this time, uplink signal was restored for a brief moment (Tab DD-5 and DD-20). This momentary uplink restoration resulted in a throttle idle command and a significant right rudder command being sent to the MRPA (Tab DD-12 and DD-20).

The MRPA executed the throttle idle and right rudder commands which sent the MRPA abruptly toward the right side of the runway (Tab DD-12 and DD-19 to DD-20). The MP observed the abrupt move to the right, and quickly countered with a corrective left rudder command (Tabs R-4 and DD-19). At this point, the uplink signal was lost again, driving the MRPA back into high-speed lost link logic, selecting full power and commanding the nose wheel to a neutral position where it remained until impact (Tab DD-4 and DD-20).

e. Impact

At approximately 0116L, the MRPA exited the runway with an approximate 30 degree diverging vector from runway heading (Tab DD-6 and DD-20). The MRPA had not attained sufficient speed for rotation and takeoff prior to exiting the runway (Tab DD-4). The MRPA was unable to become airborne when the landing gear and tails sheared off as it traveled across the unprepared surface (Tab DD-12). The aircraft came to rest on the north side of the runway on rising terrain (Tab S-10). Approximately 30 seconds after turning off the GDT power, the GDT Tx1 was turned off, and GDT power was turned back on in order to regain downlink and observe the MRPA at rest off the runway (Tabs V-1.4 to V-1.5 and DD-7).

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

The AFTO 781 series maintenance forms for the MRPA were documented IAW applicable maintenance guidance (Tab D-3 to D-9). Prior to the mishap sortie, T/N 07-3207 had flown 10,167 total hours, 674 sorties, and 77 total engine hours (Tab D-2 and D-4).

The forms indicate all scheduled MRPA maintenance has been complied with on or before the projected due dates and times (Tab D-3 to D-9). All records indicate completion and follow-on maintenance had been accomplished on 22 April 2015 (Tab D-3 to D-9). There is no evidence to suggest aircraft maintenance was a factor in this mishap.

The AFTO 781 series maintenance forms for the GCS were documented IAW applicable maintenance guidance (Tab D-10 to D-13). Recently, there had been a scheduled 7-day Periodic Maintenance Inspection on 24 April 2015 and the forms indicate all maintenance had been completed (Tab D-10 to D-13).

During the review of the active AFTO 781 series maintenance forms, multiple delayed discrepancies were noted for non-critical parts on back order and unavailable aircraft downtime for non-essential maintenance (Tab D-10). There is no evidence to suggest these discrepancies were factors in this mishap.

b. Inspections

All MRPA and MGCS maintenance inspections were completed and documented IAW applicable regulations and AFTO 781 series maintenance forms (Tab D-3 to D-13). The last scheduled MRPA inspection was conducted on 22 April 2015 (Tab D-2). The last scheduled MGCS inspection was conducted on 24 April 2015 (Tab U-4). There is no evidence to suggest that inspections were a factor in this mishap.

c. Maintenance Procedures

There is no evidence to suggest that maintenance procedures, practices or performance were a factor in this mishap.

d. Maintenance Personnel and Supervision

Civilian contractors with BFS maintained the MRPA at an air base in the CENTCOM AOR (Tab V-1.2). A review of the maintenance crew's training records showed they were supervised, trained, experienced, and certified to complete their tasks (Tab U-3). Pre-flight and through-flight inspections were completed (Tab D-11). There is no evidence to suggest maintenance or supervision of maintainers was a factor in this mishap.

e. Fuel, Hydraulic, and Oil Inspection Analyses

The MRPA was refueled and the MRPA's oil was serviced and inspected prior to the mishap flight with no discrepancies reported (Tab V-4.1). A fuel sample test was conducted pre- and post-mishap and no discrepancies were reported (Tab U-5 to U-6). There is no evidence to suggest fuel, oil or the hydraulic system was a factor in this mishap.

f. Unscheduled Maintenance

There is no evidence to suggest that unscheduled maintenance was a factor in this mishap.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

The aircraft sustained substantial damage during the crash when the landing gear and tails were sheared off (Tab DD-6). The bottom of the MRPA nose section was significantly fractured and the sensor ball was ripped off (Tab S-3).

b. Evaluation and Analysis

GA analysts determined the factual correlation between the mishap flight datalogs and described sequence of events (Tab DD-4 to DD-32). Prior to the lost link event during attempted takeoff, the MRPA followed all commands from the MGCS and no warnings or faults were noted (Tab DD-6).

The mishap GDT LOS Tx1 was returned and tested at GA (Tab DD-7). Specifically, it was tested to verify actual transmitted power across the required output frequencies (Tab DD-7). The test showed that the mishap GDT LOS Tx1 output power was less than 1% of the designed and expected output (Tab DD-8).

These results are consistent with the recorded output power values of mishap GDT transmitters recorded by the datalogs which show approximately 0.5% for Tx1 and 100% for Tx2 when selected (Tab DD-18).

7. WEATHER

a. Forecast Weather

There is no evidence to suggest that forecast or observed weather was a factor in this mishap.

b. Observed Weather

The observed weather at the time of the mishap was: at 2040 Zulu, visual approach, runway 23 in use, bird watch condition - low to moderate, runway condition - dry, winds heading - 130 degree at 3 knots, unrestricted visibility, sky clear, temperature - 17, dew point – negative 8, altimeter - 30.03 (Tabs F-2 and N-5).

c. Space Environment

Not applicable.

d. Operations

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

8. CREW QUALIFICATIONS

a. Mishap Pilot (MP)

The MP was a current and qualified MQ-1B pilot (Tab G-19 and G-25). MP had 788.7 hours in the MQ-1B (Tab G-7). MP deployed to the CENTCOM AOR in late January 2015 (Tab V-1.1). Of the 788.7 hours he had, only approximately 45 hours had been during launch and recovery (LR) operations (Tab G-7 and G-61).

Recent flight time is as follows (Tab G-7):

	Hours	Days Flown
Last 30 Days	17.1	12
Last 60 Days	27.2	22
Last 90 Days	36.0	43

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-86 and G-91). The MSO had 929.7 hours in the MQ-1B (Tab G-16). MSO deployed to the CENTCOM AOR in late March 2015 (Tab V-2.1). Of the 929.7 hours he had, only approximately 30 hours had been during launch and recovery (LR) operations (Tab G-16 and G-125).

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

	Hours	Days Flown
Last 30 Days	19.5	13
Last 60 Days	21.9	18
Last 90 Days	43.3	27

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 (Tab AA-6).

b. Health

There is no evidence to suggest the health of the MC was a factor in this mishap.

c. Pathology

The toxicology results were negative for the MC (Tab T-3 and T-4).

d. Lifestyle

There is no evidence to suggest lifestyle factors were a factor in this mishap.

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, 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 (Tab BB-26). The MC arrived to work with the appropriate crew rest (Tab R-9 and R-20). There is no evidence to suggest crew rest was a factor in the mishap.

10. OPERATIONS AND SUPERVISION

a. Operations

At the time of the mishap, operations tempo was standard for deployed LR operations, where the MP had flown missions on 12 of the preceding 30 days and the MSO had flown on 13 of the preceding 30 days (Tab G-7 and G-16). The MP had completed ORM on 27 of the previous 30 days and the MSO completed ORM on 25 of the previous 30 days (Tab AA-4 to AA-5). While they may not have flown on all of these days, a completed ORM indicates they were at work and available to perform LR duties (Tab AA-4 to AA-5). Operations were 24/7, broken into three 8-hour shifts (Tab R-30). Transitioning between shifts was common and occurred frequently (Tab V-2.2). Operations tempo was elevated and may have contributed to the MP's slightly increased ORM score for Circadian Rhythm and Fatigue as will be discussed further in the Human Factors Analysis section (Tab AA-4).

b. Supervision

On the day of the mishap, the assigned Ops Sup accomplished all required supervisor duties (Tabs V-1.2, V-2.2, and AA-7). The GO/NO-GO tracker showed that the MP and MSO had met all GO/NO-GO required items (Tab AA-3). ORM calculation were completed and recorded by both the MP and MSO (Tab AA-4 to AA-5). There is no evidence to suggest supervision contributed to the mishap.

11. HUMAN FACTORS ANALYSIS

The AAIB considered all human factors as prescribed in the Department of Defense Human Factors Analysis and Classification System (DoD HFACS) 7.0 (Tab BB-18 to BB-22). The AAIB identified four human factors relevant to this mishap: (1) Checklist Not Followed Correctly; (2) Not Paying Attention; (3) Fatigue; and (4) Negative Habit Transfer.

a. Checklist Not Followed Correctly – DoD HFACS AE102 (Acts)

Checklist Not Followed Correctly is a factor when the individual, either through an act of commission or omission, makes a checklist error or fails to run an appropriate checklist (Tab BB-22).

The first instance of this factor is during initial ground operations, at approximately 0025L, when the MP failed to correctly accomplish the 'Aircraft Initial Link' checklist by not switching from the default to the assigned frequency (Tabs N-2, BB-4, and DD-9). This error was not caught or fixed for the duration of ground operations or attempted takeoff (Tab DD-9).

The second instance of this factor is during the MRPA lost link event on takeoff roll at 0116L, when the MSO failed to correctly accomplish the 'Link Failure Below 2,000 Feet AGL or on the Ground' CAP (Tabs N-6, V-2.4, and BB-6). This is a one-step checklist that must be performed immediately without reference to a written checklist (Tab BB-10). It was approximately 6 seconds from the time the MP called the CAP until the MSO executed the CAP by flipping the GDT switch off (Tabs N-6 and DD-20).

b. Not Paying Attention – DoD HFACS PC101 (Mental Precondition)

Not Paying Attention is a factor when there is a lack of state of alertness or a readiness to process available information immediately. The individual has a state of reduced conscious attention due to a sense of security, self-confidence, boredom or a perceived absence of threat from the environment. This may often be a result of highly repetitive tasks (Tab BB-21).

The checklist states that the GDT Tx1 should be switched from the default frequency to the operating frequency shortly after initial link is established (Tab BB-4). The MP stated that he ran the initial link checklist (Tabs R-3 and V-1.2). The GA report shows that the GDT Tx1 was left on the default frequency for the duration of ground operations through attempted takeoff (Tab DD-9). There is no evidence of extenuating circumstances which would account for the failure of the MP to complete the required frequency change.

c. Fatigue – DoD HFACS PC307 (Physical Problem Precondition)

Fatigue is a factor causing diminished physical/mental capability resulting from chronic or acute periods of prolonged wakefulness, sleep deprivation, jet lag, shift work or poor sleep habits (Tab BB-20).

The day prior to the mishap shift (26 April 2015), the MP was on day shift, arriving for duty at 1000L and returning to quarters at 1900L (Tab R-9). He arrived for duty the next day at 1815L (27 April 2015) to work the mid-shift (Tab R-8). In order to transition from day-shift to mid-shift, he stayed awake until 0445L and slept until 1645L (27 April 2015) (Tab R-8). When he arrived on shift the day of the mishap, the MP scored his 'Circadian Rhythm' a 4 correlating to the statement 'Sleep Pattern Interrupted (War Time Ops), Able to Go Back to Sleep (4-6)' (Tab AA-4). The MP also selected a 4 in the Fatigue section, correlating to the statement 'Tired, but manageable now, need day off soon) (Tab AA-4).

d. Negative Habit Transfer – DoD HFACS PC105 (Mental Precondition)

Negative Habit Transfer is a factor when the individual reverts to a highly learned behavior used in a previous system or situation and that response is inappropriate for current task demands (Tab BB-21).

The single time-critical step in the 'Link Failure Below 2,000 Feet AGL or on the Ground' checklist is executed differently and by a different member of the crew depending on which phase of operation the crew is engaged in (Tabs BB-12 and V-2.4). During LR operations, this step is accomplished by the MSO moving the GDT power switch to the off position. During Mission Control Element (MCE) operations, this step is accomplished by the pilot via pull-down menu on the control screen (Tabs BB-12 and V-2.4).

The MSO completed initial qualification training in October 2013 and at the time of the mishap had approximately 930 flight hours (Tab G-16 and G-86). In preparation for his deployment, the MSO recently completed LR training at the end of January 2015, receiving approximately 11 hours of flight time in the formal training course (Tab G-18 and G-125). Once complete with LR training, the MSO returned to home station for roughly 1.5 months before deploying (Tab V-2.1). During this time he returned to Creech AFB and flew an LR currency sortie (Tab V-2.1). Once at the deployed air base in the CENTCOM AOR, the MSO entered the local seasoning program and accomplished the required 15 takeoff and landing events between 1 April and 27 April 2015 (Tab T-5). Throughout initial qualification, his currency ride, and seasoning, all LR operations the MSO conducted had been under the supervision of an Instructor Sensor Operator or an experienced Sensor Operator (Tabs G-125, T-5, and V-2.5). The mishap sortie was the first time the MSO had performed LR operations unsupervised (Tab V-2.5). Of the 930 flight hours he had, only approximately 30 hours had been during LR operations (Tabs G-16, G-125, and T-5).

In the 15 months the MSO had been qualified, 97% of his flight hours were spent in MCE operations, where the crew member responsible for executing the critical CAP step is the pilot (Tabs G-16, G-125, T-5, and BB-12). In MCE operations, the MSO is not the one to perform the critical step (Tabs V-2.4 and BB-12). Only after the MP directed the MSO to "Get up" and called for the CAP a third time did the MSO realize that, in this circumstance, (LR operations), he was responsible for performing the CAP by standing up and turning the GDT power off (Tab V-2.4).

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,* 28 January 2016
(3) AFI 91-204, *Safety Investigations and Reports*, 12 February 2014
(4) AFI 11-202, Volume 3, General Flight Rules, 13 April 2015
(5) Air Force Guidance Memorandum to AFI 11-202 Volume 3, *General Flight Rules*, 13 April 2015

(6) AFI 11-2MQ-1&9 Volume 3, *MQ-1 And MQ-9 Operations Procedures*, 1 November 2015

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

b. Other Directives and Publications Relevant to the Mishap

(1) T.O. 1Q-1(M)B-1, *Flight Manual – USAF Series MQ-1B System*, 20 March 2015, Change 1 – 18 August 2015

(2) T.O. 1Q-1(M)B-1CL-1, *Flight Crew Checklist – All, USAF Series MQ-1B System*, 20 March 2015, Change 1 – 18 August 2015

c. Known or Suspected Deviations from Directives or Publications

No additional deviations noted.

19 APRIL 2016

CHRISTOPHER M. OLSEN, Lt Col, USAF
President, Abbreviated Accident Investigation Board

STATEMENT OF OPINION

MQ-1B, T/N 07-3207
CENTCOM AOR
28 April 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 28 April 2015, at approximately 0116 hours Local (L), the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, tail number 07-3207, assigned to the 432d Wing, Creech Air Force Base, Nevada, and operated by personnel from the 20th Reconnaissance Squadron at Whiteman Air Force Base, Missouri, exited the runway during initial takeoff from an airbase in the United States Central Command (CENTCOM) Area of Responsibility (AOR). The MRPA sustained extensive damage after it exited the runway and came to rest. Damage to the MRPA is estimated at $4.66 million. No injuries, deaths or damage to private property were reported from the mishap.

On 27 April 2015, the mishap crew (MC) reported for duty at 1815L, received a pre-mission brief, and was assigned two missions for their shift. The MC conducted a successful landing of a remotely piloted aircraft (RPA) for their first mission. At approximately 0015L, the MC stepped for their second mission to launch the MRPA. After establishing initial link communication with the MRPA on the default 'wake-up' frequency IAW the 'Aircraft Initial Link' checklist, the MP did not switch to the assigned operating frequency. Unbeknownst to the MC, the Ground Data Terminal (GDT) Transmitter #1 (Tx1) was operating in a significantly degraded state, although sufficient to control the MRPA throughout ground operations. At the time of the attempted takeoff, 0116L, two other GDTs in relatively close physical proximity to the MC's GDT were operating on the same or very similar frequency, creating a cluttered radio frequency (RF) environment.

During takeoff, the MP attempted to maintain centerline by increasing right rudder inputs as the MRPA slowly drifted left. At this time, the MPRA lost sufficient uplink signal and attempted autonomous takeoff on the high-speed lost link profile. The MC was alerted to the lost link condition of the MRPA and executed the 'Link Failure Below 2,000 Feet AGL or on the Ground' Critical Action Procedure (CAP). The CAP is designed to prevent spurious uplink commands from interfering with the MRPA's lost link profile execution during this critical phase of flight. The mishap sensor operator (MSO) was slow to execute the CAP.

During this delay, uplink control was momentarily restored, transmitting the MP's right rudder command. This input sent the MPRA sharply back across centerline and toward the right edge of the runway. At this point, the uplink signal was lost again and the MPRA returned to high-speed lost link logic attempting to takeoff, but with a significant vector toward the right edge of the runway. High-speed lost link logic commanded the nose gear to the neutral position, depriving the MRPA of the sufficient directional control authority to overcome the large vector off the runway. The MPRA was likely attempting to regain runway heading with only the limited directional control provided by the rudder as it exited the runway to the right. Once the MRPA departed the runway, it was on uneven ground and unable to attain rotation and takeoff speed before the landing gear and tails were sheared off.

I find by a preponderance of the evidence that three substantially contributing factors contributed to the mishap. Improper frequency selection and degraded GDT Tx1 output power combined to create the environment in which the MRPA lost uplink signal and the delayed CAP execution allowed an abrupt command input to be received by the MRPA, substantially decreasing its chances of successfully completing an autonomous lost link takeoff.

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 subject matter experts.

2. SUBSTANTIALLY CONTRIBUTING FACTORS

a. Improper GDT Tx1 Frequency Selected

All RPAs initialize during start-up operations on a default frequency. Shortly after start up, this frequency should have been changed to the assigned working frequency which was previously deconflicted from any other scheduled RPAs to prevent RF interference. Immediately following start-up, the MP did not input the assigned working frequency IAW checklist procedure. Instead, the MPRA remained on the default frequency for the duration of ground operations and taxi, during which time the MC was able to control the MRPA on the default frequency. At the time of attempted takeoff, two other GDTs were operating on the same or very similar frequency, one matching the default exactly and the other only 1 megahertz different. Three transmitters operating in relative close proximity in both physical location and RF spectrum created an unusually cluttered RF environment. Due to the critical nature of such interference during launch operations, procedures are put in place to mitigate such circumstances. By neglecting to switch to the assigned frequency, the MP increased the chances of experiencing RF interference. This oversight may have been caused by fatigue, likely attributed to the shift change he had just experienced.

b. Degraded GDT Tx1 Output Power

Post-mishap analysis of the GDT Tx1 revealed that its output was substantially degraded, producing less than 1% of the expected power. While the degraded power was sufficient to maintain uplink control of the MRPA during ground operations, this signal was not strong enough to successfully communicate with the MRPA through the cluttered RF environment.

c. Delayed CAP Execution

The MRPA lost link while it was drifting slightly left. At this point, high-speed lost link logic was initiated, which should have allowed the MRPA to proceed autonomously and takeoff successfully. Observing the left drift, the MP correctly input increasing right rudder corrections to correct back to centerline, but the MRPA was not receiving commands at that point. The MC realized the MRPA was no longer responding to their input and the MP appropriately verbalized the 'Link Failure Below 2,000 Feet AGL or on the Ground' CAP. There was a 6 second delay from the MP's verbalization of the CAP to the MSO turning the GDT power switch off.

The MSO's delay was due to negative habit pattern transfer from Mission Control Element (MCE) operations where it is not the MSO but the MP who performs the single critical action to apply the 'Link Failure Below 2,000 Feet AGL or on the Ground' CAP. The MSO heard the MP's command the first time, but it took two more verbalizations of the CAP and a direction to "Get up" for the MSO to realize his cognitive lapse, jump up, and turn off the GDT power switch. The MSO has just recently been qualified in launch and recovery (LR) operations, and 97% of his approximately 930 hours were MCE operations vice LR operations.

Over the course of this delay, the MRPA momentarily regained uplink control, received a significant right rudder command and then lost uplink again. While the GDT power switch was still on, the GDT continued to transmit control signals and, for a brief moment, the MRPA received the signal. This momentary signal directed the MPRA into an orientation from which a successful high-speed lost link takeoff was significantly less likely. Had the GDT power been turned off immediately, control commands would not have been transmitted to the MRPA, leaving it in a position from which a successful takeoff would have been more likely.

3. CONCLUSION

I find by a preponderance of the evidence that three substantially contributing factors contributed to the mishap. Improper frequency selection and degraded GCT Tx1 output power created the environment in which the MRPA lost uplink signal and the delayed CAP execution allowed an abrupt command input to be received by the MRPA, substantially decreasing its chances of successfully completing an autonomous lost link takeoff.

19 APRIL 2016

CHRISTOPHER M. OLSEN, Lt Col, USAF
President, Abbreviated Accident Investigation Board

INDEX OF TABS