UNITED STATES AIR FORCE ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-9A, T/N 12-4175

361ST EXPEDITIONARY RECONNAISSANCE SQUADRON
332ND AIR EXPEDITIONARY WING
INSTALLATION WITHHELD

LOCATION: UNITED STATES CENTRAL COMMAND AREA OF RESPONSIBILITY

DATE OF ACCIDENT: 6 MAY 2017

BOARD PRESIDENT: LT COL JASON P. WILLEY

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 DEPUTY COMMANDER
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30 APR 2018

ACTION OF THE CONVENING AUTHORITY

The Report of the Abbreviated Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 6 May 2017 mishap involving MQ-9A, T/N 12-4175, 361st Expeditionary Reconnaissance Squadron, 332d Expeditionary Wing, United States Central Command Area of Responsibility, complies with applicable regulatory and statutory guidance; on that basis it is approved.

//Signed//

JOHN K. MCMULLEN
Major General, USAF
Deputy Commander

Agile Combat Power

EXECUTIVE SUMMARY
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION

MQ-9A, T/N 12-4175
US CENTCOM AOR
6 May 2017

On 6 May 2017, at about 2238 Zulu Time (Z), the mishap aircraft (MA), an MQ-9A, tail number 12-4175, assigned to the 432d Wing (432 WG), and operated by the 361st Expeditionary Reconnaissance Squadron (361 ERS), 332d Air Expeditionary Wing (332 AEW), crashed in the United States Central Command Area of Responsibility after MA handover from the Mission Control Element (MCE) to the Launch and Recovery Element (LRE). The MA was destroyed following impact with terrain and no wreckage was recovered. The loss of Government property was valued at $10,310,434. There were no reported fatalities, injuries or damage to civilian property.

At about 2003Z, the LRE mishap crew (MC) gained control of the MA. The MC consisted of the mishap pilot (MP), the mishap instructor pilot, and the mishap sensor operator. After handover, the MC ran through standard checklists. In accordance with the checklists, the MP updated the emergency mission (EM) start point and attempted to send the EM to the MA. The MP elected to power down the Interim Modem Assembly (IMA) before landing, which severed the MA's link to the MCE. At about 2025Z, the Ground Control Station lost downlink from the MA on final approach to the airfield due to interference by another MQ-9A transmitting on high power on the ground. As a result, the MC lost situational awareness of the MA.

Approximately one minute after the loss of downlink, the MC terminated uplink in accordance with emergency procedures, which caused the MA to execute its EM. The MP's attempt to send the LRE EM to the MA, as required after handover, was unsuccessful. Therefore, the MA executed the last EM received from the MCE. In accordance with the MCE EM, the MA flew away from the airfield with its downlink transmitters disabled. Despite efforts, neither the LRE nor MCE could recover link to the MA. The MCE crew did not delete any EM waypoints before handover to LRE. As a result, the MA had insufficient fuel to fly through all EM waypoints before returning to the LRE airfield. The MA crashed while executing the MCE EM two hours and 13 minutes after losing downlink.

The Abbreviated Accident Investigation (AAIB) President found by a preponderance of the evidence that the causes of the mishap were: (1) the unintentional downlink interference from a ground-based MQ-9A transmitting on high power, and (2) the failure to successfully send an LRE EM to the MA after handover from the MCE. The AAIB President found by a preponderance of the evidence that factors that substantially contributed to the mishap were: (1) the LRE practice of disabling the IMA before landing, and (2) the MCE practice of not deleting EM waypoints before LRE handover.

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 12-4175
6 MAY 2017

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

12 AF	12th Air Force
332 AEW	332d Air Expeditionary Wing
361 EATKS	361st Expeditionary Attack Squadron
361 ERS	361st Expeditionary Reconnaissance Squadron
432 WG	432d Wing
ACC	Air Combat Command
AFB	Air Force Base
AFI	Air Force Instruction
AFSOUTH	Air Forces Southern
AFTO	Air Force Technical Order
AGL	Above Ground Level
AAIB	Abbreviated Accident Investigation Board
AFSOC	Air Force Special Operations Command
AIB	Accident Investigation Board
AOR	Area of Responsibility
ATC	Air Traffic Control
ATO	Air Tasking Order
CC	Commander
CS	Chief of Safety
CTR	Contractor
DoD	Department of Defense
EM	Emergency Mission
GA-ASI	General Atomics Aeronautical Systems
GCS	Ground Control Station
GDT	Ground Data Terminal
GP	Ground Pilot
GSO	Ground Sensor Operator
HDD	Heads Down Display
HFACS	Human Factors Analysis and Classification System
IMA	Interim Modem Assembly
ISR	Intelligence, Surveillance, and Reconnaissance
LAO	Local Area Orientation
LRE	Launch and Recovery Element
LREP	Launch and Recovery Element Pilot
LRESO	Launch and Recovery Sensor Operator
MA	Mishap Aircraft
MC	Mishap Crew
MCE	Mission Control Element
MCEP	Mission Control Element Pilot
MCEP2	Mission Control Element Pilot 2
MCESO	Mission Control Element Sensor Operator
MIP	Mishap Instructor Pilot
mIRC	Internet Relay Chat
MM	Maintenance Member
MP	Mishap Pilot
MSO	Mishap Sensor Operator
MSL	Mean Sea Level
NOTAMs	Notices to Airmen
ORM	Operational Risk Management
RF	Return Frequency
RPA	Remotely Piloted Aircraft
SFO	Simulated Flame Out
SIB	Safety Investigation Board
T/N	Tail Number
TO	Technical Order
USAF	United States Air Force
US CENTCOM	United States Central Command
V	Volume
Z	Zulu Time

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 9 January 2018, Major General John K. McMullen, Deputy Commander, Air Combat Command (ACC), appointed Lieutenant Colonel Jason P. Willey as the Abbreviated Accident Investigation Board (AAIB) President to investigate the 6 May 2017* accident involving an MQ-9A aircraft, tail number (T/N) 12-4175 (Tab Y-2 to Y-3). An AAIB was conducted at Nellis Air Force Base (AFB), Nevada, from 18 January 2018 to 14 February 2018, in accordance with the provisions of Air Force Instruction (AFI) 51-503, *Aerospace and Ground Accident Investigations*, Chapter 11 (Tab Y-2 to Y-3). A legal advisor and a recorder were also appointed to the AAIB (Tab Y-2). Two subject matter experts in launch and recovery and aircraft maintenance were appointed to advise the board but not serve as members (Tab Y-4 and Y-5).

b. Purpose

In accordance with AFI 51-503, this abbreviated 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 6 May 2017, at approximately 22:38:25 Zulu Time (Z), the mishap aircraft (MA), an MQ-9A with T/N 12-4175, operated by the 361st Expeditionary Reconnaissance Squadron (361 ERS), crashed after aircraft handover from the Mission Control Element (MCE) to the Launch and Recovery Element (LRE) (Tabs J-2 to J-3, V-12.1, and Z-2). The MA impacted terrain in the United States Central Command (US CENTCOM) Area of Responsibility (AOR) after running out of fuel while executing the MCE emergency mission profile (Tab V-2.5 and V-12.1). The LRE mishap crew (MC) consisted of a mishap pilot (MP), mishap sensor operator (MSO), and mishap instructor pilot (MIP), all assigned to the 361 ERS (Tab V-12.1). The MA was destroyed following impact with terrain and no wreckage was recovered (Tab V-2.5 and V-12.2). The loss of Government property was valued at $10,310,434 (Tab P-2). There were no reported fatalities, injuries or damage to civilian property (Tab V-12.1).

3. BACKGROUND

The MA belonged to the 432d Wing (432 WG), Twelfth Air Force (12 AF), ACC, based at Creech AFB, Nevada, but it was operated by the 361 ERS, 332d Air Expeditionary Wing (332 AEW), based in the US CENTCOM AOR during the mishap (Tabs V-12.1, CC-3, and CC-11).

* While this report and its supporting evidence reference the Zulu time at the time of the mishap, the crash occurred on 7 May 2017 local time in the US CENTCOM AOR.

a. Air Combat Command (ACC)

ACC is a major command of the United States Air Force (USAF) and the primary force provider of combat airpower to America's warfighting commands, established to support global implementation of national security strategy (Tab CC-2). ACC operates fighter, bomber, reconnaissance, battle-management and electronic aircraft (Tab CC-2). It also provides command, control, communications and intelligence systems, and conducts global information operations (Tab CC-2). 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-2). ACC numbered air forces provide the air component to United States Central, Southern and Northern Commands, with Headquarters ACC serving as the air component to Joint Forces Commands (Tab CC-2). ACC also augments forces to United States European, Pacific, Africa-based and Strategic Commands (Tab CC-2).

b. Twelfth Air Force (12 AF)

12 AF, or Air Forces Southern (AFSOUTH), controls ACC's conventional fighter and bomber forces based in the western United States and also serves as the air component for United States Southern Command (Tab CC-3). 12 AF is responsible for United States air and space operations in Central America, South American and the Caribbean and its subordinate commands operate more than 800 aircraft with more than 64,000 uniformed and civilian Airmen (Tab CC-5).

c. 432d Wing (432 WG)

The 432 WG consists of combat-ready Airmen who fly and maintain the MQ-1 Predator and MQ-9 Reaper remotely piloted aircraft (RPA) in direct support of the United States total force components and combatant commanders (Tab CC-10). The 432 WG also trains aircrew, intelligence, weather, and maintenance personnel for RPA operations (Tab CC-10). The RPA systems provide real-time intelligence, surveillance and reconnaissance (ISR), as well as precision attack against fixed and time-critical targets (Tab CC-10).

d. 332d Air Expeditionary Wing (332 AEW)

The 332 AEW includes a wide array of combat Air Force capabilities including precision strike, aerial refueling, space, combat search and rescue, and ISR, all in direct support of Operation Inherent Resolve (Tab CC-11). The 332 AEW operates F-15E, F-16C, HC-130P, MQ-9, A-10C, and KC-135R aircraft and is comprised of more than 3,000 Airmen who operate across four different countries (Tab CC-11 and C-12).

e. 361st Expeditionary Reconnaissance Squadron (361 ERS)

The 361 ERS is currently known as the 361st Expeditionary Attack Squadron (361 EATKS) (Tab V-12.1). The 361 ERS provided combat support to the US CENTCOM AOR in support of Operation Inherent Resolve (Tab V-12.1). The squadron is primarily comprised of MQ-1 and MQ-9 pilots and sensor operators (Tab V-12.1).

f. MQ-9A Reaper

The MQ-9A Reaper is an armed, multi-mission, medium-altitude, long-endurance remotely piloted aircraft employed secondarily as an intelligence-collection asset and primarily against dynamic execution targets (Tab CC-13). The MQ-9A's capabilities, including its significant loiter time, wide-range sensors, multi-mode communications suite, and precision weapons, make it uniquely qualified to conduct irregular, time-sensitive warfare operations in support of the combatant commander objects (Tab CC-13). Reapers can perform the following missions and tasks: intelligence, surveillance, reconnaissance, close air support, combat search and rescue, precision strike, buddy-laser, convoy/raid over watch, route clearance, target development, and terminal air guidance (Tab CC-13).

4. SEQUENCE OF EVENTS

a. Mission

On 6 May 2017, the LRE MC took control of the MA from the MCE crew in the US CENTCOM AOR (Tab V-2.2, V-6.1, and V-12.1). The LRE MC consisted of the MP, MIP and MSO (Tab V-2.1). They were responsible for recovering the inbound MA from MCE and safely landing it at the airfield, which was located in an undisclosed deployed location (Tabs V-3.1 and BB-7). The MP was new to the deployed location and was completing his final local area orientation (LAO) flight under the supervision of the more experienced and acclimated MIP (Tab V-2.2).

b. Planning

The MC's flight authorization and certification paperwork was in order (Tab K-2). The LRE mission planning consisted of a standard handover brief by the previous LRE shift regarding weather, scheduling, frequency interference and non-standard events, and a crew brief led by both the MIP and MP regarding mission expectations and academics of the day (Tab V-2.2 and V-4.1). The MIP also discussed with the MP the plan to accomplish a Simulated Flame-Out (SFO) approach to the airfield during the mishap flight as part of the MP's LAO training (Tab V-2.2). An SFO approach simulates the loss of a single aircraft engine during the aircraft's final approach and landing (Tab V-1.3).

c. Preflight

Prior to gaining the MA from the MCE crew, the MC entered the Ground Control Station (GCS) and completed their standard pre-handover setting inputs and checklists within the GCS (Tab V-

3.5). As part of the preflight procedures, the MP verified and saved a pre-built LRE Emergency Mission (EM) profile, which was stored in the GCS (Tab V-1.4, V-3.5, and V-3.11). The MCE crew relayed standard handover communications to the LRE MC over the Internet Relay Chat (mIRC) and no abnormalities were noted (Tab V-2.2 and V-3.6).

No discrepancies were noted in the maintenance records for the MA and neither the MC nor maintenance personnel recall any issues with the MA or GCS (Tab V-2.2 and V-5.4). At the time of the mishap, the MA had accumulated 4991 total flight hours and was not overdue for any inspections (Tab D-2 and D-14).

d. Summary of Accident

At approximately 20:03:15Z, the MCE crew handed control of the MA to the LRE MC without incident (Tabs N-2 to N-3 and V-6.1). Upon gaining control of the MA, the MC communicated to the MCE crew that handover was complete (Tab V-2.2). The MP then ensured that the MA altitude was set appropriately and updated all the inputs he preset prior to handover (Tab V-3.5). The MC began running through the standard checklists including the "Gaining Handover - Airborne" checklist (Tabs V-4.1 and BB-13).

One of the steps in the "Gaining Handover - Airborne" checklist requires the pilot to set the entry waypoint of the EM and send it to the aircraft (Tabs V-2.2 and BB-13 to BB-14). The purpose of the EM is to tell the MQ-9A aircraft where to go in the event that the aircraft loses uplink from its Ground Data Terminal (GDT) while airborne (Tab V-1.5). In order for an aircrew to command an MQ-9A aircraft, there must be uplink to the aircraft from the GDT (Tab V-1.5). In order for an aircrew to see what an MQ-9A aircraft is doing, there must be downlink from the aircraft to the GDT (Tab V-1.5). An aircraft will only execute an EM upon losing uplink, which is referred to as a lost link situation (Tab V-1.5). The EM ensures that an aircrew knows what its aircraft is doing at all times, especially when in a lost link situation, so that the aircraft can be recovered without issue (Tab V-1.6).

The pilot sends the EM to the aircraft in his/her GCS tracker display by clicking a drop down menu and selecting the option to send the EM (Tab V-1.5, V-2.2, and V-3.11). While not a required checklist item, the only way to verify that an EM is sent is for the pilot to immediately glance down at his/her heads down display (HDD) to see whether the warning message, "Emergency Mission Transmitting," appears (Tab V-1.5). The warning message only appears momentarily on the pilot's HDD and does not appear anywhere on the sensor operator's side (Tab V-2.2).

At approximately 20:04:54Z, the MP selected waypoint two as the start point for the EM and sent the EM to the aircraft in his tracker display screen (Tab N-3). The MIP observed the MP while he completed this step (Tab V-2.2). After completion, the MP verbally acknowledged completion by stating, "E-mission is sent, waypoint 2" at 12,500 mean sea level (MSL) (Tab N-3). According to the MP, he then looked down in his HDD and saw the "Emergency Mission Transmitting" warning message appear (Tab V-3.11 to V-3.12). The MP's HDD video playback showed that the "Emergency Mission Transmitting" warning message appeared once on the HDD while the MP was in control of the MA (Tab V-13.1).

At approximately 20:05:38Z, the MP disabled the Ku Return Frequency (RF) and elected to power down the Ku Interim Modem Assembly (IMA), which are steps in the "Ku Power-Down" checklist (Tabs N-4 and BB-15). The IMA is a system inside the MQ-9A aircraft that enables the MCE crews to control the aircraft via Ku frequencies from a satellite (Tab V-1.6 and V-2.5). Ku RF on the MCE side is the equivalent of C-band downlink on the LRE side, which allows the aircrew to see what the aircraft is doing (Tab V-1.5, V-1.6, and V-5.3). Disabling the Ku RF prior to landing is a required checklist item while powering down the Ku IMA prior to landing is an "as required" checklist item (Tabs V-2.5 and BB-15). The pilot is not required to power down the IMA until the "After Landing" checklist (Tab BB-18).

The purpose of the "Ku Power-Down" checklist is to sever the MCE's visibility of and link to the aircraft after handover to the LRE, which allows the MCE crew to proceed to other tasks (Tab V-2.5). Once the Ku IMA is powered down, there is no way for the MCE crew to regain control of an aircraft without LRE first commanding the IMA back on using uplink (Tabs V-2.5 and BB-9). However, it was a common practice among LRE crews to power down the Ku IMA soon after handover in order to free up the MCE crews and to get ahead on their checklists (Tab V-1.5 and V-2.5).

At approximately 20:10:15Z, the MC requested approval from the Air Traffic Control (ATC) tower to descend to 5000 feet MSL, which the tower approved (Tab N-6). At approximately 20:12:37Z, the MC ran through the "Descent" checklist, which required the pilot to set the EM and send it "as required" (Tabs N-7 and BB-16 to BB-17). There is no evidence that the EM was sent during the "Descent" checklist (Tabs J-2 and N-7 to N-8). Upon the MA's arrival at 5000 feet MSL, the MC lowered the landing gear and the MP announced that he was going to change the EM altitude to 5000 feet (Tabs N-7 and V-3.5). When an EM waypoint attribute is edited, the pilot needs to resend the EM to the aircraft in order for it to be incorporated (Tabs V-1.6 and BB-11). There is no evidence to indicate that the MP sent the edited EM to the MA after changing the waypoint's altitude (Tab J-2 to J-3).

Upon final approach to the airfield, the MC flew the MA at a higher elevation than usual in order to prepare for an SFO circular approach (Tabs V-1.3 and DD-3). At approximately 20:18:44Z, the MC began to experience downlink interference, which manifested as momentary hits of static or fuzziness on the GCS display screens (Tabs N-10 and V-2.3). Link interference was common in the deployed location even though frequencies between MQ-9A aircraft were de-conflicted in accordance with the relevant Technical Order (TO) (Tabs V-2.4, V-5.3, and BB-22). On the LRE side, the MQ-9A aircraft is controlled by C-band frequency beams running between the GDT transmitters and the aircraft transmitters (Tab V-5.3). Link interference can occur when multiple MQ-9As are operating in the same vicinity at the same time and one MQ-9A beam crosses the path of another MQ-9A beam, resulting in a degraded beam (Tab V-1.3 to V-1.4, V-2.3 to V-2.4, and V-5.3). In order to mitigate link interference, MQ-9A frequencies are de-conflicted per the TO, which provides a minimum delta between frequencies (Tab V-5.3). Even when frequencies are properly de-conflicted, like they were in the deployed location at the time of the mishap, link interference can still occur (Tab V-2.4).

At approximately 20:20:40Z, the MP updated the EM entry waypoint from waypoint two to waypoint one and announced to the other crewmembers that the EM was "good" (Tab N-11). As the MA continued its descent, there were two other MQ-9A aircraft operating in the airfield (Tab V-2.3). One aircraft took off from the airfield at approximately 20:23Z and, shortly afterwards, another aircraft powered up on the ground in preparation for take-off (Tabs N-12, N-18, and V-2.3). The crew of the ground-based aircraft began to run the "Taxi" checklist and, for safety purposes, set the aircraft's transmitters to high power during this procedure (Tab V-1.2).

At approximately 20:25:01Z, the MP and MSO noted increased downlink interference on their GCS display screens (Tab N-13). At approximately 20:25:13Z, the GCS lost downlink from the MA and the GCS display screens became completely fuzzy (Tabs N-13 and V-2.3). As a result, the MC lost situational awareness of the MA (Tab V-1.5 and V-2.3). At the same time that the MA lost downlink, its GDT transmitters were on high power and pointed in the same general direction as the ground-based aircraft, which also had its transmitters set to high power (Tab V-1.2 and V-2.3). In addition, the GDT antennae of the ground-based aircraft was on the wide setting pointing in the same general direction as the MA (Tab V-1.5). The wide antenna setting has a broader coverage beam than the narrow setting (Tab V-2.5). The MA was approximately three to four nautical miles away from the GDTs at the time downlink was lost, which was within range of the wide antennae (Tab V-2.5).

At approximately 20:25:34Z, the MSO called the radio and requested that "all players go low if able" (Tab N-18). When the MC didn't receive a response to the first request, the MSO called again at approximately 20:25:48Z and asked that "all players please go low, go low if able" (Tab N-19). The crew of the ground-based aircraft finally responded at approximately 20:26:03Z and confirmed that they were in low power (Tab N-19). Within a minute of losing downlink, the MC manually terminated uplink to the MA by switching off uplink, in accordance with standard emergency procedures (Tabs V-2.4 and BB-19). The MA then entered a lost link situation, which triggered the MA to execute the last EM it received (Tab V-1.5). The MC then turned the GDT back on in the wide antennae setting and began trying to reestablish downlink with the MA (Tab V-2.4).

The ATC tower provided occasional reports to the MC regarding the status of the MA (Tab V-4.2). After entering the lost link situation, the MA climbed in altitude past 12,500 feet MSL and headed in an unexpected direction away from the airfield, which was not in accordance with the MC's EM profile (Tabs N-18, V-2.4, and V-4.2). While the MA flew further and further away from the LRE airfield, the MC tried every strategy they could think of to regain downlink from the MA (Tab V-2.4). The MA was over 2000 feet Above Ground Level (AGL) when downlink was lost so the MC began running the "Loss of C-Band Downlink Above 2,000 Feet AGL" checklist (Tabs V-2.4 and BB-19). The MC requested immediate assistance from maintenance, who sent over a contractor (CTR) to assist (Tab V-2.4, V-4.2, and V-5.1). The CTR verified that the GDT settings were correct and that there were no frequency de-confliction issues (Tab V-5.2). The MC tried different GDT antenna settings and manually turned the GDT in different directions to attempt to regain downlink (Tab V-2.4). Another LRE crew turned on different GCS and GDT to try to gain downlink from the MA (Tab V-9.1). None of these efforts reestablished downlink from the MA (Tab V-2.5). Upon the recommendation of the maintenance CTR, the MC tried to control the MA in the blind by turning on the GDT transmitters with its known frequencies and manually pointing the GDT in the direction of the MA (Tab V-2.4 and V-5.2). The MC was unable to establish uplink using this method (Tab V-2.5).

The MC knew that the MA was flying to waypoint one of the MCE EM, instead of waypoint one of their own EM, because the MA was not doing what the crew expected it to do (Tabs N-11 and V-2.5). Eventually, the MA flew outside the reach of the LRE airfield (Tab V-5.2). The MIP contacted the MCE to ask whether they could gain the MA back via satellite (Tab V-2.5). The MCE crew that sent the EM to the MA earlier that day was unavailable, so a different MCE crew entered the GCS and began running the "Gaining Handover – Airborne" checklist (Tab V-11.1). Before the MCE crew could attempt to gain control of the MA, the crew was notified that the IMA was powered down by the LRE crew after handover (Tab V-11.1). As a result, there was no way for the MCE crew to gain the MA back via Ku RF without the MC reestablishing uplink first (Tabs V-5.3 and BB-9). As a result, the MCE crew shut down the GCS and discontinued their effort (Tab V-11.1 to V-11.2).

The location of the MA continued to be tracked via radar and the camera of another MQ-9A aircraft, as the MA flew further from the LRE area with its landing gear down (Tab V-2.5, V-6.1, and V-11.1). The MCE EM that was last sent to the MA before handover to the MC consisted of a series of waypoints from the mission area back to the vicinity of the LRE airfield in case link to/from the MA was lost in the mission area (Tab V-6.1 and V-11.2). The first several waypoints of the MCE EM were programmed to inhibit the MA's C-band downlink transmitters, which was a standard MCE practice (Tabs V-1.6, V-6.1 to V-6.2, and BB-10). The GDT on the LRE side can only receive downlink from an aircraft when the C-band transmitters are enabled (Tab V-1.6). The final waypoints of the MCE EM were programmed to enable the C-band transmitters once the aircraft approached the vicinity of the LRE airfield (Tab V-6.1 to V-6.2).

During the MA's return to the LRE area before handover, the MCE crew periodically updated the EM entry waypoint to a point in front of the MA, but did not delete waypoints already passed by the MA (Tab V-6.1). This was a common practice among MCE crews (Tab V-11.2). As a result, the first several waypoints of the MCE EM directed the MA to backtrack far into the mission area before it returned to the LRE area (Tab V-6.1 and V-11.2). The MA did not have enough fuel to fly the entire MCE EM and return to the LRE airfield (Tab V-6.2).

e. Impact

The MA ran out of fuel and impacted terrain in the US CENTCOM AOR approximately two hours and 13 minutes after the MC lost downlink from the MA (Tabs J-2, V-12.1, and Z-2). At the time of impact, the MA was still executing the MCE EM profile (Tab J-2). The wreckage was destroyed shortly after impact (Tab V-2.5).

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 maintenance records for the MA leading up to the mishap day revealed no relevant discrepancies or issues, and showed no overdue Time Compliance Technical Orders, time change items, or special inspections (Tab D-2 to D-18). Prior to launch, the MA was properly released for flight and post- and pre-flight inspections were completed (Tab D-8 to D-11).

b. Inspections

All maintenance inspections were current and complied with by relevant authorities (Tab D-14). Air Force Technical Order (AFTO) Form 781H indicated the MA was inspected properly prior to its last flight (Tab D-3 to D-4).

c. Maintenance Procedures

All maintenance procedures were properly conducted in accordance with applicable TOs and guidance (Tab D-8 to D-11).

d. Maintenance Personnel and Supervision

All preflight servicing and maintenance was properly documented by military and civilian maintenance personnel (Tab D-3 to D-4 and D-12 to D-13). No evidence exists that the training, qualifications, and supervision of the maintenance personnel were a factor in this mishap (Tab V-5.1).

e. Fuel, Hydraulic, and Oil Inspection Analyses

According to the MA's AFTO 781H forms, fluid levels were properly inspected and adequate to conduct the mishap mission (Tab D-12 to D-13). Due to the destruction of the MA, post-mishap fluid analysis was not assessed (Tab DD-3).

f. Unscheduled Maintenance

Maintenance documentation revealed no unscheduled maintenance prior to the mishap (Tab D-8 to D-11).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

Due to the sensitive location of impact, the MA wreckage was destroyed following impact and no portion of the wreckage was returned to the manufacturer for post-mishap analysis (Tabs V-12.2 and DD-3). Maintenance personnel inspected the mishap GCS following the loss of downlink and did not note any issues (Tab V-5.2).

b. Evaluation and Analysis

The MCE and LRE datalogs were pulled by maintenance personnel from the GCS following impact and sent for review to the contractor manufacturer of the MQ-9A, General Atomics Aeronautical Systems (GA-ASI) (Tabs J-2). GA-ASI conducted analysis of the MA data logs and noted no aircraft system malfunctions (Tabs J-2 to J-4 and DD-3 to DD-12). Their technical review of the mishap data logs found that the MC updated the EM entry waypoint to waypoint one but failed to upload a new EM (Tab DD-3).

7. WEATHER

a. Forecast Weather

The weather slides briefed prior to the mishap flight indicate that the forecast for the airfield was for clear skies and unlimited visibility (Tab F-2). Winds were forecasted out of the northwest at 10 knots with potential gusts up to 20 knots (Tab F-2). There was no other significant weather reported at the time of the mishap (Tab F-2).

b. Observed Weather

Two witnesses at the deployed location observed higher than usual humidity at the time of the mishap, which was noted to have a potential impact on link interference between MQ-9As (Tab V-1.3 and V-10.2). No other significant weather was reported or observed at the time of the mishap (Tab V-2.2 and V-3.4).

c. Operations

No evidence suggests that the MA was operated outside of prescribed operational weather limits (Tab F-2).

8. CREW QUALIFICATIONS

a. Mishap Pilot (MP)

The MP was current and qualified to conduct launch and recovery in the MQ-9A at the time of the mishap (Tabs G-4, G-5, G-7, and K-2). The MP had 76.3 hours of MQ-9A flight time and 89 hours of MQ-9A simulator time around the time of the mishap (Tab G-6). Recent flight hours were as follows (Tab G-7):

	Flight Hours	Flight Sorties
Last 30 Days	4.0	5
Last 60 Days	10.2	9
Last 90 Days	24.8	18

b. Mishap Instructor Pilot (MIP)

The MIP was current and qualified to conduct launch and recovery in the MQ-9A at the time of the mishap (Tabs G-19 and K-2). The MIP had 858.8 hours of MQ-9A flight time, 5.4 hours of MQ-9A instructor flying time, and 185.7 hours of MQ-9A simulator time (Tab G-35). Recent flight hours were as follows (Tab G-36):

	Flight Hours
Last 30 Days	18.3
Last 60 Days	43.2
Last 90 Days	52.9

c. Mishap Sensor Operator (MSO)

The MSO was current and qualified to conduct launch and recovery in the MQ-9A at the time of the mishap (Tabs G-71 and K-2). The MSO had 227.7 hours of MQ-9A flight time and 69.2 hours of MQ-9A simulator time (Tab G-72). Prior to his MQ-9A qualification, the MSO had 562.8 hours of MQ-1B flight time and 156.8 hours of MQ-1B simulator time (Tab G-72). Recent MQ-9A flight hours were as follows (Tab G-73):

	Flight Hours
Last 30 Days	24.0
Last 60 Days	48.4
Last 90 Days	62.0

9. MEDICAL

a. Qualifications

At the time of the mishap, all MC members were medically qualified for flight duty. (Tab EE-2 to EE-4).

b. Health

No evidence exists to suggest the health of the MC members contributed to the mishap (Tab EE-2 to EE-4). The MP, MIP, and MSO testified they experienced no physical or medical issues at the time of the mishap (Tab V-2.2, V-3.3, and V-4.1).

c. Pathology/Toxicology

The medical clinic in the deployed location collected blood and urine samples from each member of the MC after the mishap (Tab EE-5 to EE-7). All toxicology testing resulted in negative findings (Tab EE-5 to EE-7).

d. Lifestyle

There is no evidence to suggest lifestyle was a factor in the mishap (Tab V-2.2, V-3.3, and V-4.1).

e. Crew Rest and Crew Duty Time

Aircrew members must have proper rest, as defined in AFI 11-202, Volume (V) 3, *General Flight Rules*, ACC Supplement, dated 28 November 2012, prior to performing in-flight duties (Tab BB-24 and BB-26). Paragraph 9.4.5 of AFI 11-202 V3, ACC Supplement, defines normal crew rest as a minimum of 12-hour non-duty period before the designated flight duty period begins (Tab BB-26). Crew rest is defined as free time, and includes time for meals, transportation and the opportunity to sleep (Tab BB-26).

The MP, MIP, and MSO verified that they received the proper crew rest before the mishap flight by signing the pre-flight authorization (Tab K-2). Furthermore, the members of the MC did not indicate any noteworthy sleep issues or deficiencies before the mishap flight in their testimony (Tab V-2.2, V-3.3, and V-4.1).

10. OPERATIONS AND SUPERVISION

a. Operations

The Squadron Commander (CC) and Direction of Operations of the MC testified that the operational tempo at the deployed location was high at the time of the mishap (Tab V-1.1 and V-12.1). The mishap flight occurred towards the end of shift and the MIP and MSO testified that they both felt fatigued, which was nothing unusual given the operational tempo (Tab V-2.2 and V-4.1). The testimony of the MC and the other evidence did not identify any specific issues with the operational tempo to suggest that it contributed to the mishap (Tab V-2.2 and V-4.1).

b. Supervision

The MIP provided supervision for the MP as he conducted his second LAO flight (Tab V-2.2 and V-3.2). The MIP was qualified as an MQ-9A instructor pilot and was well-acclimated to the deployed environment at the time of the mishap (Tabs K-2 and V-2.1). An instructor pilot qualification was not required for LAO supervision (Tab V-1.2 and V-2.2). Rather, the supervising pilot only needed to be an experienced pilot who was familiar with the local area (Tab V-1.2 and V-2.2). The MIP also doubled as the shift Operational Supervisor that day (Tab V-2.1 and V-12.1). In this role, the MIP oversaw aircrew operations and Operational Risk Management (ORM) (Tab V-1.7 and V-2.1). ORM is when an aircrew member writes down on a point scale how they feel that day in order for crews and leadership to determine whether the person feels safe enough to fly (Tab V-1.7). The factors considered include health, sleep, mentality, fatigue, inexperience, weather, and things of that nature (Tab V-1.7). The MIP identified no significant issues with the MP prior to the mishap (Tab V-2.2).

11. HUMAN FACTORS ANALYSIS

The AAIB considered all human factors as prescribed in the Department of Defense (DoD) Human Factors Analysis and Classification System (HFACS), Version 7.0, to determine whether any human factors were directly related to the mishap (Tab BB-2). "Procedure not followed correctly," under DoD HFACS AE103, is a factor that applies when a procedure is performed incorrectly or is accomplished in the wrong sequence (Tab BB-3).

During the mishap flight, the MP had three opportunities to send the EM to the MA (Tabs N-3, N-7, BB-11, BB-13 to BB-14, and BB-17). The first opportunity occurred at approximately 20:04:58Z, less than two minutes after MCE handover (Tab N-3). The evidence shows that the MP set and attempted to send the new EM while running the "Gaining Handover – Airborne" checklist in accordance with procedure (Tabs N-3, V-2.2, and B-13 to BB-14). Despite following the proper procedures after handover, the MA never received the EM, which was confirmed by a technical review of the GCS datalogs conducted by the MQ-9A manufacturer and the MA's execution of the MCE EM (Tabs J-3 and DD-3). The second opportunity occurred at approximately 12:12:37Z while the MP and MSO were running the "Descent" checklist (Tab N-7). The checklist required the MP to "set" the EM start point and send, "as required" (Tab BB-16 to BB-17). The third opportunity occurred at approximately 20:13:02Z after the MP edited the EM waypoint altitude to 5000 feet MSL (Tab N-7). When an EM waypoint attribute is edited, the pilot needs to resend the EM to the aircraft in order for the edit to be incorporated (Tabs V-1.6 and BB-11). Despite these three opportunities, there is no evidence that the MP sent or attempted to send the EM to the MA after his initial attempt following handover (Tabs J-2, N-3 to N-13, and DD-3).

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, *Aerospace Accident Investigations*, ACC Supplement, 28 January 2016
(3) AFI 11-2MQ-1&9, Volume 1, *MQ-1&9 - Aircrew Training*, 23 April 2015
(4) AFI 11-2MQ-1&9, Volume 3, *MQ-1 and MQ-9 - Operations Procedures*, 28 August 2015
(5) AFI 11-202, Volume 3, *General Flight Rules,* ACC Supplement, 28 November 2012, Paragraph 9.4.5
(6) AFI 91-204, *Safety Investigations and Reports*, 19 January 2018

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) AFSOC ASI-11114, AFSOC Series MQ-9A Aircraft, 30 January 2017
(2) TO ASI-11114-CL-1, AFSOC Series MQ-9A checklist, 22 July 2017)
(3) TO 1Q-1(M)B-2-2, MD-1A Ground Control Station Maintenance Procedures, 15 December 2016
(4) DoD HFACS, Version 7.0

c. Known or Suspected Deviations from Directives or Publications

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

//Signed//

23 April 2018

JASON P. WILLEY, Lt Col, USAF
President, Abbreviated Accident Investigation Board

STATEMENT OF OPINION

MQ-9A, T/N 12-4175
US CENTCOM AOR
6 MAY 2017

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 6 May 2017, at approximately 22:38 Zulu Time (Z), the mishap aircraft (MA), an MQ-9A, tail number 12-4175, assigned to the 432d Wing (432 WG) at Creech Air Force Base, and operated by the 361st Expeditionary Reconnaissance Squadron (361 ERS), 332d Air Expeditionary Wing (332 AEW), crashed in the United States Central Command Area of Responsibility (AOR) after handover from the Mission Control Element (MCE) to the Launch and Recovery Element (LRE) mishap crew (MC). The MA was destroyed following impact with terrain and no wreckage was recovered. The loss of Government property was valued at $10,310,434. There were no reported fatalities, injuries or damage to civilian property.

The LRE MC was responsible for recovering the MA from the MCE and landing it at the airfield, which was located in an undisclosed deployed location. The LRE MC consisted of a mishap pilot (MP), mishap sensor operator, and mishap instructor pilot (MIP), who were all assigned to the 361 ERS. The MP was brand new to the deployed location so the MIP supervised the mishap flight as part of the MP's local area orientation.

The LRE MC gained control of the MA from the MCE crew without incident and began running the standard checklists. One of the steps in the "Gaining Handover - Airborne" checklist required the pilot to set and send the emergency mission (EM) from the Ground Control Station (GCS) to the MA. The EM tells the aircraft where to go in the event that uplink is lost and the LRE crew can no longer command the aircraft. The MP set the EM altitude to 12,500 Mean Sea Level (MSL) and went through the proper steps to send the EM. Despite taking the proper steps, the LRE EM was never received by the MA. During the mishap flight, the MP had two additional opportunities to send the EM, but failed to do so. The first occurred when running the "Descent" checklist and the second occurred when he changed the EM altitude to 5,000 MSL.

Two minutes after gaining the MA, the MP elected to power down the Ku Interim Modem Assembly (IMA) in order to sever the MCE's link to the MA. At approximately 20:25:13Z, while preparing for landing, the MC lost downlink from the MA and the MC could no longer see what the MA was doing. The loss of downlink was caused by another MQ-9A, which was powered up on the ground with its aircraft and Ground Data Terminal (GDT) transmitters both set to high power. The link interference occurred when the frequency beam from the MA overlapped with the frequency beam from the ground-based aircraft.

Shortly after losing downlink, the MC terminated uplink in accordance with standard emergency procedures. This action triggered the MA to execute the last EM it received, which was from the MCE crew before handover. In accordance with the MCE EM, the MA climbed to an altitude well above 12,500 MSL and flew away from the airfield in the direction of the MCE's waypoint one. Prior to losing downlink, the MP set the EM entry point as waypoint one. As the MA flew further away from LRE control, the MC ran the appropriate emergency checklist and diligently tried to regain downlink. Unknown to the MC at the time, there was no way to regain downlink on the LRE side because the downlink transmitters on the MA were set to inhibit while flying through the first several waypoints of the MCE EM. As a result, all efforts to regain downlink failed.

Once the MA flew outside of LRE control, the MCE was contacted to try to gain control of the MA via satellite. The MCE was unable to do so because the IMA was powered down by the MC. By that time, the MA had insufficient fuel to fly the entire MCE EM. Prior to the handover to LRE, the MCE crew periodically updated their EM start point to a point in front of the MA, but did not delete waypoints already passed by the MA. As a result, the EM waypoints directed the MA to backtrack far into the mission area before returning to the LRE area. The MA ran out of fuel and impacted terrain approximately two hours and 13 minutes after downlink was lost while still flying the MCE EM.

2. CAUSES

I find by a preponderance of evidence that the causes of the mishap were (a) the unintentional downlink interference from a ground-based MQ-9A transmitting on high power, and (b) the failure to successfully send an LRE EM to the MA after handover from the MCE.

a. Downlink Interference from a Ground-Based MQ-9A Aircraft

The preponderance of the evidence shows that downlink interference from the MQ-9A powered up on the ground was a cause of the mishap. The MC lost downlink from the MA while the MA was approaching the airfield on its final descent. At the time, both aircraft and GDTs were transmitting on high power within range of each other. Further, the GDT of the MA was pointed in the general direction of the ground-based aircraft while the GDT of the ground-based aircraft was pointing in the general direction of the MA. Therefore, the frequency beams of the two aircraft had a high probability of overlap, which is what caused the loss of downlink.

If the ground-based MQ-9A was not situated in such an inopportune location while operating on high power, it's unlikely that the MC would have lost downlink to the MA. If downlink was not lost, the MA would likely have landed without incident or issue. Further, the MC would not have implemented emergency procedures and shut off uplink. The MA likewise would not have executed the MCE EM. The execution of the MCE EM caused the MA to run out of fuel and ultimately crash.

b. Failure to Successfully Send an Emergency Mission to the Mishap Aircraft

The preponderance of the evidence shows that the failure to successfully send an LRE EM to the MA after handover from the MCE was a cause of the mishap. The MP was the only member of the MC positioned to upload the EM and verify that it was sent by viewing the "Emergency Mission Transmitting" caution message in his heads down display (HDD). While there were three opportunities to do so, the MP was only required to send the EM to the MA twice during flight; once after handover and once after editing the EM altitude. The evidence shows that the MP attempted to send the EM after handover and even verbalized that it was "sent." The evidence also shows that the "Emergency Mission Transmitting" warning message displayed at least once on the MP's HDD.

Despite following the proper procedures after handover, the MA never received the EM, as confirmed by a technical review of the GCS datalogs conducted by the MQ-9A manufacturer and the MA's execution of the MCE EM. There is no evidence that the MP sent or attempted to send the EM after this initial attempt even when required to do so after editing the EM altitude. This was likely due to the MP's erroneous belief that the EM was already sent and his lack of familiarity with the local area, which caused additional distraction and stress.

If the MP successfully sent the EM to the MA at least once during the mishap flight, the MA would have executed the LRE EM instead of the MCE EM upon losing link. If the MA executed the LRE EM, the MA would have remained in the LRE area with its downlink transmitters enabled. In this situation, the MC would have been able to regain downlink and recover control of the MA before landing it.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

I further find by a preponderance of the evidence that the factors that substantially contributed to the mishap were: (a) the LRE practice of disabling the IMA before landing, and (b) the MCE practice of not deleting EM waypoints before LRE handover.

a. Powering Down the IMA Before Landing by LRE

The preponderance of the evidence shows that the LRE practice of powering off the IMA before landing substantially contributed to the mishap by preventing the MCE crew from regaining the MA after link was lost. While not procedurally incorrect to power down the IMA before landing, the MP was not required to do so until after landing. At the time of the mishap, this was a common practice among LRE crews in order to get ahead on checklists and sever an aircraft's link to the MCE early, allowing the MCE crew to move on to other missions. Once the IMA is powered off, there is no way for the MCE to regain control of the aircraft without the LRE first using uplink to command the IMA back on.

After the MC lost link in this case, the MA flew outside of LRE control while executing the MCE EM. The only way to recover the MA at this time was for the MCE to regain control of the MA via satellite. As discussed, this action is only possible if the IMA is still powered on. Therefore, if the MP didn't power down the IMA before landing, the MCE may have been able to recover the MA before it ran out of fuel and ultimately crashed.

b. Not Deleting Emergency Mission Waypoints by MCE

The preponderance of the evidence shows that the MCE practice of not deleting EM waypoints before handover to LRE substantially contributed to the mishap. The MCE crew in this case periodically updated their EM start point to a point in front of the MA, but did not delete waypoints passed by the MA. As a result, the MCE EM executed by the MA directed the MA along a path of waypoints that the MA had insufficient fuel to complete. If the MCE crew deleted waypoints that were far outside of LRE range before handover, this would have shortened the path taken by the MA while executing the MCE EM. If the path was shortened, the MA may not have run out of fuel and ultimately crashed.

4. CONCLUSION

I find by a preponderance of evidence that the causes of the mishap were: (a) the unintentional downlink interference from a ground-based MQ-9A transmitting on high power, and (b) the failure to successfully send an LRE EM to the MA after handover from the MCE. I further find by a preponderance of the evidence that the factors that substantially contributed to the mishap were: (a) the LRE practice of disabling the IMA before landing, and (b) the MCE practice of not deleting EM waypoints before LRE handover.

//Signed//

23 April 2018

JASON P. WILLEY, Lt Col, USAF
President, Abbreviated Accident Investigation Board

INDEX OF TABS