UNITED STATES AIR FORCE
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 07-003190

18th Reconnaissance Squadron/3rd Special Operations Squadron
432nd Air Expeditionary Wing/27th Special Operations Wing
Creech Air Force Base, Nevada/Cannon Air Force Base, New Mexico

LOCATION: Afghanistan
DATE OF ACCIDENT: 14 February 2012
BOARD PRESIDENT: Lt Col Cade R. Sonnichsen

Abbreviated Accident Investigation, conducted pursuant to Chapter 11 of AFI 51-503

22 AUG 2012

ACTION OF THE CONVENING AUTHORITY

The Report of the Abbreviated Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 14 February 2012 mishap near a deployed airfield in Afghanistan, involving MQ-1B, T/N 07-003190, assigned to the 432d Wing, complies with applicable regulatory and statutory guidance and on that basis is approved.

FOR

WILLIAM J. REW
Lieutenant General, USAF
Vice Commander

EXECUTIVE SUMMARY

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B PREDATOR, 07-003190
AFGHANISTAN
14 FEBRUARY 2012

On 14 February 2012 at 2024Z, the Mishap Remotely Piloted Aircraft (MRPA) MQ-1B Predator, T/N 07-003190,operated by crews from the18th Reconnaissance Squadron and 62nd Expeditionary Reconnaissance Squadron, experienced a dual alternator failure, just over four hours into an operational sortie and 32 nautical miles (NM) from the deployed airfield. Upon noticing indications of the dual alternator failure, the Mishap Mission Control Element (MMCE) crew turned the MRPA back toward the deployed airfield and began to execute the Dual Alternator Failure checklist. The MMCE crew started communication with the Mishap Launch and Recovery Element (MLRE), and then coordinated a descent from the operational altitude to 8,000 feet (ft) above mean sea level (MSL) with the air traffic control (ATC) agency.

At 2040Z, the MLRE gained control of the MRPA about 3.5 NM from the airfield using a Line-of-Sight data link. At this time, the MLRE ground control station settings caused all previously switched-off systems to turn back on, increasing current draw on the MPRA's batteries. At 2043Z the MLRE crew began the Dual Alternator Failure checklist. The Launch and Recovery Element Mishap Pilot (LRE MP) descended the MRPA directly over the airfield to enter the traffic pattern for landing through High Key - a position above the approach end of the runway that allows for an engine-out spiraling glide down to landing. At 2049Z, with the MRPA at 4,190 ft MSL (approximately 2,370 ft above ground level [AGL]) just short of the approach end of the runway, the MLRE lost control of the aircraft due to a complete loss of the MRPA's electrical power. The MRPA impacted approximately 1.1 NM northeast of the approach end of Runway 31 in a farm field. No injuries or deaths resulted from the crash. Military and civilian property damages (including the MRPA, crop damage, and minor damage to a farm building) as a result of the crash totaled $3,960,209.91.

The board president found, by clear and convincing evidence, that the causes of the mishap were a dual alternator failure followed by the complete loss of aircraft electrical power, and the LRE MP's failure to adequately assess the nature of the emergency and fully execute proper procedures listed in the published flight manual. Upon gaining control of the MRPA, the LRE MP failed to fully accomplish the Dual Alternator Failure checklist and execute appropriate Forced Landing procedures. The LRE MP failed to execute appropriate electrical load-shedding measures and failed to land the MRPA as soon as possible, and instead displayed poor judgment by electing to maneuver the MRPA over the airfield with the intention of reaching High Key and executing an engine-out emergency landing. The board president also found, by a preponderance of the evidence, the Mishap LRE (MLRE) crew's poor crew coordination while executing checklists and their channelized attention on a landing gear warning indication, substantially contributed to the mishap.

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COMMONLY USED ACRONYMS AND ABBREVIATIONS
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
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A	Amps
ACC	Air Combat Command
AEW	Air Expeditionary Wing
AFB	Air Force Base
AFCENT	Air Forces Central Command
AFI	Air Force Instruction
AFMES	Armed Forces Medical Examiner System
AFSOC	Air Force Special Operations Command
AFTO	Air Force Technical Order
AGE	Aerospace Ground Equipment
AGL	Above Ground Level
AH	Amp Hours
AIB	Accident Investigation Board
AAIB	Abbreviated Accident Investigation Board
AMXS	Aircraft Maintenance Squadron
ARMS	Aviation Resource Management System
ASC-WII	Aeronautical Systems Center, Medium Altitude UAS Division
ATC	Air Traffic Control
ATO	Air Tasking Order
BFS	Battlespace Flight Services
CONUS	Continental United States
DAR	Dual Alternator Regulator
DET	Detachment
DoD	Department of Defense
DoD-HFACS	DoD Human Factors Analysis and Classification System
EP	Emergency Procedure
ERS	Expeditionary Reconnaissance Squadron
FAE	Field Area Expert
FDP	Flight Duty Period
FL	Florida
GA-ASI	General Atomics-Aeronautical Systems Inc.
GCS	Ground Control Station
GDT	Ground Data Terminal
GPS	Global Positioning System
GSE	Ground Support Equipment
IAW	In Accordance With
IFF	Identification Friend/Foe
IMDS	Integrated Maintenance Data System
ISR	Intelligence, Surveillance and Reconnaissance
JSUPT	Joint Specialized Undergraduate Pilot Training
KIAS	Knots Indicated Airspeed
Ku	K "under" - radio frequency
LLC	Limited Liability Company
LOS	Line of Sight
LR	Launch/Recovery
LRE	Launch/Recovery Element
MC	Mishap Crewmembers
MCE	Mission Control Element
mIRC	Internet Relay Chat
MLRE	Mishap Launch and Recovery Element
MMCE	Mishap Mission Control Element
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSL	Mean Sea Level
MSO	Mishap Sensor Operator
MTS	Multi-spectral Targeting System
MX	Maintenance
NM	New Mexico
NM	Nautical Miles
NV	Nevada
OG	Operations Group
O&M	Operations and Maintenance
PMATS	Predator Mission Aircrew Training System
RPA	Remotely Piloted Aircraft
ROVER	Remotely Operated Video Receiver
RS	Reconnaissance Squadron

SEPT	Simulated Emergency Procedures Training
SFO	Simulated Flame Out
SIB	Safety Investigation Board
S/N	Serial Number
SO	Sensor Operator
SOF	Special Operations Forces
SOS	Special Operations Squadron
SOW	Special Operations Wing
SPMA	Sensor Processor Modem Assembly
T.O.	Technical Order
T/N	Tail Number
TCTO	Time Compliance Technical Order
USAF	United States Air Force
USAFCENT	United States Air Forces Central Command
V	Volts
VIT	Variable Information Table
VVI	Vertical Velocity Indicator
WG	Wing
Z	Zulu

The above list was compiled from the Executive Summary, Summary of Facts, the Statement of Opinion, the Index of Tabs, and Witness Testimony.

SUMMARY OF FACTS
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B, T/N 07-003190
AFGHANISTAN
14 FEBRUARY 2012

1. AUTHORITY, PURPOSE, AND CIRCUMSTANCES

a. Authority

On 2 April 2012, Lieutenant General William J. Rew, Vice Commander, Air Combat Command (ACC), United States Air Force (USAF), convened an Abbreviated Accident Investigation Board (AAIB) conducted pursuant to Chapter 11 of Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, 26 May 2010, to investigate the 14 February 2012 crash of an MQ-1B Predator aircraft, tail number (T/N) 07-003190, in Afghanistan (Tab Y-2). The ACC/CV appointed Lieutenant Colonel Cade R. Sonnichsen as Board President. A legal advisor, recorder, pilot Field Area Expert (FAE), and maintenance FAE were also appointed. (TabY-2, Y-6)

b. Purpose

This is a legal investigation convened to inquire into the facts surrounding the aircraft or aerospace accident, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes.

c. Circumstances

The AAIB was convened to investigate the Class A mishap involving an MQ-1B Predator, T/N 07-003190, assigned to the 432nd Air Expeditionary Wing, Air Forces Central (Command) (AFCENT), and operated by the 18th Reconnaissance Squadron (18 RS), Creech Air Force Base (AFB), Nevada (NV), and the 62nd Expeditionary Reconnaissance Squadron (62 ERS), AFCENT, which occurred during a classified mission in Afghanistan on 14 February 2012. (Tab K-9 to K-11)

2. ACCIDENT SUMMARY

On 14 February 2012 at approximately 2024Z, the Mishap Remotely Piloted Aircraft (MRPA) MQ-1B Predator, T/N 07-003190 experienced a dual alternator failure. Post-mishap analysis showed that the right-side alternator's case fractured in flight due to material defects. (Tab DD-3)

At 2024Z, upon noticing indications of the dual alternator failure, the Mishap Mission Control Element (MMCE) turned the MRPA back toward the deployed airfield and began to execute the Dual Alternator Failure checklist. (Tab N-2)

At 2025Z, the MMCE extended the MRPA's landing gear. The MMCE crew received landing gear warning indications at 2026Z. The MMCE crew started communication with the Mishap Launch and Recovery Element (MLRE) via a secure chat room, and then coordinated a descent from the operational altitude to 8,000 feet (ft) above mean sea level (MSL) with the air traffic control (ATC) agency. At 2031Z, the MMCE visually confirmed the landing gear was extended using the Multi-spectral Targeting System (MTS) – a turret-mounted full-motion video sensor – and then turned the MTS off at 2032Z. (Tabs N-3 to N-4, CC)

At approximately 2027Z, the MMCE notified the MLRE in a secure chat room that they were an emergency aircraft (Tab N-28). According to the LRE Mishap Sensor Operator (MSO), prior to entering the ground control station (GCS), the LRE Mishap Pilot (MP) briefed a plan to recover the aircraft through High Key - a position above the approach end of the runway that allows for an engine-out spiraling glide down to landing. (Tab V-4.1)

At approximately 2040Z, the MLRE gained control of the aircraft using Line-of-Sight (LOS) data link. At this time, the MLRE GCS settings caused multiple electrical systems to turn back on. The powering-on of these components caused the current draw on the batteries to increase from approximately 64 amperes (A) to 80 A. (Tabs CC)

After gaining control of the aircraft, the MLRE continued descent through 10,000 ft MSL. At 2043Z the LRE MSO relayed confirmation from the MMCE that the gear had been visually checked down with the MTS (Tab N-29). At 2043Z, the MLRE commenced the Dual Alternator Failure checklist. Battery voltage at this time was 21.4 volts (V) (Tab CC). At 2045Z, the LRE MP relayed to Air Traffic Control (ATC) that he intended to descend directly over the airfield to enter the traffic pattern for landing through High Key. At 2049Z, the MLRE lost control of the aircraft due to a complete loss of MRPA electrical power. At the time of the complete loss of power, the MRPA was at 4,190 ft MSL (approximately 2,370 ft above ground level [AGL]) and had a battery reading of 15V. (Tab CC) The MRPA crashed approximately 1.1 nautical miles (NM) northeast of the approach end of Runway 31 (Tab S-3). Military and civilian property damages as a result of the crash totaled $3,960,209.91 (Tab P-4).

3. BACKGROUND

The MRPA was an asset of the 18th Reconnaissance Squadron (18 RS), 432d Wing (432 WG), Creech AFB, Nevada (NV). The 432 WG falls under Air Combat Command (ACC). At the time of the mishap, the MRPA was forward deployed to Afghanistan where it was operated by the 62d Expeditionary Reconnaissance Squadron (62 ERS), Detachment 1 (Det 1) and maintained in conjunction with Battlespace Flight Services, Limited Liability Company (LLC). The 62 ERS, Det 1 is a unit within the 451st Air Expeditionary Wing (451 AEW). The 451 AEW is operationally assigned to AFCENT. Additionally, when the mishap occurred, the MRPA was controlled by the LRE crew operating out of Afghanistan and also assigned to the 62 ERS, Det 1. The LRE MP's and MSO's home unit is the 3rd Special Operations Squadron (3 SOS), 27th Special Operations Wing (27 SOW), Cannon Air Force Base, New Mexico (NM). The 27 SOW falls under Air Force Special Operations Command (AFSOC) headquartered at

Hurlburt Field, Florida (FL). The MCE MP's and MSO's home unit is the 18 RS, 432 WG, Creech AFB, NV. (Tabs K-9 to K-11, FF-2)

Note: Because ACC remotely Piloted aircraft operate from a deployed location, employment of ACC-deployed MQ-1B aircraft by mixed crews (AFSOC & ACC) occurs regularly.

a. Air Force Special Operations Command

AFSOC is headquartered at Hurlburt Field, FL and is one of ten major Air Force commands. AFSOC provides Air Force special operations forces for worldwide deployment and assignment to regional unified commands. The command's Special Operations Forces (SOF) are composed of highly trained, rapidly deployable Airmen conducting global special operations missions, such as precision application of firepower, intelligence, surveillance and reconnaissance (ISR), infiltration, ex-filtration, resupply and refueling of SOF operational elements. (Tab FF-2)

b. 27th Special Operations Wing

The 27 SOW at Cannon AFB, NM, is one of two Air Force active duty Special Operations wings and falls under AFSOC. The primary mission of the 27 SOW is to plan and execute specialized and contingency operations using advanced aircraft, tactics, and air refueling techniques to infiltrate, ex-filtrate, and resupply SOF and provide ISR and close air support for SOF operations. (Tab FF-2)

c. 3rd Special Operations Squadron

The 3 SOS falls under the 27 SOW and accomplishes global special operations tasking as a member of the Air Force component of United States Special Operations Command. It directly supports theater commanders by providing precision weapons employment and persistent ISR. It also plans, prepares, and executes MQ-1B Predator missions supporting special operations forces. (Tab FF-2)

d. Air Combat Command

ACC is a force provider of combat airpower to America's war-fighting commands. To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management, and electronic-combat aircraft. It also provides command, control, communications and intelligence systems, and conducts global information operations. (Tab FF-2)

e. 432d Wing

The 432 WG flies and maintains the MQ-1B Predator and MQ-9 Reaper aircraft to support United States and Coalition war-fighters. The 432 WG conducts Remotely Piloted Aircraft (RPA) initial qualification training for aircrew, intelligence, weather, and maintenance personnel. The 432 WG oversees operations of the 432d Operations Group, 432d Maintenance Group, 11 RS, 15 RS, 17 RS, 18 RS, 30 RS, 42d Attack Squadron, 432d Aircraft Maintenance Squadron, 432d Maintenance Squadron, and the 432d Operations Support Squadron. (Tab FF-2)

f. 18th Reconnaissance Squadron

The 18 RS provides combatant commanders with persistent ISR, full-motion video, and precision weapons employment. Global operations architecture supports continuous MQ-1B Predator employment providing real-time actionable intelligence, strike, interdiction, close air support, and special missions to deployed war-fighters. (Tab FF-2)

g. 451st Air Expeditionary Wing

The 451 AEW provides a persistent and powerful airpower presence in the Afghanistan area of operations, to include tactical airlift, close air support, intelligence, surveillance and reconnaissance, command and control, airborne data link, combat search and rescue, casualty evacuation and aeromedical evacuation capabilities whenever and wherever needed. (Tab FF-2)

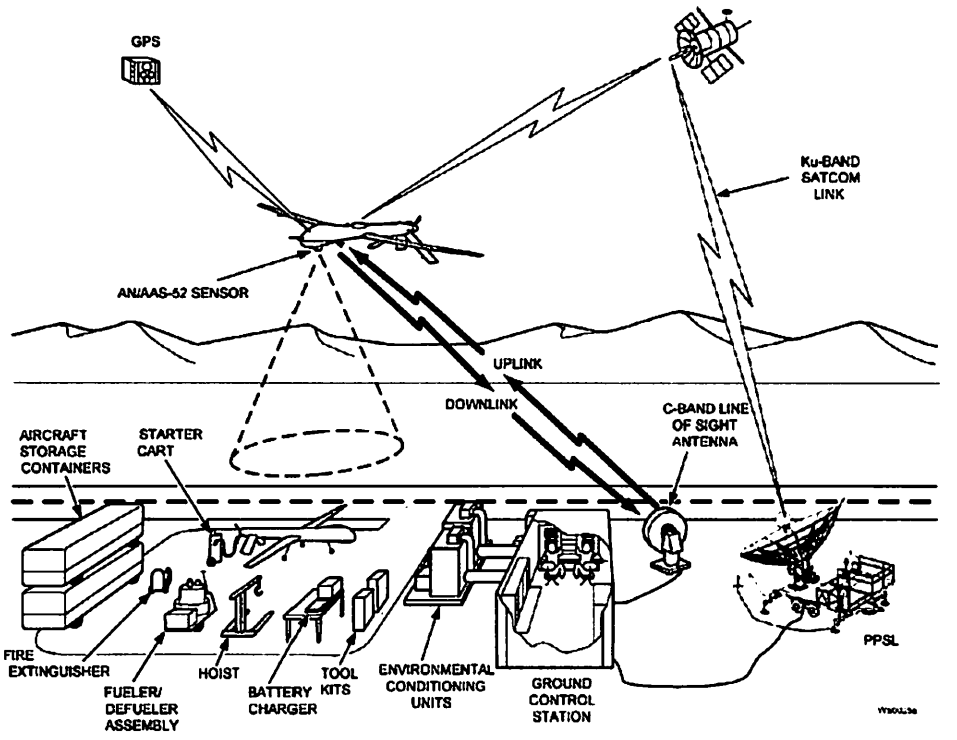
h. 62d Expeditionary Reconnaissance Squadron

The 62 ERS consists of operators that are responsible for launch and recovery of Predator aircraft in Afghanistan. (Tab FF-2)

BATTLESPACE
FLIGHT SERVICES, LLC

i. Battlespace Flight Services, LLC (Based in Las Vegas, NV)

Battlespace Flight Services (BFS), LLC provides a high level of organizational maintenance support for MQ-1 aircraft and systems to sustain the combat and training capability at tasked locations worldwide. BFS LLC provides qualified management and supervisory personnel at Continental United States (CONUS) and Outside Continental United States (OCONUS) locations. BFS LLC support includes aircraft maintenance management, Aerospace Ground Equipment (AGE) and Ground Support Equipment (GSE) maintenance, supply support, Command, Control, Communications, Computer, Intelligence Surveillance and Reconnaissance Systems (C4ISR), Quality Assurance, and an Environmental, Safety and Health (ES&H) Program. BFS LLC is currently under contract with the United States Air Force (USAF) for O&M support for the MQ-1 Predator. Organizationally, BFS LLC located in Afghanistan falls under the 62 ERS, Det 1. (Tab FF-2)



j. MQ-1B Predator System

The MQ-1B Predator aircraft is a medium-altitude, long endurance, remotely Piloted aircraft. Its primary mission is interdiction and conducting armed reconnaissance against critical perishable targets. The MQ-1B Predator is a fully operational system, not just an aircraft. The basic system consists of four aircraft (with sensors), a GCS, a Predator Primary Satellite Link (PPSL) and operations and maintenance personnel for deployed 24-hour operations. The basic crew for the MQ-1B Predator is one Pilot and one Sensor Operator (SO). They fly the MQ-1B Predator from inside the GCS via a line of sight (LOS) radio data link and via a satellite data link for beyond an LOS flight. A ground data terminal antenna provides LOS communications for takeoff and landing while the PPSL provides beyond LOS communications during the remainder of the mission. The aircraft is equipped with a color nose camera (generally used by the Pilot for flight control), a day variable-aperture television camera, a variable aperture infrared camera (for low light/night), and other sensors, as required. The cameras produce full-motion video. The MQ-1B Predator also carries the Multi-spectral Targeting System which integrates electro-optical, infrared, a laser designator and a laser illuminator into a single sensor package. The MQ-1B Predator is manufactured by General Atomics Aeronautical Systems Inc. (GA-ASI) headquartered in San Diego, California. (Tab FF-2)

4. SEQUENCE OF EVENTS

a. Mission

The mishap sortie was an armed ISR mission flown by the MCE in support of an authorized and classified air tasking order. (Tab AA)

b. Planning

The board did not find mission planning to be a factor in the mishap. (Tab AA)

c. Preflight

The board did not find preflight to be a factor in the mishap. (Tabs AA, D-4)

d. Summary of Accident

On 14 February 2012 at 1620Z, the MRPA MQ-1B Predator, T/N 07-003190, departed a deployed airfield in Afghanistan after an uneventful taxi and takeoff by the LRE. The MRPA was subsequently handed over to the MCE at 1633Z. The MCE crew called "on target" at 1748Z and remained on target without incident for the first 3 hours and 36 minutes of the mission. The MCE Pilots swapped out twice prior to the MCE MP taking control of the aircraft. The MCE Sensor Operators swapped out once prior to the MCE MSO taking the seat. These crew rotation schedules are normal for MQ-1 RPA operations. (Tab AA)

At approximately 2024Z, the MRPA experienced a dual alternator failure. Post-mishap analysis showed that the right-side alternator's case fractured in flight due to material defects, allowing the alternator halves to vibrate excessively. This vibration placed additional load on the mounting points causing a mounting boss to break. The broken mounting boss allowed the alternator to slip far enough from its mounted position to cause severe misalignment of the pulley, shredding the belt. A portion of the shredded right-side belt interfered with the left-side alternator belt, causing it to break. At this point the aircraft automatically began to run on battery power. (Tab DD-3)

At 2024Z, upon noticing indications of the dual alternator failure, the MMCE crew immediately notified the Mission Intelligence Coordinator, turned the MRPA back toward the deployed airfield and began to execute the Dual Alternator Failure checklist. (Tab N-2)

At 2025Z, the MMCE crew extended the MRPA's landing gear. The MMCE crew received landing gear warning indications at 2026Z. The MMCE crew started communication with the MLRE via a secure chat room, and then coordinated a descent from the operational altitude to 8,000 ft MSL with ATC. At 2031Z, the MMCE visually confirmed the landing gear was extended using the MTS, and then turned the MTS off at 2032Z. The MMCE did not immediately relay their visual confirmation of the gear to the MLRE. According to the data loggers, by 2032Z, the MMCE had turned off electrical power to all equipment as specified by the Dual Alternator Failure checklist except for three systems – one of which was required for flight, and the other two being very low current-draw systems. These three systems remained on for the duration of the MMCE data loggers. (Tabs N-3 to N-11, DD-4)

At approximately 2027Z, the MMCE notified the MLRE in a secure chat room that they were an emergency aircraft. The MLRE crew stepped to the GCS at 2029Z without a safety observer (Tab V-4.1). Prior to entering the GCS, the LRE MP briefed a plan to recover the aircraft through "High Key," a position above the approach end of the runway that allows for an engine-out spiraling glide down to landing (Tab V-4.1). At 2035Z, the MLRE crew requested the MMCE to transmit their downlink video feed to the MLRE; however, improper data link configuration settings by the MMCE crew caused a two minute delay in the MLRE receiving the feed (Tabs N-9 to N-10, CC).

At approximately 2040Z, the MLRE crew gained control of the aircraft via a "hostile takeover" – using the LOS data link to take command of the MRPA away from the MMCE. At this time, the GCS settings configured by the MLRE crew caused multiple electrical systems to turn back on. The powering-on of these components caused the current draw on the batteries to increase from approximately 64 A to 80 A. (Tab CC, DD-5)

After gaining control of the aircraft, the MLRE crew continued to descend the MRPA through 10,000 ft MSL. At approximately 2042Z, the LRE MP requested that the LRE MSO confirm with the MMCE that the landing gear had been visually verified with the MTS. At 2043Z the LRE MSO relayed confirmation from the MMCE that the gear had been visually checked down with the MTS. (Tab CC) Despite confirmation from the MMCE, the MLRE crew was not confident that the gear was down. (Tab V-4.2) At 2043Z, the MLRE commenced the Dual Alternator Failure checklist. Battery voltage at this time was approximately 21.4 volts. (Tab CC) The MLRE crew did not verify that the MTS was off as previously communicated by the MMCE crew. (Tab V-4.1)

At 2045Z, the LRE MP relayed to ATC that he intended to descend directly over the field to enter the traffic pattern for landing through High Key. At approximately 2046Z, the LRE MSO calculated approximately 49 minutes of battery life remaining based on Figure 3-12, Battery Duration, in the T.O. 1Q-1(M)B-1. At 2047Z, the LRE MP asked ATC whether they had any way of visually inspecting the MPRA's landing gear prior to landing. ATC responded at 2048Z that they could attempt to visually confirm the landing gear was down using light guns in the tower. Battery voltage at this time dropped below 20 V. At 2049Z, the MLRE lost control of the aircraft due to a complete loss of MRPA electrical power. At the time of the complete loss of power, the MRPA was at 4,190 ft MSL (approximately 2,370 ft AGL), just short of the approach end of the runway, and had a battery reading of 15 V. (Tab CC)

e. Impact

The MRPA crashed at approximately 2049Z in a field approximately 1.1 NM northeast of the approach end of Runway 31. The MRPA was carrying one AGM-114 Hellfire missile. Flight parameters were unknown due to a loss of downlink. (Tabs D-6, S-3)

f. Life Support Equipment, Egress and Survival

Not applicable.

g. Search and Rescue

Not applicable.

h. Recovery of Remains

Not applicable.

i. Recovery of Wreckage

The wreckage was recovered by elements of the United States Army, and delivered to the on-site maintenance facility and later shipped to Creech AFB, NV.

5. MAINTENANCE

a. Forms Documentation

(1) General Definitions

Each individual Air Force aircraft and GCS has its own set of written and electronic maintenance records used to document routine scheduled, as well as unscheduled (e.g., flight or ground reported discrepancies) maintenance. These maintenance actions are documented in writing in the Air Force Technical Order (AFTO) 781 forms and the electronically-based Integrated Maintenance Data System (IMDS). In addition to capturing historical data, these documents provide an avenue to more effectively troubleshoot and resolve new or recurring maintenance discrepancies. (Tab FF-3)

Time Compliance Technical Orders (TCTO) are system changes, usually parts upgrades, with a specific required completion date. A TCTO may also direct inspections or adjustments to equipment of parts already attached to the aircraft or ground support items. TCTOs may be immediate, urgent, or routine, based on the severity of the issue. Time change items are routine maintenance actions in which components are removed and replaced for overhaul at a given number of flight hours. (Tab FF-3)

(2) General Documentation Reviewed

Maintenance activities for the MRPA and the MLRE GCS (6114) were performed by Battlespace, LLC personnel deployed to the operating location. Maintenance activities for the MMCE GCS (5126) were performed by 432d Aircraft Maintenance Squadron personnel. (Tab O-3) A thorough review of IMDS documentation was conducted by the AAIB. This review reflected maintenance conducted 90 days prior to the mishap. The 90-day aircraft maintenance history revealed no recurring maintenance problems related to the mishap. A thorough review was conducted of the AFTO 781 series forms. (Tab D). Additionally, there were no overdue TCTOs, time change items or special inspections at the time of the mishap. There were no delayed discrepancies annotated in the 781K. Upon review of the maintenance documentation, no discrepancies were found to be a factor. (Tab D)

b. Inspections

(1) Mishap Aircraft

All scheduled inspections were accomplished within scheduled time limits. There were no overdue aircraft TCTOs. The next scheduled aircraft inspection was a 60-hour inspection for the aircraft engine. (Tab D)

(2) Mishap GCS

Both the MMCE GCS and MLRE GCS were operating normally per Aeronautical Systems Center, Medium Altitude UAS Division (ASC/WII) Detachment 3 analysis of data logs and returned to service. (Tab O-3)

(3) Mishap Engine

The Predator RPA requires an engine inspection every 60 and 720 hours. All scheduled engine inspections were completed on time and there were no overdue inspections or modifications. The mishap engine had flown 13 hours since the last scheduled 60-hour engine inspection. The engine was first installed in the MRPA on 18 November 2011 with 2 hours on the engine from the factory. At the time of the mishap the engine had flown for 639 of its 1,080-hour operational life. The alternators were installed on the MRPA engine at initial build-up and had flown for 639 of their 720-hour operational lives. (Tab D-2, D-9)

Documents in IMDS show that the engine was removed from the MRPA on 28 November 11 at 63 engine hours to replace a bad starter motor. The engine was reinstalled on 29 November 2011 and flew until the mishap. Input conditions for starter replacement require the alternator mounting plate, left and right alternators, and front engine mount to be removed. These actions were not documented in IMDS or in the engine forms, and would account for the broken orange torque stripes on the alternators and mounting plate bolts and the new yellow torque stripes as noted in the GA-ASI report. The GA-ASI report states that it is possible that the undocumented maintenance on the alternators resulted in excessive torque of the through-bolts and/or mounting bolts, which may have resulted in excessive load on these bolts. However, neither GA-ASI nor the AIB found any evidence of over-torqued bolts. (Tabs D-120 & DD-8, DD-12)

c. Maintenance Procedures

Maintenance procedures on the MRPA were completed in accordance with applicable Technical Orders (T.O.) and AFIs except for the missing documentation on the required input conditions for starter replacement. (Tab D)

d. Maintenance Personnel and Supervision

All individual training records reviewed indicated all maintenance personnel involved were trained and qualified. Maintenance supervision was adequate and not found to be a factor in the mishap. Maintenance personnel and supervision qualifications and proficiencies were also not factors in the mishap. (Tab D)

e. Fuel, Hydraulic and Oil Inspection Analysis

The documented forms illustrated correct levels of fluids in the aircraft at takeoff. Maintenance personnel properly serviced fuel tanks and oil reservoirs IAW technical data. (Tab D) The board found no evidence that petroleum, oils and lubricants were factors in the mishap.

f. Unscheduled Maintenance

A review of the unscheduled maintenance actions revealed no relevant maintenance was performed prior to final launch.

6. AIRCRAFT AND AIRFRAME

a. Condition of System

(1) Batteries

Batteries are normally charged within 12 hours of a flight. In the event that batteries fail to reach the required Amp-Hour rating after the normal charging process, a slower alternate charging (Alt

Charging) method is used. The charge/discharge curves showed one battery had to be Alt Charged twice to meet the minimum requirements specified in the T.O. GA-ASI post-mishap engineering tests of the batteries showed that this battery would not accept a full charge. (Tab DD-6)

(2) Dual Alternator Regulator

The DAR was in good condition. The board had no access to further unredacted information regarding the DAR. (Tab DD-7)

(3) Alternators/Belts

Both alternator belts were destroyed. The left belt had one rib partially detached and exhibited a clean break, while the right belt was shredded. The right-side alternator belt debris wound past the closeout ring contacting the left-side belt. IMDS records showed that the alternators and belts had 639 hours on them at the time of the mishap. (Tab D-2)

The right-side alternator casing was fractured in several places. The right-side alternator casing fractures showed a polished surface in some places, indicating that the engine was running after the damage occurred. The right-side alternator plate exhibited wear markings, indicating that the alternator shaft and nut had rubbed and extruded material from the separator plate in flight. The tip of the right alternator rotor shaft and the cap nut exhibited radial wear patterns. (Tab DD-7)

The left-hand alternator spun freely and showed no signs of fracturing or defect. (Tab DD-8)

b. Testing

(1) Dual Alternator Regulator

The DAR showed no anomalies during testing. (Tab DD-7)

(2) Alternators

The left-hand alternator spun freely and testing showed no anomalies. The right alternator rotor was seized and was deemed unsafe for testing. (Tab DD-7)

Engineering tests of both alternator assemblies showed that they were properly secured. Similarly, engineering tests of the belt-tensioners showed that both operated through their full range of motion and at the proper tension setting. (Tab DD-9)

X-Ray Radiography analysis showed a concentration of structural deficiencies in the right-side alternator casing near the fracture initiation site. The analysis also showed several deficiencies throughout the entire alternator casing. Energy dispersive spectrometry analysis of the right-side alternator identified the probable casing material as [REDACTED]. Several structural deficiencies were found throughout the casing. These deficiencies were high-porosity, inclusions, shrinkage, and gas-bubbles. The metallurgical analysis identified one of the through-bolt flanges as the initiation-site of the case fracture. This flange exhibited brittle fracture components near the initiation sight, indicating this point may have been weakened prior to failure. The location of the flange was determined to be an unlikely structural break point in the event of large loads generated by the crash. The fracture pattern showed certain metallurgical

markings indicating the material tore away from the flange, presenting further evidence that it was the initiation site. Black paint was also found inside of a crack near the initiation site, indicating that there were pre-existing flaws present in the flange prior to field operation. (Tab DD-7, DD-8)

7. WEATHER

a. Forecast weather

Source documents containing weather information are classified, but the weather forecast was not considered to be a factor by the AIB. (Tab F-2)

b. Observed/post-mishap weather

Source documents containing weather information are classified, but weather was not considered to be a factor by the AIB. (Tab F-2)

c. Space

Source documents containing space weather information are classified, but space weather was not considered to be a factor by the AIB. (Tab F-2)

d. Operations

Source documents containing weather information are classified, but weather was not considered to be a factor by the AIB. (Tab F-2)

8. CREW QUALIFICATIONS

a. MCE Mishap Pilot (MCE MP)

(1) Training

The MCE MP had been a qualified MQ-1B Pilot since 22 Sep 10. (Tab G-33)

During typical initial qualification and mission qualification courses, MQ-1 pilots and sensor operators are instructed and evaluated on diagnosing and handling dual alternator failure emergency situations. These procedures are periodically reviewed through monthly Situational Emergency Procedures Training discussions with experienced instructors. (FF-2)

(2) Experience

The MCE MP's total flight time was 835.3 hours. The MCE MP's flight time included 543.7 hours in the MQ-1B and 257.2 hours of Pilot training. Prior to flying the MQ-1B, the MCE MP was a Joint Specialized Undergraduate Pilot Training (JSUPT) student. (Tabs G-3)

The MCE MP was fully current and qualified at the time of the mishap. The MCE MP's flight time during the 30, 60 and 90 days before the mishap were as follows: (Tab G-4)

MP	Hours	Sorties*
Last 30 Days	17.2	8
Last 60 Days	17.2	8
Last 90 Days	39.8	88

b. MCE Mishap Sensor Operator (MCE MSO)

(1) Training

The MCE MSO had been a qualified MQ-1B SO since 18 Aug 11. (G-35)

During typical initial qualification and mission qualification courses, MQ-1 pilots and sensor operators are instructed and evaluated on diagnosing and handling dual alternator failure emergency situations. These procedures are periodically reviewed through monthly Situational Emergency Procedures Training discussions with experienced instructors. (Tab FF-2)

(2) Experience

The MCE MSO's total MQ-1B flight time was 179.3 hours. The MCE MSO was fully current and qualified at the time of the mishap. (Tab G-14) The MCE MSO's flight time during the 90 days before the mishap was as follows: (Tab G-15)

MSO	Hours	Sorties*
Last 30 Days	27.8	9
Last 60 Days	81.7	26
Last 90 Days	144.2	49

c. LRE Mishap Pilot (LRE MP)

(1) Training

The LRE MP had been a qualified MQ-1B Pilot since 7 Apr 10. Additionally, the LRE MP had been a qualified Launch and Recovery (LR) Pilot since 28 Sep 10. (Tab G-37)

During typical initial qualification, mission qualification and LR training courses, MQ-1 pilots and sensor operators are instructed and evaluated on diagnosing and handling dual alternator failure emergency situations. These procedures are periodically reviewed through monthly Situational Emergency Procedures Training discussions with experienced instructors. (Tab FF-2)

(2) Experience

The LRE MP's total flight time was 974.2 hours, all in the MQ-1B. (Tabs G-20)

The MCE MP was fully current and qualified at the time of the mishap. The MCE MP's flight time during the 30, 60 and 90 days before the mishap were as follows: (Tab G-21)

MP	Hours	Sorties*
Last 30 Days	14.9	21
Last 60 Days	35.3	45
Last 90 Days	78.8	73

d. LRE Mishap Sensor Operator (LRE MSO)

(1) Training

The LRE MSO had been a qualified MQ-1B SO since 11 Aug 11. Additionally, the LRE MSO had been a qualified LR Sensor Operator since 23 Nov 11. (G-38)

During typical initial qualification, mission qualification and LR training courses, MQ-1 pilots and sensor operators are instructed and evaluated on diagnosing and handling dual alternator failure emergency situations. These procedures are periodically reviewed through monthly Situational Emergency Procedures Training discussions with experienced instructors. (Tab FF-2)

(2) Experience

The LRE MSO's total MQ-1B flight time was 146.6 hours. The MCE MSO was fully current and qualified at the time of the mishap. (Tab G-27) The LRE MSO's flight time during the 90 days before the mishap was as follows: (Tab G-28)

MSO	Hours	Sorties*
Last 30 Days	6.4	8
Last 60 Days	51.8	17
Last 90 Days	87.4	23

* ACC Aviation Records Management System (ARMS) products do not count multiple LRE flights on the same day as separate sorties. Therefore, in the charts above for the MPs and MSOs, the number in the sorties column equates to the number of days flown, rather than number of actual sorties.

There was no evidence to suggest crew qualifications were a factor in the mishap.

9. MEDICAL

a. Qualifications

At the time of the mishap, all mishap crewmembers (MC) were medically qualified for flight duty. A thorough review of all MC electronic medical records and toxicology reports was conducted by a qualified U.S. Air Force Flight Surgeon.

b. Health

A qualified U.S. Air Force Flight Surgeon reviewed the Armed Forces Health Longitudinal Technology Application and the Department of Defense electronic medical record system.

Preventive Health Assessments were current for all MC. A review of each of the MC's post-accident medical examination records was conducted and the results appeared not-relational to the accident. All MCs completed 72 hour and 14 day histories regarding their sleep and nutritional habits, activities and behaviors for the specified periods preceding the mishap event. The MC's 72 hour and 14 day history revealed no erratic sleep patterns, unusual eating habits, or significant stressors.

c. Pathology

All MCs were either not taking any medication or were taking approved medication in accordance with the most recent Official Air Force Approved Aircrew Medication list prior to the mishap.

Immediately following the mishap, toxicology testing was ordered for each MC. Blood and urine samples were submitted to the Armed Forces Medical Examiner System (AFMES) for toxicological analysis. This testing included carbon monoxide and ethanol levels in the blood and urine.

Ethanol and carbon monoxide results were within normal limits for the MC. Finally, AFMES performed a urine screen for amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates and phencyclidine by immunoassay (or chromatography). These drugs were not detected.

d. Lifestyle

No lifestyle factors were found to be relevant to the mishap.

e. Crew Rest and Crew Duty Time

AFIs require all aircrew members to have proper "crew rest," as defined in AFI 11-202, Volume 3, General Flight Rules, prior to performing in-flight duties. AFI 11-202 V3 defines normal crew rest as a minimum 12-hour no-duty period before the designated flight duty period (FDP) begins. During this time, an aircrew member may participate in meals, transportation or rest as long as he/she has the opportunity for at least eight hours of uninterrupted sleep.

Crew rest and duty time requirements were met and found not to be factors in the mishap. There was no evidence to suggest that fatigue was a factor in the mishap.

10. OPERATIONS AND SUPERVISION

a. Operations Tempo

The AIB did not find that Operations Tempo played a factor in this mishap. (Tab G-4, G-15, G-21 & G-28)

b. Experience Level

The AIB did not find that Experience Level played a factor in this mishap.. (Tab G-3, G-14, G-20, G-27)

c. Supervision

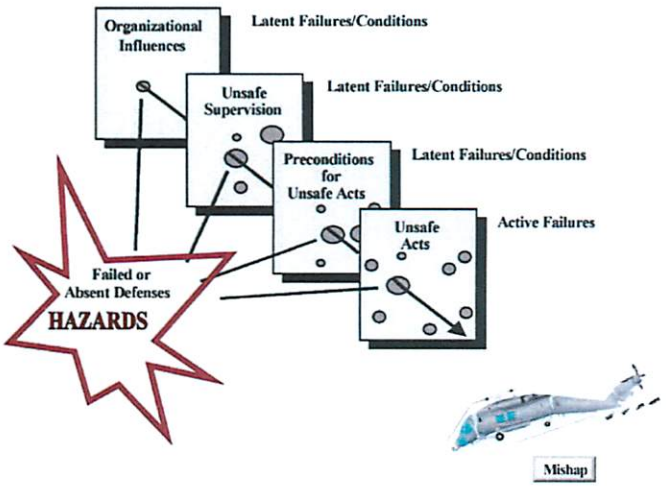
The AIB did not find that Supervision played a factor in this mishap. (Tab K-3, K-10 to K-11)

11. HUMAN FACTORS

a. Overview

A DoD taxonomy was developed to identify hazards and risks, called the DoD Human Factors Analysis and Classification System (DOD-HFACS), referenced in Attachment 1 of AFI 91-204, *Safety Investigations and Reports*, 24 Sept 2008. DOD-HFACS describes four main tiers of failures/conditions: 1) Acts, 2) Preconditions, 3) Supervision, and 4) Organizational Influences.

The investigation process endeavors to detect and identify failed or absent defenses (hazards), which can be visually depicted by the "Swiss Cheese" model (adapted from Reason, 1990), as seen below:



After reviewing the facts from the investigation, including witness testimony, human factors found to be relevant to this mishap are enumerated and justified below. Also included is the DoD-HFACS taxonomy (or "nanocodes") for reference.

Acts are those factors that are most closely tied to the mishap, and can be described as active failures or actions committed by the operator that result in human error or unsafe situation. **Errors** are factors in a mishap when mental or physical activities of the operator fail to achieve their intended outcome as a result of skill-based, perceptual, or judgment and decision making errors leading to an unsafe situation. Errors are unintended.

b. Skill-Based Errors

Skill-Based Errors are factors in a mishap when errors occur in the operator's execution of a routine, highly practiced task relating to procedure, training or proficiency and result in an unsafe a situation.

Checklist Error (AE102) 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 and this failure results in an unsafe situation.

While executing the Dual Alternator Failure checklist, the MLRE crew omitted reading all Notes, Cautions, Warnings, and expanding information to include, most notably, the first sentence of the checklist "Battery life is limited forcing the Pilot to land as soon as possible before battery failure causes complete loss of aircraft control". The crew also omitted the first caution under Step 2, "When battery voltage drops below [REDACTED] volts, all electrical power may be lost." In addition, the MLRE crew did not read or accomplish all of the sub-steps of Step 2, which prompts them to turn off non-essential electrical equipment. Finally, the LRE MSO read aloud Step 5, "BATTERY VOLTAGE - Monitor," but there is no evidence that either crewmember accomplished this step as the LRE MSO immediately moved on to the next step without response from the LRE MP. (Tabs BB-3 to BB-4 and CC)

Procedural Error (AE103) is a factor when a procedure is accomplished in the wrong sequence or using the wrong technique or when the wrong control or switch is used. This also captures errors in navigation, calculation or operation of automated systems.

The MLRE crew failed to recognize and understand that Figure 3-12 in T.O. 1Q-1(M)B-1was not applicable to their situation. The LRE MSO's calculation of remaining battery life was completely irrelevant at that point because the aircraft had been running on battery power for 21 minutes, and the battery voltage was below a critical level (Tab N-23). Information in the chart's subtitle and notes clearly specified conditions under which the chart was applicable. (Tab BB-7)

c. Judgment and Decision-Making Errors

Judgment and Decision-Making Errors are factors in a mishap when behavior or actions of the individual proceed as intended yet the chosen plan proves inadequate to achieve the desired end-state and results in an unsafe situation.

Risk Assessment (AE201) during operation is a factor when the individual fails to adequately evaluate the risks associated with a particular course of action and this faulty evaluation leads to inappropriate decision and subsequent unsafe situation. This failure occurs in real-time when formal risk-assessment procedures are not possible.

The LRE MP did not adequately evaluate the potential for imminent battery failure and subsequent complete loss of aircraft power. This faulty risk assessment led to his inappropriate decision to handle the dual alternator failure in the same manner as an engine failure by maneuvering the MRPA over the airfield (a populated area) in an attempt to reach High Key, as opposed to rapidly descending the aircraft over a less

populated area surrounding the airfield and attempting to land the aircraft via a straight-in approach. (Tab BB-5)

Task Misprioritization (AE202) is a factor when the individual does not organize, based on accepted prioritization techniques, the tasks needed to manage the immediate situation.

The MLRE crew misprioritized the landing gear warning indication over the threat of imminent battery failure, which distracted them from pertinent cues and negatively influenced their handling of the dual alternator failure. This led the MLRE crew to focus their time and attention on receiving a visual confirmation from an outside source that their gear was down as opposed to following the direction of the T.O. which states "Battery life is limited forcing the pilot to land as soon as possible before battery failure causes complete loss of aircraft control." (Tab BB-3)

Necessary Action – Delayed (AE204) is a factor when the individual selects a course of action but elects to delay execution of the actions and the delay leads to an unsafe situation.

The MMCE crew delayed switching off the MTS for approximately six minutes after they had first visually confirmed the gear was down. Two minutes after the MCE MSO confirmed the landing gear was down, the MCE Safety Observer suggested turning off the MTS. However, despite acknowledgment by the MCE MP and the MCE MSO, the MTS was not turned off for another 4 minutes. Consequently, the MMCE crew handed over control of the MRPA to the MLRE crew with less battery life and thus a shortened timeframe to safely recover the aircraft. (Tabs CC, N-4, N-7)

Decision-Making During Operation (AE206) is a factor when the individual through faulty logic selects the wrong course of action in a time-constrained environment.

The LRE MP used faulty logic when deciding to handle the dual alternator failure in the same manner as an engine-out emergency landing. In an engine-out situation, the procedure follows the logic that while the engine may fail (or has failed), the battery will provide electrical power long enough to allow for downlinked video feedback and uplinked control commands, permitting the pilot to glide the aircraft to a safe landing. However, when handling a dual alternator failure, the procedure follows the logic that total electrical loss (and thus total system loss) is imminent, and therefore the aircraft must be safely landed as quickly as possible avoiding populated areas. (Tab BB-3 to BB-5)

d. Preconditions

Preconditions are factors in a mishap if active and/or latent preconditions such as conditions of the operators, environmental or personnel factors affect practices, conditions or actions of individuals and result in human error or an unsafe situation.

Environmental Factors are factors in a mishap if physical or technological factors affect practices, conditions and actions of individual and result in human error or an unsafe situation.

Technological Environment is a factor in a mishap when cockpit/vehicle/control station/workspace design factors or automation affect the actions of individuals and result in human error or an unsafe situation.

Instrumentation and Sensory Feedback Systems (PE202) is a factor when instrument factors such as design, reliability, lighting, location, symbology or size are inadequate and create an unsafe situation. This includes Night Vision Displays, Heads-Up Display, off-bore-site and helmet-mounted display systems and inadequacies in auditory or tactile situational awareness or warning systems such as aural voice warnings or stick shakers.

The MQ-1B GCS does not provide an audible battery warning indication when voltage drops to key levels, nor does it provide a running calculation of estimated battery duration, based on internal battery temperature and instantaneous system load. The absence of these features inhibited the MMCE and MLRE crew's situational awareness of the extremely limited timeframe they had to safely recover the aircraft. (Tab FF-3)

e. Condition of Individuals

Condition of Individuals is a factor in a mishap if cognitive, psycho-behavioral, adverse physical state, or physical/mental limitations affect practices, conditions or actions of individuals and result in human error or an unsafe situation.

Cognitive Factors are factors in a mishap if cognitive or attention management conditions affect the perception or performance of individuals and result in human error or an unsafe situation.

Inattention (PC101) is a factor when 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 which degrades crew performance. (This may often be a result of highly repetitive tasks, lack of a state of alertness or readiness to process immediately available information.)

The MLRE crew had a state of reduced conscious attention to the battery voltage due to the sense of security brought about by the LRE MSO's irrelevant battery duration calculation and their perceived absence of threat from the aircraft's imminent electrical failure. Both of these factors degraded crew performance in safely recovering the aircraft. (Tab N-23)

Channelized Attention (PC102) is a factor when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others of a subjectively equal or higher or more immediate priority, leading to an unsafe situation. May be described as a tight focus of attention that leads to the exclusion of comprehensive situational information.

The LRE MP channelized his attention on the landing gear warning indicators, and verbally stated he believed only one landing gear was down, despite confirmation from the MMCE crew that they had visually verified all landing gear were down. This channelization precluded the LRE MP from noting the aircraft's low battery voltage and recognizing the extremely urgent nature of the situation. (Tab N-20)

Checklist Interference (PC108) is a factor when an individual is performing a highly automated/learned task and is distracted by anther cue/event that results in the interruption and subsequent failure to complete the original task or results in skipping steps in the original task.

While the LRE MSO was reading the Dual Alternator Failure checklist, the LRE MP interrupted just after accomplishing step 2.a. and began to ask for verification that he had completed the "Gaining Handover" checklist. When the LRE MSO continued the Dual Alternator Failure checklist, he omitted the remainder of substeps in step 2 and resumed with step 3. These substeps instruct the crew to turn off non-essential electrical equipment as necessary, which the MLRE crew never accomplished. (Tab N-22)

f. Physical/Mental Limitations

Physical/Mental Limitations are factors in a mishap when an individual, temporarily or permanently lacks the physical or mental capabilities to cope with a situation and this insufficiency causes an unsafe situation.

Technical/Procedural Knowledge (PC405) is a factor when an individual was adequately exposed to the information needed to perform the mission element but did not absorb it. Lack of knowledge implies no deficiency in the training program, but rather the failure of the individual to absorb or retain the information. (Exposure to information at a point in the past does not imply "knowledge" of it.)

As a fully-qualified and experienced MQ-1 Pilot, the LRE MP was adequately exposed to the proper procedures for handling a dual alternator failure. The LRE MP was also knowledgeable about the immediate situation (the fact that he was gaining an aircraft suffering from a dual alternator failure) but failed to make key decisions based on that information. Most notably, the LRE MP chose to land the aircraft via a spiraling engine-out approach, which is not a procedure that is instructed during training for handling a dual alternator failure. (Tabs G-20, G-37, N-17, V-4.1)

g. Perceptual Factors

Perceptual Factors are factors in a mishap when misperception of an object, threat or situation, (visual, auditory, proprioceptive, or vestibular conditions) creates an unsafe situation.

Misinterpreted/Misread Instrument (PC505) is a factor when the individual is presented with a correct instrument reading but its significance is not recognized, it is misread or is misinterpreted.

The MLRE crew were presented with correct battery voltage along with system current load, but failed to recognize the significance of either during the in-flight emergency. The low battery voltage signified an extremely urgent emergency situation that required landing the aircraft immediately. The system current load was an indication that multiple non-essential electrical systems had turned on when the MLRE crew gained control of the aircraft. (Tabs CC, DD)

h. Personnel Factors

Personnel Factors are factors in a mishap if self-imposed stressors or crew resource management affect practices, conditions or actions of individuals and result in human error or an unsafe situation.

Coordination/Communication/Planning Factors refer to interactions among individuals, crews, and teams involved with the preparation and execution of a mission that resulted in human error or an unsafe situation.

Miscommunication (PP112) is a factor when correctly communicated information is misunderstood, misinterpreted, or disregarded.

The LRE MSO misunderstood the LRE MP when he stated he wanted to omit the Notes, Cautions and Warnings under step 1 of the Dual Alternator Failure checklist. The LRE MSO misinterpreted the LRE MP's statement to mean that he should omit all Notes, Cautions, and Warnings for the remainder of the checklist which caused him to fail to read further pertinent information in the checklist. Most notably the LRE MSO did not read the first caution under step 2 which reads, "When battery voltage drops below [REDACTED] volts, all electrical power may be lost." Had the LRE MSO read this step, the crew would have been prompted to check their battery voltage, which was below the cited voltage at that point. (Tab N-22, BB-4)

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications

1. T.O. 1Q-1(M)B-1, Flight Manual USAF Series MQ-1B System, 13 December 2010, incorporating Change 3, 11 January 2012
2. AFI 51-503, *Aerospace Accident Investigations*, 26 May 2010*
3. AFI 91-204, *Safety Investigations and Reports*, 24 Sept 2008*

* Directives and publications can be found on http://www.e-publishing.af.mil

Note: Numerous Air Force Instructions and Technical Orders were referenced during the conduct of this investigation, but are omitted from this list because they were not specifically cited or not releasable under the Arms Export Control Act (Title 22, U.S.C. 2751, et seq.) or the Export Administration Act of 1979, as amended, Title 50, U.S.C., App 2401 et seq.

b. Maintenance Directives and Publications

Note: Numerous Air Force Instructions and Technical Orders were referenced during the conduct of this investigation, but are omitted from this list because they were not specifically cited or not releasable under the Arms Export Control Act (Title 22, U.S.C. 2751, et seq.) or the Export Administration Act of 1979, as amended, Title 50, U.S.C., App 2401 et seq.

c. Known or Suspected Deviations from Directives or Publications

As previously discussed in Section 11.

13. ADDITIONAL AREAS OF CONCERN

None.

6 Aug 2012

CADE R. SONNICHSEN, Lt Col, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B PREDATOR, T/N 07-3190
AFGHANISTAN
14 FEBRUARY 2012

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report 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

I find, by clear and convincing evidence, that the causes of the mishap were 1) a dual alternator failure followed by the complete loss of aircraft electrical power while the aircraft was approximately 2,370 feet (ft) above ground level (AGL), and 2) the Launch and Recovery Element (LRE) Mishap Pilot's (MP) failure to adequately assess the nature of the emergency and fully execute proper procedures listed in the published flight manual. At approximately four hours into the mission, both of the Mishap Remotely Piloted Aircraft's (MRPA) alternators failed, forcing the MRPA to rely solely on batteries for electrical power. Upon gaining control of the MRPA, the LRE MP failed to fully accomplish the Dual Alternator Failure checklist and execute appropriate Forced Landing procedures. Specifically, the LRE MP did not execute appropriate electrical load-shedding measures and failed to land the MRPA as soon as possible, and instead displayed poor judgment by electing to maneuver the MRPA over the airfield with the intention of reaching High Key - a position above the approach end of the runway that allows for an engine-out spiraling glide down to landing - and executing an engine-out emergency landing.

Further, I find, by a preponderance of the evidence, the Mishap LRE (MLRE) crew's poor crew coordination while executing checklists and their channelized attention on a landing gear warning indication, substantially contributed to the mishap.

While attempting to execute the Dual Alternator Failure checklist, the MLRE crew skipped over significant portions, including all of the Notes, Cautions, and Warnings, due to poor communication between the LRE MP and LRE Mishap Sensor Operator (MSO). These portions of the checklist contain critical information, such as the importance of landing the aircraft as soon as possible, and closely monitoring battery voltage as an indicator of imminent electrical failure. Further, the MLRE crew's continued concern over the landing gear warning indication – even after they had received confirmation from the Mishap Mission Control Element (MMCE) crew that the landing gear was visually checked with the Multi-spectral Targeting System (MTS) – prompted them to coordinate for a low approach with the airfield's control tower in order to facilitate another visual inspection of the landing gear.

2. DISCUSSION OF OPINION

a. Cause: Dual Alternator Failure

The MRPA suffered a dual alternator failure in flight resulting in the aircraft relying solely on the dual batteries for all electrical power demands. Analysis revealed that the right-side alternator case fractured in flight due to material defects, allowing the alternator halves to vibrate excessively. This vibration placed additional load on the right-side alternator mounting points causing a mounting boss to break. The broken mounting boss allowed the right-side alternator to slip far enough from its mounted position to cause severe misalignment of the pulley, shredding the belt. A portion of the shredded right-side belt interfered with the left-side alternator belt, causing it to break. At this point the aircraft automatically began to run on battery power. After approximately 26 minutes, battery voltage dropped below the minimum operational bus voltage, resulting in total electrical failure, and the MRPA crashed.

b. Cause: Pilot Error

The LRE MP failed to properly analyze the emergency situation and fully accomplish the Dual Alternator Failure checklist and the appropriate Forced Landing procedures. The LRE MP failed to ensure step 2 of the Dual Alternator Failure checklist, "ELECTRICAL LOAD – Reduce (P, SO)" was completed, which prevented the MLRE crew from recognizing that several high-load systems remained on and were significantly reducing available battery life. The LRE MP also failed to expedite a descent to a position that would allow for a straight-in approach to the airfield, avoiding populated areas, in consideration of imminent battery failure. The LRE MP followed incorrect procedures, initially configuring the MRPA for an "engine-out" recovery, setting a glide speed and slowing the rate of descent, then dangerously proceeded to maneuver the MRPA over the airfield with the intention of reaching High Key and executing an engine-out emergency landing. During multiple recreations of the mishap flight in an MQ-1 simulator, the Accident Investigation Board (AIB) found that, had the mishap pilot followed T.O. instructions and rapidly descended the aircraft over an unpopulated area for a modified straight-in approach, the aircraft could have been safely recovered.

3. CONTRIBUTING FACTORS

a. Substantially Contributing Factor: Crew Error – MLRE crew's poor crew coordination while executing checklists

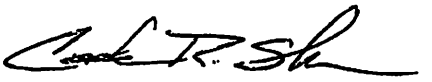
The LRE MP attempted to execute the Dual Alternator Failure checklist, but instructed the LRE MSO to "skip" the Notes, Cautions, and Warnings under step 1. The LRE MSO proceeded to omit all subsequent Notes, Cautions, and Warnings for all other steps in the checklist. The omission of these portions of the checklist prevented the MLRE crew from noting critical information such as the importance of landing the aircraft as soon as possible, and closely monitoring battery voltage as an indicator of imminent electrical failure.

b. Substantially Contributing Factor: Crew Error – MLRE crew's fixation on landing gear warning indication

The LRE MP continued to express concern over the landing gear warning indication – even after he had received a message from the MMCE crew indicating visual confirmation of the landing gear – and coordinated for a low-approach with the airfield's control tower to facilitate a visual inspection of the landing gear. During an interview with the AIB, the LRE MSO stated that even after receiving the message from the MMCE crew he also had no confidence in the landing gear status. This fixation on the gear status and subsequent troubleshooting consumed precious time and diverted the MLRE crew's attention from higher-priority issues such as the low battery voltage.

4. CONCLUSION

I arrived at my opinion by examining the GA-ASI Report, witness testimony, video and audio from the MMCE and MLRE Ground Control Stations, voice and "chat" transcripts, applicable technical data, multiple recreations of the mishap flight in an MQ-1 simulator and consulting with subject matter experts. All evidence is consistent with the following causes: 1) the MRPA's dual alternator failure, due to material deficiency, which caused the aircraft to rely on electrical power solely from the batteries and 2) the LRE MP's failure to adequately assess the nature of the emergency, expedite a descent, reduce the load on the batteries and execute proper forced landing procedures.



6 Aug 2012

CADE R. SONNICHSEN, Lt Col, USAF
President, Accident Investigation Board

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

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ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B PREDATOR, T/N 07-3190
AFGHANISTAN
14 FEBRUARY 2012