UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B T/N 05-3141
432D RECONNAISSANCE WING
CREECH AIR FORCE BASE, NEVADA

LOCATION: BALAD, IRAQ

DATE OF ACCIDENT: 16 AUGUST 2010

BOARD PRESIDENT: LIEUTENANT COLONEL BRIAN T. JANNEY

Conducted IAW Air Force Instruction 51-503

EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION

MQ-1B, T/N 05-3141 JOINT BASE BALAD, IRAQ
16 AUGUST 2010

An MQ-1B Predator Remotely Piloted Aircraft (RPA) crashed shortly after takeoff near Joint Base Balad (JBB), Iraq on 16 August 2010. The aircraft belonged to the 432d Reconnaissance Wing at Creech Air Force Base (AFB), Nevada, but was deployed at the time in support of Operation IRAQI FREEDOM. The crew flying the aircraft was also deployed to JBB from Creech AFB and was assigned to the 46th Expeditionary Reconnaissance Squadron at the time of the mishap. No one was injured, and no private property was damaged. The aircraft and its system were catastrophically damaged during the crash. The total mishap cost was approximately $3,900,278.

All aircraft systems were functioning normally prior to liftoff, but as soon as the mishap pilot (MP) raised the nose of the aircraft for takeoff, flight control became erratic and remained so throughout the approximately two-minute long flight. Just after the MP raised the landing gear, the aircraft pitched up, rolled dramatically to the right, and ultimately impacted the ground. No maintenance issues that would have caused the mishap were documented or discovered after extensive post-mishap testing on the aircraft and ground control station. A review of the audio and video from the crew's ground control station, as well as analysis of the flight parameters, revealed that the aircraft's Stability Augmentation System was never turned on, prior to or during the flight, and this caused the departure from controlled flight.

The Board found by clear and convincing evidence that the cause of the mishap was due to pilot error when the MP failed to correctly execute the procedure to turn on the aircraft's Stability Augmentation System. The Board further found by a preponderance of the evidence that the human factors of Checklist Error, Inattention, and Expectancy substantially contributed to the mishap.

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.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-1B T/N 05-3141
16 AUGUST 2010

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COMMONLY USED ACRONYMS & ABBREVIATION

ACC	Air Combat Command
AEW	Air Expeditionary Wing
AIB	Accident Investigation Board
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFSOUTH	United States Southern Air Forces
AFTO	Air Force Technical Order
AOA	Angle of Attack
AOR	Area of Responsibility
ATC	Air Traffic Control
ATSO	Aileron Tip Stall Override
EOG	Expeditionary Operations Group
ERS	Expeditionary Reconnaissance Squadron
GCS	Ground Control Station
GDT	Ground Data Terminal
HDD	Head-down Display
HG	Mercury
HUD	Head-up Display
IMDS	Integrated Maintenance Data System
IN	Inches
ISR	Intelligence, Surveillance and Reconnaissance
JBB	Joint Base Balad
KIAS	Knots Indicated Airspeed
L	Local Time
LOS	Line of Sight
LRE	Launch and Recovery Element
MAP	Manifold Air Pressure
MC	Mishap Crew
MMIC	Mishap Mission Intelligence Coordinator
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSL	Mean Sea Level
MSO	Mishap Sensor Operator
MTS-A	Multi-spectral Targeting System
OG	Operations Group
OIF	Operation IRAQI FREEDOM
PPSL	Predator Primary Satellite Link
RPA	Remotely Piloted Aircraft
RPM	Revolutions Per Minute
RS	Reconnaissance Squadron
RW	Reconnaissance Wing
S/N	Serial Number
SUPT	Specialized Undergraduate Pilot Training
TCTO	Time Compliance Technical Order
TO	Technical Order
TV	Television
USAF	United States Air Force
USAFCENT	United States Air Forces Central
USCENTCOM	United States Central Command
Z	Zulu or Greenwich Meridian Time (GMT)

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 27 October 2010, Lieutenant General William J. Rew, Vice Commander Air Combat Command, appointed Lieutenant Colonel Brian T. Janney as the Accident Investigation Board (AIB) President to investigate the 16 August 2010 crash of an MQ-1B Predator aircraft, tail number T/N 05-3141, near Joint Base Balad, Iraq. An abbreviated AIB was conducted at Nellis Air Force Base (AFB), Nevada, from 1 November 2010 through 23 November 2010, pursuant to Chapter 11 of Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*. A Legal Advisor and Recorder were also appointed to the AIB, and a Pilot and Maintainer were named as Functional Area Experts to assist the AIB. (Tab Y-3, Y-4)

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.

2. ACCIDENT SUMMARY

On 16 August 2010, the mishap remotely piloted aircraft (MRPA), an MQ-1B Predator, T/N 05-3141, was flying an operational mission in support of Operation IRAQI FREEDOM (OIF). Approximately two minutes into the flight, the MRPA crashed into an unpopulated field just outside of the Joint Base Balad (JBB) perimeter. The aircraft had taken off and was performing a full-power climb at 850 feet Mean Sea Level (MSL) when communication between the aircraft and the ground control station (GCS) was lost. The GCS datalogs indicated the aircraft was airborne for approximately two minutes before the loss of communication occurred. The aircraft was totally destroyed upon impact with the loss valued at $3,900,278. There were no injuries or damage to personal property. (Tabs P-3 and DD-6, DD-7, GG-5)

3. BACKGROUND

a. Units and Organization

(1) Air Combat Command (ACC)

Air Combat Command is a major command of the United States Air Force and primary force provider of combat airpower to America's warfighting commands. Its mission is to organize, train, equip, and maintain 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. ACC operates fighter, bomber, reconnaissance, battle-management, and electronic-control aircraft and provides command, control, communications, and intelligence systems and conducts global information operations. Over 67,000 active duty members, 13,500 civilians, and when mobilized, 50,000 Air National Guard and Reserve members compose ACC, and its units operate 1,800 aircraft. (Tab CC-3, CC-4, CC-5)

(2) United States Air Forces Central (USAFCENT)

United States Air Forces Central (USAFCENT) is the air component of United States Central Command (USCENTCOM), a regional unified command whose mission is to project decisive air and space power for USCENTCOM and America. USAFCENT is responsible for air operations, either unilaterally or in concert with coalition partners, and developing contingency plans in support of national objectives for USCENTCOM's 20-nation area of responsibility (AOR) in Southwest Asia. Additionally, USAFCENT manages an extensive supply and equipment prepositioning program at several sites in its AOR. Since 2001 USAFCENT has supported Operations ENDURING FREEDOM (OEF) and IRAQI FREEDOM (OIF) and subsequent operations by conducting close air support; airlift; air refueling; and intelligence, surveillance, and reconnaissance (ISR), among other missions from operating locations within Iraq, Afghanistan, and throughout Southwest Asia. (Tab CC-6, CC-7)

(3) 12th Air Force (12 AF)

12th Air Force controls ACC's conventional forces in the western United States and has the warfighting responsibility for U.S. Southern Command as well as the U.S. Southern Air Forces. It manages all Air Force assets and personnel in the AFSOUTH AOR, which includes Central and South America. 12th Air Force has worked closely with nations in the Caribbean, Central and South America in the Global War on Terrorism by providing forces to OEF, OIF, and Operation NOBLE EAGLE, and it also has supported efforts to stem the flow of illegal drugs into the U.S. and neighboring countries.

12th Air Force directs 10 active duty wings and one direct reporting unit as well as 13 gained wings and other units of the Air National Guard and Reserve. (Tab CC-8, CC-9)

(4) 432d Reconnaissance Wing (432 RW) and 432d Air Expeditionary Wing (432 AEW)

The 432d Reconnaissance Wing (432 RW), stationed at Creech AFB, Nevada, flies the MQ-1B Predator and MQ-9 Reaper remotely piloted aircraft (RPA) systems to provide real-time reconnaissance, surveillance, and precision attack against fixed and time-critical targets to support American and coalition forces worldwide. The 432 RW also conducts initial qualification training for aircrew, intelligence, weather, and maintenance personnel who will fly and support RPA systems. The wing's organization includes two groups, six RPA flying squadrons, an operational support squadron, and a maintenance squadron. The wing and its subordinate units are components of the Air Force's ACC and 12 AF. (Tab CC-10, CC-11, CC-12, CC-13, CC-14)

The 432 RW also serves as the 432d Air Expeditionary Wing (AEW) when providing RPA support to Overseas Contingency Operations, and the 432 AEW oversees the operations of two active duty units as well as Air National Guard units in Arizona, California, North Dakota, and Texas. (Tab CC-14)

(5) 432d Operations Group (432 OG) and 15th Reconnaissance Squadron (15 RS)

The 432d Operations Group/Expeditionary Operations Group employs RPA in 24-hour Combat Air Patrols in support of combatant commander needs, and deploys combat support forces worldwide. This includes combat command and control, tactics development, intelligence support, weather support, and standardization and evaluation oversight for ACC, USAFCENT, Air Force Material Command, Air National Guard, the United Kingdom Royal Air Force, seven geographic combatant commanders, and Air Reserve Command RPA units. The Group is also responsible for all air traffic control, airfield management, and weather services for RPA operations at Creech AFB, NV. (Tab CC-12)

The 15th Reconnaissance Squadron is one of the first armed RPA squadrons. The squadron 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 CC-12)

(6) 332d Air Expeditionary Wing (332 AEW)

The 332d Air Expeditionary Wing is a deployed combat wing supporting United States Forces-Iraq transition from combat to stability operations, and helps strengthen the capabilities of a sovereign, secure and self-reliant Iraq. The 332 AEW employs the spectrum of airpower capability throughout the Iraqi theater of operations in support of ground forces and Iraqi capacity-building, including: close-air support, airlift, combat search and rescue, aeromedical evacuation, and ISR. The 332 AEW is headquartered at JBB, Iraq, approximately 65 km north of Baghdad. It consists of six distinct groups, five of which are located at JBB. (Tab CC-15, CC-16)

(7) 332d Expeditionary Operations Group (332 EOG)
and 46th Expeditionary Reconnaissance Squadron (46 ERS)

The 332d Expeditionary Operations Group is responsible for total-force expeditionary flying operations for eight squadrons at the 332 AEW, JBB, Iraq. The group oversees combat operations providing close-air support, airbase defense, combat search and rescue, medical evacuation, tactical air control, unmanned systems launch and recovery, and ISR capabilities in support of combined forces air component commander taskings and ground-force operations. The 332 EOG comprises more than 700 Airmen who maintain, support and fly the MQ-1B Predator, F-16 Fighting Falcon, C-130 Hercules, MC-12 Liberty, Battlefield Command and Control CENTCOM system, and HH-60 Pave Hawk aircraft. The 332 EOG consists of eight active-duty, Air National Guard and Air Force Reserve squadrons. (Tab CC-17, CC-18, CC-19)

The **46th Expeditionary Reconnaissance Squadron** is responsible for launch and recovery of the MQ-1B Predator unmanned aerial systems in Iraq providing ISR capability for 24-hour coverage of the Iraqi battlespace. The squadron also provides a line-of-sight base-defense mission for JBB. (Tab CC-18)

b. Aircraft: MQ-1B Predator

Figure 1. Fully Armed MQ-1B Predator Taxiing

The MQ-1B Predator is a medium-altitude, long-endurance, unmanned aircraft system with primary missions of close air support, air interdiction, and ISR. It acts as a Joint Forces Air Component Commander-owned theater asset for reconnaissance, surveillance and target acquisition in support of the Joint Forces Commander. The MQ-1B is actually a system, not just an aircraft, which consists of four aircraft (with sensors and weapons), a GCS, a Predator Primary Satellite Link (PPSL), and spare equipment along with operations and maintenance crews for deployed 24-hour operations. The entire system is deployable worldwide for operations and can be transported on almost any Air Force cargo aircraft. (Tab CC-20, CC-21, CC-22)

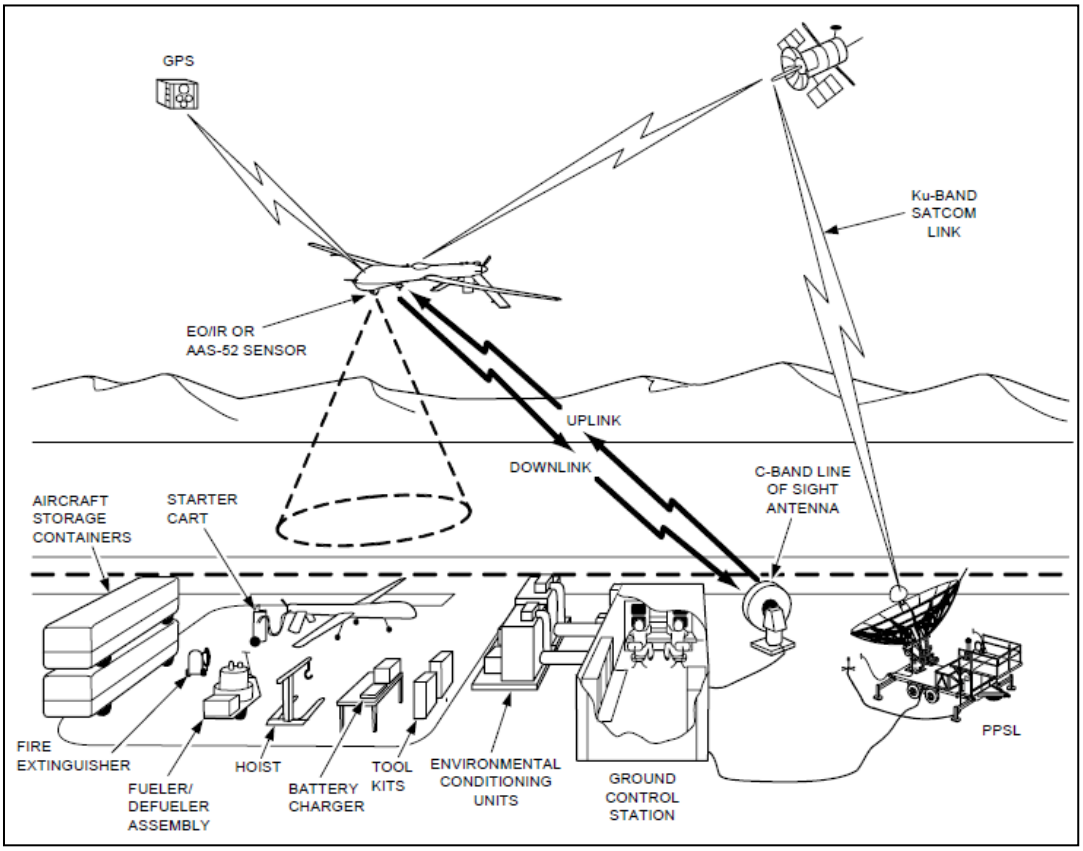

Figure 2. Typical Components of the MQ-1B System (Tab BB-4)

Figure 3. Inside View of Ground Control Station

The basic crew for the Predator consists of a pilot to control the aircraft and command the mission and an enlisted aircrew member to operate sensors and weapons plus a mission coordinator, when required. The crew employs the aircraft from inside a GCS via a line-of-sight data link or a satellite data link for beyond line-of-sight operations. The MQ-1B carries the Multi-spectral Targeting System, or MTS-A, which integrates an infrared sensor, a color/monochrome daylight television (TV) camera, an image-intensified TV camera, a laser designator and a laser illuminator into a single package. The full motion video from each of the imaging sensors can be viewed as separate video streams or fused together. The aircraft can employ two laser-guided AGM-114 Hellfire missiles which possess a highly accurate, low collateral damage, and anti-armor and anti-personnel engagement capability. The aircraft has a wingspan of 55 feet, a maximum takeoff weight of 2,250 pounds, and cruises at 84 miles per hour. (Tab CC-20, CC-21, CC-22)

The aircraft is initially controlled by a launch and recovery element (LRE), which consists of a crew in a GCS at the same airfield as the aircraft, using line-of-sight data link connections between the aircraft and ground data terminal, which is a radio antenna at the same airfield. The LRE is typically deployed in a theater of operations, where it will launch the aircraft, get it to a specified altitude, accomplish a systems check, and via either multi-user internet relay chat or a phone call, hand the aircraft off to a stateside GCS in what is called remote split operations. The stateside GCS crew will control the aircraft via Ku-band satellite data link and performs the designated mission until the aircraft is ready to land at which time control is returned to the LRE. Some missions, however, such as local base defense missions, are performed entirely by the LRE using the line-of-sight data link with the aircraft. (Tab CC-20, CC-21, CC-22)

4. SEQUENCE OF EVENTS

a. Mission.

The mishap crew (MC) members are members of the 432 RW's 15 RS but were deployed at the time of the mishap to Joint Base Balad (JBB), Iraq as part of the 332 AEW's 46 ERS. The flight was an MQ-1B local base defense mission conducted by the 46 ERS. Launch and recovery of the mishap remotely piloted aircraft (MRPA) was to be accomplished from a GCS at JBB. Launch and recovery operations are conducted by a line-of-sight (LOS) radio link using a ground data terminal (GDT) located on the ground at the airfield. Since this was planned to be a local base defense sortie, control of the MRPA was never going to be transferred to a satellite link or a remote flight crew. (Tabs CC-18, CC-20 and V-3.2, 3.4, V-3.12, V-3.15, V-3.20, V-3.21, V-5.1, V-5.12, V-5.13, V-5.14)

The MC was scheduled for multiple events, defined as either a takeoff or landing, during their shift. The mishap occurred on their third scheduled event for the shift. (Tab V-3.20, V-5.12)

b. Planning.

The MC's shift began at 13:00 local time (L) (10:00 Zulu or Greenwich Mean Time) on 16 August 2010 with their standard crew shift change brief consisting of weather reports, intelligence reports, emergency procedures review, and other required briefing items before their first sortie. The MC reviewed applicable flight/mission documents prior to their shift. No maintenance discrepancies were noted for the aircraft that the MC would be flying during their shift. (Tab V-3.21, V-3.22, V-3.23, V-5.14)

c. Preflight.

The MC began preflight preparations for the mishap event, their third event of the day, at approximately 19:50L (16:50 Zulu, or Greenwich Mean Time). The MC had several exchanges with the maintenance crew chief between 19:50L and 20:03:28L regarding systems checks and aircraft preparation. The MC ran their flight preparation checklists largely silently and independently using the "abbreviated checklist" or "keystroke checklist," though some steps were verbalized. The keystroke notes guide is a one-sheet compilation of all the steps required to prepare the aircraft for takeoff, and for applicable steps, it lists the actual computer keystrokes needed to accomplish the steps. It is a notes page and a reference to be used in conjunction with the multiple checklists contained in the official flight manual for the MQ-1B, which does not list the actual keystrokes needed to accomplish the checklist steps. (Tabs O-3, V-3.22, V-4.3, V-5.9, V-5.16, V-5.31 and DD-3, DD-4, DD-7, DD-14)

During the preflight preparation, at 19:50:06L "Ready to turn on SAS" appeared very briefly on the ground control station's (GCS) head-up display (HUD), denoting that the aircraft's stability augmentation system had been initialized by the mishap pilot (MP) depressing the SAS initialization button on the control joystick. The normal message that follows the initialization,

"SAS on," which occurs after the pilot pulls the joystick trigger while depressing the initialization button, never appeared on the HUD. The MRPA's engine was started at 19:56:56L with no anomalies noted. The mishap pilot (MP) began to taxi the MRPA at 20:03:33L. (Tab DD-3, DD-4, DD-7)

The MP and mishap sensor operator (MSO) did not note any problems with the MRPA during preflight and taxi, and the maintenance crew chief stated the launch was the "cleanest of his career" regarding the functioning of the aircraft and communication with the aircrew. (Tab V-3.25, V-5.18 and DD-12)

d. Summary of Accident.

The MRPA's initial movements were uneventful. After holding short of the runway and receiving clearance to takeoff, the MRPA taxied onto the runway and performed a rolling takeoff at 20:07:10L, meaning that the aircraft moved continuously and did not stop once it entered the runway. All engine indications were normal on the takeoff roll. The MRPA reached 40 knots indicated airspeed (KIAS, the speed at which the MQ-1B will continue and liftoff if the communications link with the GCS is lost) 31 seconds into its takeoff roll. When the MRPA reached this speed, the MSO stated, "40," over the headset. (Tabs V-3.26, V-3.27 and DD-5)

At 20:07:51L the MRPA reached 59 KIAS, its designated rotate speed (the speed at which the pilot commands the aircraft to raise the pitch of its nose), and the MSO called "rotate" over headset. The MRPA began to encounter controllability issues when the MP attempted to raise the nose for liftoff. The MRPA veered across the runway, first left of the runway centerline, then right, and then sharply back to the left as the MP raised the nose of the MRPA approximately 5 degrees. The MP stated the MPRA was airborne at 20:08:03L, and at that time it was left of the runway centerline moving at 72 KIAS. The engine was at its maximum power setting, producing 5,592 revolutions per minute (RPM) with a manifold air pressure (MAP) of 38.0 inches (in) of mercury (Hg), and operating normally. (Tabs V-3.27 and DD-5)

Controllability issues continued after takeoff. During its initial climb, the MRPA started a gradual left roll 24 seconds after liftoff, banking 5 degrees to the left and moving at a speed of 75 KIAS at an altitude of 360 feet mean sea level (MSL). The engine was at its maximum power setting and performing normally at this time producing 5,444 RPMs with a MAP of 36.4 in Hg. The MP countered the left bank by commanding the MRPA to roll back to the right inputting 10 degrees of bank at 20:08:33 (30 seconds after liftoff). The MRPA's bank angle then increased to 20 degrees to the right, and the nose pitch increased to 15 degrees nose high (above the horizon) with an airspeed of 73 KIAS 33 seconds into the flight. These parameters resulted in an angle of attack (AOA, the angle at which the aircraft's wings are oriented in relation to relative wind. See Figure 4.) reading of 5.7 degrees, which is in the caution range. (Tab DD-5)

The MSO first commented on the erratic motion of the aircraft at 20:08:39L, and the MP responded, "It's okay. I got it." The MP diagnosed the cause of the oscillations as interference from the wind. The MP countered the nose-high pitch, and the MRPA's pitch sank to 4 degrees nose low. The MRPA then began a shallow descent to 320 feet MSL at 75 KIAS, which yielded an AOA of negative 0.1. (Tab DD-5)

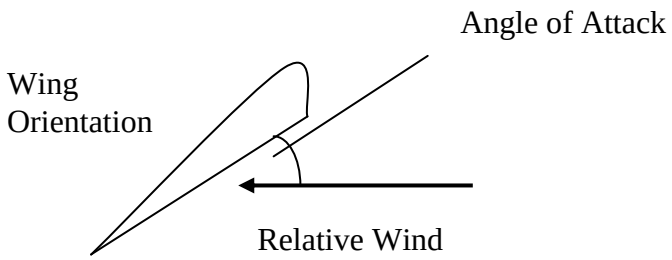

Figure 4. Angle of Attack Diagram

After a steep left bank pushed the MRPA to a heading of 252 degrees from its departure heading of 327 degrees, the MRPA gained some stability 83 seconds into its flight. The MRPA rolled wings level with a heading of 316 degrees, a speed of 72 KIAS, and had climbed to an altitude of 550 feet MSL. The engine was operating at 5,530 RPMs with a MAP of 35.8 in Hg. The MP then trimmed the aircraft (adjusted the flight control surfaces) to hold a pitch of approximately 6 degrees nose high, and the MP told the mishap mission intelligence coordinator (MMIC) to advise other crews to depart using the opposite direction runway in order to avoid the wind. The MP trimmed the aircraft again at 20:09:38 (95 seconds into the flight). (Tab DD-5, DD-6)

The MP believed the MRPA had gained enough stability to raise its landing gear at this point, and at 20:09:45L, the MP stated, "Gear up," and commanded the landing gear into the up position. The MP trimmed the MRPA once again, and the heading was 294 degrees at 67 KIAS. The AOA indicator showed a caution reading of 6.3 at this time. Then at 20:10:00, the "Aileron Tip Stall Override" warning began to flash in the HUD with an accompanying "WARN" HUD message and audible tone indicating that the AOA had exceeded 7.0. At that time the MRPA was approaching a stall condition, meaning it was approaching a point where it would no longer have the aerodynamic lift force to keep it aloft. The MRPA's parameters were 5 degrees of right bank, 11 degrees of nose high pitch, 64 KIAS, and 7.1 AOA. (Tab V-3.28 and DD-6)

The MRPA began to roll sharply right at 20:10:06L, 123 seconds into the flight. At that moment the bank angle was approximately 15 degrees, and the AOA was denoted in red on the HUD as 10.4. The MSO then called out the wind speed and direction as being 11.5 knots from 262 degrees. Three seconds later at 20:10:09L, the bank angle, pitch, and AOA had increased to 25 degrees to the right, 16 degrees nose high, and 10.4, respectively, while the speed decreased to 60 KIAS. The MRPA continued its right roll, and the MSO called out, "AOA stall." At 20:10:11L the pilot commanded "Landing Configuration" by depressing the landing configuration command button and pulling the trigger on the joystick, and the words "Landing configuration completed" appeared on the HUD in blue. The "Landing Configuration – Command" is the first step of the Loss of Control Prevent checklist. Immediately after that the MP turned off the link in the hope that the aircraft would recover and fly a pre-programmed route autonomously. It was not possible to determine if the loss of downlink was due to the MP turning off the link or due to loss of line-of-sight resulting from the extreme attitude of the MRPA. (Tab V-3.29 and DD-6)

The final flight parameters displayed on the HUD were: approximately 50 degrees of right bank, 23 degrees of nose high pitch, a speed of 58 KIAS, an AOA of 11.8, and engine readings of 5,524 RPMs and a MAP of 35.0 in Hg. Both the MP and MSO recalled no abnormal warnings or indications after checking the head-down display (HDD) when the MRPA crashed. (Tabs V-3.29, V-3.30, V-5.22, V-5.23 and DD-6)

After link was lost, the MP made several attempts to confirm with the Air Traffic Control (ATC) tower to verify that the aircraft was still climbing and flying the pre-programmed route, but ATC relayed that the aircraft was no longer on their radar scope and sent another RPA to locate it. The other aircraft soon located smoke near the end of the runway in an area that appeared to be the scene of a crash. (Tabs V-3.32 and DD-6, DD-7)

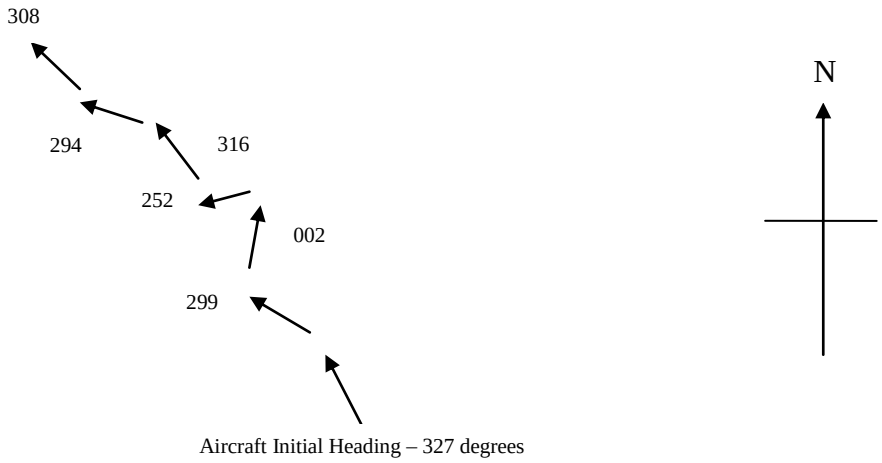

Figure 5. Aircraft Orientation Throughout Flight

e. Impact.

Aircraft T/N 05-3141 impacted the terrain at approximately 20:10:11L (17:10:11Z) on 16 August 2010 near JBB. The crash site was in a field just outside of the base, and the aircraft was broken into multiple pieces over a diameter of 30 meters. (Tab R-10, R-11, R-12, R-13, R-15, R-17)

Figure 6. Impact Area

f. Egress and Aircrew Flight Equipment.

This section is not applicable for mishaps involving RPA.

g. Search and Rescue.

This section is not applicable for mishaps involving RPA.

h. Recovery of Remains.

This section is not applicable for mishaps involving RPA.

5. MAINTENANCE

a. Forms Documentation.

All forms for the mishap remotely piloted aircraft (MRPA) were documented in accordance with applicable maintenance technical orders for the MQ-1B, and the forms indicated that the MRPA had no outstanding maintenance issues that would prevent it from flying. The Air Force Technical Order (AFTO) Form 781A for the MRPA only had one outstanding issue, an in-flight operations check of an electronic component of the MQ-1B's video camera that had been changed out earlier that day. The component had been operationally checked satisfactorily, and the maintenance crew requested additional testing that could not be performed on the ground. No delayed discrepancies were noted on the AFTO Form 781K, and the production superintendent, the maintainer who ultimately approves the aircraft for flight, approved the aircraft for flight after reviewing all forms. The production superintendent noted the exceptional release with a red dash to convey the aircraft had a flyable condition, the in-flight operations check noted above. (Tab D-3)

A 30-day pre-mishap history check in Integrated Maintenance Data System (IMDS) revealed no maintenance issues with the GCS relevant to this mishap. The GCS was tested extensively after the mishap, and no malfunctions were found. Minor forms errors were noted in conjunction with the 4 April 2010 equipment check; however, these errors were not relevant to the mishap. (Tabs U-19, U-20, U-21 and GG-7, GG-8)

b. Inspections.

All required inspections were accomplished on the MRPA, and there were no overdue Aircraft Time Compliance Technical Orders (TCTO) directing the modification of the aircraft or the performance of any inspection for the aircraft. The MRPA's next scheduled inspection was its 150-hour airframe inspection, which was due in 6.4 flying hours. (Tab D-20)

c. Maintenance Procedures.

Maintenance procedures were not relevant to this mishap; however, some discrepancies were noteworthy. First, on the day of the mishap, the tire servicing, weapons post load inspection and supervisory post load inspection, verification of proper placement of missiles on the aircraft, were not signed off in the Integrated Maintenance Data System per regulation, but they were correctly signed on the actual hardcopy AFTO Form 781A. (Tab D-24) Second, the replacement of the electronics unit for the MTS-A ball described above required a quality assurance weight and balance recomputation that was not documented in the maintenance forms as being accomplished. (Tab D-17) The weight difference, if any, resulting from the electronics unit change would have been negligible, however. Also, the MRPA's secure radio communications antenna utilized when the aircraft is receiving control inputs via its Ku band satellite link was removed and reinstalled to facilitate other maintenance two days prior to the mishap, and no operational check was performed. (Tab U-23) Since the MRPA was not receiving commands via satellite link at the time of the mishap, this could not have contributed

to the mishap. Other discrepancies included minor forms documentation errors that were not relevant to the mishap.

d. Maintenance Personnel and Supervision:

Maintenance personnel were not relevant to this mishap. Both aircraft and GCS maintenance was performed by the contractor Battlespace Flight Services, and all personnel were properly trained. (Tab G-41 through G-58)

e. Fuel, Hydraulic and Oil Inspection Analysis.

Maintenance personnel properly serviced fuel tanks and oil reservoirs in accordance with technical data. The servicing certification on the AFTO Form 781H reflected full oil levels and adequate fuel levels. The "Info Note" page correctly reflected the 3 to 2 ratio in the forward and aft fuel tanks per the applicable technical order. (Tab D-5). One out of four fuel samples did fail for vapor pressure, (Tab J-2, J-3, J-4, J-5); however, the data logs showed the engine performed normally throughout the flight. (Tabs DD-5, DD-6 and GG-5). No evidence indicated petroleum, oils, and lubricants contributed to this mishap. (Tabs D-5, J-2, J-3, J-4, J-5 and DD-5, DD-6 and GG-5)

f. Unscheduled Maintenance.

All necessary repairs or replacements were properly made when required independent of maintenance schedules and were not relevant to the mishap.

6. AIRCRAFT AND AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems.

The mishap remotely piloted aircraft (MRPA) was catastrophically and irreparably damaged upon impact. The wing sections were recovered, partially intact, as was the Multi-spectral Targeting System (MTS) ball. The MRPA's "radome," the top cover of the aircraft's forward fuselage was recovered intact as were many of the electrical components directly underneath the radome with the exception of the aircraft's primary control module. The MRPA's engine was also recovered. Many parts of the aircraft, including the propeller, were not discovered or recovered from the crash site. (Tab R-10, R-11, R-12, R-13, R-15, R-17)

The ground control station (GCS) was immediately sequestered for test and evaluation. (Tab GG-7, GG-8)

b. Engineering Evaluations and Analyses.

General Atomics Aerospace Systems (GA) received, reassembled, and analyzed key recovered components of the MRPA and analyzed the functioning of the GCS. Part of this analysis included recreation of certain flight parameter data from the GCS datalogs, which were corrupted for unknown reasons, and the head-up display (HUD) video from the flight. GA was able to retrieve some data from the logs, and they were able to "replay" the flight in the GCS, which provided them the flight parameters. This data from this replay reflected some settings of the GCS as they were at the time of the replay, but not necessarily as they were during the flight. GA verified the recreated parameters by comparing them against the real time data observed in the HUD video to produce reliable results. (Tabs DD-11 and GG-4)

The right and left aileron servos, devices that receive control input commands from the aircraft's computer and move the aileron control surfaces, were extracted from the recovered wing sections and tested by connecting the motors to a voltage source and measuring the voltage range and performance. Though the right servo had a bent ball screw assembly likely from crash damage, which prevented rotation of the gears when tested, the motor operated at both high and low voltage when powered on reassembly and the servo had the full voltage range; therefore, the motor successfully passed formal testing as did the left servo. (Tab GG-8)

The GCS consoles were cycled through multiple tests and passed inspection. Specifically, the joystick button and trigger used to enable the SAS were cycled through activations and deactivations, pressing the SAS button and pulling the joystick trigger, and each was successfully completed on every test for 30 cycles. For each cycle the head-up display (HUD) correctly displayed the appropriate message, either "Ready to turn on SAS" or "Ready to turn off SAS" when the SAS button was depressed, and then either "SAS on" or "SAS off" after the joystick trigger was pulled simultaneously with the depressed button. (In order to receive the "SAS on" message, the pilot must simultaneously depress the button and pull the trigger until the message appears. SAS will not enable if either the SAS button is released before the trigger is pulled to confirm the action, or if the trigger is very rapidly depressed and released before the "SAS on" message appears on the HUD.) The SAS indicators located on the GCS head-down display also correctly indicated the SAS status for each cycle. (Tabs BB-5 and GG-7, GG-8)

All recovered components that could be tested, both from the MRPA and the GCS, operated normally during the analysis and did not appear to contribute to the mishap. (Tabs I-4, I-7, I-10, I-13 and GG-7, GG-8)

The MQ-1B flight manual states that aircraft control is completely different with the SAS off. With SAS off Any pitch or roll input will cause the aircraft to continue to change attitude in the direction of the input. Pitch and Roll commands are a scaled summation of joystick deflection and trim values and this summation is scaled by different factors depending on if SAS is enabled or disabled. The relationship between pitch and roll commands versus joystick movement was consistent with SAS being disabled throughout the datalogs. (Tabs BB-8 and GG-6, GG-7)

The Board attempted to recreate the conditions of the flight in an MQ-1B simulator, and a current MQ-1B evaluator pilot flew a mission with the SAS off. The simulated aircraft's movements were similar to those on the HUD video for the MRPA, and the same warnings were received in the simulator as the MC received during the flight. (Tab DD-14)

7. WEATHER

a. Forecast Weather.

The MP received a verbal weather brief from the outgoing MQ-1 operations superintendent. Forecast weather conditions at 19:55 local time were winds from 200 degrees at a speed of 4 knots with unlimited visibility and a clear sky. The forecast at 20:39L had winds coming from 110 degrees at 3 knots still with unlimited visibility and a clear sky. (Tab F-3)

b. Observed Weather.

The Balad Air Traffic Control tower reported the winds at takeoff were from 200 degrees at a speed of 3 knots. The mishap sensor operator noted winds were coming from 262 degrees at 11.5 knots as indicated by the ground control station tracking monitor shortly after takeoff when the MRPA had attained an altitude of approximately 800 feet mean sea level. The MP stated that wind was responsible for erratic MRPA attitude on initial takeoff according to recovered audio recordings from the mishap. (Tabs N-6 and DD-6)

c. Operations.

The MQ-1B's crosswind limit for takeoff is 17 knots, the windspeed at which attempting a takeoff is unsafe. The maximum reported or forecast wind speed for the mishap mission was 11.5 knots, well within prescribed weather limitations as defined by the MQ-1B technical order. No evidence suggests weather was a factor in the mishap. (Tab DD-6)

8. CREW QUALIFICATIONS

a. Mishap Pilot

(1) **Training**

The MP was qualified in the MQ-1B as a pilot since 9 November 2009. The MP was qualified as a launch and recovery (LRE) pilot on 15 June 2010.

(2) **Experience**

The MP had a total flight time of 636.9 hours, with 370 hours in the MQ-1B. The MQ-1B was the MP's first assignment since specialized undergraduate pilot training (SUPT). The MP was not designated as an "Experienced" crewmember in the MQ-1B (had less than 500

hours flying the aircraft). The MP's flight time during the 90 days before the mishap was as follows:

	Hours	Sorties
30 days	23.1	39
60 days	28.9	43
90 days	43.0	50

(Tabs BB-10 and G-2 through G-18)

b. Mishap Sensor Operator

(1) **Training**

The MSO has been a qualified MQ-1B sensor operator since 9 June 2008. The MSO upgraded to mission instructor sensor operator on 21 Apr 2009 and was qualified as an LRE sensor operator on 18 June 2010.

(2) **Experience**

The MSO had a total flight time of 1190 hours, all in the MQ-1B. The MQ-1B was the MSO's first flight operations assignment. Prior to becoming a MQ-1 B sensor operator, the MSO was in a non-aviation career field. The MSO was designated as an "Experienced" crewmember in the MQ-1B. The MSO's flight time during the 90 days before the mishap was as follows:

	Hours	Sorties
30 days	40.6	29
60 days	41.9	31
90 days	51.7	36

(Tabs BB-10 and G-19 through G-40)

9. MEDICAL

a. Qualifications.

At the time of the mishap flight, both crew members had current flight physicals, no known illnesses or injures, and were medically qualified to perform flying duties. (Tab FF-7)

b. Health.

No health issues for the mishap crew members were relevant to the cause of the mishap.

c. Pathology.

Pathology was not applicable to this mishap.

d. Lifestyle.

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

e. Crew Rest and Crew Duty Time.

Aircrew members are required to have 12 hours of crew rest, eight of which must be uninterrupted, and both mishap crew members reported having the required amount of sleep prior to the mishap. (Tabs V-3.34, V-5.26 and BB-10)

10. OPERATIONS AND SUPERVISION

a. Operations.

The operations tempo at the 46 Expeditionary Reconnaissance Squadron historically had been high, and they were, and still are, operating in a wartime environment. However, the operations tempo has slowed considerably in recent months. Launch and recovery element crews are continually rotated through the theater, and the mishap crew was about six weeks into a four-month rotation. The crews work eight hour shifts, seven days a week for their entire 120-day deployment. During a typical shift, a crew will fly between one and five "events," either a takeoff or a landing sequence, and these flight events are typically of a short duration of less than one hour. When not executing an event the crews are on standby in the event an aircraft returns early The crewmembers testified to being well rested, prepared, and not rushed for the mission. (Tabs V-3.16, V-3.34, V-4.1, V-5.18, V-5.26 and DD-12) No evidence indicated that stress due to continual operations in the deployed environment was a factor in the mishap.

b. Supervision.

The 46 ERS is commanded by a Lieutenant Colonel on a one-year tour in Iraq. The squadron's Director of Operations, the person directly responsible for assigning personnel to fly missions and overseeing daily operations, for the 46 ERS is deployed on a four-month rotational basis and is usually a senior Captain. The 46 ERS also utilizes Operations Supervisors, usually the most experienced pilots, which are designated to be in charge of each shift the Commander and Director of Operations are unavailable, and in this case the mishap pilot was the Operations Supervisor for the shift until the Director of Operations arrived. (Tabs DD-12, DD-14 and V-5.31, V-5.32) Operations supervision was not a factor in this mishap flight.

11. HUMAN FACTORS ANALYSIS

The Department of Defense Human Factors Analysis and Classification System was established to provide a method of cross-feeding human error data for mishaps to all services. Human factors studies how humans interact with their tools, the tasks, and the working environment and how those elements affect performance.

a. Skill-Based Errors - Checklist Error (AE102)

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 situation. Checklist Error human factor applies 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 leads to an unsafe situation.

Both crewmembers testified that they were using an "abbreviated checklist" or a "keystroke checklist." This type of "checklist" refers to a keystroke notes guide used to help facilitate required Technical Order checklists. This type of guide is not intended to be used exclusively or replace the TO checklist; however, according to the MSO's testimony the crew was using the "abbreviated checklist" exclusively. Though the example "abbreviated checklist" the board obtained resembles the TO checklist it omits a second "SAS-On" step usually contained in the Pre-Takeoff checklist. SAS should already be on at this point; however, the amplified checklist in the TO indicates during this step the pilot should "Verify Yaw SAS, Pitch SAS, and Roll SAS On in the head-down display aircraft status area." The MC was not using the appropriate checklist, and the checklist step "SAS – on (P)" was not verified in the Pre-Takeoff checklist. (Tabs V-4.3, V-5.5, V-5.31, BB-7 and DD-14)

The MC's failure to use the approved TO checklist as well as the failure to verify SAS was enabled created an unsafe situation.

b. Skill Based Errors – Procedural Error (AE103)

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 situation. Procedural Error 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.

Step number 22 on the Aircraft Initial Link checklist is "SAS – on (P)." The procedure for turning on the SAS using the joystick, the method the MP testified to using, is as follows: 1. Press and hold the SAS switch, 2. Squeeze the joystick trigger. The empirical evidence obtained showed that the stability augmentation system (SAS) was never turned on by the MP; however, this step was attempted. The video from the ground control station HUD showed that the SAS

initialization button was pressed on the control joystick resulting in the message, "Ready to turn on SAS," but the standard follow-up message of "SAS on" was never displayed in the video. The MP failed to completely execute the procedure by either releasing the SAS button before the trigger was pulled to confirm the action, or by very rapidly depressing and releasing the trigger, thus not confirming the action and creating an unsafe situation. (Tabs V-4.2 and BB-9)

c. Cognitive Factor - Inattention (PC101)

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 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 the result of highly repetitive tasks.

The MP had been deployed approximately a month and a half at the time of the mishap. During a standard shift, the mishap crew (MC) would fly anywhere from one to five events, each of which would require running the standard set of checklists. The mishap sensor operator (MSO) reported that they did so many of these events so often that they could do it from "muscle memory." As stated previously, both crew members failed to notice that SAS was never enabled as indicated by the lack of the "SAS on" message on the HUD, and both failed to notice the red warnings on the HDD indicating that SAS was not enabled. This inattention created an unsafe situation where the MRPA could be launched without SAS active. (Tabs V-3.15, V-5.28 and DD-12, DD-14)

d. Perceptual Factor - Expectancy (PC506)

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.. Expectancy is a factor when an individual expects to perceive a certain reality and those expectations are strong enough to create a false perception of the expectation.

As stated in the paragraphs above, the MC had run their checklists, including enabling SAS, multiple times during the course of their deployment prior to the mishap to the point of operating on "muscle memory," and both crew members appeared to believe it was on during the mishap flight. The empirical data obtained from the GCS HUD video as well as the performance of the aircraft indicated that SAS was not enabled. The MC appeared to have expected to see what they had seen numerous times before, and this expectancy created an unsafe situation where neither member verified that SAS was actually enabled. (Tabs V-5.28 and DD-7)

12. GOVERNING DIRECTIVES AND PUBLICATIONS

c. Primary Operations Directives and Publications.

(1) T.O. 1Q-1(M)B-1, USAF Series MQ-1B and RQ-1B Systems, 1 November 2003, incorporating change 13, 8 April 2009
(2) T.O. 1Q-1(M)B-1CL-1, USAF Series MQ-1B and RQ-1B Systems Flight Checklist, 1 November 2003, incorporating Change 15, 8 April 2009
(3) AFI 11-2MQ-1, Volume 1, MQ-1 Aircrew Training, 21 January 2010
(4) AFI 11-2MQ-1, Volume 2, MQ-1 Crew Evaluation Criteria, 28 November 2008
(5) AFI 11-2MQ-1, Volume 3, MQ-1 Operations Procedures, 29 November 2007
(6) AFI 11-418, Operations Supervision, 21 October 2005, incorporating Change 1, 20 March 2007
(7) AFI 11-401, Aviation Management, 7 March 2007, incorporating through Change 2, 18 May 2009
(8) AFI 11-202, Volume 3, General Flight Rules, 22 October 2010

d. Maintenance Directives and Publications.

(1) T.O. 1Q-1(M)B-2-93GS-00-1, General System Surveillance, 8 February 2010
(2) T.O. 1Q-1(M)B-5-1, Basic Weight Checklists, USAF Series, MQ-1B Remotely Piloted Aircraft, 26 March 2010
(3) T.O. 00-20-1, Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures, 1 September 2010
(4) T.O. 1Q-1(M)B-2-48JG-00-1, Job Guide, Communication/Navigation/Identification, General, USAF Series, MQ-1B Remotely Piloted Aircraft, 09 October 2009
(5) T.O. 1Q-1(M)B-2-32JG-10-1, Job Guide, Landing Gear, Main Gear, Extension/Retraction, USAF Series, MQ-1B Remotely Piloted Aircraft, 2 January 2010
(6) T.O. 1Q-1(M)B-2-32JG-10-1, Job Guide, Landing Gear, Main Gear, Extension/Retraction, USAF Series, MQ-1B Remotely Piloted Aircraft, 2 January 2010
(7) T.O. 1Q-1(M)B-2-05JG-10-1, Ground Handling USAF Series, MQ-1B Remotely Piloted Aircraft, 9 Jun 2009, thru change 5 21 July 2010
(8) T.O. 1Q-1(M)B-6WC-1, Preflight, Thruflight, Basic Postflight, Combined Basic Postflight/Preflight inspection requirements, ASAF Series, MQ-1B Remotely Piloted Aircraft, 21 January 2010
(9) T.O. 1Q-1(M)B-6WC-2, Aircraft Periodic Inspections and Maintenance Requirements, USAF Series, MQ-1B Remotely Piloted Aircraft, 21 January 2010
(10) T.O. 1Q-1(M)B-2-72JG-00-2, Job Guide Engine Reciprocating General Volume II, USAF Series MQ-1B and RQ-1B Remotely Piloted Aircraft, 08 June 2010
(11) T.O. 1Q-1(M)B-6, Aircraft Scheduled Inspection and Maintenance Requirements, USAF Series MQ-1B Remotely Piloted Aircraft, 21 January 2010
(12) AFI 21-101, Aircraft and Equipment Maintenance Management, 26 July 2010

e. Known or Suspected Deviations from Directives or Publications.

The MC failed to use the published and approved Technical Order checklists for the MQ-1B. Both crewmembers testified that they were using an "abbreviated checklist" or a "keystroke checklist." This type of "checklist" refers to a keystroke notes guide used to help facilitate required TO checklists. This type of guide is not intended to be used exclusively or replace the TO checklist; however, according to the MSO's testimony the MC was using the "abbreviated checklist" exclusively. (Tabs O-3, V-3.22, V-5.18 and DD-3, DD-4, DD-7)

13. ADDITIONAL AREA OF CONCERN

None.

23 November 2010

BRIAN T. JANNEY, Lt Col, USAF
President, Accident Investigation Board

STATEMENT OF OPINION
MQ-1B T/N 05-3141
16 AUGUST 2010

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, 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 16 August 2010, an MQ-1B (T/N 05-3141) lost control and crashed shortly after takeoff near Joint Base Balad, Iraq. The flight was a local base defense reconnaissance mission in support of Operation IRAQI FREEDOM. Based on recreated datalogs and the actual head-up display (HUD) video from the flight, I determined that the Stability Augmentation System (SAS) was not enabled at anytime during the flight. The ground control station's (GCS) HUD video indicated that the mishap pilot (MP) attempted to enable SAS during pre-flight preparations, which was evidenced by the "Ready to turn on SAS" command message displayed on the HUD. However, the normally expected next message "SAS on," indicating that SAS was enabled, was never displayed. Furthermore, the correlation between pilot joystick position and the pitch and roll commands executed by the aircraft was consistent with SAS not being enabled. The failure to enable SAS was due to pilot error in not completing the execution of the command. The GCS control assembly was tested and found to operate correctly, and there were no indications of any aircraft systems failures during the flight.

The primary cause of this accident, supported by clear and convincing evidence, was the MP's failure to enable the SAS due to a procedural error prior to flight. The factors that substantially contributed to the mishap, supported by a preponderance of the evidence, include: Checklist Error, Inattention, and Expectancy.

3. DISCUSSION OF OPINION:

c. Cause: Pilot Error

The MP procedurally failed to engage the SAS during the Aircraft Initial Link checklist, when it is supposed to be engaged, and at any subsequent point during the flight. The evidence supporting this conclusion is drawn from the GCS HUD video from the flight and the physical performance of the aircraft during takeoff and flight.

Engaging SAS is a two step procedure. The SAS switch must be held down while simultaneously pulling the joystick trigger to execute the command. If the SAS switch is prematurely released or the trigger is very quickly pulled, the SAS will not engage and the corresponding "SAS on" message will not be displayed.

The GCS HUD video never displayed a message confirming that SAS was enabled during pre-flight preparations or the flight itself. Shortly after the HUD video begins, the message "Ready to turn on SAS" was displayed on the HUD. This message indicated two things. First, SAS was not engaged at the time the message was displayed, and second, it indicated that the MP attempted to engage SAS by depressing the "SAS switch" on the joystick. The HUD video clearly showed "Ready to turn on SAS," but "SAS on" is never displayed at anytime from that point on through the mishap flight.

The actual performance of the MRPA during flight provides further evidence that SAS was not enabled prior to or during the flight. Both the MP and MSO noted how erratic the aircraft performed as soon as it began to liftoff, and the HUD video shows how dramatic the aircraft moved during flight, swinging back and forth from an initial heading of 327 degrees to 252 degrees during the MP's attempt to stabilize the aircraft.

Additionally, the MQ-1B flight manual states that aircraft control is completely different with the SAS off. Any pitch or roll input will cause the aircraft to continue to change attitude in the direction of the input. Pitch and Roll commands are a scaled summation of joystick deflection and trim values and this summation is scaled by different factors depending on if SAS is enabled or disabled. The relationship between pitch and roll commands versus joystick movement was consistent with SAS being disabled throughout the datalogs. The Board attempted to recreate the conditions of the flight in an MQ-1B simulator, and a current MQ-1B evaluator pilot flew a mission with the SAS off. The simulated aircraft's movements were similar to those on the HUD video for the MRPA, and the same warnings were received in the simulator as the MC received during the flight. Visual and analytical evidence strongly supports the premise that the SAS system was not engaged for the mishap flight due to the MP employing improper procedure to engage the SAS by either prematurely releasing the SAS switch or pulling the trigger too quickly.

No evidence of mechanical failure was provided, and to the contrary, all systems appeared to function as expected. The MC clearly had communications link with the aircraft until the very end of the flight as evidenced by the aircraft responding to all command inputs by the MC. The MC noted that the aircraft's performance on the ground was normal. The engine performed at its maximum setting throughout the brief flight. Post-mishap evaluation showed that the GCS control consoles responded correctly to all commands, and the components of the aircraft available for testing all passed. All of this evidence supports the maintenance documentation showing that the aircraft and GCS were mission ready.

Similarly, both MC members' assertions that they both verified that SAS was on during the mission as well as the MP's assertion that she turned on SAS are outweighed by the empirical evidence. The MC members may well be remembering what they normally saw and expected to see on this flight regarding the SAS messages and indicators, but the data clearly shows that SAS was not enabled, nor were messages indicating so received at any point during the mishap.

d. Contributing Factors.

I find by a preponderance of the evidence that the following factors substantially contributed to the mishap: Checklist Error, Inattention and Expectancy.

(1) Contributing Factor – Checklist Error

The MC failed to use the approved checklist for the mishap flight, and the MP failed to verify that SAS was enabled as part of the Pre-Takeoff checklist, both of which are checklist errors and substantially contributed to the mishap.

The only approved checklists for the MQ-1B are contained in the TO for the aircraft. The MC did not use these checklists and instead used an "abbreviated checklist" or "keystroke checklist." The keystroke notes guide is a one-sheet compilation of all the steps required to prepare the aircraft for takeoff, and for applicable steps, it lists the actual computer keystrokes needed to accomplish the steps. It is a notes page and a reference to be used in conjunction with the multiple checklists contained in the official flight manual for the MQ-1B. Testimony showed that the MC exclusively used the "abbreviated checklist" during the mishap.

Though the "abbreviated checklist" resembles the TO checklist it omits a second "SAS-On" step usually contained in the Pre-Takeoff checklist. SAS should already be on at this point; however, the amplified checklist in the TO indicates during this step the pilot should "Verify Yaw SAS, Pitch SAS, and Roll SAS On in the head-down display aircraft status area." The steps required to enable and verify enablement of SAS were not accomplished.

(2) Contributing Factor – Inattention and Expectancy

Through their inattention neither crew member noticed that the "SAS on" message did not appear in the HUD, and both failed to notice the red warnings on the HDD indicating that SAS was not enabled. Their inattention was likely due to the expectancy to receive the same result they had gotten numerous times before when engaging SAS. This expectancy created a false perception that the SAS was on and the aircraft was ready for flight. As the MSO stated, they ran the checklist so many times they could do it from "muscle memory." The MC's inattention and expectancy more likely than not substantially contributed to the mishap.

23 November 2010

BRIAN T. JANNEY, 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, 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.