UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 07-3249
49th WING
HOLLOMAN AIR FORCE BASE, NEW MEXICO

LOCATION: REPUBLIC OF DJIBOUTI

DATE OF ACCIDENT: 17 MAY 2011

BOARD PRESIDENT: LIEUTENANT COLONEL THOMAS E. HAZLEBECK

Conducted IAW Air Force Instruction 51-503

Abbreviated Accident Investigation pursuant to Chapter 11

EXECUTIVE SUMMARY

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
MQ-1B, 07-3249, Republic of Djibouti
17 May 2011

On 17 May 2011, at approximately 0217L, an MQ-1B, Tail Number (T/N) 07-3249, deployed from the 49 Wing (WG) at Holloman Air Force Base (AFB), NM impacted the terrain during approach and landing in Djibouti. The mishap crew (MC), deployed from the 432 WG, Creech AFB, NV, were recovering the mishap remotely piloted aircraft (MRPA) on an early return from an operational mission in support of Operation ENDURING FREEDOM (OEF). The MRPA returned early due to a slow oil leak. The mishap pilot (MP) attempted to maneuver the MPRA to avoid clouds on the arrival and intercepted final approach course and glidepath. However, low clouds and high humidity in the Djibouti local area obscured both infrared sensors used by the crew to visually identify the runway environment at night. Additionally, inaccuracies in the LN100G Inertial Navigation System (INS)/global positioning system (GPS) altitude resulted in a commanded glidepath approximately 420 feet below the correct glidepath. On the approach to Djibouti from the west, the terrain slopes from approximately 50 feet above mean sea level (MSL) at the touchdown zone upwards to 300 feet above MSL at four nautical mile (NM) from the end of the runway on final approach. The MP initiated a go-around at approximately 20 feet above ground level (AGL) at 2.4 NM on final approach, but was too late to avoid impact. The MRPA and one Air-to-Ground Missile (AGM)-114 Hellfire missile onboard were destroyed on impact at a cost of $2,983,766. There was no other government or private property damage or injuries to civilians on the ground.

After a careful and complete investigation of this mishap, the AIB president found by clear and convincing evidence the following two causes of this mishap. First, inaccurate LN100G INS/GPS altitudes resulted in dangerously low glidepath indications; and second, the MC failed to recognize and correct the dangerous situation in time to avoid impact with the terrain. Additionally, the AIB president found from a preponderance of the evidence that low clouds and high humidity in the Djibouti local area and MP deviation from AFI 11-202, Volume 3, ACC SUP directed minimum approach altitudes significantly contributed to this accident.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-1B, 07-3249
17 MAY 2011

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COMMONLY USED ACRONYMS & ABBREVIATION

ACC	Air Combat Command	MC	Mishap Crew
AEW	Air Expeditionary Wing	MCE	Mission Crew Element
AIB	Accident Investigation Board	ME	Mishap Engine
AAIB	Abbreviated Accident Investigation Board	MIS	Maintenance Information System
		MP	Mishap Pilot
AF	Air Force	MRPA	Mishap Remotely Piloted Aircraft
AFB	Air Force Base	MS	Mishap Sortie
AFI	Air Force Instruction	MSL	Mean Sea Level
AFTO	Air Force Technical Order	MSO	Mishap Sensor Operator
AFSOC	Air Force Special Operations Command	OG	Operations Group
		PPSL	Predator Primary Satellite Link
ATC	Air Traffic Control	RPA	Remotely Piloted Aircraft
CC	Commander	RPM	Revolutions Per Minute
DO	Director of Operations	RS	Reconnaissance Squadron
EGT	Exhaust Gas Temperature	RW	Reconnaissance Wing
FOB	Forward Operating Base	S/N	Serial Number
GA	General Atomics	SOF	Special Operations Forces
GCS	Ground Control Station	SOS	Special Operations Squadron
HUD	Head-up Display	SATCOM	Satellite Communications
IMDS	Integrated Maintenance Data System	TCTO	Time Compliance Technical Order
IAW	In Accordance With	TO	Technical Order
ISR	Intelligence, Surveillance and Reconnaissance	TV	Television
		USAF	United States Air Force
KIAS	Knots Indicated Airspeed	USAFCENT	United States Air Forces Central
L	Local Time	USCENTCOM	United States Central Command
LOS	Line of Sight	Z	Zulu or Greenwich Meridian Time (GMT)
LRE	Launch and Recovery Element		

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 28 June 2011, Lieutenant General William J. Rew, Vice Commander Air Combat Command, appointed Lieutenant Colonel Thomas E. Hazlebeck as the Abbreviated Accident Investigation Board (AAIB) President to investigate the 17 May 2011 crash of an MQ-1B Predator aircraft, tail number T/N 07-3249. An abbreviated AIB was conducted at Holloman AFB, New Mexico from 11 July 2011 to 28 July 2011, pursuant to Chapter 11 of Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*. A Legal Advisor and Recorder were also appointed to the AAIB. A pilot, physiologist, and maintenance advisor were detailed as Functional Area Experts. (Tab Y-3, Y-5, Y-7, Y-9)

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

After normal preflight, the MQ-1B, T/N 07-3249, deployed from the 49 WG at Holloman AFB, NM, took off at approximately 0404L, 16 May 2011. (Tabs V-3.1, CC-17) After normal departure and handover to the mission control element (MCE) (Tab V-3.2), the MPRA was flown for approximately 8.3 hours on an operational mission in support of Operation ENDURING FREEDOM (Tab CC-17, V-3.2), when a decreasing oil level was noticed. After approximately 16.9 hours of flight the MCE crew on duty noticed a visible oil leak and initiated a return to base (RTB). At approximately 18.8 hours into flight, the launch and recovery element (LRE) mishap crew (MC) took control of the aircraft for the approach and landing portion of the mission. (Tab CC-17) The MC was deployed from the 432 WG, Creech AFB, NV. (Tabs V-1.2, V-2.2) The MP maneuvered the aircraft to avoid clouds on the arrival and intercepted final approach and glidepath. (Tab CC-19) However, low clouds and high humidity in the Djibouti local area obscured both infrared sensors used by the MC to visually acquire the runway environment at night. (Tab CC-20 to CC-21) On final approach, the MP intercepted and maintained a commanded glidepath approximately 420' below normal. (Tab CC-5) The MP initiated a go-around at approximately 20 feet above ground level (AGL), but was too late to avoid impact. (Tab CC-21) At approximately 0217:22L, 17 May 2011, the MRPA impacted the terrain approximately 2.4 NM short of the threshold and 890 feet south of centerline to runway 09 at an airport in Djibouti. (Tab CC-21) The MRPA and one AGM-114 Hellfire missile loaded onboard were destroyed on impact at a cost of $2,983,766. There was no other government or private property damage or injuries to civilians on the ground. (Tab P-2)

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 DD-5, DD-6, DD-7, DD-8)

(2) 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 DD-9, DD-10, DD-11)

(3) 432d Wing (432 WG)

The 432d Wing, 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 WG 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 DD-13)

(4) 432d Operations Group (432 OG)

The 432d 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 DD-13)

b. Aircraft: MQ-1B Predator (Figure 1. Cover, 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 DD-3, DD-4)

Figure 1. Typical Components of the MQ-1B System

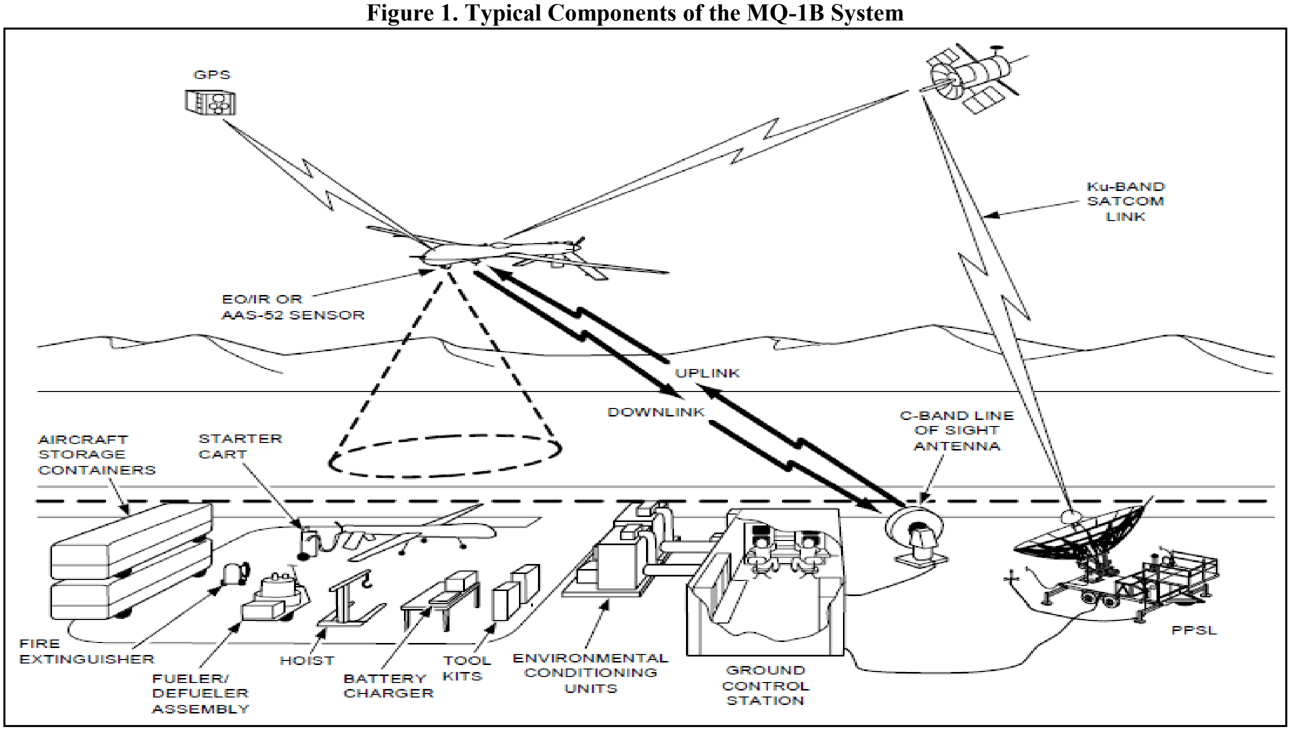

Figure 2. Inside View of Ground Control Station

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 DD-3, DD-4)

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 DD-3, DD-4)

4. SEQUENCE OF EVENTS

a. Mission.

The mishap sortie was an intelligence, surveillance and reconnaissance (ISR) mission flown in support of OEF and was authorized by an Air Tasking Order (ATO). (Tab V-3.2) The mishap crew (MC) consisted of the mishap pilot (MP) and mishap sensor operator (MSO) who were assigned to the 18 RS (MP) and 11 RS (MSO), both from the 432 WG, Creech AFB, NV. (Tabs V-1.2, V-2.2)

The MPRA's mission profile consisted of a crew from the LRE launching the aircraft (Tab V-3.1), several crews from the MCE performing the ATO assigned mission (Tab R-26 through R-29), and then recovery by the LRE MC. (Tab V-1.3)

b. Planning.

The MC planned and the MP briefed the mission in accordance with (IAW) the 60 Expeditionary Reconnaissance Squadron (ERS) Squadron Standards (Tab V-1.3), to include checking weather, Notices to Airmen (NOTAMs), Flight Crew Information Files (FCIFs) and other required items. The MP was also assigned as the Operations Supervisor (Ops Sup) and accomplished duties required as the Ops Sup during this shift. (Tab V-1.10 to V-1.11) The MC had launched one remotely piloted aircraft (RPA) and landed one RPA previously on their shift prior to recovery of the MRPA. (Tab V-2.3)

c. Preflight.

After normal preflight, the MRPA took off uneventfully at approximately 0404L, 16 May 2011. (Tab V3.1, CC-17)

d. Summary of Accident.

After normal departure and handover to the mission control element (MCE) (Tab V-3.1 to V-3.2), the MRPA was flown for approximately 8.3 hours when a decreasing oil level was noticed. (Tab CC-17) After approximately 16.9 hours of flight the sixth MCE crew noticed a visible oil leak and initiated a return to base (RTB). (Tab CC-17) At approximately 18.8 hours into flight, the LRE MC took control of the MRPA for the approach and landing portion of the mission. (Tab CC-17) After completing the low oil level checklist due to the oil level at 57%, the MC completed all required checklists for landing, while remaining at higher altitude as a precaution due to the oil leak. (Tabs CC-19, AA-7, V-1.5)

The MQ-1 has two GPS systems, normally referred to as Nav1 (the LN100G INS/GPS system) and Nav2 (the Novatel GPS only system). (Tab BB-5) The MQ-1 defaults to the Nav1 for GPS altitude (Tab BB-5), and the MP had selected Nav1. (Tab V-1.8) The selected altitude is used by the aircraft computer to generate commands for the GPS landing system. An additional altitude source is the static port on the aircraft that measures static air pressure. This pressure is compared to the current pressure at ground level (the altimeter given to the pilot by air traffic control (ATC)) and converted to an altitude. This altitude is separate from the GPS altitudes. All three sources can be read and compared on a heads-down display (HDD), but only one is displayed in the HUD. (Tab BB-5) The MP had static port pressure displayed in the HUD. (Tab CC-19)

At approximately 8000 feet MSL, the MP checked the LN100G INS/GPS altitude against both the Novatel GPS altitude and the static port altitude and believed they were matched within 100 feet. (Tabs V-1.5 to V-1.6 and V-1.9) However, at that point, telemetry data downloaded after the accident from the ground control station (GCS) showed the LN100G INS/GPS altitude was actually 420 feet higher than the Novatel GPS altitude (Tab CC-7) and 820 feet higher than the static port derived altitude that was displayed in the MP's HUD. (Tab CC-8)

The MP continued the normal arrival from the north and was directed to descend over the Very high frequency Omnidirectional Range navigation aid (VOR) to set up for the approach (Tabs AA-5, CC-19). The MP attempted to maneuver the MRPA to avoid visible clouds during the arrival and approach. However, at approximately 2050 feet, the MRPA entered visible clouds and remained in clouds or haze until just prior to impact. (Tab CC-20)

Low, broken clouds from approximately 3400 feet MSL to ground level, as well as high humidity and haze in the Djibouti local area obscured both infrared sensors used by the MP and MSO to visually identify the runway environment. (Tab CC-19 through CC-21) At 1,020 feet MSL and again at 680 feet MSL, the MSO initiated a 2-point non-uniformity correction (NUC2), (Tab CC-20) A "NUC2" or "nuke" procedure is a 30 to 40 second procedure internal to the infrared sensor used by the MSO that attempts to obtain a better thermal image. (Tab BB-5) However, because the MRPA was still in weather conditions at the time the NUC2 was performed, the "nuke" did not significantly improve the image. (Tab CC-20)

The GPS Landing System (GLS) uses GPS position information and preset airfield information of approach and departure end locations to project a final approach course. The GLS uses GPS altitude information, preset touchdown point elevation, touchdown point displacement from the threshold, and glideslope to project a glidepath. (Tab BB-5) The airport elevation was 49 feet, the glideslope was set to 3 degrees and the point of intercept on runway 09 at Djibouti was set to 500 feet from the approach end. (Tab V-2.4)

After descent over the VOR, the MP reported a 5 mile final and received clearance to land. (Tab N-3) At this point, the MRPA was at approximately 4.7 nautical miles (NM), 1,290 feet above mean sea level (MSL), heading 115 degrees, 2.5 degrees north of GLS centerline and 1.9 degrees above the GLS commanded glidepath. (Tab CC-20)

After reporting a 5 mile final, the MP attempted to intercept final approach from the north using an intercept angle to final ranging from 26 to 35 degrees. As a result, the MRPA moved from 2.5 degree north of course at 4.7 NM to approximately 2.5 degrees south of course at 3.7 NM. At this point, the MP began a series of three course corrections over the span of 54 seconds on final approach in an attempt to move back towards GLS course centerline. However, due to the small course corrections and some right roll tendencies in the MRPA on final, course alignment throughout the remainder of the approach was consistently 2.8 to 2.4 degrees south of course. (Tabs CC-20 to CC-21, J-4, J-7)

On final approach, continued inaccuracies in the LN100G INS/GPS altitude resulted in a commanded glidepath approximately 420 feet below the correct glidepath (Tabs CC-20 to CC-21, CC-10). At 4.1NM, the MP intercepted this incorrect glidepath and maintained it within 0.2 degrees on final approach until impact. (Tab CC-20 to CC-21). Neither the MP nor the MSO reference the distance to touchdown after the 5 mile final call (Tab N, Tab CC-20 to CC-21). This information is available in the HUD as a numeric readout (Tab BB-5) and also graphically on the tracker display at each crew position (example at Tab AA-3).

On approach to Djibouti from the west, the terrain slopes from approximately 50 feet above mean sea level (MSL) at the touchdown zone to over 300 feet above MSL at 4 miles on final approach to the runway. (Tab CC-3)

At 320 feet MSL, which at that location was approximately 20 feet above ground level (AGL), the MSO saw the terrain approaching and queried the MP about altitude. (Tabs CC-21, V-2.6) A go-around was initiated by the MP, but the MRPA was too low to avoid impact and struck the ground approximately one second later. (Tab CC-21)

e. Impact

At 0217:22L, 17 May 2011, the MRPA impacted the terrain approximately 2.4 NM short and 890 feet south of centerline of runway 9 at Djibouti/Ambouli Airport, Djibouti. The MRPA was in 2 degrees of left bank, 1.5 degrees nose low, heading 081 degrees, 2.4 degrees south of GLS course centerline, 0.2 degrees below commanded glidepath, 310 feet MSL, at a speed of 74 nautical miles per hour (KTS). (Tab CC-21)

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.

The active 781-series forms for the MRPA were documented in accordance with (IAW) applicable maintenance guidance for the MQ-1B, and the forms indicated that the MRPA had no outstanding maintenance issues that would prevent it from flying. 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 certified the aircraft for flight. (Tab D-13)

b. Inspections.

All required inspections were accomplished on the MRPA, and there were no overdue Aircraft Time Compliance Technical Orders directing the modification of the aircraft or the performance of any inspection for the aircraft. The MRPA's next scheduled inspection was a 28-day battery check due 23 May 2011 and a 720-hour engine inspection due in 29 flying hours. (Tab D-4 through Tab D-16)

c. Maintenance Procedures.

Review of maintenance procedures noted the following discrepancy.

1. The Air Handler (AH) was removed and reinstalled on 15 May 2011 (Tab D-8). IAW Technical Order (TO) 1Q-1(M)B-2-93JG-70-1, 93-71-01-004 an AH test is required as Follow-On-Maintenance. This test was not documented in the AFTO 781A's as being completed. This discrepancy was not relevant to the mishap.

d. Maintenance Personnel and Supervision:

Aircraft maintenance records and statements provided by maintenance personnel indicated all preflight maintenance and supervisory activities were normal. (Tab R-16 through R-24) A thorough review of the training records provided and special certification rosters of those who performed maintenance on the MRPA were accomplished. All individual training records indicate they were trained and qualified. Maintenance personnel qualification and proficiencies were not a factor in this mishap. (Tab G-62 through G-99)

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-4) The MQ-1 does not have a hydraulic system.

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 MRPA impacted the ground during landing, after handoff from the MCE to LRE and was recovered. The LRE GCS 6119 was immediately sequestered for test and evaluation. (Tab J-3) The MRPA crew reported decreasing oil levels. (Tab J-5)

b. Engineering Evaluations and Analyses

Depot engineering reviewed the logger data for GCS 6119 and it was determined that it was operating normally and was not a factor in this incident. (Tab J-3) At 8.3 hours of flight, the aircraft oil level began slowly decreasing. At that time, the oil level was at ~78% (yellow low is 60% and red low is 50%) and oil pressure was ~66 psig (yellow low is 32 psig and red low is 28 psig). At the end of MCE segment, at approximately 18.8 hours of flight, oil level was ~57% and oil pressure was ~59 psig. Shortly after handover to the LRE, oil level was ~57% and oil pressure was ~60 psig. During final descent, oil level was ~60% and oil pressure was ~55 psig. When salvage crews reached the MRPA, the engine was still running and had to wait for it to run out of fuel. The engine appeared to have maintained power at all times and the slow oil leak was not a factor in this mishap. (Tab J-6, J-7, J-8)

7. WEATHER

a. Forecast Weather.

Prevailing forecast weather for the recovery period was scattered clouds at 2000 feet above ground level (AGL), 5 statute miles (SM) visibility with haze, and surface winds variable at 6 KTS. (Tab F-23)

A temporary forecast was in effect from 2200L to 0700L for broken clouds at 2000 feet AGL, 3 SM visibility with smoke. (Tab F-23)

b. Observed Weather.

At 0155L, observed weather was reported as few clouds at 1600 feet AGL, visibility greater than 10 miles, altimeter 29.78, surface winds 090 at 6 KTS, temperature 30 degrees Celsius and dew point 25 degrees Celsius. This data was from the automated surface observation system (ASOS) at the airfield in Djibouti. (Tab F-3)

c. Space Environment

There was no forecast GPS degradation for the Djibouti area. (Tab F-27)

d. Operations.

On final approach, the MC encountered weather conditions worse than forecast and worse than what was observed over the field by the automated observation system, a system which only sees weather that is over where the ASOS is sitting. In the HUD, the cloud layer appears to be broken in the area, starting at approximately 3400 feet AGL and going down to almost the surface in areas. (Tab CC-19)

From the MP HUD infrared view at approximately 5000 feet and 6.5 NM looking east towards the field, the broken deck appears to cover an area from approximately 2 NM final to at least 5NM final, from Djibouti runway 09 extended centerline to approximately 2 NM south of centerline. The broken deck at 3,400 feet MSL appears to continue over the field; however, the runway is visible with no low clouds observed over the field or out to approximately a 2 NM final. (Tabs CC-19)

This weather and high humidity, on centerline and south from 5 NM to 2 NM, obscures both the MP and MSO infrared sensors throughout the final approach to the airfield. (Tab CC-19 through Tab CC-21)

While the GPS/INS in the MQ-1B is not certified for instrument approaches (Tab BB-12), there was a waiver in effect for deployed aircrew allowing instrument approaches using the GLS. (Tab BB-3) Generally, an instrument approach is a procedure on which a pilot flies an aircraft, using indications from instruments on the aircraft, to align the aircraft with the runway and descend out of the weather to a point where the pilot can see the runway and safely land. An instrument crosscheck (in relation to an instrument approach) is the movement of the pilot's eyes around the cockpit to each relevant instrument, the information in the HUD and the visual through the HUD (to look for the runway) to ensure the aircraft remains safely on the instrument approach until visual with the runway or runway environment.

However, on the mishap GLS instrument approach, the MP deviates from AFI 11-202V3 ACC SUP, paragraph 8.13.4 and his AFI 11-202V3 ACC SUP weather category minimums. (Tabs T-3, BB-9, BB-8) The MP continues through his pilot weather category 2 minimum of 350 feet MSL (300 feet above touchdown zone elevation) on the approach and does not attempt a go-around until 320 feet MSL. Per AFI 11-202V3 ACC SUP, paragraph 8.13.4 the MP should have executed a missed approach at 350 feet MSL when the runway environment was not in sight. (Tab BB-9, Tab CC-21)

8. CREW QUALIFICATIONS

a. Mishap Pilot

(1) Training

MP was qualified in the MQ-1B as a pilot since 23 Feb 2010.

(2) Experience

MP had a total flight time of 1051.0 hours, with 800.9 hours in the MQ-1B. The MQ-1B was MP's first assigned aircraft. MP was designated as an "Experienced" crewmember in the MQ-1B. The MP's flight time during the 90 days before the mishap was as follows:

	Hours	Sorties
30 days	24.7	43
60 days	32.1	55
90 days	61.3	67

(Tabs G-2 through G-22 and G-42 through G-45)

b. Mishap Sensor Operator

(1) Training

MSO has been a qualified MQ-1B sensor operator since 10 October 2007.

(2) Experience

MSO had a total flight time of 1,004.1 hours, with 985.3 hours in the MQ-1B. The MQ-1B was MSO's first flight operations assignment. MSO was designated as an "Experienced" crewmember and instructor in the MQ-1B. The MSO's flight time during the 90 days before the mishap was as follows:

	Hours	Sorties
30 days	27.9	41
60 days	45.8	71
90 days	60.0	77

(Tabs G-23 through G-41 and G-46 through G-61)

9. MEDICAL

a. Qualifications.

At the time of the mishap flight, both crew members had current flight physicals, no known illnesses or injuries, and were medically qualified to perform flying duties. (Tab EE-3)

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. (Tab EE-3)

10. OPERATIONS AND SUPERVISION

a. Operations.

The operations tempo for the 60 ERS aircrew was high. With limited crews available and 24 hour operations in support of Operation ENDURING FREEDOM and other operations, this tempo was required to accomplish the mission. However, pilots and sensor operators were scheduled for 8 hour shifts and were given 12 hours crew rest each day. (Tabs T-3, V-1.3, EE-3) There is no evidence to suggest that operations tempo was a factor in this mishap.

All the crews in the 60 ERS are experienced. The MP was experienced and had accomplished 43 missions in the last 30 days, with the majority of these missions as a paired crew with the MSO. (Tabs G-4 to G-5, V-1.3) However, the MP stated he had not seen an actual weather instrument approach while deployed. (Tab V-1.7) The MP had accomplished a GPS precision and non-precision approach for his last instrument checkride on 28 Jan 11. (Tab G-43) Additionally, he had logged a GLS precision approach on 13 May 11 and was therefore current in precision approach (Tab T-8).

b. Supervision.

The MP was the scheduled operations supervisor and was designated on the letter of X's as an operations supervisor. (Tabs V-1.3, T-3) The operations supervisor was scheduled, on duty and accomplished all tasks required under AFI 11-418. (Tab V-1.10 to V-1.11) All pilots at the 60 ERS were qualified and designated as operations supervisors. (Tab T-3) Having an operations supervisor that was not piloting the MRPA would have allowed another person to check the MC's recovery plan, but manning at the 60 ERS would not support an additional pilot on shift. (Tab T-3) Additionally, the MC's intended recovery plan, descending to 2000 feet and remaining VFR until touchdown (Tab CC-19), was adequate to safely recover the MRPA.

The operations supervisor and supervision were not factors in this mishap.

11. HUMAN FACTORS ANALYSIS

A human factor is any environmental or individual physical or psychological factor a human being experiences that contributes to or influences his performance during a task.

The following are the DoD Human Factors Analysis Classification System (HFACS) factors found in AFI 91-204 Attachment 5 that related to this mishap.

a. Breakdown in Visual Scan

Breakdown in visual scan is a factor when the individual fails to effectively execute learned/practiced internal or external visual span patterns leading to unsafe situation.

MP appears to perform an inadequate cross check during the final approach to Djibouti/Ambouli Airport, Djibouti. The last time the pilot mentions an altitude is departing 4000 feet over the VOR, over 5 minutes prior to impact. (Tab CC-19) The last time the MSO mentioned altitude was at approximately 1600ft MSL in reference to the cloud deck. (Tab CC-20) The next mention of altitude was by the MSO 3 seconds prior to impact. (Tab CC-21) There were no additional indicators that the MP was aware of the MRPA's low actual above ground level (AGL) altitude. Other than reporting 5 mile final at 4.7NM, the MP does not reference range to the field during the entire approach. (Tab CC-19 through CC-21) The breakdown in visual scan of instruments and lack of awareness of altitude and range to the field was a factor in this mishap.

b. Task Misprioritization

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

During the decent in the clouds, the MSO was not aggressive in monitoring the safety of the approach. The last mention of altitude was at 1600ft MSL as the aircraft was descending into IMC conditions. (Tab CC-20) While there was talk of a potential go-around if the MP could not visually locate the runway, the MSO became focused on the IR sensor picture instead of the approach information depicted on the HUD. Additionally, the MSO attempted two 2-point non-uniformity corrections to his IR picture at lower altitudes, once at just over 600ft MSL. (Tab CC-20 to CC-21) This caused him to essentially be blind for up for 40 seconds while the camera recalibrated in the weather which was a non-essential task at the time. (Tab BB-5)

c. Error Due to Misperception

Error due to Misperception is a factor when an individual acts or fails to act based on an illusion; misperception or disorientation state and this act or failure to act creates an unsafe situation.

The MC expected from forecast weather that cloud coverage would end by approximately 1,600 feet MSL. (Tab F-3, CC-20) However, worsening weather and humidity caused the crew to remain in IMC conditions. (Tab CC-19 through CC-21) The MC perceived that their obscured infrared HUD pictures were due to fogging or malfunctioning sensors. (Tab N-3) This misperception leads the MSO to continue attempting to correct his sensor below a safe altitude. (Tab CC-20 to CC-21)

d. Vision Restricted by Meteorological Conditions

Vision Restricted by Meteorological Conditions is a factor when weather, haze or darkness restricted the vision of the individual to a point where normal duties were affected.

Analyzing data from the MC sensors, weather was a factor in this mishap. The conditions displayed on the sensors depicted low cloud decks and high humidity, causing an unclear picture on both screens. (Tab CC-19 through CC-21) Additionally, the mishap occurred at night, causing the MP to rely solely on his infrared sensors. (Tab CC-17) Through examination, the AIB was able to make out ground and terrain features through the IR images, while clouds or haze were moving in the display. Additionally, at and just after impact, ground features are clearly visible, with a haze layer above. This indicated that IR obscuration was caused by outside conditions and not fogging on the lens or internal IR sensor degradation. (Tab CC-20 to CC-21)

e. Channelized Attention

Channelized Attention 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.

On final approach, MP focused his conscious attention on the course and glidepath corrections, but failed to adequately monitor his altitude and distance from the runway. This is evidenced by the MP’s 3 course corrections in the final minute of flight and close adherence to the GLS commanded glidepath that was 420 feet low from the correct glideslope. (Tab CC-20 to CC-21)

The MSO also fell victim to channelized attention during the mishap. The MSO nuked his sensor twice during the critical phase of flight (Tab CC-20 to CC-21) One nuke occurred at approximately 650ft MSL and caused the MSO sensor to be essentially non-operational for upwards of 40 seconds within 600 feet AGL. The MSO was so focused on getting a clear sensor image that he never called or mentioned altitudes or range to the field until 3 seconds prior to impact. (Tab CC-20 to CC-21)

f. Local Training Issues/Programs

Local Training Issues/Programs are a factor when one-time or recurrent training programs, upgrade programs, transition programs or any other local training is inadequate or unavailable and this creates an unsafe situation.

Due to AFI 11-2MQ-1 Volume 3, 4.6.1.1.2 restrictions from flying in weather, pilots on home station and during initial training do not normally fly the MQ-1 in IMC conditions, but in simulated conditions to satisfy training requirements. In the AOR, a waiver allows aircrew to fly the mission in IMC conditions (Tab BB-3) The MP expected to fly a VFR approach by 3NM final. (Tab CC-19) Encountering Instrument Meteorological Conditions (IMC) instead, the MP quickly became channelized and proceeded to have a breakdown in his visual scan, contributing to him flying the MPRA into the terrain roughly 2.4NM from the end of the runway. (Tab CC-21)

Through the investigation, it became evident that the majority of the MQ-1 community uses 200ft as a decision height. (Tabs V-1.6, V-2.5, V-3.2, V-4.4 to V-4.5, CC-15) Per AFI 11-202 Volume 3, ACC SUP, Table 8.1, the decision height to be used on an instrument approach is based only on experience level of the pilot. (Tab BB-8) Per AFI 11-202V3 ACC SUP, paragraph 8.13.4, decision height is not an altitude chosen by the pilot, but dictated by the pilot's weather category minimums. (BB-9) This inaccurate decision height is taught at the formal training unit (FTU) as well. (Tab CC-15)

g. Informational Resources/Support

Informational Resources/Support is a factor when weather, intelligence, operational planning material or other information necessary for safe operations planning are not available.

The air traffic controllers at Djibouti/Ambouli Airport, Djibouti had given incorrect altimeter settings in the past, including during the launch of the mishap sortie. (Tab V-3.1 to V-3.2) The MRPA static port altitude after impact was reading 50 feet higher than the altitude that flight planning software indicated for terrain at the impact site. (Tabs CC-21, CC-5) This discrepancy could have been due to incorrect altimeter setting, as the barometric pressure was trending lower at the time of the crash. (Tab F-3)

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. 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
(9) AFI 11-202, Volume 3, General Flight Rules, ACC SUPP Chg 1, 28 April 2008, continued.
(10) AFI 91-204, Safety Investigations and Reports, 24 September 2008

b. 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-2-93JG-70-1, Job Guide Surveillance Alternate Payloads, USAF Series MQ-1B Remotely Piloted Aircraft, 08 February 2010
(12) T.O. 1Q-1(M)B-6, Aircraft Scheduled Inspection and Maintenance Requirements, USAF Series MQ-1B Remotely Piloted Aircraft, 21 January 2010
(13) AFI 21-101, Aircraft and Equipment Maintenance Management, 26 July 2010
(14) AFI 21-101, Holloman AFB Supplement 1, Aircraft and Equipment Maintenance Management, 6 October 2010
(15) 380 AEWI 21-101, Aircraft and Equipment Maintenance Management, 28 September 2009

The AFIs listed above are all available on the Air Force E-Publishing web site: http://www.epublishing.af.mil

c. Known or Suspected Deviations from Directives or Publications.

There is a deviation noted in section 5, Maintenance. Please see above. This deviation was not found to be causal or contributory.

During the GLS approach, the MP deviated from AFI 11-202, Volume 3, General Flight Rules, ACC SUPP Chg 1, 28 April 2008, continued. The MP was weather category 2. (Tab T-3) Per AFI 11-202, Volume 3, General Flight Rules, ACC SUPP Chg 1, 28 April 2008, continued, Table 8.1, weather category 2 approach minimums are: published minimums for the approach to be flown or ceiling 300 feet and visibility 1 mile (runway visual range (RVR) of 5000 feet), whichever is higher. (Tab BB-8) Approach minimums are the minimum altitude that a pilot will descend to on an instrument approach before either transitioning to a visual approach (i.e. the pilot sees the runway or runway environment) or goes missed approach (climbs back up to altitude).

Since the GLS approach is not a published approach, but one approved by COMUSAFCENT FCIF 09-09/B (Tab BB-3), it has no minimum published. Therefore, the weather minimums for that approach for pilot weather category 2 should have been 300 feet and 1 mile visibility. The touchdown elevation for Djibouti runway 09 is 49 feet MSL (Tab CC-11). Per AFI 11-202, Volume 3, ACC SUP, paragraph 8.13.4.1 (Added-ACC), the MP should have used 350 feet MSL as his minimum altitude to descend to before going missed approach or transitioning to a visual approach and landing. (BB-9) However, the MP continued through his weather minimums and attempted a go-around at 320 feet MSL. (Tab CC-21) This deviation significantly contributed to the mishap.

13. ADDITIONAL AREA OF CONCERN

There are no additional areas of concern.

Date 28 July 2011

THOMAS E. HAZLEBECK, Lt Col, USAF
President, Accident Investigation Board

STATEMENT OF OPINION
MQ-1B, 07-3249 ACCIDENT
17 MAY 2011

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 17 May 2011, at approximately 0217L, an MQ-1B, Tail Number 07-3249, impacted the terrain during approach and landing while on an operational mission in support of Operation ENDURING FREEDOM. The MQ-1B and an Air-to-Ground Missile (AGM)-114 onboard were destroyed. There was no other government or private property damage or injuries to civilians on the ground.

After a careful and complete investigation of this mishap, I find by clear and convincing evidence the following two causes of this mishap. First, inaccurate LN100G Inertial Navigation System (INS)/ Global Positioning System (GPS) altitudes resulted in dangerously low glidepath indications; and second, the mishap crew (MC) failed to recognize and correct the dangerous situation in time to avoid impact with the terrain. Additionally, I find from a preponderance of the evidence that low clouds and high humidity in the Djibouti local area and mishap pilot (MP) deviation from AFI 11-202, Volume 3, ACC SUP, Paragraph 8.13.4 minimum altitude on instrument approach restrictions significantly contributed to this accident.

2. DISCUSSION OF OPINION:

The MC's initial actions in gaining control of the mishap remotely piloted aircraft (MRPA), dealing with the oil leak and beginning recovery were in accordance with procedure. The MC's initial recovery plan of returning under visual flight rules (VFR), descending to 2000 feet above mean sea level (MSL) over the Very high frequency Omnidirectional Range navigation aid (VOR) and landing in visual meteorological conditions (VMC) was appropriate.

At 8000 feet MSL on descent, the MP testified that he checked the LN100G INS/GPS altitude against the Novatel and static port altitudes and did not notice a discrepancy. However, telemetry data shows there was a significant altitude difference between the LN100G altitude and static port altitude shown in the heads-up display (HUD). This difference in altitude between the LN100G and static port altitudes decreased to approximately 420 feet on final, but was significant throughout the descent. This altitude check in the descent was the first chance for the MC to recognize the potential unsafe approach conditions.

As the descent continued, the MC observed considerably more clouds on final approach than they expected. At this point, they had two options. They could take more time to find a descent point where they could maintain visual meteorological conditions (VMC), or they could proceed with an approach that penetrated the weather on final.

After careful tape review, on the third review of the MP HUD view, I observed a 10 second portion during the descent over the VOR, at approximately 5000 feet MSL, where the runway is visible and a VMC descent to the north of final approach course was possible. It is apparent that inflight, the MC did not notice the runway or clear airspace, or they likely would have descended in this VMC airspace to land. Due to the short time it was visible, it is reasonable to assume most MQ-1 aircrew would not have seen the cloud break.

Both crew members stated inflight during the descent that they planned to land as soon as practical. Both later testified that their mindset was to land as soon as possible, due to the oil leak condition they had observed. According to the MQ-1B procedures for dealing with a visible oil leak, landing as soon as possible was the correct course of action. While they stated otherwise inflight, they executed a course of action that showed the intent to land as soon as possible, and their response to the oil leak was not a factor to the mishap.

The MC therefore elected to continue the descent, attempting to avoid the weather. Due to the location of the weather on final, the MC was unable to avoid it when executing their normal approach to runway 09.

Once the decision was made to enter the weather to execute the approach, multiple human factors began to impact the MC. The unexpected weather obscured both the MP and mishap sensor operator (MSO) infrared (IR) sensors from the time the MRPA entered the weather at 2050 feet MSL until just prior to impact. The MC expected to breakout from the weather to VMC conditions (clear of the clouds) at 1600 feet MSL, and this expectancy led the MSO to channelize his attention on recovering the IR sensor view, a lower priority than safe execution of the instrument approach. The MSO effectively did not monitor the safety of the approach until 6 seconds prior to impact. Additionally, the MSO did not recognize how far from the field the MRPA was in relation to altitude.

The MP also expected to breakout from the clouds in his IR HUD image. While the MP intercepted and maintained the GLS glidepath, he dropped the range to the field from his instrument crosscheck and channelized on course and glidepath corrections. The MP did not appear to bring altitude into his instrument crosscheck until just prior to impact. As a result, the MP flew the MRPA below his pilot weather category (PWC) minimums on the instrument approach. While prior training and community standards may have conditioned the MP to use a precision approach decision height of 200 feet, the MP was responsible for knowing and adhering to AFI 11-202 Volume 3 ACC SUP that directs a missed approach (climb away and abort the approach) when still in the weather at his PWC minimum of 300 feet above touchdown elevation on instrument approaches. If the MP had executed a missed approach at his PWC minimum altitude of 350 feet MSL, he may have avoided contact with the terrain.

As the descent continued, the MC observed considerably more clouds on final approach than they expected. At this point, they had two options. They could take more time to find a descent point where they could maintain visual meteorological conditions (VMC), or they could proceed with an approach that penetrated the weather on final.

After careful tape review, on the third review of the MP HUD view, I observed a 10 second portion during the descent over the VOR, at approximately 5000 feet MSL, where the runway is visible and a VMC descent to the north of final approach course was possible. It is apparent that inflight, the MC did not notice the runway or clear airspace, or they likely would have descended in this VMC airspace to land. Due to the short time it was visible, it is reasonable to assume most MQ-1 aircrew would not have seen the cloud break.

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The MP also expected to breakout from the clouds in his IR HUD image. While the MP intercepted and maintained the GLS glidepath, he dropped the range to the field from his instrument crosscheck and channelized on course and glidepath corrections. The MP did not appear to bring altitude into his instrument crosscheck until just prior to impact. As a result, the MP flew the MRPA below his pilot weather category (PWC) minimums on the instrument approach. While prior training and community standards may have conditioned the MP to use a precision approach decision height of 200 feet, the MP was responsible for knowing and adhering to AFI 11-202 Volume 3 ACC SUP that directs a missed approach (climb away and abort the approach) when still in the weather at his PWC minimum of 300 feet above touchdown elevation on instrument approaches. If the MP had executed a missed approach at his PWC minimum altitude of 350 feet MSL, he may have avoided contact with the terrain.

Ultimately, if the crew had followed a proper instrument crosscheck and cross-checked range to touchdown with aircraft altitude in their HUD at any point inside of reported 5 mile final approach to the airfield, they would have noticed the 300-400 foot discrepancy between actual and expected altitude. This altitude error, caused by the inaccurate LN100G INS/GPS altitude and compounded by the lack of IR visibility, resulted in a dangerously low glidepath. The MC failed to monitor the MRPA altitude in relation to distance from the field, followed the low glidepath and flew the MRPA into the ground, destroying the MRPA.

Date 28 July 2011

THOMAS E. HAZLEBECK, 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.