UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 04-3125

60 EXPEDITIONARY RECONNAISSANCE SQUADRON
3 SPECIAL OPERATIONS SQUADRON
27 SPECIAL OPERATIONS WING
CAMP LEMONNIER, DJIBOUTI

LOCATION: CAMP LEMONNIER, DJIBOUTI

DATE OF ACCIDENT: 21 FEB 12

BOARD PRESIDENT: LT COL WILLIAM F. HARDIE

CONDUCTED IAW AIR FORCE INSTRUCTION 51-503

Abbreviated Accident Investigation pursuant to Chapter 11

EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION

MQ-1B, T/N 04-3125
CAMP LEMONNIER, DJIBOUTI
21 FEB 12

On 21 Feb 2012 at 0508 GMT, a crew assigned to the 60th Expeditionary Reconnaissance Squadron at Camp Lemonnier, Djibouti uneventfully launched the Mishap Aircraft (MA), a MQ-1B, tail number 04-3125. The MA was handed to the Mission Control element (MCE) from the 3rd Special Operations Squadron at Cannon AFB, NM. Beginning at approximately 0700 GMT the aircraft experienced numerous engine anomalies while on target in support of mission operations. At approximately 0855 GMT, the MP directed the MA back to the Launch and Recovery Element (LRE) due to the MA inability to hold mission altitude and a decreasing oil level trend. At 1010 GMT, the MA engine failed due to low oil quantity and at 1025 GMT, the MA impacted the water 90 miles from Camp Lemonnier, Djibouti and was destroyed on impact. The MA structure and components were destroyed on impact and no significant components were recovered from the ocean site. There were no injuries and there were no damages to other government or private property.

The Abbreviated Accident Investigation Board (AAIB) President found, by clear and convincing evidence, the cause of the mishap was the failure of the turbocharger bearing which resulted in the eventual engine failure and the destruction of the MA. Initially, the turbo charger wastegate was working above expected levels based on altitude and requested power settings. It performed its function of providing additional thrust increasing air pressure in the combustion chamber above 10,000 ft. However, as the aircraft crossed 10,000 ft, the wastegate increased turbocharger output erratically and remained erratic after reaching cruising altitude until it reached 100%. These events are consistent with the turbocharger bearing failure. The mission cruising altitude for this mission was 18,000 MSL. After approximately three hours of flight, the aircraft began a gradual uncommanded descent. This is consistent with the turbocharger not producing the additional boost needed to maintain level flight at altitudes greater than 10,000 ft for airspeed commanded.

As the turbocharger wastegate attempted to overcome increased friction from the bearing failure, the degraded bearing damaged the turbocharger oil seal which caused oil to leak the into the intake manifold closest to #2 engine cylinder; causing poor combustion, decreased engine power and corresponding lowered Exhaust Gas Temperature (EGT). Available evidence indicates the engine oil loss was caused by the turbo charger bearing failure. The MA was enroute to the LRE location when the engine failed. Upon determining the MA would not reach the LRE location, the MP and MSO sought and received guidance from the supported unit, directing a “hard-ditch” or an increased rate of descent to ensure destruction upon impact with the water. At 1025 GMT, the MA and one AGM-114P Hellfire missile were destroyed upon impact and no significant parts were recovered. The estimated government loss is valued at $4.4M.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-1B, T/N 04-3125
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COMMONLY USED ACRONYMS AND ABBREVIATIONS

AB	Air Base
AEW	Air Expeditionary Wing
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AFSOC	Air Force Special Operations Command
AIB	Accident Investigation Board
ANG	Air National Guard
ARB	Air Reserve Base
ATC	Air Traffic Control
BP	Board President
CAS	Close Air Support
CFIT	Controlled Flight Into Terrain
CONUS	Continental United States
CRM	Crew Resource Management
DoDI	Department of Defense Instruction
DSN	Defense Switched Network
"Dash 1"	TO 1Q-1(M)B-1 Flight Manual
EEI	Essential Elements of Interests
EGT	Exhaust Gas Temperature
EM	Emergency Mission
EO	Electro-Optical
FAE	Functional Area Expert
FCIF	Flight Crew Information File
FOIA	Freedom of Information Act
FPM	Feet per Minute
FTU	Field Training Unit
GA-ASI	General Atomics Aeronautical Systems, Incorporated
GCS	Ground Control Station
GMT	Greenwich Mean Time (Z)
HDD	Heads-down Display
HUD	Heads-up Display
IAW	In Accordance With
IMDS	Integrated Maintenance Data System
IR	Infrared
KIAS	Knots Indicated Airspeed
L	Local (Afghanistan)
LOS	Line of Sight
LRE	Launch and Recovery Element
MAJCOM	Major Command
MAP	Manifold Air Pressure
MC	Mishap Crew
MCE	Mission Control Element
MCT	Manifold Charge Temperature
MIRC	Mardem-Beys Internet Relay Chat
MMC	Mishap Mission Coordinator
MP	Mishap Pilot
MRPA	Mishap Remotely Piloted Aircraft
MSA	Minimum Safe Altitude
MSL	Mean Sea Level
MSO	Mishap Sensor Operator
MX	Maintenance
NM	Nautical Miles
OEF	Operation ENDURING FREEDOM
OIF	Operation IRAQI FREEDOM
ORM	Operational Risk Management
PA	Public Affairs
PCL	Point-Click Loiter
PHA	Periodic Health Assessment
POC	Point of Contact
PPSL	Predator Primary Satellite Link
RS	Reconnaissance Squadron
RPA	Remotely Piloted Aircraft
RTB	Return to Base
SA	Situational Awareness
SAT	Satellite
SMIC	Senior Mission Intelligence Coordinator
SSO	Special Security Officer
TCTO	Time Compliance Technical Order
T/N	Tail Number
TO	Technical Order
TRB	Tactical Range and Bearing
UAS	Unmanned Aerial System
UCMJ	Uniform Code of Military Justice
U.S.	United States
U.S.C.	United States Code
USAF	United States Air Force
VVI	Vertical Velocity Indicator
WOC	Wing Operations Center
WG	Wing
Z	Zulu

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 4 June 2012, Brigadier General Michael J. Kingsley, Vice Commander AFSOC, appointed Lieutenant Colonel William F. Hardie to conduct an aircraft accident investigation of the 21 February 2012 crash of a MQ-1B Predator, tail number (T/N) 04-3125, near Camp Lemonnier, Djibouti (Tab Y-3). The investigation was conducted at Hurlburt Field, FL, from 25 June 2012 through 3 July 2012. A Legal Advisor, Recorder, and Maintenance Functional Area Expert were appointed (Tab Y-3, Y-5). A Pilot Subject Matter Expert was also appointed (Tab Y-7).

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 21 February 2012 a MQ-1B, T/N 04-3125, experienced turbocharger failure and subsequent engine failure while on target in support of mission operations (Tab B-2). The MA impacted the water 90 miles from Camp Lemonnier, Djibouti at 1025 GMT while returning to base and was destroyed on impact (Tab B-2). There was no additional damage to government or private property. The aircraft was totally destroyed upon impact with the loss valued at $4.4M (Tab P-2).

3. BACKGROUND

a. Air Force Special Operations Command

The primary mission of the Air Force Special Operations Comand (AFSOC) is to present combat ready Air Force Special Operations Forces to conduct and support global special operations missions (Tab CC-4 – 5). AFSOC's vision is to be America's specialized airpower by being a step ahead in a changing world, delivering Special Operations power anytime, anywhere (Tab CC-4 – 5). AFSOC provides Air Force special operations forces (SOF) for worldwide deployment and assignment to regional unified commands (Tab CC-4 – 5). The command's SOF are composed of highly trained, rapidly deployable Airmen, conducting global special operations missions ranging from precision application of firepower, to infiltration, exfiltration, resupply and refueling of SOF operational elements (Tab CC-4 – 5).

b. United States Africa Command

United States Africa Command (U.S. AFRICOM) is one of six of the U.S. Defense Department's geographic combatant commands and is responsible to the Secretary of Defense for military relations with African nations, the African Union, and African regional security organizations (Tab CC-9). A full-spectrum combatant command, U.S. AFRICOM is responsible for all U.S. Department of Defense operations, exercises, and security cooperation on the African continent, its island nations, and surrounding waters (Tab CC-9). AFRICOM began initial operations on Oct. 1, 2007, and officially became an independent command on Oct. 1, 2008 (Tab CC-9).

c. 23d Air Force

The 23d Air Force (23 AF) is the only numbered air force in AFSOC and is designated as AFSOC's unit of execution to U.S. Special Operations Command (Tab CC-7). The mission of the 23 AF is to provide highly trained special operations command and control, intelligence, weather and reachback support forces to deployed air commanders for execution of assigned missions (Tab CC-7).

d. 380th SPECIAL OPERATIONS WING

Established at a non-disclosed base in Southwest Asia on Jan. 25, 2002, the 380th Air Expeditionary Wing is one of the most diverse combat wings in the Air Force (Tab CC-11). The wing is comprised of five groups and 18 squadrons (Tab CC-11). Its mission partners include an Army air defense battalion, an Air Force training group and a Navy aerial maritime surveillance detachment (Tab CC-11). The wing's mission is to conduct combat operations directed by the President to provide high-altitude all-weather intelligence, surveillance, reconnaissance, airborne command and control and air refueling for Operations New Dawn and Enduring Freedom, and Combined Joint Task Force - Horn of Africa (Tab CC-11). They act as the "eyes and ears," serve as guardians of the sky and provide greater range and endurance for coalition aircraft throughout the Area of Responsibility (Tab CC-11).

e. 27th SPECIAL OPERATIONS WING

The 27th Special Operations Wing (27 SOW) at Cannon Air Force Base, N.M., is one of two Air Force active duty Special Operations wings within Air Force Special Operations Command (AFSOC) (Tab CC-17). The primary mission of the 27 SOW is to plan and execute specialized and contingency operations using advanced aircraft, tactics, and air refueling techniques to infiltrate, exfiltrate, and resupply special operations forces and provide intelligence, surveillance and reconnaissance, and close air support in support of special operations forces (Tab CC-11). The wing's core missions include close air support, agile combat support, information operations, personnel recovery operations, precision aerospace firepower, forward presence and engagement, intelligence, surveillance and reconnaissance (ISR) operations, and specialized aerospace mobility (Tab CC-11). The 27 SOW is a pivotal component of AFSOC's ability to provide and conduct special operations missions ranging from precision application of firepower to infiltration, exfiltration, resupply, and refueling of special operations forces (Tab CC-11). In addition, the 27 SOW brings distinctive intelligence capabilities to the fight, including ISR, predictive analysis, and targeting expertise to joint special operations forces and combat search and rescue operations (Tab CC-11).

f. 3rd SPECIAL OPERATIONS SQUADRON

The 3rd Special Operations Squadron accomplishes global special operations tasking as a member of the Air Force component of United States Special Operations Command (Tab CC-19). It directly supports theater commanders by providing precision weapons employment and persistent intelligence, surveillance, and reconnaissance. It also plans, prepares, and executes MQ-1B Predator missions supporting special operations forces (Tab CC-19). The 3rd SOS is located at Cannon Air Force Base, N.M. The squadron is the first Remotely Piloted Aircraft (RPA) squadron within AFSOC (Tab CC-19). The MQ-1B Predator provides actionable intelligence support to conventional and special operations forces engaged in the Global War on Terror. The platform's unique capability provides SOF with an unblinking eye over the battlefield (Tab CC-19). Outfitted with television and infrared cameras for full motion video support and the deadly Hellfire missile, the Predator is used to track both stationary and mobile targets and, when necessary, to eliminate those targets (Tab CC-19).

g. MQ-1B PREDATOR

The MQ-1B Predator is a medium-altitude, long-endurance, RPA. The Predator's primary missions are close air support, air interdiction, and intelligence, surveillance and reconnaissance, or ISR (Tab CC-15 – 16). 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 (Tab CC-15 – 16). The MQ-1B Predator is a system, not just an aircraft. A fully operational system consists of four aircraft (with sensors and weapons), a Ground Control Station (GCS), a Predator Primary Satellite Link (PPSL), and spare equipment along with operations and maintenance crews for deployed 24-hour operations (Tab CC-15 – 16).

The basic crew for the Predator is a rated 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 (CC-15). The crew employs the aircraft from inside the GCS via a line-of-sight data link or a satellite data link for beyond line-of-sight operations (CC-15).

The MQ-1B Predator carries the Multi-spectral Targeting System (MTS), which integrates an infrared sensor, a color/monochrome daylight TV camera, an image-intensified TV camera, a laser designator and a laser illuminator into a single package (CC-15). The full motion video from each of the imaging sensors can be viewed as separate video streams or fused together (CC-15). The aircraft can employ two laser-guided AGM-114 Hellfire missiles possessing a highly accurate, low collateral damage, and anti-armor and anti-personnel engagement capability (CC-15).

4. SEQUENCE OF EVENTS

a. Mission

The mishap sortie was an intelligence, surveillance, and reconnaissance (ISR) mission to track a moving vehicle target and observe the permission planned stationary target (Tab V-10.1). The mishap crew (MC) consisted of the mishap pilot (MP), mishap sensor operator (MSO), relief pilot and relief sensor operator (Tab-V-10.1 – 10.4).

The MA's profile consists of a Launch and Recovery Element (LRE) crew from Camp Lemonnier and the Mission Control Element (MCE) from Cannon AFB. The MP assumed command and control of the MA at approximately 0630 GMT (Tab K-7). The MC were the primary operators of the MA and in the seats when the MA experienced the engine and altitude anomalies and when the MA's engine quit at 1010 GMT and MA impacted the ocean at 1025 GMT (Tab DD-6; K-7,8; AA-3).

b. Planning

There is no evidence that mission planning contributed to this mishap.

c. Preflight and Launch

There is no evidence that flight plans, aircraft configuration, stepping to the aircraft, or any other related preflight actions or procedures contributed to this mishap. The LRE crew taxied and performed the launch without incident through handover to the MCE crews (Tab J-3).

d. Summary of Accident

The MA departed the LRE location at 0508 GMT (Tabs K-7 – 8, AA-3). The start of the logs, indicated oil level was 100% (Tab DD-4). The aircraft take off was uneventful. LRE handover to the MCE occurred at 0525 GMT and the MA climbed normally to ~18,000 ft MSL (Tab DD-4). MP and MSO were on station at 0630 GMT and by ~0700 GMT, the MA was in a loiter pattern at a range of approximately 190 nautical miles (nm) (Tab DD-4). Static pressure was 15" at this time, and Manifold Air Pressure (MAP) was ~23" (Tab DD-4).

At 0716 GMT, commanded power changed from ~65% to ~70%, and Manifold Charge Temperature (MCT) increased slightly from ~165° F to ~175° F (Tab DD-4). MAP had been stable at ~23" and increased to ~24", but became slightly less stable, with a variation of ~2" MAP (Tab DD-4). Wastegate increased from ~90% to 100%, Exhaust Gas Temperatures (EGT) were 1350-1500° F (Tab DD-4). Oil temperature was ~210° F, and turbo oil temperature rose from ~250° F to ~270° F (Tab DD-4). Prop pitch also became slightly less stable (Tab DD-4). These phenomena are all consistent with the early symptoms of the turbocharger bearing failure.

The wastegate is a valve that varies the amount of exhaust gases through the turbocharger turbine. When the wastegate is closed, all of the gases must pass through the turbine, and the turbocharger develops maximum boost (Tab U-3).

At 0720 GMT, commanded power was decreased from ~60% to ~50% (Tab DD-5). MAP decreased from ~24" to ~21" and both MAP and prop pitch continued to be unstable (Tab DD-5). Wastegate remained at 100%, EGTs dropped slightly to 1300-1450° F (Tab DD-5). Oil temperature was ~210° F, and turbo oil temperature dropped from ~270° F to ~250° F (Tab DD-5).

At 0751 GMT, oil pressure dropped suddenly from ~55 lbs to ~47 lbs (Tab DD-5). Engine speed remained unchanged at ~4700 rpm, and power gauge remained steady at ~55-60% (Tab DD-5). Oil level immediately before and after the oil pressure change was ~90% (Tab DD-5). MAP remained at ~22", wastegate remained at 100%, and EGTs remained at 1350-1500 ° F (Tab DD-5). Oil temperature was ~210° F, and turbo oil temperature dropped slightly from ~250° F to ~245° F (Tab DD-5).

Between ~ 0755 and 0805 GMT, the Relief Pilot MP controlled the MA (Tab AA-3). The MP and Relief Pilot used the handover briefing guide which, during the handover with the relief pilot, covered the altitude, emergency mission altitude, what the operational mission is doing, airspeed, points of lost link, and discussion of actual target intelligence (Tab V-10.4). Due to the time extensive amount of time and number of missions flown since the mishap, MP cannot specifically recall whether the relief pilot briefed the altitude when MP returned from the break (Tab V-10.4).

At ~0810 GMT, the aircraft began an uncommanded, slow rate descent from 18,000 ft MSL, engine power was increased to 100%, engine speed increased to ~5200 rpm, and airspeed was ~72 KIAS (Tab DD-5). The rate of descent was less than 100 FPM and no Vertical Velocity Indicator (VVI) or altitude warning light was displayed (Tab AA-3). Wastegate dropped slightly from 100% to ~95%, EGTs dropped slightly to 1300-1450° F (Tab DD-5). Oil temperature was ~210° F, and turbo oil temperature was ~250° F. During the descent, AOA remained at positive 4-5° (Tab DD-5). MAP decreased further, dropping to ~18", and static pressure was 15" (Tab DD-5). During this period of the mission, the MC entered the pre-programmed mission into the autopilot (Tab V-10.1).

At 0817 GMT, the MA was 200 ft below the commanded and assigned altitude (AA-3). However, the velocity vector indicating the VVI would be same the color as the rest of the HUD graphics, white, appearing "normal" to pilot (Tab AA-5).

At 0827 GMT, MAP briefly increased from ~17" to ~21" and then dropped back to ~17" (Tab DD-5). Static pressure at that altitude was approximately 17"which indicated that no boost was occurring (Tab DD-5). Commanded power was 100% and unchanged. Immediately after the anomaly, oil level began to drop below 90% (Tab DD-5). Oil pressure remained at ~45-50 psi (Tab DD-5).

At ~0855 GMT, the crew recognized the altitude loss and began to diagnose the problem. The MP checked to ensure the MP had not inadvertently commanded the altitude deviation and then checked to make sure that both the altitude hold and pre-programmed altitude were set to the cleared altitude (Tab V.10-3). When MP confirmed the settings were correct, the MP turned both of those items off and MP ran through a common technique for diagnosing loss of thrust issues, pushing the throttle forward to look at the MAPs and Wastegate to see if they were responding correctly and to evaluate the aircraft's performance and throttle response (Tab V-10.3). MP noted that MAP 1 and 2 were lower than the static pressure and MP was still getting what would be appropriate throttle response when pushing the throttle full forward (Tab V-10.4). MP diagnosed the anomalous descent as a turbo-charger failure and expected the altitude to level off at approximately 10,000 ft (Tab V-10.1, V-10.4).

As soon as MP noticed the altitude deviation the MP directed the MA towards the ocean (Tab V-10.1). Being cautious, the maintained glide-speed in case it failed to level off in order to preserve as much altitude as possible (Tab V-10.1). At that point the MA was about 2 hrs distant from the LRE location (Tab V-10.1). MA did not take the most direct route because the MP wanted to push out over water instead of populated areas in the event that it did not level off (Tab V-10.1).

As the aircraft turned back toward the controlling GCS, it continued its descent through ~14,000 ft MSL (Tab DD-5). Earlier in the mission, during the ascent under full power at this same altitude, MAP was ~28", but after the anomaly, during descent through the same altitude and power, MAP was only ~18" (Tab DD-5). During the return flight, the aircraft continued to descend, airspeed remained at ~70 KAIS, and AOA was +5-6° (Tab DD-5). EGT temperatures were fairly normal but exhibited a ~100° F split, oil temperature was ~210° F, turbo oil temp was ~230° F. MAP continued to read abnormally low at ~19" (Tab DD-5).

At 0900 GMT, Operational Checks Data indicated oil level was 79%, a significant decrease from previous levels (Tab K-9, V-10.4). MP began to closely monitor the oil level and noted that it lowered 2% every few minutes (Tab V-10.4).

At 0904 GMT, the crew performed actions associated with the Turbocharger Failure checklist (Tab V-10.1). Oil level fell to 77% (Tab AA-3)

At 0926 GMT, the #2 engine EGT momentarily dropped to 988° F and the pilot's Head's Up Display indicated "EGT – temp low" in Yellow (Tab AA-3).

At 0931 GMT, the engine oil level dropped below 60% and was now rapidly decreasing (Tab AA-3). "Engine Oil - quantity low" indicated Yellow on the pilot's Head's Up Display (Tab AA-3).

MP tried to maintain altitude but it seemed any action did not result in a better glide speed or slower descent; throttle movement appeared to accelerate the oil loss so after a few adjustments MP elected to leave the throttle in the position it was in and accept the glide as it was (Tab V-10.2). After that, the MA went into a more shallow descent (Tab V-10.2).

The MA was still well over a 100 nautical miles from the LR when the oil level reached 40% (Tab V-10.2). The MP asked the supported unit what they wanted them to do in the event the MA could not make to the LRE (Tab V-10.2). After making contact, MP began to preemptively run checklists (Tab V-10.2). MP ran the oil leak checklist and then waited to see if the engine would hold out until the MA was within glide-back range (Tab V-10.2).

At 0948 GMT, engine oil level reached ~25%, the practical lower limit of the oil supply (Tab DD-5). The aircraft was at ~10,000 ft MSL and at full power, airspeed was ~70 KAIS, and AOA was ~+6° (Tab DD-5). At this time, the MA was over 120 nm and 1 hour, 30 minutes from the LRE (Tab AA-3).

The MP noted that after 20% the oil level gets fairly unreliable; when the reading was at 15% it stopped ticking down as continuously but MP was sure it was still leaking (Tab V-10.2). It was only a matter of a few minutes after it hit the 15% level that all the indications of having an engine failure occurred (Tab V-10.2). MP accomplished the Bold Face and started scanning the ocean for a place that was free of vessels as a suitable place to ditch (Tab V-10.2) At that time MP had not heard back yet from the supported unit indicating either a hard or gentle ditch (Tab V-10.2).

At ~0950 GMT, oil pressure began dropping rapidly (Tab DD-5). Oil temperature, which had been ~230-240° F, began increasing rapidly (Tab DD-5).

By 1010 GMT, oil pressure dropped to zero, oil temperature increased rapidly to ~300° F, and the engine stopped running (Tab DD-5). Engine speed for the remainder of the flight was zero, indicating that the propeller was not rotating (windmilling) (Tab DD-5).

At ~1018 GMT, the aircraft was at ~5000 ft MSL when the MC commanded the MA into a steep descent (Tab DD-6). Airspeed increased from ~70 KIAS to ~115 KAIS at which time aircraft telemetry became static as the aircraft reached zero altitude MSL (Tab DD-6). Before, during, and after the engine anomaly, engine ignition was hot (Tab DD-6). The datalogs showed little to no turbulence (Tab DD-6).

e. Impact

Aircraft S/N 04-3125 impacted the water at approximately 1025 GMT on 21 Feb 2012 approximately 90 nm from the LRE location (Tab S-2). This was a "hard ditch" impact, as directed by the supported unit, and was intended to destroy the aircraft upon impact (Tab V-10.2).

f. Egress and Aircrew Flight Equipment (AFE)

Not applicable to this mishap.

g. Search and Rescue (SAR)

Not applicable to this mishap.

h. Recovery of Remains

Not applicable to this mishap.

5. MAINTENANCE

a. Forms Documentation

All maintenance was appropriately documented IAW TO 00-5-1 (Tab U-3). A review of the current aircraft forms for the day of the mishap revealed standard preflight maintenance activities (Tab U-3).

A detailed 90-day review of records and forms revealed a scheduled engine replacement was performed on 14 Feb12 (Tab U-3). The aircraft was flown on 15 Feb12 for over 20 hours (Tab U-3).

The 25 hour scheduled inspection was performed prior to the flight on 21 Feb12 (Tab U-3).

A comprehensive review of all daily flight logs, DRs, and IMDS was accomplished to determine airworthiness of the MA (Tab U-3). No TCTO or OTIs restricted the MA from flying (Tab U-3).

There were no major maintenance discrepancies that would have prevented the MA from flying (Tab U-3).

b. Inspections

The most recent scheduled inspection for the MA was performed on 15 Feb12 (Tab U-3). Prior to the mishap sortie the next PM inspection for the MA was due in 40 flight hours (Tab U-3). The PM inspections were current and not contributory to the mishap (Tab U-3).

c. Maintenance Procedures

The most-recent significant maintenance procedures performed on the MA was the accomplishment of an engine change for scheduled maintenance (Tab U-4).

d. Maintenance Personnel and Supervision

All pre-mission activities were normal and all personnel involved in the BPO and launch of the MA were highly experienced and competent (Tab U-4). A thorough review of maintenance training records revealed all involved personnel were properly trained, qualified and experienced (Tab U-4).

e. Fuel, Hydraulic and Oil Inspection Analyses

Fuel samples (Grade 100LL) from the Camp Lemonnier, Djibouti fuel supply were quarantined. There is no evidence to suggest fuel was a factor in the mishap (Tab J-5).

The MQ-1 does not have a hydraulic system.

The MA was serviced with commercial SR5, Grade: 5W-30 oil (Tab J-6). There are no pre-flight oil samples (Tab J-6). No unusual compounds were present from the oil lot (Tab J-6).

Due to the MA being destroyed on impact, there were no post flight fuel or oil samples available (Tab J-6). There is no evidence to suggest petroleum, oils or lubricants contributed to the mishap.

f. Unscheduled Maintenance

The only unscheduled maintenance was the replacement of a modem assembly to correct a link malfunction (Tab U-4). This was not contributory to the mishap.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS.

a. Structures and Systems

(1) Datalink and Ground Control Station

The datalink and LRE Ground Control Station (GCS 6119) and MCE GCS (GCS 5031) did not contribute to the mishap (Tab J-3). Datalink parameters were normal for the duration of the flight (Tab J-3). The aircraft responded to commands from the LRE and MCE GCSs during the entire flight (Tab J-3).

(2) Engine

The logs began with oil level at 100% (Tab DD-6). It is not possible to know how much additional oil was present in the reservoir tank since it may be filled above the sensor. It is also possible that additional oil was present in the crankcase (Tab DD-6). When the aircraft reached cruise altitude, indicated oil level was ~90% (Tab DD-6). The drop may have been due to oil pooling in the crankcase, or the oil level sensor may have been reading low due to oil-foaming (Tab DD-6).

It is possible that an abnormally large volume of oil was present in the crankcase prior to flight (Tab DD-7). Additionally, the engine must be warm for the manual propeller rotation procedure to work well, otherwise little oil will be returned to the reservoir tank (Tab DD-7). If this procedure was not followed properly, the total volume of oil would not be accounted for (the oil level sensor is located in the oil reservoir tank) before the engine oil was serviced (Tab DD-7). The unaccounted-for volume of oil may have served as a buffer to the indicated oil level, masking a leak which was present before the loss became obvious in the data logs (Tab DD-7).

At 0716 GMT, commanded power changed from ~65% to ~70%, and MCT increased slightly from ~165° F to ~175° F (Tab DD-7). MAP had been stable at ~23” with a variation of ~1” and increased to ~24”, but became slightly less stable with a variation of ~2” MAP (Tab DD-7).

Prop pitch also became slightly less stable (Tab DD-7). The turbocharger most likely began to fail at that time, which could have been caused by lack of oil, or coking of existing oil (Tab DD-7). A second indication of a MAP anomaly was that immediately before the anomaly occurred, prop pitch was at ~18° and dropped to ~16° but became irregular (Tab DD-7). As the anomaly progressed, prop pitch dropped further to ~12°, which indicated that available engine thrust had dropped and that the autopilot had to reduce prop pitch in order to provide the commanded engine speed (Tab DD-7). EGTs dropped from ~1400-1500° F to 1370-1500° indicating irregular combustion, which may have been caused by oil leaking into the intake tract from a failed turbocharger seal, or oil pooled in the crankcase contacting the pistons, and decreasing engine performance (Tab DD-7). MAP dropped from 24" to ~20" within several minutes (Tab DD-7). Static pressure was 15", which indicated that the turbocharger was providing only 5" of boost at half-power (Tab DD-7).

Oil pressure was somewhat low before the anomaly, indicating that the oil bypass valve was likely closed and that the oil pump was producing maximum achievable pressure at altitude (Tab DD-7). It was likely that an oil seal on either the turbo or crankcase failed, and the oil pump had no reserve capability to overcome the loss of pressure, so the pressure dropped (Tab DD-7). MCT was 165° F deg before the anomaly and decreased to ~155 ° F as the anomaly started, rolling off to 110-120° F as the anomaly worsened (Tab DD-7). This indicated that the turbocharger was producing less boost and was likely beginning to seize (Tab DD-7).

At 0827 GMT, MAP briefly increased from ~17" to ~21", and then dropped back to ~17" (Tab DD-7). Commanded power at that time was 100% and did not change (Tab DD-7). Immediately after the MAP change, oil level began to drop below 90% (Tab DD-7). Oil pressure remained at ~45-50 psi (Tab DD-7). It is likely that the turbocharger briefly recovered and returned to full speed, providing full boost, then again seized (Tab DD-7). This is evidenced by the fact that after ~0825 GMT, MAP had dropped to static pressure (Tab DD-7).

At ~0855 GMT, the aircraft turned toward the GCS and continued its descent through ~14,000 ft MSL (Tab DD-8). During ascent under full power at that altitude, MAP was ~28", but during descent through the same altitude and power, MAP was only ~18" (Tab DD-8). Because of the differing turbocharger performance at 14,000 ft MSL under identical engine conditions, it was highly likely that the turbocharger was providing little to no boost after the initial anomaly (Tab DD-8).

At ~0950 GMT, the oil level reached a critically low level (having been consumed by the engine or accumulated in the crankcase) and oil pressure dropped rapidly (Tab DD-8). Oil temperature, which had been ~230-240° F, began increasing rapidly.

At 1010 GMT, the engine failed. Oil pressure dropped to zero, oil temperature increased rapidly to ~300° F, and the engine stopped running (Tab DD-8). Engine speed for the remainder of the flight was zero, indicating that the propeller was not rotating (windmilling) (Tab DD-8).

7. WEATHER

No significant airspace weather disturbances were expected and or observed (Tab F-23 – 24). There is no evidence that weather was a factor in this mishap.

8. CREW QUALIFICATIONS

The LRE crew were qualified, current, and experienced (Tab AA-3). The MCE the MP, MSO were qualified, current, and experienced (Tab AA-3). There is no evidence that qualifications contributed to this mishap.

9. MEDICAL

LRE and MCE crews were medically qualified. (Tab G-9). Toxicology reports for all parties involved were negative (Tab AA-3).

10. OPERATIONS AND SUPERVISION

There is no evidence that operations tempo, experience level of relevant units, or oversight of the mission contributed to this mishap (Tab AA-3).

11. HUMAN FACTORS

There is no evidence that human factors contributed to this mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications Relevant to the Mishap

(1) AFI 11-2MQ-1, Volume 1, MQ-1 Crew Training, 12 January 2010
(2) AFI 11-2MQ-1, Volume 2, MQ-1 Crew Evaluation Criteria, 28 November 2008
(3) AFI 11-2MQ-1, Volume 3, MQ-1 Operations Procedures, 29 November 2007
(4) AFI 11-202, Volume 3, General Flight Rules, 22 October 2010
(5) AFI 11-401, Aviation Management, 10 December 2010
(6) AFI 11-418, Operations Supervision, 15 September 2011
(7) AFI 21-101, Aircraft and Equipment Maintenance Management, 26 July 2010

NOTICE: The AFIs listed above are available digitally on the AF Departmental Publishing Office internet site at: **http://www.e-publishing.af.mil**.

b. Other Directives and Publications Relevant to the Mishap

c. Known or Suspected Deviations from Directives or Publications

There is no evidence that deviation from directives or publications contributed to this mishap (Tab AA-3).

13. ADDITIONAL AREAS OF CONCERN

None

7/3/2012

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President, Abbreviated Accident Investigation ...

STATEMENT OF OPINION

MQ-1B, T/N 04-3125
CAMP LEMONNIER, DJIBOUTI
21 FEB 12

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

I find by clear and convincing evidence that the cause of the mishap was the failure of the turbocharger bearing leading to the eventual engine failure and the destruction of the MA. After approximately three hours of flight, the aircraft began a gradual uncommanded descent (Tab DD-5). This is consistent with the turbocharger not producing the additional boost needed to maintain level flight at altitudes greater than 10,000 ft for airspeed commanded. The turbocharger wastegate was attempting to overcome increased friction from the bearing failure. The damaged turbocharger oil seal began leaking oil into the intake manifold closest to #2 engine cylinder; causing poor combustion, decreased engine power and corresponding lowered Exhaust Gas Temperature (EGT). At 0830 GMT, the observed oil level was 90% and had decreased to 79% at 0900 GMT (Tabs DD-4, K-9, V-10.4). By 0931 GMT, the oil had dropped below 60% (Tab AA-3). During the remainder of the flight back to the LRE location, the oil level continued to drop until the engine RPM dropped to zero at 1010 GMT resulting in the loss of altitude and subsequent crash of the MA at 1025 GMT (Tab DD-5).

2. DISCUSSION OF OPINION

During launch and ascent to enroute, the turbo charger wastegate was working above expected levels based on altitude and requested power settings (Tab U-4). These events are consistent with the turbocharger bearing failure (Tab U-4). The turbocharger produces increased air pressure in the combustion chamber above 10,000 ft and provides additional thrust (Tab U-4). As the aircraft crossed 10,000 ft, the wastegate erratically increased turbocharger output even after reaching cruising altitude until it reached 100% (Tab U-4). The mission cruising altitude for this mission was 18,000 MSL (Tabs DD-4, V-10.1). After approximately three hours of flight, the aircraft began a gradual uncommanded descent (Tab DD-5). This is consistent with the turbocharger not producing the additional boost needed to maintain level flight at altitudes greater than 10,000 ft for airspeed commanded.

The altitude deviation was not noticed immediately but that was of no consequence to the ultimate outcome. Even if the altitude deviation was noted within the first 10 min. of its deviation and Return to Base was immediately initiated, the MA could not have reached the point power-off glide point to reach the LRE (Tab AA-4).

The turbocharger wastegate was attempting to overcome increased friction from the bearing failure. The damaged turbocharger oil seal began leaking oil into the intake manifold closest to #2 engine cylinder; causing poor combustion, decreased engine power and corresponding lowered Exhaust Gas Temperature (EGT) (Tab DD-4). Turbo charger bearing failure is consistent with all available evidence and is the cause of the engine oil loss. The MA was enroute to the LRE location when the engine failed (Tab V-10.1 – 10.2). Upon determining the MA would not reach the LRE location, the MP and MSO commanded the MA was into an increased rate of descent to insure destruction upon impact with the water (Tab DD-6). At 1025 GMT, the MA and one AGM-114P Hellfire missile were destroyed upon impact and no significant parts were recovered (Tab S-2). The estimated government loss is valued at $4.4M (Tab P-2). There were no reported deaths, injuries, or other damages to government or private property.

I arrived at my opinion by examining the MA data log information compiled at the GCS, GA ASI Engineering report, and witness testimony. All evidence points to failure of the turbocharger bearing and failure of the turbocharger oil seal. This failure caused higher turbocharger oil temperature, a drop in oil pressure, oil loss, and decreased MAP. The leaking oil into the manifold reduced engine performance and EGTs. During the remainder of the flight, the oil level decreased, leadin to the loss of engine lubrication and cooling, and eventually engine failure leading to the crash of the MA into the ocean 15 minutes later.

7/3/2012

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Lt Col, USAF

President, Abbreviated Accident Investigation ...

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.