UNITED STATES AIR FORCE ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-9A, T/N 10-4098

27TH SPECIAL OPERATIONS WING
CANNON AIR FORCE BASE, NEW MEXICO

LOCATION: UNDISCLOSED LOCATION
DATE OF ACCIDENT: 3 SEPTEMBER 2018
BOARD PRESIDENT: LIEUTENANT COLONEL RYAN S. KENNEDY

Conducted In Accordance with Chapter 12 of Air Force Instruction 51-307, *Aerospace and Ground Accident Investigations*

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION

MQ-9A, T/N 10-4098
UNDISCLOSED LOCATION
3 September 2018

On 3 September 2018, at 0449 Zulu (Z) time, an MQ-9A, Tail Number (T/N) 10-4098, departed the runway at an undisclosed location and crashed on landing. The Mishap Aircraft (MA) was assigned to the 27th Special Operations Wing (SOW) at Cannon Air Force Base (AFB), New Mexico, and was flown by a Launch and Recovery Element (LRE) crew deployed to the undisclosed location from the 489th Attack Squadron (ATKS), 432nd Operations Group, 432nd Wing, Creech Air Force Base, Nevada. The Mishap Crew (MC) received an "Engine – metal detected" red warning 10 minutes after takeoff, turned back towards the field and established an orbit to begin fuel dumping. Nine minutes later the engine oil pressure exceeded the limit of 126 pounds per square inch (psi) and the MC received a red warning. Per Aeronautical Systems Incorporated ASI-11114, *Flight Manual*, the MC elected to make an immediate straight-in landing using engine out procedures due to the possibility of catastrophic engine failure. Upon touchdown the propeller failed to go into reverse and the MA departed the prepared surface; according to Aeronautical Systems Incorporated ASI-11114, *Flight Manual,* the MQ-9A relies primarily on reverse thrust to slow and stop the aircraft upon landing. After departing the runway, the MA caught fire and was destroyed with all modifications and four missiles. The resulting loss was valued at $12,726,187. There were no fatalities or damage to private property.

The Abbreviated Accident Investigation Board President found, by the preponderance of the evidence, the cause of the mishap to be the design of the engine. Further, the Board President found, by the preponderance of the evidence, the delay between engine Spectrometer Oil Analysis Program (SOAP) samples being taken and analyzed, as well as the design of the MQ-9A brake system, to be substantially contributing factors.

SUMMARY OF FACTS AND STATEMENT OF OPINION
MQ-9A, T/N 10-4098
3 September 2018

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

AAIB	Abbreviated Aircraft Investigation Board	LRQT	Launch and Recovery Qualification
AF	Air Force	Lt Col	Lieutenant Colonel
AFB	Air Force Base	MA	Mishap Aircraft
AFE	Aircrew Flight Equipment	MAJCOM	Major Command
AFI	Air Force Instruction	MC	Mishap Crew
AFSOC	Air Force Special Operations Command	MCE	Mission Control Element
AFTO	Air Force Technical Order	MGCS	Mishap Ground Control Station
AGL	Above Ground Level	MIL-STD	Military Standard
AGM	Air-to-Ground	MM	Maintenance Member
ATC	Air Traffic Control	MP	Mishap Pilot
ATKS	Attack Squadron	MSL	Mean Sea Level
CAMS	Control and Monitoring System	MSgt	Master Sergeant
CDCS	Containerized Dual Control Segment	MSO	Mishap Sensor Operator
C/W	Comply with	MTS	Multi-Spectral Targeting System
DDBA	Direct Drive Brushless Alternator	Mx	Maintenance
DEEC	Digital Electronic Engine Controller	nm	Nautical Miles
DVR	Digital Video Recorder	Ops	Operations
EATKS	Expeditionary Attack Squadron	Ops Sup	Operations Superintendent
EGT	Exhaust Gas Temperature	ORM	Operational Risk Management
EOD	Explosive Ordinance Disposal	psi	Pounds Per Square Inch
FCIF	Flight Crew Information File	RPA	Remotely Piloted Aircraft
g	Force of Gravity	SAR	Search and Rescue
GCS	Ground Control Station	SEO	Single Engine Operations
GDT	Ground Data Terminal	SFO	Simulated Flameout (Forced Landing)
HDD	Heads Down Display	SO	Sensor Operator
HUD	Heads Up Display	SOW	Special Operations Wing
Hz	Hertz	SrA	Senior Airman
IFE	In Flight Emergency	SSgt	Staff Sergeant
ILS	Instrument Landing System	TCI	Time Change Item
IMDS	Integrated Maintenance Data System	TCTO	Time Compliance Technical Order
KIAS	Knots Indicated Air Speed	T/N	Tail Number
Kts	Knots	T.O.	Technical Order
LOS	Line-Of-Sight	TX	Transmit
L/R	Launch and Recovery	U.S.C.	United States Code
LRE	Launch and Recovery Element	Z	Zulu

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 10 June 2019, Major General Vincent K. Becklund, Deputy Commander, Air Force Special Operations Command (AFSOC), appointed Lieutenant Colonel Ryan S. Kennedy to conduct an Abbreviated Aircraft Accident Investigation Board (AAIB) of a mishap that occurred on 3 September 2018 involving an MQ-9A aircraft at an undisclosed overseas location. The AAIB was conducted in accordance with Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations*, Chapter 12, at Hurlburt Field, Florida, from 10 June 2019 to 9 September 2019. Board members included a Lieutenant Colonel Legal Advisor, a Lieutenant Colonel Pilot Member, a Master Sergeant Maintenance Member, and a Staff Sergeant Recorder. (Tab T-1).

b. Purpose

In accordance with AFI 51-307, *Aerospace and Ground Accident Investigations*, this abbreviated accident investigation board conducted a legal investigation to inquire into all the facts and circumstances surrounding this Air Force aerospace accident, prepare a publicly releasable report, and obtain and preserve all available evidence for use in litigation, claims, disciplinary action, and adverse administrative action.

2. ACCIDENT SUMMARY

On 3 September 2018, at 0449 Zulu (Z) time, an MQ-9A, Tail Number (T/N) 10-4098, departed the runway at an undisclosed location and crashed on landing. The Mishap Aircraft (MA) was assigned to the 27th Special Operations Wing at Cannon Air Force Base (AFB), New Mexico, and was flown by a Launch and Recovery Element (LRE) crew deployed to the undisclosed location from the 489th Attack Squadron, 432nd Operations Group, 432nd Wing, Creech Air Force Base, Nevada. The Mishap Crew (MC), consisting of a Mishap Pilot (MP) and Mishap Sensor Operator (MSO), received an "Engine – metal detected" red warning 10 minutes after takeoff, turned back towards the field and established an orbit to begin fuel dumping. Nine minutes later the engine oil pressure exceeded the limit of 126 pounds per square inch (psi) and the MC received a red warning. Per Aeronautical Systems Incorporated ASI-11114, *Flight Manual*, the MC elected to make an immediate straight-in landing using engine out procedures. Upon touchdown the propeller failed to go into reverse and the MA departed the prepared surface and caught fire, destroying the MA, modifications, and four missiles. The resulting loss was valued at $12,726,187. There were no fatalities or damage to private property. (Tabs D-1, J-1, R1 to R2).

3. BACKGROUND

a. Air Force Special Operations Command (AFSOC)

AFSOC's primary mission is to organize, train and equip Airmen to execute global special operations as America's Air Commandos. AFSOC is one of ten Air Force major commands (MAJCOM) and is the Air Force component of United States Special Operations Command. AFSOC has more than 20,800 active duty, Air Force Reserve, Air National Guard, and civilian personnel operating in several subordinate units. (Tab V-2). The core missions of AFSOC are agile combat support, precision strike, information operations, specialized air mobility, command and control, special tactics, aviation foreign internal defense, and intelligence, surveillance and reconnaissance. (Tab V-2)

b. 27th Special Operations Wing (27 SOW)

The 27 SOW, located at Cannon AFB, NM, conducts infiltration/exfiltration, combat support, tilt-rotor operations, helicopter aerial refueling, close air support, unmanned aerial vehicle operations, and other special missions. (Tab V-7). It directs the deployment, employment, training, and planning for squadrons that operate the AC-130W, MC-130J, CV-22B, U-28A, MQ-9 and provides operational support to flying operations. (Tab V-7)

c. 489th Attack Squadron (489 ATKS)

The 489 ATKS conducts MQ-9 launch and recovery training deployed aircrews into areas of responsibility to execute takeoff, departure, arrival, and landing of air tasking order missions; delivers immediate persistent attack and reconnaissance combat operations in response to emerging base threats. (Tab V-13) The 489 ATKS is assigned to the 432nd Operations Group, 432nd Wing, Creech AFB, NV. (Tab V-12)

d. MQ-9A Reaper

The MQ-9A Reaper is an armed, medium-altitude, long endurance aircraft that is employed primarily to strike dynamic execution targets and secondarily for intelligence collection. (Tab V-15). The MQ-9A provides unique capabilities for strike coordination and reconnaissance against high value, fleeting and time sensitive targets because of its significant loiter time, wide-range sensors, multi-mode communications suite and precision weapons. (Tab V-15). In addition to its primary uses, the MQ-9A also performs close air support, combat search and rescue, target development and terminal air guidance, among others, making it uniquely qualified for irregular warfare operations. (Tab V-15).

Utilizing satellite communication links, this remotely piloted aircraft (RPA) can acquire and pass real-time imagery data to ground users around the clock, and beyond- line-of-sight. The MQ-9A

can employ up to four Air-to-Ground (AGM)-114 Hellfire missiles, which provide highly accurate, low-collateral damage, anti-armor and anti-personnel engagement capabilities. (Tab V-15).

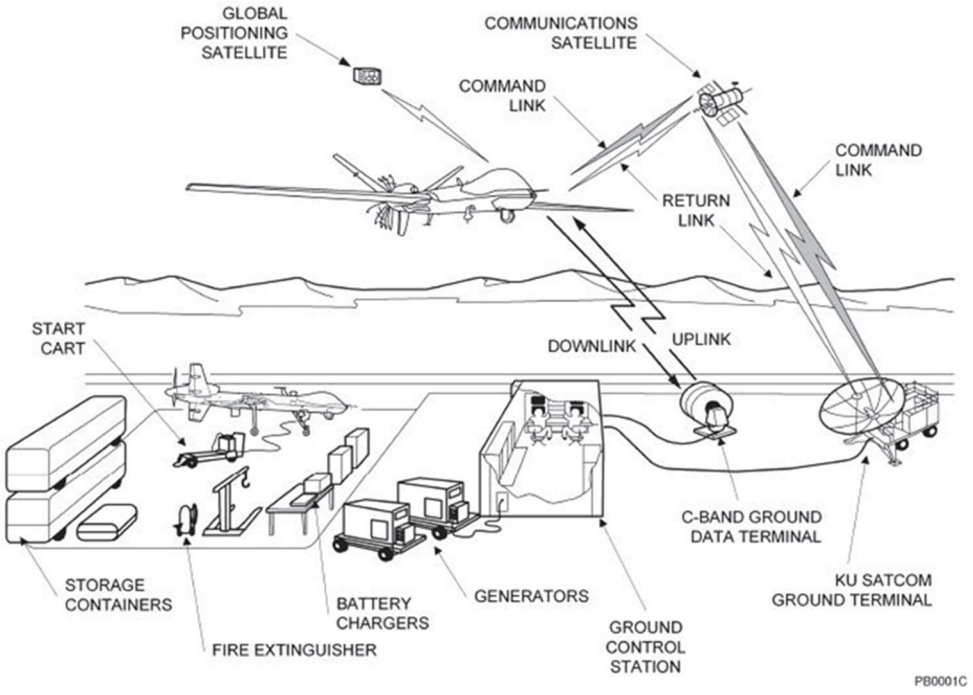

Diagram displaying typical system components of MQ-9A Reaper

The Remote Split Operations construct allows launch and recovery element (LRE) crews to launch and recover the aircraft from a forward deployed location while the mission control element (MCE) crew can conduct the mission at another more conducive location, often stateside, through SATCOM links. (Tab V-15).

There are two distinct satellite datalinks between the aircraft and the ground control station (GCS). The uplink (UL) sends control inputs from the GCS to the aircraft, while the downlink (DL) sends the video and telemetry data from the aircraft to the GCS. Losing DL is a serious situation because an aircrew is unable to monitor the aircraft position. The aircraft may violate airspace restrictions, fly into threat areas, or fly into hazardous weather. (Tab V-15).

4. SEQUENCE OF EVENTS

a. Mission

The aircraft was departing for an operational mission at an undisclosed location (Tab D-4).

b. Planning

Mission planning was conducted without incident. (Tabs K-2 to K-3).

c. Preflight

Mishap Aircraft (MA) and Mishap Ground Control Station (MGCS) preflights were conducted without incident. (Tab R-3).

d. Summary of Accident

On 3 September 2018, the Mishap Crew (MC) relinquished control of the MA to the Mission Command Element (MCE) without incident while climbing from approximately 8,000 feet Mean Sea Level (MSL) to 15,000 feet MSL in departure airspace. (Tab R, R-3)

The MC heard an audible tone and noticed an "Engine – metal detected" red warning displayed on the Heads Down Display (HDD). (Tab R, R-3) The MC regained control of the aircraft from the MCE and leveled off at 10,000 feet MSL to troubleshoot the warning. (Tab R, R-3)

The Mishap Pilot (MP) coordinated with air traffic control (ATC) to hold in departure airspace at 10,000 feet MSL and turned towards the airfield. (Tab R, R-4) The MP asked the Mishap Sensor Operator (MSO) to look up the HDD warning in the emergency procedures checklist while he analyzed the situation. (Tab R, R-4) The MP noted all engine instruments were indicating normal operations and the aircraft was maintaining altitude. (Tab R, R-4) After reviewing the warning in the emergency procedures checklist, the MSO informed the MP that the corrective action was to "Land as soon as possible." (Tab R, R-4) The MC initiated the Fuel Dump checklist and started dumping fuel in order to reduce gross weight to the maximum landing weight (10,500 lbs). (Tab R, R-4)

While the MC was dumping fuel, the MP noticed the engine oil pressure began to steadily increase and elected to cease dumping fuel at approximately 11,300 lbs total gross weight. (Tab R, R-4) The MC executed the High Oil Pressure emergency checklist and the MP declared an emergency with ATC and requested a straight-in approach to Runway 26. (Tab R, R-4)

After relaying required emergency information to include the armament of the MA (four AGM-114 missiles), the MP switched to Tower frequency for landing coordination. (Tab R, R-4) During final approach, the MP made two S-turns, followed by a left slip to lose altitude. (Tabs R, R-4)

After the MA landed Runway 26, the MP elected to apply reverse thrust with the throttles. As the MP noticed the MA engines were not going into reverse thrust, he then applied full brakes around 100 KIAS. (Tab R, R-5)

e. Impact

The MA departed the departure end overrun with both left and right brakes commanded and full reverse thrust commanded, traveling at approximately 60 knots ground speed. (Tab R, R-4, R-5) The downlink from the MA was severed and the MC did not receive additional feedback from the MA in the MGCS. (Tab R, R-5)

f. Egress and Aircrew Flight Equipment (AFE)

Not applicable.

g. Search and Rescue (SAR)

Not applicable.

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Review

Review of Air Force Technical Order (AFTO) 781 series forms, which document maintenance actions and inspections, revealed the Mishap Aircraft (MA) maintenance complied with applicable guidance and regulations. The use of Time Compliance Technical Orders (TCTOs) is the process for aircraft system changes, such as part and software upgrades. The Integrated Maintenance Digital System (IMDS), which tracks TCTO implementation, showed MA as current on all TCTOs as of the date of the mishap. (Tab D-2.19 – 2.38).

No deficiencies were found in the MA or Mission Ground Control Station (MGCS) forms documentation. (Hardcopy records).

b. Inspections

All scheduled inspections for the MA were current and satisfactorily completed at the time of the mishap. The MA had 8691.7 flight hours, 9117.3 engine hours, and 6582.5 propeller hours since installation at the time of the mishap. The last scheduled inspections completed on the MA were the 200 & 400 Hour Engine Inspection, 200 & 400 Hour Airframe Inspection, 200 Hour Fuel Filter Replacement, 800 Hour Engine Oil Replacement, 3,000 Hour Propeller Time Change Item (TCI), and the pre-flight inspection. All inspections were completed on 2 September 2018. (Tab D-2.19 – 2.36).

All scheduled inspections for the MGCS were current and satisfactorily completed at the time of the mishap. The last scheduled inspections completed on the MGCS were the seven Day Ground Control Station (GCS) inspection completed on 1 September 2018 and a pre-flight completed on 31 August 2018. There were multiple thru-flights completed between 1 September and 3 September 2018, day of the mishap. (Hardcopy records).

c. Maintenance Procedures

Maintenance Procedures and practices for the MA and MGCS were in accordance with applicable technical orders. (Tab D-2 and Hardcopy records)

d. Maintenance Personnel and Supervision

Maintenance personnel had appropriate training, qualification, and supervision. (Hardcopy records)

e. Fuel, Hydraulic, Oil, and Oxygen Inspection Analyses

Fuel sample dated 3 September 2018 and tested on 10 September 2018 revealed no evidence of contaminants. No hydraulic samples were analyzed as a result of this mishap. The last oil sample dated 2 September 2018 was taken then sent to Honeywell Aerospace, following a 400 Hour Engine Inspection and Engine run. Honeywell tested sample on 14 September 2018 and results revealed oil sample contained carbon and steel platelets. (Tab J1.1-6) No oxygen systems are installed on either the MA and/or MGCS. (Hardcopy records)

f. Unscheduled Maintenance

There were no unscheduled maintenance issues on the MA or the MGCS relevant to the mishap.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

MA condition was nominal (Tabs D-5 to D-6).

b. Evaluation and Analysis from General Atomics

Analysis of data logged in the MGCS indicated the MGCS was operating as designed throughout the mishap sequence. (Hardcopy Records).

7. WEATHER

a. Forecast Weather

Weather forecast was briefed to the aircrew by weather personnel as follows: (Tab F-1)

a. Winds: 320 at 12 knots gusting 18 knots
b. Visibility: Clear
c. Significant Weather: None

b. Observed Weather

Weather observed at the initiation of the mishap sequence: (Tab F-2)

a. Winds: 310 at 16 knots gusting 17 knots
b. Visibility: Clear
c. Significant Weather: None
d. Outside Air Temperature: 25 Celsius

c. Space Environment

Not applicable.

d. Operations

Not applicable.

8. CREW QUALIFICATIONS

Each crewmember was current and qualified to accomplish the mission. (Tab G-2)

a. Mishap Pilot (MP)

The MP accomplished his initial instrument/mission qualification on 15 February 2018. The MP accomplished his most recent instrument/mission qualification evaluation on 22 May 2018 as an out-of-cycle evaluation to remove a Launch and Recovery (L/R) restriction. (Tab G-2)

	Hours	Sorties
30 days	18.1	58
60 days	35.1	107
90 days	58.6	155
RPA	75.6	165
Total	1557.0	

b. Mishap Sensor Operator (MSO)

The MSO accomplished his initial instrument/mission qualification evaluation on 12 May 2017. The MSO passed his special mission qualification on 14 November 2017. (Tab G-7)

	Hours	Sorties
30 days	19.0	62
60 days	38.2	117
90 days	50.4	142
RPA	2,239.0	297
Total	2,239.0	

9. MEDICAL

a. Qualifications

There is no evidence to suggest physical or medical qualifications of the aircrew or maintenance personnel were factors in this mishap.

b. Health

There is no evidence to suggest the health of the aircrew or maintenance personnel was a factor in this mishap.

c. Pathology

Not applicable.

d. Lifestyle

There is no evidence to suggest patterns or behaviors for the aircrew or maintenance personnel were factors in the mishap.

e. Crew Rest and Crew Duty Time

There is no evidence to suggest crew rest or duty time of the aircrew or maintenance personnel were factors in the mishap.

10. OPERATIONS AND SUPERVISION

There is no evidence to suggest operations and supervision were a factor in this mishap.

11. HUMAN FACTORS ANALYSIS

Human factors were considered but ultimately determined to not be a factor in this mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

(1) AFI 11-2MQ-9, Volume 2, *MQ-9 Crew Evaluation Criteria*, 15 April 2008

(2) AFI 11-2MQ-1&9 Volume 1, *MQ-1&9 Aircrew Training*, 23 April 2015

(3) AFI 11-2MQ-1&9 Volume 3, *MQ-1 and MQ-9 Operations Procedures*, 1 November 2012, Certified Current on 28 August 2015

(4) AFI 11-202, Volume 3, *General Flight Rules*, 10 August 2016

(5) AFI 11-202, Volume 3, *General Flight Rules, AFSOC Supplement*, 28 July 2017

(6) AFI 51-307, *Aerospace and Ground Accident Investigations*, 18 March 2019

(7) AFI 91-204, *Safety Investigations and Reports*, 27 April 2018

NOTICE: All directives and publications listed above are available digitally on the Air Force Departmental Publishing Office website at: http://www.e-publishing.af.mil.

b. Other Directives and Publications Relevant to the Mishap

(1) AFSOC Flight Crew Information File 15-171

(2) AFLCMC/WIIQL (Detachment 3) Depot Flash 19-006

(3) AFSOC ASI-11114, *Flight Manual*, 15 September 2017

(4) Department of Defense Human Factors Analysis Classification System, Version 7.0

(5) General Atomics Engineering Memorandum FT-15-0186, *Reaper ER Engine-Out Landing Distance Analysis for AFSOC MQ-9 Software Line*, 3 August 2015

(6) TO 1Q-9(M)A-1-1, *Flight Manual Appendix A Performance Data*, 12 November 2018

c. Known or Suspected Deviations from Directives or Publications

None.

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9 September 2019

RYAN S. KENNEDY, Lt Col, USAF
President, Abbreviated Accident Investigation Board

STATEMENT OF OPINION

MQ-9A, T/N 10-4098
UNDISCLOSED
LOCATION 3 September
2018

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

1. OPINION SUMMARY

I find, by the preponderance of the evidence, the cause of the mishap to be the design of the engine installed in the MQ-9A aircraft due to the known possibility of compressor bearing failure at higher altitudes and low power settings. I find the delay between engine Spectrometer Oil Analysis Program (SOAP) samples being taken and analyzed to be a substantially contributing factor. I also find the design of the MQ-9A brake system to be a substantially contributing factor. I was significantly hindered in my investigation by both Headquarters Air Force Life Cycle Management Center, Detachment 3 (AFLCMC/Det 3) and General Atomics-Aeronautical Systems, Incorporated (GA-ASI) Mishap Investigation division's inability to provide substantive assistance to the Abbreviated Accident Investigation Board due to their previous contact with the Safety Investigation Board and subsequent access to Safety Privilege information. The lack of forethought and absence of a plan to assist both Investigation Boards by holding at least one individual separate from Safety Privilege was a major oversight of both aforementioned parties. Additionally, the large amount of time between the mishap and the release of the GA-ASI Contractor Report regarding the mishap and the lack of mandated timeline by AFLCMC/Det 3 for release of the report caused unneeded delays in the investigation.

2. CAUSE

a. Engine Design

The cause of the MQ-9A mishap on 3 September 2019 involving Tail Number (T/N) 10-4098 was the failure of a compressor bearing within the engine, which then contaminated the oil system and by extension the propeller governor, leading to the failure of the propeller to enter the reverse range (GA Contractor Report to USAF Safety Investigation Board, pg. 2). The failure of the bearing was due to low bearing preload, a condition which most often occurs when flying at higher altitudes and using low engine power settings (GA Contractor Report to USAF Safety Investigation Board, pg. 2). These are the conditions most associated with the mission and usage of the MQ-9A in USAF service, leading to my conclusion that the design of the engine is the root cause of this mishap.

b. Maintenance Actions

On 2 September 2018 maintenance personnel performed a 400-flight hour engine inspection and a 3000-flight hour Time Change Item (TCI) propeller change. All maintenance actions and inspections were accomplished in accordance with (IAW) applicable Technical Orders (T.O.) and guidance. A SOAP sample was taken from the engine oil in the course of the checks. A full engine operations check was performed after the 400-flight hour engine maintenance and propeller change with no issues noted. This check includes a brief, partial-power reverse (beta) range check (Tab D-2 and Hardcopy Records). In my opinion, maintenance actions did not cause or contribute to this mishap.

c. Aircrew Procedures

The mishap flight occurred the following day, on 3 September 2018. Preflight, engine start, taxi, and takeoff were all uneventful. Ten minutes after takeoff and approximately one minute after the Launch and Recovery Element (LRE) transferred control of the Mishap Aircraft (MA) to the Mission Control Element, the LRE crew (referred to as Mishap Crew [MC] from this point forward) received an Engine – Metal Detected warning on their Heads Down Display (GA Quick Look, pg 1). The MC immediately regained control of the MA from the Mission Control Element per standard operating procedures and consulted the Flight Manual for the appropriate action, which directed them to land the MA as soon as possible (Tab R, R-4). The MC elected to begin dumping fuel in order to reduce gross weight to a normal landing weight (10,500 pounds) (Tab R, R-4) but received a high oil pressure warning soon after beginning to dump (GA Quick Look, pg 2). In this case the Flight Manual requires an immediate landing and lists a Warning for possible engine failure due to compressor bearing failure (ASI-11114, *Flight Manual*, pg. 3-13). The MC ceased dumping fuel and began an immediate approach for landing while declaring an emergency with appropriate Air Traffic Control agencies (Tab R, R-4). The MP made an approach which met all Flight Manual and checklist guidance; the MA and engine seemed to be operating normally, with the exception of the high oil pressure (Tab R, R-4).

At this point the MA was heavier than normal for landing (Tab R, R-4). Using 0° flaps, the MA crossed the runway threshold at somewhere around 130 Knots Indicated Airspeed (KIAS) instead of the calculated approach speed of 127 KIAS (Tab R, R-4 and R-17). This is a negligible difference of 14 feet per second traveled between the actual airspeed and calculated speed. The MA touched down towards the end of the first third of the 9021 foot long runway (Tab R, R-4 and R-17). The MP selected reverse thrust after touchdown while travelling at 110-115 KIAS (Tab R, R-4 and R-17). The MP verbalized that he was commanding reverse early but wanted to slow the MA. Data indicates that although the command was given the propeller never entered the beta range (GA Contractor Report to USAF Safety Investigation Board, pg. 13). When the MA did not slow the MP commanded full brakes; the MA continued gradually slowing until it departed the prepared surface (Tab R, R-4 and R-17; GA Contractor Report to USAF Safety Investigation Board, pg. 2, 4). The MC lost link and the MA eventually stopped, caught fire, and was destroyed (GA Contractor Report to USAF Safety Investigation Board, pg. 2, 4). In my opinion, the actions taken by the MC did not cause or contribute to this mishap.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

I find, by the preponderance of the evidence, that each of the following factors substantially contributed to the mishap.

a. SOAP Sample Analysis Delay

A SOAP sample was taken on 2 September 2018 but was not able to be analyzed until 14 September 2018 due to transit times from the undisclosed location to the laboratory. The analysis showed evidence of the impending failure of the compressor bearing in the form of metal particles (Tab J1.1-6). Due to the delay, the aircraft was flown and the compressor bearing failed before action could be taken to correct the impending failure.

b. MQ-9A Brake Design

Normally the MQ-9A relies primarily on reverse thrust to slow and stop the aircraft upon landing. The pilot selects reverse thrust at approximately 85 KIAS and then activates brakes at approximately 20 KIAS to slow the aircraft to a full stop (ASI-11114, *Flight Manual,* pg. 2-106).

During engine out landings reverse thrust is not available and therefore only aerodynamic braking (drag) and aircraft brakes can be used to bring the aircraft to a stop. In August 2015, GA-ASI released an Engineering Memorandum that was then distributed to AFSOC crews as Flight Crew Information File (FCIF) 15-171 which detailed the effects of the MQ-9ER modification in regards to engine out landings and brake energy. The analysis showed that it is possible to stop the aircraft with brakes-only within approximately 3500 feet of runway at sea level and remain outside of the brake-energy danger zone, but only when braking is activated below the maximum brake-energy Caution zone (about 90 Knots Ground Speed for heavy weight landings). While this analysis was distributed for informational purposes only and does not consist of fully validated testing data, it does show that in a heavy-weight engine-out landing the brakes are insufficient to fully stop the aircraft if brake activation cannot begin until 40 knots below touchdown speed. In this mishap, GA-ASI's analysis showed that brake-energy required during the attempt to stop was over maximum brake-energy able to be produced by new brakes (GA Contractor Report to USAF Safety Investigation Board, pg. 8-9).

4. CONCLUSION

Engineering analysis of the data logs, engine components, and propeller governor, as well as reports from Honeywell Aerospace, Woodward, Inc., and GA-ASI in this mishap prove, by the preponderance of the evidence, this mishap was caused by the design of the engine installed in the MQ-9A aircraft due to the possibility of failure at higher altitudes and low power settings.

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9 September 2019

RYAN S. KENNEDY, Lt Col, USAF
President, Abbreviated Accident Investigation Board

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