

UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT



HH-60G, T/N 92-6466

46TH EXPEDITIONARY RESCUE SQUADRON
332D AIR EXPEDITIONARY WING
USCENTCOM AOR



LOCATION: USCENTCOM AOR

DATE OF ACCIDENT: 15 March 2018

BOARD PRESIDENT: Brigadier General Bryan P. Radliff

Conducted IAW Air Force Instruction 51-503



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR COMBAT COMMAND
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JUL 18 2018

ACTION OF THE CONVENING AUTHORITY

The Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 15 March 2018 mishap involving an HH-60G, T/N 92-6466, 46th Expeditionary Rescue Squadron, 332d Air Expeditionary Wing, United States Central Command Area of Responsibility, complies with applicable regulatory and statutory guidance; on that basis it is approved.

A handwritten signature in black ink, appearing to read "J. Holmes".

JAMES M. HOLMES
General, USAF
Commander

**EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION**

**HH-60G, T/N 92-6466
USCENTCOM AOR 15 MARCH 2018**

On 15 March 2018, at approximately 1840 Zulu time (Z), 2140 Local time (L), the mishap aircraft (MA), an HH-60G, Tail number (T/N) 92-6466, assigned to the 332nd Air Expeditionary Wing (AEW), and operating within the USCENTCOM AOR, crashed in an uninhabited desert area. Four MA flight crew members and three members of the Guardian Angel team were fatally injured in the mishap. The MA was destroyed upon impact, there were no other injuries or fatalities, and there was no damage to private property.

The mishap formation (MF) consisted of two HH-60G helicopters, with the MA operating as the lead aircraft and the mishap wingman as the trail aircraft. The assigned mission was to pre-position the MF to a helicopter landing zone (HLZ) closer to the vicinity of ground operations. The flight plan for the pre-position mission was a near direct path from the base of departure to the intended HLZ with an air refueling control point between the origin and destination points. A more extensive route of flight was loaded to the navigation system for potential follow on mission taskings, but it was not to be utilized on this mission. The loaded navigation route continued north to points beyond the intended HLZ. Night illumination for the flight was low.

The MF departed the base at approximately 1800Z. The flight up to air refueling was uneventful, but refueling operations concluded later than planned. While conducting normal crew duties, the MF erroneously overflew the intended HLZ and descended to low altitude. As the mishap co-pilot turned left to avoid a tower, a blade on the MA's main rotor assembly struck the second of four 3/8 inch galvanized steel cables horizontally spanning two 341-foot towers. The cable tangled around the main rotor assembly resulting in catastrophic damage, rendering the aircraft un-flyable. The MA impacted the ground at approximately 1840Z. An extensive rescue operation was immediately conducted.

The Accident Investigation Board (AIB) president found by a preponderance of evidence the cause of the mishap was the result of: the mishap pilot misinterpreting aircraft navigation displays, causing the MF to descend into an unplanned location and strike a 3/8 inch diameter galvanized steel cable strung horizontally between two 341 foot high towers. The AIB president also found by a preponderance of evidence that three factors substantially contributed to the mishap: (1) mission planning created a route of flight enabling navigation beyond the intended HLZ; (2) a breakdown in crew resource management within the MC and between the MF failed to sufficiently detect and effectively communicate the navigation error; and (3) low illumination conditions present rendered night vision goggles insufficient to detect the cables.

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

**HH-60G, T/N 92-6466
15 MARCH 2018**

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ACRONYMS AND ABBREVIATIONS

AC	Aircraft Commander	FP	First-Pilot
ACC	Air Combat Command	FQSMSA	Fully Qualified Special Missions Aviator
ACO	Air Space Control Order45	GA	Guardian Angel
AEW	Air Expeditionary Wing	GPSGlobal	Positioning System
AF	Air Force	HAAR	Helicopter Air to Air Refueling
AFB	Air Force Base	HLZ	Helicopter Landing Zone
AFE	Aircrew Flight Equipment	IAW	In Accordance With
AFPET	Air Force Petroleum Office Laboratory	ICRM	Infrared Countermeasures
AFI	Air Force Instruction	ID	Identification
AFIP	Air Force Institute of Pathology	IMDS	Integrated Maintenance Data System
AFTERS	AF Tactical Ruggedized Receiver System	Intel	Intelligence
AFTO	Air Force Technical Order	IP	Instructor Pilot
AFTP	Additional Flight Training Period	IVHMS	Integrated Vehicle Health Monitoring System
AFTRS	Air Force Tactical Radio System	JOG	Joint Operations Graphic
AFTTP	Air Force Tactics, Techniques & Procedures	JPRC	Joint Personnel Recovery Center
AGL	Above Ground Level	JTAC	Joint Terminal Attack Controller
AIB	Accident Investigation Board	KIAS	Knots Indicated Air Speed
AOR	Area of Responsibility	L	Local
AR	Air Refueling	LOS	Line of Sight
ARCP	Air Refueling Control Point	Lt Col	Lieutenant Colonel
ARCT	Air Refuel Control Time	LZ	Landing Zone
ARM	Aviation Resource Management	MA	Mishap Aircraft
AT	Annual Tour	MAG	Mishap Aerial Gunner
AWE	Aircraft Weapons and Electronics	Maj	Major
BFT	Blue Force Tracker	MAJCOM	Major Command
Capt	Captain	MC	Mishap Crew
CDU	Control Display Unit	MCP	Mishap Co-Pilot
CHU	Housing Unit	MCRO	Mishap Combat Rescue Officer
CHUM	Chart Hazard Updating Manual	MEDEVAC	Medical Evacuation
CMR	Combat Mission Ready	MF	Mishap Formation
Col	Colonel	MFE	Mishap Flight Engineer
CMDS	Countermeasures Dispensing System	mIRC	Internet Relay Chat
CRM	Cockpit/Crew Resource Management	MP	Mishap Pilot
CRO	Combat Rescue Officer	MPJ	Mishap Pararescueman
CSAR	Combat Search and Rescue	MSL	Mean Sea Level
CSARSAT	CSAR Satellite Communications	MW	Mishap Wingmen
DME	Distance Measuring Equipment	MWA	Mishap Wing Aircraft
DO	Director of Operations	MWAG	Mishap Wingman Aerial Gunner
DoD	Department of Defense	MWC	Mishap Wingmen Crew
DTS	Data Transfer System	MWCP	Mishap Wingmen Co-Pilot
EGI MOD	Enhance GPS System Modification	MWFE	Mishap Wingman Flight Engineer
ELMO	Electronically Linked Mission Overlay	MWP	Mishap Wingmen Pilot
ERQS	Expeditionary Rescue Squadron	MWPJ	Mishap Wingman Pararescueman
FL	Flight Lead	NM	Nautical Miles
FOB	Forward Operating Base	NOTAMs	Notices to Airmen
H3	HIT, Hover, Hoist	NVGs	Night Vision Goggles
FARP	Air Refueling Point	Ops Tempo	Operations Tempo
FLIR	Forward Looking Infrared	ORM	Operational Risk Management
FOB	Forward Operating Base	PFPS	Portable Flight Planning Software
IFF	Identification, Friend or Foe	PHA	Physical Health Assessment
ft	Feet	PJ	Pararescueman
		PR	Personnel Recovery

Prepo	Preposition	T/N	Tail Number
PSI	Pounds Per Square Inch	TO	Technical Order
QA	Quality Assurance	UAV	Unmanned Aerial Vehicle
QRF	Quick Reaction Force	UCM	Unit Crew Member
ROC	Rescue Operations Center	UHF	Ultra-High Frequency
RQS	Rescue Squadron	UCM	Unit Crew Member
SA	Situational Awareness	VTC	Video Tele-Conference
SAR	Search and Rescue	VTR	Video Tape Recorder
SMA	Special Missions Aviator	VVOD	Vector Vertical Obstruction Date
SMFCD	Smart Multi-function Color Display	WIT	Witness
SVTC	Secure Video Teleconference	WSPS	Wire Strike Protection System
TACAN	Tactical Air Navigation System	XO	Executive Officer
TCTO	Time Compliance Technical Order	XSAR	Airborne Search and Rescue Alert
TDY	Temporary Duty Location	Z	Zulu
TFR	Temporary Flight Restriction		

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 17 March 2018, General James M. Holmes, Commander, Air Combat Command (ACC), appointed Brigadier General Bryan P. Radliff to conduct an aircraft accident investigation of a mishap that occurred on 15 March 2018, involving an HH-60G helicopter, tail number (T/N) 92-6466, within the United States Central Command area of responsibility (USCENTCOM AOR) (Tab Y-3 to Y-4). The aircraft accident investigation was convened at Shaw Air Force Base (AFB), South Carolina (SC), from 27 April 2018 to 24 May 2018. Also appointed were a Legal Advisor (Lt Col), a pilot member (Capt), a maintenance member (MSgt), a medical member (Maj), and a recorder (TSgt) (Tab Y-3 to Y-4). A special mission aviator (MSgt) was appointed as a subject matter expert (Tab Y-6).

b. Purpose

In accordance with Air Force Instruction (AFI) 51-503, *Aerospace and Ground Accident Investigations*, this accident investigation board conducted a legal investigation to inquire into all the facts and circumstances surrounding this Air Force 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 15 March 2018, at approximately 1840 Zulu time (Z), 2140 Local time (L), the mishap aircraft (MA), an HH-60G, T/N 92-6466, assigned to the 332d Air Expeditionary Wing (AEW), and operating within the USCENTCOM AOR, struck a galvanized steel cable and subsequently impacted an uninhabited desert area (Tabs Q-5 to Q-6, V-3.17, Y-4, Z-3, EE-3, EE-13 and FF-14). Four MA flight crewmembers and three members of the Guardian Angel (GA) team were fatally injured in the mishap (Tabs Q-5 to Q-7 and X-3 to X-4). The MA was destroyed upon impact, there were no other injuries or fatalities, and there was no damage to private property (Tabs EE-3 to E-5, P-2 to P-3, Q-5 to Q-7 and X-3 to X-4).

3. BACKGROUND

a. Air Combat Command (ACC)

ACC is the primary provider of air combat forces to America's warfighting commanders (Tab CC-3). To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management and electronic-combat aircraft (Tab CC-3). It also provides command, control, communications and intelligence systems, and conducts global information operations (Tab CC-3).



b. United States Air Forces Central Command (USAFCENT)

USAFCENT is the air component of USCENTCOM, a regional unified command (Tab CC-6). USAFCENT, in concert with our coalition, joint, and interagency partners, delivers decisive air, space, and cyberspace capabilities for USCENTCOM, ally nations, and America (Tab CC-6).



c. 332d Air Expeditionary Wing (332 AEW)

332 AEW's mission is to generate, execute and sustain combat air and space power across the Levant (Tab CC-8). The wing is comprised of the 332d Expeditionary Operations Group, 332d Expeditionary Maintenance Group, 332d Expeditionary Mission Support Group, 332d Expeditionary Medical Group, 407th Air Expeditionary Group, 447th Air Expeditionary Group, and 1st Expeditionary Rescue Group (Tab CC-8).



d. 1st Expeditionary Rescue Group (1 ERQG)

1 ERQG – Operating Location Alpha is a small unit of Airmen trained to provide rapidly deployable, expeditionary, and agile combat search and rescue (CSAR) forces to theater commanders in response to contingency operations worldwide (Tab CC-10 to CC-11). The effect of their presence is difficult to display in numbers and charts – but to coalition forces in harm's way, there is no doubt as to their impact (Tab CC-10 to CC-11).



e. 801st Expeditionary Maintenance Squadron (801 EMXS)

Maintenance professionals of the 801 EMXS must keep aircraft prepared to fly CSAR forces to theater commanders in response to contingency operations worldwide (Tab CC-10 to CC-11).



f. 46th Expeditionary Rescue Squadron (46 ERQS)

In tandem with Airmen from the 52d Expeditionary Rescue Squadron, the 46 ERQS's mission is to provide rapidly deployable, expeditionary, and agile CSAR forces to theater commanders in response to contingency operations worldwide (Tab CC-10 to CC-11). Rescue teams are typically comprised of two pilots operating the aircraft; two special mission aviators responsible for various inspections, in-flight tasks and on-board weapons employment; and a team of pararescue professionals trained in all aspects of personnel recovery and medical treatment in combat environments (Tab CC-10).



g. Pararescuemen (PJs)

PJs rescue, recover, and return American or Allied forces in danger conditions or times of extreme duress (Tab CC-10 and CC-12). Whether shot down or isolated behind enemy lines; surrounded, engaged, wounded, or captured by the enemy; PJs will do whatever is required to deny the enemy a victory and bring our warriors home to fight another day (Tab CC-10 and Tab CC-12). "Leave no Airman, Marine, Soldier, or Sailor behind" is our nation's supreme promise and responsibility to our brave war fighters (Tab CC-12). The Air Force holds true to this moral imperative (Tab CC-10 and CC-12). Personnel Recovery is an Air Force Core Function; one of twelve functions the Air Force provides the nation (Tab Tab CC-10 and CC-12). The PJs are the elite ground forces that provide our nation with the capability to execute this noble responsibility (Tab CC-10 and CC-12).



h. HH-60G Pave Hawk

The HH-60G Pave Hawk helicopter conducts day or night personnel recovery operations into hostile environments to recover isolated personnel during war (Tab CC-14). The HH-60G is also tasked to perform military operations other than war, including civil search and rescue, medical evacuation, disaster response, humanitarian assistance, security cooperation/aviation advisory, NASA space flight support, and rescue command and control (Tab CC-14). The Pave Hawk is a highly modified version of the Army Black Hawk helicopter that features an upgraded communications and navigation suite that includes integrated inertial navigation/global positioning/Doppler



navigation systems, satellite communications, secure voice, and Have Quick communications (Tab CC-14).

4. SEQUENCE OF EVENTS

a. Mission

The MA was the lead helicopter in a formation of two HH-60Gs during a combat pre-position mission departing from its base at night on 15 March 2018 (Tab V-5.2 and Tab V-6.3). The MA was followed by the mishap wingman (MW) aircraft for the duration of the flight (Tab V-5.7 and V-6.3). The MA and MW comprised the mishap formation (MF) (Tab V-6.3). The MA contained a seven member mishap crew (MC): the mishap pilot (MP); the mishap co-pilot (MCP); the right special mission aviator (SMA), known as the mishap flight engineer (MFE); the left SMA, known as the mishap aerial gunner (MAG); and three pararescue (PJ) team members, comprised of the mishap Combat Rescue Officer (MCRO), mishap PJ 1 (MPJ1) and mishap PJ 2 (MPJ2) (Tab K-3 and K-5). The MW aircraft contained two pilots, two SMAs, and two PJs, collectively known as the mishap wingman crew (MWC) (Tab V-7.4 and V-3.2 to V-3.3).

The purpose of the mission was to pre-position the MF to a helicopter landing zone (HLZ) closer to the location of an upcoming operation in order to expedite the recovery of any potential personnel or assets in need of rescue (Tabs V-5.2 and V-6.4). The mission involved a nighttime departure from the base, en route helicopter air-to-air refueling (HAAR) with an HC-130, and a descent to low-level (less than 500 feet above ground level (AGL)) prior to landing at the HLZ (Tab V-1.5, V-5.4, and V-6.4). Once at the HLZ, the MF would remain on ground alert during the upcoming operation, and then return to the base once the operation was completed (Tab V-5.2 to V-5.4, V-6.4, and V-3.12).

b. Planning and Crew Mission Briefing

Planning for the mission started at approximately 0930Z on the morning of 15 March 2018 based upon notification from the Joint Personnel Recovery Center (JPRC) (Tab V-10.3). Due to crew rest considerations, preliminary planning was conducted by Blue flight members of the 46th Expeditionary Rescue Squadron (ERQS) prior to the MC and MWC starting their duty day (Tab V-3.3 and V-10.11 to V-10.12). Once the MC and MWC started their normal duty day, they took over primary responsibility of the mission planning process (Tab V-3.3 to V-3.4 and V-10.11 to V-10.2).

HAAR was coordinated with the supporting HC-130 unit and continuous coordination with the JPRC was conducted throughout the planning process as updates became available (Tab V-2.3 to V-2.5, and V-4.3).

The planned timeline for the MF was an 1800Z take-off, en route HAAR at 1817Z, and landing at the HLZ immediately thereafter (Tab V-1.5, V-3.5, and V-3.17). Upon departure from the base, the MF planned to climb above low-level in order to conduct HAAR, then descend to low-level for the ingress and final approach to the HLZ (Tab V-5.4 to V-5.5 and V-6.4).

The navigation route (Figure 1) that the mishap crew planned for the mission contained seven navigational waypoints (Tabs V-3.3 to V-3.7, V-9.4 to V-9.5, and Z-4). This route provided navigation to the HLZ for the pre-position and then continued beyond the HLZ to a location that the MF would use for holding airborne alert if needed (Tabs V-5.2 to V-5.4, V-9.4 to V-9.5, and Z-4). Only the first three waypoints (waypoints 1, 32, and 25) were planned to be used for the pre-position mission to the HLZ (Figure 1) (Tabs V-5.2 to V-5.4, and Z-4). The remaining waypoints (waypoint 33 and on) were to be flown at higher altitudes and used for holding airborne alert in the event the MF had to launch from the HLZ for a rescue mission(s) later that night (Tabs V-3.8, V-9.4 to V-9.5, and Z-4).

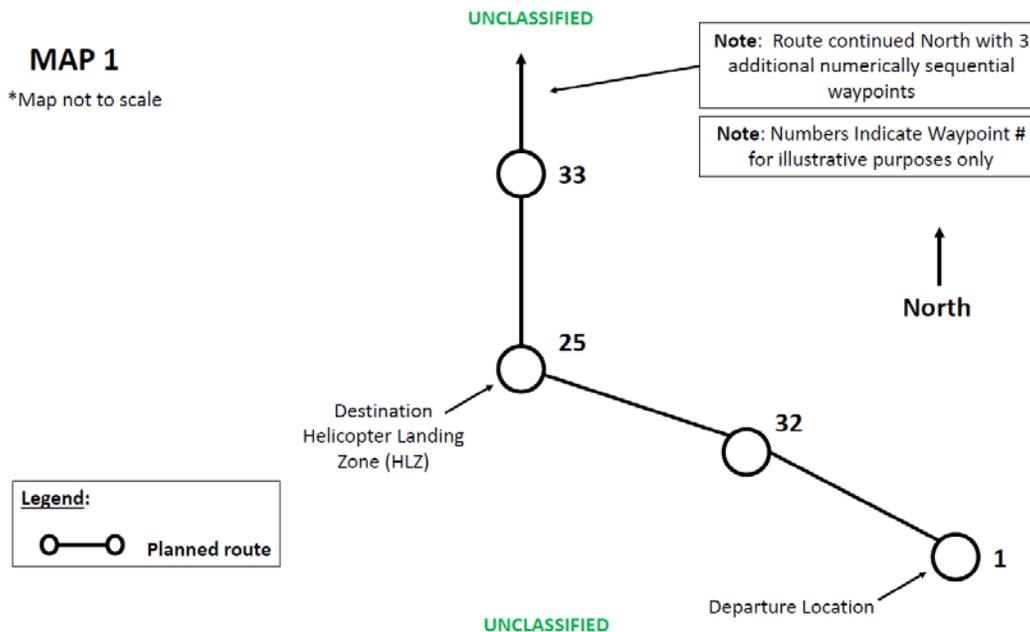


Figure 1: Map 1, MF Planned Route (Tab Z-4)

The MP gave the flight brief in the rescue operations center (ROC) at 1630Z (Tab V-1.3). All members of the MF were present as well as the crew of the supporting HC-130, 46 ERQS Director of Operations, and the ROC “Battle Captain” (Tab V-10.11 and V-5.3 to V-5.4). The flight brief was approximately 30 to 45 minutes and covered all required areas to include weather, sequence of events, route of flight, flight altitudes, hazards, threats, HAAR plan, approach and parking plan at the HLZ, alert posture, mission notification and launch procedures, operational risk management (ORM), contingencies, and an intelligence update (Tab V-10.11 and V-5.3 to V-5.4). During the flight brief, JPRC called the ROC to give confirmation that the planned pre-position mission to the HLZ was officially approved for execution (Tab V-10.11). ORM was assessed as low for this mission (Tab Z-13 to Z-14).

The mission planning and briefing complied with 46 ERQS requirements, alert standards, and Air Force requirements, to include AFI 11-2HH-60, Volume 3, Flying Operations, 5 January 2011 (Tab BB-12 to BB-20).

c. Preflight

Planned time to be in seats at the aircraft was 15 minutes prior to departure (Tab V-3.17). Just prior to stepping to the aircraft, JPRC directed the MF to bring additional aircrew flight equipment based on additional mission requirements (Tab V-2.3). Because the requirement to bring the extra equipment affected the aircraft weight and balance and max gross weight margin, the SMAs and PJs were required to reconfigure the aircraft and gear (Tab V-7.4).

A formal aircrew preflight of the MA was not required on the day of the mishap (Tab V-5.8). In accordance with normal alert procedures, the MA was preflighted on 14 March 2018 and placed on alert (Tabs U-22 and V-5.8).

d. Summary of Accident

Engine start, taxi, takeoff, departure, and HAAR of the MF were uneventful (Tab V-3.32 and V-5.5). The rendezvous with the HC-130 for HAAR occurred approximately 10 minutes late and northwest of the planned Air Refueling Control Point (ARCP). (Tab V-5.5). The MF refueled uneventfully and cleared the HC-130 to depart to the south (Tabs N-3 and V-5.5). Until this time, the MP had been flying the MA (Tab N-2). Following the completion of HAAR for the MA, the MP turned control of the MA over to the MCP (Tab N-2). The MF was a couple of miles north of their planned HAAR track and approximately five minutes east of the destination HLZ (Figure 2) (Tabs V-5.6, V-6.7 and Z-5).

Once clear of the HC-130, the MF began navigating directly to the next waypoint in their flight plan, waypoint 25, which was the intended HLZ (Figure 2) (Tabs N-3, V-3.21, V-5.6, and Z-5). Over the next four and a half minutes, the MF proceeded to this waypoint while simultaneously starting a shallow descent from refueling altitude (Tabs FF-7 to FF-11 and V-5.6). During this same period, the MP was interrupted multiple times during his navigation duties including communications with the MW regarding landing zone plan changes and MC requests for pre-landing power calculations and JTAC information requests (Tabs N-6 to N-9 and V-5.6). The JTAC at the HLZ initiated contact with the MF and discussed with the MP that they were still expecting the MF to approach from south to north and that the JTAC was able to employ a signaling device to point out the HLZ's location if required (Tab FF-10 to FF-11). The JTAC also reiterated that there were some towers located in the immediate area surrounding the HLZ (Tab FF-11). By the end of this dialogue with the JTAC, the MF was slightly to the northeast of the HLZ, and subsequently made a right turn to the north towards waypoint 33, a waypoint intended only for a follow on mission (Figure 2) (Tabs FF-11, V-5.8, V-9.4 to V-9.5 and Z-5).

During the turn north, the MF overflew the HLZ (Figure 2), and began a descent to low-level (Tabs FF-11 and Z-5). As the MA descended through approximately 900 feet AGL, the MC began to identify and avoid a set of power lines and four towers (Tab FF-12 to FF-13). Two of the towers were to the left side (Tower Set A) and two were on the right side (Tower Set B) of the MA's flight path (Figure 7) (Tab FF-12 to FF-13). Immediately after the MC called out these obstacles, the MCP decided to level off at 300 feet AGL (Tab FF-13).

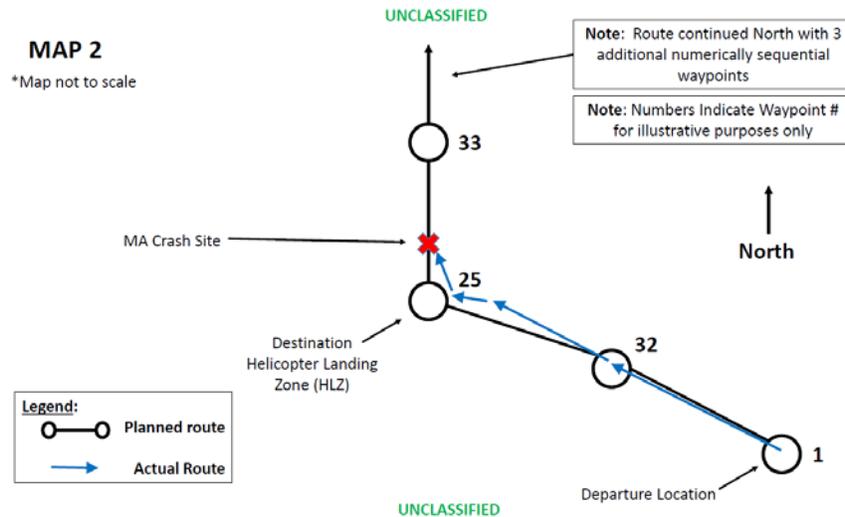


Figure 2: Map 2, MF Planned and Flown Routes (Tab Z-5)

Seconds before contact with the cable, the MCP turned the MA left to avoid the north tower of “Tower Set C” at the MA’s one o’clock position while at the same time announcing the presence of towers to the MW (Figure 7) (Tab FF-13). Following the left turn away from the north tower, the MA struck a cable located second from the top in a series of four cables strung horizontally between two 341 foot towers spaced an estimated 1,000 yards apart (Tabs EE-3, FF-13, and Z-12). Each of the four cables were spaced approximately 20 vertical feet apart (Tab EE-3). No member of the MC or MWC verbally announced seeing the other tower the cables were connected to or any of the four cables between the towers. (Tab FF-13). At the time of impact with the cable, the MA was traveling an estimated 125 knots indicated airspeed at an altitude between 250 and 270 feet AGL (Tab EE-3). Immediately following cable impact, the MP and MCP swiftly and calmly switch control of the MA (Tab FF-13). The MCP also made the near simultaneous and directive call to land (Tab FF-13). Immediately after the “land” call, the aircraft suffered catastrophic structural failures and was completely uncontrollable prior to impact with the ground (Tabs FF-13 and EE-3).

The main rotor blade(s) of the MA were the first components to make contact with the cable (Tab EE-6 and EE-17). Post-crash analysis determined the cable broke free from the tower to the left of the MA (Tab EE-3).

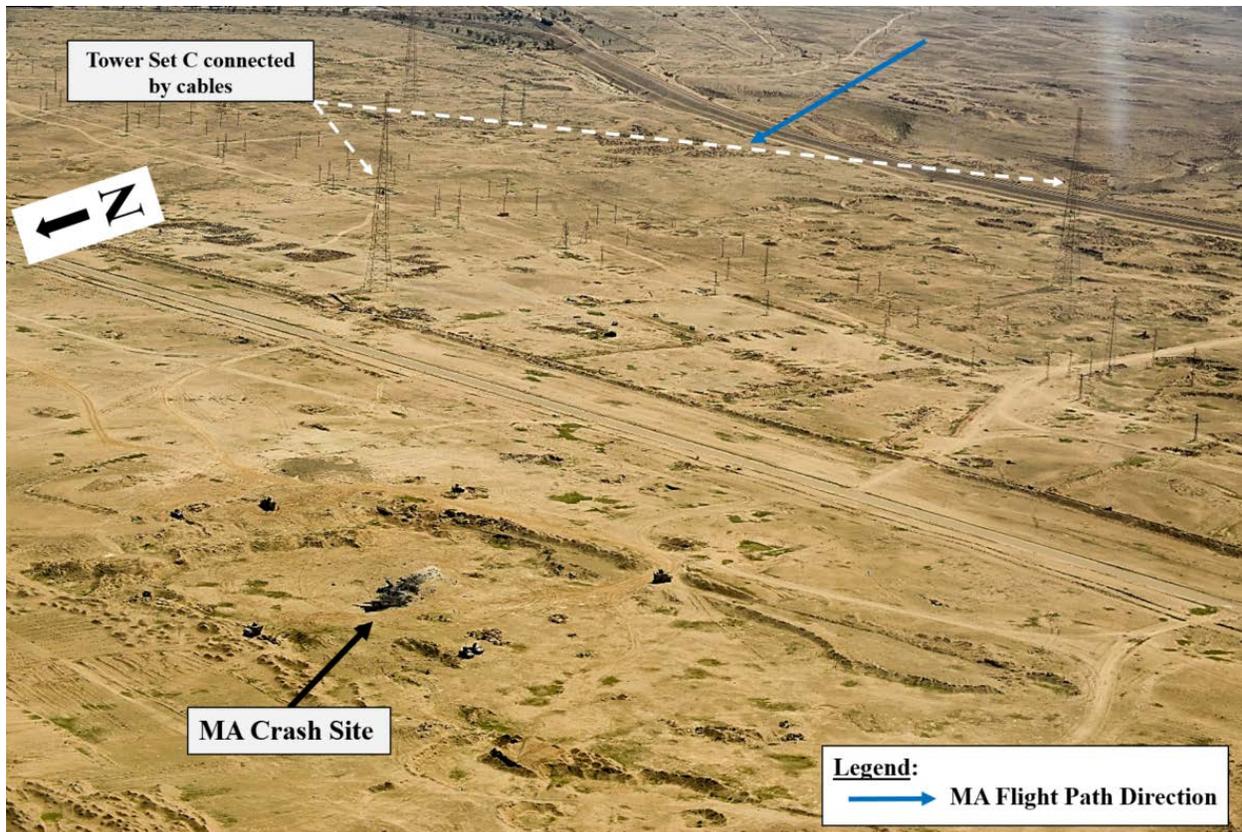


Figure 3: MA Flight Path, Looking South East (Tab Z-3)

The cable which remained attached to the right tower was pulled in the direction of the MA's flight path (Tab EE-3). As the cable wrapped around the main rotor and associated components, it also struck the tail rotor driveshaft and tail rotor blade(s) leaving behind transfer marks (Tab EE-6 and EE-16). With the main rotor turning at 258 rotations per minute, the loops of cable recovered took about five seconds to wrap and tighten around the main rotor hub and slow the rotor system (Tab EE-6). With torque still being applied to the rotor system from the engines, the main rotor hub experienced severe misalignment and mass imbalance, thus bending the main rotor shaft causing catastrophic failure of the shaft and liberation of the main rotor hub (Tab EE-6). As main rotor blades were lost, the imbalance caused vibrations throughout the aircraft that are incapacitating to the occupants, eventually causing complete failure of the transmission mount structure, which is evident by the main transmission module being completely torn from the aircraft while in the air (Tab EE-6). Failure of the tail rotor pylon was secondary to the failure of the main rotor system (Tab EE-6). The liberating of parts, vibrations, and severe right yaw as the rotor slowed caused separation of the upper section of the tail pylon (Tab EE-6). Based on their damage and location in the debris field, it appears that the aircraft main rotor blades, main rotor head, main transmission gearbox, tail rotor system, and tail pylon separated prior to the fuselage impacting the ground (Figure 5.1) (Tabs EE-3 and S-13). The length of the debris field containing the fuselage parts indicates a significant forward velocity at impact with the ground, prior to most of the fuselage being consumed in a post-crash fire (Tabs EE-4 and S-13). Based on the estimated impact acceleration forces, the crash was not survivable (Tab EE-6).

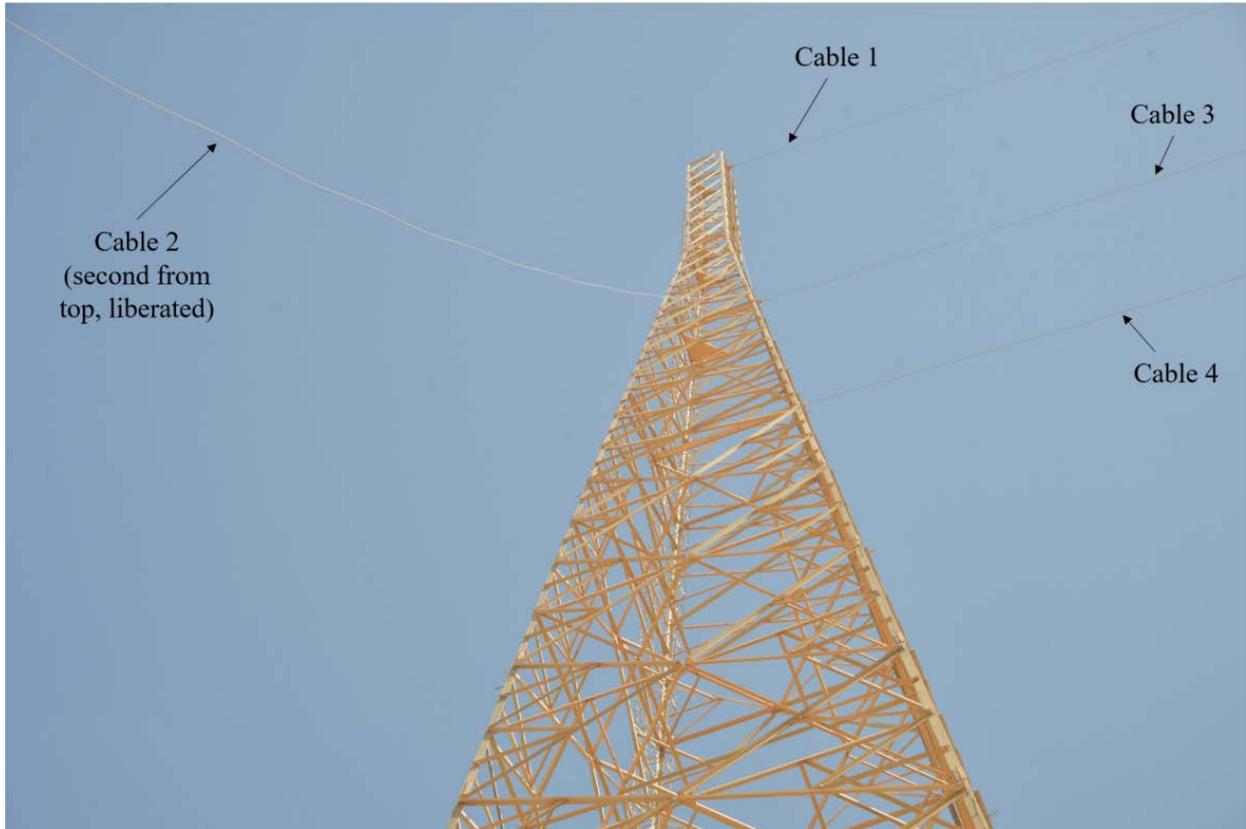


Figure 4: Tower with liberated cable (Tab Z-8)



Figure 5: Coiled cable segment (Tab Z-9)



Figure 5.1: Mishap Site Survey (Tab S-13)

The HH-60G is equipped with a wire strike protection system (WSPS); however, post-crash analysis determined that it was not effective because it does not appear that the cable had the opportunity to be pulled through any of the WSPS wire cutters (Tab EE-7 and EE-17). Post-crash material transfer analysis indicates that the leading edge of a main rotor blade was the only component to come in contact with the upper WSPS assembly (Tab EE-16). It is unknown whether the WSPS would have been effective in cutting the heavy gauge cable, had it been pulled directly into the WSPS cutters (Tab EE-7).



Figure 6: HH-60G Wire Strike Protection System (Tab Z-7)

e. Impact

The aircraft impacted the ground at approximately 1840Z (Tabs FF -5 to FF-14 and V-3.17). At the time it struck the cable, the MA was traveling an estimated 125 knots indicated airspeed, at an altitude between 250 and 270 feet AGL (Tab EE-3). The aircraft main rotor blades, main rotor head, main transmission gearbox, tail rotor system, and tail pylon separated prior to the fuselage impacting the ground (Figure 5.1) (Tabs EE-3 and S-13).

f. Egress and Aircrew Flight Equipment (AFE)

No evaluation of occupant protection equipment was conducted as it had all been consumed in the resulting fire (Tab EE-6).

g. Search and Rescue (SAR)

The MW was in a position to observe the impact of the MA (Tab V-8.2). Within approximately 10 to 20 minutes of the crash, the MW observed vehicles responding to the crash location (Tab V-8.2 to V-8.3 and V-8.5 to V-8.6). At the time of the MA's impact with the cable, the MW was just under a half-mile away and had the MA slightly lower at their ten o'clock position (Figure 7) (Tabs V-5.10, V-3.20, and Z-6). Near simultaneously to when the MA contacted the cable the MW

turned right to avoid a tower (South Tower of Set B) only a few hundred meters off the nose of their aircraft (Figure 7) (Tabs V-5.9, V-7.10, and Z-6). While the MW was in a right turn away from that tower, light generated from the MA's crash illuminated another tower and associated cables in front of the MW (North Tower of Set B), enabling the MWC to see and climb to avoid the hazards (Tab V-7.10 and V-3.29). This is the first and only time leading up to the mishap any members of the MF were able to see the cables strung between the different sets of towers (Tab V-7.10 and V-3.29).

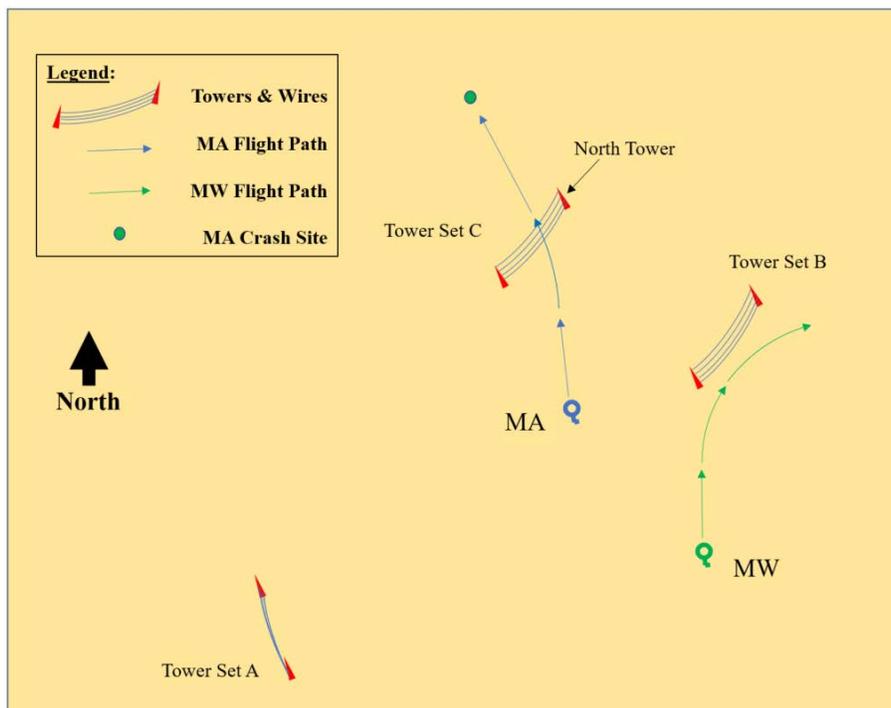


Figure 7: MF Flight Path Illustration (Tab Z-6)

As the MW continued its right turn and began to climb, they quickly realized that the bright flash was caused by the MA crash (Tab V-5.10 and V-8.2). Once safely above the hazards in the area, the MWC began coordinating to have a Quick Reaction Force (QRF) dispatched to secure the site, then notified command of the incident (Tab V-3.20 and V-8.2). A third HH-60G and additional PJs were also scrambled to the crash site while they continued working to identify a safe approach path and landing zone near the crash site (Tab V-1.17 and V-8.2 to V-8.5). Hindering the MW's ability to land near the crash site were the extensive amount of towers and cables in the vicinity (only now visible due to the illumination from the crash) and severity of the fire from the crash, which was also obstructing their vision through NVGs (Tab V-7.10 and V-8.2 to V-8.3). The fire was also causing the ammunition that was onboard the MA to ignite, causing an additional hazard and risk to the MW (Tab V-8.5). About 20 minutes before the MW was able to land, coalition ground forces arrived and ensured security of the crash site (Tab V-8.5 to V-8.6).

Approximately 40 minutes after the crash, the MW was able to land roughly 700 meters from the site and inserted their two PJs to begin recovery operations (Tab V-8.3). With them, the PJs had more than 300 pounds of extrication equipment to include hydraulic jaws and generator, shovels, pry tools, medical rucks/backpacks, fire extinguishers from the MW aircraft, and two air packs for

protection from smoke and debris inhalation (Tab V-8.3 to V-8.4). Due to gross weight and power restrictions of the HH-60G, PJs split up their equipment between the two aircraft in formation (Tab V-7.4 and V-8.3). As a result, the extrication equipment was located on the MW, but the aircraft fire suppression equipment was on the MA and therefore not available for recovery operations (Tab V-8.3). As the two PJs from the MWC were making their way via foot to the crash site, the third HH-60G arrived and inserted their two PJs and one Combat Rescue Officer (CRO) to assist the rescue effort (Tab V-8.4 to V-8.5). The CRO and four PJs then met with the coalition forces on-scene commander and were briefed on the situation at the crash site (Tab V-8.5 to V-8.6).

h. Recovery of Remains

Once at the site, the CRO and PJs worked with coalition forces and performed a comprehensive search to locate and recover the bodies of all seven of the fallen MC (Tab V-8.6). Throughout the recovery, the team utilized fire extinguishers from the two other helicopters and ground vehicles to continuously battle the ongoing fire at the crash site (Tab V-8.6). Once the MC members were recovered, they were driven back to the HLZ in coalition QRF ground vehicles (Tab V-8.6). From the HLZ, United States Army Medical Evacuation helicopters transported the MC back to the base from which they departed (Tab V-8.6).

Below is a countdown timeline beginning at takeoff and ending shortly after the MA's impact with the cable.

Time Until Cable Strike (Min:Sec)	Summary of Mishap Timeline
40:00	Approximate MF Takeoff
12:22	Rendezvous with HC-130 for HAAR
06:40	HAAR complete
01:47	MF passes Northeast of HLZ and turns North
01:35	MF begins descent to low-level
00:30	MA descends through 900' AGL
00:24	MC visually acquires towers at 11 o'clock
00:10	MFE visually acquires towers at two o'clock
00:08	MA levels off at ~300' AGL
00:05	MCP turns left to avoid tower at one o'clock
00:03	MCP announces towers to MW
00:00	MA Strikes Cable
-00:05	Inflight Structural Failure of MA

Summary of Mishap Timeline (Tab FF-14)

5. MAINTENANCE

a. Forms Documentation

Each individual Air Force aircraft has its own set of written and electronic maintenance records used to record all flight discrepancies, capture all maintenance performed, and inspection histories in the form of Air Force Technical Order (AFTO) Form 781s and the Integrated Maintenance Data

System (IMDS) respectively (Tab BB-4 to BB-6). The AFTO Form 781 is a series of records documenting status of an aircraft to include aircraft condition and repairs (Tab BB-4).

The hard copy AFTO 781 forms found on the Mishap Aircraft (MA) at the time of the mishap were severely damaged (Tabs D-3 and FF-15). Two photos of AFTO 781A pages showing the last maintenance actions on the aircraft prior to flight were available via a non-standard photo taken by maintenance personnel (Tabs D-3 and U-21 to U-22). All remaining existing aircraft AFTO 781 series forms to include Time Compliance Technical order (TCTO) status, MA Jacket File, and 73 days of archived electronic IMDS were reviewed for accuracy and completeness (Tabs U-3 to U-82 and FF-15). This review indicated that the aircraft was properly maintained and ready for the mission (Tabs U-9 to U-20 and FF-15). At the time of the mishap, the MA total airframe time was 6,769.8 hours (Tab U-9). The MA flew a total of 6.4 hours on the three previous missions (Tab U-78 to U-80). The review of archived electronic aircraft forms, also known as IMDS, revealed no maintenance discrepancies that would have prevented the MA from being airworthy or unable to perform the mission and no evidence suggests that maintenance or forms documentation was a factor in the mishap (Tabs FF-15 and U-40 to U-52).

b. Inspections

All scheduled maintenance inspections were current and accurately documented prior to the mishap (Tabs U-44 and FF-15). The last scheduled inspection was a 50-hour inspection accomplished on 12 February 2018 (Tabs U-67 and FF-15).

In addition to the last scheduled inspection, the MA received a preflight maintenance inspection (Tab U-81). This type of inspection is accomplished prior to first flight of the flying period and is valid for a period of 72 hours (Tab BB-10 to BB-11). This preflight inspection was accomplished on 14 March 2018 at 1300Z and had approximately 42 hours of validity remaining at the time of the mishap (Tabs U-81 and BB-11). The maintenance documentation confirmed that all inspections and maintenance actions were accomplished and documented in accordance with applicable maintenance directives, and there is no evidence to suggest that an inspection was a factor in the mishap (Tabs U-81, U-40 to U-52 and FF-15).

c. Maintenance Procedures

The most recent physical archived forms from the aircraft jacket file and current IMDS were reviewed, revealing insignificant documentation discrepancies; however none of the discrepancies were a factor in the mishap (Tabs U-23 to U-39, U-51 and FF-15). The review of active and historical MA AFTO 781 series aircraft forms revealed no discrepancies in maintenance procedures, practices or actions that deviated from established directives on the MA (Tabs U-23 to U-39 and FF-15). A comprehensive review of all available maintenance data from 1 January 2018 up to the day of the mishap indicate that maintenance was not a factor during this mishap (Tabs U-5 to U-8, U-53 to U-71 and FF-15).

d. Maintenance Personnel and Supervision

Individual military training records for all maintenance personnel who performed a preflight inspection on the MA were thoroughly reviewed (Tabs T4, T-6 to T-11 and FF-15). All maintenance members were fully qualified and performed proper maintenance actions (Tabs T-3 to T-4, T-6 to T-11, U-5 to U-8, U-53 to U-71 and FF-15).

e. Fuel, Hydraulic and Oil Analysis

Three fuel samples were provided for testing to the Air Force Petroleum Office (AFPET) Laboratory from different sources that provided fuel to the MA (Tab U-72 to U-76). All three samples showed no evidence of contamination or deficiency (Tab U-72 to U-76). There is no evidence to indicate fuel was a factor in this mishap (Tab U-72 to U-76). Hydraulic and Oil samples from the MA aircraft could not be recovered for processing and testing because they were consumed when the fuselage was destroyed by the post-crash fire (Tabs Tab U-72 to U-76, EE-4 and FF-15). Cockpit oil pressure indications were within normal operating limits (Tab J-5).

f. Unscheduled Maintenance

A review of all maintenance activities on the MA from 1 January 2018 to the day of the mishap revealed no discrepancies or recurring maintenance issues (Tabs U-5 to U-8 and FF-15). There is no evidence to suggest that unscheduled maintenance was a factor in the mishap (Tabs U-5 to U-8 and FF-15).

6. AIRFRAME SYSTEMS

a. Structures and Systems

At the time of the incident, all relevant MA systems were operating properly (Tab J-4). Damage and Crash Analysis was provided by the Air Force Safety Center, and material and failure analysis was provided by the Materials Integrity Branch, Wright-Patterson Air Force Base (Tab EE-3 to EE-55).

(1) Airframe

The main fuselage with the lower portion of tail pylon and stabilator were still attached (Tab EE-4). Most of the fuselage was destroyed in a post-crash fire (Tab EE-4). The length of the debris field containing fuselage parts indicates significant forward velocity at impact (Tab EE-4). The MA main rotor blades, main rotor head, main transmission gearbox, tail rotor system and tail pylon all appear to have separated in flight, based on their damage and location in the debris field, prior to the fuselage impacting the ground (Tab EE-3).

(2) Rotor System

A main rotor blade recovered showed scraping along the leading edge and an impact mark on the upper airfoil surface that is similar to the surface of the tower cable (Tab EE-4 and EE-14). The impact mark begins 2–3 feet inboard of the rotor blade tip, indicating that the aircraft struck the cable with a main rotor blade first (Tab EE-4 and EE-14). Damage to the tip of the blade is from

impact with the ground from the rear direction, indicating it was not turning at the time of impact (Tab EE-4). The root end is broken free close to the hub (Tab EE-4). Scrape marks from the ground are present in the span wise direction, indicating it slid along the ground after impact (Tab EE-4).

The main rotor head and rotating swash plate are completely broken free from the transmission drive shaft, with a short portion of the shaft still contained in the main rotor head (Tab EE-4). The drive shaft failure appears to be from torsional overload, with smearing from interaction between the shaft and hub (Tab EE-4). Three of the four pitch control rods are broken with some portions missing (Tab EE-4). Three of the main rotor blade roots are present, with the blade spars broken and or separated just outboard of the root (Tab EE-4). One blade root is missing, broken where the blade shaft attaches at the elastomeric bearing (Tab EE-4). The significant damage to the rotor head and drive shaft indicates it suffered catastrophic damage under power (Tab EE-4).

(3) Wire Strike Protection System (WSPS)

The WSPS is a simple, light-weight system without motorized or pyrotechnic components which is used to cut, break or deflect wires that may strike the helicopter in the frontal area between the tires and the fuselage and between the fuselage and the main rotor in level flight (Tab FF-16). Protection is provided against horizontal strung wire at 60-90 degrees to the flight path by cutting or deflecting the wire without exceeding the structural criteria, by cutting or deflecting, as applicable, a wire up to 3/8 inch diameter, 1x7 strand steel cable having an ultimate strength of up to 11,000 pounds (Tab FF-16). The WSPS was not effective because it does not appear that the wire was pulled into any of the WSPS cutters or deflectors (Tab EE-7).

The upper WSPS showed no contact damage along the length of the cutter with the cable (Tab EE-14). Paint was intact and undisturbed after it was wiped clean (Tab EE-14). Areas of missing paint and contact damage were observed on the support structure for the upper WSPS (Tab EE-14). Both support arms were bent and the connection bolt fractured; however, titanium transferred onto the upper WSPS support arm, which suggests the leading edge of a blade was the source of the support arm scrape and not a cable. (Tab EE-14 and EE-16).

A piece of the lower WSPS cutter that is fuselage mounted by the aircraft landing gear was bent with paint missing on the convex tension side (Tabs Z-7 and EE-14). Contact damage was observed in an area where the cutter blade attached (Tab EE-14). A fractured surface also observed at the curved end of the piece (Tab EE-14). The fractured surface exhibited material rubbed along with fine, elongated dimples indicative of shear ductile overload (Tab EE-14). Since only a portion of the lower WSPS assembly was recovered without any of the cutter, it is unknown if this assembly caught the cable, which led to the observed failure (Tab EE-16). However, the directionality of the dimples on the lower WSPS piece does not support this scenario (Tab EE-16).

b. Evaluation and Analysis

(1) Cable Segment

The cable wires were galvanized steel of a right hand lay, seven wire strand design (Tab EE-12). Measurements using a machinist's microscope indicated the cable diameter to be between 0.35

and 0.36 inches and the average individual wire diameter was 0.115 (Tab EE-12). The cable tensile strength was tested and the max load achieved was 14,929 lbs. before wire failure occurred (Tab EE-13).

(2) Integrated Vehicle Health Monitoring Systems (IVHMS) Data

IVHMS provides monitoring and diagnostic capabilities that include exceedance monitoring, engine and drive train health monitoring (Tab J-4). The IVHMS analysis indicated the engines, drive train, flight controls, and associated parametric data were all within expected operating ranges (Tab J-4 to J-6). Data examined from both engines indicated normal operations and expected power was available (Tab J-5 to J-6). Aircraft flight data indicated that the MA was responding normally to flight control inputs (Tab J-4). All monitored MA systems functioned properly until after contact with the cable (Tab J-5).

7. WEATHER

a. Forecast Weather

The forecasted weather at the departure base was a broken ceiling at 15,000 feet mean sea level (MSL) and 20,000 feet MSL, visibility greater than 9,000 meters, and winds from 320 degrees at 6 knots (Tab F-2). The forecast surface temperature was 18 degrees Celsius, with light rime icing from 10,000 feet MSL to 20,000 feet MSL (Tab F-2). The forecasted altimeter setting was 29.90 inches of mercury, and pressure altitude was 585 feet MSL with a density altitude of 1,065 feet MSL (Tab F-2). Lunar illumination was forecast to be seven percent with moonrise at 0212Z and moon set at 1320Z (Tab F-2). The forecasted weather for the HLZ was the same (Tab V-5.8).

b. Observed Weather

The mishap sortie began at 1800Z, well after the moon had set, resulting in very low lunar illumination for the entirety of the flight (Tabs F-2 and V-3.17). Conditions during the flight and subsequent search and rescue were reported as clear skies, low illumination, no moon, with dust and haze reducing visibility to three or four miles (Tab V-5.9).

c. Space Environment

Not applicable.

d. Operations

Flight operations were conducted within the prescribed operational weather limitations for the aircraft systems and in accordance with regulatory guidance (Tab F-2).

8. CREW QUALIFICATIONS

a. Mishap Pilot (MP)

MP was a qualified Instructor Pilot and experienced HH-60G Pilot (Tab T-38). MP was current in all Combat Mission Ready (CMR) flight areas, in accordance with AFI 11-2HH-60, Volume 1,

Table 4.1 (Tabs T-38 and BB-23 to BB-24). MP completed the most recent mission qualification checkride in the HH-60G on 27 April 2017 (Tab T-32). MP had 1019.7 total flight hours and 805.1 HH-60G flight hours (Tab T-12 and T-19).

At the time of the mishap, MP's flight times were as follows (Tab T-12):

	Hours	Sorties
Last 30 Days	22.7	15
Last 60 Days	39.0	24
Last 90 Days	44.2	31

f. Mishap Co-Pilot (MCP)

MCP was a qualified and experienced HH-60G Co-Pilot (Tab T-38). MCP was current in all CMR flight areas, in accordance with AFI 11-2HH-60, Volume 1, Table 4.1 (Tabs T-38 and BB-23 to BB-24). MCP completed the most recent mission qualification checkride in the HH-60G on 19 December 2017 (Tab T-33). MCP had 2465.5 total flight hours and 531.4 HH-60G flight hours (Tab T-13 and T-21).

At the time of the mishap, MCP's flight times were as follows (Tab T-13):

	Hours	Sorties
Last 30 Days	9.3	6
Last 60 Days	24.8	14
Last 90 Days	27.5	16

c. Mishap Flight Engineer (MFE)

MFE was a qualified and experienced Fully Qualified Special Missions Aviator Instructor in the HH-60G (Tab T-39). MFE was current in all CMR flight areas, in accordance with AFI 11-2HH-60, Volume 1, Table 4.2 (Tabs T-39 and BB-24 to BB-26). MFE completed the most recent mission qualification checkride in the HH-60G on 26 September 2017 (Tab T-34). MFE had 887.7 total flight hours and 887.7 HH-60G flight hours (Tab T-14 and T-22).

At the time of the mishap, MFE's flight times were as follows (Tab T-14):

	Hours	Sorties
Last 30 Days	14.8	10
Last 60 Days	28.8	16
Last 90 Days	28.8	16

d. Mishap Aerial Gunner (MAG)

MAG was a qualified and experienced Fully Qualified Special Missions Aviator in the HH-60G (Tab T-39). MAG was current in all CMR flight areas, in accordance with AFI 11-2HH-60,

Volume 1, Table 4.2 (Tabs T-39 and BB-24 to BB-26). MAG completed the most recent mission qualification checkride in the HH-60G on 10 August 2017 (Tab T-35). MAG had 746.2 total flight hours and 746.2 HH-60G flight hours (Tab T15 and T-23).

At the time of the mishap, MAG’s flight times were as follows (Tab T-15):

	Hours	Sorties
Last 30 Days	10.2	12
Last 60 Days	21.6	20
Last 90 Days	24.3	24

e. Mishap Combat Rescue Officer (MCRO)

MCRO was a current and qualified Pararescue Team Commander (Tab T-36). MCRO was current in all CMR flight areas, in accordance with AFI 10-3502, Volume 1, Table 5.1 (Tabs T-36 and BB-41 to BB-42). MCRO completed the most recent mission evaluation on 19 July 2017 (Tab T-36). MCRO had 102.1 total flight hours and 69.0 HH-60G flight hours (Tab T-16 and T-24).

At the time of the mishap, MCRO’s flight times were as follows (Tab T-16):

	Hours	Sorties
Last 30 Days	21.5	13
Last 60 Days	41.4	22
Last 90 Days	41.4	22

f. Mishap Pararescueman 1 (MPJ1)

MPJ1 was a qualified and experienced Pararescue Element Leader (Tab T-5). MPJ1 was current in all CMR flight areas, in accordance with AFI 10-3502, Volume 1, Table 5.1 (Tabs T-5 and BB-41 to BB-42). MPJ1 completed the most recent mission evaluation on 15 October 2017 (Tab T-5). MPJ1 had 346.4 total flight hours and 117.0 HH-60G flight hours (Tab T-17 and T-27).

At the time of the mishap, MPJ1’s flight times were as follows (Tab T-17):

	Hours	Sorties
Last 30 Days	9.2	6
Last 60 Days	20.3	10
Last 90 Days	20.3	10

g. Mishap Pararescueman 2 (MPJ2)

MPJ2 was a qualified and experienced Instructor Pararescue Team Leader (Tab T-37). MPJ2 was current in all CMR flight areas, in accordance with AFI 10-3502, Volume 1, Table 5.1 (Tabs T-37 and BB-41 to BB-42). MPJ2 completed the most recent mission evaluation on 14 October 2017 (Tab T-37). MPJ2 had 1145.3 total flight hours and 571.2 HH-60G flight hours (Tab T-18 and T-30).

At the time of the mishap, MPJ2's flight times were as follows (Tab T-18):

	Hours	Sorties
Last 30 Days	9.2	6
Last 60 Days	20.3	10
Last 90 Days	20.3	10

9. MEDICAL

a. Qualifications

The MC had current Annual Flight Physicals and were medically qualified for flight related duties without restrictions at the time of the mishap (Tab DD-128, DD-132, DD-136, DD-140, DD-144, DD-149, and DD-153).

b. Health

All members of MC were in good health, and had no duty-limiting conditions or illnesses prior to the mishap (Tab DD-128, DD-132, DD-136, DD-140, DD-144, DD-149, and DD-153).

c. Pathology

Upon impact, all members of the MC sustained rapid lethal blunt traumatic forces (Tab X-3).

The toxicology report included testing for carbon monoxide, ethanol, amphetamine, barbiturates, benzodiazepines, cannabinoids, cocaine, opioids, phencyclidine, sympathomimetic amines (Tab DD-120).

Toxicology test results for the MC were negative with one exception (Tab DD-147). The MFE had traces of an inactive metabolite of the prescribed Cyclobenzaprine (Tab DD-147). IAW the Air Force Aerospace Medicine Approved Medications list, a member is returned to flight status if a medication is discontinued and its effects have dissipated (Tab BB-50). Because the MFE had discontinued use, the medication was processed by the body and its effects no longer impacting duty performance, the deployed flight surgeon evaluated and returned the MFE to flight status (Tab DD-145).

All maintenance personnel associated with the mishap provided samples for toxicology testing. All toxicology samples were negative (Tab DD-120 to DD-127).

There is no evidence to indicate any toxicological substances were a factor in the mishap (Tab DD-130, DD-134, DD-138, DD-142, DD-147, DD-151, and DD-155).

d. Lifestyle

There is no evidence to suggest lifestyle factors were relevant to the mishap (Tabs DD-38, DD-63, DD-73, DD-89, DD-157, DD-172, Tab V-1.13, V-9.2 and V-10.11).

e. Crew Rest and Crew Duty Time

Mandatory crew rest and maximum flight duty periods for all personnel were IAW AFI 11-2HH-60 Volume 3, *HH-60—Operations Procedures* (Tabs BB-52, V-1.13 and V-10.11). Crew members and formations typically maintained alert status for 48-hour shifts, putting them on a two days on, two days off schedule (Tab V-1.14). The MC was left in crew rest until reaching their normal duty period (Tab V-10.11 to V-10.12). There is no evidence to suggest crew rest and duty time requirements were a factor in this mishap (Tab V-10.11 to V-10.12).

10. OPERATIONS AND SUPERVISION

a. Operations

On 15 March 2018, the 46th Expeditionary Rescue Squadron was six to seven weeks into their operational deployment (Tab V-1.13). Operational tempo prior to 15 March 2018 was unremarkable and described as “slow,” with “not too much going on” (Tab V-1.13). Crew members and formations typically maintained alert status for 48-hour shifts, putting them on a two days on, two days off schedule (Tab V-1.14). When there were no planned missions, the crews would fly local “mission rehearsal” sorties in order to maintain aircrew proficiency (Tab V-1.14). Every 72 hours, alert aircraft received a full maintenance pre-flight and aircraft run-up (Tab V-5.10).

A characteristic of rescue unit deployments is for crews to fly as part of a “hard crew” (Tab V-1.2). The purpose of a hard crew is for the same individuals to fly and work together consistently on the same crew throughout the deployment for crew resource management purposes (Tab V-5.3 and V-7.2). This usually improves a crew’s or formation’s effectiveness as they become familiar with each other’s tendencies, habits, and preferences, which is especially important during the increased tempo over the course of an actual rescue mission (Tab V-10.14 to V-10.15, V-7.2 and V-5.3).

The 46 ERQS was in the process of realigning their hard crews at the mid-point rotation of personnel on the deployment at the time of the mishap (Tab V-7.3). The MCP and another co-pilot were on an eight-day rotation, taking turns between flying on the MC with the MP and working as the Battle Captain (Tab V-1.2). The MAG had joined the MC a day or two prior in order to start flying with the MFE in preparation of the upcoming planned rotation of crews for the final two months of the deployment (Tab V-7.3 and V-10.6).

b. Supervision

The mission flown on 15 March 2018 was appropriately supervised and approved by the 46 ERQS Director of Operations as the acting A3 and by the JPRC (Tab V-10.11 and V-10.13). ORM was assessed as low for this mission (Tab Z-13 to Z-14). The 46 ERQS squadron commander flew in the MF and provided inputs during planning (Tab V-5.2). The 1 ERQG commander was also aware of the mission that night and was in the ROC to check on the status of the MF when notification of the mishap occurred (Tab V-1.16).

11. HUMAN FACTORS ANALYSIS

The Department of Defense Human Factors Analysis and Classification System version 7.0 (DoD HFACS 7.0) lists potential human factors that can play a role in aircraft mishaps (Tab BB-46). Human factors describe how a person's interaction with tools, tasks, working environments, and other people influence human performance (Tab BB-46). All human factors as prescribed in the Department of Defense Human Factors Analysis and Classification System 7.0 were considered (DoD HFACS 7.0) (Tab BB-46 to BB-49).

Four human factors were identified as being relevant to the mishap: (1) Misinterpreted/Misread Instrument; (2) Interference/Interruption; (3) Inaccurate Expectation; (4) Environmental Conditions Affecting Vision.

a. PC505 Misinterpreted/Misread Instrument

Misinterpreted/Misread Instrument is a factor when the individual is presented with a correct instrument reading but its significance is not recognized, it is misread or is misinterpreted (Tab BB-47).

The MF pilots developed and were familiar with the flight plan route (Tab V-5.4, V-3.3 to V-3.4). There were no reported navigation system or equipment problems (Tab V-3.16). After completing HAAR, the MP navigated the MF toward the HLZ and then erroneously navigated to a waypoint beyond their intended destination (Tabs N-6 and V-3.23). Although the MCP made a correct estimated arrival time to the HLZ, the MP misinterpreted the time to be arrival at a waypoint prior to the intended HLZ (Tab N-6). No route corrections were made by anyone in the MF (Tabs N-6 to N-9, V-3.1 to V-3.32, V-4.1 to V-4.7, and V-5.1 to V-5.11). The MWC had accurate navigation data and also failed to recognize instrument indicators directing the MF to the HLZ (Tab V-3.22).

b. PC108 Interference/Interruption

Interference/Interruption is a factor when an individual is performing a highly automated/learned task and is distracted by another cue/event that results in the interruption and subsequent failure to complete the original task or results in skipping steps in the original task (Tab BB-48).

The MP had multiple duties in addition to navigation of the MF (Tab N-3 to N-9). In the time after completing HAAR and leading up to time of mishap, the MP received multiple interrupting requests for information (Tab N-2 to N-9). The MP coordinated with the MW regarding landing zone plan changes, MC requests for pre-landing power calculations and JTAC information requests (Tab N-6 to N-9). These non-navigation related tasks consumed the vast majority of the MP and MF's time following HAAR, and reduced their time available to identify their navigation error (Tab FF-7 to FF-13).

Crew Resource Management (CRM) is the effective use of all available resources--people, weapon systems, facilities, and equipment, and environment -- by individuals or crews to safely and efficiently accomplish an assigned mission or task (Tab BB-54). The MF lacked effective CRM in the performance of their duties to aviate, navigate and communicate, which resulted in

their failure to verify navigation information being provided by MP (Tabs N-6 to N-9, V-3.1 to V-3.32, V-4.1 to V-4.7, and V-5.1 to V-5.11).

c. PC110 Inaccurate Expectation

Inaccurate expectation is a factor when the individual expects to perceive a certain reality and those expectations are strong enough to create a false perception of the expectation (Tab BB-48).

The MF had the perceived reality that the MF was south of the intended destination (Tab V-4.4 and V-6.11). Based on their route study, the MF also expected a south to north approach to the HLZ (Tabs FF-11 and V-3.8). Therefore, even the turn to the north, while in error, supported the MF's perception of an approach to the HLZ (Tab V-6.9 and V-3.30). And when the MF's navigation equipment indicated an overflight of the HLZ, the perception of the MF was strong enough to create the perception that the MF was on track to the HLZ (Tab V-3.22 to V-3.23 and V-3.30). The MF understood the approach to the HLZ would be safe and did not expect hazards on their planned approach (Tab V-3.14).

d. PE101 Environmental Conditions Affecting Vision

Environmental Conditions Affecting Vision is a factor that includes obscured windows; weather, fog, haze, darkness, smoke, etc.; brownout/whiteout (dust, snow, water, ash or other particulates); or when exposure to windblast affects the individual's ability to perform required duties (Tab BB-49).

Night navigation involves inherent challenges such as darkness affecting visual acuity and includes hazards due to vision illusions (Tab BB-29). The aircrew members of the MC had battery-powered AN/AVS-9G night vision goggles (NVGs) mounted to their helmets as their primary means of maintaining night vision (Figure 8) (Tabs H-3 and V-5.7). NVGs enable aircrew to operate in a night environment, but when compared to the human eye under daylight conditions, vision under NVGs is limited (Tab BB-32). This results in a decreased level of situational awareness, amplified by certain human factors and environmental limitations (Tab BB-38). NVGs have a more reduced field of view compared to the human eye, particularly in peripheral vision, requiring an active and aggressive scan on the part of the NVG user in order to compensate appropriately during flight (Tab BB-32 to BB-33). Current NVGs have a resolution capability of 20/25 to 20/40 Snellen visual acuity, less than "normal day vision," which is 20/20 (Tab BB-32). Of note, this visual acuity of 20/25 to 20/40 is the best that aircrew can expect to attain under optimal conditions (Tab BB-32). When flying with NVGs "detection ranges decrease and recognition of objects, terrain and targets can be severely limited" (Tab BB-32). Current HH-60G Tactics, Techniques, and Procedures contains a warning stating, "electric power lines, unlit towers, poles, antennas, dead trees, and all types of wires are extremely difficult to see while conducting NVG operations" (Tab BB-38).

Factors such as low or zero lunar illumination present on the night of the mishap degraded visual acuity and significantly limited the MF's ability to see obstacles until at close range (Tabs BB-32, V-5.7, V-5.9, and V-6.5). This also negatively impacted the MF's ability to use visual geographic references to improve their situational awareness of their actual location (Tab V-6.5).



Figure 8: ANVIS-4949 NVGs Mounted to HGU-56/P Helmet (Front and Side Views) (Tab Z-10 to Z-11)

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publicly Available Directives and Publications Relevant to the Mishap

- (1) Air Force Instruction 11-2HH-60, Volume 3, *HH-60 Operations Procedures*, 5 January 2011
- (2) Air Force Instruction 11-2HH-60, Volume 1, *HH-60 Aircrew Training*, 12 Apr 2016
- (3) Air Force Instruction 11-217, Volume 2, *Visual Flight Procedures*, 22 October 2010
- (4) Air Force Instruction 11-217, Volume 3, *Supplemental Flight Information*, 23 February 2009
- (5) Air Force Instruction 10-3502, Volume 1, *Pararescue and Combat Rescue Officer Training*, 30 March 2017
- (6) Air Force Instruction 11-290, *Cockpit/Crew Resource Management Program*, 15 October 2012, AFGM2017-01, 27 June 2017.
- (7) Air Force Instruction 51-503, *Aerospace and Ground Accident Investigations*, 14 April 2015, AFGM2018-01, 12 March 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) Air Force Tactics, Techniques, and Procedures 3-3 HH-60G, *Combat Aircraft Fundamentals*, 20 November 2017
- (2) Technical Order 1H-60(H)G-6WC-6, *Organizational Maintenance Instructions Preflight, Postflight, and Alert Inspection*, 1 November 2011
- (3) Technical Order 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures*, 11 July 2016
- (4) Technical Order 00-20-2, *Maintenance Data Documentation*, 15 March 2016
29 September 2017

c. Known or Suspected Deviations from Directives or Publications

NONE.

A handwritten signature in black ink, appearing to read "B. P. Radliff". The signature is fluid and cursive, with a large initial "B" and a stylized "P" and "R".

6 July 2018

BRYAN P. RADLIFF
Brigadier General, USAF
President, Accident Investigation Board

STATEMENT OF OPINION
HH-60G, T/N 92-6466
USCENTCOM AOR
15 March 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

On 15 March 2018, at approximately 1840 Zulu time, 2140 Local time, the mishap aircraft (MA), an HH-60G, tail number (T/N) 92-6466, assigned to the 332d Air Expeditionary Wing and operating in the USCENTCOM AOR crashed in an uninhabited desert area fatally wounding all seven Airmen on board.

I find by a preponderance of evidence that the cause of the mishap was the result of the mishap pilot misinterpreting aircraft navigation displays, causing the mishap formation (MF) to descend into an unplanned location and strike a 3/8 inch diameter galvanized steel cable strung horizontally between two 341 foot high towers. In addition, I found by a preponderance of evidence that three factors substantially contributed to the mishap: (1) mission planning created a route of flight that enabled navigation beyond the intended helicopter landing zone (HLZ); (2) a breakdown in crew resource management (CRM) within the mishap crew (MC) and between the mishap formation (MF) failed to sufficiently detect and effectively communicate the navigation error; and (3) low illumination conditions present during the mission rendered night vision goggles (NVGs) insufficient to detect the cables.

I developed my opinion by analyzing factual data from historical records, Air Force directives and guidance, engineering analysis, witness testimony, flight recorded data, animated simulations and information provided by technical experts.

2. CAUSE

I find by a preponderance of evidence that the cause of the mishap was the mishap pilot misinterpreting aircraft navigation displays resulting in the MF descending into an unplanned location and striking a 3/8 inch diameter galvanized steel cable strung horizontally between two 341 foot high towers. There were no reported navigation system or equipment problems. The MC was familiar with the planned route and intended to land at the HLZ. Following helicopter air-to-air refueling (HAAR), the MP initially directed the MF to the intended HLZ, but the MP subsequently directed a turn to the north, away from the HLZ. This route of flight indicates either a selection by the MP of the next navigation waypoint as the MF's destination and/or a misinterpretation of the HLZ as a turn-point prior to the HLZ. The Mishap Co-Pilot (MCP) took evasive action to avoid striking a tower at the MA's one o'clock position by turning left. This left turn resulted in the MA striking the second from the top of four galvanized steel cables. It is

determined that the MC never visually acquired the cables or the other tower connecting the cables. The cable quickly entangled in the main rotor assembly resulting in catastrophic damage and an unflyable aircraft condition.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

a. Mission planning created a route of flight that continued beyond the intended HLZ.

I find by a preponderance of evidence that mission planning created a route of flight with additional waypoints beyond the intended HLZ, which substantially contributed to the mishap. This additional route symbology and numerology displayed on the navigation display enabled a waypoint beyond the HLZ to be selected in error or an interpretation of the HLZ as a turnpoint prior to the HLZ. Had the route terminated at the intended HLZ, it is unlikely the MF would have flown past the HLZ.

b. A breakdown in CRM within the MC and between the MF failed to sufficiently detect and effectively communicate the navigation error.

I find by a preponderance of evidence CRM was not effectively used or accepted, which substantially contributed to the mishap. During MC communications regarding landing time, the MCP correctly identified distance and time to the HLZ, but was erroneously corrected by the MP as the distance and time relative to the waypoint. Further, the Mishap Wingman (MW) failed to adequately provide the proper navigation support of overflying the intended HLZ. This lack of CRM by the MF failed to identify the error, first by failing to correct the MA's erroneous communication and second, during overflight of the intended HLZ, the MF proceeded north despite the indication that navigation instruments properly depicted the overflight.

c. Low illumination conditions present on the evening of the mishap rendered the NVGs insufficient to detect the cables.

I find by a preponderance of evidence that low illumination conditions rendered night vision goggles insufficient to detect the cables which substantially contributed to the mishap. No member of the MF visually identified the cables while using NVGs as the primary equipment to see and avoid unexpected hazards, prior to the MA making contact with them. Low illumination and subsequent NVG visual acuity limitations severely restricted the MC's ability to identify and recognize the field of towers and cables they flew into. Further, the MA was not equipped with any sensors enabling them to identify cables strung between towers. The result was delayed obstacle detection on a very low illumination night as experienced by the MF. This accounted for the late visual acquisition of towers and not being able to detect the cables by the MF.

5. CONCLUSION

I find by a preponderance of evidence that the cause of the mishap was the MP misinterpreting aircraft navigation displays resulting in the MF descending into an unplanned location and striking a 3/8 inch diameter galvanized steel cable strung horizontally between two 341 foot high towers. In addition, I found by a preponderance of evidence that three factors substantially contributed to

the mishap: (1) mission planning created a route of flight which enabled navigation beyond the intended HLZ; (2) a breakdown in CRM within the MC and between the MF failed to sufficiently detect and effectively communicate the navigation error; and (3) the low illumination conditions present during the mission rendered NVGs insufficient to detect the cables.

6 July 2018

A handwritten signature in black ink, appearing to read "B. P. Radliff", written in a cursive style.

BRYAN P. RADLIFF
Brigadier General, USAF
President, Accident Investigation Board

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