UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

UH-1N, T/N 69-6666

37TH HELICOPTER SQUADRON
90TH MISSILE WING
F.E. WARREN AIR FORCE BASE, WYOMING

LOCATION: CHEYENNE REGIONAL AIRPORT (KCYS), CHEYENNE, WYOMING

DATE OF ACCIDENT: 30 AUGUST 2023

BOARD PRESIDENT: COLONEL ADAM C. RUDOLPHI

CONDUCTED IAW AIR FORCE INSTRUCTION 51-307

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE GLOBAL STRIKE COMMAND

NOV 0 4 2024

ACTION OF THE CONVENING AUTHORITY

The report of the accident investigation board, conducted under the provisions of AFI 51-307, that investigated the 30 August 2023 mishap near Cheyenne Regional Airport (KCYS), Cheyenne, Wyoming, involving a UH-1N, T/N 69-6666, assigned to the 37th Helicopter Squadron, substantially complies with the applicable regulatory and statutory guidance and on that basis is approved.

[redacted]

THOMAS A. BUSSIERE
General, USAF
Commander

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

UH-1N, T/N 69-6666
CHEYENNE REGIONAL AIRPORT (KCYS), CHEYENNE, WYOMING
30 AUGUST 2023

On 30 August 2023, at 1029 hours local time (L), a UH-1N, tail number 69-6666, assigned to the 37th Helicopter Squadron (37 HS), 582d Helicopter Group (582 HG), F.E. Warren Air Force Base (AFB), Wyoming (WY) landed hard and then flipped over during an Emergency Procedure (EP) sortie alongside Cheyenne Regional Airport (KCYS) runway 13/31. The Mishap Crew (MC) consisted of the Mishap Instructor Pilot (MIP), Mishap Pilot (MP), and Mishap Flight Engineer (MFE). The MC flew the mishap EP sortie (MS) for MP to regain currency. The Mishap Aircraft (MA) sustained severe damage resulting in a total loss of the MA and the forward looking infrared (FLIR) valued at $5,048,624.00. There was no damage to private property.

The MC departed F.E. Warren AFB, WY at 0925L on the MS. Prior to engaging in the mishap maneuver (MM), a 180-degree autorotation, the MC performed various uneventful maneuvers as part of the scheduled mission. At 1028L, the MC entered the 180-degree autorotation. During the course of the maneuver, the MC overcontrolled the MA resulting in excessive right bank, excessive nose low attitude and uncoordinated flight (being out of trim). This caused a high rate of descent (sink rate). Despite exceeding maneuver parameters, the MC failed to identify the need for a power recovery. Instead, the MC continued to try to salvage the maneuver. When the MIP eventually identified the need for a power recovery, they conducted it incorrectly and executed it too late to avoid ground impact. The MA impacted to the left of KCYS runway 13 tail boom first. The MA proceeded to bounce between the tail boom and the main landing skids until the tail boom and skids broke off. After the tail boom broke off, the MA rotated 540-degrees and came to rest upside down. The MC safely egressed the MA.

The Accident Investigation Board President found by the preponderance of the evidence the mishap was caused by the MIP's failure to recognize the need to execute a power recovery in a timely manner. There were two factors that substantially contributed to the mishap. First, the MP's flight control manipulation when entering the 180-degree autorotation, which resulted in a high sink rate. Second, the MC failed to correctly execute a power recovery once directed by the MP.

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 by the United States or by any person referred to in those conclusions or statements.

SUMMARY OF FACTS AND STATEMENT OF OPINION
UH-1N, T/N 69-6666
CHEYENNE REGIONAL AIRPORT (KCYS), CHEYENNE, WYOMING
30 AUGUST 2023

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ACRONYMS AND ABBREVIATIONS

20 AF	20th Air Force
37 HS	37th Helicopter Squadron
582 HG	582d Helicopter Group
90 MW	90th Missile Wing
ADI	Attitude Display Indicator
AF	Air Force
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFGSC	Air Force Global Strike Command
AFI	Air Force Instruction
AFMAN	Air Force Manual
AFTO	Air Force Technical Order
AFTTP	Air Force Tactics, Techniques, and Procedures
AGL	Above Ground Level
AIB	Accident Investigation Board
BL	Butt-Line
BPO	Basic Post-Flight
BS	Boom Station
CCIR	Commander's Critical Information Requirement
CGB	Combining Gear Box
CT	Computerized Tomography
CVR	Cockpit Voice Recorder
DAFMAN	Department of the Air Force Manual
DoD-HFACS	Department of Defense Human Factors Analysis
DP	Demo Pilot
EP	Emergency Procedure
FA	Flight Authorization
FCF	Functional Check Flight
FLIR	Forward Looking Infrared
FPM	Feet Per Minute
GSC	Global Strike Command
HS	Helicopter Squadron
IAW	In Accordance With
ICBM	Intercontinental Ballistic Missile
IDAR	Integrated Data Acquisition Recorder
IMDS	Integrated Maintenance Data System
IP	Instructor Pilot
JCS	Joint Chiefs of Staff
KCYS	Cheyenne Regional Airport
KIAS	Knots Indicated Airspeed
L	Local Time
LH	Left
Lt Col	Lieutenant Colonel
MA	Mishap Aircraft
MC	Mishap Crew
MFE	Mishap Flight Engineer
MIP	Mishap Instructor Pilot
MIS	Management Information System
MM	Mishap Maneuver
MP	Mishap Pilot
MS	Mishap EP Sortie
MW	Missile Wing
Nf	Engines
NOTAMS	Notice to Airmen
Nr	Rotor
OML	Outer Mold Line
OPREP	Operations Report
Ops Sup	Operations Supervisor
ORM	Operational Risk Management
OTI	One Time Inspection
PF	Pilot Flying
PR	Pre-Flight
RAP	Ready Aircrew Program
RTM	Ready Aircrew Program Tasking Memorandum
RH	Right
RPM	Revolutions Per Minute
SAR	Search and Rescue
STOL	Short Takeoff and Landing
T/N	Tail Number
TC	Training Circular
TH	Thru-Flight
TO	Technical Order
TOLD	Takeoff and Landing Data
VFR	Visual Flight Rules
WaRTAK	Wave Relay Tactical Assault Kit

WR-ALC	Warner Robins Air Logistic Command	WY	Wyoming

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 3 October 2023, Major General Kenneth S. Eaves, Deputy Commander AFGSC, appointed Lieutenant Colonel Adam C. Rudolphi to conduct an aircraft accident investigation of the 30 August 2023 mishap of a UH-1N aircraft, tail number (T/N) 69-6666, that occurred on runway 13/31 of Cheyenne Regional Airport (KCYS), Cheyenne, WY (Tab Y-3 to Y-4). The aircraft accident investigation was conducted at F.E. Warren Air Force Base (AFB), Wyoming (WY), from 8 October 2023 through 1 November 2023 in accordance with (IAW) Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations*, dated 18 March 2019 (Tab DD-50). The following board members were also appointed: Major Pilot Member, Major Medical Member, Captain Legal Advisor, Senior Master Sergeant Maintenance Member, and Technical Sergeant Recorder (Tab Y-3).

b. Purpose

In accordance with AFI 51-307, this Accident Investigation Board (AIB) 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 30 August 2023, at 1029 hours local time (L), a UH-1N, T/N 69-6666, assigned to the 37th Helicopter Squadron (37 HS), 582d Helicopter Group (582 HG), F.E. Warren AFB, WY landed hard and then flipped over during an Emergency Procedure (EP) sortie alongside KCYS runway 13/31 (Tabs S-4 to S-5, Z-6 to Z-11, DD-14, DD-48, and DD-50). The Mishap Crew (MC) consisted of the Mishap Instructor Pilot (MIP), Mishap Pilot (MP), and Mishap Flight Engineer (MFE) (Tab K-3). The MC flew the mishap EP sortie (MS) for MP to regain currency (Tab K-10 and R-38). The Mishap Aircraft (MA) sustained severe damage resulting in a total loss of the MA and forward looking infrared (FLIR) valued at $5,048,624.00 (Tabs P-3 and S-20). There was no damage to private property (Tab P-3).

The MC departed F.E. Warren AFB, WY at 0925L on the MS (Tab K-36). Prior to engaging in the mishap maneuver (MM), a 180-degree autorotation, the MC performed various uneventful maneuvers as part of the scheduled mission (Tab R-32, R-38, and R-43). At 1028L, the MC entered the 180-degree autorotation (Tabs N-4 and Tab DD-48 to DD-49). During the course of the maneuver, the MA had excessive right bank, excessive nose low attitude, uncoordinated flight (being out of trim), and a high rate of descent (sink rate) (Tab DD-13 to DD-14 and DD-18). Due to the MA's continued high sink rate, high forward airspeed, and lack of power and rotor speed, the MC impacted the ground 20 seconds after the practice 180-degree autorotation began (Tab DD-13 to DD-14 and D-25). The MA impacted to the left of KCYS runway 13, tail boom first (Tab DD-14). The MA proceeded to bounce between the tail boom and the main

landing skids until the tail boom and skids broke off (Tab DD-14 and DD-37). After the tail boom broke off, the MA rotated 540-degrees and came to rest upside down (Tab DD-14 and DD-45). All three MC members remained trapped into their seats during the impact and rollover sequence and then safely egressed the MA (Tab R-42, R-38, and R-44).

3. BACKGROUND

The MA was assigned to the 582 HG, F.E. Warren AFB, WY (Tab G-11, G-60 and G-102). The MC was assigned to the 37 HS at F.E. Warren AFB, WY (Tab G-11, G-60, G-102 and CC-11).

a. AFGSC

AFGSC, activated 7 August 2009, is a major command with headquarters at Barksdale AFB, Louisiana, in the Shreveport-Bossier City community (Tab CC-3). AFGSC is responsible for the nation's three intercontinental ballistic missile (ICBM) wings, the Air Force's entire bomber force, to include B- 52, B-1 and B-2 wings, the Long-Range Strike Bomber program, Air Force Nuclear Command, Control and Communications systems, and operational and maintenance support to organizations within the nuclear enterprise (Tab CC-3).

b. 20 AF

20 AF is a Numbered Air Force with headquarters at F.E. Warren AFB, WY, in the Cheyenne community (Tab CC-6). 20 AF is responsible for the Nation's three ICBM wings, one nuclear operations support wing and one geographically separated unit (Tab CC-6). As the missile Numbered AF for AFGSC, 20 AF is responsible for operating, maintaining, securing and supporting the AF's ICBM force (Tab CC-6). 20 AF provides on-alert, combat ready ICBMs to the President (Tab CC-6).

c. 90 MW

F.E. Warren AFB, WY, is home to the 90 MW, which activated 1 July 1963, with the original designation of the 90th Strategic Missile Wing (Tab CC-8). F.E. Warren AFB became the nation's first operational ICBM base with the introduction of the Atlas missile in 1958 (Tab CC-8). Today, the Mighty Ninety operates Minuteman III (LGM-30G) ICBMs on full alert 24-hours a day, 365 days a year (Tab CC-8).

d. 582 HG

The 582 HG provides operations, maintenance, standardization evaluation, flight safety and aircrew flight equipment oversight for three helicopter squadrons and one support squadron at the 90th, 91st and 341st Missile Wings (Tab CC-11). The group is headquartered at F.E. Warren AFB, WY (Tab CC-11). Enables key airborne security capability and airlift for Task Force 214 operations supporting nuclear security missions for 450 ICBM sites (Tab CC-11). Provides rescue operations

in support of Joint Chiefs of Staff (JCS) National Search and Rescue (SAR) and Response Plans (Tab CC-11).

e. 37 HS

The 37 HS provides helicopter security response for the 90 MW located at F.E. Warren AFB, WY (Tab CC-12). The squadron supports emergency war order taskings, by transporting tactical response force teams in support of launch facility denial and recapture and convoy operations (Tab CC-12). The squadron also conducts priority passenger and cargo airlift, as well as executes search and rescue and medical evacuation operations in support of JCS National SAR and Response Plans for federal, state, and local agencies (Tab CC-12).

f. UH-1N – Iroquois

The UH-1N is a light-lift utility helicopter used to support various missions (Tab CC-14). The primary missions include: airlift of emergency security forces, security and surveillance of off-base nuclear weapons convoys, and distinguished visitor airlift (Tab CC-14). Other uses include: disaster response operations, search and rescue, medical evacuation, airborne cable inspections, support to aircrew survival school, aerial testing, routine missile site support and transport (Tab CC-11).

The UH-1N has a crew of three (pilot, co-pilot and one or two flight engineers) and is capable of flight in instrument and nighttime conditions (Tab CC-14). When configured for passengers, the UH-1N can seat up to 13 people, but actual passenger loads are dependent on fuel loads and atmospheric conditions (may be less) (Tab CC-14). The medical evacuation configuration can accommodate up to six litters (Tab CC-14). Without seats or litters, the cabin can carry bulky, oversized cargo (Tab CC-11). Access to the cabin is through two full- sized sliding doors (Tab CC-14).

g. Autorotation

An autorotation is when the rotor of the helicopter is driven solely by the action of the air flowing upward through the rotor blades rather than by engine power (Tab BB-209 and BB-212 to BB-214). The upward airflow during the descent provides the energy to turn the rotor; thus, the descending helicopter is in a state of autorotation (Tab BB-207 and BB-211). As the helicopter's altitude decreases, potential energy is converted into kinetic energy used in turning the rotor, which is used to slow the rate of descent to a controlled rate and affect a smooth touchdown (Tab BB-209 and BB-213). It is the means by which a helicopter can be landed safely in the event of an engine failure (Tab BB-222).

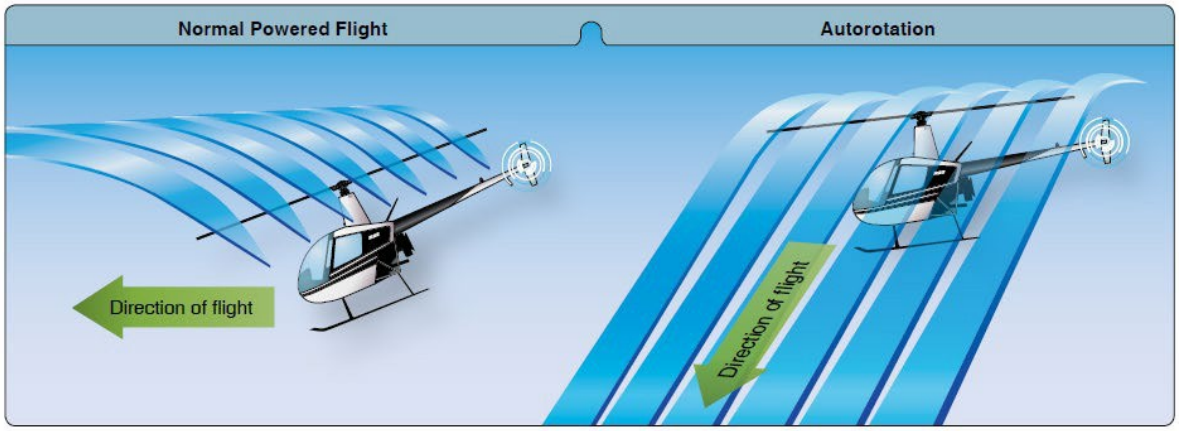

Figure 3-1 (Tab BB-222)
Figure from FAA Helicopter Flying Handbook

4. SEQUENCE OF EVENTS

a. Mission

The MS was scheduled as an EP instrument sortie (Tab K-3). The MS was planned to take place at both the Short Takeoff & Landing (STOL) area on F.E. Warren AFB and the runway at KCYS (Tabs K-36, R-38, and BB-58). The expected duration of the MS was 2.5 hours in accordance with the crew Flight Authorization (FA) (Tab K-3). The purpose of the MS was to get the MP recurrent on EP training (Tab K-9). He had not flown in over three months and had therefore exceeded the currency requirements outlined in Table A3.1 of the Air Force Manual (AFMAN) 11-2UH-1N, Volume 1 (AFMAN 11-2UH-1NV1), *UH-1N Helicopter Aircrew Training*, dated 8 January 2023 (Tabs V-3.3 and BB-65). The approval authority for the MS was the Operations Supervisor (Ops Sup) (Tab K-9).

(1) Crew Composition

The FA indicated the MIP was the aircraft commander (Tabs K-3 to K-4). He occupied the left seat during the MS and was responsible for monitoring the flight controls throughout the sortie (Tabs H-14, R-36, and BB-69). Per the Air Force Tactics, Techniques, and Procedures (AFTTP) 3-3.H-1, *Combat Fundamentals H-1,* 4 August 2023 (AFTTP 3-3.H-1), the MIP is also responsible for "executing corrective action at the first indications of deteriorating aircraft performance or serious crew proficiency problems" during simulated emergency maneuvers (Tab BB-145). The MP occupied the right seat during the MS and was the pilot flying (PF) at the start of the mishap sequence (Tab R-38 and R-44). The MFE occupied the left jump seat in the MA (Tabs H-15 and R-33). He monitored gauges and made rotor calls during the mishap sequence (Tab R-33 and R-35).

b. Planning

All three MC members met two hours prior to takeoff time (Tab R-32, R-38, and R-43). At that point, pre-flight duties were divided amongst the three MC members (Tab R-30 and R-43). MIP conducted go/no-go checks on each MC member, ensured required paperwork was in order, and accomplished the Operational Risk Management (ORM) worksheet (Tab R-38). According to the ORM worksheet, the MC determined their overall risk to be a 13, which put them in the "Low" category (Tab K-9). The MP checked Notices to Airmen (NOTAMS) and the weather and completed standard pre-flight duties (Tab R-43). The MFE calculated weight & balance, ran the Takeoff and Landing Data (TOLD), and conducted the pre-flight on the aircraft (Tab R-32).

The MIP briefed the crew using AFMAN 11-2UH-1N Volume 3, Checklist-1, (AFMAN 11-2UH-1NV3CL-1) *UH-1N Crew Briefing Guides/Checklists*, dated 18 May 2022 (Tabs R-11, R-15, R-32, V-1.4 to V-1.5, and BB-477). The MFE stated MIP also delivered the *Transition/Emergency Procedures Briefing*, the requirements for that briefing can be found in the *Specialized Briefings* section of AFMAN 11-2UH-1NV3CL-1 (Tabs R-15 and BB-477).

The MIP stated the mission prep and brief were unremarkable, while the MP commented that it was a standard EP brief for F.E. Warren AFB (Tabs R-38 and R-43). The MFE noted that it was a quick brief that wasn't really in depth, as compared to other EP instructors' briefs, but that it was fine overall (Tab R-32).

c. Preflight

The 37 HS Ops Sup gave the MIP a step brief during which time the Ops Sup verified the mission paperwork was in order, and the MC members were current and/or qualified for the training mission (Tabs K-9, R-38, BB-88, and BB-133 to BB-134). The MC's AFE was serviceable (Tabs R-43 and AA-3 to AA-15). As stated previously, the MFE conducted the pre-flight of the aircraft prior to the aircrew briefing (Tab R-32). Each MC member stated independently that they did not believe there to be any mechanical issues with the aircraft prior to takeoff (Tab V-1.3, V-2.5 to V-2.6, and V-3.3). The aircraft had been "cocked" the night before the MS, which placed the aircraft in a "scramble" status, so the MC performed the "scramble" checklist procedures in order to start and run- up the aircraft (Tabs R-41 and BB-478 to BB-481).

d. Summary of Accident

At 0925L, the MC took off from the helicopter pad at F.E. Warren AFB and entered the Visual Flight Rules (VFR) traffic pattern at F.E. Warren AFB (Tabs K-36 and BB-58). The MC began the sortie by conducting two warm-up patterns to STOL lane 13 (Tab R-32 and R-43). The MIP and MP each flew one of these warm-up patterns (Tab R-32 and R-43). Upon completion of the warm-up patterns, the MC shifted to STOL lane 23 when winds were 180-degree at 10 knots (Tab R-43). Once established on the STOL, both the MIP and MP flew a Single Hydraulic System Failure approach (Tabs R-32 and R-43). The MC then proceeded to Manual Fuel operations where each pilot flew a Manual Fuel approach (Tabs R-32, R-43, DD-48, and EE-17). At this point, the MC began their practice autorotations (Tabs DD-48 and EE-19 to EE-21). The MP flew the first autorotation of the day (Tabs R-32 and R-43). The aircraft controls were then transferred to the MIP, and he performed straight-ahead autorotation (Tabs R-32, DD-48, and EE-21 to EE-22). None of the MC members expressed anything unusual or noteworthy about either of the straight-ahead autorotations (Tabs R-32, R-38, and R-43). From here, the MC transitioned to KCYS to

finish conducting the rest of their EP maneuvers (Tabs R-33 and EE-25).

The MC contacted Cheyenne tower and requested to join the closed traffic pattern for runway 13 (Tabs DD-48 and EE-25). The tower subsequently cleared them for right closed traffic to runway 13 (Tabs DD-48, EE-25 to EE-26, and EE-29). The MP and MIP each executed a right 90-degree autorotation to runway 13 (Tabs DD-48 and EE-25 to EE-28). Following both 90-degree autorotations, the MC requested high inside downwind so they could conduct their 180-degree autorotations (Tabs R-44, DD-48, and EE-26 to EE-27). The tower denied this request due to aircraft sequencing issues with other aircraft in the pattern (Tabs DD-48 and EE-29). The tower instead cleared MC for left closed traffic, and as a result, the MC elected to return to runway 13 for a "Single Engine Failure Inflight" approach (Tabs DD-48 and EE-29). The MC simulated a single engine failure due to a hypothetical bird strike in the #1 engine (Tabs DD-48 to DD-49 and EE-29). The MP executed the appropriate EP checklists and flew the "single engine slide" landing to runway 13 (Tabs R-44, DD-49 and EE-29). Upon completion of the slide landing, the tower cleared the MC for high inside downwind back to runway 13 (Tabs R-44, DD-49, and EE-34). The MP setup to come back around for his right turning 180-degree autorotation (Tabs R-44, DD-49, and EE-34).

Approximately 1 hour and 3 minutes into flight, at 10:27:24L, the tower cleared the MC for the option to runway 13 with the stipulation of "minimal delay" on the runway (Tabs N-4, DD-49, and EE-35). The normal entry parameters for a 180-degree autorotation are a minimum altitude of 800 feet above ground level (AGL), and between 60-100 knots indicated airspeed (KIAS) (Tab BB-137). The MC entered the autorotation at 920 feet AGL and 84 KIAS (Tab DD-12 and DD-16). Upon entry into the maneuver, the MP called "autorotate throttles flight idle," and began a right turn (Tabs N-4, DD-49, and EE-35). The MFE called "good disengagement," which implies a good split between the rotor (Nr) and engines (Nf) (Tabs BB-142, DD-49 and EE- 35).

At approximately 680 feet AGL, the MIP called, "watch your nose down" (Tabs DD-12 and EE-35). At this point, the MA had a sink rate of approximately 3,300 feet per minute (FPM) (Tab DD-12). The MP stated that after the MIP made this call, he "brought the nose up" (Tab R-42). According to the Integrated Data Acquisition Recorder (IDAR), there are no indications the MP ever made this control input (Tab DD-12). The sink rate and nose down attitude of the MA continued to increase over the next four seconds of the autorotation (Tab DD-12). According to AFMAN 11-2UH-1NV3, "at the first indication of an excessive sink rate, aircrew WILL terminate autorotations and initiate a power recovery" (Tab BB-137) (emphasis added). The AFTTP 3-3.H-1, defines a normal sink rate as "less than 3,000 FPM (Tab BB-141)."

Figure 4-1 (Tab DD-12)
MA and Demo Sortie Comparison – Sink Rate and Nose Low - 1

At the request of the AIB, the demo pilot (DP) utilized an already scheduled EP sortie to record data during a 180-degree autorotation (henceforth, "demo sortie") (Tab V-6.2 and V-6.5). This 180-degree autorotation adhered to all the parameters outlined in the AFMAN 11-2UH-1NV3 and AFTTP 3-3.H-1 (Tabs BB-137 to BB-138, BB-141, and DD-11). As the MA passes through 500 feet AGL, a side-by- side comparison of the MA's sink rate and nose low attitude, versus the demo sortie's sink rate and nose low attitude, illustrate just how excessive these two parameters were in the MA (Tab DD-12).

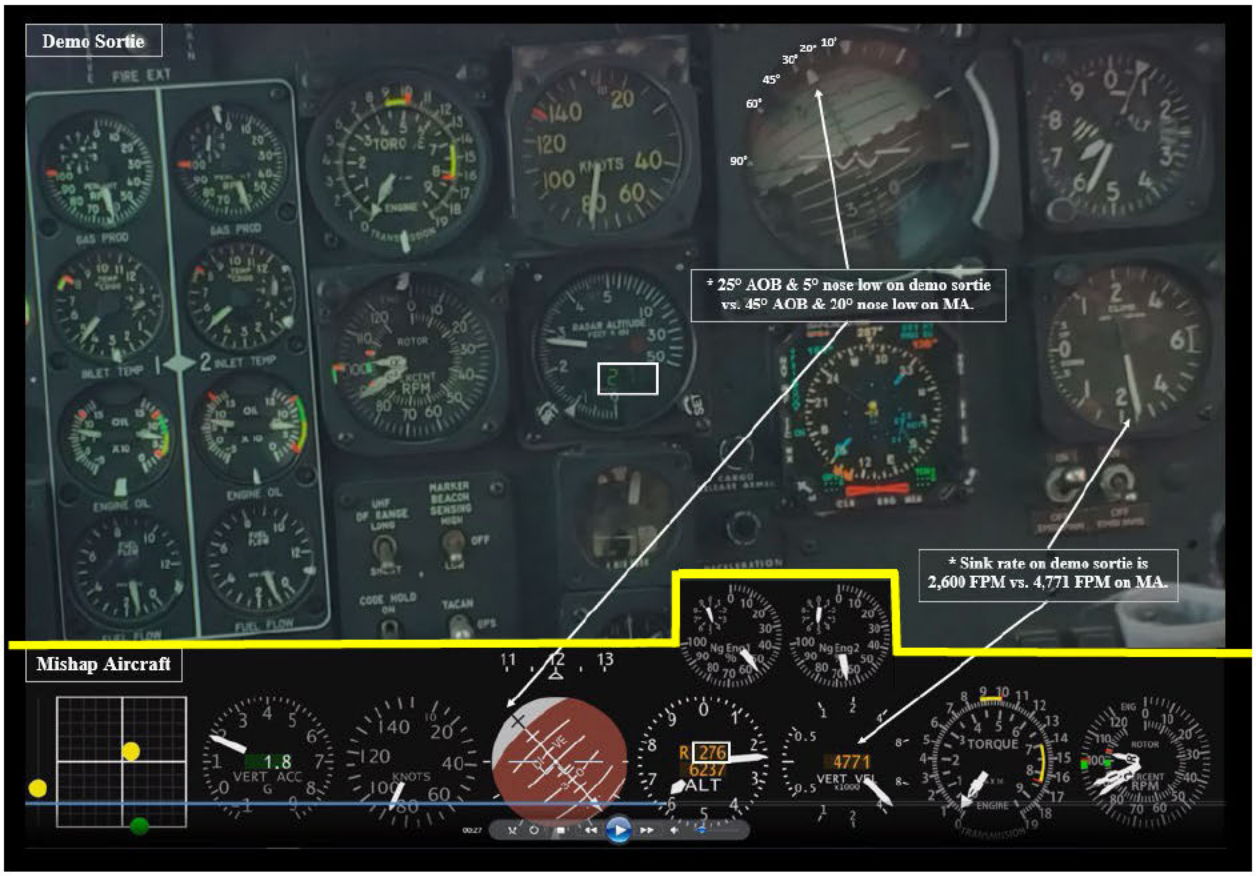

Figure 4-2 (Tab DD-13)
MA and Demo Sortie Comparison – Sink Rate and Nose Low – 2

During the post mishap interviews, both the MIP and the MP reported having an extreme nose down attitude and excessive sink rate (Tab R-38 and R-44). MIP stated, "it was through the turn I noticed we were extremely nose down (Tab R-38)." And the MP said, "as we turned right, as we started to view the runway, we still had a pretty honkin sink" (Tab R-44). At no point throughout the maneuver did a member of the MC call "power recovery", which is the standard call made to terminate an autorotation and roll the throttles to full open in order to engage the rotor (Tabs N-3 and BB-142). It was not until approximately 200 feet AGL that a "go around" call was made by the MP (Tabs N-3 and DD-12). A "go around" implies the aircraft already has power (throttles full open), so when collective is applied, the aircraft will climb away from the ground (Tabs V-7.10 to V-7.11 and BB-165). In the case of the MA, when the go around was called, the throttles were at flight idle, and therefore did not have power when the MC applied collective (Tab DD-13). Shortly after the go around call was made, the MIP took the flight controls in an effort to recover the aircraft (Tab V-1.11 to V-1.13).

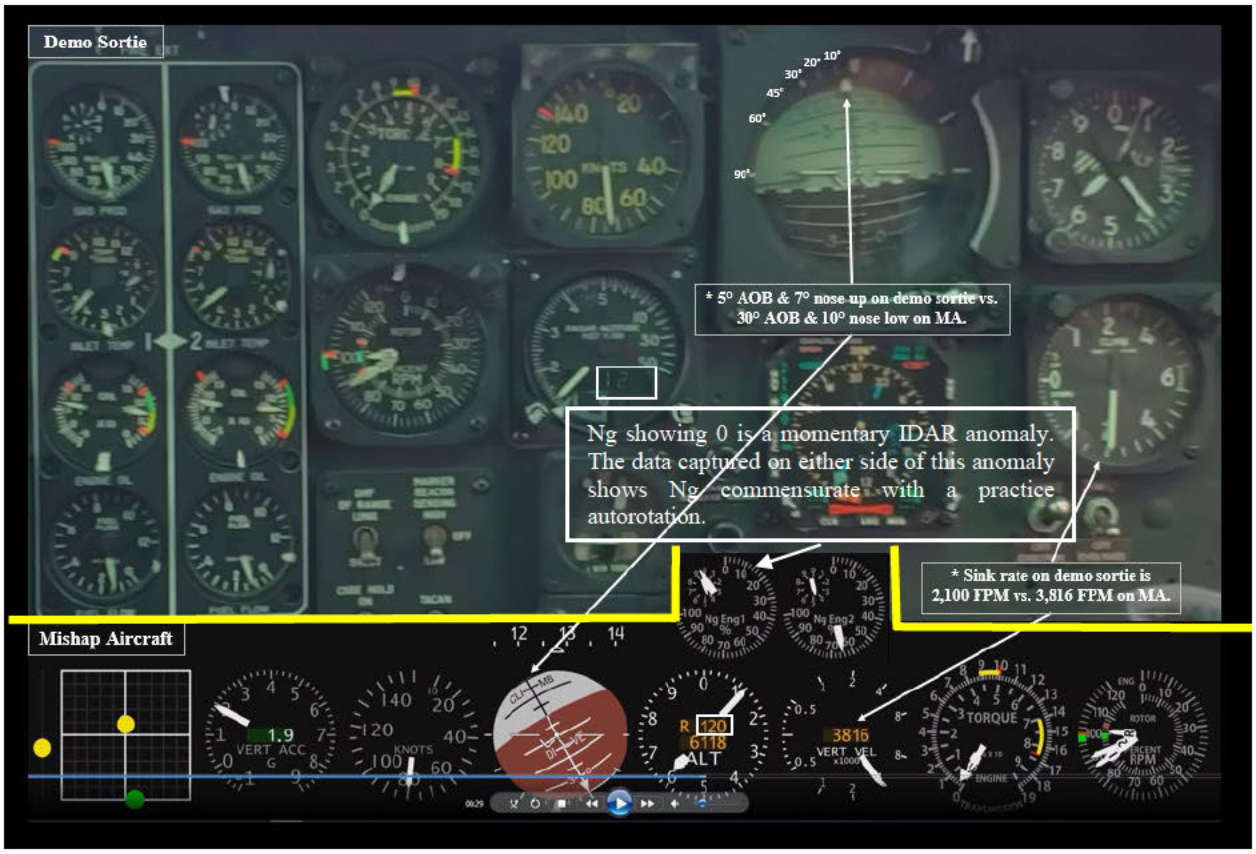

Figure 4-3 (Tab DD-23)
MA and Demo Sortie Comparison – Sink Rate and Nose Low – 3

According to AFMAN 11-2UH-1NV3, "When performing any autorotation, prior to descending below 150 feet AGL, aircrew must maneuver the aircraft to wings level, have a minimum of 60 KIAS, have rotor revolutions per minute (RPM) within limits, and be aligned within 30 degrees of the landing/recovery heading. If any of these conditions are not met, aircrew will initiate a power recovery immediately (Tab BB-138)." At 120 feet AGL, the MA still had 30 degrees of bank and a 10-degree nose down attitude (Tab DD-12). Additionally, the MA had a 3,816 FPM sink rate, and no throttle application had been made (Tab DD-12 and DD-23). Of note here, is the significant difference in sink rate and nose down attitude between the MA and demo sortie as noted in the above figure (Tab DD-12 to DD-13).

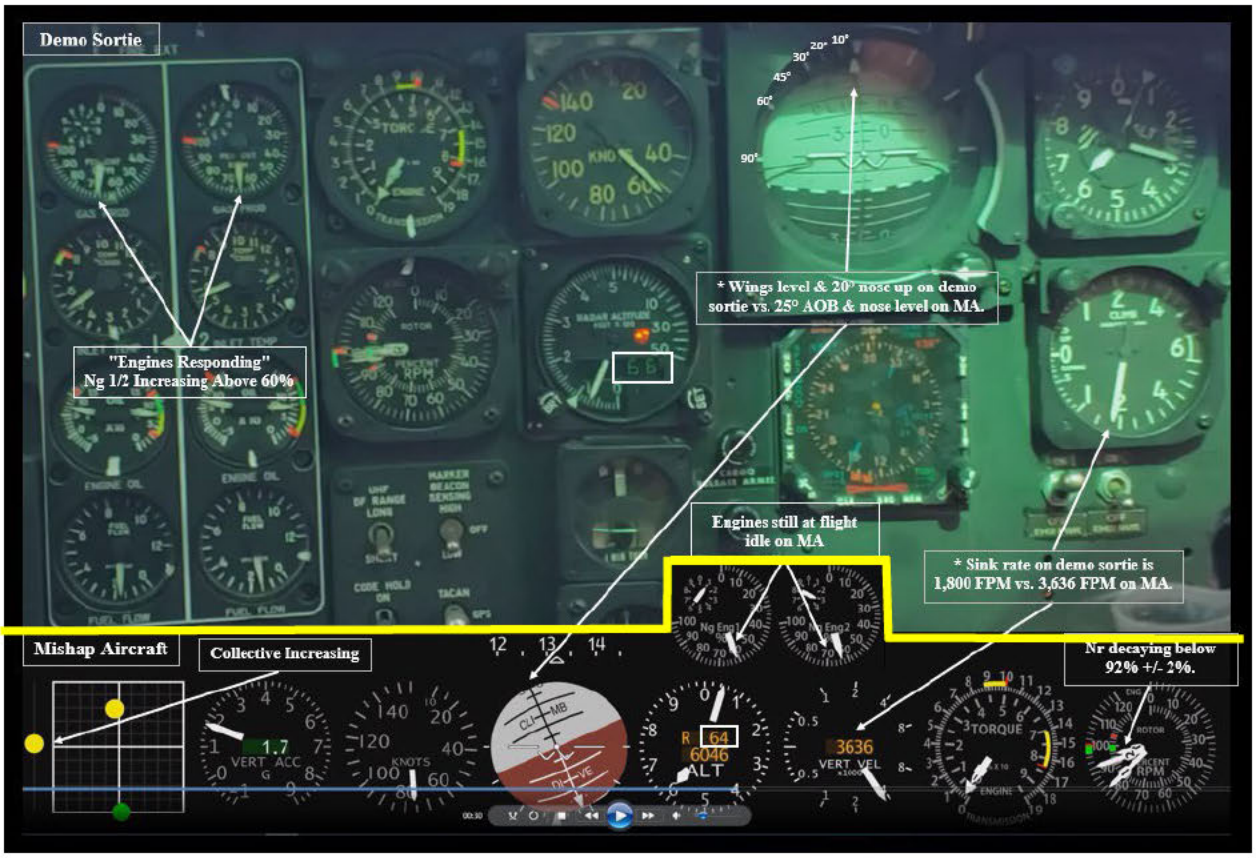

Figure 4-4 (Tab DD-15)
MA and Demo Sortie Comparison – Instrument Readings -1

At approximately 100 feet AGL, the MC gets the rotor RPM low warning audio alert, which comes on when Nr drops below 92% +/- 2% (Tabs BB-139, DD-12, and DD-16). This is a result of collective being applied while throttles are still at flight idle (Tab DD-13). The MP stated that as he started to see the "ground come up," and knew the MA was going to impact the ground, he instinctively pulled up on the collective despite the MIP having the controls (Tabs R-45 and V-2.12 to V-2.13). At 65 feet AGL, the MA is still in a 25-degree bank turn and nose level attitude as the MIP attempts to get the MA lined up with runway 13 (Tab DD-13 and DD-23). The most notable differences between the MA and demo sortie at this juncture are the lack of throttle application on the MA and the ineffectiveness of the flare on the MA with a nose level attitude compared with a 20-degree nose up attitude on the demo sortie (Tab DD-13 and DD-24).

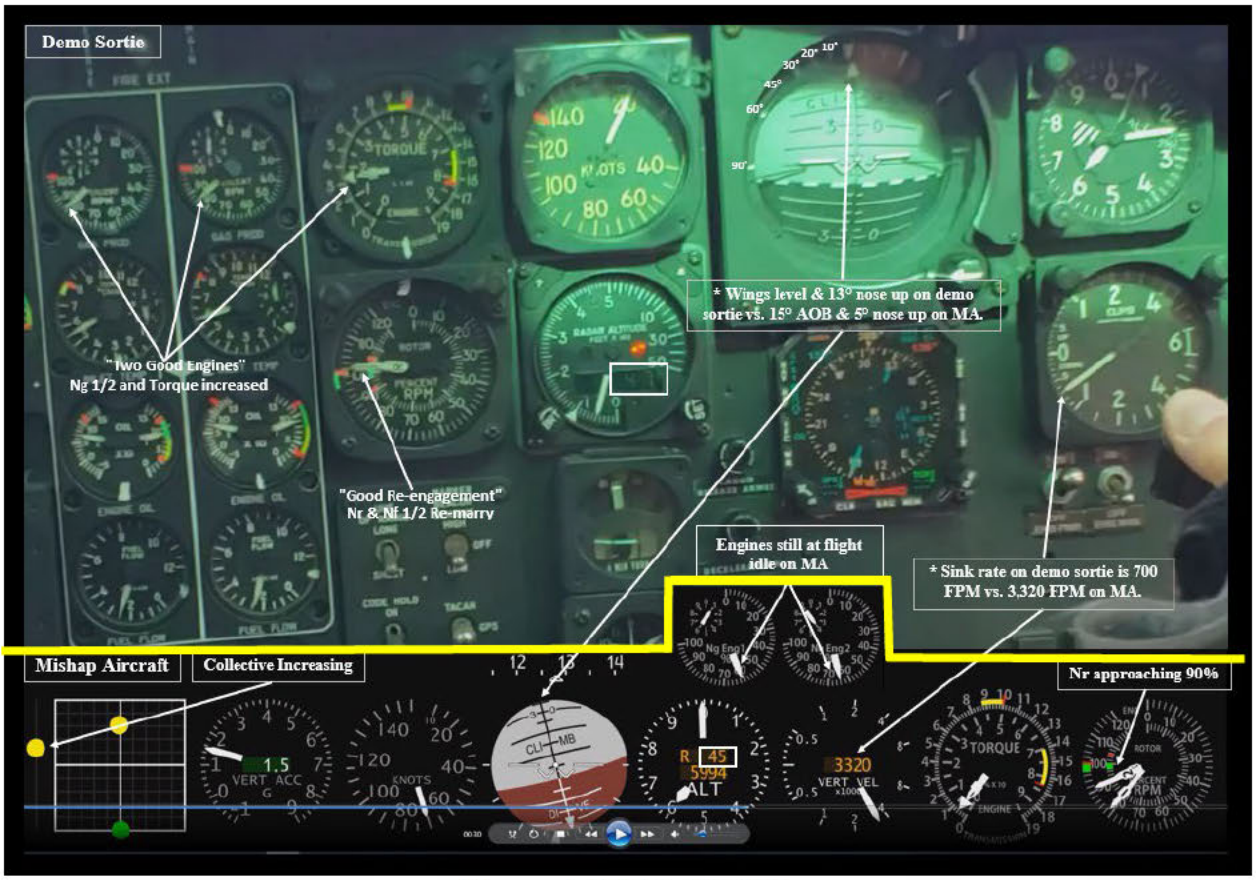

Figure 4-5 (Tab DD-16)
MA and Demo Sortie Comparison – Instrument Readings -2

As the MA passes through 50 feet AGL, the first indications of a "flare" are seen on the attitude display indicator (ADI), when the pitch of the aircraft reaches 5-degrees nose up (Tab DD-13 and DD-24). A flare just before touchdown reduces airspeed and decreases rate of descent (Tab DD-13). The flare is accomplished by applying aft cyclic, which changes the attitude of the rotor disk in relation to the relative wind (Tab DD-14). This attitude change increases the resultant lift of the rotor system, which in turn, slows forward airspeed and reduces rates of descent (Tab DD-13). This ultimately enables the helicopter to attain a safe landing speed and attitude, as collective pitch is applied in order to cushion the landing (Tab DD-14).

However, passing through 50 feet AGL, the MA is still in a 15-degree right bank turn with a high sink rate of 3,320 FPM (Tab DD-13). The rotor continues to decay and is approaching 90% Nr (Tab DD-13). Throttles still have not been rolled in and the aircraft is doing 70 KIAS (Tab DD-13). At this point in the mishap sequence, there is a vast difference in sink rate, Nr, and torque between the MA and demo sortie (Tab DD-13).

Figure 4-6 (Tab DD-17)
MA and Demo Sortie Comparison – Instrument Readings -3

As the MA approaches 15 feet AGL, the nose-up attitude of the aircraft reaches 8-degrees (Tab DD-13). The sink rate is decreasing, but still indicating 2,409 FPM, which is over 40 feet per second (Tab DD-13). It is at this altitude that the first signs of throttle application can be seen, as Ng's increase past 65%, and torque increases to 15% (Tab DD-13). As can be seen in the side-by-side graphic, the demo sortie has 80% torque applied and 100% Nr, which allows them to arrest their sink rate (650 FPM) and terminate the maneuver no lower than 5 feet AGL (the minimum altitude for terminating a 180-degree autorotation per AFMAN 11-2UH-1NV3) (Tabs DD-13 and BB-137). Due to the MA's high sink rate, high forward airspeed (65 KIAS), and lack of power and rotor speed, the MC was unable to recover the MA above the 5 feet AGL minimum altitude and descends into the ground (Tab DD-13 and DD-25).

e. Impact

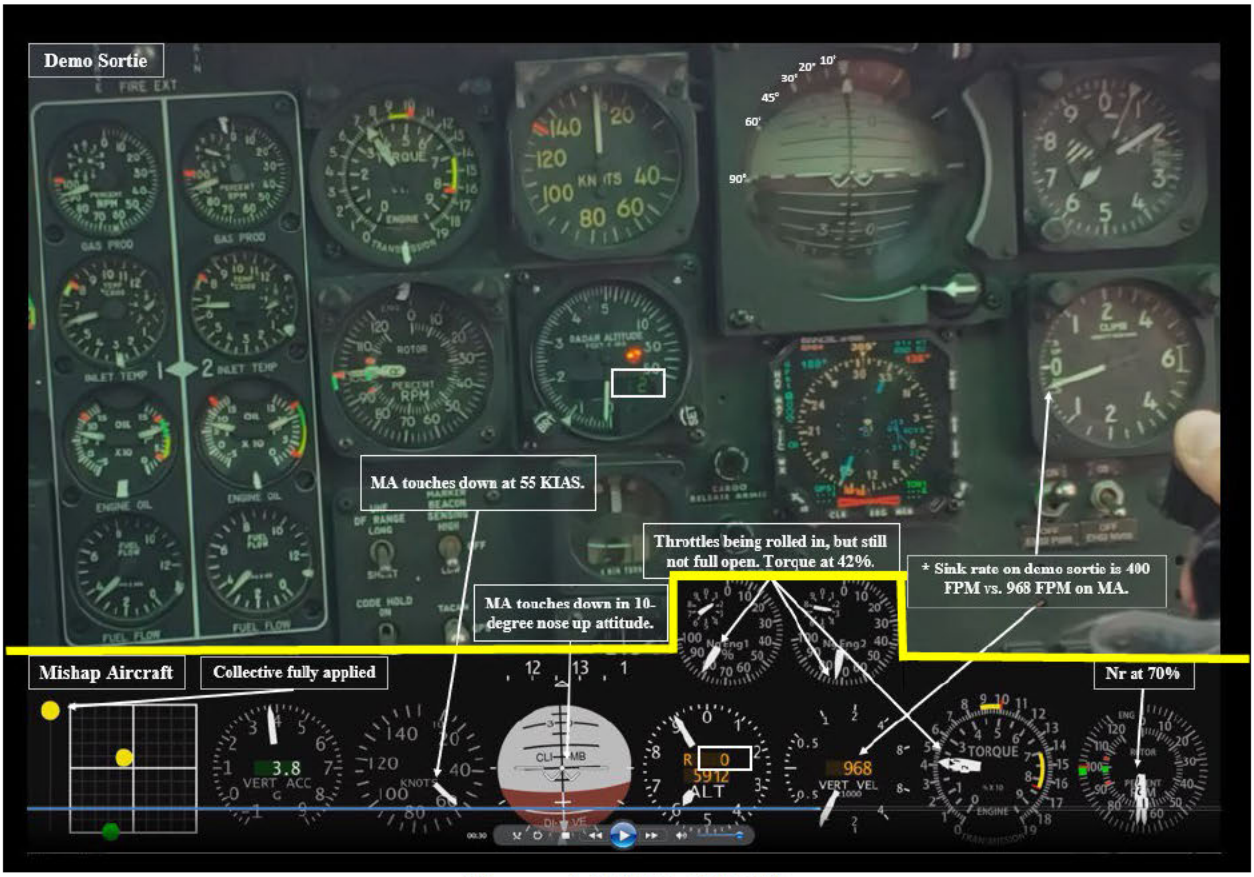

Figure 4-7 (Tab DD-18)
MA and Demo Sortie Comparison – Instrument Readings -4

The MA impacted the ground 20 seconds after the practice 180-degree autorotation began (Tab DD-14). This occurred just prior to the runway 13 threshold and off the left side of the runway on a heading of 126 degrees (Tabs S-4 and DD-14). The MA touched down with a 10-degree nose up attitude, wings level, approximately 968 FPM sink rate, and 55 KIAS (Tab DD-14). Due to the nose up attitude of the aircraft, the tail boom impacted the ground first, which then propelled the nose of the aircraft into the ground at a force of 3.8 Gs (Tabs H-10, BB-163 and DD-14). The MA completed two full iterations of bouncing back and forth between the tail boom and skids, at which time, the tail boom and skids separated from the aircraft (Tabs DD-14, DD-32 to DD-37, and S-5).

The tail rotor provides anti-torque for the aircraft and counteracts the rotation of the main rotor blade, which in turn, keeps the aircraft from spinning (Tabs BB-164 and BB-196). When the tail boom departed the aircraft, so did the anti-torque system (Tab DD-14). This resulted in the MA spinning to the right and rolling over onto its left side (Tab DD-14). The rolling motion caused the main rotor blades to contact the runway three times before separating from the aircraft (Tab S-4 and DD-14). The aircraft spun a total of 540-degrees before coming to a stop, upside down, just off the left edge of runway 13 (Tab DD-14). All three MC members remained strapped into their seats during the impact and rollover sequence (Tab R-34, R-38, and R-44).

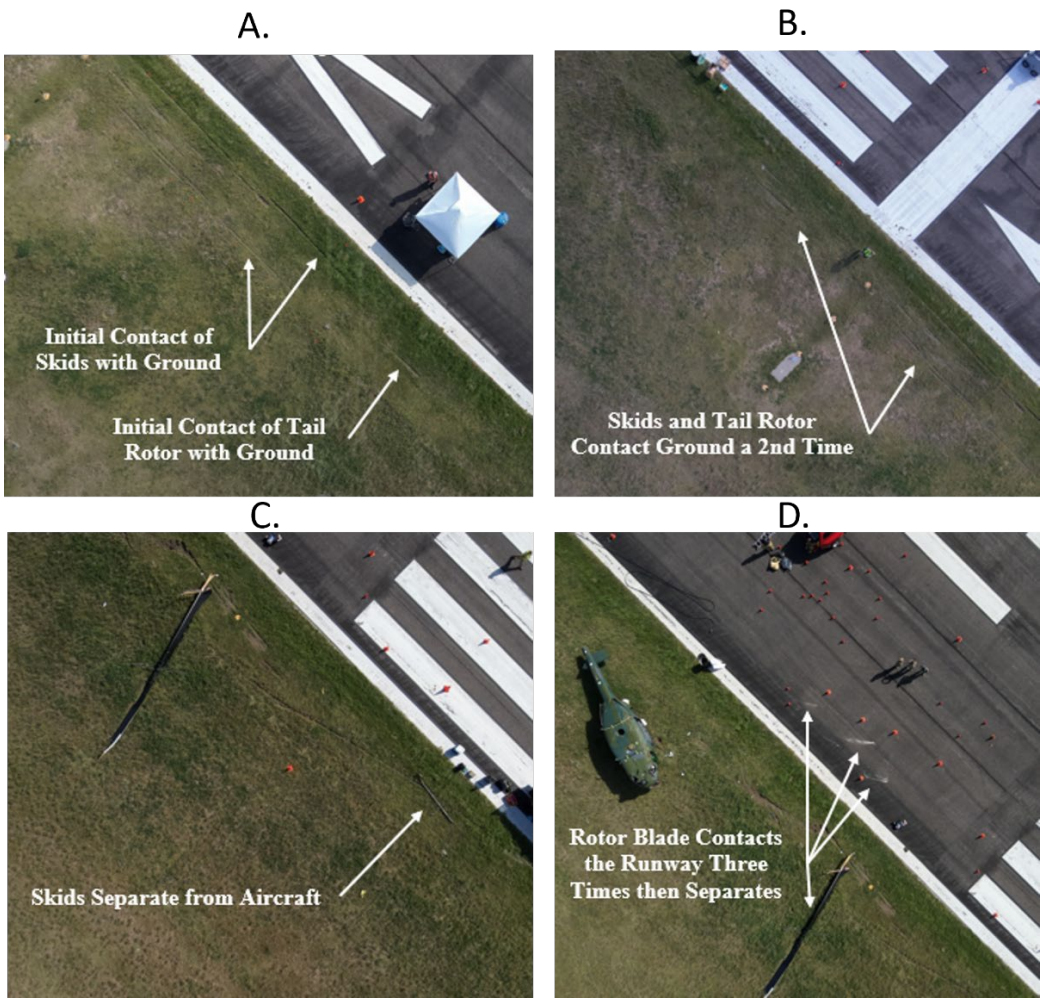

Figure 4-8 (Tab S-4 to S-7)
Crash Site Photos

f. Egress and AFE

Once the MA came to rest upside down, each MC member released their seatbelts and egressed the aircraft (Tab R-34, R38, and R-44). The MIP fell through the windshield and then crawled out the front of the aircraft (Tab R-38). The MP climbed into the cabin of the aircraft to check on the MFE and then both the MP and MFE exited the aircraft through the right cabin door (Tab R-34 and R-44). All three MC members met up at the 12 o'clock of the MA (Tab R-44). No emergency shutdown procedures were completed by the MC before they egressed the aircraft (Tab R-38 to R-39 and R-44). The violent nature of the crash, and the way the MA came to rest, caused the engines to flame out (loss of fuel source to engine) (Tabs L-279 to L-281 and DD-14). When the Wyoming Air National Guard Fire Department arrived on scene, they verified all MC members were okay, then proceeded to pull the "T handles" in order to ensure no more fuel was being fed to the engines (Tab V-8.1 to V-8.3). The Fire Department then asked the MIP to assist with removing power to the aircraft by turning off the battery switch and disconnecting the battery in the nose compartment (Tabs R-39, V-8.3, and EE-4).

All life support equipment, restraining devices and emergency egress points functioned as designed (Tabs H-14 to H-16, R-34, R-38, and R-44). Inspections on the MC members aircrew flight equipment were current at the time of the mishap (Tab AA-3 to AA-14).

g. SAR

The Fire Department members recalled looking out the kitchen window of their alert facility and watching the aircraft "hit hard" (Tab V-8.1 to V-8.2). The Fire Department did not wait for a crash support call from Cheyenne Tower, but instead responded to the incident as soon as they saw the aircraft experience the hard landing (Tab V-8.2). While waiting for emergency responders to arrive, the MIP called the 37 HS Ops Sup to report what had happened and start the "checklist" (Tab R-39). The occurrence of an aerospace mishap requires up-channeling of information through the Commander's Critical Information Requirements (CCIR) and operations report (OPREP) processes (Tab BB-95). The Fire Department arrived on scene within four minutes of the aircraft coming to a stop upside down (Tab EE-3 to EE-4). Before The Fire Department attempted to shut down the aircraft, they conducted an initial assessment of all three MC members to ensure they did not require any immediate and/or additional medical care (Tab V-8.2). The MP and MFE were transported to the Cheyenne Regional Emergency Department for follow on care (Tab X-3).

5. MAINTENANCE

a. Forms Documentation

At the time of the mishap, the MA's total aircraft time was 20,045.2 hours (Tab DD-8). The left (LH) engine had 13,301.9 hours and the right (RH) engine had 10,519.9 hours, and the combining gearbox (CGB) had 12,542.6 hours (Tab DD-8).

All existing aircraft Air Force Technical Order (AFTO) 781 series forms were reviewed for accuracy and completeness (Tab DD-8). This information, along with the information gained from Integrated Maintenance Data System (IMDS), was used to evaluate the overall mechanical condition of the aircraft (Tab DD-8). The AFTO Form 781A, AFTO Form 781H, AFTO Form 781J, AFTO Form 781K, and all documented maintenance were reviewed with only minor documentation discrepancies noted (Tab DD-8).

There was one annotated repeating pilot reported discrepancy (Tab DD-8). On 10 July 2023, the pilot reported "co-pilot's microphone hot mics after keying switch" (Tab DD-8). Maintenance repaired the discrepancy by cleaning copilot's mic switch, operational check was good (Tab DD-8). On the second sortie for the MA on 10 July 2023, the pilot reported "co-pilot cyclic mic switch sticks in the first detent, stays hot mic" (Tab DD-8). Maintenance repaired the discrepancy after finding a spring clip wedged in switch causing hot mic, adjusted clip, and operational check good (Tab DD-8). There were no further reports of the discrepancy after final repair (Tab DD-8). There is no evidence that suggest this repeat discrepancy was a factor in the mishap (Tab DD-8).

There was one annotated recurring pilot reported maintenance discrepancy (Tab DD-8). On 25 July 2023, the pilot reported a "collective stiff" discrepancy (Tab DD-8). Maintenance repaired the discrepancy by adjusting the collective friction shoes (Tab DD-8). On 27 July 2023, the pilot

reported a "collective stiff/ratchetty" discrepancy (Tab DD-8). Maintenance corrected the discrepancy by replacing the collective friction shoes and performing collective friction adjustment and collective pull test (Tab DD-9). There were no further reports of the discrepancy after the final repair (Tab DD-9). There is no evidence that suggest this recurring discrepancy was a factor in the mishap (Tab DD-9).

b. Inspections

There was one pre-flight (PR) and seven thru-flight (TH) inspections accomplished prior to the mishap (Tab DD-9). All Thru-flight inspections were accomplished within the allotted 72-hour window (Tab DD-9).

Prior to the MS, there were two (2) scheduled inspections accomplished:

- 25-hour Wave Relay Tactical Assault Kit (WaRTAK) inspection due IAW AFGSC modification 17-047, part 9 (Tab DD-9). Maintenance complied by conducting a visual inspection which noted no defects (Tab DD-9).
- 25-hour visual inspection of main rotor hub grip and blades due IAW 1H-1(U)N-6 (Tab DD-9). Maintenance complied by conducting visual inspection which noted no defects (Tab DD-9).

Aircraft phase inspections for the UH-1N are completed on a 400-hour cycle (Tab DD-9). The last phase (#2) for the MA was 145.4 flight hours prior to the mishap (Tab DD-9). The next scheduled phase inspection was due in 254.6 hours (Tab DD-9).

All maintenance members were fully qualified and appropriate maintenance inspections were being performed and satisfactorily completed (Tab DD-9). There is no evidence to suggest the inspections were factors in the mishap (Tab DD-9).

c. Maintenance Procedures

Maintenance personnel reported the following discrepancies during PR, basic post-flight (BPO), and TH inspections for the MA from 3 through 30 August 2023 (Tab DD-9). There is no evidence that maintenance discoveries prior to flight contributed to the mishap (Tab DD-9).

There were two (2) open discrepancies and one (1) open Informational Note in the Form 781As. The first was an Air Force Safety one time inspection (OTI) to update Management Information Systems (MIS) to current requirements (Tab DD-9). Second, the left-hand and right-hand crew doors were removed for flight at request of MC (Tab DD-9). Prior to MS on 30 August 2023, the MA was cocked at 2330 on 29 August 2023 by non-MC aircrew with maintenance cleared to refuel, reconfigure, and conduct TH inspection before MS (Tab DD-9).

There were seven (7) delayed discrepancies (Tab DD-9). The delayed discrepancies consisted of the following:

- The chip detector caution panel momentarily illuminated when turning the landing light off (Tab DD-9). Maintenance was awaiting information from Minot AFB on fixing issue (Tab DD-9). The discrepancy was also awaiting Warner Robins Air Logistic Complex

(WR-ALC) "107" (technical assistance request to engineering) evaluation team action (Tab DD-9).

- The main and auxiliary fuel tank close circuit receiver would not stay latched and the discrepancy tracker states "Do not close circuit refuel" (Tab DD-9). Maintenance was awaiting parts to correct the discrepancy (Tab DD-9).
- The vertical fin door was cracked on lower center leading edge (Tab DD-10). Maintenance was awaiting ordered parts to correct the discrepancy (Tab DD-10).
- "Multi memory" resets on IDAR system (Tab DD-10). Maintenance was awaiting parts to correct discrepancy (Tab DD-10).
- The MA was due for overhaul replacement of the reduction gearbox (over-flyable to 20,224.9 aircraft hours) (Tab DD-10). Maintenance was awaiting parts to correct discrepancy (Tab DD-10).
- OTI for part number NAS1304 bolts produced by Mac Fasteners (part number 01D0MNFD) (Tab DD-10). No maintenance action noted (Tab DD-10).
- The right-hand scoop cowling brace over the CGB was cracked (Tab DD-10). No maintenance action noted (Tab DD-10).

There is no evidence the noted discrepancies contributed to the mishap (Tab DD-10).

d. Maintenance Personnel and Supervision

A thorough review of the MA forms and maintenance members' training records was performed (Tab DD-10). All maintenance members were fully qualified and appropriate maintenance actions were being performed (Tab DD-10).

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

The Air Force Petroleum Laboratory at Wright-Patterson AFB, Ohio conducted post-mishap fluid analysis of samples from the main fuel tanks, engines, hydraulics, and reduction (or combining), intermediate (42-degree), and tail rotor (90-degree) gearboxes (Tab DD-10). No discrepancies were noted (Tab DD-10). There is no evidence to suggest oils, hydraulics or fuels were factors in this mishap (Tab DD-10).

f. Unscheduled Maintenance

A thorough review of all maintenance activities on the MA from 2 May 2023 through 30 August 2023 was performed (Tab DD-10). The MA flew 97 sorties, totaling 145.4 flight hours from 8 May 2023 through 30 August 2023 (Tab DD-10). There were 445 completed scheduled maintenance, unscheduled maintenance, and configuration changes accomplished from 23 May 2023 through 30 August 2023 (Tab DD-10). There is no evidence that unscheduled maintenance, scheduled maintenance or configuration changes contributed to the mishap (Tab DD-10).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

Post-crash structural inspection was performed after the MA had been removed from the airfield (Tab H-4). The MA was flipped right side up and transported to a hangar and stabilized (Tabs H-4 and Tab Z-3).

Both the right-hand and left-hand skids were separated from the MA (Tab H-4). The left-hand skid was found attached to the forward and aft cross tubes, which had been fractured immediately above the saddle mounts (Tab H-4). The right-hand skid was found with the forward cross-tube saddle mount sheared off and no attached forward cross tube, as well as the aft saddle mount and attached aft cross tube which had been fractured just above the saddle (Tab H-4).

Remaining parts of the forward and aft cross tubes were found in place under the MA fuselage (Tab H-4). Both the aft cross tubes were found fractured approximately at the aircraft outer mold line (OML) (Tab H-4). The forward cross tube was found fractured on the left-hand side at the aircraft OML and fractured on the right-hand side just outboard of the bearing support under the butt-line (BL) 14 beam (Tab H-4). Total rotation of the aft cross tube was found to be approximately 90-degrees counterclockwise when viewed from the left-hand side (Tab H-4). Rotation of the forward cross-tube was found to be approximately 45-degrees counterclockwise when viewed from the left (Tab H-4). Significant amounts of grass and dirt were found forward of the right side of the aft cross-tube, supporting a primary aft right-hand side landing impact (Tab H-4).

(1) Right Rear Cross-Tube Damage

Figure 6-1 (Tab H-5)
Right Rear Cross Tube Damage

Crippling of the underside skin just forward of the tail boom to fuselage interface was noted with a 2.5” deep ripple on the left-hand side, and 3.0” depth on the right-hand side (Tab H-5). No dirt, grass, or witness marks were noted on the underside skin near the tail boom/fuselage interface (Tab H-5). The upper-right fuselage side tail boom attach fitting was found pulled through the aft fuselage bulkhead (Tab H-5). No other fuselage side tail boom attach fittings were found pulled or pushed through (Tab H-5). Crippling of the underside skin, along with the pull through of the upper-right fitting indicates a downward vertical acceleration event (Tab H-5).

(2) Fuselage Underside Damage

Witness marks primarily in the fore-aft direction were found on the right underside skin between forward and aft cross-tubes (Tab H-5). Additional witness marks running fore-aft were also noted under the copilot door (Tab H-5). Significant crumpling of the lower copilot door and skin was overserved with large amounts of grass and dirt (Tab H-5). Underside wire strike does not show any accumulation of grass or dirt (Tab H-5).

Figure 6-2 (Tab H-5)
Fuselage Underside Damage

(3) Fuselage Front Right Damage

Figure 6-3 (Tab H-6)
Fuselage Front Right Damage

The tailfin and aft section of the tail boom from boom station (BS) 194 aft were separated from aircraft during the landing (Tab H-6). The tail boom skid was bent at a 45-degree angle towards the top of the aircraft with much of the forward paint being scratched (Tab H-6). Fittings that attach the tail boom skid to the aft side of the tailfin to tail boom canted bulkhead were dislodged with all fasteners sheared (Tab H-6). A hole in the right-hand side tail boom skin between BS 194 and the aft canted bulkhead was found with the surrounding metal pushed outboard (Tab H-6).

(4) Right Side Tailfin Damage

The tail rotor blade assembly was no longer attached to the tail rotor (Tab H-7). Fore-aft witness marks and impacted structure were discovered on the forward right underside of the separated tail boom and tailfin section (Tab H-7). On top of the tail boom and tailfin section opposite of the impacting, the upper part of the BS 194 bulkhead was completely crushed, indicating a primarily vertical impact with the tail rotor driveshaft (Tab H-7). The driveshaft in this section was not connected to the 42-degree gearbox (Tab H-7). On the aft-most tail boom

Figure 6-4 (Tab H-7)
Right Side Tailfin Damage

section still connected to fuselage, there was a matching impact area on the right-hand underside with fore-aft witness marks at the fracture plane (Tab H-7). Like the separated aft tail boom/tailfin section, the matching side on the fuselage connected tail boom, had the upper portion crushed from impact with the tail rotor driveshaft (Tab H-7). The elevator was discovered with the outboard half of the left portion separated during the mishap (Tab H-7).

b. Evaluation and Analysis

The MA vertical velocity prior to impact was estimated to be -16 feet per second (Tab H-16). The horizontal velocity prior to impact was 60 knots (Tab H-16). The conditions of the impact exceeded the ultimate design criteria for the aircraft cross-tubes (Tab H-16).

This UH-1N was built with a crashworthy fuel system (Tab H-16). There were no indications of fuel leaks at the mishap site (Tab H-14). Multiple access panels around the fuselage were not present upon investigator arrival to the hangar (Tab H-16). The fuel bladders were fully intact (Tab H-16). There was no compromised breakaway, self-sealing fittings (Tab H-16). There was no fuselage structure impingement on any of the fuel lines (Tab H-16).

7. WEATHER

a. Forecast Weather

Forecast weather on the morning of 30 August 2023 was clear skies and unlimited visibility, with winds from 230-degrees at 15 knots gusting to 25 knots (Tab F-3). At the time of the mishap, the temperature was 26 degrees Celsius rising to 28 degrees Celsius (Tab F-3). The altimeter setting and pressure altitude were forecasted to between 30.18 to 30.14 and 5,933 feet to 5,968 feet, respectively (Tab F-3).

b. Observed Weather

The winds were not consistent with the morning forecast (Tab N-3 to N-4). At the beginning of the mishap pattern, the tower called the winds 180-degrees at 10 knots (Tab N-3), and again relayed winds 180-degrees at 11 knots prior to mishap events (Tab N-4).

c. Operations

IAW AFMAN 11-2UH-1NV3, the weather on the day of the mishap was within prescribed operational limits (Tabs N-5 and BB-138). There is no evidence to suggest either forecast or observed weather were a factor in the mishap (Tabs R-38, N-5, and BB-138).

8. CREW QUALIFICATIONS

a. MIP

MIP was a current and qualified Instructor Pilot (IP) with a total of 4107.1 hours, 3976.1 of which was in a rotary wing aircraft (Tabs G-62 and T-247). MIP had 1263.5 hours as an instructor/evaluator on rotary wing aircraft (Tabs G-62 and Tab T-247).

MIP was contracted to perform functional check flights (FCFs) with 37 HS in accordance with T.O. 1H-1(U)N-6CF-1, T.O. 1H-1(U)N-6CL-1, and MH-139 specific technical orders (Tabs G-69, V-1.3, and BB- 340 to BB-341). The contract and the performance work statement are silent as to the scope of contracted FCF pilot duties on EP sorties (Tabs V-4.3 and BB-340 to BB-341).

Recent flight time is as follows (Tab G-62):

	Hours	Sorties
30 days	2.6	3
60 days	13.0	11
90 days	21.8	22

b. MP

MP was a non-current, qualified IP with a total of 1529 hours, 1447.3 of which were in a UH-1N (Tab G-13 to G-14). MP was non-current due to a medical procedure requiring 90 days recovery before flying again (Tabs R-37 and X-3). The MS was the MP's recurrency flight (Tab K-3 to K-4).

Recent flight time is as follows (G-13):

	Hours	Sorties
30 days	0	0
60 days	0	0
90 days	0	0

c. MFE

MFE was a current and qualified flight engineer with a total of 446.3 hours, 419.7 of which was in a UH-1N (Tab G-105 to G-106).

Recent flight time is as follows (Tab G-105):

	Hours	Sorties
30 days	13.2	7
60 days	30.8	15
90 days	46.0	24

9. MEDICAL

a. Qualifications

At the time of the mishap, all members of the MC had current annual physical examinations and were medically qualified for flight duty (Tab X-3 to X-4). MP and MFE were qualified in accordance with Department of the Air Force Manual (DAFMAN) 48-123*, Medical Examinations and Standards,* dated 8 December 2020*,* and AFI 48-170*, Periodic Health Assessment,* dated 7 Oct 2020 (Tabs X-3 to X-4, BB-148, and BB-151). MP had recently been returned to flight status after corneal refractive surgery in May 2023, for which he met the requirements in Aerospace Medicine Waiver Guide, dated November 2020 (Tabs X-3 and BB-154 to BB-155). MIP was qualified in

accordance with Title 14 of the Code of Federal Regulations, part 67, section 67.4 (Tab X-4).

b. Health

A review of all available medical records as well as the written histories documenting the 72-hour and 7-day time periods prior to the mishap indicated all MC members were medically qualified for duty (Tab X-4). Additionally, all mishap maintainers submitted 72-hour and 14-day histories (Tab X-4 to X-6). MP and MFE were evaluated at a local emergency room (Tab X-6). MP sustained an abrasion to the left forehead, minor neck pain and minor back pain (Tab X-6). A computerized tomography (CT) of MP's head and neck were normal (Tab X-6). MFE sustained an abrasion to the chest wall, an abrasion to the thigh, and a thumb injury (Tab X-6). These were evaluated with imaging with normal findings (Tab X-6). Medical records for MIP were not available due to restrictions on requesting medical records for civilian aviators (Tab X-6).

There is no evidence to suggest that any medical condition, unusual habits, abnormal behavior or significant stressors on the part of the MC or mishap maintainers were a factor in the mishap (Tab X-3 to X-6).

c. Toxicology

On 30 Aug 2023, post-mishap urine and blood specimens were obtained from the MC (Tab X-6). All specimens were sent for examination to the Armed Forces Medical Examiner System, Dover AFB, Delaware for toxicological analysis (Tab X-6). The blood specimens were tested for the presence of carbon monoxide and ethanol (Tab X-6). The urine specimens were screened for amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates, and phencyclidine (Tab X-6). There were no abnormalities, ethanol, illicit drugs, or toxins found in the blood and urine samples taken from the MC (Tab X-6).

d. Lifestyle

Testimony from the MC and all mishap maintainers, as well as a review of the 72-hour and 7-day histories, revealed no evidence to suggest lifestyle factors were a factor in the mishap (Tabs R-30, R-36, R-41, and X-4 to X-6).

e. Crew Rest and Crew Duty Time

AFMAN 11-202, Volume 3, *Flight Operations*, dated 10 January 2022, and the 582 HG Operating Instruction, dated 10 June 2022, requires aircrew members have proper crew rest prior to performing flight duties (Tab BB-100 and BB-158). Normal crew rest is defined as a minimum 12-hour non-duty period before the designated flight duty period begins (Tabs BB-158 and BB-186). During this time, an aircrew member may participate in meals, transportation or rest, as long as they have the opportunity for at least eight hours of uninterrupted sleep (Tab X-4).

There was no evidence to suggest that fatigue, crew rest or crew duty time were factors in the mishap (Tab X-4).

10. OPERATIONS AND SUPERVISION

a. Operations

The 37 HS provides helicopter security response for the 90 MW area of operations (Tab CC-12). The unit is located at F.E. Warren AFB (Tab CC-12). The squadron's current operations tempo is high due to the rate they get tasked and because they have a large amount of aircrew to keep current (Tab V-7.6). 37 HS uses contracted FCF pilots one to two times per week to conduct EP sorties (Tab V-5.5). The experience levels of the MIP and MP were high, both pilots were qualified instructors and very experienced (Tabs G-10 to G-12, G-60 to G-61, and V-5.3). There is no evidence to suggest operations tempo was a factor in the mishap (Tab V-7.6).

b. Supervision

Members of the squadron leadership team were involved in the planning process and in assessing the ORM for the MS (Tabs K-9 and V-5.3). Squadron leadership had no concerns about the composition of the MC (Tab V-5.3 and V-7.3). The MC was appropriately briefed on weather conditions and pertinent information (Tabs F-3, K-9, K-29, and K-31 to K-37). All appropriate "go/no-go" verifications and risk assessments were authenticated prior to the MS (Tab K-3 to K-10). There is no evidence to suggest supervision was a factor in the mishap.

11. HUMAN FACTORS ANALYSIS

a. Introduction

The Department of Defense Human Factors Analysis and Classification System (DoD-HFACS) is a systematic and comprehensive tool that is comprised of a list of potential human factors that can be contributory or causal to a mishap (Tab BB-4). DoD-HFACS helps investigators perform a more complete investigation, classify particular actions (or inactions) that sustained the mishap sequence, and contribute to a safety database as a repository for detecting mishap trends and preventing future mishaps (Tab BB-4). The DoD-HFACS classification system divides the failures into active failures and latent failures. (Tab BB-4 and BB-11 to BB-21). DoD-HFACS classification taxonomy describes four main tiers of human factors including Acts, Preconditions, Supervision, and Organizational Influences, which are briefly described below:

1. *Unsafe Acts* are those factors that are most closely tied to the mishap and can be described as active failures or actions committed by the operator that result in human error or unsafe situation. (Tab BB-7)

2. *Preconditions* are evidence supported conditions in a mishap if active and/or latent conditions of the individual, the operating environment, or team communications affect the performance or actions of the mishap individual and result in human error or an unsafe situation. (Tab BB-11)

3. *Supervision* is a factor in a mishap if the methods, decisions, or policies of the supervisory chain of command directly affect practices, conditions, or actions of individuals and this result in human error or an unsafe situation. (Tab BB-21)

4. *Organizational Influences* are factors in a mishap if the communications, actions, omissions or policies of upper-level management directly or indirectly affect supervisory practices, conditions or actions of the operator(s) and result in system failure, human error or an unsafe situation. (Tab BB-26)

b. DOD-HFACS Present

1. **AE201 Inadequate Real-Time Risk Assessment:** Inadequate Real Time Risk Assessment is defined as when the mishap individual, through inexperience, faulty logic, poor judgment, or insufficient information, selected or proceeded with the wrong course of action based on an ineffective real-time assessment of immediate hazards during execution of a task/mission/activity, which resulted in the near-miss or mishap (Tab BB-9).

(a) PC102 Fixation (Channelized Attention). Fixation is a precondition when the individual focused all conscious attention on a limited number of environmental cues to the exclusion of others, which resulted in a hazardous condition or unsafe act (Tab BB-11). This may be described as a tight focus of attention that led to the exclusion of comprehensive situational information (Tab BB-11).

(b) PC206 Overconfidence. When the individual unreasonably overvalued or overestimated his or her own capability, the capability of others or the capability of aircraft/vehicle/vessel or equipment, which resulted in hazardous conditions or unsafe act (Tab BB-13). For this to be selected, there must be strong evidence the individual acted in a manner inconsistent with the "reasonable person concept" (this individual's overestimation is above and beyond what a reasonable person in a similar situation would have been expected to do) (Tab BB-13).

(c) PC103 Task Saturation. Task Saturation is when the quantity of information an individual was processing exceeded his or her mental resources in the amount of time available and resulted in a hazardous condition or unsafe act. In other words, there is simply too much to accomplish with not enough time or resources (Tab BB-11).

2. **AE104 Overcontrolled/Undercontrolled Aircraft.** Overcontrolled/undercontrolled aircraft is a factor when the mishap individual(s) inappropriately reacted to conditions by either over- or under-controlling the aircraft/vehicle/vessel/system, which resulted in the near-miss or mishap (Tab BB-8).

(a) PT103 Lack of Currency**.** When an individual's familiarity with a specific task or process was either not current or was limited by infrequent or rare performance of the task to permit safe execution, which resulted in a hazardous condition or unsafe act. The mishap individual was once trained to proficiency to operate a specific system or perform a process but has not done so in many months or years (Tab BB-20).

(b) PC103 Task Saturation. Task Saturation is when the quantity of information an

individual was processing exceeded his or her mental resources in the amount of time available and resulted in a hazardous condition or unsafe act. In other words, there is simply too much to accomplish with not enough time or resources (Tab BB-11).

3. **AE105 Breakdown in Instrument Cross-Check.** Breakdown in Instrument Cross-heck is when the mishap individual did not effectively execute learned/practiced internal or external visual scan patterns, which resulted in the near-miss or mishap (Tab BB-8). There error results from one or more preconditions and/or supervisory influence and/or ineffective training (Tab BB-8).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publicly Available Directives and Publications Relevant to the Mishap

(1) AFI 51-307, *Aerospace and Ground Accident Investigations*, 18 March 2019, incorporating administrative changes as of 3 February 2023.
(2) Department of the Air Force Instruction 91-204, *Safety Investigation and Reports*, 10 March 2021.
(3) AFMAN 11-202V1, *Aircrew Training*, 27 September 2019.
(4) AFMAN 11-202V3, *Flight Operations*, 10 January 2022.
(5) AFMAN 11-2UH-1NV1, *UH-1N Helicopter Aircrew Training*, 9 January 2023.
(6) AFMAN 11-2UH-1NV2, *UH-1N Aircrew Evaluation Criteria*, 24 March 2023.
(7) AFMAN 11-2UH-1NV3, *UH-1N Helicopter Operations Procedures*, 3 April 2020, *Incorporating Change 2*, 6 December 2022.
(8) AFMAN 11-2UH-1NV3CL-1, *UH-1N Crew Briefing Guides/Checklists*, 18 May 2022.
(9) AFMAN 11-2UH-1NV3_AFGSCSUP, *UH-1N Helicopter Operations Procedures*, 3 November 2022.
(10) AFI 11-418, *Operations Supervision*, 22 December 2021, *Incorporating Change 1*, 3 August 2023.
(11) DAFMAN 48-123, *Medical Examinations and Standards*, 7 December 2020.
(12) AFI 48-170, *Periodic Health Assessment*, 7 October 2020.
(13) DAFMAN 11-401_DAFGM2023-02, *Aviation Management*, 14 June 2023.

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

b. Other Directives and Publications

(1) DoD Human Factors Analysis and Classification System, Version 8.0, 25 May 2022.
(2) Technical Order (TO) 1H-1(U)N-1, *Flight Manual USAF Series UH-1N Helicopter*, 15 December 2017, incorporating Change 12, 15 April 2023.
(3) UH-1N Ready Aircrew Program (RAP) Tasking Memorandum (RTM), Aviation Schedule (AS-23), effective 8 May 2023, Change 2.
(4) AFTTP 3-3.H-1, (U) *Combat Fundamentals H-1*, 4 August 2023.

(5) TO 33-1-37-3, *Technical Manual Joint Oil Analysis Program Manual, Volume 3 – Laboratory Analytical Methodology and Equipment Criteria (Aeronautical)*, 30 April 2018, incorporating Change 3, 15 June 2022.
(6) TO 42B2-1-3, *Technical Manual General – Fluids for Hydraulic Equipment*, 1 December 2019.
(7) Training Circular (TC) 3-04.4, Department of the Army, *Fundamentals of Flight*, 5 July 2022.
(8) 582d Helicopter Group, *Operating Instruction*, 10 June 2022, *Incorporating Change 2*, 27 April 2023, and Correction, 5 May 2023.
(9) 582d Helicopter Group UH-1N Ops Limits, current as of 27 April 2023.
(10) 37th Helicopter Squadron, *Operating Instruction*, 25 January 2023.
(11) United States Air Force Aerospace Medicine Waiver Guide Compendium, 21 September 2023.
(12) FAA-H-8083, *Helicopter Flying Handbook 2019*, Federal Aviation Administration

c. Known or Suspected Deviations from Directives or Publications

(1) AFMAN 11-2UH-1NV3, paragraph 6.7.

(a) The AFMAN states the aircrew will terminate autorotations and initiate a power recovery at the first indication of excessive sink rate (Tab BB-137). The MC failed to terminate the autorotation and initiate a power recovery at the first indication of an excessive sink rate, which is contrary to paragraph 6.7.1 (Tabs N-3 and Tab BB-137).

(b) The MC failed to maneuver the MA to ensure they were wings level, with a minimum of 60 KIAS, with rotor RPMs within limits, and aligned within 30-degrees of the landing heading before descending below 150 feet AGL, which is contrary to paragraph 6.7.5. (Tabs BB-138 and DD-12 to DD-13). Since they were not within these parameters at 150 feet AGL, guidance states they will immediately initiate a power recovery, which they failed to do (Tabs BB-138 and DD-12).

[redacted]

21 October 2024

ADAM C. RUDOLPHI, Colonel, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

UH-1N, T/N 69-6666
CHEYENNE REGIONAL AIRPORT (KCYS), CHEYENNE, WYOMING
30 AUGUST 2023

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.

I find, by the preponderance of the evidence, the mishap was caused by the Mishap Instructor Pilot's (MIP) failure to recognize the need to execute a power recovery in a timely manner. There were two factors that substantially contributed to the mishap. First, the Mishap Pilot's (MP) flight control manipulation when entering the 180-degree autorotation, which resulted in a high sink rate. Second, the Mishap Crew (MC) failed to correctly execute a power recovery once directed by the MP.

1. OPINION SUMMARY

The Accident Investigation Board (AIB) used a combination of witness interviews, consultation with experts, results of technical analyses, simulator analysis, examination of relevant documents, and inspection of the wreckage to reach a conclusion. The AIB studied the complete training and personnel records of all personnel directly involved in the mishap. The AIB reviewed the Mishap Aircraft's (MA) maintenance records, with a particular focus on flight controls, power plant and power train. Review of technical analyses included an engineering analysis of component crashworthiness and technical analysis of MA fluids. The AIB reviewed the complete medical histories, toxicology test results, and explored the roles of Human Factors, such as overconfidence and channelized attention.

2. CAUSE

After initiating the practice 180-degree autorotation, the MP's flight control inputs caused the aircraft to sink at an excessive rate. The MIP made a descriptive call to the MP as the MA descended through 680 feet above ground level (AGL) to "watch your nose down." The integrated data acquisition recorder (IDAR) records the MA having between a 20- and 25- degree nose low attitude when descending though 700 feet AGL to 400 feet AGL. During my interview with the MIP, the MIP stated the reason he made the call was because he was "looking straight down at the runway[.]" The MC had the opportunity to terminate the maneuver before it progressed but relied on an overconfident assessment of MP's ability to fix the attitude despite the rapidly decreasing timeframe. However, MIP was ultimately responsible for the MA and the mission. MIP did not take action until after the "go around" call was initiated, drastically reducing his window in which effective actions would be taken. During the simulator recreations of the MS, when the sim crew initiated a power recovery with a nearly 30-degree nose low attitude at approximately 500 feet AGL, they achieved a successful power recovery above 300 feet AGL. Had the MIP made the directive

call to execute a power recovery instead of the descriptive call for the MP to watch the nose low attitude, the mishap would have been averted.

a. SUBSTANTIALLY CONTRIBUTING FACTORS

The following factors substantially contributed to the mishap:

b. MP's Flight Control Inputs Resulted in an Excessive Sink Rate

The AFTTP 3-3.H-1 states a normal sink rate is less than 3000 feet per minute (FPM) during a practice 180-degree autorotation. During a demo sortie at KCYS, the highest sink rate observed on a nominal 180- degree autorotation was 3000 feet AGL with an average sink rate of around 2500 FPM observed throughout the maneuver. The MA's IDAR records the sink rate during the MM at as high as 5200 FPM, with an average value of 4185 FPM from 500 feet AGL to the time the MA descended through 100 feet AGL.

By way of comparison, a 3000 FPM sink rate at 500 feet AGL results in a 10 second window where, if nothing is corrected, the MA will impact the ground. A 4200 FPM sink rate only gives a crew 7.1 seconds before impact. Since there were only 10 seconds from time the MIP announced, "Watch your nose down," to ground impact, this disparity in reaction time eliminated 30% of the MC's decision space. The high sink rate observed is the result of the nose low attitude combined with the aircraft being out of trim (uncoordinated flight) for the majority of the mishap sequence.

Data taken from the IDAR denotes the MP failed to maintain coordinated flight from maneuver initiation through 100 feet AGL. During simulator recreations, the only way the sim crew was able to achieve a sink rate similar to that of the MA, was to maneuver the simulator out of trim and pitch the simulator 20- to 25-degrees nose low. The high sink rate generated by the MP's flight control inputs drastically decreased the time available for the MIP to make a corrective action. Furthermore, the excessive nose low attitude of the MA caused the MIP to channelize his attention on the ground rather than have a composite crosscheck of all flight parameters.

I find, by the preponderance of the evidence, by considering cockpit voice recorder (CVR) data, IDAR data, MC statements, simulator recreation, and demo sortie data the excessive sink rate generated by the MP's flight control inputs substantially contributed to the mishap.

c. MC's Failure to Correctly Execute a Power Recovery once directed by the MP

As the MA descended through 200 feet AGL, the MP directed a "go-around" (point 1 on figure X). Although there is no 3-way verbal change of aircraft control recorded on the CVR, the MP and MIP stated that at this point of the mishap sequence, the MIP took the flight controls from the MP (of note, the Mission Flight Engineer (MFE) was not aware of a change of flight controls, according to his sworn statement). In accordance with (IAW) the AFTTP 3-3.H-1, the correct call to terminate the autorotation should have been "power recovery" instead of "go around." However, all three crew members stated at this point in the mishap sequence, they understood the MC was executing a power recovery. Based on when the MC initiated the power recovery, three steps needed to be accomplished.

1. Aft cyclic needed to be applied to flare the aircraft enough to nullify the sink rate and transfer the kinetic energy of the sink rate into potential energy that increases the rotor speed.

2. The throttles needed to be rolled full open immediately to increase rotor speed.

3. The collective needed to be applied as necessary to manage rotor speed. Too much collective results in an Nr decay, while too little collective results in an Nr overspeed.

Instead, the MC continuously increased collective pitch (denoted by steep slope starting at point 2 on figure 1-1), failed to apply sufficient aft cyclic, and delayed rolling the throttles to full open (denoted by increase in engine RPM at point 4 on figure 1-1). Ultimately, these control inputs resulted in a sharp decrease in Rotor (Nr) (denoted by sharp negative slope starting at point 3 on figure x). The sharp decrease in Nr was due to the continuous collective increase combined with lack of opening the throttle, all without a substantial reduction to the sink rate because there was insufficient aft cyclic to bring the MA's nose up. During simulator recreations of the mishap sequence, arresting the sink rate required a nose-pitch up angle of 15- to 20-degrees. The MC's maximum pitch up attitude during the mishap sequence was 10-degrees. The sim crew was able to recover the maneuver within normal practice 180 autorotation parameters (i.e., greater than 5 feet AGL) the majority of the time when they used a 15- to 20-degree nose pitch up attitude. Had the MC applied sufficient aft cyclic, opened the throttle and applied appropriate collective inputs to keep the rotor above 91% Nr (the -1 limit of rotor speed during a practice autorotation), it is likely the aircraft would have either not touched down, or touched down with a structurally acceptable sink rate.

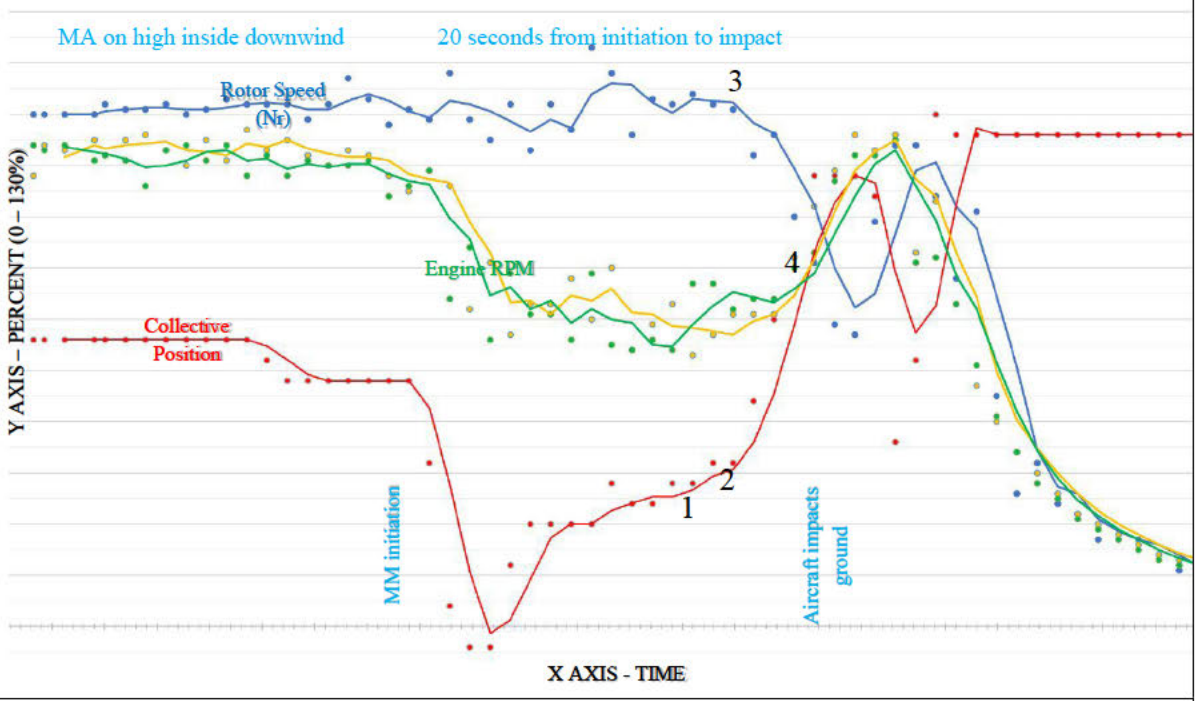

Figure 1-1 (Tab DD-1.2)
MS IDAR Data

I find, by a preponderance of the evidence, by considering CVR data, IDAR data, MC statements, simulator recreation, and demo flight that failure to correctly execute a power recovery once directed by the MP substantially contributed to the mishap.

3. CONCLUSION

I find, by the preponderance of the evidence, the mishap was caused by the MIP's failure to recognize the need to execute a power recovery in a timely manner. There were two factors that substantially contributed to the mishap. First, the MP's flight control manipulation when entering the 180-degree autorotation, which resulted in a high sink rate. Second, the MC failed to correctly execute a power recovery once directed by the MP.

[redacted]

21 October 2024

ADAM C. RUDOLPHI, Colonel, USAF
President, Accident Investigation Board

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